FERULA ASSA-FOETIDA AS A MAIN MEDICAL PLANT IN EAST OF IRAN (HARVESTING, MAIN CHARACTERISTICS AND ECONOMICAL IMPORTANCE)

Farhood Golmohammadi[1]

[1]Assistant Professor, Department of Agricultural Extension and Education, Islamic Azad University– Birjand Branch – Birjand. IRAN.

E-mail: farhood.gol@gmail.com

Received: 26.09.16
Accepted: 09.10.16

ABSTRACT

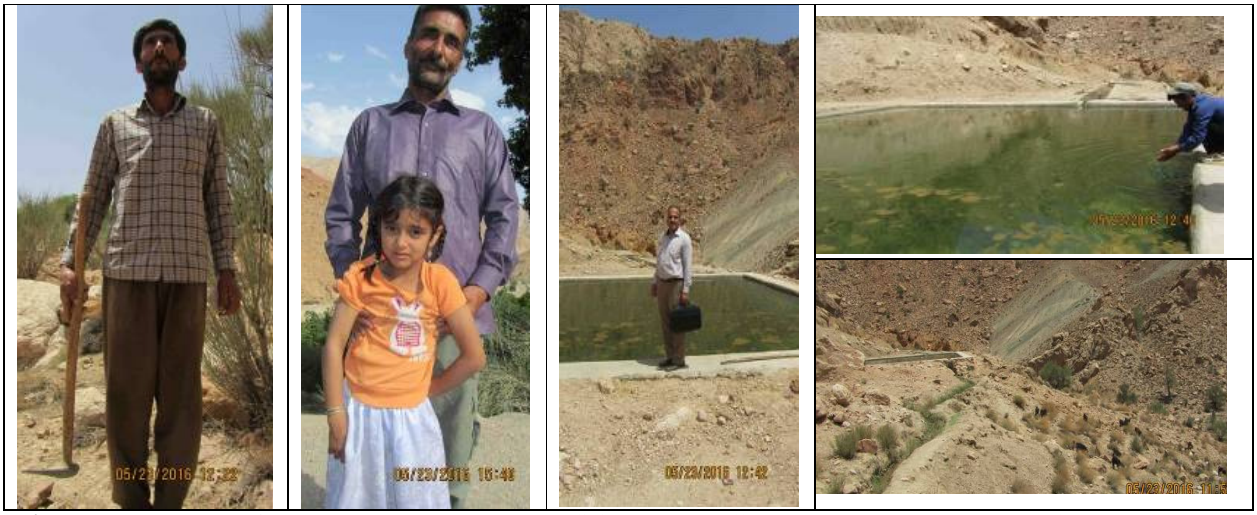
Many people in Mediterranean region who consult with spiritual healers, homeopaths and herbalists are utilizing traditional therapies. These are the first choice for problems such as liver diseases, inflammation, skin diseases, infertility, impotence, diabetes, obesity, epilepsy, psychosomatic troubles, and many other diseases. The demand for medicinal plants has increased globally due to the resurgence of interest in and acceptance of herbal medicine. Most of the demand is being met through collection of large quantities of medicinal plants and plant parts from wild populations. The methods of extraction employed are almost invariably crude and unsystematic. As a consequence, the rates of exploitation may exceed those of local natural regeneration. *Ferula assa-foetida* L. (Apiaceae) is a medicinal plant indigenous to Iran and Afghanistan. This plant is one of the most important among the thirty species of *Ferula* distributed in Iran. It is an herbaceous and perennial plant that grows up to 2 m high. One part used is an oleo-gum resin, called asa-foetida or Anghoze in Persian, obtained by incision from the roots. It has been reported in Iranian folk medicine to be antispasmodic, aromatic, carminative, digestive, expectorant, laxative, sedative, nerving, analgesic, anthelmintic, aphrodisiac and antiseptic. Iran is one of the most important producers of this plant in the world. Also *Ferula* is one of the most important endangered medicinal plants, which is rare in nature due to poor seed germination. In this article author introduce his field, qualitative and participatory study on harvesting, main characteristics and economical importance of this valuable medicinal plant in South-Khorasan province, east of Iran as a major producer and exporter.

***Key words*:** Ferula, harvesting, medical plant, economic, Iran.

Medicinal plants are an important element of medical system. These resources are usually regarded as part of cultural traditional knowledge (Golmohammadi, 2013).

The genus Ferula belongs to Umbelliferae family consists of 140 species which are widespread from Mediterranean region to central Asia. Ferula assa-foetida L. is one of the most important species of this genus that is native to Iran and Afghanistan,and commonly known as asafoetida. It is herbaceous, monoecious and perennial plant that grows up to 2m height, and is in two types, bitter and sweet (Iranshahy and Iranshahi, 2011).
Ferula assa-foetida L. (Apiaceae) is a medicinal plant indigenous to Iran and Afghanistan. This plant is one of the most important among the thirty species of *Ferula* distributed in Iran. It is an herbaceous and perennial plant that grows up to 2 m high. One part used is an oleo-gum resin, called asa-foetida or anghouzeh in Persian, obtained by incision from the roots. It has been reported in Iranian folk medicine to be antispasmodic, aromatic, carminative, digestive, expectorant, laxative, sedative, nervine, analgesic, anthelmintic, aphrodisiac and antiseptic.

Asafoetida's English and scientific name is derived from the Persian word for resin (*asa*) and Latin *foetida*, which refers to its strong sulfurous odour. Its pungent odour has resulted in its being called by many unpleasant names; thus in French it is known (among other names) as *merde du diable* (devil's faeces); in some dialects of English, too, it was known as *devil's dung*, and equivalent names can be found in most Germanic languages (e.g. German *Teufelsdreck*, Swedish *dyvelsträck*, Dutch *duivelsdrek*, Afrikaans *duiwelsdrek*), also in Finnish *pirunpaska* or *pirunpihka*. In Turkish, it is known as *şeytantersi* (devil's sweat), *şeytan boku* (devil's shit) or *şeytanotu* (the devil's herb) (HASSANI et al., 2009).
Medicinal plant collectors are usually poor villagers. Plant collection is their part time activity besides farming and live stock keeping (Hamayun et al., 2003).
This situation also has been seeing in plant collectors that are usually poor villagers and medicinal plant collection is their part time activity besides farming and livestock keeping in villages of South Khorasan province (Figures 1, 2, 3, 4 & 5).



Figures 1, 2, 3, 4 & 5: Author presence among medicinal plant collectors that are usually poor villagers and plant collection is their part time activity besides farming and herds keeping. Sorond village of Tabas City, 300 km. distance to Birjand, centre of South Khorasan province (May 23, 2016).

Table 1: Names of Ferula assa Foetida in different languages

Persian	English	French	German	Hindi	Arabic	Botanical name	Family
Anghose	Stinking assa	Stinkender assand	Teufels treck stinkender assand	Hing, Hingra	Zallouh	Ferula assa – foetida	Apiaceae

(Golmohammadi, 2013).

Table 2: Some of the meteorology, geology and botanical information of growth regions of Ferula assa Foetida in South Khorasan province

Average amount of rainfall in province (2005-2016)	81/03 Millimeters
Maximum temperature (in June and July months)	46.59 Centigrade
Minimum temperature (in December and January months)	-2.11 Centigrade
Time that need for maturing Ferula assa Foetida shrubs and producing gum	5 years
Time of growth of Ferula assa Foetida shrubs	From end of winter until end of June
Time of dormancy of immature Ferula assa Foetida shrubs	From beginning of July until end of winter
Main type of lands that Ferula can growth	Sandy and lime
Main locations that Ferula can growth	Mountains and pastures
Main type of reproducing of Ferula	Only by seed
Average rainfall that need for growth of Ferula shrubs	90 – 150 Millimeters
Slope of growth regions of Ferula shrubs	30-60 Percent
Main origin regions of Ferula shrubs	Iran and Afghanistan
Acreage of potential pasture areas for producing medicinal fresh gum of Ferula assa Foetida	100000 ha
Number of rural households that their income are dependent on Ferula	2000

(Information and Statistical Department, 2016).

Table 3: Some of the economic information of Ferula assa Foetida in South Khorasan province

Amount of medicinal fresh gum that produce from one shrub of Ferula assa Foetida	20-40 Grams
Value of annually exporting dried gum of Ferula assa Foetida	4000000 $ USD
Total amount of dried gum of Ferula assa Foetida in rainy years	60 tons
Amount of dried gum of Ferula assa Foetida in dried years	15-20 tons
Main cities that producing medicinal fresh gum of Ferula assa Foetida in their pasture areas	Tabas, Qaen, Ferdows, Boshrooyeh
Value of one kg. dried gum of Ferula in global markets	130-170 $ USD

Value of one kg. dried gum of Ferula assa Foetida that buy by middlemen from native medicinal plant collectors (in 2016)	60-70	$ USD
Value of one kg. dried stem of Ferula assa Foetida that buy by middlemen from native medicinal plant collectors (in 2016)	25-30	$ USD
Selecting shrubs of Ferula that ready for catching its gum and marking on them by rural people	April and November	
Harvesting gum for supplying to market	June, July and August	
Sowing seeds of Ferula assa Foetida by rural people	Winter	
New germinating shrubs of Ferula assa Foetida plants	End of winter and beginning of spring	
Main pests of Ferula assa Foetida shrubs	Desert mice, one type of worm, and grasshopper	
Main targeted global markets for exporting dried gum of Ferula assa Foetida	India, Europe Union, and Arab countries around the Persian Gulf	
Percent of dried gum that each year exported to global markets	Approximately 100 %*	
Main type consumption of dried gum of Ferula assa Foetida	Medicinal factories	
Number of Medicinal factories in South Khorasan province	zero	
Years that need for producing seeds by shrub of Ferula assa Foetida	4 -5 years	
Times that each shrub of Ferula assa Foetida can produce seeds in his life period	One time **	

*Consumption of dried gum among locally people is very limited and mainly in medicinal plants shops.
****** Each shrub of Ferula assa Foetida after producing seeds will be died because of using all of its fresh gum.
(Information and Statistical Department, 2016).

Figures 7& 8 & 9 & 10 & 11& 12 & 13 & 14: Shrubs of Ferula assa Foetida in mountains and pasturelands of South Khorasan province in different stages of their growing (By author. 2012 & 2013).

2. Various stages for harvesting Ferula gum, plus producing and sowing its seeds

Ferula assa Foetida grows to 2 meters high, with a circular mass of 30–40 cm leaves. Stem leaves have wide sheathing petioles. Flowering stems are 2.5–3 meters high and 10 cm thick and hollow, with a number of schizogenesis ducts in the cortex containing the resinous gum. Flowers are pale greenish yellow produced in large compound umbels. Fruits are oval, flat, thin, reddish brown and have a milky juice. Roots are thick, massive, and pulpy. They yield a resin similar to that of the stems. All parts of the plant have the distinctive fetid smell.

The resin-like gum comes from the dried sap extracted from the stem and roots and is used as a spice. The resin is grayish-white when fresh but dries to a dark amber color. The asafoetida resin is difficult to grate and is traditionally crushed between stones or with a hammer. Today, the most commonly available form is compounded asafoetida, a fine powder containing 30% asafoetida resin, along with rice flour and gum Arabic.

Ferula assa Foetida is exudates which are obtained by tapping the root stock of the plant. The root of plants have been used for their perceived anthelmintic, antimicrobial, antispasmodic, aromatic, laxative, antispasmodic, diuretic and antiseptic actions in folk medicine.

Ferula assa-foetida L. (Apiaceae) is one of the most important endangered medicinal plants, which is rare in nature due to poor seed germination. Although the flora of Persia is thus fairly well known, there are still very few works on its overall vegetation (Information and Statistical Department, 2016) & (Golmohammadi, 2013).

In this regard, various stages for harvesting and catching Ferula gum are as following:

A) Selecting shrubs of Ferula assa Foetida that ready for catching its medicinal gum and marking on them by rural people in April and November (Figures 7-14);

B) Fencing of stones around these selected shrubs (Figures 12 & 15-22);

C) Harvesting its gum - final stage for producing dried gum for supplying to market- in June, July and August. In this stage in each 4-5 days in these months, native medicinal plant collectors by their traditional tools (Figures 23-25) create a thin cutting on the stem and after this time period, gathering resin-like gum that oozing by plant in the place of cutting stem, and then again replicating this process in 12-16 rounds each 4-5 days on the stems of Ferula in these months (Figures 15-22);

Plus gathering its gum, then thin cutting stems of Ferula shrubs by native medicinal plant collectors in above 12-16 rounds will be gathered and dried by them and present as dried cutting stems of Ferula assa (Keshteh - in endemic Persian language) for supplying to market and processing by foreign medicinal factories (Figures 32-35);

Each skillful native medicinal plant collectors in one day can cut stems of 1000 Ferula shrubs and gathering 4-10 grams of resin-like gum from each cutting stems in 4-5 days ago. This means that a skillful native medicinal plant collector can obtain 2-3 kg. gum from Ferula shrubs in good and rainy seasons in these months of harvesting (Figures 15-22 & 32-35);

D) Producing seeds from shrub of Ferula assa Foetida that ready for this in end of summer;

E) Sowing seeds of Ferula assa Foetida by rural people in winter and beginning a new germinating shrub of plant in the end of winter and beginning of spring (Figures 26-31) (Information and Statistical Department, 2016).

Figures 15 & 16 & 17 & 18 & 19 & 20 & 21 & 22: Villagers that doing various stages in preparing shrubs of Ferula assa and cutting its stem for harvesting and catching its medicinal gum (Shireh). Sorond village of Tabas City, 300 km. distance to Birjand, centre of South Khorasan province (May 23, 2016 & 2013).

Figures 23 & 24 & 25: Traditional tools of villagers for doing various stages in preparing shrubs of Ferula assa and cutting its stem for harvesting and catching its medicinal gum. Sorond village of Tabas City, 300 km distance to Birjand, centre of South Khorasan province (May 23, 2016).

Figures 26 & 27 & 28 & 29 & 30 & 31: Shrubs of Ferula assa Foetida that ready for producing seeds (Figure A) and its seeds (Figures B & C) and rural people that sowing its seeds in end of winter (Figures D & E) and a new germinated shrub of plant in winter (Figure F) in South Khorasan province (By author, 2012 & 2013).

Figures 32 & 33 & 34 & 35: Final production of dried thin cutting stems of Ferula assa (Keshteh- in endemic Persian language) for supplying to market and processing by medicinal factories. Sorond village of Tabas City, 300 km. distance to Birjand, centre of South Khorasan province (May 23, 2016).

3. Essential oil of Ferula

Essential oil (volatile oils) are aromatic oily liquids obtained from plant materials such as flowers, herbs, buds, fruits, twigs, bark, seeds, wood, roots, resin, gum and latex. Essential oil components are chemically derived from

terpenes and their oxygenated derivatives, which are aromatic and aliphatic acid, esters and phenolic compounds.

The percentage of the components of the essential oils varies among species and plants parts which indicated that depending on the species, climate, and altitude, time of collection and growth stage. The composition of essential oils might be differed qualitavely and quantitavely.

Ferula assa-foetida is a medicinal plant in the Apiaceae family. The plant is an herbaceous perennial with an unpleasant odour and is often considered to be the main source of oleo-gum-resin (OGR, a milky exudates from certain plants that coagulates on exposure to air) which has a characteristic sulfurous odour and bitter taste (Kavoosi and Rowshan, 2013).

Oleo-gum resin is obtained as secretions of the upper parts of the roots of the plants by incision. It is dark brown to black resin-like gum obtained from the juice of the rhizome. After drying, it becomes darker brown, resin-like mass. Different grades of resins, dried granules, chunks, or powders are sold. It is marketed in three forms-tears, mass, and paste (Figures 36 & 37).

Figures 36 & 37: Essential medicinal oil – Oleo Gum Resin (OGR) - of Ferula assa-foetida (Shireh- in endemic Persian language) in jelly (first) and solid (final) formats. Obtained from pastures of Sorond village of Tabas City, 300 km. distance to Birjand, centre of South Khorasan province (May 23, 2016).

Chemical composition and antibacterial activity of essential oils from commonly consumed herbs, such as Citrus aurantium, C. limon, Lavandula angustifolia, Matricaria chamomilla, Mentha piperita, M. spica, Ocimum basilicum, Origanum vulgare, Thymus vulgaris, Salvia officinalis and Zataria multiflora and their main components have been evaluated in many countries.

The main constituent of OGR is essential oil which contains ferulic acid, sesquiterpene, sulfur-containing compounds, monoterpenes and other volatile terpenoids.

Although advances in chemical and pharmacological evaluation of F. assa-foetida have occurred in the recent past, however several useful feature of this plant have been remained unknown (Kavoosi and Rowshan, 2013).

Accordingly, essential oils obtained from F. assafoetida OGRs in different collections had different chemical composition, antioxidant, ROS, RNS, H2O2 and TBARS scavenging. The essential oil from OGR1 was constituted high levels of acyclic sulfur-containing compounds [(E)-1-propenyl sec-butyl disulfide and (Z)-1-propenyl secbutyl disulfide] and bicyclic sesquiterpenes [10-epi-c-eudesmol] and showed the highest radical scavenging and the lowest antibacterial and antifungal activities. Essential oil from OGR2 was constituted high levels of acyclic sulfur-containing compounds [(Z)-1-propenyl sec-butyl disulfide and (E)-1-propenyl sec-butyl disulfide] and bicyclic monoterpenes [b-pinene and a-pinene] and showed moderate radical scavenging, antibacterial and antifungal activities. Essential oil from OGR3 was constituted high levels of bicyclic monoterpenes [b-pinene and a-pinene] and heterocyclic disulfide [1,2-dithiolane] and showed the lowest radical scavenging and the highest antibacterial and antifungal activities. For that reason, the essential oil obtained from the earlier stages of F. assafoetida growth could be used as safe and effective natural antioxidants

in food industry to improve the oxidative stability of fatty foods during storage while, the essential oil obtained from the later stages of F. assa-foetida growth could be used in health industry as a safe and effective source of antimicrobial agents. However, this is the first report on the effect of growth stage on the

essential oil profile in F. assa-foetida. More professional study required to examined phenolic and flavonoid biosynthetic pathway and expression profile of the related enzymes. With these expertise study we can talk with assurance about tentative applications of essential oils (Kavoosi and Rowshan, 2013).

4. Ferula and traditional medicine

In traditional medicine the plant is used for the treatment of different diseases, such as asthma, epilepsy, stomachache, flatulence, intestinal parasites, weak digestion and influenza (Kavoosi and Rowshan, 2013).

Ferula assa-foetida L. belongs to the Apiaceae (Umbelliferae) family of plants and its oleo gum resin is known as asafetida and people of some countries still consume it as a spice and medicinal herb

The old traditional phytomedicine asafoetida, an oleo-gum-resin obtained from the roots of different Ferula assa-foetida, is used in different countries for various purposes. Asafoetida is not only used as a culinary spice but also traditionally used to treat various diseases, including asthma, gastrointestinal disorders, intestinal parasites, etc. This oleo-gum-resin has been known to possess antifungal, anti-diabetic, anti-inflammatory, anti-mutagenic and antiviral activities. A wide range of chemical compounds including sugars, sesquiterpene coumarins and polysulfides have been isolated from this plant. Recent studies have shown new promising antiviral sesquiterpene coumarins from this old phytomedicine.

Asafoetida is an oleo-gum-resin obtained from the exudates of the roots of the Iranian endemic medicinal plant, Ferula assa-foetida. This species (Ferula assa-foetida) is often considered to be the main source of asafoetida, although other Ferula species, such as Ferula foetida, Ferula rubricaulis, Ferula rigidula, Ferula alliacea and Ferula narthex, are also sources of asafetida.

Ferula assa-foetida grows wildly in the central and southern mountains of Iran. The oleo-gum-resin asafoetida is called “Anghouzeh”, “Khorakoma” and “Anguzakoma” in Iran.

The plant, which belongs to the Apiaceae family, is an herbaceous perennial with an unpleasant odor that grows to about 2m in height. The oleo-gum-resin is often obtained by incision of the roots or removal of the stems. Hardened exudates (oleo-gumresin) are then collected and packed for export.

Asafoetida occurs in two principle forms, tears and mass. Mass is the most common form of asafoetida in the market. Asafoetida has been used as a spice and a folk phytomedicine for centuries. Asafoetida has a characteristic sulfurous odor and a bitter taste. It is used as a flavoring spice in a variety of foods, particularly in India. In addition, Nepali people regularly consume it in their daily diets, and it is believed that asafoetida has aphrodisiac, sedative and diuretic properties.

It is traditionally used for the treatment of different diseases, such as asthma, epilepsy, stomachache, flatulence, intestinal parasites, weak digestion and influenza.

Asafoetida consists of three main fractions, including resin (40–64%), gum (25%) and essential oil (10–17%).

The resin fraction contains ferulic acid and its esters, coumarins, sesquiterpene coumarins and other terpenoids.

The gum includes glucose, galactose, l-arabinose, rhamnose, glucuronic acid, polysaccharides and glycoproteins, and the volatile fraction contains sulfur-containing compounds, monoterpenes and other volatile terpenoids. Bioassay-guided fractionation studies of asafoetida have led to the identification of some interesting bioactive compounds; for example, Lee et al. characterized antiviral sesquiterpene coumarins from asafoetida that aremorepotent than amantadine against influenza A.

In Iranian folk medicine, asafoetida is also used as a medicine for the treatment of asthma. It seems that the most frequent uses of asafoetida are in upper respiratory diseases, including the treatment of asthma, bronchitis and whooping cough (as an expectorant), and gastrointestinal disorders as an antihelminthic, anti-flatulence and antispasmodic.

Although asafoetida has been reported to be obtained from different sources, Ferula assa-foetida is considered to be the main source of asafoetida. This plant is native to central Asia,

particularly eastern Iran and Afghanistan, from where it is exported to the rest of the world.

Although asafoetida is not native to India, it has been used in Indian medicine and cookery for ages. In addition, it has been used in traditional medicine of other countries such as Malaysia, Nepal and Fiji.

New pharmacological studies have almost confirmed the traditional uses of asafoetida as an antihelminthic, antispasmodic and antibacterial agent. In addition, there is a correlation between some traditional uses of asafoetida and those of new studies. For example, modern phytochemical and pharmacological studies have been revealed that umbelliprenin is one of the major components of asafoetida possessing strong lipoxygenase inhibitory activity.

Another biological activity of asafoetida, which has been confirmed by a number of new studies, is cancer chemoprevention.

Antihelminthic property (or anthelmintic) is another emphatically reported traditional use of asafoetida in different countries.

In Iran, China and Nepal, it is traditionally used for infestation with intestinal parasites. (Iranshahy and Iranshahi, 2011) & (Gundamaraju, 2013).

According to the Chinese, European, Iranian and Indian traditional medicines, oleo gum resin of Ferula assa-foetida (asafoetida) has therapeutic effects on different kinds of diseases. Some of these effects are related to the diseases of nervous system such as hysteresis and convulsion (Moghadam et al., 2014) (Figures 38- 46).

Figures 38 & 39 & 40 & 41 & 42 & 43 & 44 & 45 & 46: Scientific tour & field trip of author in medical plant of Ferula assa Foetida with research team from Botanical Garden belonged to ministries of education and science of the Republic of Kazakhstan in visiting from historical market of Birjand and its traditional shops of medicinal plants plus visiting pastures and mountains around Sorond village of Tabas City, 300 km. distance to Birjand, centre of South Khorasan province (May 22 & 23, 2016) (Golmohammadi, 2016).

5. Situation of exploitation pastures of Ferula in the South Khorasan province

Pastures are the most valuable national resources for each country which its proper utilization and basic management can provide an essential role in soil and water conservation, in addition to meeting the country needs for protein.

Disproportion between the number of exploiters and thus the number of livestock units that feed on the pasture forage provide the grounds for the major problems including retrogression of pastures, reduction of the value pasture species, proliferation of invader species, soil erosion and totally destruction the environment.

The different methods of range management including long-term exploitation, short-term exploitation and under grazing indicate the effects of grazing pressure on the reduction of vegetation and palatable species with forbs in the grazed pastures and by removing the factor of livestock grazing, the percent of vegetation and litter increases in the short and long-term. The exploitation also leads to increase the soil conservation and decrease the bare soil surface in the pasture (Tajali and Khazaeipool, 2012).

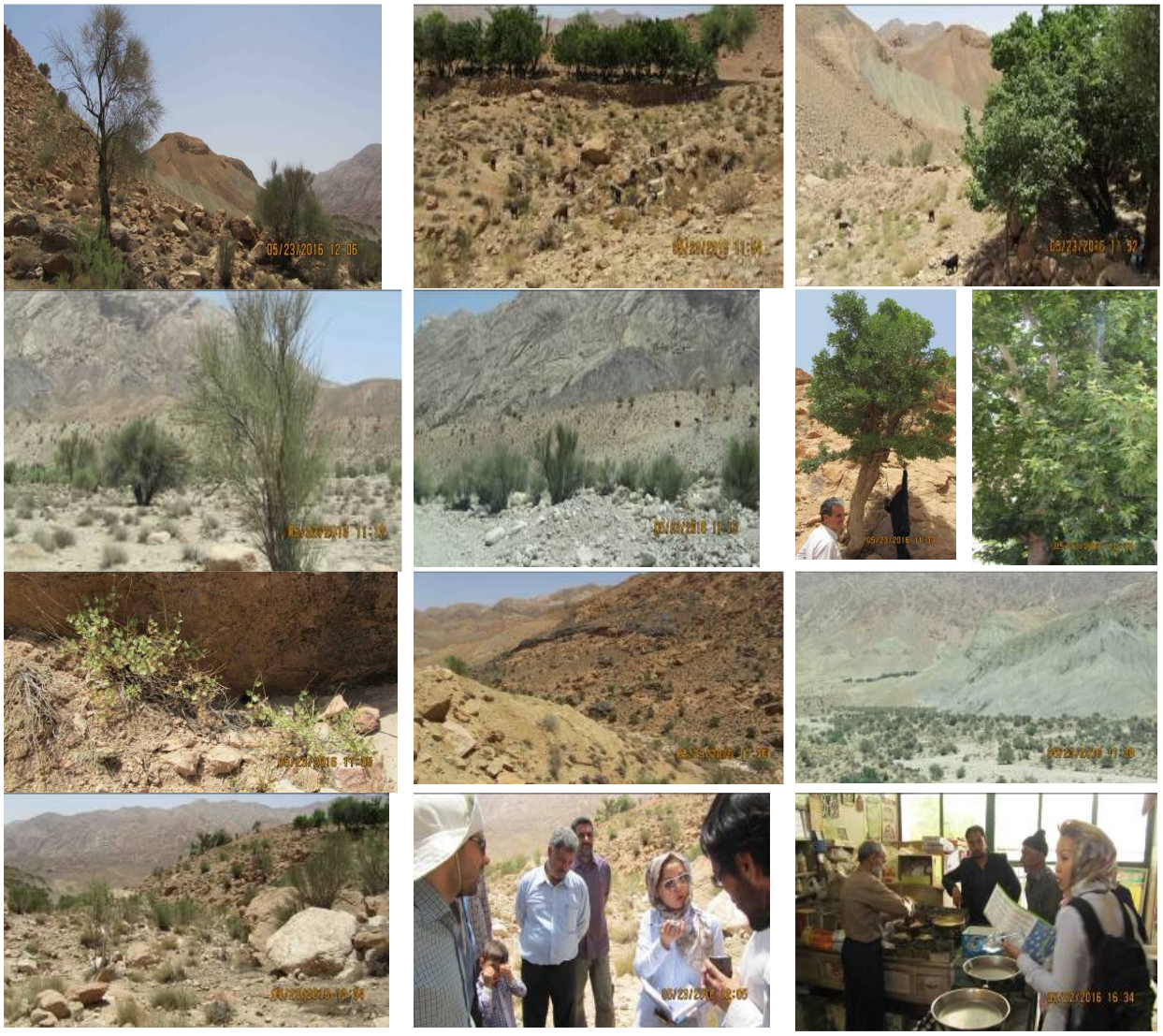
In this regard, in South Khorasan province as a most deprived and dried region of Iran, we see all of the above problems plus high periods of drought and overgrazing of herds specially cattles of goats and sheep (Information and Statistical Department, 2016) (Figures 47 - 55).

Figures 47 & 48 & 49 & 50 & 51 & 52 & 53 & 54 & 55: Author presence in pastures and ranges of Ferula assa Foetida (major weak) with herds of sheep and goats (specially). Sorond village of Tabas City, 300 km. distance to Birjand, centre of South Khorasan province (May 23, 2016).

6. Other important pasture medicinal plants in South Khorasan province

There are some other important pasture medicinal plants in South Khorasan province that local people traditionally collect and use them. During thousands of years accumulated a huge amount of indigenous and local knowledge about these medicinal plants which are important elements in traditional herbal and medicinal system of these native people. Nowadays we can observe this indigenous and local knowledge among native people from high rate of reception and going to meet from traditional shops of medicinal plants among various categories of society in South Khorasan province.

We can note for example to followings medicinal plants: Ash tree, Pomegranate, Apricot, Black cherry, Borage, Althaea offichnalis, Portulca olaraceae, Tribulus terrstrhs, Achillea eriophoradc, Alhagi-Persarumboiss, Descurahnha sofia., Portulca olaraceae, Tribulus terrstrhs, Onobrychis aucheri boiss, Peganum harmala, Malva neglecta wallr, Common mallow, Cynodon dactylon L pers, Crataegus turkestanica, Eremurus luteus Baker, Cuscuta sp, Polygonum aviculare L., Artemisia dracunculus L., Allium porrum, Rumex chaalepensis miller, Tamarix serotina Juglans regeal, Nigella sativa L., and etc. (Information and Statistical Department, 2016). (Figures 56 - 86).



Figures 56 - 86: Some endemic medicinal plants during scientific tour & field trip of author in Ferula assa Foetida with research team from Botanical Garden belonged to ministries of education and science of the Republic of Kazakhstan in visiting from historical market of Birjand and its traditional shops of medicinal plants plus visiting pastures, mountains and gardens around Sorond village of Tabas City, 300 km. distance to Birjand, centre of South Khorasan province (May 22 & 23, 2016) (Golmohammadi, 2016) & Achieve (Information and Statistical Department, 2016).

CONCLUSIONS

Water is a major natural resource which is limiting factor in the development of agriculture and natural resources especially in a dried region such as Iran. Therefore, it is necessary to adopt water management technologies for utilizing the available water resources. Water is the most precious commodity in the arid region of Iran due to prevalence of unfavorable hydro meteorological condition (Golmohammadi, 2012).

We are living in a knowledge driven world where knowledge is the ultimate power (Kumari, 2014). In this regard, indigenous and local knowledge about medicinal plants are important elements of herbal and medicinal system. These resources are usually regarded as part of the cultural traditional knowledge.

Despite all kinds of technological advances, the geographic variation is one element that is far from human control, because of different climatic conditions and edaphic factors that exist in each region. Essential oil quality and quantity in general are extremely dependent on the weather conditions; also several authors considered that the physic chemical characteristics are determinant factors in secondary metabolites composition especially for quality of volatiles. So these could be explanations for the differences which are found in essential oils of the same species such as the high chemical variability of the essential oils (Moghaddam and Farhadi, 2015).

Although the flora of Persia is thus fairly well known, there are still very few works on the overall its vegetation. With approximately six thousand recorded species of ferns and flowering plants, Persia harbors one of the richest floras of the Near Eastern countries, which is surprising, given that more than two-thirds of the country's surface consists of deserts, semi deserts, and steppes. This varied geo botanical landscape reflects the great contrasts of climate within the country and the evolution of the flora. Many plant genera evolved or diversified primarily on Persian territory, particularly in the mountain regions; examples of such indigenous include taxa of *Astragalus*, *Acantholimon*, *Acanthophyllum*, *Nepeta*, *Onosma*, and *Cousinia*. The flora and vegetation of Persia are also enriched by remnants of floras that were once far more widespread.

The demand for medicinal plants has increased globally due to the resurgence of interest in and acceptance of herbal medicine. Most of the demand is being met through collection of large quantities of medicinal plants and plant parts from wild populations. The methods of extraction employed are almost invariably crude and unsystematic. As a consequence, the rates of exploitation may exceed those of local natural regeneration. Also, the natural habitats are quickly being depleted. There is thus an urgent need to develop and implement conservation strategies for exploited medicinal plant species. The medicinal plant is propagated through seeds. However, its natural populations are very limited in native habitats, which may be due to poor seed germination. Low seed germination in Apiaceae is known (Moghadam et al., 2014) & (Golmohammadi, 2012).

Utilizing from pastures as renewable natural resources has been attended from thousands years ago by human kind. Available plants in these pastures are valuable from several aspects. Some of these plants plus their ecological value also have high economic value. Medicinal plants that available in these pastures because of their natural products have special value and have been utilizing directly (their main and principal products) or indirectly (their secondary products especially by industrial medicinal factories). In this regard *Ferula assa-foetida* L. (Apiaceae) is one most important and valuable medicinal plants in pastures of Iran and especially South-Khorasan province that major of its products (about 99%) export to foreign countries (especially for utilizing by industrial medicinal factories in developed countries). Because of above reasons, main goals of managers of Natural Resources and Watershed Administration of South Khorasan province are sustainable exploitation plus maximum economical efficiency from this plant.

Also *Ferula* is one of the most important endangered medicinal plants, which is rare in

nature due to poor seed germination (Information and Statistical Department, 2016).

The seed of many medicinal plant species are dormant and do not germinate unless specific environmental signals or events occur. Most production of this valuable plant, produce in South-Khorasan province in extent of 100000 ha, that produce 60 tons (in rainy years) and 15-20 tons (in dried years) annually and almost all of this production export to abroad because of lack of processing industries in this province. This plant generates incomes for many rural and nomadic households, that in the conditions of their subsistence agriculture, have high dependence to this production.

One of the main problems preventing sustainable use of medicinal plants native to arid lands is that they can germinate within the native environment, but fail to show good germination under laboratory conditions or when cultivation is attempted. Seed germination is an important event in the life of Ferula assa Foetida. Seed dormancy is a common phase of the Ferula assa Foetida plant life cycle, and several parts of this seed can contribute to dormancy.

South Khorasan province in east of Iran has good ethno botanical potential for medicinal plants. This study is one of the first contributions to the ethno botany of this region with emphasizing to Ferula assa Foetida.

With attending to above mentioned cases, author state following recommendations for sustainable management and exploitation with increasing economical efficiency of this plant:

- Utilizing from *Ferula assa-foetida* in present traditional form namely cutting its stem from above of its root for producing gum is not a sustainable way for exploiting because of after one season producing gum by mature plant, in next year *Ferula* will die. In this regard in research canters of Natural Resources and Watershed Organization of Iran, researches have been found methods for sustainable utilizing of *Ferula* such as concave and staircase methods. These new, scientific and sustainable methods must be extended among farmers (especially by agriculture and natural resources extension workers) and replacing to present prevailing hazardous traditional method.
- Reducing number of small livestock (especially goats and sheep herds) and big livestock (cow's herds in second order) in major weak pastures of South Khorasan province. Also preventing from grazing of these livestock herds especially in germination and exploitation seasons of *Ferula.* In this regard Natural Resources and Watershed Organization of Iran must allow livestock grazing in these pastures only after the last exploitation stage of *Ferula.*
- Development strategic planning for exploitation of *Ferula* in forward to achieving appropriate utilizing from available potentials in field of *Ferula* and other medicinal plants in South Khorasan province.
- Controlling on exploitation stages and Monitoring on quantity and quality of *Ferula* products.
- Conserving and restoring to life of germinating locals and pastures of *Ferula* in South Khorasan province.
- Absorbing participation of local people on implementing *Ferula* plans and projects of Natural Resources and Watershed Organization of South Khorasan province by strengthening their local organizations of medicinal plant collectors that are usually poor villagers.
- Establishing factories in field of medicinal plants especially for *Ferula* in the South Khorasan province. This can plus providing job creating for unemployed youth local people, preventing from raw and cheap selling and exporting of *Ferula* gum and increasing its final achieving value. This also is an important step for accessing to sustainable development and poverty alleviation goals and criteria in this deprived, dried and remote region of Iran.

ACKNOWLEDGEMENT

Author of this article is very thankful and grateful from Mr. Seyyed Esmaeel Ghoreyshi – Staff member and Management Expert (Master of Science in Geology, Rangeland and Watershed) in Natural Resources and Watershed Administration of Tabas city in South Khorasan province, east of Iran. Because of his very valuable efforts and helps in gathering information, pictures and doing scientific tour and field work of this study with research team from Botanical Garden belonged

to ministries of education and science of the Republic of Kazakhstan in visiting from pastures, mountains and gardens around Sorond village of Tabas City, 300 km. distance to Birjand, centre of South Khorasan province in May 23, 2016.

Also author of this article is very thankful and grateful from local people in Sorond village because of their great and valuable co-working and hospitality with our research team.

REFERENCES

Golmohammadi F. (2012) Sustainable agriculture and rural development in Iran, Some modern issues in sustainable agriculture and rural development in Iran Germany, LAP LAMBERT Academic Publishing GmbH & Co. KG.

Golmohammadi F. (2013) Medical plant of Ferula assa-foetida and its cultivating, main characteristics and economical importance in South khorasan province - east of Iran. Technical Journal of Engineering and Applied Sciences 3:2334-2346

Golmohammadi F. (2016) Certification for scientific collaboration and scientific field participation in Medical plant of Ferula assa Foetida- with research team from: General Director, Mangyshlak Experimantal, Botanical Garden, Candidate of Biology Science, Akzhunis Imanbayeva, Aktau, Kazakhstan. Belonged to Ministries of Education and science of the Republic of Kazakhstan.

Gundamaraju R. (2013) Evaluation of anti-helmintic activity of Ferula foetida "Hing- A natural Indian spice" aqueous extract. Asian Pac J Trop Dis 3:189-191.

Hamayun M., Khan M.A., Begum S. (2003) Marketing of medicinal plants of Utror-Gabral Valleys, Swat, Pakistan. Ethnobotanical Leaflets http://www.siu.edu/~ebl/.

Hassani S.B., Saboora A., Radjabian T., Fallah Husseini H. (2009) Effects of temperature, ga3 and cytokinins on breaking seed dormancy of ferula assa-foetida. Iranian Journal of Science & Technology, Transaction 33:41-59.

Information and Statistical Department. (2016) Annually Reports of Natural Resources and Watershed Organization of South Khorasan province, Iran.

Iranshahy M., Iranshahi M. (2011) Traditional uses, phytochemistry and pharmacology of asafoetida (Ferula assa-foetida oleo-gum-resin)—A review. Journal of Ethnopharmacology 134:1-10.

Kavoosi G., Rowshan V. (2013) Chemical composition, antioxidant and antimicrobial activities of essential oil obtained from Ferula assa-foetida oleo-gum-resin: Effect of collection time. Food Chemistry 138:2180–2187.

Kumari N.C., S.B. Jha, S.K. and Singh, S.R.K. (2014) Radio: An Educational Media to Transfer Agricultural Information among Farmers. Indian Res. J. Ext. Edu. 14:130-132.

Moghadam F.H., Dehghan M., Zarepur E., Dehlavi R., Ghasemini F., Ehsani S., Mohammadzadeh G., Barzegar K. (2014) Oleo gumresinof Ferulaassa-foetida L. amelioratesperipheral neuropathyinmice. Journal of Ethnopharmacology 154:183–189.

Moghaddam M., Farhadi N. (2015) Influence of environmental and genetic factors on resin yield, essential oil content and chemical composition of Ferula assa-foetida L. populations. Journal of Applied Research on Medicinal and Aromatic Plants 2:69-76.

Tajali A.A., Khazaeipool M. (2012) Management effects on vegetation characteristics of pastures in north of Iran. International Journal of Biosciences (IJB) 2:2222-5234.

ORGANIC FARMING IN INDIA: STATUS, OPPORTUNITIES AND CONSTRAINTS

V. Visha Kumari[1], Peter Hobbs[2] and Sarath Chandran M.A[3]
[1 &3]CRIDA, Hyderabad
[2]Cornell University, Ithaca, NY
Email: visha.venugopal@gmail.com

Received: 16.07.16
Accepted: 18.08.16

ABSTRACT

Sustainable agriculture is necessary to attain the goal of sustainable development. According to the Food and Agriculture Organization (FAO), sustainable agriculture "is the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of environment and conserving natural resources". A great challenge facing India in the coming years is to provide safe and adequate food for the population not only for today but also for the future. Organic farming is considered as a holistic approach for health of human beings, live stock and agro ecosystem.

Organic food is one of the ways to produce healthy food for human health but it is not so easy for the performance-oriented farm sector to revive this conventional practice since it has the challenge of producing food for the huge population. Organic farming has its own constraints like lack of agricultural policy, infrastructure, marketing, low yield, availability of organic source of manures and fertilizers and many other social and economical factors. This paper will cover the scope, progress and constraints of organic farming in India.

Organic farming is gaining momentum across the world. Awareness of human health and environmental issues in agriculture has demanded production of safe and environmentally friendly food as an attractive source of farm income generation. While there are trends of rising consumer demand for organic food in India among the wealthiest consumers, sustainability in production of crops has become the prime concern in agriculture development. Even though organic food production has several advantages and growing demand, there are many constraints for its adoption in a country like India. India has potential for organic production and agriculture is the main sector of the economy. The growing and large population limits organic farming, as some say it cannot provide enough food to meet this demand. Use of organic farming in India is therefore a topic of debate.

Definition

According to Codex Alimenarius "organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity". The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people (Scialabba and Hattam). There are many other definitions for organic farming (See Lieberhardt, 2003; Lampkin *et al*., 1999). For a farmer to certify a product as organic he/she should not use any synthetic input including genetically modified crops.

Both organic farming and conservation agriculture are different forms of sustainable agriculture which aim to meet the future food demand without degrading the natural resources. The difference between these two is organic farming restricts the usage of some commercial inputs and use of genetically engineered crops whereas CA does not have such restrictions.

Principles of sustainable farming:

i) To maintain the long-term productivity of soils.

ii) To produce foodstuffs of high nutritional quality and sufficient quantity.

iii) To increase the efficiency of fossil fuel use and research alternative sources of energy.

iv) To give livestock conditions of life that conforms to their physiological need.

v) To make it possible for agricultural producers to earn a living through their work and develop their potentialities as human beings.

vi) To reduce and minimize environmental degradation by controlling soil erosion and desertification.

Environmental benefits of organic agriculture

The impact of organic agriculture on natural resources favours interactions within the agro-

ecosystem that is vital for both agricultural production and nature conservation. Ecological services derived include soil forming and conditioning, soil stabilization, waste recycling, carbon sequestration, nutrient cycling, predation, pollination, habitat and biodiversity conservation and clean water (IFOAM, 1998). Organic farming systems have reportedly better performance in all the environmental impact indicators (floral diversity, faunal diversity, habitat diversity, landscape, soil organic matter, soil biological activity, soil structure, soil erosion, nitrate leaching, pesticide residues, GHG emissions, nutrient use, water use and energy use) than conventional systems. There is also a higher consumer health cost with conventional agriculture, particularly in the use of pesticides (Conway and Pretty, 1991).

Safety and quality of organically produced food

There is a growing demand for organic foods driven primarily by the consumer's perceptions of the quality and safety of these foods and to the positive environmental impact of organic agriculture practices (Pell, 1997). There have been many claims that eating organic foods increases exposure to microbial contaminants (Avery, 1998). But studies investigating these claims have no evidence to support them (Pell, 1997; Jones, 1999). Organic foods must meet the same quality and safety standards applied to conventional foods. These include the CODEX General Principles of Food Hygiene and Food Safety Programmes based on the Hazard Analysis and Critical Control Point (HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product). Analysis of pesticide residues in produce in the US and Europe has shown organic products have significantly lower pesticide residues than conventional products (Rutenberg, 2000; Woese *et al.,* 1997; Benbrook and Baker, 2001). Some studies have shown increases in vitamin C, minerals and proteins (Lampkin, 1990), sweeter and less tart apples (Reganold *et al.,* 2001) in organic products than conventional one. Organic crops had significantly higher levels of all nutrients analyzed compared with conventional produce including vitamin C (27% more), magnesium (29% more), iron (21% more) and phosphorous (14% more) (Worthington, 2001). Generally, organic crops are not protected by pesticides and research has shown that organically produced fruit contain higher levels of phenolic compounds than conventionally grown fruit and contain 10% to 50% more antioxidants than conventional crops (Brandt and Molgaard 2001).

Scope of organic farming in India

Green revolution and monoculture

The need for organic farming in India arises from the unsustainability of agriculture production and the damage caused to ecology through conventional farming practices. It is true that the green revolution saved India from starvation. But the negative consequences include the use of plant protection chemicals like fungicides, insecticides, and herbicides farmers used to protect crops from pest and disease problems. Scientific surveys and sampling indicate that pesticides sprayed on crops leave harmful residues that are transferred to human and other living bodies through grains, vegetables, fruits and grasses, causing a number of diseases, ailments and harmful effects on our health (Bhattacharyya, 2004). It is not also the amount of pesticides but also the time of application and LD 50 value (LD50 is the amount of a material, given all at once, which causes the death of 50% of a group of test animals) is also important. The other issue is the practice of monoculture (growing the same crop year after year) that can lead to build up of pest outbreaks. But monocropping may be the only option, for example deep water rice in flooded areas. Except for this practice crop rotation is recommended. It is also better to rotate a leguminous crop with a non leguminous one. This has the advantage of shifting the pest and disease problem, and the different root architecture in both will help in bringing nutrients deep in the soil to the upper layer (in most of the cases). Another issue is the manufacture of fertilizers and a pesticide, two major inputs, which need energy from fossil

fuels to produce, as well as their association with environmental and health issues.

Increasing population

Increasing global population and decrease in the availability of non renewable resources such as energy, land, and water, creates a real challenge for farmers in the coming years. We are in need of a production system that can meet the growing food demands without degrading the natural resources needed for food production. A sustainable way of crop production is the only way to achieve this target.

Traditional knowledge of organic farming

India has a long history of traditional agriculture. It was initiated thousands of years ago when farmers started cultivation using only natural resources. Every farmer used this tradition until the introduction of fertilizers and pesticides in the 20th century. This is said to be the traditional agriculture of a country. There is a brief mention of several organic inputs in India's ancient literatures like Rigveda, Ramayana, Mahabharata, Kautilya Arthasashthra etc. (Table 1).

India is endowed with various types of naturally available organic forms of nutrients in different parts of the country and they can be used for organic cultivation of crops. There is diversity in environments- climates with 100 to10,000 mm rainfall, flat and hill areas, deserts, areas with strong traditional farming systems involving crops, trees and animals, many innovative farmers, vast rainfed lands (60% of the agriculture land), and areas that use very few chemical inputs. In fact, the rainfed, tribal, north east and hilly regions of the country where negligible chemicals are used have practiced subsistence, organic agriculture for a long period (Bhattacharyya, 2004).

Table 1: Historical perceptive of Organic farming in India

Oldest practice	10000 years old, dating back to Neolithic age, practiced by ancient civilization like Mesopotamia, Hwang Ho basin etc.
Ramayana	All dead things - rotting corpse or stinking garbage returned to earth are transformed into wholesome things that nourish life.
Mahabharata (5500 BC)	Mention of *Kamadhenu,* the celestial cow and its role on human life and soil fertility.
Kautilya Arthashastra (300 BC)	Mentioned several manures like oil cake, excreta of animals.
Brihad-Sanhita (by *Varahmihir)*	Described how to choose manures for different crops and the methods of manuring.
Rig Veda (2500-1500 BC)	Mention of organic manure in Ria Veda 1, 161, 10, 2500- 1500 BC, is Green Manure in Atharva Veda II 8.3, (1000 BC). In Sukra (IV, V, 94, 107-112) it is stated that to cause healthy growth the plant should be nourished by dungs of goat, sheep, cow, water as well as meat.
Holy u;-an (590 AD)	At least one third of what you take out from soils must be returned to it implying recycling or post-harvest residue.

Source : Bhattacharyya and Chakraborty, 2005

Progress in Organic farming

India is bestowed with lot of potential to produce all varieties of organic products due to its various agro climatic regions. In several parts of the country, the inherited tradition of organic farming is an added advantage. This holds promise for the organic producers to tap the market which is growing steadily in the domestic market related to the export market. According to the "Agricultural and Processed Food Products Export Development Authority" (APEDA) India ranks 10th among the top ten countries in terms of cultivable land under organic certification. The certified area includes 15% cultivable area with 0.72 million Hectare and rest 85% (3.99 million Hectare) is forest and wild area for collection of minor forest produces. The total area under organic certification is 4.72 million Hectare (2013-14)

Table 2: Data for Organic Products (2013-2014)

Total production	1.24 million MT
Total quantity exported	194088 MT
Value of total export	403 million USD
Total area under certified organic cultivation	4.72 million hectares
Increase in Export Value over previous year	7.73 approx.

Organic products are exported to US, European Union, Canada, Switzerland, Australia, New Zealand, South East Asian countries, Middle East, South Africa etc. Soybean (70%) lead among the products exported followed by Cereals & Millets other than Basmati (6%), processed food products (5%), Basmati Rice (4%), Sugar (3%), Tea (2%), Pulses and Lentils (1%), dry fruits (1%), Spices (1%) and others.

Constraints in organic farming

Lack of knowledge

Most Indian farmers lack organic crop management knowledge. Many farmers in the country know little about organic farming and its advantages compared to conventional farming methods (Singh *et al.,* 2001). Knowledge about the availability and usefulness of an integrated organic approach to enrich the soil is also vital to increase productivity. Farmers lack the knowledge of recent technologies in compost making. Largely small farmers lack knowledge in proper certification requirements.

Inadequate certification and infrastructure

In spite of the adoption of the NPOP (National programme on Organic Production) during 2000, state governments in India are yet to formulate policies and a credible mechanism to implement them (Narayanan, 2005). There are only four agencies for accreditation and their expertise is limited to fruits and vegetables, tea, coffee and spices. The certifying agencies are inadequate, the recognized green markets are non-existent, the trade channels are yet to be formed and the infrastructure facilities for verification leading to certification of the farms are inadequate (Narayanan, 2005).

Farmers adopting organic production methods in India have difficulties to get certification (Certification is the assurance given to the consumer for its safety and quality). Often high amounts of money are involved in the process of certification which depends on the size of the farm, the cost of inspection, reorganization and paperwork done for accreditation which becomes expensive for small farmers. The high cost of certification hinders exports to international markets where higher profits could be obtained but not without being certified. On the other hand farmers have difficulties complying with the standards of certified organic production, especially when these require high initial costs of investment. In India there is no need of certification or labelling for the domestic market. But in the future this may be required. In the absence of regulation, there are many fakes stacked up with authentic ones. Some years back there was also a case of producing GM cotton in the name of organic cotton by the farmers in some districts of Andhra Pradesh. All this happened because of the lack of proper certification.

High input costs

The small and marginal farmers in India have been practicing organic farming in the form of the traditional farming system. They use local or own renewable farm resources and carry on their agricultural practices (Katyal, 2000). Often the larger farms need to get organic inputs from the market. The costs of the organic inputs are higher than those of industrially produced chemical fertilizers and pesticides including other inputs used in the conventional farming system (Kler *et al.,* 2001). Organic inputs are bulkier than synthetic inputs in terms of nutrient content and so cost more labour to transport and spread on the fields. There is also a government subsidy on synthetic fertilizer making them cheaper per unit of nutrient. The groundnut cake, neem seed cake, vermi-compost, silt, cow dung, other manures, etc. applied as organic manure are increasingly more costly making them unaffordable to the small cultivators if they do not have sufficient of their own manure (Kler *et al.,* 2001). The organic sources listed above also have other competing uses like cattle feed, fuel etc. which also hinders availability.

Absence of appropriate agriculture policy

Appropriate agriculture policy in India is vital for national food security including policies related to supply of inputs, promotion of organic farming for export and domestic markets, product and input supplies (FAO, 2003). These are serious issues and a solution for them along with a national consensus is essential for future growth. Formulation of an appropriate agriculture policy that takes care of these complexities is essential to encourage

organic agriculture in a big way in India (Narayanan, 2005).

Low yields

In many cases farmers experience some loss in yield when switching away from synthetic inputs or conversion of their farming method from conventional to organic. Restoration of full biological activity in terms of growth of beneficial insect populations, nitrogen fixating bacteria and other soil microbes, pest suppression and improved nutrient recycling will take time before these transition yield declines can be reversed (Hanson *et al.,* 1997). It may also take years to make organic production profitable on the farm (Peters, 1994; Liebhardt *et al.,* 1989). Small and marginal farmers cannot take the risk of low yields for the initial 2-3 years when converting to organic farming. There is a need for schemes to compensate them during this transition period if small farmers are to be encouraged to grow organic food. The price premiums on organic products will not be much help, as they will disappear once significant quantities of organic farm products are made available (Narayanan, 2005).

Marketing

There is a lack of a marketing and distribution network for organic produce. Often the retailers are not interested in buying organic produce from farmers because of the higher cost and less demand by Indian consumers. This is because the majority of the people are poor and cannot afford to buy organic products because of its higher price. Lack of cold storage facilities is the other factor which is very important for perishable products like fruits and vegetables. Organic products like fruits and vegetables are more likely to find an organic market than other staple food crops like cereals. India should concentrate on good marketing channels for fruits and vegetables.

Pest and disease management in organic farming

Organic farming like conventional farming must be able to manage pest issues. Consumers are more aware of buying quality food. The challenge in organic farming is the resurgence of secondary pests and diseases, emergence of resistance strains and slow action against the pest and disease (Kajimura *et al*., 1995). Taking into consideration the pesticide residue problem in food, the integrated approach of pest management (IPM) is a better choice and should be promoted in any type of agriculture. IPM uses many strategies to control pests and includes: cultural, physical, biological, genetic and chemical methods.

Biomass availability

There is shortage of biomass availability in India. The crop residues are removed after harvest from the farms and they are used as fodder and fuel. Experiments have shown that the crop residues ploughed back into soil will increase productivity and this is a better alternative than conversion into compost (Narayanan, 2005). The manure also has competition for other uses like fuel (cow dung patties). Some farmers either burn the residue in the field or market them. There is a need to develop an alternative source of cheap fuel or more efficient stoves to decrease the use of manure as fuel so more can be returned to the land to improve soil health.

RECOMMENDATION

To meet the human needs for food in a more efficient and ecologically friendly way it is important to combine both organic and inorganic approaches of crop production. To ensure food and nutritional security, rather than promoting organic farming universally, it would be desirable to carefully delineate areas for organic farming. At this point of time it is important to have a sustainable method of farming to meet the future food demand and at the same time be safe to the environment.To have a sustainable approach that meets food security needs it is better to have an integrated approach; a combination of both organic and inorganic farming.

- Small farmers with potential areas for organic production can organized themselves into groups to better avail markets for organic products.
- Suitable organic crops would be high value crops like, spices, medicinal plants, fruits and vegetables.
- Better education in organic crop production is needed. For example, educating farmers

about sensible choice of varieties, sowing time, increase in natural predators, management of time and space will help in pest reduction.

- Due to the high cost involved in the certification process, farmer groups can be formed. These groups need to be supported by the government or NGO for production and marketing.
- Proper marketing channel for organic products needs to be identified**.**
- Better agricultural policies are needed to promote agricultural institutions and extension to provide more market oriented services for organic crops. Organic agricultural policies that combine increased income generation and improved domestic food production from organic farming are needed.
- Since availability of adequate organic biomass sources is a problem, feasible technologies are needed for *in situ* recycling/rapid composting of on-farm residues and wastes. Identification of better stoves to recycle the char back to the field is another option.
- Policies need to be developed for using non traditional organic sources like slaughter house waste, human waste etc. Urban waste remains a serious problem in developing countries that contaminates soil and water bodies and endangers human and animal life. Much of the waste contains nutrients that can be effectively reused for agriculture. This type of approach will lead to a win-win situation.
- Crop-specific and farming situation-specific package of practices for organic cultivation should be developed and after thorough on-farm validation, recommended for adoption. Such proven technology packages need to be documented in regional languages. Participatory approaches where farmers can interact and learn in farmer school approaches need to be developed.
- Good political, financial and infrastructural facilities need to be provided.
- Knowledge in proper certification procedures is important for the future of organic food production.

CONCLUSION

India is bestowed with a lot of potential to produce all varieties of organic products due to its various agro climatic regions and traditional knowledge. The export market potential is also increasing. But there are many constraints for organic production in a country like India. Depending upon organic farming to meet food security needs will not be sufficient to meet the food needs of more than 1 billion people. Overcoming constraints and identifying the prime areas and potential hotspots to produce organic products will help India emerge as a good exporter of organic products and increase farm net revenues. To combine a sustainable production system to meet food security needs of India with a healthy environment an integrated approach that combines organic and inorganic methods of crop production is recommended.

REFERENCES

Agricultural and Processed Food Products Export Development Authority APEDA. 2013-14.

Avery, D. T. 1995. Saving the planet with pesticides and plastic: The environmental triumph of high-yield farming. Hudson Institute, Indianapolis. pp. 432.

Bhattacharyva, P. and G. Chakraborty. 2005. Current Status of Organic Farming in India and other Countries. Indian Journal of Fertilisers. 9, 111-123.

Bhattacharyya, P. 2004. Organic Food Production in India- Status, Strategy and Scope. Agribios 1, 182-184.

Brandt, K and J.P. Molgaard. 2001. Organic Agriculture: Does it enhance or reduce the nutritional value of food plants. Journal of Science in Food and Agriculture. 81, 924 – 931

Conway, G. and J.N. Pretty. 1990. Unwelcome Harvest: Agriculture and Pollution, Earthscan Publications, London. pp. 645.

FAO. 2003. Organic agriculture and the environment. Food and Agricultural Organization,Rome.

Geeta Singh, CSSIngh and RVS Rajpoot, 2014. Sustainable agriculture development in tribal district through organic farming, TECHNOFAME, Vol. 3(1): 102-108.

Hanson, J. C., E. Lichtenberg, and S.E. Peters. 1997. Organic versus conventional grain production in the mid-Atlantic: An economic and farming system overview. Am. J. Alternative Agric. 12, 2 -9.

International Federation of Organic Agriculture Movements. 1998., IFOAM Basic Standards for Organic Production and Processing, IFOAM Publications, Tholey-Tholey, Germany.

Jones, D. L. 1999. Potential health risks associated with the persistence of *Escherichia coli* O157 in agricultural environments. Soil Use Manage.15, 76–83.

Kajimura, T., K. Fujisaki, and F. Nakasuji. 1995. Effect of organic rice farming on leafhoppers and planthoppers. Appl. Entomol. Zool. 30, 17–22.

Katyal, J. C. 2000. Organic matter maintenance: Mainstay of soil quality. J. Indian Soc. Soil Sci.48, 704–716.

Lampkin, N. 1990. Organic Farming, Farming Press, Ipswich, UK. pp. 715

Liebhardt, W. C., R.W. Andrews, M.N. Culik, R.R. Harwood, R.R. Janke, J.K. Radke, and S. L. Rieger-Schwartz. 1989. Crop production during conversion from conventional to low-input methods. Agron. J. 81, 150–159.

Mohan Singh. 2003. Organic farming prospects in Indian agriculture. Souvenir of 68th Annual Convention of Indian Society Soil Science, CSAU&T, Kanpur, 4–8 November 2003, pp. 52–60.

Narayanan, S. 2005. Organic farming in India: relevance, problems and constraints. National Bank for Agriculture and Rural Development, Occasional paper 38, pp. 1-93.

Pell, A. N. 1997. Manure and microbes: Public and animal health problem. J. Dairy Sci. 80, 2673–2681.

Peters, S. E. 1994. Conversion to low-input farming systems in Pennsylvania, USA: An evaluation of the Rodale Farming Systems Trial and related economic studies. In Lampkin, N. H. and Padel, S. (Eds). Economics of Organic Farming. CAB, Wallingford, UK, pp 265–284.

Ramaswami, P. P. 1999. Recycling of agricultural and agro-industry wastes for sustainable agricultural production. J. Indian Soc. Soil Sci. 47, 661–665.

Reganold, J. P., J.D. Glover, P.K. Andrews, and H.R. Hinman. 2001. Sustainability of three apple production systems. Nature 410. pp. 926–930.

Rutenberg, J. 2000. Report on organic foods challenged. New York Times: 11.

Scialabba, E.N. and C. Hattam. 2002. (eds.) Organic Agriculture Environment and Food Security. FAO, Rome. pp. 252-253.

Singh, G. R., N.K. Chaure, and S.S. Parihar. 2001. Organic farming for sustainable agriculture. Indian Farm. 52, 12–17.

SS Gautam and Nidhi Pathak, 2014. Effet of organic fertilizer on soyabean yield in Bundelkhand, TECHNOFAME, Vol. 3(2):84-87.

Woese, K., D.Lange, C. Boess, and K.W. Bogl. 1997. A comparison of organically and conventionally grown foods – Results of a review of the relevant literature. J. Sci. Food Agric.74, 281–293.

Worthington ,V. 2001. Nutritional quality of organic versus conventional fruits, vegetables, and grains. The Journal of Complimentary Medicine. 7, 161 – 173.

EXTENT, PATTERN AND DEGREE OF INTEGRATION AMONG SOME SELECTED COCOA MARKETS IN WEST AFRICA: AN INNOVATIVE INFORMATION DELIVERY SYSTEM

Sadiq, M S[1]*, Singh, I.P[2], Suleiman, Aminu[3], Umar, S.M[4], Grema, I.J[5], Usman, B.I[6], Isah, M.A[7] and Lawal, A.T[8]

[1]Resarch Scholar, Department of Agricultural Economics, SKRAU, Bikaner, India*
[2]Professor, Department of Agricultural Economics, SKRAU, Bikaner, India
[3]Professor, Dept. of Agril. Economics and Extension, Bayero University Kano, Nigeria
[4]Research Scholar, Department of Agricultural Economics, PJSTSAU, Hyderabad, India
[5]Department of Agricultural Technology, Yobe State College of Agriculture, Gujba, Nigeria.
[6]Dept. of Agril. and Bio-Environmental Engineering, Federal Polytechnic Bida, Nigeria.
[7]Research Scholar, Department of Agricultural Economics, UAS, Dharwad, India
[8]Department of Agricultural Economics and Extension, Bayero University Kano, Nigeria
Email: sadiqsanusi30@gmail.com

Received: 24.08.16
Accepted: 01.09.16

ABSTRACT

Regional market integration in many agricultural commodities had been extensively studied for the insight it provide into the functioning of such markets, given that they provides valuable information about the dynamics of market adjustment, and whether there exist market imperfection which may justify government interventions. This research used yearly producer price ($ per ton) data spanning from 1991 to 2014, and empirically estimated the degree of integration, volatility and forecast in West Africa cocoa markets using Cointegrtaion model, restricted VAR, GARCH family members and ARIMA model. Cointegration results showed long run price association among these markets in West Africa. The degree of market integration observed indicated that West African cocoa markets were quite competitive, thus, providing little justification for extensive and costly intervention designed to enhance competitiveness aimed at ensuring market efficiency.

Key words: Cointegrtaion; VECM; Impulse; Forecast; Volatility; Leverage effect; Cocoa market; West Africa

Market information termed "lifeblood of a market' is an important marketing function which insures the smooth and efficient operation of the marketing system. Accurate, adequate and timely availability of market information facilitates decision about when and where to market products. Market information creates a competitive market process and checks the growth of monopoly or profiteering by individuals. Everyone engaged in production, and in buying and selling of products is continually in need of market information. This is truer when agricultural commodities are concerned, because their prices fluctuate more widely than products of other sectors. On the basis of market information, market participants will be able to know the pulse of the market, i.e., whether the market is active or sluggish, the temperature of the market (whether prices are rising or falling), and market pressure (whether supply is adequate, scarce or abundant). On these basis, they project their estimates and take decisions about whether to sell immediately or stock goods for some time, whether to sell into the local market or go in for import or export, whether to sell in their original form or add value and sell, and so on. The failure of a business may partly be attributed to either the non-availability of market information or its inadequate availability and interpretation. Importance of research on flow of market information has considerably increased in recent years, particularly in the cases of food grains (Blay *et al.,* 2015; Mahalle *et al.,* 2015; Akpan *et al.*, 2014; Mafimisebi *et al*., 2013; Archarya *et al.*, 2012), fruits (Beag and Singla, 2014) and vegetables where fluctuations and inter-spatial price differences are considerably more. It is in this connection that the researchers tends to devise a mechanism of market information for cash crop (cocoa) in West Africa, because the importance of market

intelligence can be realized from the wide range concern expressed by people in the inflationary trends brought out by the Wholesale Price Index (WPI) numbers. Market information is essential for the government in creating a policy environment for smooth conduct of marketing business, protection of all the groups of persons associated with it, framing its agricultural policy relating to market regulation, buffer stocking, import-export, administered prices and decisions related to fiscal and monetary measures; support prices, open market operation, moral suasion etc. Furthermore, literatures showed few studies on market integration of cash crops in developing, e.g Rapsomanikis *et al.*(2006); Acquah and Rebecca (2012).

METERIALS AND METHODS

Yearly producer cocoa price data ($ per ton) for Congo, Cameroon, Ghana, Ivory Coast, Nigeria and Togo markets in West Africa, spanning from 1991 to 2014 sourced from FAOSTAT data bank were used for the study.

The analytical techniques used in the study are shown below.

1. Model Selection Criteria

The information criteria are computed for the VAR models of the form:

$Y_t = A_1 Y_{t-1} + ... + A_n Y_{t-n} + B_q X_t + ... + B_q X_{t-q} + CD_t + \mathcal{E}_t$ ..... (1)

Where Y_t is K-dimensional. The lag order of the exogenous variables X_t, q, and deterministic term D_t have to be pre-specified. For a range of lag orders n the model is estimated by OLS. The optimal lag is chosen by minimizing one of the following information criteria:

$AIC\ (n) = log\ det\ \{ \Sigma_u(n))\} + (2/T)\ nK^2$ ... (2)

$HQ\ (n) = log\ det\ \{\Sigma_u(n)\} + (2log\ log\ T/T)\ nK^2$ ..... (3)

$SC\ (n) = log\ det\ \{\Sigma_u(n)\} + (log\ T/T)\ nK^2$ (4)

$FPE\ (n) = (T + n^*/T-n^*)^k\ det\ \{\Sigma_u(n)\}$ ..... (5)

Where $\Sigma_u(n)$ is estimated by $T^{-1} \sum_{t=1}^{T} UtU't$, n^* is the total number of parameters in each equation of the model when n is the lag order of the endogenous variables, also counting the deterministic terms and exogenous variables. The sample length is the same for all different lag lengths and is determined by the maximum lag order.

2. Augmented Dickey Fuller Test

The Augmented Dickey-Fuller test (ADF) is the test for the unit root in a time series sample. The autoregressive formulation of the ADF test with a trend term is given below:

$\Delta p_t = \alpha + p_{t-1} + \sum_{j=2}^{it} \beta i \Delta p_{it-j+t} + \mathcal{E}$ ..... (6)

Where, p_{it} is the price in market i at the time t, Δpit $(p_{it} - p_{t-1})$ and α is the intercept or trend term. The joint hypothesis to check the presence of unit root is: H_0: $\gamma = \alpha_0 = 0$ using ϕ_1 statistic. Failure of the rejection of null hypothesis means that the series is non-stationary.

3. Saikkonen and Lütkepoh Cointegration Test

Saikkonen and Lütkepohl (2000a, b,c) proposed tests for the pair of hypotheses which proceed by estimating the deterministic term Dt first, subtracting it from the observations and applying a Johansen type test to the adjusted series. In other words, the test is based on a reduced rank regression of the system

$\Delta x_t = \prod x_{t-1} + \sum_{j=1}^{p-1} \Gamma j \Delta x_{t-j} + U_t$ ..... (7)

Where $x_t = y_t - D_t$ and D_t is the estimated deterministic term. The parameters of the deterministic term are estimated by the GLS procedure proposed by Saikkonen and Lütkepohl. The critical values depend on the kind of deterministic term included.

4. Granger Causality Test

Granger (1969) causality test was used to determine the order and direction of short-term and long-term equilibrium relationships. Whether market p_1 Granger causes market p_2 or vice-versa was checked using the following model:

$p_t = c + \sum_{i=1}^{n} (\phi p_{1t-i} + \delta_i p_{2t-i}) + \mathcal{E}_i$ ..... (8)

A simple test of the joint significance of δ_i was used to check the Granger causality, i.e.

H_0: $\delta_1 = \delta_2 = ... \delta_n = 0$.

5. Vector Error Correction Model (VECM)

After establishing the multiple co-integrating relationships among price series, Vector Error Correction Model (VECM) was constructed to determine the short-term disturbances and the adjustment mechanism to estimate the speed of

adjustment. The VECM explains the difference in y_t and y_{t-1} (i.e. Δy_t) and it is shown below:

$\Delta y_t = a + \mu(y_{t-1} - \beta x_{t-1}) + \sum_{i=0}^{i=r} \delta_i \Delta x_{t-1} + \sum_{i=1}^{i=r} \gamma_i \Delta \gamma_{t-1}$ ..... (9)

It includes the lagged differences in both x and y, which have a more immediate impact on the value of Δy_t. For example, if Δx_t increases by one percentage point, then Δy_t would increase by δ percentage point. The value of β indicates the percentage point would change in the long-run in response to changes in x. Therefore, part of the change in Δy_t could be explained by y correcting itself in each period to ultimately reach the long-run path with x. The amount by which the value of y changes (or corrected) in each period is signified by μ. This coefficient (μ) indicates the percentage of the remaining amount that y has to move to return to its long-run path with x. In explaining changes in a variable, the VECM accounts for its long-run relationship with other variables. The advantage of VECM over an ordinary OLS model is that it accounts for dynamic relationships that may exist between a dependent variable and explanatory variable, which may span several periods.

6. Impulse Response Functions

Granger causality tests do not determine the relative strength of causality effects beyond the selected time span. In such circumstances, causality tests are inappropriate because these tests are unable to indicate how much feedback exists from one variable to the other beyond the selected sample period (Rahman and Shahbaz, 2013). The best way to interpret the implications of the models for patterns of revenue transmission, causality and adjustment are to consider the time paths of revenues after exogenous shocks, i.e. impulse responses. The impulse response function traces the effect of one standard deviation or one unit shock to one of the variables on current and future values of all the endogenous variables in a system over various time horizons (Rahman and Shahbaz, 2013). For this study the generalized impulse response function (GIRF) originally developed by Koop *et al*. (1996) and suggested by Pesaran and Shin (1998) was used. The GIRF in the case of an arbitrary current shock, δ, and history, ω_{t-1} is specified below:

$GIRF_Y(h, \delta, \omega_{t-1}) = E[Y_t + h/\delta, \omega_{t-1}] - E[y_{t-1}/\omega_{t-1}]$ ..... (10)

For $n = 0, 1$

7. GARCH Model

The representation of the GARCH (p, q) is given as:

$Y_t = \alpha + b_1 Y_{t-1} + b_2 Y_{t-2} + \varepsilon_i$

(Autoregressive process) ..... (11)

And the variance of random error is:

$\sigma^2_t = \lambda_0 + \lambda_1 \mu^2_{t-1} + \lambda_2 \sigma^2_{t-1}$ ..... (12)

$\sigma^2 t = \omega + \sum_{i=1}^{p} \beta_i \sigma^2_{t-i} + \sum_{j=1}^{q} \alpha_i \varepsilon^2_{t-i}$ ... (13)

Where, Y_t is the price in the i^{th} period of the i^{th} market, p is the order of the GARCH term and q is the order of the ARCH term. The sum of $(\alpha + \beta)$ gives the degree of persistence of volatility in the series. The closer is the sum to 1; the greater is the tendency of volatility to persist for a longer time. If the sum exceeds 1, it is indicative of an explosive series with a tendency to meander away from the mean value.

8. TGARCH Model

The Threshold GARCH, or TGARCH (P,Q), model is one of the widely used models introduced by Zakeian (1990) and Glosten *et al*. (1993), and the TGARCH model with mean and conditional variance equations is as follows:

$y_t = \phi_0 + \sum_{i=1}^{p} \phi_i y_{t-1} - \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} + \varepsilon_t$... (14)

$\sigma^2_t = \alpha_0 + \sum_{i=1}^{q} \alpha_1 \varepsilon^2_{t-1} + \sum_{i=1}^{q} \lambda d_{t-1} \varepsilon^2_{t-1} + \sum_{j=1}^{p} \beta_j \sigma^2_{t-1}$ ..... (15)

Where $d_{t-i} = 1$ if $\varepsilon_{t-1} \geq 0$, and $d_{t-i} = 0$. The TGARCH model allows a response of volatility to news with different coefficients for good and bad news. That is, depending on whether ε_{t-1} is above or below the threshold value of zero, ε^2_{t-1} has different effects on the conditional variance σ^2_t: when ε_{t-1} is positive, the total effect is given by $\alpha_i \varepsilon^2_{t-1}$; when ε_{t-1} is negative, the total effect is given by $(\alpha_i + \lambda_i)\ \varepsilon^2_{t-1}$. So, one would expect λi to be positive for bad news to have larger impacts. The presence of leverage effects can be tested by the hypothesis that $\lambda_i = 0$. The impact is asymmetric if $\lambda_i \neq 0$.

9. ARIMA Model

A generalization of ARMA models which incorporates a wide class of non-stationary time-series is obtained by introducing the differencing into the model. The simplest example of a non-stationary process which reduces to a stationary one after differencing is Random Walk. A process $\{y_t\}$ is said to follow an integrated ARMA model, denoted by ARIMA *(p, d, q)*, if $\nabla^d y_t = (1-\beta)^d \varepsilon_t$ is ARMA (p, q), and the model is written below:

$$\varphi(\beta) \quad (1-\beta)^d \quad y_t \quad = \quad \theta \quad (\beta) \quad \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(16)$$

Where, $\varepsilon t \sim WN(0, \sigma^2)$, and *WN* indicates white noise. The integration parameter d is a non-negative integer. When $d = 0$, ARIMA (p, d, q) = ARMA (p, q).

Forecasting Accuracy

For measuring the accuracy in fitted time series model, mean absolute prediction error (MAPE), relative mean square prediction error (RMSPE) and relative mean absolute prediction error (RMAPE) were computed using the following formulae (Paul, 2014):

$$MAPE = 1/T \sum \{A_t - F_t\} \ldots\ldots\ldots\ldots\ldots\ldots (17)$$

$$RMPSE = 1/T \sum \{(A_t - F_t)^2 / A_t\} \ldots\ldots (18)$$

$$RMAPE = 1/T \sum \{(A_t - F_t) / A_t\} X\ 100 \ldots (19)$$

Where, A_t = Actual value; F_t = Future value, and T= Time period(s)

RESULTS AND DISCUSSION

Lag selection criteria

Because of sensitivity of time series to lag length, lag selection criteria were used to determine the suitable number of lag to be included in the model. The output below used vector autoregressive selection order criteria to determine the lag order of the time series data. Results *viz.* Akaike information criterion (AIC), Hannan–Quinn criterion (HQC) and Schwarz Bayesian criterion (SBC) tests respectively, all selected lag 2 (Table 1). However, it should be noted that when all the selection criteria agree, the selection is clear, but in situation of conflicting results, the selection criteria with the highest lag order is considered or chosen.

Table 1: Lag selection criteria for major cocoa markets

Items	No. of selected lag	Maximum lag search
Akaike Information Criterion (AIC)	2	10
Hannan-Quinn Criterion (HQC)	2	10
Schwarz Bayesian Criterion (SBC)	2	10
Final Prediction Error	2	10

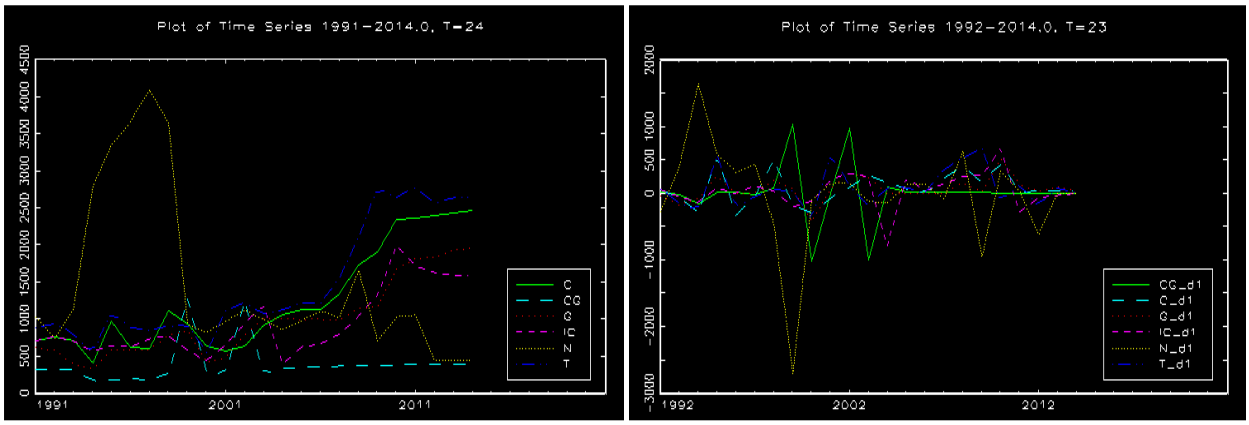
Test for unit roots

Before conducting cointegrating tests, there is need to examine the univariate time-series properties of the data and confirm that all the price series are non-stationary and integrated of the same order. This can be established by a visual examination of the price series and by using the Augmented Dickey Fuller (ADF) test developed by Dickey and Fuller (1979). Through a visual examination of the series at level it can be observed that the prices of cocoa in different locations have trends or unit roots as evident by the upward movement (Figure 1), while at first difference, these trends disappeared as evident by the plato movements of the prices (Figure 2); implying that these series are stationary at this point. To make an objective judgment about unit roots, ADF test was further conducted and results of the Augmented Dickey-Fuller (ADF) unit root test applied at level and first difference to the logarithmically transformed series reveals that price series were not stationary at level, as the absolute values of test statistics were below 5 percent test critical values, while after first difference the price series became stationary, as absolute values of test statistics were greater than the 5 percent test critical values (Table 2). With the proof that the price series were non-stationary and integrated of the order 1 i.e I(1), test for cointegration among the selected cocoa markets using Saikkonen and Lütkepoh test approach was applied.

Table 2: ADF unit root test of major cocoa markets

Market	Stage	T-statistics	T-critical at 5%	Remarks
Ivory Coast	Level	2.3468	3.41	Non-stationary
	1st Difference	3.9429**	2.86	Stationary
Cameroon	Level	2.2509	3.41	Non-stationary
	1st Difference	3.4722**	3.41	Stationary
Congo	Level	2.0500	3.41	Non-stationary
	1st Difference	3.4135**	2.86	Stationary
Ghana	Level	3.1070	3.41	Non-stationary
	1st Difference	4.3085**	2.86	Stationary
Nigeria	Level	3.3088	3.41	Non-stationary
	1st Difference	2.5467**	1.94	Stationary
Togo	Level	2.2838	3.41	Non-stationary
	1st Difference	2.9419**	1.94	Stationary

Note: ** indicate that unit root at level or at first difference was rejected at 5 per cent significance.



Saikkonen and Lütkepoh Multivariate Cointegration Test

The results of Saikkonen and Lütkepoh cointegration test are given in Table 3. To check the first null hypothesis that the variables were not cointegrated ($r = 0$), the calculated LR statistic rejected the null hypothesis as LR value was significant at 5 percent probability level ($P< 0.05$), and accepted the alternative of one or more cointegrating vectors. Similarly, the null hypotheses: $r \leq 1$, $r \leq 2$ and $r \leq 3$ were rejected against their alternative hypotheses of $r \geq 1$, $r \geq 2$ and $r \geq 3$, respectively. The null hypothesis $r \leq 4$ test was accepted and its alternative hypothesis ($r = 5$) was rejected as the LR value was non-significant at 5 percent probability level ($P<0.05$). This test confirmed that all the six selected cocoa markets had 4 cointegrating vectors out of 6 cointegrating equations, indicating that they are well integrated and price signals are transferred from one market to the other to ensure efficiency. Thus, Saikkonen and Lütkepoh cointegration test show that even though these major cocoa markets in West Africa are geographically isolated and spatially segmented, they are well-connected in terms of cocoa prices, indicating that these selected markets have long-run price linkage across them. Also, it signifies that there is one stochastic trend present in the system.

Table 3: Overall Cointegration in major cocoa markets

H_0	H_1	LR	Critical Value at 5%	P-value
r = 0	r ≥1	158.95*	83.80	0.0000
r ≤ 1	r ≥2	097.82*	59.95	0.0000
r ≤ 2	r ≥3	054.66*	40.07	0.0007
r ≤ 3	r ≥4	040.18*	24.16	0.0001
r ≤ 4	r =5	010.12	12.26	0.1142

Note: *denotes rejection of the null hypothesis at 5 per cent level of significance

Saikkonen and Lütkepoh Pair-wise Cointegration Test

Results of pair-wise cointegration test across the markets are presented in Table 4. A perusal of Table 4 shows that these market pair, *viz.*, Ivory Coast-Cameroon, Ivory Coast-Congo, Ivory Coast-Ghana, Ivory Coast-Nigeria, Ivory Coast-Togo, Cameroon-Congo, Cameroon- Nigeria, Cameroon-Togo, Congo-Nigeria, Ghana-Nigeria and Ghana-Togo, had zero cointegrating vector(s), implying that these market pairs are not cointegrated, thus, non-existence of long-run price association between them. On the other hand, these market pairs: Cameroon-Ghana, Congo-Ghana and Congo-Togo had one cointegrating equation, indicating existence of cointegration between these market pairs, thus, long-run price association between these three market pairs. The reasons for non-integration between market pair may be due to differences in product grades which command different prices, poor market conducts, arbitrary marketing costs, low market arrivals, while the opposite are the reasons for those market pairs that are integrated.

Table 4: Pair-wise cointegration in major cocoa markets

Market pair	H_0	H_1	LR	Critical value (5%)	Cointegrtaing equation (s) (CE)
Ivory Coast-Cameroon	r = 0	r ≥1	31.94	16.10	NONE
	r ≤ 1	r ≥2	12.91	6.93	
Ivory Coast-Congo	r = 0	r ≥1	46.82	16.10	NONE
	r ≤ 1	r ≥2	13.03	6.93	
Ivory Coast-Ghana	r = 0	r ≥1	20.48	16.10	NONE
	r ≤ 1	r ≥2	13.11	6.93	
Ivory Coast-Nigeria	r = 0	r ≥1	23.46	16.10	NONE
	r ≤ 1	r ≥2	9.42	6.93	
Ivory Coast-Togo	r = 0	r ≥1	34.46	16.10	NONE
	r ≤ 1	r ≥2	12.90	6.93	
Cameroon-Congo	r = 0	r ≥1	44.23	16.10	NONE
	r ≤ 1	r ≥2	15.78	6.93	
Cameroon-Ghana	r = 0	r ≥1	27.50	16.10	1CE
	r ≤ 1	r ≥2	1.48	6.93	
Cameroon-Nigeria	r = 0	r ≥1	29.54	16.10	NONE
	r ≤ 1	r ≥2	11.29	6.93	
Cameroon-Togo	r = 0	r ≥1	29.94	16.10	NONE
	r ≤ 1	r ≥2	10.11	6.93	
Congo-Ghana	r = 0	r ≥1	31.25	16.10	1CE
	r ≤ 1	r ≥2	5.31	6.93	
Congo-Nigeria	r = 0	r ≥1	39.22	16.10	NONE
	r ≤ 1	r ≥2	10.81	6.93	
Congo-Togo	r = 0	r ≥1	21.80	16.10	1CE
	r ≤ 1	r ≥2	6.37	6.93	
Ghana-Nigeria	r = 0	r ≥1	26.49	16.10	NONE
	r ≤ 1	r ≥2	8.29	6.93	
Ghana-Togo	r = 0	r ≥1	23.96	16.10	NONE
	r ≤ 1	r ≥2	14.93	6.93	
Nigeria-Togo	r = 0	r ≥1	26.52	16.10	NONE
	r ≤ 1	r ≥2	9.73	6.93	

Note:*denotes rejection of the null hypothesis at 5 per cent level of significance

Error Correction Model

The presence of co-integration in the multivariate analysis indicates the existence of long-run equilibrium among these cointegrated variables. The short-run dynamics of the cointegrated equation was modeled through the error correction model. The error correction term indicates the speed of adjustment among the variables before converging to equilibrium in the dynamic model, with the coefficient showing how quickly variable(s) return back to equilibrium. Perusal of Table 5 indicates

coefficients of speed of adjustment for all the markets except Cameroon market to be significant with each having negative signs, implying that prices in these markets tend to converge in the long-run. The coefficients of error correction terms/speed of adjustments of prices with respect to Ivory Coast, Congo, Ghana, Nigeria and Togo markets are -0.483; -0.959; -0.443; -0.876 and -0.138 respectively, indicates that approximately 48.3, 95.9, 44.3, 87.6 and 13.8 percent of the discrepancies between long-term and short-term or divergence from the long-run equilibrium were being corrected each year. In other words, any disturbance in market prices will get corrected in about 5 months in Ivory Coast; approximately 11 months in Congo, approximately 5 months in Ghana, approximately 10 months in Nigeria and approximately 1 month in Togo cocoa markets respectively, to restore back to long-run equilibrium as indicated by the level of significance and the rapid speed of adjustment. However, the process of adjustments in Congo and Nigeria markets were relatively slow and might be due to high transfer and transaction costs in these markets, low market performance and conduct, low market arrivals and poor infrastructure; adjustment process *viz.* Ivory Coast and Ghana markets are moderate, while Togo market has fast adjustment process, which is attributed to high efficiency. The insignificant of error correction term of Cameroon market may be due to very high transaction costs, spatiality with almost all the market except Nigeria, very low market arrivals, poor market performance and conduct, and poor market infrastructures, thus causing inefficiency in this market.

In the short run, Ivory Coast market prices was influenced by market prices of Congo, Cameroon and its own market prices; Congo market prices was not influenced in the short run by any of the market prices, inclusive itself; Cameroon market prices was only influenced by Togo market prices; Ghana cocoa market prices was influenced by almost all the market prices (itself inclusive) except Ivory Coast market prices; Nigeria market prices was influenced by only Congo market price; while Togo market prices was influenced by Ghana market, Ivory Coast market and its own market prices, respectively. In other words, for Ivory Coast market, two lags joint significance tests indicates short run causality running from Congo market to Ivory Coast market and also from Cameroon market to Ivory Coast market ; for Congo, joint significance tests shows no causality running from any of the markets to Congo market in the short run; for Cameroon market, two lags joint significance tests showed only one short run causality running from Togo market to Cameroon market; for Ghana market, two lags joint significance tests indicates short run causality running from all the markets except Ivory Coast market to Ghana markets; for Nigeria market, two lags joint significance tests indicates only one short run causality running from Congo market to Nigeria market; while for Togo market, two lags joint significance tests indicates short run causality running from Ghana market to Togo market and also from Ivory Coast markets to Togo market. To strength the linkages and interconnectedness among these markets for speedy price transmission and management of commodity from surplus area to deficit area, the clarion call is to enhance the development of market infrastructure, use of information and technology in transaction of goods, processing, transportation and other back-end supply chain of cocoa. These will definitely help in the development of single integrated economic market for cocoa in West Africa.

Table 5: Vector Error Correction Model of major cocoa markets

Variable	D(Ivory coast)	D(Cameroon)	D(Congo)	D(Ghana)	D(Nigeria)	D(Togo)
ECT	-0.483	-0.959	-0.207	-0.443	-0.876	-0.138
	(0.119)	(0.498)	(0.177)	(0.079)	(0.317)	(0.047)
	{-4.059}***	{-1.926}**	{-1.168}^{NS}	{-5.637}***	{-2.765}***	{-2.945}***
D(Ivory Coast)	-0.207	-0.181	0.356	-0.049	0.351	-0.174
	(0.101)	(0.150)	(0.422)	(0.067)	(0.269)	(0.040)

	{-2.057}**	{-1.204}^{NS}	{0.844}^{NS}	{-0.734}^{NS}	{1.307}^{NS}	{-4.366}^{NS}
D(Cameroon)	0.373	0.118	0.090	0.485	0.070	-0.046
	(0.185)	(0.276)	(0.773)	(0.122)	(0.492)	(0.073)
	{2.018}**	{0.429}^{NS}	{0.117}^{NS}	{3.972}^{NS}	{0.141}^{NS}	{-0.636}^{NS}
D(Congo)	0.567	0.105	-0.103	0.205	0.387	-0.004
	(0.081)	(0.121)	(0.339)	(0.053)	(0.126)	(0.032)
	{7.003}***	{0.873}^{NS}	{-0.305}^{NS}	{3.839}^{NS}	{1.797}*	{-0.124}^{NS}
D(Ghana)	-0.340	0.509	0.787	0.517	-0.086	0.732
	(0.270)	(0.402)	(1.128)	(0.178)	(0.718)	(0.106)
	(-1.261)^{NS}	{1.267}^{NS}	{0.698}^{NS}	{2.906}***	{-0.120}	{6.884}***
D(Nigeria)	-0.073	-0.128	-0.196	-0.106	-0.039	-0.024
	(0.067)	(0.100)	(0.282)	(0.044)	(0.179)	(0.027)
	{-1.085}^{NS}	{-1.279}^{NS}	{-0.697}^{NS}	{-2.392}**	{-0.218}^{NS}	{-0.918}^{NS}
D(Togo)	-0.286	-0.797	0.282	-0.855	-0.761	-0.474
	(0.217)	(0.323)	(0.906)	(0.143)	(0.577)	(0.085)
	{-1.322}^{NS}	{-2.467}**	{0.311}^{NS}	{-5.981}***	{-1.318}^{NS}	{-5.545}***
Constant	11.3 (2.1)***	5.2(3.2)^{NS}	13.5(8.9)^{NS}	10.3(1.4)^{NS}	10.7(5.7)*	9.3(0.8)***
Trend	0.15(2.1)***	0.13(0.03)***	0.1(0.1)^{NS}	0.12(0.1)***	-0.1(0.1)*	0.2(0.0)***

Note: *** ** * implies significance at 1%, 5% and 10% respectively, NS: Non-significant, (); {} implies Standard error and t-statistic

Granger Causality Test

After finding cointegration among different cocoa markets, granger causality was also estimated between the selected pairs of selected cocoa markets in West Africa. The granger causality shows the direction of price formation between two markets and related spatial arbitrage, i.e., physical movement of the commodity to adjust the prices difference. Results of granger causality tests showed that t-statistics for the causality tests of producers' prices *viz.* Cameroon; Congo; Ghana and Togo markets respectively, on other markets were statistically significant (Table 6). Thus, null hypothesis of no granger causality were rejected for these markets. However, t-statistics for the causality with respect to Ivory Coast and Nigeria markets on other markets were not significant. Therefore, the null hypotheses of no granger causality were accepted.

A perusal of the granger causality tests (Table 6), revealed unidirectional causalities between these market pairs: Cameroon-Ivory Coast; Congo-Ivory Coast; Ghana-Ivory Coast; Togo-Ivory Coast; Cameroon-Nigeria; Congo-Nigeria; Ghana-Nigeria; Togo-Nigeria market pairs, meaning that a price change in the former market in each pair granger causes the price formation in the latter market, whereas the price change in the latter market is not feedback by the former market in each pair, i.e a change in the price of the former market in each pair granger cause change in the price of the latter, while a change in the latter do not granger cause change in the price of the former in each market pair. Furthermore, bidirectional causality were observed to exist between Cameroon-Congo, Cameroon-Ghana, Cameroon-Togo, Congo-Ghana, Congo-Togo and Ghana-Togo market pairs. In these cases, the former market in each pair granger causes the price formation in the latter market which in turn provides the feedback to the former market as well, i.e a change in the price of the former market granger cause a change in the price of the latter market, which inturn granger cause a change in the price of the former market in each market pair. However, Ivory Coast-Nigeria market pair has no direct causality between them, implying that neither Ivory Coast market granger cause the price formation in Nigeria market, nor the Nigeria market granger cause the price formation in Ivory Coast market. In other words, there is no long-run price association between this market pair.

Therefore, it can be inferred that markets *viz.* Cameroon, Congo, Ghana and Togo were efficient because they had causal effects, while Ivory Coast and Nigeria markets were not efficient because they had no causal effects on other markets. Furthermore, it is obvious that Nigeria cocoa market is a price follower and not a price setter in West Africa cocoa market, which is very unfortunate for a country that

occupy a prime position in international cocoa market in 60s to early 80s. The outcome with respect to Ivory Coast Cocoa market is surprising, given that it is the current largest cocoa producing country in Africa, though, lingering political instability (episodic condition) may be responsible for inefficiency. However, the researchers opined that the major drawbacks of efficiency in Nigeria cocoa market can be attributed to total neglect of agriculture after the oil boom, abolition of commodity boards, low market arrivals, poor market conduct, poor market performance, lackadaisical political will from the government and ineptitudes of the research institutes mandated with the promotion of this commodity.

Table 6: Pair-wise Granger causality in major cocoa markets

H_0	t-stat	Prob.(P<0.05)	Granger cause	Direction
Cameroon → Congo	2.17	0.037**	Yes	**Bidirectional**
Cameroon ← Congo	9.12	0.000**	Yes	
Ghana → Cameroon	2.61	0.013**	Yes	**Bidirectional**
Ghana ← Cameroon	2.17	0.037**	Yes	
Ivory Coast → Cameroon	1.41	0.205	No	**Unidirectional**
Ivory Coast ← Cameroon	2.17	0.037**	Yes	
Nigeria → Cameroon	1.32	0.248	No	**Unidirectional**
Nigeria ← Cameroon	2.17	0.037**	Yes	
Togo → Cameroon	3.09	0.004**	Yes	**Bidirectional**
Togo ← Cameroon	2.17	0.037**	Yes	
Congo → Ghana	9.12	0.000**	Yes	**Bidirectional**
Congo ← Ghana	2.61	0.013**	Yes	
Ivory Coast → Congo	1.41	0.205	No	**Unidirectional**
Ivory Coast ← Congo	9.12	0.000**	Yes	
Nigeria → Congo	1.32	0.248	No	**Unidirectional**
Nigeria ← Congo	9.12	0.000**	Yes	
Togo → Congo	3.09	0.004**	Yes	**Bidirectional**
Togo ← Congo	9.12	0.000**	Yes	
Ghana → Ivory Coast	2.61	0.013**	Yes	**Unidirectional**
Ghana ← Ivory Coast	1.41	0.205	No	
Nigeria → Ghana	1.32	0.248	No	**Unidirectional**
Nigeria ← Ghana	2.61	0.013**	Yes	
Togo → Ghana	3.09	0.004**	Yes	**Bidirectional**
Togo ← Ghana	2.61	0.013**	Yes	
Ivory Coast → Nigeria	1.41	0.205	No	**None**
Ivory Coast ← Nigeria	1.32	0.248	No	
Togo → Ivory Coast	3.09	0.004**	Yes	**Unidirectional**
Togo ← Ivory Coast	1.41	0.205	No	
Nigeria → Togo	1.32	0.248	No	**Unidirectional**
Nigeria ← Togo	3.09	0.004**	Yes	

Note:**denotes rejection of the null hypothesis at 5 per cent level of significance

Instantaneous Causality Test

Also, it is important to investigate the short-run price association between market pair for quick adjustment with respect to market arrivals (Table 7). According to instantaneous causality tests, only bidirectional causality exist between all these market pairs, Ivory Coast-Cameroon, Ivory Coast-Congo, Ivory Coast-Ghana, Ivory Coast-Nigeria, Ivory Coast-Togo, Cameroon-Congo, Cameroon-Ghana, Cameroon-Nigeria, Cameroon-Togo, Congo-Ghana, Congo-Nigeria, Congo-Togo, Ghana-Nigeria, Ghana-Togo and Nigeria-Togo, indicating that a change in the price of the former market in each pair will granger cause a change in the price of the latter which in turn granger cause a change in the price of the former market in each market pair, i.e, there is feed-forward and feed-backward relationship between these market pairs. This implies there is short-run association between this market pair.

Table 7: Pair-wise Instantaneous causality in major cocoa markets

H_0	T-stat	Prob.(P<0.05)	Instantaneous cause	Direction
Cameroon → Congo	21.33	0.000**	Yes	Bidirectional
Cameroon ← Congo	27.51	0.000**	Yes	
Ghana → Cameroon	54.66	0.000**	Yes	Bidirectional
Ghana ← Cameroon	21.33	0.000**	Yes	
Ivory Coast → Cameroon	48.06	0.000**	Yes	Bidirectional
Ivory Coast ← Cameroon	21.33	0.000**	Yes	
Nigeria → Cameroon	36.59	0.000**	Yes	Bidirectional
Nigeria ← Cameroon	21.33	0.000**	Yes	
Togo → Cameroon	41.67	0.000**	Yes	Bidirectional
Togo ← Cameroon	21.33	0.000**	Yes	
Congo → Ghana	27.51	0.000**	Yes	Bidirectional
Congo ← Ghana	54.66	0.000**	Yes	
Ivory Coast → Congo	48.06	0.000**	Yes	Bidirectional
Ivory Coast ← Congo	27.51	0.000**	Yes	
Nigeria → Congo	36.59	0.000**	Yes	Bidirectional
Nigeria ← Congo	27.51	0.000**	Yes	
Togo → Congo	41.67	0.000**	Yes	Bidirectional
Togo ← Congo	27.51	0.000**	Yes	
Ghana → Ivory Coast	54.66	0.000**	Yes	Bidirectional
Ghana ← Ivory Coast	48.06	0.000**	Yes	
Nigeria → Ghana	36.59	0.000**	Yes	Bidirectional
Nigeria ← Ghana	54.66	0.000**	Yes	
Togo → Ghana	41.67	0.000**	Yes	Bidirectional
Togo ← Ghana	54.66	0.000**	Yes	
Ivory Coast → Nigeria	48.06	0.000**	Yes	Bidirectional
Ivory Coast ← Nigeria	36.59	0.000**	Yes	
Togo → Ivory Coast	41.67	0.000**	Yes	Bidirectional
Togo ← Ivory Coast	48.06	0.000**	Yes	
Nigeria → Togo	36.59	0.000**	Yes	Bidirectional
Nigeria ← Togo	41.67	0.000**	Yes	

Note:**denotes rejection of the null hypothesis at 5 per cent level of significance

Impulse–response functions

With a model considered acceptably well specified, we estimated the impulse response functions. Whereas IRFs from a stationary unrestricted VAR die out over time, IRFs from a restricted VAR (VECM) do not always die out. Because each variable in a stationary unrestricted VAR has a time invariant mean and finite, time-invariant variance, the effect of a shock to any one of these variables must die out so that the variable can revert to its mean. In contrast, the I(1) variables modeled in a restricted VAR (VECM) are not mean reverting, and the unit moduli in the companion matrix imply that the effects of some shocks will not die out over time. These two possibilities gave rise to new terms. When the effect of a shock dies out over time, the shock is said to be transitory, while if the effect of a shock does not die out over time, the shock is said to be permanent.

The graphs indicated that an orthogonalized shock to the prices of cocoa in Cameroon market will have permanent effects on the prices of Togo market, and a transitory effects on its own prices and prices in Cameroon; Congo: Ghana and Nigeria markets respectively. An orthogonalized shock to the prices of cocoa in Congo market will have transitory effects on all the markets; unexpected shock that are local to the Ghana cocoa market will have a transitory effects on all other markets; unexpected shock that are local to the Togo cocoa market will have transitory effects on all other markets; while an orthogonalized shock to the price of cocoa in Nigeria market will have permanent effects on its own market price and Togo market, and a transitory effects on the prices in other markets. Unexpected

shocks that are local Ivory Coast market will have permanent effects on almost all the market, with no effect no effect on Congo market (Figure 3). With respect to permanent effect, it can be inferred that there exist active price transmission between Cameroon-Togo markets, and Nigeria-Togo markets, which may be attributed to market arrival in Togo market and proximity.

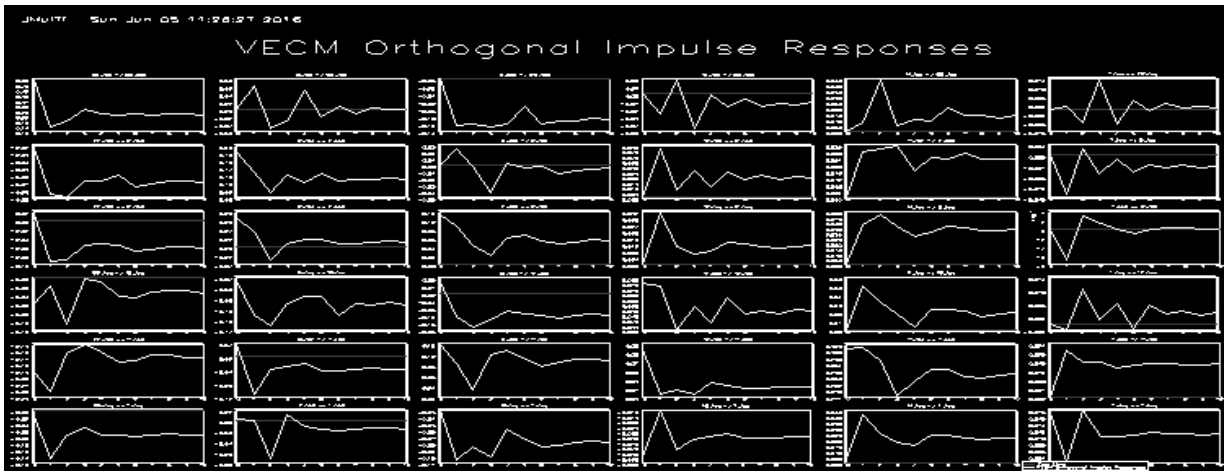


Figure 3: Impulse response functions

Note: Column 1(Congo→ all other markets); Column 2 (Cameroon→ all other markets); Column 3(Ghana→ all other markets); Column 4(Ivory Coast→ all other markets); Column 5(Nigeria→ all other markets), and Column 6(Togo→ all other markets)

Forecasting using VECM

Cointegrating VECMs are also used to produce forecasts of both the first-differenced variables and the levels of the variables. Comparing the variances of the forecast errors of stationary unrestricted VAR with those from a restricted VAR (VECM) reveals a fundamental difference between the two models. Whereas the variances of the forecast errors for a stationary unrestricted VAR converge to a constant as the prediction horizon grows, the variances of the forecast errors for the levels of a restricted VAR (VECM) diverge with the forecast horizon (Lütkepohl , 2005). Because all the variables in the model for the first differences are stationary, the forecast errors for the dynamic forecasts of the first differences remain finite (Figure 5).

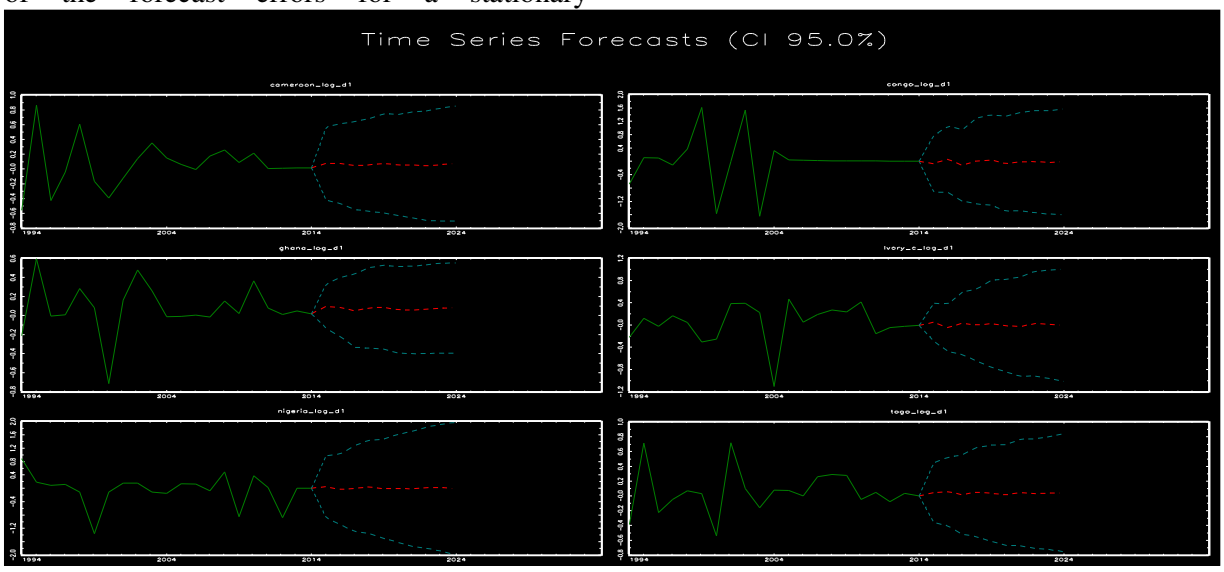


Figure 5: VECM forecast

VECM Diagnostic Checking

Diagnostic checking *viz*. autocorrelation and normality tests for residuals were conducted to determine the suitability of VECM (Table 8). The test indicates no autocorrelation in the residuals as evident from the t-statistic which was not different from zero at 5 percent probability level (P>0.05), thus, the null hypothesis of no autocorrelation was accepted and the alternative rejected. For normality test (Lütkepohl), results indicate that the residuals were normally distributed as evident from t-statistics which were different from zero, i.e were significant at 5 percent probability level (P<0.05), thus, the alternative hypotheses were accepted while the null was rejected. Therefore, it can be inferred that the model used certified all the necessary criteria for it to be term best fit. However, Doornik and Hansen, and Jarque-Bera tests of normality were not different from zero, thus contradicting Lütkepohl test for normality. It should be noted that a situation of non-normality is not considered a serious problem, because in most cases data are not normally distributed.

Table 8: VECM Diagnostic test

Test	T-stat	P-value
Portmanteau Test (Autocorrelation)	386.19	1.000
Normality Tests		
1. Doornik and Hansen (1994)		
Joint test	17.89	0.1191
Skewness	9.93	0.1276
Kurtosis	7.96	0.24
2. Lütkepohl (1993)		
Joint test	65.82	0.0000
Skewness	27.28	0.0001
Kurtosis	38.54	0.0000
3. Jarque – Bera Test	0.6482	0.7232

Extent of Price Volatility in cocoa markets

The GARCH model results indicated that different models of various order fit different markets, and Ivory Coast market was found to have the highest GARCH order (1, 2) (Table 9). Estimated sum of the gamma and beta coefficients for Ghana, Nigeria and Togo markets, were close to 'one', indicating persistence of volatility in cocoa prices of these markets, while the estimated sum of gamma and beta coefficients for Ivory Coast, Cameroon and Congo markets showed explosive pattern of volatility as the summed coefficient exceeded one, which infers high attendant risks in marketing of cocoa in these countries, i.e., producers in these countries are not making remunerative returns in cocoa marketing due to poor market as a result of persistent episodic conditions. Therefore, Ivory Coast, Cameroon and Congo governments need to put in place drastic measures to ensure remunerative prices in cocoa trading for their producers. The reasons for persistence volatility in prices *viz*. Ghana, Nigeria and Togo markets could be due to low market arrivals and changing world trade policies in cocoa market.

Results of GARCH analysis revealed that volatility in current cocoa prices in Ivory Coast market was caused by two years lagged prices as evident by significant two years lagged GARCH-term; volatility in current cocoa prices in Cameroon market was caused by preceding year prices and information on the preceding year prices as evident by significance one year lagged GARCH and ARCH-terms; volatility in the current cocoa prices in Congo market was caused by one year lagged prices and information on one year lagged prices as evident by significance of one year lagged GARCH and ARCH-terms; and volatility in the current cocoa prices in Ghana, Nigeria and Togo markets were neither affected by lagged prices nor information on lagged prices as evident by non-significance of their respective GARCH and ARCH-terms. In otherwords, volatility for Ivory Coast, Cameroon, Congo markets were caused by internal/family shocks and assumed external shocks, while volatility in

rest of the markets is caused by only assumed external/international shocks, i.e., volatility in prices of other markets. Therefore it could be inferred that cocoa prices in Ghana, Nigeria and Togo markets had persistent fluctuation over a period of time and was maximum in Ghana market, while cocoa prices in Ivory Coast, Cameroon and Congo markets had explosive fluctuation over a period of time and was maximum in Ivory Coast market.

Table 9: Estimates of GARCH model for measuring volatility in prices of cocoa from 1991-2014

Particulars	Ivory Coast	Cameroon	Congo	Ghana	Nigeria	Togo
Constant	7.3E-07(0.0)^{NS}	1.2E-06 (0.01)^{NS}	1.4E-08(0.00)^{NS}	4.8E-06(0.0)^{NS}	4.3E-03(0.1)^{NS}	1.7E-03(0.3)^{NS}
Beta 1	0.11(0.36)^{NS}	0.67 (3.25)***	0.13(1.7)*	0.98(0.28)^{NS}	0.02(0.08)^{NS}	0.09(0.45)^{NS}
Gamma 1	0.28 (0.57)^{NS}	0.39 (1.69)*	0.87(7.61)***	0.013(0.10)^{NS}	0.14(0.013)^{NS}	0.014(0.0)^{NS}
Gamma 2	1.29(1.76)*	-	-	-	-	-
Log likelihood	36.02	39.32	34.8	38.3	28.3	38.7
GARCH fit	1,2	1,1	1,1	1,1	1,1	1,1
$\alpha + \beta$	1.68	1.06	1.0	0.993	0.16	0.104

Notes: Figures within the parentheses indicate the calculated t-statistic ,*** ** and * indicate the significance at 1%, 5% and 10% probability levels respectively, NS: Non-significant

Leverage effect in cocoa markets

Leverage effect is called correlation between past time and future volatility of prices. Negative news such as inflation has more impact on the volatility of prices than the positive news. If gamma_1 is positive and significant, thus we can say there is a leverage effect. In the TGARCH model for each market, gamma_1 were positive but non-significant, indicating no leverage effect in any of these markets, implying that producers will not leave cocoa business for other business, because their equity-debt ratio is equal as evident by non-significance of TGARCH-terms (Table 10). Therefore, neither good nor bad news has impact on conditional variance

Table 10: Estimates of TGARCH model for measuring leverage effects in prices of cocoa from 1991-2014

Particulars	Ivory Coast	Cameroon	Congo	Ghana	Nigeria	Togo
Constant	1.3E-07(0.1)^{NS}	3.8E-08 (0.00)^{NS}	5.7E-03(0.23)^{NS}	4.8E-05(0.0)^{NS}	4.5E-03(0.0)^{NS}	2.8E-05(0.0)^{NS}
Beta 1	0.4(0.10)^{NS}	0.95(1.4)	0.04(0.18)^{NS}	0.93(0.64)^{NS}	0.09(0.00)^{NS}	1.7E03(0.0)^{NS}
Gamma1	0.23 (0.12)^{NS}	0.19 (0.2)^{NS}	0.16(0.32)^{NS}	0.02(0.09)^{NS}	0.000(0.00)^{NS}	0.014(0.0)^{NS}
Gamma_1	0.01(0.00)^{NS}	0.07 (0.24)^{NS}	0.43(0.00)^{NS}	0.03(0.11)^{NS}	0.05(0.02)^{NS}	5.7E-02(0.2)^{NS}
Log likelihood	32.2	37.7	18.7	38.4	28.2	38.7

Notes: Figures within the parentheses indicate the calculated t-statistic *** ** and * indicate the significance at 1%, 5% and 10% probability levels respectively, NS: Non-significant

Diagnostic checking (GARCH and TGARCH)

Arch LM and normality tests were performed for all the series in other to determine the best model fits (Table 11). Results of Arch Lm tests for all the series indicates no arch effects in the residuals, as evident by the t-statistics which are not different from zero ($P > 0.05$), while the normality tests also indicates that the residuals of most of the series are normally distributed as evident by the t-statistics which are significant different from zero ($P<0.05$). However, normality distribution in residuals is not considered a serious problem, because most data are not normally distributed.

Table 11: Diagnostic checking for GARCH and TGARCH

Model	Market	ARCH-LM Test	Jarque-Bera Test
GARCH	Ivory Coast	0.47(0.79)	3.82(0.148)
	Cameroon	2.74(0.254)	8.33(0.02)
	Congo	0.42(0.81)	77.00(0.00)

	Ghana	1.23(0.54)	4.96(0.08)
	Nigeria	1.55(0.46)	5.26(0.07)
	Togo	4.93(0.09)	2.05(0.36)
TGARCH	Ivory Coast	0.06(0.97)	35.77(0.00)
	Cameroon	4.73(0.094)	1.54(0.46)
	Congo	2.59(0.27)	4.48(0.12)
	Ghana	1.03(0.60)	6.23(0.05)
	Nigeria	1.59(0.45)	5.27(0.072)
	Togo	5.23(0.07)	2.02(0.36)

Note: Values in parentheses are probability

Validation of ARIMA Model

Various combinations of the ARIMA models were tried after first differencing of all the series, and based on the smallest AIC value the best ARIMA model was selected. Among all the ARIMA models tested, ARIMA (0,1,1) model had minimum AIC and BSC values for all the series (Table 12a). Out of the total 23 data points (1991-2014), first 18 data points (1991to 2009) were used for model building, while the remaining 5 data points (2010 to 2014) were used for model validation, i.e one-step ahead forecasts of cocoa prices along with their corresponding standard errors using naïve approach for the period 2010 to 2014 in respect of above fitted model were computed.

Table 12a: AIC and BIC values of different ARIMA models

Market		**1,1,1**	**1,1,0**	**0,1,1**
Ivory Coast	AIC	313.21	313.00	312.93
	BSC	316.485	315.18	315.12
Cameroon	AIC	309.27	307.72	307.545
	BSC	312.54	309.899	309.73
Congo	AIC	319.91	327.298	318.144
	BSC	323.18	329.48	320.326
Ghana	AIC	296.147	294.79	294.7285
	BSC	299.42	296.97	296.91
Nigeria	AIC	360.07	358.02	357.93
	BSC	363.34	360.20	360.12
Togo	AIC	316.44	315.18	315.16
	BSC	319.71	317.37	317.35

One step ahead forecast (2010-2014) for cocoa prices in the selected markets in West Africa used in determining the accuracy of the chosen model are given in Table 12b.

Table 12b: One step ahead forecast of prices for selected cocoa markets in West Africa

Year	**Ivory Coast market**		**Cameroon market**		**Congo market**	
	Actual	**Forecast**	**Actual**	**Forecast**	**Actual**	**Forecast**
2010	1988.43	1322.22	2344.78	1944.58	380.85	375.71
2011	1703.33	1944.35	2361.55	2350.31	384.28	378.83
2012	1628.23	1771.36	2387.92	2436.67	387	382.15
2013	1591.44	1684.16	2422.39	2473.77	389.16	365.6
2014	1580.54	1641.14	2463.73	2508.71	390.88	369.14
Year	**Ghana market**		**Nigeria market**		**Togo market**	
	Actual	Forecast	Actual	Forecast	Actual	Forecast
2010	1678.32	1216.49	1032.47	1079.68	2639.78	2786.03
2011	1815.23	1804.49	1052.96	1000.12	2768.17	2730.79
2012	1835.94	1874.91	437.56	400.46	2557.62	2841.42
2013	1925.06	1888.30	437.56	400.33	2642.31	2661.92
2014	1958.65	1988.58	437.56	430.74	2642.31	2721.07

For measuring the accuracy in fitted time series model and validation of the forecasts, relative mean square prediction error (RMSPE), mean absolute prediction error (MAPE) and relative mean absolute prediction error (RMAPE) were computed. A perusal of Table 12c reveals that

in all the price series, RMAPE values were less than 10 percent, indicating the accuracy of the model used. Furthermore, as the root mean absolute prediction error (RMAPE) values of series were quite low, it confirmed that the selected ARIMA (0,1,1) can model and forecast volatile data efficiently.

Table 12c: Validation of models

Markets	MAPE	RMSPE	RMAPE (%)
Ivory Coast	25.75	55.52	0.181
Cameroon	53.27	14.25	2.31
Congo	12.15	0.57	3.1
Ghana	88.09	25.83	5.3
Nigeria	14.46	2.25	3.7
Togo	98.21	8.52	3.8

Forecasting

Out of sample forecast of cocoa prices for all the selected markets during the period 2015 to 2024 were estimated, and the forecast values along with their corresponding lower and upper 95 per cent confidence limit are shown in Table 13d. Results showed a rising trends in cocoa prices in all the markets, except Nigeria market, thus, onus lies on Nigerian policy makers to devise mechanism or strategy to improve the performance of cocoa production in Nigeria, so that producers, middlemen and even the government can benefit enormously from marketing of this cash crop. However, forecast values are depicted in Appendix 1 to visualize the future performance of this cash crop in major cocoa markets in West Africa. As indicated, prices of cocoa for Congo and Nigeria markets will be volatile during the period 2015-2024, as reflected by the wider confidence intervals associated with the ARIMA forecasts during this period. Alternatively, while the confidence intervals of cocoa price forecasts for Ivory Coast, Cameroon, Ghana and Togo markets, do fluctuate, they tend to be more stable. These, in part, reflect the relatively even growth of the cocoa production during the period 2015-2024.

Table 13d: Out of sample forecast of cocoa prices for selected markets in West Africa

Year	Ivory Coast market			Cameroon market		
	Forecast	**Upper CI**	**Lower CI**	**Forecast**	**Upper CI**	**Lower CI**
2015	1626.37	2169.98	1082.76	2548.92	3030.46	2067.39
2016	1664.62	2387.06	942.18	2626.06	3249.08	2003.03
2017	1702.87	2567.93	837.81	2703.19	3441.05	1965.33
2018	1741.13	2728.41	753.84	2780.33	3617.41	1943.24
2019	1779.38	2875.35	683.41	2857.46	3783.20	1931.72
2020	1817.63	3012.44	622.83	2934.60	3941.21	1927.98
2021	1855.88	3141.95	569.82	3011.73	4093.19	1930.27
2022	1894.14	3265.40	522.87	3088.86	4240.32	1937.41
2023	1932.39	3383.87	480.92	3165.99	4383.42	1948.58
2024	1970.64	3498.12	443.17	3243.13	4523.14	1963.13
Year	**Congo market**			**Ghana market**		
	Forecast	**Upper CI**	**Lower CI**	**Forecast**	**Upper CI**	**Lower CI**
2015	461.29	1031.54	108.96	2012.25	2372.67	1651.83
2016	467.13	1037.38	103.12	2070.34	2619.51	1521.17
2017	472.97	1043.22	97.28	2128.43	2816.38	1440.48
2018	478.81	1049.06	91.44	2186.52	2989.61	1383.43
2019	484.65	1054.90	85.60	2244.61	3148.29	1340.93
2020	490.49	1060.74	79.75	2302.70	3296.85	1308.55
2021	496.33	1066.58	73.91	2360.79	3437.83	1283.75
2022	502.17	1072.42	68.07	2418.88	3572.87	1264.89
2023	508.01	1078.26	62.23	2476.97	3703.10	1250.85
2024	513.85	1084.10	56.39	2535.06	3829.31	1240.82

Year	Nigeria market			Togo market		
	Forecast	Upper CI	Lower CI	Forecast	Upper CI	Lower CI
2015	409.65	1925.66	110.60	2726.79	3299.07	2154.51
2016	381.67	2745.26	198.19	2803.66	3574.85	2032.47
2017	353.69	3332.76	262.54	2880.52	3808.95	1952.10
2018	325.71	3813.29	316.19	2957.39	4020.03	1894.75
2019	297.72	4228.57	163.31	3034.25	4215.96	1852.54
2020	296.74	4598.70	105.91	3111.12	4400.95	1821.29
2021	241.76	4935.18	145.17	3187.99	4577.55	1798.42
2022	213.78	5245.33	181.78	3264.85	4747.46	1782.24
2023	185.80	5534.14	162.80	3341.72	4911.87	1771.57
2024	157.82	5805.21	148.96	3418.58	5071.64	1765.52

Note: CI: Confidence Interval

ARIMA Diagnostic Checking

The model verification is concerned with checking the residuals of the model to see if they contained any systematic pattern which still could be removed to improve the chosen ARIMA, and was done through examining the autocorrelations of the residuals. For this purpose, autocorrelations of the residuals were computed and it was found that none of these autocorrelations were significantly different from zero at any reasonable level (Table 13e). This proved that the selected ARIMA model was an appropriate model for forecasting the data efficiently. Also, distribution of the residuals were tested, and results indicates that most of the series were normally distributed ($P< 0.05$). However, normality in distribution of residuals is not considered to be a serious problem, because of inherent correlation among time series data (Table 13e).

Table 13e: ARIMA (0,1,1) Diagnostic checking

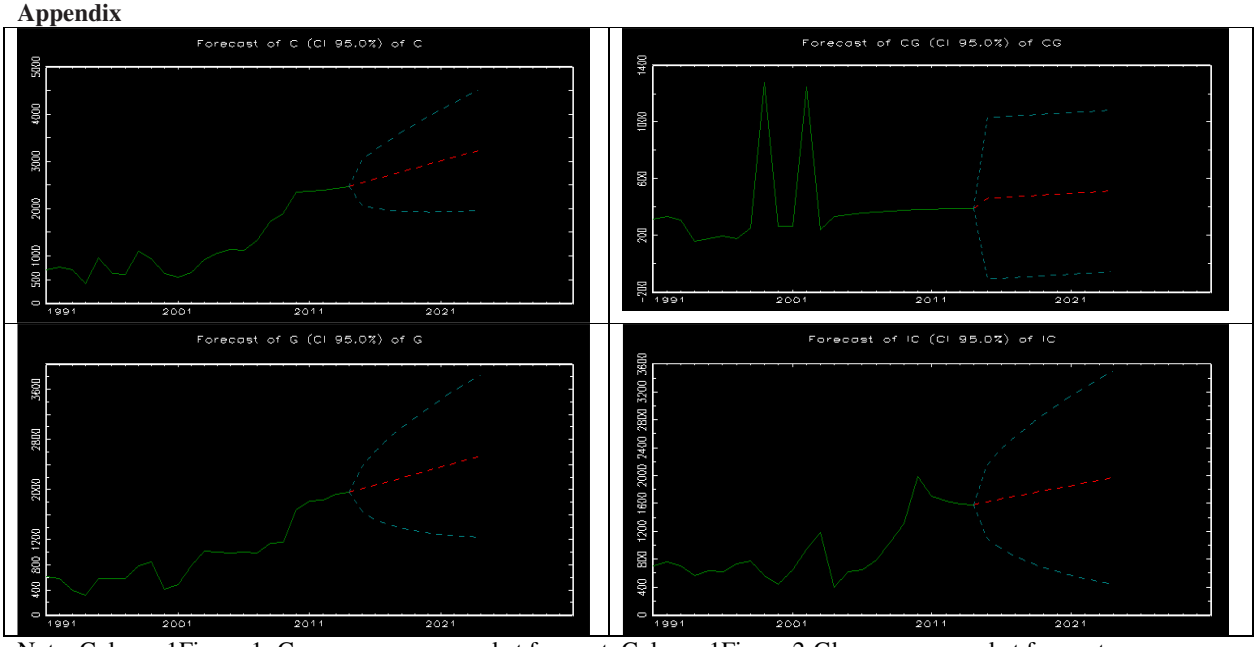
Markets	Autocorrelation Test		Jarque-Bera Test (Normality)
Ivory Coast	Portmanteau Test	0.401 (1.00)	5.804 (0.055)
	Ljung-Box Test	0.481 (1.00)	
Cameroon	Portmanteau Test	0.255 (1.00	0.5735 (0.7507)
	Ljung-Box Test	0.31 (1.00)	
Congo	Portmanteau Test	0.91(1.00)	60.199(0.00)
	Ljung-Box Test	1.06(1.00)	
Ghana	Portmanteau Test	2.268 (1.00)	3.289 (0.193)
	Ljung-Box Test	2.72 (1.00)	
Nigeria	Portmanteau Test	0.057 (1.00)	27.402 (0.00)
	Ljung-Box Test	0.069 (1.00)	
Togo	Portmanteau Test	0.027 (1.00)	1.789 (0.409)
	Ljung-Box Test	0.033 (1.00)	

CONCLUSION

The study empirically investigated cointegration, causality and price transmission among the major cocoa markets in West Africa. Results of tests for stationarity indicated that all the price series had unit roots at level, but after fist difference they became stationary, implying integration at order one. Furthermore, multiple cointegration test result showed that different cocoa markets in West Africa are well integrated and have long-run price association across them. The market pair-wise cointegration test confirmed only the pairs of Cameroon – Ghana; Congo – Ghana and Congo – Togo markets to have price association between them, while the remaining market pairs do not have any price association between them. The market prices in general, attains a long-run equilibrium relationship or converge in the long-run after restating and correcting prices ranging from -0.138 per cent to -0.959 per cent per annum in West Africa cocoa markets. However, six market pairs showed bidirectional causality, eight market pairs depicted unidirectional causality, and one market pair showed no causal

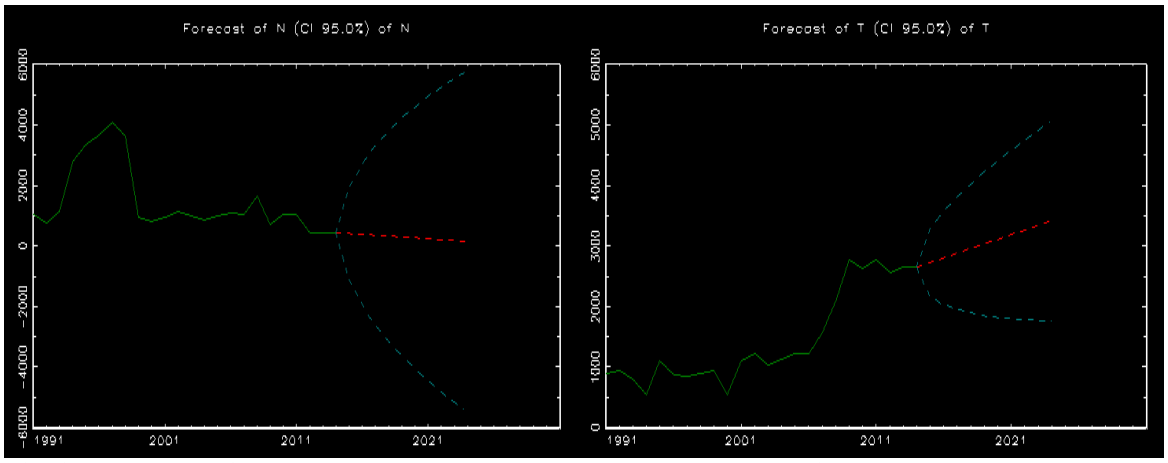
direction on price formation between them. This shows that cocoa markets in the region have acquired competitive strength in price formation after correcting short-run and long-run fluctuations. Results of impulse response functions confirmed that the speed as well as magnitude of a shock given to Ivory Coast market is highly transmitted to other markets except Congo market, thus indicating Ivory Coast market to be the trend setter in West Africa cocoa markets, while the remaining markets are trend followers. It should be noted that a positive standard deviation shocks in cocoa prices forces the consumers to shift from low-quality to high quality cocoa products and thus the rise in low-quality prices will be relatively less reflected in West Africa cocoa markets. Quality improvement in low- quality cocoa products is a meaningful implication reflected in Ivory Coast market. Therefore, Ivory Coast market was found comparatively competent, and this may be due to its leading position in cocoa production in the region- the centre-most among the selected cocoa markets in West Africa. As such, price signals in Ivory Coast market is quickly transmitted to other markets except Congo market. It means that the geographical situation and optimal distance between the market places hold the mutual forces on commodity movements and price formation. It is therefore, suggested that the network of west Africa cocoa markets should be well-designed so as to enhance technical efficiency, because it will not only boost a direct inter-market competition, but will also control the high marketing margins. Strengthening of physical infrastructure, use of information and communication technology and well defined transparent agricultural policy or market measures in the region will help in the development of single uniform economic market in the region in particular and Africa in general. Results of volatility showed explosive as well as persistent volatilities over a period of time. However, leverage effects were not observed in any of the markets. ARIMA (0,1,1) was found suitable to forecast the future prices in all the selected markets. Based on these findings, the researchers recommend that the regional organization i.e ECOWAS should devise a mechanism that will improve the symmetric nature of information among participants in cocoa marketing in the region, because excessive externality costs could distort the free flow of cocoa and bring about significant price differential among these markets in the region; thus all sources of such costs in the region should be curtailed.

Appendix



Note: Column 1Figure 1- Cameroon cocoa market forecast; Column 1Figure 2-Ghana cocoa market forecast

Column 2 Figure 1- Congo cocoa market forecast; Column 2 Figure 2- Ivory Coast market forecast.



Nigeria cocoa market forecast

Togo cocoa market forecast

REFERENCES

Acharya, S.S., Chand, R., Birthal, P. S., Kumar, Shiv and Negi, D.S., 2012.*Market Integration and Price Transmission in India: A Case of Rice and Wheat with Special Reference to the World Food Crisis of 2007- 08*. Food and Agriculture Organization, Rome. Pp. 1-67.

Akpan, S.B., Patrick, I.V. and Udoka, S.J., 2014.Analysis of monthly price transmission of local and foreign rice in rural and urban markets in Akwa Ibom State, Nigeria (2005 to 2013). *International Journal of Agriculture and Forestry*, Vol. 4(1): 6-18

Beag, F.A. and Singla, N., 2014.Cointegration, causality and impulse response analysis in major Apple Markets of India. *Agricultural Economics Research Review,* Vol. 27(2):289-298

Blay, J.K., Maiadua, S.U. and Sadiq, M.S., 2015. Horizontal market integration and price transmission between maize, sorghum and millet in Dawanau market, Kano State, Nigeria: Evidence from non-linear vector error correction model. *Global Journal of Agricultural Economics, Extension and Rural Development*, Vol. 3(10):330-337.

Dickey, D.A. and Fuller, W.A., 1979. Distribution of estimators for Autoregressive Time Series with a Unit root. *Journal of the American Statistical Association,* Vol. 74: 427-431.

Granger, C.W.J., 1969. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, Vol. 37(3): 424-38.

Mafimisebi T.E., Agunbiade B.O., and Mafimisebi O.E., 2013.Price variability, co-integration and leadership in the market for locally produced Rice: A case study of Southwest Zone of Nigeria. *Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammamet, Tunisia*

Mahallea, S.L., Shastrib, S. and Kumar, S., 2015. Integration of wheat markets in Maharashtra. *Agricultural Economics Research Review* Vol. 28 (No.1) 179-187

Rahman, M.M. and Shahbaz, M., 2013. Do imports and foreign capital inflows lead Economic Growth? cointegration and causality analysis in Pakistan. *South Asia Economic Journal*, Vol. 14(1): 59-81

Rapsomanikis, G., Hallam, D., Comforti, P. and Sharma, R.,2006. Market integration and price transmission in selected food and cash crop markets of Developing Countries*: Review and Applications*. Commodities and Trade Division, Food and Agriculture Organization, Rome. Pp. 1-20.

Saikkonen, P. and Lütkepohl, H. 2000a. Testing for the cointegrating rank of a VAR process with an intercept. *Econometric Theory,* Vol. 16:373-406.

Saikkonen, P. and Lütkepohl, H. 2000b. Testing for the cointegrating rank of a VAR process with structural shifts. *Journal of Business and Economic Statistics,* Vol. 18: 451-464.

Saikkonen, P. and Lütkepohl, H., 2000c. Trend adjustment prior to testing for the cointegrating rank of a vector autoregressive process. *Journal of Time Series Analysis,* Vol. 21: 435-456.

ANALYSIS OF GENETIC VARIABILITY AND HERITABILITY FOR YIELD, QUALITY, AND RESISTANCE TO VIRUS AND FRUIT FLY IN MUSKMELON

M.S. Fageria
Forest and Conservation Genomics and Biotechnology Lab, Faculty of Forestry and Environmental Management, University of New Brunswick, Tweeddale Centre, 1350 Regent Street, Fredericton NB E3C 2G6, CANADA
Saroj Rolania
Defence Research and Development Organization, Timarpur, Delhi, India-110054
Additional index words. Muskmelon, yield, quality, virus, fruit fly, genetic variability, heritability
Email: msfageria@hotmail.com
Received: 07.09.16
Accepted: 01.10.16

ABSTRACT

Muskmelon (*Cucumis melo* L.) is an important fruit crop in many parts of the world. In recent years, preference of consumers has shifted toward organic fruit with higher in TSS, and flesh thickness, better in flesh texture and flavour and of small sized seed cavity. However, viral diseases, particularly Cucumber mosaic virus (CMV), Watermelon mosaic virus, and Fruit fly (*Dacus cucurbitae, D. dorsalis*) are the limiting factors in organic crop production. We studied 112 diverse genotypes of muskmelon under virus and fruit fly pressure for yield, quality characteristics, and resistance against these pests. Replicated field experiments were conducted to determine phenotypic and genotypic coefficients of variation, heritability (broad sense) and genetic advance. The results revealed that the differences between the genotypes were highly significant for all the 12 characters studied. High estimates of heritability were recorded for number of fruits per hill, fruit yield, rind thickness, TSS, shelf life, severity of viruses and fruit fly incidence. High heritability along with high genetic advance was observed for incidence of fruit fly, severity of virus, number of fruits per hill, rind thickness, and shelf life.

Muskmelon (*Cucumis melo* L.) is one of the most important cucurbits, cultivated in many tropical, sub-tropical, and temperate regions around the world. It is a good cash crop in Asia and South American countries and is an unavoidable item of Western dietary. India being the centre of diversity provides a greater range of variation for genetic improvement of muskmelon. Production and resistance are the two major pathways in the development of superior genotypes and achievement of the goal of self sustenance. Before aiming an improvement in yield, and resistance against fruit fly and virus it is necessary to have the knowledge of genetic variability present in a population. Large variability ensures better chances of producing new forms. It is known that the apparent variability in a population is the result of genetic and environmental factors. To apportion the observed variability to these two factors, parameters such as genotypic and phenotypic coefficients of variation (GCV and PCV) have to be assessed. Heritability is another index for calculating the influence of environment on the expression of the genotypes. Genotypic coefficient of variation together with heritability estimates provide best picture about the extent of advance to be expected by selection. Estimates of genetic advance together with heritability would be helpful in assessing nature of gene actions. Therefore, the present investigation was conducted to estimate PCV, GCV, heritability, and genetic advance for yield and yield attributes and resistance to fruit fly and virus in muskmelon.

MATERIALS AND METHODS

The material for this experiment consisted of 112 elite diverse genotypes of muskmelon. These genotypes were procured from Department of Horticulture, ARS, Durgapura, Jaipur, India. The experiment was laid out in a randomized block design with three replications under open field conditions during summer season. The two lines of each genotype accommodating 20 plants with row-to-row and plant-to-plant distance of 200 cm and 60 cm respectively were planted under ridge and furrow method of planting. All recommended cultural and management practices were followed to raise a healthy crop. All the observations were recorded on five randomly selected plants in each genotype for characters

like vine length, days taken to first fruit harvest, average weight of first three harvested fruits, number of fruits per hill, fruit yield per hill, size of seed cavity, rind thickness, flesh thickness, TSS, shelf life, severity of virus and incidence of fruit fly and average was taken. The coefficients of variation were estimated as per Burton and De Vane (1953) and Johnson et al. (1955). Heritability in broad sense was calculated by the formula given by Hanson et al. (1956) and was multiplied by 100 (Lush, 1940) to get it in percentage. The genetic advance was calculated as suggested by Johnson et al. (1955).

RESULTS AND DISCUSSION

Highly significant variation was found among 112 genotypes of muskmelon with regard to all the characters studied (Table 1). The mean values of the genotypes are given in Table-2. On partitioning the total variance into genotypic and phenotypic variances, it was found that the phenotypic variances were generally higher than the genotypic ones, indicating significant effect of environment on the character expression.

A perusal of the data (Table-3) revealed that the PCV and GCV (which are free from the units of measurement) were high for fruit weight, number of fruits per hill, rind thickness, shelf life, and incidence of fruit fly. These results are in broad conformity to earlier researchers (Sachan and Tikka, 1971; Thakur and Nandpuri, 1974; Prasad et al., 1988). Similar results for number of fruits per plant in muskmelon have also been reported by Kalloo et al. (1983) and Vijay (1987). Somkuwar et al. (1997) observed high genotypic and phenotypic coefficients of variation for number of fruits per plant in muskmelon. Dharmendra et al. (2004) observed high PCV and GCV for fruit weight and number in muskmelon. Moderate values for genotypic and phenotypic coefficient of variation were recorded for vine length, fruit yield, size of seed cavity, flesh thickness, TSS and severity of virus. Similar results have been reported by Chhonkar et al. (1979), Swamy et al. 1985 and Prasad et al. (1993). Vijay (1987) recorded moderate to high coefficient of variation for flesh thickness and fruit yield per vine in muskmelon. The rest of the characters had low coefficients of variation. Thus, further selection for these characters would be least effective.

Besides information on PCV and GCV, heritability is useful in predicting the expected progress to be achieved through selection (Burton, De Vane, 1953; Hanson, et al 1956). High estimates of heritability were recorded for number of fruits per hill, fruit yield, rind thickness, flesh thickness, TSS, shelf life, severity of virus and fruit fly incidence (Table 3), which indicated that the large amount of phenotypic variation in these characters was genetically governed and response to selection for these characters would be high due to small effect of environment on character expression. Kalloo et al. (1983) reported high heritability for fruit yield in muskmelon. Swamy et al. (1985) reported high heritability for flesh thickness and total fruit yield per plant. Lal and Singh (1997) reported high estimates of heritability for yield and low for number of fruits per vine in muskmelon. Dharmendra et al. (2004) made a study on 33 genotypes of muskmelon and observed that heritability ranged from 31.2 (TSS per cent) to 89.2 per cent (fruit yield per plant), which was in general high for all the characters.

Moderate estimates of heritability were recorded for vine length, number of days to first fruit harvest, fruit weight, and size of seed cavity. None of the character had shown low estimate of heritability.

Johnson et al. (1956) stressed that for estimating the real effect of selection, heritability is not sufficient and genetic advance along with heritability is more useful. In the present study, high genetic advance was observed for rind thickness, incidence of fruit fly, shelf life, number of fruits per hill, fruit weight, and severity of virus. High genetic advance for fruit weight in muskmelon has been reported by Chhonkar et al. (1979), Swamy et al. (1985) and Lal and Singh (1997). Contrary to the present study, Vijay (1987) had reported low genetic advance for fruit fly incidence. Moderate genetic advance was observed for vine length, TSS, flesh thickness, fruit yield per hill and size of seed cavity. Moderate genetic advance for fruit weight in muskmelon has also been reported by earlier researchers (Chhonkar et al., 1985; Kalloo et al., 1986). The estimate of

genetic advance as percentage of mean was low for days to first fruit harvest. The low genetic advance for days to first fruit harvest in watermelon has been reported by Prasad et al. (1998).

High heritability along with high genetic advance was observed for incidence of fruit fly, severity of virus, number of fruits per hill, rind thickness, shelf life, and flesh thickness. Kalloo et al. (1983) reported high heritability coupled with high genetic advance for number of fruits in muskmelon. Somkuwar et al. (1997) reported high heritability with medium genetic advance for number of fruits per plant and cucumber green mottle mosaic virus (PDI). High heritability coupled with high genetic advance for these characters in present study indicates the presence of additive gene effects. In respect of traits such as fruit yield per hill, TSS and flesh thickness, high heritability was associated with moderate genetic advance, which again indicate that these characters might be under the control of additive gene action. High heritability along with moderate genetic advance for yield/plant has also been reported by Somkuwar et al. (1997). Moderate heritability in combination with moderate genetic advance was observed for vine length and size of seed cavity. Moderate heritability along with lower genetic advance for days to first fruit harvest may be attributed to the non additive gene effects and this may be improved through hybridization.

The visual data showed considerable genetic variation for quality traits in muskmelon (Table 4). This information can be utilized by the muskmelon breeders to breed desirable hybrids.

Table 1. Analysis of variance for fruit yield and other traits in muskmelon

Characters	**Mean Sum of Squares**		
Source of variation	**Replications**	**Genotypes**	**Error**
d f	**2**	**111**	**222**
Vine length	00.251	01.186**	0.1070
Days to first fruit	36.75**	60.356**	7.8100
Fruit weight	00.034	00.563**	0.0170
Fruits/hill	00.096	07.151**	0.1240
Yield/hill	0.246**	01.932**	0.0440
Size of seed cavity	00.866	05.404**	0.7010
Rind thickness	0.0014	0.0432**	0.00080
Flesh thickness	00.107	01.223**	0.0570
TSS	01.738	17.235**	0.7150
Shelf life	00.079	04.685**	0.0910
Severity of viruses	005.26	137.96**	2.0480
Incidence of fruit fly	002.27	418.13**	4.0560

** Significant at p= 0.01

Table 2. Estimates of mean values for fruit yield and other traits in muskmelon

Geno types	**Vine length**	**Days to first**	**Fruit weight**	**Fruits/ hill**	**Yield/ hill**	**Size of seed**	**Rind thickness**	**Flesh thickness**	**TSS (%)**	**Shelf life**	**Severity of viruses**	**Incidence of fruit fly**
GP-2	4.03	80.00	1.03	3.91	4.03	8.83	0.10	3.37	10.50	1.31	18.13(25.20)	55.67(48.25)
GP-4	3.13	82.73	0.93	4.41	4.10	8.00	0.40	2.27	10.00	2.41	17.27(24.55)	54.33(47.49)
GP-5	3.13	81.30	1.20	3.17	3.80	4.87	0.30	3.77	11.33	3.26	22.27(28.14)	10.00(18.42)
GP-6	3.07	87.87	1.73	2.18	3.77	9.00	0.31	3.13	8.93	4.88	26.93(31.26)	15.00(22.78)
GP-7	3.53	80.00	1.53	2.75	4.20	9.00	0.20	3.20	9.03	3.30	15.70(23.33)	20.00(26.55)
GP-11	2.53	74.57	0.87	5.44	4.73	8.00	0.50	3.20	13.00	3.07	12.53(20.72)	11.00(19.36)
GP-12	3.03	81.33	2.42	4.62	3.00	6.33	0.30	3.00	12.00	3.00	32.10(34.49)	27.00(31.30)
GP-13	3.10	80.67	1.07	3.64	3.90	6.50	0.49	3.20	7.10	3.71	21.57(27.66)	11.67(19.94)
GP-17	3.07	83.67	0.63	5.92	3.73	6.00	0.10	1.80	5.93	1.75	21.90(27.89)	65.67(54.18)
GP-18	2.53	75.00	0.57	7.19	4.10	6.17	0.20	2.57	11.60	2.03	17.67(24.85)	48.00(43.85)

Geno types	Vine length	Days to first	Fruit weight	Fruits/ hill	Yield/ hill	Size of seed	Rind thickness	Flesh thickness	TSS (%)	Shelf life	Severity of viruses	Incidence of fruit fly
GP-19	2.63	74.67	0.52	5.96	3.10	5.23	0.10	1.90	6.03	1.45	28.23(32.09)	60.33(50.99)
GP-21	3.03	82.67	0.77	6.49	5.00	7.50	0.20	2.87	10.00	2.80	9.20(17.64)	50.33(45.19)
GP-22	2.30	76.83	0.87	5.63	4.90	6.67	0.30	3.10	14.00	4.33	11.90(20.17)	18.00(25.08)
GP-24	3.03	81.67	0.87	6.36	5.53	6.83	0.31	3.80	7.93	2.95	8.60(17.03)	21.00(27.26)
GP-27	2.73	83.30	0.65	6.20	4.03	6.00	0.19	2.97	6.93	5.63	19.10(25.91)	15.00(22.78)
GP-29	2.73	78.77	0.77	3.86	3.20	7.50	0.11	1.97	8.57	2.93	27.53(31.64)	26.00(30.65)
GP-30	1.73	84.17	1.27	3.07	3.90	8.50	0.20	3.13	12.97	4.81	20.93(27.22)	11.67(19.97)
GP-31	2.53	84.40	1.10	4.25	4.67	5.43	0.20	4.00	10.83	3.33	12.73(20.90)	26.33(30.84)
GP-33	3.03	88.30	0.70	6.04	4.23	5.33	0.12	2.87	10.10	2.74	14.20(22.13)	50.67(45.38)
GP-34	3.53	88.40	0.68	5.15	3.50	7.00	0.21	3.10	14.00	5.40	25.27(30.16)	58.57(49.95)
GP-36	3.67	86.03	1.60	3.14	5.03	9.67	0.12	3.63	11.17	1.98	9.13(17.58)	61.00(51.36)
GP-37	2.75	77.83	0.79	5.62	4.33	6.17	0.21	2.67	13.33	5.20	16.17(23.70)	28.67(32.36)
GP-39	3.03	85.43	0.68	7.27	5.60	6.00	0.43	3.83	14.70	4.77	5.67(13.75)	35.00(36.26)
GP-40	3.63	87.33	1.07	3.64	3.90	8.00	0.40	3.80	11.03	1.90	21.37(27.51)	52.33(46.33)
GP-41	3.53	89.00	0.65	5.96	3.40	6.33	0.20	1.97	9.17	1.51	26.73(31.13)	67.33(55.15)
GP-42	3.33	85.97	0.67	5.71	4.00	8.50	0.11	1.93	11.80	1.35	19.77(26.39)	69.00(56.33)
GP-43	3.03	85.43	0.79	6.43	5.60	6.00	0.42	3.53	14.17	5.00	6.17(14.37)	18.67(25.59)
GP-44	3.17	88.07	1.20	3.41	4.40	7.33	0.41	4.03	13.07	4.10	15.93(23.52)	14.00(21.94)
GP-45	2.23	80.37	1.07	4.85	5.30	8.33	0.30	2.47	12.00	3.20	8.77(17.21)	35.33(36.47)
GP-48	2.57	84.53	0.65	6.32	2.40	5.50	0.30	2.03	13.07	5.23	47.17(43.38)	44.00(41.54)
GP-49	2.33	78.17	0.47	2.95	3.83	5.23	0.41	3.10	15.03	4.34	23.00(28.65)	16.00(23.57)
GP-59	3.03	78.43	1.43	2.59	5.17	7.50	0.30	3.17	14.00	6.12	8.40(16.84)	9.00(17.44)
GP-60	2.17	74.90	1.48	3.28	3.80	6.50	0.29	3.20	11.00	3.07	21.43(27.56)	17.67(24.84)
GP-61	1.53	75.13	1.40	5.33	4.10	5.33	0.20	4.30	7.17	3.00	17.40(24.65)	27.33(31.50)
GP-63	3.03	85.60	0.92	5.02	4.00	5.10	0.30	3.00	12.83	3.93	20.80(27.12)	29.33(32.79)
GP-68	3.03	87.50	0.85	1.54	5.17	6.33	0.40	3.10	12.50	2.60	9.13(17.58)	29.67(32.99)
GP-69	4.03	89.60	1.87	2.63	3.23	9.00	0.20	3.50	9.27	3.20	27.63(31.71)	27.00(31.30)
GP-72	2.53	84.33	1.80	4.00	5.00	7.50	0.21	4.53	16.60	2.95	9.13(17.57)	30.00(33.20)

Cont.....

Geno types	Vine length (m)	Days to first fruit harvest	Fruit weight (kg)	Fruits/ hill	Yield/ hill (kg)	Size of seed cavity (cm)	Rind thickness (cm)	Flesh thickness (cm)	TSS (%)	Shelf life (days)	Severity of viruses	Incidence of fruit fly
GP-73	2.53	85.17	1.43	2.77	4.00	7.83	0.30	3.47	13.43	4.67	18.37(25.37)	35.67(36.65)
GP-77	4.03	79.33	1.40	5.26	4.80	8.50	0.31	3.07	14.03	1.73	12.07(20.32)	58.00(49.61)
GP-82	3.03	86.60	1.23	5.44	5.10	8.33	0.22	2.07	13.33	2.62	8.37(16.80)	9.23(17.68)
GP-84	2.53	87.27	0.77	3.78	3.10	5.50	0.29	2.97	14.23	5.73	28.40(32.20)	8.83(17.28)
GP-85	2.03	88.07	0.81	3.45	3.97	6.83	0.31	3.50	10.10	4.82	20.13(26.65)	26.33(30.87)
GP-89	2.53	92.13	1.40	3.36	4.83	8.00	0.40	3.73	12.33	3.81	11.70(19.99)	19.00(25.84)
GP-90	2.83	85.90	1.17	3.99	4.03	6.50	0.31	3.63	8.20	4.68	19.10(25.91)	10.67(17.37)
GP-91	2.83	87.77	1.28	5.58	5.07	9.33	0.39	3.60	8.03	2.60	8.87(17.31)	12.67(20.84)
GP-92	2.23	84.77	0.88	4.30	4.07	6.60	0.31	2.70	11.67	2.43	18.37(25.37)	20.00(26.55)
GP-94	2.43	88.40	1.07	3.50	4.73	8.00	0.41	2.97	11.10	2.21	13.33(21.41)	40.00(39.22)
GP-95	2.53	80.37	1.40	6.74	5.50	6.17	0.41	4.10	12.50	5.27	7.20(15.55)	23.67(29.10)
GP-96	2.63	84.37	0.50	4.41	3.37	5.17	0.10	3.10	12.30	4.53	19.83(25.28)	47.00(43.28)
GP-98	3.23	76.67	0.83	5.04	3.67	6.80	0.60	3.87	12.00	5.48	23.77(29.17)	14.67(22.50)
GP-102	2.43	83.70	1.00	6.37	5.03	7.03	0.50	4.00	14.53	3.35	8.63(17.08)	50.67(45.38)
GP-105	4.13	78.00	0.90	3.19	5.73	5.03	0.49	3.10	15.10	5.62	4.87(12.74)	29.00(32.57)
GP-108	2.93	85.53	1.52	2.88	5.40	7.10	0.49	3.50	14.83	4.81	5.37(13.39)	23.00(28.64)
GP-109	3.03	89.67	1.40	2.82	4.03	7.67	0.31	2.20	12.00	3.07	18.33(25.34)	44.67(41.94)
GP-110	3.13	89.27	1.63	6.75	4.60	7.00	0.50	3.60	8.30	4.71	14.27(22.19)	19.00(25.84)
GP-115	2.60	80.40	0.80	6.44	5.40	4.67	0.40	3.17	12.60	4.25	5.00(12.92)	30.33(33.41)

GP-116	3.53	82.50	0.87	5.52	5.60	4.53	0.43	4.20	15.13	5.02	3.60(10.94)	37.00(37.46)
GP-120	2.53	78.40	0.87	4.37	4.80	7.00	0.19	3.53	7.00	3.78	11.67(19.95)	28.00(31.94)
GP-121	2.53	89.30	0.70	3.25	3.07	6.33	0.31	2.50	14.00	2.85	28.63(32.35)	69.67(56.62)
GP-122	3.17	90.30	1.23	3.06	4.00	10.0	0.11	3.50	10.50	5.65	19.00(25.84)	17.00(24.33)
GP-123	3.13	87.03	0.62	5.22	1.90	5.50	0.10	2.37	8.07	2.51	47.67(43.66)	56.33(48.64)
GP-125	3.03	91.50	0.60	1.82	3.13	6.67	0.30	2.67	13.03	2.07	28.87(32.49)	58.33(49.80)
GP-126	4.03	84.63	1.77	4.92	3.23	11.0	0.50	3.00	9.03	4.80	27.90(31.88)	24.67(29.77)
GP-128	2.73	85.63	0.63	7.74	3.10	5.50	0.41	2.80	10.50	3.15	28.70(32.39)	55.33(48.07)
GP-131	2.03	81.37	0.50	6.48	3.87	7.50	0.11	2.07	11.33	1.68	21.87(27.87)	24.67(29.77)
GP-133	3.13	84.33	0.73	7.59	4.73	6.43	0.43	3.17	14.00	4.91	12.30(20.52)	18.00(25.10)
GP-134	2.03	80.67	0.51	3.61	3.87	3.63	0.29	3.03	7.07	3.75	21.63(27.71)	17.33(24.57)
GP-136	3.03	89.23	0.83	5.07	3.80	8.00	0.09	2.80	10.10	1.84	21.70(27.75)	55.67(48.26)
GP-137	3.03	88.57	1.00	6.24	5.07	7.00	0.31	3.43	13.00	2.81	8.50(16.94)	54.67(47.68)
GP-139	2.53	82.73	0.78	4.14	4.87	7.33	0.20	2.50	12.33	4.25	12.13(20.38)	25.00(29.99)
GP-140	2.13	83.33	1.25	6.49	5.17	5.50	0.50	3.60	15.07	3.86	8.00(16.42)	15.33(23.05)
GP-144	2.33	76.00	0.57	5.00	3.70	6.00	0.20	3.17	11.50	2.69	22.77(28.49)	54.00(47.30)
GP-146	2.23	86.00	1.00	6.98	5.00	5.50	0.19	3.13	12.00	2.57	9.30(17.74)	58.33(49.80)
GP-148	2.53	82.53	0.53	3.56	3.67	6.00	0.30	2.50	11.00	2.91	21.60(27.67)	19.00(25.84)
GP-149	3.03	78.33	1.18	4.87	4.20	9.00	0.10	2.67	9.47	2.54	17.47(24.70)	32.00(34.44)
GP-150	2.03	84.63	0.93	2.71	4.37	6.50	0.32	2.50	10.03	4.96	16.30(23.80)	16.00(23.57)

Cont.....

Genotypes	Vine length (m)	Days to first fruit harvest	Fruit weight (kg)	Fruits/ hill	Yield/ hill (kg)	Size of seed cavity (cm)	Rind thickness (cm)	Flesh thickness (cm)	TSS (%)	Shelf life (days)	Severity of viruses	Incidence of fruit fly
GP-151	2.73	82.00	1.87	7.07	5.07	8.00	0.50	4.00	11.33	3.48	9.73(18.16)	17.33(24.59)
GP-152	2.03	86.33	0.41	5.22	2.90	4.60	0.30	3.17	11.50	2.82	45.77(42.57)	28.67(32.36)
GP-154	2.33	79.00	0.78	6.57	4.07	5.80	0.32	3.50	14.00	5.05	18.37(25.36)	24.67(29.77)
GP-156	3.63	82.70	0.70	2.02	4.60	7.83	0.31	3.07	10.00	1.59	13.30(21.38)	75.00(60.03)
GP-158	1.53	79.97	1.83	3.76	3.67	7.87	0.30	3.30	11.33	3.93	22.77(28.49)	10.00(18.42)
GP-160	2.03	80.23	1.35	7.12	5.07	7.83	0.41	3.77	8.83	3.19	9.13(17.58)	12.33(20.56)
GP-165	3.03	78.67	0.65	3.75	4.63	7.00	0.31	2.00	13.00	2.22	13.07(21.18)	51.33(45.76)
GP-169	2.17	87.03	0.80	6.76	3.00	6.83	0.31	2.00	9.83	4.10	31.20(33.95)	17.33(24.59)
GP-170	2.03	84.47	0.68	4.34	4.60	6.83	0.20	2.97	8.07	2.98	14.00(21.96)	18.00(25.10)
GP-171	2.43	83.37	0.73	5.91	3.17	5.50	0.31	3.17	10.33	1.66	27.57(31.67)	67.33(55.16)
GP-172	2.03	85.63	0.57	4.37	3.37	6.33	0.21	2.00	11.50	3.75	23.80(29.19)	55.67(48.26)
GP-174	2.50	76.67	0.71	4.17	3.10	6.70	0.20	2.20	10.10	3.25	28.83(32.47)	52.67(46.53)
GP-176	1.70	80.67	1.23	3.00	5.13	7.00	0.11	3.00	12.17	1.83	8.43(16.87)	54.00(47.30)
GP-178	2.07	78.73	1.70	1.89	5.10	7.50	0.21	4.50	13.00	2.91	9.00(17.44)	37.67(37.85)
GP-179	1.90	87.77	1.90	3.88	3.60	7.50	0.32	3.80	14.23	5.21	22.87(28.56)	18.00(25.10)
GP-180	2.33	86.00	1.03	3.73	4.00	7.00	0.30	3.03	7.97	4.95	20.17(26.67)	14.00(21.96)
GP-181	2.60	80.63	1.00	4.97	3.73	6.30	0.50	3.57	13.57	5.11	21.67(27.72)	16.67(24.09)
GP-182	2.37	88.73	1.00	3.08	4.97	9.50	0.21	2.77	10.10	3.83	10.47(18.86)	45.00(42.13)
GP-183	2.83	85.00	1.57	4.59	4.83	8.17	0.51	3.70	8.10	2.99	12.27(20.48)	31.00(33.82)
GP-184	3.53	87.67	1.03	7.72	4.73	6.80	0.29	3.00	9.47	5.32	12.27(20.49)	17.00(24.34)
GP-186	2.67	89.33	0.67	5.25	5.17	6.00	0.20	2.97	7.97	3.28	7.87(16.28)	16.67(24.09)
GP-187	1.47	75.27	0.80	7.62	4.20	6.33	0.30	2.80	12.50	3.20	15.73(23.35)	8.00(16.41)
GP-189	1.53	89.33	0.37	3.92	2.82	7.50	0.21	1.17	11.33	1.59	47.10(43.33)	71.00(57.44)
GP-190	2.40	89.00	0.97	1.89	3.80	6.00	0.40	3.70	12.93	4.40	20.73(27.08)	9.00(17.44)
GP-194	1.57	76.67	2.73	6.83	5.17	9.00	0.20	4.00	15.00	3.81	8.37(16.80)	13.67(21.68)
GP-195	2.57	80.67	0.63	5.94	4.30	5.83	0.39	3.10	13.00	5.91	12.10(20.34)	8.33(16.77)
GP-196	1.60	86.00	0.50	6.50	2.97	4.10	0.29	3.00	14.13	2.77	41.00(39.82)	17.00(24.34)
GP-197	2.67	91.63	0.60	4.33	3.90	7.00	0.21	3.07	14.17	2.73	20.80(27.13)	23.33(28.88)
GP-198	2.33	76.67	1.00	6.07	4.33	7.83	0.50	3.17	12.83	4.45	16.07(23.62)	10.00(18.42)
GP-199	1.53	83.47	0.52	6.13	3.17	6.33	0.39	2.20	13.87	2.96	25.47(30.30)	7.67(16.07)
GP-200	1.60	75.33	0.75	4.75	4.60	6.00	0.31	3.50	8.07	4.82	13.20(21.30)	13.00(21.12)

GP-201	3.03	76.00	0.80	6.81	3.80	6.33	0.20	2.50	9.03	2.87	21.57(27.66)	16.00(23.57)
GP-202	1.47	83.00	0.57	6.18	3.90	6.00	0.40	3.67	8.00	1.40	20.27(26.73)	41.00(39.81)
GP-203	2.17	85.87	0.55	5.37	3.40	5.83	0.32	3.30	12.17	2.90	23.13(28.74)	43.67(41.36)
GP-204	1.27	81.67	0.95	3.9	5.10	4.50	0.41	3.03	8.50	5.37	7.77(16.17)	16.00(23.57)
S Em±	0.19	1.61	0.07	0.20	0.12	0.48	0.02	0.14	0.49	0.17	0.83	1.16
CD at 5%	0.53	4.50	0.21	0.57	0.34	1.35	0.05	0.38	1.36	0.48	2.30	3.24
CV %	12.34	3.35	12.86	7.36	5.00	12.25	9.60	7.73	7.46	8.51	5.83	6.08

Values in parenthesis are transferred values

Table 3. Estimates of genetic variability for fruit yield and other traits in muskmelon

Characters	Mean	Range	Variance		Coefficient of variation (%)		Heritability in broad sense (%)	Genetic advance (GA)	Genetic advance as percentage of mean
			Genotypic (σ^2g)	Phenotypic (σ^2p)	Genotypic (GCV)	Phenotypic (PCV)			
Vine length	2.65	1.27-4.13	0.36	0.47	22.58	25.74	77.0	1.08	40.75
Days to first fruit harvest	83.35	74.57-92.13	17.52	25.33	5.02	6.04	69.2	7.17	8.60
Fruit weight	1.00	0.37-2.73	0.18	0.20	38.20	52.05	53.9	0.58	58.00
Fruits/hill	4.79	1.54-7.74	2.34	2.47	31.97	32.81	95.0	3.07	64.09
Yield/hill	4.21	1.90-5.73	0.63	0.67	18.85	19.51	93.4	1.58	37.53
Size of seed cavity	6.84	3.63-11.00	1.57	2.27	18.32	22.04	69.1	2.14	31.29
Rind thickness	0.30	0.09-0.60	0.014	0.015	39.87	41.01	94.5	0.24	80.00
Flesh thickness	3.09	1.17-4.53	0.39	0.45	20.18	21.60	87.2	1.20	38.83
TSS	11.33	5.93-16.60	5.51	6.22	20.70	22.01	88.5	4.55	40.16
Shelf life	3.54	1.31-6.12	1.53	1.62	34.99	36.01	94.4	2.48	70.06
Severity of viruses	24.53	3.60-47.67	45.30	47.35	27.44	28.05	95.7	13.56	55.28
Incidence of fruit fly	33.13	7.67-75.00	138.02	142.08	35.46	35.98	97.1	23.85	71.99

Table 4. Visual observations on different qualitative characters in muskmelon

Genotypes	Fruit shape	Fruit rind colour	Fruit skin texture	Skin hardness	Fruit skin design produced	Flavour	Flesh colour	Flesh texture
GP-2	Flattened	Orange	Smooth	Soft	Self sutured	Moderate	Light green	Grainy firm
GP-4	Round	Light yellow	Smooth	Intermediate	Unsutured	Mild	Orange	Grainy
GP-5	Round	Reddish brown	Netted	Hard	Sutured	Strong	Light green	Smooth firm
GP-6	Ovate	Brown	Netted	Hard	Unsutured	Mild	Light green	Smooth firm
GP-7	Oblate	Yellow	Netted	Hard	Self sutured	Mild	Off white	Smooth firm
GP-11	Round	Yellow	Light netted	Hard	Sutured	Strong	Light green	Smooth firm
GP-12	Ovate	Yellow	Very light netted	Intermediate	Unsutured	Mild	Light orange	Smooth firm
GP-13	Ovate	Light yellow	Semi-netted	Hard	Sutured	Mild	Orange	Smooth firm
GP-17	Oblong	Greenish yellow	Smooth	Soft	Unsutured	Mild	Light green	Smooth firm
GP-18	Oblate	Light yellow	Smooth	Intermediate	Unsutured	Mild	Green	Smooth firm
GP-19	Elliptical	Yellow	Smooth	Soft	Unsutured	Mild	Light green	Smooth firm
GP-21	Flattened	Yellow	Smooth	Intermediate	Lobed,	Mild	Whitish	Smooth firm

	round				sutured		green	
GP-22	Oblong	Yellow	Netted	Hard	Unsutured	Strong	Orange	Grainy
GP-24	Flattened	Yellow	Netted	Hard	Unsutured	Moderate	Orange	Grainy firm
GP-27	Round	Creamy	Netted	Very hard	Unsutured	Mild	White	Smooth firm
GP-29	Round	Yellow	Netted	Intermediate	Sutured	Mild	Light green	Smooth firm
GP-30	Flattened	Yellow	Netted	Hard	Unsutured	Mild	Light green	Watery (grainy)
GP-31	Flattened	Yellow	Semi-netted	Hard	Sutured	Strong	Light green	Grainy firm
GP-33	Oblate	Creamy	Light netted	Intermediate	Unsutured	Mild	White	Grainy firm
GP-34	Round	Green	Netted	Hard	Unsutured	Mild	Light green	Grainy firm
GP-36	Round	Yellowish brown	Smooth	Soft	Sutured	Mild	Orange	Smooth firm
GP-37	Round	Light green	Smooth	Hard	Unsutured	Mild	Light green	Smooth firm
GP-39	Round	Light yellow	Netted	Hard	Lobed	Moderate	Light green	Grainy firm
GP-40	Round	Light green	Smooth	Soft	Lobed	Mild	Green	Smooth firm
GP-41	Oblate	Greenish white	Smooth	Soft	Sutured	Strong	Greenish orange	Smooth firm
GP-42	Round	Light yellow	Smooth	Soft	Sutured	Moderate	Light green	Grainy firm
GP-43	Flattened	Brown	Semi-netted	Hard	Lobed, sutured	Strong	Green	Grainy firm
GP-44	Round	Brown	Netted	Hard	Unsutured	Very strong	Dark orange	Smooth firm
GP-45	Round	Brown	Light netted	Hard	Unsutured	Strong	Orange	Smooth firm

Cont....

Genotypes	Fruit shape	Fruit rind colour	Fruit skin texture	Skin hardness	Fruit skin design produced	Flavour	Flesh colour	Flesh texture
GP-48	Round	Light green	Netted	Hard	Unsutured	Moderate	Orange	Grainy firm
GP-49	Round	Green	Netted	Hard	Sutured	Strong	Pink	Smooth firm
GP-59	Ovate	Green	Netted	Hard	Unsutured	Strong	Green	Grainy
GP-60	Flattened round	Brown	Netted	Hard	Sutured	Moderate	Orange	Smooth firm
GP-61	Oblate	Reddish orange	Netted	Hard	Unsutured	Mild	Orange	Smooth firm
GP-63	Round	Light yellow	Light netted	Hard	Sutured	Mild	White	Grainy firm
GP-68	Round	Yellow	Semi-netted	Hard	Unsutured	Strong	Light green	Smooth firm
GP-69	Round	Creamy white	Netted	Hard	Lobed, sutured	Mild	White	Grainy firm
GP-72	Flattened	Light yellow	Smooth	Hard	Unsutured	Moderate	White	Smooth firm
GP-73	Flattened	Yellow	Semi-netted	Hard	Sutured	Strong	Light green	Smooth firm
GP-77	Ovate	Light yellow	Smooth	Soft	Unsutured	Mild	Light orange	Smooth firm
GP-82	Round	Light yellow	Smooth	Soft	Sutured	Moderate	Greenish orange	Smooth firm

GP-84	Flattened	Yellow	Netted	Very hard	Sutured	Mild	Dark green	Soft spongy
GP-85	Flattened round	Light yellow	Light netted	Hard	Lobed, sutured	Moderate	Whitish green	Smooth firm
GP-89	Ovate	Brown	Netted	Hard	Self sutured	Strong	Orange	Smooth firm
GP-90	Flattened	Greenish yellow	Netted	Hard	Unsutured	Mild	Green	Grainy firm
GP-91	Flattened	Orange	Light netted	Hard	Sutured	Strong	Dark orange	Smooth firm
GP-92	Flattened	Yellow	Semi-netted	Hard	Sutured	Strong	Orange	Grainy firm
GP-94	Oblate	Light yellow	Smooth	Hard	Self sutured	Strong	Light orange	Grainy
GP-95	Round	Yellow	Well netted	Hard	Lobed, light sutured	Strong	Orange	Smooth firm
GP-96	Oblong	Orange	Semi-netted	Hard	Self sutured	Mild	Whitish orange	Smooth firm
GP-98	Flattened	Light green	Well netted	Hard	Unsutured	Strong	Orange	Smooth firm
GP-102	Flattened	Brown	Light netted	Hard	Sutured	Mild	Green	Watery
GP-105	Round	Yellowish brown	Well netted	Hard	Lobed, sutured	Strong	Orange	Grainy firm
GP-108	Round	Creamy	Very light netted	Hard	Sutured	Strong	Light green	Smooth firm
GP-109	Oblate	White	Netted	Hard	Unsutured	Strong	Greenish orange	Smooth firm
GP-110	Oblate	Light green	Netted	Hard	Unsutured	Strong	Light green	Smooth firm
GP-115	Round	Light orange	Light netted	Hard	Sutured	Strong	Orange	Grainy firm
GP-116	Round	Light yellow	Smooth	Hard	Unsutured	Strong	Orange	Watery
GP-120	Round	Green	Semi-netted	Hard	Sutured	Strong	Green	Smooth firm

Cont.....

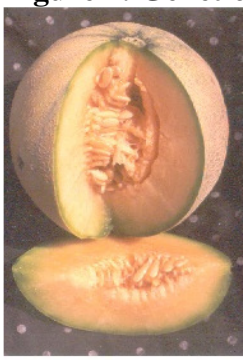
Genotypes	**Fruit shape**	**Fruit rind colour**	**Fruit skin texture**	**Skin hardness**	**Fruit skin design produced**	**Flavour**	**Flesh colour**	**Flesh texture**
GP-121	Flattened	Yellow	Smooth	Intermediate	Self sutured	Mild	Green	Smooth firm
GP-122	Round to oval	Light yellow	Well netted	Very hard	Unsutured	Mild	Light orange	Grainy firm
GP-123	Round to oval	Reddish brown	Smooth	Intermediate	Lobed, sutured	Mild	Whitish green	Smooth firm
GP-125	Round	Yellow	Smooth	Intermediate	Sutured	Mild	Orange	Smooth firm
GP-126	Flattened	Yellow	Netted	Hard	Lobed, sutured	Strong	Orange	Smooth firm
GP-128	Oblong	Green	Smooth	Hard	Self sutured	Strong	Orange	Smooth firm
GP-131	Flattened	Yellow	Smooth	Soft	Sutured	Mild	Orange	Grainy
GP-133	Flattened	Brown	Netted	Hard	Unsutured	Mild	Light green	Smooth firm
GP-134	Round	Yellow	Light netted	Hard	Unsutured	Mild	Pink	Smooth firm
GP-136	Flattened	Orange	Very light netted	Soft	Sutured	Moderate	Light green	Watery
GP-137	Flattened	Light green	Smooth	Hard	Unsutured	Mild	Orange	Smooth firm
GP-139	Round	Yellow	Netted	Hard	Sutured	Strong	Light green	Smooth
GP-140	Oblate	Yellow	Netted	Hard	Unsutured	Strong	Light green	Smooth firm
GP-144	Oblong	Yellow	Very light netted	Intermediate	Unsutured	Strong	Green	Grainy firm
GP-146	Oblong	Orange	Semi-netted	Intermediate	Unsutured	Mild	White	Smooth firm
GP-148	Round	Yellow	Light netted	Hard	Sutured	Strong	Light green	Smooth firm

GP-149	Round	Orange	Very light netted	Intermediate	Self sutured	Mild	Orange	Smooth firm
GP-150	Oblate	Yellow	Netted	Hard	Unsutured	Mild	Green	Smooth firm
GP-151	Oblate	Creamy	Netted	Hard	Unsutured	Strong	Light green	Smooth firm
GP-152	Oblate	Light yellow	Smooth	Hard	Sutured	Mild	Light green	Smooth firm
GP-154	Oblong	Light green	Semi-netted	Hard	Lobed, sutured	Strong	Light green	Smooth firm
GP-156	Flattened	Yellow	Smooth	Soft	Unsutured	Strong	Pink	Smooth firm
GP-158	Oblate	Greenish yellow	Well netted	Hard	Unsutured	Mild	Green	Smooth firm
GP-160	Oblong	Yellow	Netted	Hard	Unsutured	Mild	Light green	Smooth firm
GP-165	Round	Light yellow	Smooth	Intermediate	Unsutured	Mild	Light green	Smooth firm
GP-169	Round	Green	Netted	Hard	Unsutured	Moderate	Light green	Grainy firm
GP-170	Flattened	Light green	Light netted	Hard	Unsutured	Mild	Light green	Watery
GP-171	Ovate	Brown	Smooth	Soft	Unsutured	Moderate	Light green	Smooth firm
GP-172	Flattened	Yellow	Smooth	Hard	Unsutured	Mild	Green	Smooth firm
GP-174	Round	Yellow	Smooth	Intermediate	Sutured	Mild	Whitish green	Grainy

Cont....

Genotypes	**Fruit shape**	**Fruit rind colour**	**Fruit skin texture**	**Skin hardness**	**Fruit skin design produced**	**Flavour**	**Flesh colour**	**Flesh texture**
GP-176	Elliptical	Yellow	Light netted	Soft	Unsutured	Off flavour	Light green	Smooth firm
GP-178	Pyriform	Light green	Netted	Intermediate	Lobed, sutured	Moderate	Light green	Grainy firm
GP-179	Round	Green	Netted	Hard	Sutured	Strong	Orange	Grainy firm
GP-180	Round	Light yellow	Netted	Hard	Unsutured	Mild	Light orange	Smooth firm
GP-181	Round	Yellow	Netted	Hard	Self sutured	Mild	Light green	Grainy firm
GP-182	Round	Greenish yellow	Light netted	Intermediate	Sutured	Mild	Light green	Grainy firm
GP-183	Oblong	Yellow	Netted	Hard	Sutured	Mild	Green	Smooth firm
GP-184	Oblate	Light green	Semi-netted	Very hard	Self sutured	Strong	Orange	Watery
GP-186	Round	Orange	Netted	Hard	Sutured	Moderate	Light orange	Grainy firm
GP-187	Oblate	Light yellow	Well netted	Hard	Sutured	Mild	Orange	Smooth firm
GP-189	Flattened	Yellow	Smooth	Soft	Unsutured	Mild	Light green	Grainy firm
GP-190	Round	Greenish yellow	Netted	Hard	Sutured	Mild	Whitish green	Smooth firm
GP-194	Ovate	Light green	Netted	Hard	Sutured	Mild	Light pink	Smooth firm
GP-195	Flattened round	Yellow	Semi-netted	Very hard	Sutured	Mild	Green	Grainy firm
GP-196	Round	Yellow	Light netted	Hard	Sutured	Strong	Light green	Grainy firm
GP-197	Oblate	Yellow	Light netted	Hard	Sutured	Strong	Light green	Grainy firm
GP-198	Flattened	Light green	Well netted	Hard	Unsutured	Strong	Orange	Smooth firm
GP-199	Oblate	Green	Netted	Hard	Sutured	Moderate	Greenish orange	Grainy firm
GP-200	Round	Brown	Netted	Hard	Unsutured	Mild	Orange	Smooth firm
GP-201	Round	Brown	Netted	Hard	Unsutured	Mild	Orange	Smooth firm
GP-202	Oblate	Light yellow	Very light netted	Intermediate	Unsutured	Strong	Light green	Grainy firm
GP-203	Round	Yellow	Semi-netted	Intermediate	Unsutured	Mild	Green	Smooth firm
GP-204	Elliptical	Yellow	Smooth	Very hard	Unsutured	Mild	Light green	Smooth firm

Figure 1: Genetice Variability in Muskmelon



G.P.- 105

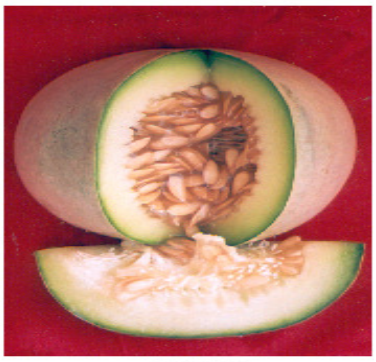
G.P.- 39

G.P.- 115

G.P.- 116

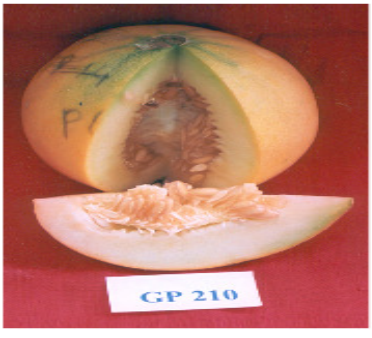
Kesar

EC-2



EC-3

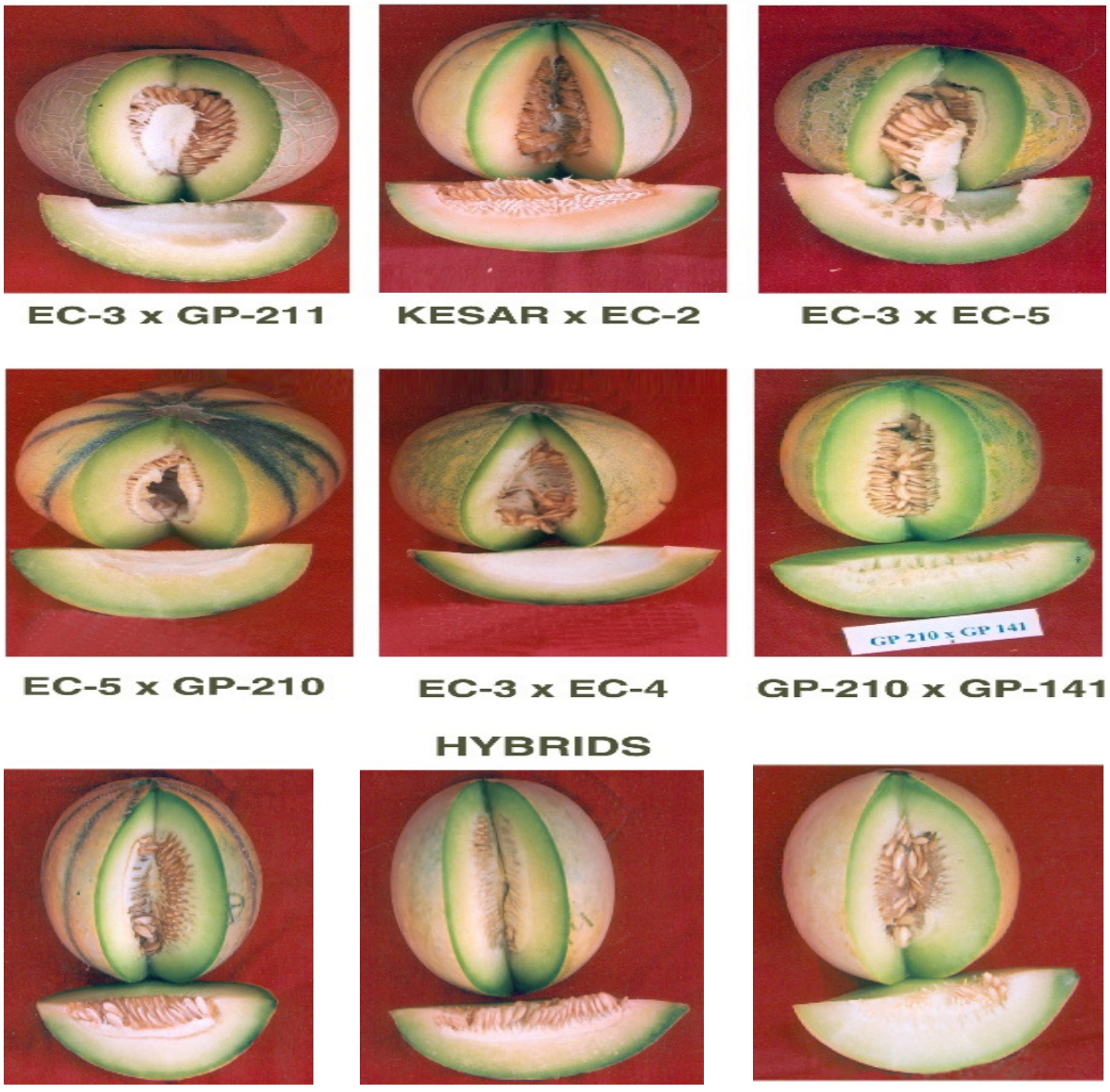
EC-4



GP-210

GP-211

PARENTS



REFERENCES

Burton, G.W. and E.H. De Vane. 1953. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. Agron. J. 45:478-481.

Chhonkar, V.S., D.N. Singh, and R.L. Singh. 1979. Genetic variability and correlation studies in muskmelon. Indian J. Agric. Sci. 49(5):361-363.

Dharmendra Kumar, J. Dixit, and V.K. Sharma. 2004. Studies on genetic variability and correlation in muskmelon (*Cucumis melo* L.). *In:* International Seminar on Recent Trends in Hi-tech Horticulture and Post Harvest Technology, CSAUAT, Kanpur, India, February 4-6, 2004.

Hanson, C.H., H.F. Robinson, and R.E. Comstock. 1956. Biometrical studies on yield in segregating population of Korean Lespedeza. Agron. J. 48: 262-272.

Hanson, C.H., H.F. Robinson, and R.E. Comstock. 1955. Estimates of genetic and environmental variability in soybeans. Agron. J. 47: 314-318.

Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soybeans. *Agron. J*., 47:314-318.

Kalloo, G., J. Dixit, and A.S. Sidhu. 1983. Studies on genetic variability and character association in muskmelon (*Cucumis melo* L.). Indian J. Hort. 40(1-2): 79-85.

Lal, T. and S. Singh. 1997. Genetic variability and selection indices in melon (*Cucumis melo* L.). Veg. Sci. 24(2): 111-117.

Lush, J.L. 1940. Intra-sire correlation and regression of offspring on dam as a method of estimating heritability of characters. Proc. Amer. Soc. Ani. Prod. 33:292-301.

Prasad, L., N.C. Gautam, and S.P. Singh. 1988. Studies on genetic variability and character association in watermelon. Veg. Sci. 15(1): 86-94.

Prasad, M., M. Singh, and B.P. Srivastava. 1993. Genetic variability and correlation in bottle gourd. Haryana J. Hort. Sci. 22(3): 222-227.

Sachan, S.C.P. and S.B.S. Tikka. 1971. Genetic variability and correlation studies in watermelon (*Citrullus lanatus* (Thunb.) Mansf.). Rajasthan J. Agric. Sci. 2(2): 91-96.

Somkuwar, R.G., T.A. More, and R.B. Mihra. 1997. Correlation and path coefficient analysis in muskmelon. Indian J. Hort. 54(4): 312-316.

Swamy, K.R.M., O.P. Dutta, P.R. Ramachander, and S.D. Wahi. 1985. Variability studies in muskmelon (*Cucumis melo* L.). Madras Agric. J. 72(1): 1-5.

Thakur, J.C. and K.S. Nandpuri. 1974. Studies on variability and heritability of some important quantitative characters in watermelon. Veg. Sci. 1:1-8.

Vijay, O.P. 1987. Genetic variability, correlation, and path analysis in muskmelon (*Cucumis melo* L.). Indian J. Hort. 44(3-4): 233-238.

EXPLOITATION OF ORGANIC INPUTS FOR GROWTH AND YIELD OF MULTIPLIER ONION (*Allium cepa* var. *aggregatum*) var. Co (On 5)

K. Sundharaiya[1], K. Sujatha [2], P.R. Renganayaki[3]and G. Sathish[4]

[1]Assistant professor (Horti), Citrus Research Station, Vannikonenthal, Sankarankovil, Tirunelveli, [2]Professor (SST), Forest College and Research Institute, Mettupalayam and [3]Professor (SST), Agricultural College and Research Institute, Madurai.

Email: aiya_hort@rediffmail.com

Received: 17.03.16
Accepted: 25.07.16

ABSTRACT

A field experiment on "Exploitation of organic inputs for growth and yield of multiplier onion" was conducted at Agricultural Research Station, Vaigaidam, Tamil Nadu Agricultural University during 2010-2013 to find out the suitable organic inputs for growth and yield of multiplier onion. The experiment was laid out in a Factorial Randomized Block Design *viz.,* Factor I as four level of organic manures including Control (M_1), FYM (M_2-12.5 tha^{-1}), Neem cake (M_3-2tha^{-1}) and Vermicompost (M_4-2tha^{-1}) and Factor II as five levels of biostimulants comprising Control (S_1-water spray), Humic acid @ 0.2 % (S_2), Panchagavya @ 2% (S_3), vermiwash @ 2% (S_4) and seaweed extract @ 2% (S_5). Totally 20 treatments were replicated in thrice. Soil application of FYM@12.5 tha^{-1} significantly increased the plant height, number of leaves, leaf length and leaf breadth at 30 DAP, 60 DAP, 90 DAP and at the time of harvest and yield attributing traits *viz.,* bulb length, bulb girth, number of bulblets per clump, individual bulb weight, yield per plot and yield per hectare. Among the different biostimulants, foliar application of seaweed extract@2% registered significantly higher plant height, number of leaves, leaf length and leaf breadth at 30 DAP, 60 DAP, 90 DAP and at the time of harvest and yield attributing traits *viz.,* bulb length, bulb girth, number of bulblets per clump, individual bulb weight, yield per plot and yield per hectare. Interaction effect showed that combined application of FYM @ 12.5 tha^{-1}+seaweed extract @ 2% recorded the highest values for plant height, number of leaves, leaf length and leaf breadth at 30 DAP, 60 DAP, 90 DAP and at the time of harvest and yield attributing traits *viz.,* bulb length, bulb girth, number of bulblets per clump, individual bulb weight, yield per plot and yield per hectare.

***Key words*:** Onion-Allium cepa var. aggregatum-Organic manures-FYM-Biostimulants-seaweed.

Multiplier onion (*Allium cepa* var. *aggregatum*) is biennial, foetid and scapigerous herb belonging to the family Alliaceae. Alliums are among the oldest cultivated plant species. Multiplier onion also known as small onion is used as an important vegetable and spice in culinary preparation. It is available in fresh, frozen, canned, pickled and chopped form. The dehydrated product is available as sliced, minced, chopped, granulated and powdered forms. Onion bulbs are rich in Vitamin C, Vitamin B6 and folic acid and are good source of dietry fibre. Onion contains chemical compounds such as phenolics and flavonoids that have potential anti-inflammatory, anit-chlolestrol, anti-cancer and anti-oxidant properties. The pungent juice of onion is used as moth repellant and can be rubbed on the skin to prevent insect bites. In India multiplier onion is largely cultivated in Tamil Nadu particularly in Erode, Coimbatore, Dindigul and Theni Districts for its underground bulb. Multiplier onion is commercially propagated through bulbs. A seed producing multiplier onion variety Co (On 5) was developed at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore becoming popular among the onion growers. Onion being a short duration crop requires high inputs for better growth and yield. However, indiscriminate use of chemical fertilizers leads health hazardous to human being and to the environment. Increasing awareness on organic produce among the consumers and such produce get premium price in the market compel the producer to think about the organic farming. Use of organic manures to meet the nutrient requirement of crop would be an inevitable practice in the years to come for sustainable agriculture since, organic manures generally improve the soil physical, chemical and biological properties

along with conserving the moisture holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop produce. Research studies on organic farming multiplier onion are very meagre. With this view the present investigation was carried out to standardize the organic protocol for commercial cultivation of multiplier onion.

MATERIALS AND METHODS

A field experiment on "Exploitation of organic inputs for growth and yield of multiplier onion" was conducted at Agricultural Research Station, Vaigaidam, Tamil Nadu Agricultural University during 2010-2013. The experiment was laid out in a Factorial Randomized Block Design *viz.,* Factor I as four level of organic manures including Control (M_1), FYM (M_2-12.5 tha^{-1}), Neem cake (M_3-2tha^{-1}) and Vermicompost (M_4-2tha^{-1}) and Factor II as five levels of biostimulants comprising Control (S_1-water spray), Humic acid @ 0.2 % (S_2), Panchagavya @ 2% (S_3), vermiwash @ 2% (S_4) and seaweed extract @ 2% (S_5). Totally 20 treatments were replicated in thrice. Nursery was raised with seeds of multiplier onion variety Co (On 5), obtained from Horticultural College and Research Institute, Periyakulam. Main field was ploughed three times to get fine tilth. Ridges and furrows were made at a distance of 30 cm. The main field was divided in to 60 plots with a plot size of 4m X 3m. About 40 days old healthy seedlings were transplanted on both the side of the ridges at a spacing of 10 cm. Life irrigation was given on 3rd of transplanting. Organic manures were applied basally in the main field as per the technical programme before planting and the main field was irrigated copiously. Biostimulants were applied through leaves as foliar application at fortnight intervals as per the technical programme. Irrigation, weeding and other horticultural operations were done at regular intervals. The nutrient content of organic manures tried viz., FYM, neem cake and vermicompost were 0.4, 0.3 and 0.3 and 1.5, 0.2 and 0.3 and 0.5, 0.25 and 0.5 respectively.

Biometrical observations *viz.,* Plant height (cm), Number of leaves, Leaf length (cm) and Leaf breadth (cm) were made at 30 DAP, 60 DAP, 90 DAP and at the time of harvest and yield attributing traits *viz.,* bulb length (cm), bulb girth (cm), number of bulblets per clump, individual bulb weight (g), yield per plot (kg) and yield per hectare (t) were recorded from randomly selected 20 plants from each treatment and the mean data were subjected to statistical analysis as per the procedure suggested by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Perusal of data on plant height and leaf length revealed that soil application of organic manures, foliar application of biostimulants and their interaction effect had significant influence (Table 1). Significantly higher plant height and leaf length values were registered by application of FYM @ 12.5 tha^{-1} (M_2) at all the stages of crop growth *viz*., 30 DAP (18.90 cm and 18.64 cm), 60 DAP (23.51 cm and 20.11 cm), 90 DAP (27.81 cm and 25.73 cm) and at the time of harvest (32.91 cm and 28.55 cm). It was followed by application of vermicompost @ 2 tha^{-1} (M_4) which recorded a plant height values of 18.80 cm, 21.66 cm, 25.97 cm and 31.32 cm and leaf length values of 17.55 cm, 18.84 cm, 24.14 cm and 27.38 cm at all the stages of crop growth *viz*., 30 DAP, 60 DAP, 90 DAP and at the time of harvest. Whereas the lowest plant height and leaf length were recorded by Control (M_1) at all the stages of crop growth *viz.,* 30 DAP (15.80 cm and 14.16 cm), 60 DAP (17.51 cm and 16.21 cm), 90 DAP (21.75 cm and 19.53 cm) and at the time of harvest (28.53 cm and 24.46 cm). Significant differences were exhibited by foliar application of bio stimulants for the traits plant height and leaf length. Among the biostimulants seaweed extract @ 2 percent (S_5) proved better performance through increased plant height (19.73 cm, 22.47 cm, 27.43 cm and 32.63 cm) and leaf length (17.79 cm, 20.14 cm, 25.30 cm and 27.68 cm) at 30 DAP, 60 DAP, 90 DAP and at the time of harvest respectively. Meanwhile lower plant height values (17.50 cm, 19.42 cm, 22.68 cm and 29.34 cm) and leaf length values (14.94 cm,

16.76 cm, 20.98 cm and 25.61 cm) were recorded by Control (S_1) at 30 DAP, 60 DAP, 90 DAP and at the time of harvest.

Combined application of organic manures and bio stimulants also showed significant differences for the trait plant height and leaf length. From the table it was observed that among the different combinations, the treatment M_2S_5 (FYM @ 12.5 tha^{-1}+seaweed extract @ 2%) recorded the highest plant height (22.13 cm, 26.67 cm, 31.80 cm and 37.80 cm) and leaf length (20.43 cm, 21.87 cm, 29.70 cm and 31.90 cm) values at 30 DAP, 60 DAP, 90 DAP and at the time of harvest respectively. It was followed by M_2S_3 (FYM @ 12.5 tha^{-1}+panchagavya @ 2%). Whereas the lowest plant height (13.60 cm, 16.00 cm, 19.30cm and 26.10 cm) and leaf length (12.53 cm, 13.30 cm, 17.97 cm and 23.00 cm) values were recorded by M_1S_1 (Control). Increased plant height and leaf length were recorded by the soil application of FYM might be due to the presence of mg might have helped in chlorophyll synthesis which in turn increase the rate of photosynthesis resulted in higher plant height and leaf length. The results are in agreement with the findings of Nehra *et al*. (2001) in wheat, Sanwal *et al.* (2007) and Premsekhar and Rajashree (2009) in okra. Significant effect of seaweed extract on plant height and leaf length was also reported by Kumari *et al.* (2011) in tomato.

The results of leaf breadth and number of leaves are presented in the Table 2. From the table it was observed that the organic manures had significant influence on leaf breadth and number of leaves. Among the different organic manures, application of FYM @ 12.5 t ha^{-1} (M_2) registered higher leaf breadth (0.50 cm, 0.55 cm, 0.65 cm and 0.88 cm) and number of leaves (6.67, 20.47, 21.75 and 28.79) at all stages of crop growth *viz.*, 30 DAP, 60 DAP, 90 DAP and at the time of harvest. It was followed by application of vermicompost @ 2 tha^{-1} (M_4) which registered a leaf breadth values of 0.47 cm, 0.51 cm, 0.63 cm and 0.81 cm and 10.23, 24.87, 26.09 and 29.65 number of leaves at 30 DAP, 60 DAP, 90 DAP and at the time of harvest. Whereas, lower values for leaf breadth and number of leaves were registered by Control (M_1). Foliar application of biostimulants also had significant influence on leaf breadth and number of leaves. Among the different biostimulants foliar application of seaweed extract (S_5) registered higher leaf breadth and number leaves at 30 DAP (0.47 cm and 10.89), 60 DAP (0.54 cm and 25.42), 90 DAP (0.66 cm and 27.43) and at the time of harvest (0.90 cm and 31.41). It was followed by foliar application of panchagavya @ 2% (S_3). Whereas, the control (S_1) registered lower leaf breadth and number of leaves at all the stages of crop growth *viz.,* 30 DAP (0.42 cm and 7.88), 60 DAP (0.44 cm and 21.17), 90 DAP (0.54 cm and 22.68) and at the time of harvest (0.87 cm and 27.63).

Regarding interaction effect the treatment M_2S_5 (FYM @ 12.5 tha^{-1}+sea weed extract @ 2 percent) recorded the highest leaf breadth and number of leaves at 30 DAP (0.53 cm and 13.80), 60 DAP (0.70 cm and 28.67), 90 DAP (0.79 cm and 31.80) and at the time of harvest (0.90 cm and 36.93). It was followed by M_2S_3 (12.5 tha^{-1}+panchagavya @ 2 percent). The lowest leaf breadth and number of leaves were recorded by M_1S_1 (Control) which recorded a leaf breadth values of 0.30 cm, 0.40 cm, 0.50 cm and 0.63 cm and 6.07, 19.30, 19,67 and 25.99 number leaves at 30 DAP, 60 DAP, 90 DAP and at the time of harvest respectively. This significant increase on growth characters due to the application of organic manures might have been due to the enhancement of uptake of nutrients favoured by the addition of organic manures. The organic manures increase the soil physical, chemical and biological property which resulted in greater uptake of nutrients as reported by Gaur *et al*. (1972). Similar reports also made by Subbarao *et al*. (1998) in brinjal. Enhancement of plant growth parameter due to application of seaweed extract would be related to the presence of auxin, gibberellin and cytokinin as reported by Ab del-mawgoud *et al*. (2010) in watermelon.

The result on yield traits *viz*., bulb length, bulb girth, number of bulblets, bulb weight, yield per plot and yield per hectare were presented in the table 3. The results showed that different organic manures and biostimulants had

significant influence for all the yield contributing traits. Among the organic manures soil application of FYM @ 12.5 tha^{-1} (M_2) registered higher bulb length (5.99 cm), bulb girth (8.12 cm), number of bulblets (4.76), bulb weight (4.31 g), yield per plot (17.36 kg) and yield per hectare (14.32 t). It was followed by soil application of vermicompost @ 2 tha^{-1}. Whereas lower bulb length (4.07 cm), bulb girth (5.37 cm), number of bulblets (3.46), bulb weight (3.15 g), yield per plot (12.79 kg) and yield per hectare (10.69 t). among the biostimulants foliar application of seaweed extract @ 2% (S_5) recorded increased bulb length (5.80 cm), bulb girth (7.71 cm), number of bulblets (4.72), bulb weight (4.14 g), yield per plot (16.54 kg) and yield per hectare (13.96 t). It was followed by S_3 (panchagavya @ 2%). Lower values for bulb length (4.42 cm), bulb girth (6.05 cm), number of bulblets (3.25), bulb weight (3.55 g), yield per plot (14.35 kg) and yield per hectare (12.00 t). These findings are in line with the findings of Prasad *et al*. (2010), Yokoya *et al*. (2010) and Takezawa *et al*. (2010) in soyabean.

From the results of interaction effect it was noticed that the organic manures and biostimulants showed significant influence on bulb length, bulb girth, number of bulblets, and non significant influence on bulb weight, yield per plot yield per hectare. The maximum bulb length (6.67 cm), bulb girth (9.03 cm), number of bulblets (5.20), bulb weight (4.57 g), yield per plot (18.40 kg) and yield per hectare (15.37 t) were registered by M_2S_5 (FYM @ 12.5 tha^{-1} + sea weed extract @ 2 percent).and it was followed by M_2S_3 (FYM @ 12.5 tha^{-1} + panchagavya @ 2%). This could be ascribed to improvement in physical and biological properties of soil due to organics resulted in better supply of nutrients led to increased crop growth and yield. The reason for increased bulb weight and yield could be attributed to solubilisation effect of plant nutrients by the addition of FYM and vermicompost leading to increased uptake of NPK (Sendurkumaran *et al.,* 1998). Vermicompost are rich in microbial population and diversity particularly fungi, bacteria and actinomycetes (Tomati *et al*., 1987; Edwards, 1998) which consistently promote biological activity. This helps the plant, to germinate, flower and yield better than other fertilizers (Atiyeh *et al*., 2000). The better efficiency of organic manures might be due to the fact that the FYM and vermicompost would have provided the micronutrients such as Zn, Cu, Fe, Mn and Mg in an optimum level (Anburani and Manivannan, 2002) which resulted in early crop growth and higher yield. Whereas, the minimum bulb length (3.37 cm), bulb girth (5.27 cm), number of bulblets (3.10), bulb weight (3.00 g), yield per plot (12.13 kg) and yield per hectare (10.17 t) were registered by M_1S_1 (Control). Significant influence on yield traits by seaweed extract and panchagavya also report by Ab del-mawgoud *et al.* (2010). Increase in yield was mainly due to hormonal substances present in the extracts especially cytokinins (Featonby-Smith and Van staden, 1984). Further, the biostimulant seaweed extract which contain an appreciable quantities of trace elements *viz.*, Fe, Cu, Zn, Co, Mo, Mn and Ni besides growth stimulators like auxins, gibberellins and cyokinins would have helped in better growth and yield. (Stephen *et al.,* 1989).

From the results it was inferred that soil application of FYM @ 12.5 tha^{-1}, vermicompost @ 2 tha^{-1}, and foliar application of seaweed extract @ 2% and panchagavya @ 0.2% had performed better by significantly increasing the growth and yield parameters in onion *var*. Co (On 5).

Table 1. Effect of organic manures and biostimulants on plant height (cm) and leaf length (cm) of multiplier onion var. Co(On 5)

Treatments	30 DAP	60 DAP	90 DAP	at the time of harvest	30 DAP	60 DAP	90 DAP	at the time of harvest
Factor I- Organic manures (M)								
M_1	15.80	17.51	21.75	28.53	14.16	16.21	19.53	24.46
M_2	18.90	23.51	27.81	32.91	18.64	20.11	25.73	28.55
M_3	18.30	21.25	24.40	30.43	16.65	18.91	22.27	26.08
M_4	18.80	21.66	25.97	31.32	17.55	18.84	24.14	27.38

Treatments	30 DAP	60 DAP	90 DAP	at the time of harvest	30 DAP	60 DAP	90 DAP	at the time of harvest
SED	**0.436**	**0.591**	**0.701**	**0.852**	**0.469**	**0.514**	**0.518**	**0.737**
CD	**0.883**	**1.195**	**1.420**	**1.725**	**0.951**	**1.042**	**1.049**	**1.492**
Factor II- Bio stimulants (S)								
S_1	17.50	19.42	22.68	29.34	14.94	16.76	20.98	25.61
S_2	16.15	21.00	25.30	29.97	16.44	17.39	22.49	26.14
S_3	18.44	21.19	24.49	31.64	17.28	19.16	23.16	26.45
S_4	17.95	20.83	25.02	30.41	17.31	19.13	22.68	27.21
S_5	19.73	22.47	27.43	32.63	17.79	20.14	25.30	27.68
SED	**0.488**	**0.660**	**0.784**	**0.952**	**0.525**	**0.575**	**0.579**	**0.824**
CD	**0.982**	**1.336**	**1.588**	**1.929**	**1.063**	**1.165**	**1.173**	**1.669**
Interaction between – M X S								
M_1S_1	13.60	16.00	19.3	26.10	12.53	13.30	17.97	23.00
M_1S_2	13.70	16.63	21.73	29.67	12.77	14.53	18.90	24.40
M_1S_3	15.19	17.97	21.93	28.70	14.50	16.47	20.13	24.70
M_1S_4	15.07	17.97	22.9	28.40	15.40	17.57	20.67	24.90
M_1S_5	15.30	18.97	22.9	29.80	15.60	19.17	20.00	25.30
M_2S_1	15.63	18.70	23.3	29.77	15.70	18.40	21.73	25.37
M_2S_2	16.87	23.47	28.53	33.70	19.70	19.60	26.17	28.10
M_2S_3	19.93	25.53	29.37	32.70	18.93	21.29	27.30	30.10
M_2S_4	19.97	23.20	26.03	30.60	18.73	19.37	23.77	27.30
M_2S_5	22.13	26.67	31.8	37.80	20.43	21.87	29.70	31.90
M_3S_1	18.33	21.87	24.33	30.63	15.73	17.77	22.90	25.70
M_3S_2	16.73	21.10	23.77	27.80	16.57	17.10	21.30	24.30
M_3S_3	19.50	20.27	21.33	32.57	17.77	20.89	19.10	26.57
M_3S_4	19.13	20.73	25.89	30.03	17.10	18.53	23.27	27.67
M_3S_5	20.13	22.30	26.67	31.13	16.10	20.20	24.80	26.17
M_4S_1	16.13	21.13	23.77	30.87	15.80	17.55	21.30	28.37
M_4S_2	17.37	22.80	27.17	28.70	17.03	18.30	23.57	27.77
M_4S_3	19.13	21.00	25.37	32.60	17.90	17.97	26.10	24.47
M_4S_4	17.60	21.43	25.23	32.60	18.00	21.03	23.03	28.97
M_4S_5	21.33	21.93	28.33	31.80	19.03	19.33	26.70	27.33
SED	**0.976**	**1.320**	**1.569**	**1.905**	**1.050**	**1.151**	**1.159**	**1.649**
CD	**1.976**	**2.673**	**3.176**	**3.858**	**2.126**	**2.331**	**2.346**	**3.338**

Table 2. Effect of organic manures and biostimulants on leaf breadth (cm) and number of leaves of multiplier onion var. Co(On 5)

Treatments	30 DAP	60 DAP	90 DAP	at the time of harvest	30 DAP	60 DAP	90 DAP	at the time of harvest
Factor I- Organic manures (M)								
M_1	0.35	0.42	0.54	0.68	6.67	20.47	21.75	28.79
M_2	0.50	0.55	0.65	0.88	11.35	25.67	27.81	31.81
M_3	0.42	0.47	0.58	0.73	9.59	23.66	24.29	27.46
M_4	0.47	0.51	0.63	0.81	10.23	24.87	26.09	29.65
SED	**0.012**	**0.013**	**0.016**	**0.031**	**0.277**	**0.658**	**0.701**	**0.820**
CD	**0.025**	**0.028**	**0.033**	**0.063**	**0.561**	**1.332**	**1.420**	**1.661**
Factor II- Bio stimulants (S)								
S_1	0.42	0.44	0.54	0.87	7.88	21.17	22.68	27.63
S_2	0.42	0.46	0.58	0.87	8.99	23.25	25.30	28.39
S_3	0.42	0.51	0.62	0.87	10.11	24.92	24.49	30.16
S_4	0.44	0.49	0.60	0.87	9.43	23.59	25.02	29.55
S_5	0.47	0.54	0.66	0.90	10.89	25.42	27.43	31.41
SED	**0.013**	**0.015**	**0.018**	**0.034**	**0.310**	**0.736**	**0.784**	**0.917**
CD	**0.028**	**0.031**	**0.037**	**0.070**	**0.627**	**1.490**	**1.568**	**1.857**
Interaction between – M X S								

Treatments	30 DAP	60 DAP	90 DAP	at the time of harvest	30 DAP	60 DAP	90 DAP	at the time of harvest
M_1S_1	0.30	0.40	0.50	0.63	6.07	19.30	19.67	25.99
M_1S_2	0.30	0.40	0.53	0.67	6.23	20.67	21.33	26.99
M_1S_3	0.33	0.40	0.53	0.63	6.73	20.67	21.93	30.00
M_1S_4	0.40	0.47	0.57	0.70	7.10	20.67	22.90	30.00
M_1S_5	0.43	0.43	0.57	0.77	7.20	20.67	22.90	31.00
M_2S_1	0.53	0.43	0.53	0.87	7.22	21.33	23.30	25.93
M_2S_2	0.53	0.53	0.63	0.87	12.23	26.67	28.53	29.90
M_2S_3	0.43	0.60	0.67	0.87	13.39	26.67	29.37	33.00
M_2S_4	0.50	0.50	0.63	0.87	10.10	25.00	26.03	33.00
M_2S_5	0.53	0.70	0.79	0.90	13.80	28.67	31.80	36.93
M_3S_1	0.40	0.43	0.53	0.67	8.80	21.67	23.77	29.80
M_3S_2	0.43	0.43	0.57	0.70	9.10	22.67	23.77	26.77
M_3S_3	0.43	0.50	0.62	0.73	9.53	25.67	21.33	25.97
M_3S_4	0.40	0.50	0.60	0.70	9.43	23.00	25.89	26.97
M_3S_5	0.43	0.50	0.59	0.83	11.13	25.33	26.67	27.77
M_4S_1	0.43	0.50	0.60	0.73	9.43	22.00	24.33	28.80
M_4S_2	0.43	0.47	0.60	0.80	8.43	23.00	27.17	29.90
M_4S_3	0.50	0.53	0.67	0.80	10.77	26.67	25.37	31.67
M_4S_4	0.47	0.50	0.60	0.87	11.10	25.67	25.23	27.93
M_4S_5	0.50	0.53	0.70	0.87	11.43	27.00	28.33	29.93
SED	**0.027**	**0.030**	**0.037**	**NS**	**0.620**	**NS**	**1.569**	**1.834**
CD	**0.056**	**0.062**	**0.075**		**1.255**		**3.177**	**3.714**

Table 3. Effect of organic manures and biostimulants on bulb yield traits of multiplier onion var. Co(On 5)

Treatments	Bulb length (cm)	Bulb girth (cm)	No. of bulblets	Bulb weight (g)	Yield per plot (Kg)	Yield per hectare (t)
Factor I- Organic manures (M)						
M_1	4.07	5.37	3.46	3.15	12.79	10.69
M_2	5.99	8.12	4.76	4.31	17.36	14.32
M_3	5.31	7.09	4.15	4.01	16.01	13.42
M_4	5.58	7.39	4.21	4.10	16.78	14.06
SED	**0.149**	**0.199**	**0.118**	**0.108**	**0.381**	**0.295**
CD	**0.333**	**0.404**	**0.239**	**0.220**	**0.772**	**0.597**
Factor II-Bio stimulants (S)						
S_1	4.42	6.05	3.25	3.55	14.35	12.00
S_2	5.15	6.80	3.99	3.84	15.66	13.01
S_3	5.66	7.55	4.29	4.04	16.11	13.62
S_4	5.18	6.85	4.49	3.91	16.03	13.18
S_5	5.80	7.71	4.72	4.14	16.54	13.96
SED	**0.166**	**0.223**	**0.132**	**0.121**	**0.426**	**0.330**
CD	**0.337**	**0.452**	**0.268**	**0.246**	**0.863**	**0.668**
Interaction between – M X S						
M_1S_1	3.37	5.27	3.10	3.00	12.13	10.17
M_1S_2	4.07	5.27	3.07	3.03	12.37	10.32
M_1S_3	4.27	5.23	3.47	3.13	12.73	10.67
M_1S_4	4.23	5.43	3.63	3.23	13.17	10.99
M_1S_5	4.43	5.63	4.03	3.37	13.53	11.32
M_2S_1	4.63	6.23	3.30	4.00	16.13	12.57
M_2S_2	6.47	8.83	5.20	4.33	17.53	14.66
M_2S_3	6.63	9,03	5.00	4.47	17.97	14.99
M_2S_4	5.57	7.43	5.10	4.17	16.77	13.99
M_2S_5	6.67	9.03	5.20	4.57	18.40	15.37
M_3S_1	4.63	6.03	3.30	3.47	14.12	11.70

Treatments	Bulb length (cm)	Bulb girth (cm)	No. of bulblets	Bulb weight (g)	Yield per plot (Kg)	Yield per hectare (t)
M_3S_2	4.87	6.47	4.27	3.93	15.83	13.37
M_3S_3	5.67	7.77	4.19	4.27	16.60	14.33
M_3S_4	5.53	7.47	4.63	4.13	16.87	13.87
M_3S_5	5.83	7.23	4.33	4.27	16.67	14.43
M_4S_1	5.03	6.67	3.30	3.73	15.03	13.57
M_4S_2	5.17	6.63	3.40	4.07	16.90	13.67
M_4S_3	6.07	8.17	4.47	4.27	17.13	14.47
M_4S_4	5.37	7.07	4.60	4.10	17.30	13.87
M_4S_5	6.27	8.43	5.30	4.33	17.57	14.70
SED	**0.333**	**0.447**	**0.265**	**NS**	**NS**	**NS**
CD	**0.674**	**0.905**	**0.586**			

REFERENCES

Abdel-Mawgoud, A.M.R., Tantaway, A.S., Hatez, M.M. and Habib, H.A.M. 2010. Sea weed extract improves growth, yield and quality of different watermelon hybrids. Res. J. Agri & Biol.Sci., **6(2):** 161-168.

Anburani, A. and Manivannan, K. 2002. Effect of integrated nutrient management on growth in brinjal (*Solanum melongena* L.) cv. Annamalai. South Indian Horticulture, **50(4-6):** 377-386.

Atiyeh, R.M., Aran con, N. Edwards, C.A. and Metzgar. 2000. Influence of earthworm processed pig manure on the growth and yield of green house tomatoes. Bioresource technology. **3:** 175-180.

Edwards, C.A. 1998. The use of earthworms in the breakdown and management of organic wastes. Pp. 327-354.

Featonby-Smith, B.C. and Vnstaden, J. 1984. Identification and seasonal variation of endogenous asrokinia in *Ecklonia maxima* (Osbeck) papen. F. Bot mar., **17:** 527-531.

Gaur, A.C.R., V. subba rao and K.V. Sadasivm, 1972. Soil Structure as influenced by organic matter and inorganic fertilizers. Labden. J. Sci Technol India. **10-B:** 55.

Kumari, R., Kaur, I., Bhatnagar, A.K. 2011. Effect of aqueous extract of *Sargassum johnstonii* Setchell & Gardner on growth, yield and quality of *Lycopersicon esculentum* Mill. J. Appl. Phycol., **23:** 623-633.

Nerhra, A.S., Hooda, I.S. and K.P. Singh. 2001. Effect of integrated nutrient management on growth and yield of wheat (*Triticum aestivum* L.) Indian J. Agron., **45:** 112-117.

Panse, V.G. and Sukhatme, P.V. 1978. Statistical Method for Agricultural Workers. Indian Council of Agricultural Research, New Delhi. P 108.

Premsekhar, M. and Rajashree, V. 2009. Influence of Organic Manures on Growth and quality of Okra. American-Eurasian Journal of Sustainable Agriculutre. **3(1):** 6-8.

Prasad, K., Das, A.K., Oza, M.D., Brahmbhatt, H., Siddhanta, A.K., Meena, R., Eswaran, K., Rajyaguru, M.R., Ghosh, P.K. 2010. Detection and quantification of some plant growth regulators in a seaweed-based foliar spray employing a mass spectrometric technique sans chromatographic separation. J Agric Food Chem., **58(8):**4594 4601.

Sanwal, S.K., Lakshminarayana, K., Yadav, R.K., Rai, N., yadav, D.S. and B. mousmi. 2007. Effect of organic manures on soil fertility, growth, physiology, yield and quality of turmeric. Indian J. Hort., **64(4):** 444-449.

Sendurkumaran, S., Natarajan, S. and S. Thamburaj. 1998. Effect of organic and inorganic fertilizers on growth, yield and quality of tomato. South Indian Hort., **46(364):** 203-205.

Stephen, A.B., John, K.M.T., Palnia, L.M.S. and D.S. Lethama. 1985. Detection of cytokinin in a sea weed extract. Phytochemistry. 24(11): 2611-2614.

Subbarao, T.S.S. and C. Ravi Shankar. 2001. Effect of organic manures on growth and yield of brinjal. South Ind. Hort., **49**(Special): 288-291.

Takezawa, D., Komatsu, K., Sakata, Y. 2011. ABA in bryophytes: how a universal growth regulator in life became a plant hormone? J Plant Res., **124:** 437 453.

Tomati, V., Grappelli, A. and Galli, E. 1987. The presence of growth regulators in earth worm-worked wastes. In: *Proceeding of international symposium on earth worm* (eds. A.M. Bonvicini paglioi and P. Omodeo). Pub. Unione Zoological italiana, Z. Mucchi, Modena. Pp. 423-435.

Yokoya, N.S., Stirk, W.A., van Staden, J., Novak, O., Ture kova, V., P n ík, A., Strnad, M. 2010. Endogenous cytokinins, auxins, and abscisic acid in red algae from Brazil. J Phycol., **46:**1198 1205.

MORPHOLOGICAL TRAITS FOR IDENTIFICATION OF RICE HYBRID CORH3 AND ITS PARENTAL LINES IN GROW OUT TEST

J. Padma[1*], R. Jerlin[1] and S. Anbu[2]
Department of Seed Science & Technology, Tamil Nadu Agricultural University, Coimbatore -3.
Department of Biochemistry, Sacred Heart College, Tirupattur, Vellore - 635 601
E.Mail: jpadmasst@gmail.com

Received: 25.08.16
Accepted: 01.09.16

ABSTRACT

The genetic purity is one of the most important characteristics for quality control of seed. The present study was aimed at characterization of morphological traits for identification of rice hybrid CORH3 and its parental lines *viz*., TNAU CMS 2A, CB87R and TNAU CMS 2B in grow out test (GOT) plot. The thirty two morphological traits including qualitative and quantitative characters recorded from four hundred plants individually in the four rice genotypes as per the National Test Guidelines for distinctiveness, uniformity and stability (DUS) testing. Out of 32 morphological observations variations were observed only in 16 morphological traits like pubescence of leaf blade surface, attitude of flag leaf blade at late observation, panicle curvature of main axis, panicle attitude of branches, panicle exertion, length of leaf blade, width of leaf blade, days to 50 per cent flowering and maturity, length of main axis of panicle, stem length, panicle number per plant and seed traits such as 1000 grain weight, grain length and width were found to be more useful for characterization of genotypes and also these characters can very well be used for identification of off types in GOT field.

***Key words*:** DUS testing; Genotypes; Grow out Test; Morphological traits and TNAU CORH3

Rice is one of the most important cereal grain crops and is consumed by almost half of the world population. There are about 10,000 varieties of rice in the world out of which about 4,000 are grown in India. The quality of rice seeds has distinct effect on the yield of rice, so the proper inspection of rice seed quality is very important. The varietals purity is one of the factors whose inspection is more difficult and more complicated than that of other factors[1]. The success of improved variety/hybrid in the farmers' field depends upon the availability of seed with high genetic purity, which decides the effect of all other inputs in increasing the productivity[2]. Full potential of any hybrid can be exploited by ensuring the supply of genetically pure seeds. Conventionally, hybrid seed genetic purity assessment is done through GOT, which is based on the morphological and floral characters of plants grown to maturity. When a seed lot is passed from one generation to another, some form of genetic contamination is likely to occur that cannot be detected morphologically. The possibilities of gene flow from traditional land races, weedy related species and genetically engineered cultivars to all new crop cultivars pose the problem of seed genetic purity by cross contamination. Such contamination of cultivars may not express phenotypically in the immediate generation[3]. Monitoring of seed genetic purity is thus imperative in the context of detection of pollen contamination from wild relatives. Maintenance of high level of genetic purity of hybrid is essential to exploit the moderate level of heterosis observed in this crop. It is estimated that for every 1% impurity in the hybrid seed, the yield reduction is 100 kg per hectare[4]. Hence, the present study was aimed to find out the genetic purity through GOT.

MATERIALS AND METHODS

Four hundred seeds of rice hybrid CORH3 and its parental lines *viz*., the TNAU CMS2A (CMS line), TNAU CMS2B (Maintainer line) and CB87R (Restorer line) obtained from a seed-lot were planted in a 20-row x 20-column of grow-out matrix at the Wet Lands of Central farm, Tamil Nadu Agricultural University, Coimbatore. Field dimension and all the recommended agronomic and plant protection measures were adopted for raising a healthy crop[5,6]. The experimental field view is given in Plate 1. The characteristics and

their states given as per the National Test Guidelines for DUS[7] were recorded at different stages of crop growth period. The data on DUS characters were recorded on single plant basis in each of the genotype.

Plate 1. Grow out test of rice hybrid CORH3 and its parental lines in field

RESULTS AND DISCUSSION

The qualitative morphological characters recorded among the genotypes was given in Table 1. The basal leaf sheath colour and anthocyanin colouration did not show any variation in the genotypes studied and hence was given a score '1' *i.e.*, green. Pubescence of leaf blade surface was found to be weak in two genotypes (CORH3 and CB87R) with a score of '3' whereas rest of the genotypes showed medium pubescence of blade surface with a score of '5'.

Leaf auricle and ligules were present in all genotypes studied and hence given a score of '9'. Shape of leaf ligules was found to be split in all the genotypes and was given a score of '3'. The colour of leaf ligule was found to be white in all the genotypes and was given a score of '1'. The early observation on attitude of flag leaf was found to be erect in all the genotypes which were assigned a score of '1'. However, at ripening stage, the flag leaf varied from erect to horizontal in attitude. Two genotypes *viz*., TNAU CMS 2A and TNAU CMS 2B exhibited erect with score of '1', whereas CORH3 showed semi-erect attitude of blade with a score of '3'. CB87R was classified as horizontal with a score of '5'. The attitude of flag leaf blade at early stage of anthesis is a useful parameter for describing the specific character of each genotype. However, in the present study, not much variation was observed for this character at early stage of anthesis and at later stage of anthesis.

The density of pubescence of lemma in the spikelet was medium in all the genotypes which were assigned a score of '5'. The lemma anthocyanin colouration of keel and area below apex were absent for all the genotypes and did not show any variation and given a score of '1'. Spikelet colour of stigma was found to be white in all the genotypes and was given a score of '1'. None of the genotypes had anthocyanin colouration of nodes and internode of stem hence was given a score of '1'. The panicle curvature of the main axis in CORH3 was drooping scoring a value of '7'. The genotype, CB87R had a deflexed panicle curvature with a score of '5' and the rest of the genotypes were grouped as straight with a score of '1'. Spikelet colour tip of lemma was found to be yellowish in all the genotypes and was given a score of '2'. Curvature of panicle main axis has its effect in shattering which occurs due to environmental influences and ultimately affects the yield. In the present study, the genotypes were classified as straight (TNAU CMS 2A and TNAU CMS 2B), deflexed (CB87R) and drooping (CORH3). Attitude of panicle branches and the secondary branching has a direct impact on yield and stronger the branching pattern, the more will be the yield. The secondary branching of panicle was found to be weak for TNAU CMS 2A and CB87R and strong for CORH3 genotype.

The panicle awns were absent in all the genotypes with a score of '1'. The presence of secondary branching of panicle was observed in all the genotypes with a score of '9'. Panicle of secondary branching was observed strong in CORH3 with a score of '2' and the rest of genotypes were classified into weak with score of '1'. The panicle attitude of branches was observed as semi erect with a score of '5' in CB87R and the rest of the genotypes were classified as erect to semi erect with a score of '3'. The exertion of panicles was recorded as well exerted with a score of '7' in CORH3, mostly exerted with a score of '5' in CB87R and the remaining genotypes showed partly exerted panicle which were given a score of '3'. Observation for 22 qualitative traits observed from all the plants of four genotypes indicated that sixteen traits *viz*., basal leaf sheath colour, leaf anthocyanin colouration, leaf auricles and ligules, shape and colour of ligule, attitude of flag

leaf of blade at early observation, spikelet density of pubescence of lemma, lemma anthocyanin colouration of keel and lemma anthocyanin colouration of area below apex, spikelet colour of stigma, anthocyanin colouration of nodes and internodes on stem, spikelet colour of tip of lemma, panicle awns and presence of secondary branching did not show any variation, on individual plant basis of four hundred plants in all the four genotypes. Among these, only three genotypes *viz*., TNAU CMS 2A, CB87R and CORH3 possessed particular variations of qualitative traits as off type plants. The quantitative observations were recorded for various morphological characters of rice hybrid and its parental lines are presented in Table 2. The leaf length varied from 20.05 cm (TNAU CMS 2A) to 24.20 cm (CORH3). The leaf length was classified as short for all the genotypes. Based on leaf width, the genotypes were grouped as medium for all the genotypes which is varied from 1.06 cm (TNAU CMS 2A) to 1.30 cm (CORH3). Among the genotypes CORH3 (90 days) and its parental lines *viz*., TNAU CMS 2A and TNAU CMS 2B (86 days) lines were grouped as early and CB87R (94 days) was medium based on days taken for time of heading with 50% panicle. Time of heading is one of the important quantitative morphological traits for rice and has a direct influence on the success of cross pollinations due to synchronization of flowering of parental lines. It was clear from the present study that the restorer line was late in flowering (94 days) and showed considerable variations compared to other genotypes of rice. The time of heading ranged from 86 days to 94 days, which suggested significant variations in days to flowering that could be used for identification of cultivars in rice. Similarly variation in time of heading was reported earlier[8,9,10],

Stem length varied from 37.90 cm (TNAU CMS 2A) to 54.10 cm (CB87R) and also 49.80 cm for CORH3. Hence, all the genotypes were grouped into very short category. The panicle length of main axis was observed long for 28.13 cm (CB87R) and 26.42 cm (CORH3) and for remaining genotypes as medium 24.00 cm (TNAU CMS 2A) and 24.42 cm (TNAU CMS 2B). Similar results were obtained by earlier, where they characterized 142 rice genotypes and found that eight genotypes showed more than 25 cm panicle length and the remaining genotypes recorded lesser panicle length[11]. Stem length is an important character in identification of rice genotypes and assessment of seed genetic purity. The present study revealed that this character was less variable among the genotypes under study. All the genotypes were classified as very short group as per National DUS test guidelines. In this study, the stem length ranged only from 37.90 cm (TNAU CMS 2A) to 54.10 cm (CB87R). Variation in stem length could be used for identification of off types in genetic purity assessment[12]. The panicle number per plant was observed as medium for all the genotypes, which ranged from 15 numbers (TNAU CMS 2B) to 16 numbers (TNAUCMS 2A) and the other genotypes ranged from 12 numbers (CORH3) to 13 numbers (CB87R). Based on the days taken for maturity, the genotypes were grouped as early and medium. CB87R was grouped as medium (123days), the remaining genotypes were grouped as early *i.e*., CORH3 (120 days), TNAU CMS2A (115 days) and TNAU CMS2B (116days). The 1000 grain weight ranged from 20.00g to 22.20g and the genotypes were grouped as low for TNAU CMS2A (20.00) and TNAU CMS2B (20.03 g) and the rest of genotypes as medium for CB87R (22.20 g) and CORH3(22.10 g). The grain length of all the genotypes was grouped as short and it's ranged from 6.00 mm (TNAU CMS2A) to 6.60 mm (CB87R). The grain width of all the genotypes was grouped as narrow which ranged from 2.00 mm (TNAU CMS 2A) to 2.20 mm for (CB87R). The observations were recorded on individual plant basis for four hundred plants in four genotypes. Among them, only three genotypes *viz*., TNAU CMS2A, CB87R and CORH3 possessed particular variations of quantitative traits as off type plants.

Table 1. Scoring of qualitative traits in CORH3 rice hybrid and its parental lines

Qualitative traits	Genotypes			
	TNAU CMS2A	TNAU CMS 2B	CB87R	CORH3
Basal leaf: Sheath color	1	1	1	1
Leaf: Anthocyanin colouration	1	1	1	1
Leaf: Pubescence of blade surface	5	5	3	3
Leaf: Auricle	9	9	9	9
Leaf: Ligule	9	9	9	9
Leaf: Shape of ligule	3	3	3	3
Leaf: Colour of ligule	1	1	1	1
Flag leaf: Attitude of blade early observation	1	1	1	1
Spikelet: Density of pubescence of lemma	5	5	5	5
Lemma: Anthocyanin colouration of keel	1	1	1	1
Lemma: Anthocyanin colouration of area below apex	1	1	1	1
Spikelet: Colour of stigma	1	1	1	1
Stem: Anthocyanin colouration of node	1	1	1	1
Stem : Anthocyanin colouration of internodes	1	1	1	1
Flag leaf: Attitude of blade(late observation)	1	1	5	3
Panicle: Curvature of main axis	1	1	5	7
Spikelet: Colour of tip of lemma	2	2	2	2
Panicle: Awns	1	1	1	1
Panicle: Presence of secondary branching	9	9	9	9
Panicle: Secondary branching	1	1	1	2
Panicle: Attitude of branches	3	3	5	3
Panicle: Exertion	3	3	5	7

Table 2. Average quantitative traits in CORH3 rice hybrid and ts parental lines

Quantitative traits	Genotypes			
	TNAU CMS 2A	TNAU CMS 2B	CB87R	CORH3
Leaf length (cm)	20.05 (S)	20.05 (S)	20.05 (S)	20.05 (S)
Leaf width (cm)	1.06 (M)	1.06 (M)	1.06 (M)	1.06 (M)
Time of heading (days)	86 (E)	86 E	94 (M)	90 (E)
Stem length (cm)	37.90 (V.S)	37.90 (V.S)	37.90 (V.S)	37.90 (V.S)
Length of main axis of panicle (cm)	24.00 (M)	24.00 (M)	24.00 (M)	24.00 (M)
Panicle number plant^{-1}	16 (M)	16 (M)	16 (M)	16 (M)
Time maturity (days)	115 (E)	115 (E)	115 (E)	115 (E)
1000 grain weight (g)	20.00 (L)	20.00 (L)	20.00 (L)	20.00 (L)
Grain length (mm)	6.00 (S)	6.00 (S)	6.00 (S)	6.00 (S)
Grain width (mm)	2.00 (N)	2.00 (N)	2.00 (N)	2.00 (N)

S- Short; M- Medium; E- Early, V.S – Very Short; L – Low; N - Narrow

CONCLUSION

The present study clearly demonstrates the utility of morphological characters for the assessment of genetic purity of rice hybrid and parental lines by accurately detecting the presence of off types as admixture in the hybrid and parental lines seed lot. This can be used by the public and private seed companies for accurate and reliable detection of off-types in commercial rice hybrid seed lots for ensuring the supply of good quality seeds to the market.

REFERENCES

Virmani, S.S. and I. Kumar. 2004. Development and use of Hybrid rice technology to increase rice productivity in the tropics. Intl Rice Research Newslr., 29: 10-20.

Agrawal, R.L. 1980. Seed Technology. Oxford and IBH Published Co., New Delhi.

Bhatia, C.R. and R. Mitra. 2003. Consequence of gene flow from genetically engineered crops. Current Sci., 84(2): 138 -141.

Mao, C.X., S.S. Virmani and I. Kumar. 1996. Technological innovations to lower the costs of hybrid rice seed production. In: Virmani SS *et al*., (eds) Advances in hybrid rice

Verma, M.M. 1996. Procedures for Grow-Out Test (GOT). Seed Tech. New., 26: 1-4.

Singh, S. 1997. Modern Techniques of raising field crops. Oxford & IBH, Publishing co.

Shobarani, N., L.V. Subha Rao, B.C. Viraktamath and B. Mishra. 2004. National Guidelines for the Conduct of Tests for Distinctness, Uniformity and Stability. Directorate of Rice Research, Hyderabad, Technical Bulletin No.8.

Santy, V. 1999. Use of biochemical and molecular markers for characterization of parental lines of promising rice (*Oryza sativa* (L.)) hybrids. Ph.D. Thesis, Division of Seed Science and Technology, IARI, New Delhi.

Nethra, N. 2003. Studies on varietal characterization based on morphological, biochemical and molecular markers in rice (*Oryza sativa* (L.)) M.Sc (Ag.) Thesis, UAS, Bangalore

Le, M.T. and Y. Yang. 2005. Morphological characterization and phytochemical analysis of pigmental rice cultivars from diverse regions. AAES Research series 540, B.R. Wells Rice Research Studies. 77-86.

Sarma, M.K., A.K. Richharia and R.K. Agarwal. 2004. Characterisation of ahu rices of Assam for morphological and agronomic traits under transplanted conditions. *Oryza*, 41 (1&2): 8-12.

Rosta, K. 1975.Variety identification in rice. Seed Sci. and Technol., 3: 161-169.

Journal of Progressive Agriculture, Vol., 7 No. 2: Oct. 2016

KNOWLEDGE OF FARMERS ABOUT IMPROVED BT COTTON PRODUCTION TECHNOLOGY

Manmeet Bishnoi[*], S.S. Sisodia[**] and Yogita Ranawat[***]
*M. Sc. Student, **Professor and ***Ph. D. Scholar
Dept. of Extn.Edun., Rajasthan college of Agriculture, Udaipur-313001 (Rajasthan)
E-mail:yogitaranawat27@gmail.com

Received: 06.05.16
Accepted: 10.09.16

ABSTRACT

This study was an attempt to get the response regarding Knowledge of farmers about improved Bt cotton production technology. A comprehensive list of all Bt cotton growers was prepared separately for all selected village of identified tehsil. Thereafter the farmers were categorized in to three categories i.e. large, small and marginal farmers. Following the procedure laid down above a sample of total 15 respondents i.e. 5 in each category from every selected village was drawn randomly. Thus the study sample for the present investigation was comprised of 120 respondents. (i.e. 60 from each tehsil) in all eight village. It has Concluded that out of 120 respondents, majority of respondents 42.50 per cent fell in medium level of knowledge group followed by high and low level of knowledge about bt cotton production technology. In overall, it has found that first rank is given to soil & field preparation with MPS 91.25 and followed by time of sowing with MPS 88.33.

***Key words*:** Knowledge, Bt cotton, production, technology and adoption.

In Rajasthan Bt cotton is mainly grown in Bhilwara, Chittorgarh, Rajasmand, Banswara, Shri Ganganagar, Bikaner and Nagaur district. Bhilwara is major Bt cotton growing district of the state. Bt cotton is grown in 6,529 ha. area with production of 10,400 metric tonnes in Bhilwara district. The climatic conditions of the district are most suitable for cultivation of Bt cotton but the productivity of this crop is far below than desired level. This level can be achieved through timely adoption of recommended Bt cotton cultivation technology by the farmers. Hence, this aspect is a key indicator to assess the knowledge of farmers about improved Bt cotton production technology.

MATERIAL AND METHODS

The present study was conducted in Bhilwara district of Rajasthan. There are total twelve tehsils in Bhilwara district of Rajasthan, out of which two tehsil namely Mandalgarh and Asind have been selected on the basis of maximum area under Bt cotton cultivation. Four-four villages identified from each tehsil were selected on the basis of maximum area under Bt cotton cultivation. Thus, total 120 Bt cotton growers (40 marginal, 40 small and 40 large farmers) were randomly selected from identified villages for data collection. interviewed with specially designed interview schedule. The data were analyzed using statistical tools viz; frequencies, percentage, mean and mean per cent score.

RESULTS AND DISCUSSION

1. Knowledge of farmers about improved bt cotton production technology

The data in table 1 reveal that out of 120 respondents, majority of respondents 42.50 per cent fell in medium level knowledge group whereas, 40.00 per cent Bt cotton growers were observed in the high level knowledge group and remaining 17.50 per cent respondents possessed low level of knowledge about improved Bt cotton cultivation technology. Further analysis of data in table 1 indicates that 50.00 per cent marginal farmers, 50.00 per cent small farmers and 27.50 per cent large farmers had medium level of knowledge about improved Bt cotton cultivation technology. Whereas, 30.00, 40.00 and 50.0 per cent marginal, small and large farmers possessed high level of knowledge about improved Bt cotton cultivation technology respectively.

On the other hand, 20.00 per cent marginal farmers, 10.00 per cent small farmers and 22.50 per cent large farmers were kept in the low level of knowledge group about improved Bt cotton cultivation technology. On the basis of above data, it could be inferred that majority (50.00 %)

of the large farmers possessed high level of knowledge about improved practices of Bt cotton cultivation.

2. Aspect-wise knowledge of respondents about improved Bt cotton production Technology

The data presented in table 2 shows that large farmers of the study area possessed 78.42 per cent of knowledge about use of high yielding varieties aspect of Bt cotton production technology whereas, knowledge of marginal and small farmers about this practice was comparatively less with 63.29 per cent and 67.24 per cent. It was observed that majority of the farmers had knowledge about the name of varieties of Bt cotton namely NCS-145, NCS-913, NCS-858, NCS-855 and NCS-138 and they were fully acquainted with duration and average yield of these recommended varieties of Bt cotton in the study area.

The knowledge about soil and field preparation, it was noted that marginal, small and large had knowledge 88.75, 93.75 and 91.25 per cent respectively. Further, analysis of table shows the marginal, small and large farmers had extent of knowledge about soil treatment was 68.33, 58.33 and 55.00 MPS respectively. Majority of the respondents were not aware of chemicals used for the soil treatment for killing termites in their fields in small group of farmers.

Further, analysis of table shows the marginal, small and large farmers had extent of knowledge about seed treatment was 60.83, 73.33 and 77.50 MPS respectively The knowledge about time of sowing, it was found that 85.31, 94.06 and 85.63 per cent knowledge was recorded in marginal, small and large farmers and ranked second by large farmers.

Regarding knowledge about seed rate and recommended spacing, it was noted that marginal, small and large farmers had 76.25, 81.88 and 80.63 per cent extent of knowledge respectively. In case of fertilizers application, marginal, small and large farmers had 75.83, 78.33 and 78.75 per cent knowledge and ranked fifth by small, large and sixth by marginal farmers respectively. Whereas, in case of irrigation management, marginal, small and large farmers had 69.58, 74.17 and 75.00 per cent knowledge and ranked eighth by small and marginal farmers and ninth by large farmers respectively.

Regarding knowledge about weed management practice was placed at seventh rank by marginal farmers, small farmers and sixth rank by large farmers with 72.50, 74.38 and 78.75 MPS respectively.

Regarding knowledge about plant protection measures, it was found that marginal, small and large farmers had knowledge 93.17, 87.17 and 82.83 per cent respectively. Table clearly shows that all the category of farmers had high knowledge about plant protection measures and this aspect ranked first by marginal farmers third by small farmers, and large farmers respectively. It means that Bt cotton growers were acquainted with plant protection measures they have fair knowledge about insect-pest of Bt cotton in comparison with chemicals quantity used to control them. At last the knowledge about harvesting, it was found that 80.00, 75.00 and 71.25 per cent was recorded in marginal, small and large farmers respectively. The knowledge about this aspect at sixth ranked by the small, fourth by marginal farmers, tenth rank by large farmers respectively.

In overall, it has found that first rank is given to soil and field preparation with MPS 91.25, followed by time of sowing with MPS 88.33, plant protection with MPS 87.72, seed rate and recommended method of sowing with MPS 79.58 and were ranked second, third and fourth respectively. It indicate that Bt cotton growers knew very well about soil and field preparation, time of sowing, plant protection measure and seed rate and recommended spacing. Whereas less knowledge regarding soil treatment with MPS 60.56, use of high yielding varieties with 69.65 and seed treatment with MPS 76.56.It was observed that most of the respondents were not aware about chemical used for seed treatment and soil treatment.

CONCLUSION

It has Concluded that out of 120 respondents, majority of respondents 42.50 per cent fell in medium level of knowledge group followed by high and low level of knowledge about bt cotton production technology. Further, revealed that 50 per cent of marginal farmer and small farmer had medium level of knowledge. Whear as, 50 per cent large farmers possess high level of knowledge about bt cotton production technology.

In overall, it has found that first rank is given to soil & field preparation with MPS 91.25 and followed by time of sowing with MPS 88.33. Whereas less knowledge regarding soil treatment with MPS 60.56, use of high yielding varieties with 69.65 and seed treatment with MPS 76.56.It was observed that most of the respondents were not aware about chemical used for seed treatment and soil treatment.

Table 1: Distribution of respondents on the basis of level of knowledge about Bt cotton production technology **n =120**

Knowledge level	Marginal farmers		Small farmers		Large farmers		Total	
	f	%	f	%	f	%	f	%
Low (<63)	8	20.00	4	10.00	9	22.50	21	17.50
Medium (63 to 75)	20	50.00	20	50.00	11	27.50	51	42.50
High (>75)	12	30.00	16	40.00	20	50.00	48	40.00
Total	40	**100.00**	**40**	**100.0**	**40**	**100.0**	**120**	**100.0**

f = frequency, % = per cent, n= total size of sample.

Table 2: Extent of knowledge of respondents about Bt. Cotton production technology **n=120**

Aspects	Marginal farmers		Small farmers		Large farmers		Total	
	MPS	Rank	MPS	Rank	MPS	Rank	MPS	Rank
High yielding varieties	63.29	10	67.24	10	78.42	7	69.65	10
Soil and field preparation	88.75	2	93.75	2	91.25	1	91.25	1
Soil treatment	68.33	9	58.33	11	55.00	11	60.56	11
Seed treatment	60.83	11	73.33	9	77.50	8	70.56	9
Time of sowing	85.31	3	94.06	1	85.63	2	88.33	2
Seed rate and recommended spacing	76.25	5	81.88	4	80.63	4	79.58	4
Fertilizer application	75.83	6	78.33	5	78.75	5	77.64	6
Irrigation management	69.58	8	74.17	8	75.00	9	72.92	5
Weed management	72.50	7	74.38	7	78.75	6	75.21	8
Plant protection measure	93.17	1	87.17	3	82.83	3	87.72	3
Harvesting and storage	80.00	4	75.00	6	71.25	10	75.42	7

MPS= mean per cent score, n= total size of sample

REFERENCES

Bheemappa, A., 2001. A comparative analysis of knowledge and technological gap in adoption of Paddy and Cotton cultivation practices between migrant and nonimmigrant farmers of TBP command area in Karnataka. Ph. D. Thesis, Univ. Agric. Sci., Dharwad (India).

Bhople, R. S., Shinde, P. S. and Dhule, S. S., 2001. Knowledge and adoption of biocontrol pest management in Cotton. *Maharashtra J. Extn. Edu* **20**: 18-21.

Chaturvedi, D., Panwar, J.S. and Sharma, S.K. 2000. Technological knowledge of improved cotton production technology of the farmers of IGNP and non-IGNP area of Bikaner district of Rajasthan. *Rajasthan Journal of Extension Education* **10:** 99-103.

G.Sridhar, DV Patil, B.Shrihari Rao, SSM Rao and SRRM Kumar, 2014. KVKs, are the district centres for the improvement in knowledge level of farmers in rural India. Jr. of Progressive Agriculture, Vol. 5(1): 55-61.

Sachin Rathore, Sheela Raghuwanshi, Kamini Bisht and SPSingh, 2016. Knowledge level of farmers on fish production technology in Tikamgarh district of MP. Jr. of Progressive Agriculture, Vol. 7 (1): 50-53.

Sonu, SS Sisodia and Y.Ranawat, 2016. Knowledge of improved sugarcane production technology by the farmers of Chitorgarg distrct of Rajasthan. Jr. of Progressive Agriculture, Vol. 7(1): 23-26.

Yogita Ranawat, Pravesh Singh, SS Sisodia, Santosh Devi and NR Meena, 2014. Association between knowledge and adoption level of improved maize cultivation practices with selected variables of maize growers. Jr. of Progressive Agriculture, Vol. 5 (1): 24-27.

.

BIOLOGICAL CHARACTERIZATION OF *Papaya ringspot virus* PATHOTYPES

B. Parameswari* and R.K. Jain
Division of Plant Pathology (Advanced Centre for Plant Virology), IARI, New Delhi
*Present address: Sugarcane Breeding Institute Regional Centre, Karnal
Email: parampathnem@gmail.com

Received: 07.05.16
Accepted: 10.07.16

ABSTACT

***Papaya ringspot virus* (PRSV), a definitive member of the '*Potyviridae*' family and the genus '*Potyvirus*' is a major limiting factor affecting papaya and cucurbits in various parts of the world, including the Indian sub-continent. Two pathotypes of PRSV, papaya infecting (P) or non-papaya infecting (W) have been recognized. To study the prevalence and association of PRSV pathotypes in India, glass house and laboratory experiments were conducted at Division of Plant Pathology, Indian Agricultural Research Institute, New Delhi. The results revealed association of *Papaya ringspot virus* (PRSV) with infected papaya (*Carica papaya*) and sponge gourd (*Luffa cylindrica*) samples collected from IARI experimental fields and it was confirmed by leaf-dip electron microscopy, bio-assay (host range) and immuno-assay (ELISA) studies. Based on the bio-assay, the virus isolates from papaya and sponge gourd were classified as P and W pathotypes respectively. Pathotype P could infect members of the family Caricaceae and Cucurbitaceae, while W pathotype could infect only Cucurbitaceous hosts. Both localized and systemic infection was observed on Cucurbitaceous hosts for pathotype W, while only localised infection was observed in few cucurbits for pathotype P. Pathotypes P and W collected from Delhi were unable to induce local lesions on *Chenopodium quinoa* and *C. amaranticolor*. Though some of the Cucurbitaceous hosts like ridge gourd, pumpkin, watermelon and muskmelon supported multiplication of pathotype P, yet pathotype P was more adapted to papaya, while pathotype W to Cucurbitaceous hosts.**

***Key words*:** *Papaya ringspot virus*, Pathotypes P and W, Host range, ELISA.

Papaya cultivation is severely affected by several biotic and abiotic stresses. Among the biotic stresses, papaya ringspot, caused by Papaya ringspot virus (PRSV) is a major disease affecting papaya industry worldwide including India (Varma, 1988; Chakraborty et al., 2015). The disease is characterized by a variety of symptoms like mosaic, distortion and filiformy of leaf lamina, water soaked oily streaks on the petiole, trunk and ringspot on fruits. The disease seems to be wide spread and occurs wherever papaya is grown. *Papaya ringspot virus* (PRSV), a definite member of the family '*Potyviridae*' and the genus, *Potyvirus* (Fauquet et al., 2005) was first reported in western (Capoor and Varma, 1958) and subsequently northern (Khurana, 1974) parts of the country, where it was confined for a long time. In the 1980´s it started spreading to the southern parts of the country, where papaya cultivation was taken up on a large scale. PRSV has now been reported from all major papaya growing areas of the country (Bag et al., 2007, Parameswari, 2009, Srinivasulu and Sai Gopal, 2011,) and incidence of more than 90% or even upto 100% has been recorded in some Indian states (Jagadish Chandra and Samuel, 1999). Like other Potyviruses (Shukla et al., 1994), PRSV has a narrow host range (P and W) restricted to only three dicotyledonous families and two pathotypes have been recognized. Pathotype P isolates infect the species belonging to the families Caricaceae, Chenopodiaceae and Cucurbitaceae, whereas type W isolates infect species of Chenopodiaceae and Cucurbitaceae. Pathotype W isolates are non-infectious to the species of family Caricaceae (Purcifull et al., 1984). Though both the pathotypes (P and W) are known to occur in India (Roy et al., 1999), their detailed comparative host range studies are lacking.

MATERIALS AND METHODS

The present investigation was carried out based on the *Papaya ringspot virus* (PRSV) infected papaya and sponge gourd samples collected from Indian Agricultural Research Institute (IARI)

experimental fields. Infected papaya samples exhibited a variety of symptoms ranging from mild mottling (MM) to yellow mosaic (YM)), vein clearing (VC), leaf blistering (LB), leaf distortion (LD) and shoe stringing (SS). Infected sponge gourd samples exhibited foliar symptoms ranging from mottling (MT) to mosaic (M), vein banding (VB), vein clearing (VC) and leaf blistering (LB). Infected papaya samples were tested for the presence of pathotype P by sap inoculation on papaya (cv. Pusa nanha). Similarly infected sponge gourd samples showing different symptoms were tested for the presence of pathotype W by pathogenicity test on papaya (cv. Pusa nanha) and cucurbits (pumpkin (*Cucurbita moschata*) and squash (*Cucurbita pepo*)). Test plants were raised in insect- proof glass house conditions. Five to eight seeds were planted in each plastic pot (180×195 cm) and seedlings with uniform growth were selected for inoculation. Infected as well as healthy leaves tissues were macerated separately using sterilized chilled pestle and mortar in 0.01M phosphate buffer (pH 7.2, 1:1, w/v) containing 0.1% ß-mercaptoethanol as extraction buffer (EB). The extracted sap was kept on ice till the inoculation was completed. The test plant seedlings (papaya - inoculated at 2-3 leaf stage, pumpkin and squash - inoculated at cotyledonary leaf stage) were dusted with celite (diatomaceous earth), which served as an abrasive. The inoculum was applied directly on to the upper surface of the leaves. Seedlings were then sprayed with distilled water and kept in the insect-proof glass house. The inoculated seedlings were observed for symptoms development for 3-4 weeks and also tested for the presence of virus by direct antigen–coated enzyme linked immunosorbent assay (DAC-ELISA) (Clark and Bar-Joseph, 1984), using polyclonal antiserum generated against the coat protein of PRSV at Advanced Centre of Plant Virology (ACPV). Forty six plant species belonging to eleven families were tested for ascertaining the host range of PRSV pathotypes P and W (Table 1). Seeds of the test plant species were procured from National seeds corporation (NSC), New Delhi. Seedlings of the test plant species were raised in earthern pots (5 per pot) and rub-inoculated at 2-3 leaf stage as described earlier. Inoculated seedlings were observed for symptoms development up to 4-6 weeks and tested for the presence of virus by DAC-ELISA.

RESULTS AND DISCUSSION

Leaf-dip electron microscopy revealed the association of flexuous viral particles with symptomatic papaya and sponge gourd samples. The association of pathotypes P and W with infected papaya (*Carica papaya*) and sponge gourd (*Luffa cylindrica*) plants respectively, was confirmed by bio- and immuno- assays. Suspected *Papaya ringspot virus* affected papaya and sponge gourd samples reacted positively with polyclonal antiserum to coat protein of PRSV pathotype P in DAC-ELISA. The absorbance values (A405nm) for papaya and sponge gourd samples ranged from 1.76-2.23 and 1.53-1.85 respectively. The virus from symptomatic papaya plants was mechanically transmitted to papaya (cv. Pusa nanha) and pumpkin (*C. moschata*). Both localized as well as systemic (Fig 1) infections were observed on papaya. Seedlings showed prominent vein clearing (Fig 1C) and mottling (Fig 1B) of the young leaves in about 1-2 weeks. After 2-3 weeks, the leaves become blistering (Fig 1D) and distorted (Fig 1 E), the lobes being markedly reduced in size resulting in filiformy (Fig 1F). Only mosaic and mild mottling symptoms were produced on cucurbits. The absorbance values (A405nm) for PRSV-P infected papaya and pumpkin samples varied from 1.32-2.87. Similarly, the virus from symptomatic sponge gourd plants was sap transmitted to pumpkin and squash but failed to infect papaya. The foliar symptoms on pumpkin and squash varied from mottling (MT) to vein banding (VB), vein clearing (VC), leaf blistering (LB) and filiformy (Fig 2). The

absorbance value (A405nm) for PRSV-W infected pumpkin was 1.97.

The experimental host range of PRSV pathotypes P and W was determined by sap inoculation of 46 plant species belonging to 11 families (Table 1). Both symptomatology and virus multiplication in different hosts were compared (Table 2). None of the Asteraceaeous, Chenopodiaceaeous, Cruciferaceous, Euphorbiaceous, Fabaceaeous, Labiataeous, Malvaceaeous, Solanaceaeous, Umbelliferaeous species tested was infected locally or systemically by pathotypes P and W. With some exceptions, pathotype P could infect plant species belonging to Caricaceae and Cucurbitaceae, whereas pathotype W could infect all cucurbitaceous species tested (Table 2). Pathotype P caused a variety of symptoms such as vein clearing, mild mottling, leaf blistering, leaf distortion and filiformy on papaya, whereas pathotype W was non-infectious (Table 2). Both localized and systemic symptoms were observed on all Cucurbitaceous species tested by pathotype W (Fig 2). Except kakri (0.74), the absorbance values (A405nm) in other Cucurbitaceous plants tested varied from 1.33-3.59. Pathotype P was pathogenic to only a few Cucurbitaceous plants tested and with some exception; only localized symptoms were observed (Table 2). Except ridge gourd (3.02), the absorbance values (A405nm) in other cucurbitaceous plants varied from 0.71-1.34. Based on the host range studies, PRSV isolates collected from papaya and sponge gourd were identified as pathotypes P and W respectively. Host range of pathotype P was mainly restricted to Caricaceae and of pathotype W to Cucurbitaceae and none of the pathotypes could infect plant species belonging to Asteraceae, Chenopodiaceae, Cruciferaceae, Euphorbiaceae, Fabaceae, Labiatae, Malvaceae, Solanaceae and Umbelliferae (Table 2). Further, among the various Cucurbitaceous plant species tested, ridge gourd, pumpkin, watermelon and muskmelon (Table 2) were identified as a good propagative host for PRSV pathotype P and zuchinni, summer squash, ridge gourd, sponge gourd, pumpkin and tinda (Table 2) were identified as good propagative hosts for pathotype W. Thus, possibility of natural infection of pathotype P and W together on cucurbits exists. However, the host range of pathotypes P and W from Delhi varied from PRSV pathotypes reported from other geographical regions (Surekha et al., 1977; Yemewar and Mali, 1980; Verma et al., 2006; Mantri et al., 2005). Both the pathotypes found to produce local lesions on *Chenopodium quinoa* and *C. amaranticolor*. This is in confirmation with our earlier observation on pathotypes P and W collected from Delhi (Roy et al., 1999). Pathotype P collected from Delhi (Roy et al., 1999) and Uttar pradesh (Khurana, 1974) were restriced to Caricaceae, whereas the isolates from Rajasthan (Surekha et al., 1977) and Maharastra (Yemewar and Mali, 1980) possessed a wide host range infecting the plant species belonging to families Chenopodiaceae and Cucurbitaceae, besides Caricaceae.

ACKNOWLEDGEMENT

The authors are thankful to Head, Professor and staffs of Division of Plant Pathology, IARI, New Delhi for providing all the facilities to carry out the work and B. Parameswari was supported by a fellowship from the Indian Agricultural Research Institute (IARI), New Delhi.

Table 1. Test plants used for ascertaining host range of *Papaya ringspot virus* pathotypes P and W

Family	No. of plant species tested	Family	No. of plant species tested
Asteraceae (6)	*Helianthus annus* (Sunflower)	Euphorbiaceae (1)	*Ricinus communis* (Castor)
	Carthamus tinctorius		
	Tridax procumbens (Tridax)		
	Cosmos bipinnatus		

Family	No. of plant species tested	Family	No. of plant species tested
	(Cosmos) *Tagetes erecta* (Marigold) *Zinnia hybrida* (Zinnia)		
Caricaceae (1)	*Carica papaya* (Papaya)	Fabaceae (7)	*Arachis hypogaea* *Cicer arietinum* (Chickpea) *Glycine max* (Soybean) *Phaseolus vulgaris*(French bean) *Vigna mungo* (Blackgram) *Vigna radiata* (Greengram) *Vigna unguiculata* (Cowpea)
Chenopodiaceae (2)	*Chenopodium quinoa* *C. amaranticolor*	Labiatae (1)	*Ocimum sanctum* (Tulsi)
Cruciferae (4)	*Brassica nigra* (Mustard) *B. oleraceae* var. *botrytis*(Cauliflower) *B. oleraceae* var. *Capitata* (Cabbage) *Raphanus sativus* (Radish)	Malvaceae (2)	*Abelmoschus esculentus*(Bhendi) *Gossypium hirsutum*(Cotton)
Cucurbitaceae (13)	*Citrullus lanatus* (Watermelon) *C. vulgaris* var *fistulosus* (Tinda) *Cucumis melo* (Musk melon) *C. melo* var *momardica* (Snap melon) *C.Sativus* (Cucumber) *C. melo* var *utilissmus* (Kakri) *Cucurbita maxima* (Summer squash) *C. moschata* (Pumpkin) *C. peop* (Squash) *Lagenaria siceraria* (Bottle guard) *Luffa acutangula* (Ridge gourd) *L. cylindrica* (Sponge gourd) *Momordica charantia* (Bitter gourd)	Solanaceae (7)	*Datura metel* (Datura) *Lycopersicon esculentum* (Tomato) *Nicotiana benthamiana* *Nicotiana tabacum(Tobacco)* *Nicotiana glutinosa* *Solanum melongena (Brinjal)* *Solanum tuberosum* (Potato)
		Umbelliferae (2)	*Coriandum sativum* (Coriander) *Dacus carota* (Carrot)

Table 2. Infectivity of *Papaya ringspot virus* (PRSV) pathotypes P and W on different hosts

Host	P				W			
	Visual observation			ELISA	Visual observation			ELISA
	No. of plants infected/ No. of plants inoculated	Inoculated Leaves	Uninoculated leaves	A405nm	No. of plants infected/ No. of plants inoculated	Inoculated leaves	Uninoculated leaves	A405nm
Cucurbitaceae								
Squash	12/15	4	-	0.71(0.28)	15/15	4, 5	1, 3, 8, 9	3.59 (0.15)
Summer squash	9/15	4	-	0.84(0.26)	15/15	4, 5	1, 3, 8, 9	3.23 (0.17)
Pumpkin	12/15	4	-	1.34(0.25)	15/15	4, 5	1,2, 3, 8	3.42 (0.18)
Snap melon	8/15	5	-	0.76(0.27)	15/15	4, 5	2, 3	1.76 (0.27)
Muskmelon	9/15	5	-	1.12(0.22)	14/15	4, 5	2	1.62 (0.21)

Cucumber	0/10	-	-	0.21(0.19)	12/13	4, 5	9	1.33 (0.23)
Kakri	0/10	-	-	0.35(0.25)	9/15	4, 5	2	0.74 (0.13)
Watermelon	8/15	5	-	1.08(0.29)	13/15	4, 5	2	1.87 (0.28)
Tinda	10/15	4, 5	2	0.78(0.19)	12/15	4, 5	2	2.73 (0.19)
Bottle gourd	9/15	5	-	0.94(0.21)	13/15 4, 5 2, 3	4, 5	2, 3	1.51 (0.25)
Bitter gourd	0/15	-	-	0.32(0.25)	15/15	4, 5	2	2 1.65 (0.14)
Ridge gourd	15/15	4, 5	2, 3, 9	3.02(0.28)	15/15	4, 5	9	3.15 (0.24)
Sponge gourd	0/14	-	-	0.19(0.14)	15/15	4, 5	2, 9	3.05(0.26)
Caricaceae Papaya	15/15	4, 5	2, 3, 6, 7, 8, 9	3.25(0.21)	0/10	-	-	0.26 (0.22)

F: Filiformy (1); LB: Leaf blistering (2); LD: Leaf distortion (3); M: Mosaic (4); MT: Mottling (5); SS: Shoe stringing (6); S: Stunting (7); VB: Vein banding (8); VC: Vein clearing (9)

Fig. 1 Characteristic symptoms induced by *Papaya ringspot virus* (PRSV) pathotype P on inoculated papaya (cv. Pusa nanha) seedling: Uninoculated control (A); (B-E) Inoculated seedling showing mottling (B); vein clearing (C); leaf blistering (D); leaf distortion (E) and shoe stringing (F)

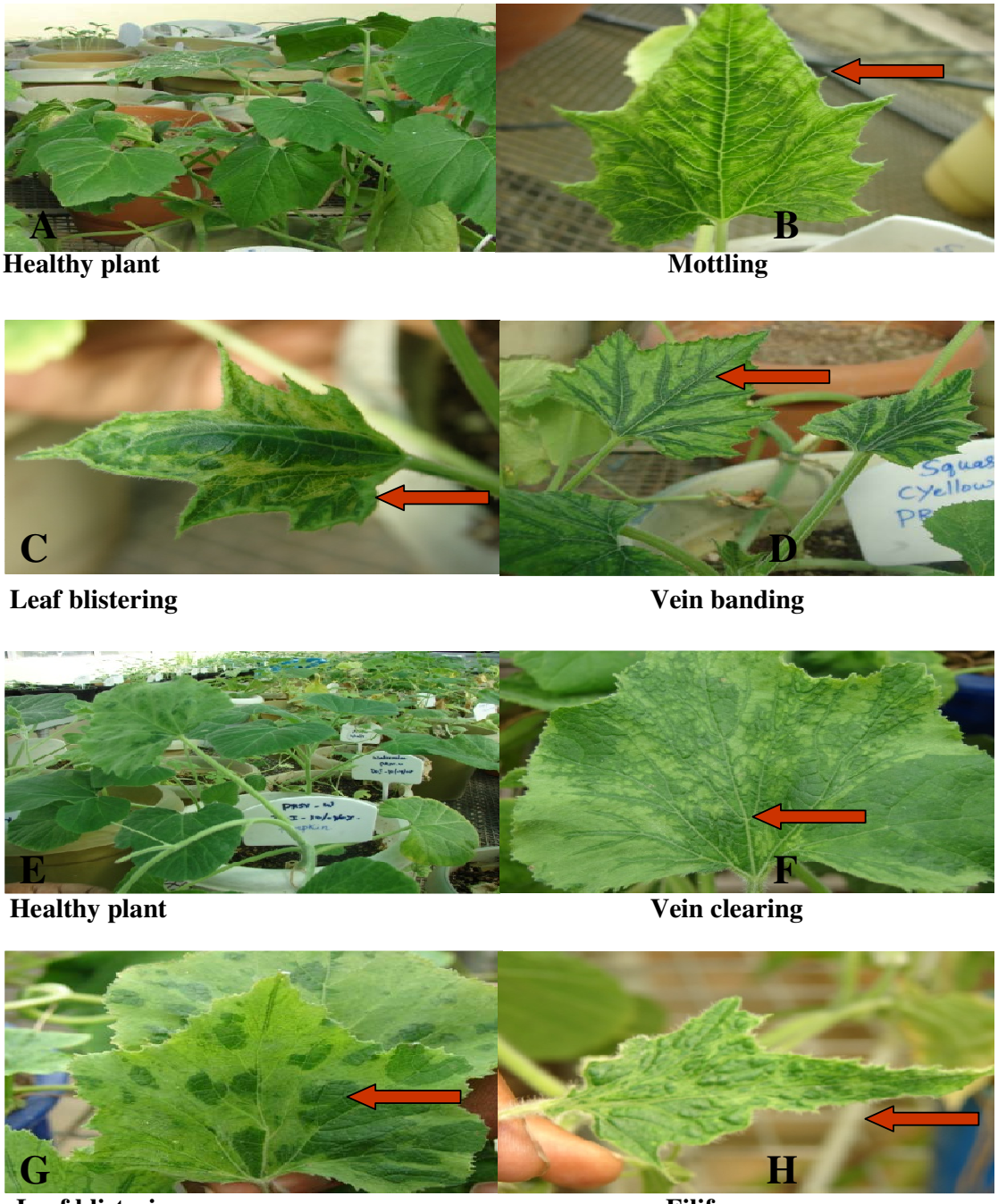


Fig. 2 Characteristic symptoms induced by *Papaya ringspot virus* (PRSV) pathotype W on inoculated squash (A-D) and pumpkin ((E-H)) plants: Healthy plant (A and E); Mottling (B); Leaf blistering (C and G); Vein banding (D); Vein clearing (F) and Filiformy (H)

REFERENCES

Bag, S., Agarwal, S. and Jain, R. K. 2007. Sequence diversity in the coat proteins of *Papaya ringspot virus* isolates originating from different locations in India. *Indian Phytopathol*., **60:** 244–252.

Capoor, S.P. and Varma, P.M. 1958. A mosaic disease of papaya in Bombay. Indian J Agril Sci., **28:** 225-235.

Chakraborty, P., Das, S., Saha, B., Sarkar, P., Karmakar, A., Saha, A., Saha, D., and Sahaa, A. 2015. Phylogeny and synonymous codon usage pattern of *Papaya ringspot virus* coat protein gene in the sub-Himalayan region of north-east India. Canadian J. Microbiol., **61:** 555-564.

Clark, M.F. and Bar-Joseph. 1984. Enzyme-linked immunosorbent assay in plant virology: In Marmorash, K. and Korowski, H. Eds. Methods in virology, vol VII . Academic press, New York. pp. 51-85.

Fauquet, C.M., Mayo, M.A., Maniloff, J., Desselbenger, U. and Ball, L.A. 2005. Virus taxonomy – Eigth report of the International committee on Taxonomy of viruses. Academia press, New York.

Jagadish Chandra, K. and Samuel, L.D.K. 1999. Viral and phytoplasmal diseases of papaya in India. In: Verma, L.R. and Sharma, R.C. Eds. Diseases of Horticultural crops – fruits. Indus Publishing Co, New Delhi.

Khurana, S.M.P. 1974. Studies on three virus diseases of papaya in Gorakhpur. India. Abstract Pro XIX Int Hort Cong, Warszawa, Poland. **7:** 260.

Mantri, N.L., Kitkaru, A.S., Misal, M.B. and Ravi, K.S. 2005. First report of Papaya ringspot virus – W in bottle gourd (*Lagenaria siceraria*) from India. Plant pathol., **54:** 806.

Parameswari, B. 2009. Genome organization of *Papaya ringspot virus* isolates from India and their biological characterization. Ph.D. Thesis, IARI, New Delhi.

Purcifull, D.E., Edwardson, J.R., Hiebert, E. and Gonsalves, D. 1984. *Papaya ringspot virus*. CMI/AAB Description of plant viruses. No. 292 Wallingford, UK: CAB International.

Roy, G., Jain, R.K., Bhat, A.I. and Varma, A. 1999. Comparative host range and serological studies of papaya ringspot potyvirus isolates. Indian Phytopath **52:** 14-17.

Shukla, D.D., Ward, C.W. and Brunt, A.A. 1994. The potyviridae. CAB International, Wallingford, UK.

Srinivasulu, M. and Sai gopal D.V.R. 2011. Coat protein sequence comparison of south Indian isolates of *Papaya ringspot virus* with other Indian subcontinent isolates. Phytopatholo Mediter., 50: 359-367.

Surekha, S.K., Mathur,K. and Shukla, D.D. 1977. Virus diseases of papaya (*Carica papaya*) in Udaipur. Indian J. Mycol. Plant Path., **7:** 115-121.

Varma, A. 1988. The economic impact of filamentous plant virus – The Indian sub- continent. In: Miline, R.G. Eds. The plant viruses. Plenum Press, New York. 4: 371-376.

Verma, R., Baranwal, V.K., Prakash, S.P.S, Pant, R.P. and Ahlawat, Y.S. 2006. First report of *Papaya ringspot virus* W in sponge gourd from India. Plant Disease **90:** 974.

Yemewar, S.I. and Mali, V.R. 1980. On the identity of a sap transmissible virus of papaya in Marathwada. Indian J. Mycol. Plant Pathol., **10:** 155-160.

ANALYSIS OF DROUGHT TOLERANCE IN MAIZE HYBRIDS BY LINE X TESTER

Roshni Vijayan and A.Kalamani
Center for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, India.
Email: roshnivij@gmail.com

Received: 10.05.16
Accepted: 15.07.16

ABSTRACT

Drought is a major constraint in the cultivation of crops especially in tropical areas. Drought tolerance studies in maize help to understand the parameters which are associated with drought stress in the crop. This research was conducted to analyze the impact of drought on yield of maize (*Zea mays*L.). The development of drought tolerant hybrids for rainfed and moisture stress conditions with emphasis on using genotypic and phenotypic data was another objective. The initial study started with 100 genotypes from which the 10 best genotypes (lines) were selected for drought tolerance studies. Screening was carried out using physiological and phenotypic data. Thirty hybrids were developed from the 10 lines and 3 testers (locally adapted varieties)utilizing a LINE X TESTER analysis. Parentsand hybrids were phenotypically assessed in twofield conditions: irrigatedand moisture stress. Results showed that hybrid IBET IE 1253-8 X UMI 61 was best under normal irrigation and IBET IE 1256-6 X COH (M)5 was best under moisture stress. Taking both fields together, the best hybrid was IBETIE1253 X UMI 61 which averaged 6.4t/ha. The best parental lines for both conditions were COH (M) 5 and Hy R`06 6143-16. Results support the fact that yields are low when maize is subjected to drought stress. The best hybrid was equal to the local variety under both irrigatedand moisture stress condition. Drought tolerant maize hybrids can help to improve productivity in drought stressed areas.

Key words: Drought, line X tester, moisture stress, *gca*, *sca*

Maize (*Zeamays*.L.) is the most important crop next to wheat and rice in the world agricultural economy. It is important for food, animal feed and industrial utilization. It is the crop of the future as mentioned by Dr. Norman E. Borlaug(Dahiya 2008). Maize can play a vital role in ensuring food security as well as nutritional security for developing countries and the world as a whole. According to the Food and Agriculture Organisation (2003) report, out of 593 million tons of maize produced on 142.3 million hectares globally, 17 per cent is used as human food and 66 per cent as animal feed. Drought is a major constraint to maize production in all areas where there is no adequate rains or irrigation.

Global climate change is considered to be underway and is expected to result in a long-term trend towards higher temperatures, greater evapo-transpiration and an increased incidence of drought in many regions of the world (Hillel and Rosenzweig. 2002). Water shortage in India by 2020 is expected to be severe, as the per capita availability of water per personbecomes less than 1,000 cubic meters. Water shortage isimportant, as 85 per cent of water is used for agriculture, 10 per cent for industry and 5 per cent for domestic use (outlookindia. 2009).Above mentioned trends emphasis the fact that competition for water will increase in future with domestic and industrial demands meaning less water for agriculture and irrigation. The expansions of cultivation of maize into marginal production areas are generating increasingly drought-prone maize production environments. The grain loss in maize due to drought in the tropics averages 24 million mega grams per year (Wilkinson 1992). Climate change will further increase the chances of drought.

Maize hybrid breeding objectives depend on various factors like the requirements of farmers, market forces, production levels, constraints and crop ecology. However, the most important breeding objective is increased grain yield. The average annual yield loss in maize due to drought is estimated to be 17% in the tropics (Wilkinson 1992). Drought tolerance is not a simple character governed by one or two genes but controlled by a number of morpho-

physiological characters independently controlled by more than two genes(Fukai and Cooper. 1995). The major problem in drought tolerance breeding is the poor understanding of genetics and the inheritance of drought tolerant traits, and lack of understanding of the relationship between the physiological traits in drought tolerance and plant productivity under stress (Wilkinson 1992). Improvement of drought resistance in high yielding genotypes can be achieved by the incorporation of morphological and physiological mechanisms of drought resistance in new lines through breeding programs.

The use of genetics to improve drought tolerance and to provide yield stability is an important part of the solution to stabilizing global maize production. Breeding genotypes suitable for both irrigated and drought conditions will be useful to farmers and to industries. This research uses physiological and morphological drought tolerant mechanisms for the development of drought tolerant hybrids. The objective of the study was to provide useful information for breeders in developing drought tolerant maize hybrids. The activities of the research comprised of three parts: i) Screening of the germplasm for drought tolerance ii) Line x Tester analysis.

MATERIALS AND METHODS

The present investigation was carried out from 2007– 2009 at the Department of Millets, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, India (11° North latitude, 77° East longitude). Soils for the experiment were black cotton soils (vertisols) with a loamy texture for the irrigated treatment and a clay loam for the induced moisture stress treatment. During the experimentthe mean annual rainfall was17.7mmreceived in 4 rainy days. The mean maximum and minimum temperatures were 30.2°C and 21.5°C, respectively.

Drought Tolerance Screening of Genotypes

A hundred lines obtained from the maize germplasm collection at the Department of Millets, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore were screened for drought and identification of tolerance traits. Initial Screening was done in a greenhouseusing relative water content, chlorophyll content values and specific leaf area data. Seeds were sown in 250 ml paper cups filled with garden soil, peat and sand in 1:1:3 ratios. A completely randomized design (CRD) with 3 replicates, with 10 plants per treatment was used. All 3 measurements were taken from five plants randomly selected from each replication on the 30^{th} day after seedling emergence. The Chlorophyll meter from Minolta (SPAD model 502 of Minolta, Japan) was used to measure chlorophyll values fromthe newly emerged leaf on either side of the midrib at a point three - fourths of the way from the base to leaf tip.

Specific leaf area is a measure of the leaf area of the plant to leaf dry weight. Matured leaves after 20 days of emergence were collected and leaf area was measured using a LI-3100C Area Meter and leaf dry weight was taken after oven drying for 8 hours at 80C

The relative water content was estimated by taking 25 leaf discs of 1 cm diameter from 25 day old leaves using a punch machine and fresh weight of the leaf discs was taken. The leaf discs were then immersed in water at 25C. After 4 hours the turgid weight of the discs was measured. The leaf discs were oven-dried for 8 hours at 80C andthe dry weight taken. The formula proposed by(Barrs and Weatherley 1962)was utilized to derive RWC values.

For the 100 genotypes, the means of the 3 measured traits were used to do cluster analysis by numerical taxonomy techniques, using NTSYS-pc package, version 2.01, (Rohlf. 1997). An Unweighted Pair-Group Method of the Arithmatic (UPGMA) (Sokal and Michener. 1958)average clustering procedure was employed to construct the dendrogram. Based on the groupings in the dendrogram, 34 genotypes were selected for further studies.

Line x Tester Analysis

The selected 34 genotypes were taken to a field crossing block during June 2008. Each genotype was raised on a ridge spaced 60 cm apart, five meter long, and 30 cm between plants; sowing of genotypes was at three dates,

10 days apart, for synchronization of flowering. From 34, 10 were selected for the line x tester analysis based on the anthesis tosilking intervalof 1-2 days. The ten lines selected were crossed with three testers (locally adapted varieties) individually in a line x tester model (Kempthorne. 1957) to obtain 30 hybrids.

All thirteen parent lines (10 lines and 3 testers) (Table1) along with the 30 hybrids were evaluated from December 2008 to February 2009, under irrigated and induced moisture stress conditions in **tw**o different fields. The moisture stress was created artificially by withdrawing irrigation a week before flowering started for 28 days and another field grew the same lines under normal irrigated conditions with 10 irrigations spaced 10 days apart. Each entry was grown in two rows of five-meter longusing a randomized block design(RBD) replicated thrice; spacing was 60 x 30 cm. Recommended agronomic and plant protection practices were followed to maintain healthy growth.

Observations were recorded on five plants selected randomly from each entry and replication. The parents and F1 hybrids were examined for morphological traits and yield components whose genes were found to have an impact on drought stressed output as grains. The yield components which were responsible for yield were cob weight, 100 seed weight, number of kernels per row, number of rows per cob, and single plant yield. The morphological traits which showed an influence on drought tolerance of the crop includes,anthesissilking interval (ASI), root volume, chlorophyll stability index (CSI), and relative water content (Table 2).

Statistical Analysis

The data was subjected to statistical analysis using the INDOSTAT statistical package developed by Indostat Services, Hyderabad, India.Analysis of variance for all characters was determined(Panse and Sukhatme. 1961). The mean values were used to estimate heterosis per cent under three categories of mid parent, better parent and standard parent (Fonesca and Paterson. 1968).

RESULTS AND DISCUSSION

Drought Tolerance Screening of Genotypes

Means of 3 measured traits, chlorophyll meter reading, relative water content and leaf area were used to do cluster analysis and developa dendrogram (Fig 1). This allowed thehundred genotypesselected for drought testing to be grouped into eleven major clusters (Fig.1) and 34 genotypes were selected, with 3 each from 8 groups, 1 each from group 2 and 6 and rest 8 from the group 3 which was the largest group.The 34 genotypes were selected as drought tolerant genotypes for further study which are diverse from each other. These genotypes were planted in field. The 10 genotypes (lines) which had an ASI of 1-2 days were further selected for Line X Tester analysis, since ASI is the major criteria for selection of lines with drought tolerance in maize.

Line X Tester Analysis

The present investigation tested ten inbred lines as female parents and three inbreds as male parents for their genetic potential in breeding program for grain yield under irrigated and stress conditions. The parents which possess desirable genes were identified by comparing the mean values and general combining ability (*gca*). The line L10 and tester T2 was found to perform best (Table3). The magnitude of heterosiswas studied for characters that affected yield and drought tolerance (Table 5). Since yield is a complex trait, knowledge of the association of different components with yield is necessary.

For the expression of maximum yield, all genes which contribute to yield should have a positive heterosis for the exploitation of hybrid vigor in the development of hybrids (Table 4). The major traits which have a genetic contribution to yield showing significant effects are cob weight, 100 kernel weight, number of kernels per row, number of kernel rows per cob, single plant yield. All these traits were showing positive heterosis in the superior F1 hybrids developed. Not much variation was noticed in normal irrigated or induced moisture stress developed hybrids in terms of hybrid vigor.

This has lead to the selection of a particular hybrid which performs well in both conditions.

A positive heterosis in chlorophyll stability index, relative water content and negative heterosis in traits of root volume and anthesissilking interval is desired to exploit heterosis in development of drought tolerant hybrids (Table 4).This was noticed in the case of both the conditions of normal irrigation as well as induced moisture stress. There was maximum contribution of crosses resulted from lines x testers to total variance for grain yield per plant, 100 seed weight and cob weight, CSI, root volume followed by contribution of female parents for ASI, and plant height.

In normal irrigated condition,the hybrid L5XT3 was best suited to heterosis breeding for cob weight, 100 kernel weight, number of kernels per row, and single plant yield. The hybrid L10XT2 was suited for number of kernels per row and 100 kernel weight.For drought prone environments, the hybrids L6XT2 was suited to heterosis breeding for 100 kernel weight, number of kernels per row and single plant yield. The hybrid L5XT3 was suited for root volume. The hybrid L1XT3 was best for number of kernel rows.

In induced moisture stress situation, the hybrid L6 X T2 (IBET IE 1256-6 X COHM5) was performing better with positive significant value for grain yield and number of kernel rows per cob while in the irrigated condition, the hybrid L5 X T3 (IBET IE 1253-8 XUMI 61) recorded positive significant values for grain yield and drought related traits of root volume, chlorophyll stability index and relative water content and was the best hybrid for irrigated condition.

In both induced moisture stress and normal irrigation, the hybridL5 X T3 (IBET IE 1253-8 X UMI 61) recorded positive significant values for grain yield per plant and was the best hybrid for both conditions. While considering the various traits in both conditions of induced stress and normal irrigation, the hybrid L5 X T3 expresses a positive significant value for grain yield per plant, which can happen only when the genes which contribute to maximum yield are expressed well in the hybrid along with the desirable environmental effects.

The hybrid L5 X T3 (IBET IE 1253-8 XUMI 61)did not show a wide difference in grain yield of 6.4t/ha, 6t/ha for irrigated and induced stress conditions respectively. In the L5 X T3 hybrid both the parents has positively significant *gca* effects for most of the traits.

Drought Tolerance Screening of Genotypes

From the dendrogram data, it is clear that physiological parameters play a vital role in the study of drought tolerance. The selection of suitable plants from a germplasm collection using specific physiological traits is a viable way for crop improvement for water stress tolerance (Kiani *et al*. 2007, Reynolds *et al*. 2005, Tambussi *et al*. 2007) The initial selections of 34 inbred lines from the 16 clusters in the dendrogram (Fig 1) were based on the physiological traits related to drought. Hence a simple method of screening maize lines using three potential physiological selection criteria, relative water content, chlorophyll content and specific leaf area were tested in the present study. The clusters indicate the diverse nature of the inbred lines used for development of drought tolerant hybrids. (Burke. 2001, Srikanthbabu *et al.* 2002) expressed that genetic variability for water stress response can only be expressed when plants are exposed to water stress. The higher water stress tolerance is due to expression of water stress-responsive genes that can be translated into certain physiological phenomena such as maintenance of relative water content and chlorophyll content (Bruce *et al*. 2002, Waseem *et al*. 2006). Selection of inbreds with the physiological parameters in the initial stage of seedlings itself has an impact on the final development of hybrids since physiological traits are found to have its impact in drought tolerance.

Line x Tester analysis

The ten inbred lines identified as female parents and three testers as male parents, according to the Line X Tester analysis, the genetic potential and the nature of the gene action of the genes involved was assessed. The best parents L10 (Hy R`06 6143-16) and T2 (COH (M) 5) identified had a better general combining

ability, but those were not able to produce the better hybrids. The reason could be the good combiners will not result in specific combiners leading to better hybrids. The F1 hybrids which were evaluated for grain yield under irrigated as well as in stress conditions (Ganunga. 2007). In the present study, the magnitude of heterosis, and general and specific combining abilities were studied for drought specific characters(Dadheech and Joshi. 2007;Fonesca and Paterson. 1968). Since yield is a complex trait, knowledge of the association of different components with yield like cob weight, number of kernel rows per cob, number of kernels per cob and interrelation among themselves is useful.

Per cent heterosis over mid parent and better parents were estimated to know the possible gene action and to exploit heterosis for drought associated traits and yield. Parents with high mean values like L10 and T2 are preferred for using in hybridization program as they are expected to produce desirable segregants(Frova *et al*. 1999). Evaluation of hybrids in F2 generation becomes necessary to consider whether a hybrid can be used on a commercial basis or could be utilized in a breeding program. The hybrids can be evaluated based on their mean value and degree of heterosis.

For cob weight, 100 kernel weight, number of kernels per row, and single plant yield the hybrid L5XT3 recorded the highest value under normal irrigated condition. This shows that genes contributing these traits were able to express better in this hybrid. The specific combining ability of this hybrid is better. While comparing the induced moisture stressed field, the variation observed is due to the impact of stress condition. In a stressed situation certain genes are expected to express well resulting in overdominance of the genes related to drought resulting in another hybrid to express better. In induced moisture stress the hybrid which performed best was L6 X T2. While comparing both hybrids L6XT2 AND L5XT3, the parents involved were different in both. For obtaining good specific combining crosses, good combiners should come together, but this is not a rule for all crosses. Sometimes two poor combiners may yield good specific combination due to epistatic gene action. The crosses with poor combiners will yield transgressivesegregants in segregating generations.

CONCLUSION

The development of drought tolerant maize hybrids can help to improve productivity in drought stressed areas.From the research the F1 hybrids developed had the presence of drought tolerant genes. Now when we need to extend the research for F2 generation where we will be able to see the segregating pattern of the genes and also will be able to select the best from the F2 for further development of hybrids for commercial cultivation.

ACKNOWLEDGMENTS

I thank Professor Peter Hobbs, Cornell University, Ithaca, New York, USA for his valuable suggestions in the development of this manuscript.

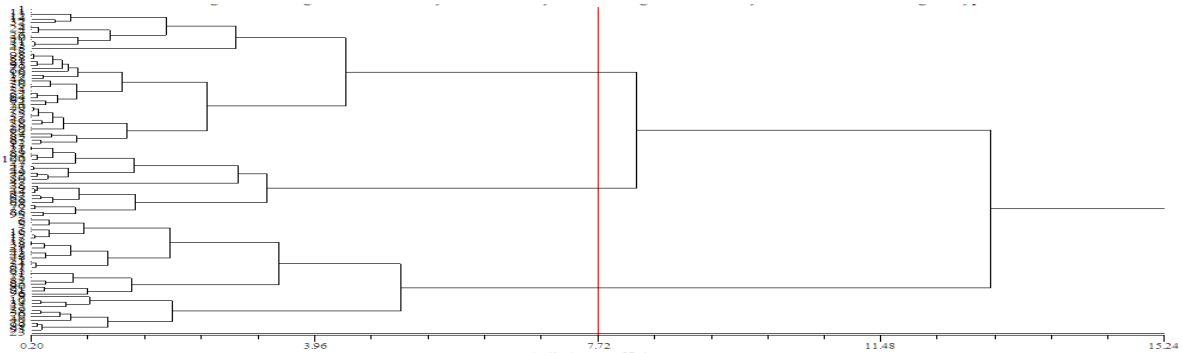


Fig.1 Dendrogram obtained by cluster analysis showing the 16 clusters which constitute the 100 genotypes

Indicates the starting of each cluster where cluster numbering starts serially from the top.

RWC = [(Fresh wt – Dry wt)/(Turgid wt- Dry wt)]x 100

Table.1: Details of the 10 Lines & 3 Testers used

		Genotype	Source / Origin
TESTERS	T1	UMI 285	Selection from (96123 (Sarhaelx Suwan1)x (Suwan))
	T2	COH(M) 5	UMI 285 * UMI 61
	T3	UMI 61	Selection from (Taiwan DMR13)
LINES	L1	IBET IE1207-6	Department of Millets, Coimbatore
	L2	IBET IE 1554-5	Department of Millets, Coimbatore
	L3	IBET IE 1224-9w	Department of Millets, Coimbatore
	L4	IBET IE 1051-5	Department of Millets, Coimbatore
	L5	IBET IE 1256-6	Department of Millets, Coimbatore
	L6	IBET IE 1253-8	Department of Millets, Coimbatore
	L7	IBET IE 1076-5	Department of Millets, Coimbatore
	L8	IBET IE 1182-5	Department of Millets, Coimbatore
	L9	Hyd.R`06. 2199-1	Department of Millets, Coimbatore
	L10	Hy R`06 6143-16	Department of Millets, Coimbatore

Table.2: Description of morphological traits and yield components which had influence on yield and drought.

Trait	Abbreviation	Description / Reference
Cob weight	**CW**	**The cob was weighed after harvest at 12% moisture.**
100 seed weight	100SW	One hundred normal grains per ear were counted and weighed
Number of kernals per row	K/R	The number of kernals per row of the cob were counted after harvest
Number of kernal rows per cob	KR/C	The numbers of kernal rows in each cob were counted after harvest.
Single plant yield	SPY	The cob of tagged plants were separated, cleaned and weighed
Anthesissilking interval	ASI	Difference in days between 50% tassels have extruded the anther and 50% of cobs have emerged silk
Chlorophyll Stability Index	CSI	(Murty and Majundar. 1962)(Harrigan *et al*. 2007)
Relative Water Content	RWC	(Barrs and Weatherley. 1962)
Root Volume	RV	Plants were uprooted at maturity, roots were cut and washed and the volume was recorded adopting water displacement method

Table 3: Selected Parents for specific traits based on mean values and *gca*(general combining ability)

Traits	Selected parents	
	Irrigated	**Moisture stress**
*Plant height	L10, T2	L10,T2
*100 Kernel weight	L10,T1	L10,L1,T2
*Number of kernel rows per cob	L3	L8
*Number of kernels per row	L3,T2	L10,T3
Harvest index	L10	L4,L10,T2
*Grain yield/ Plant	L10,L7,T2	L10,L5,T1,T2
AnthesisSilking Interval	L1	L7,L10,L3,T2
*Root volume	L5,L3,L10,L4,T1	L10,L5,L1,T1
*Chlorophyll Stability Index	L5,L10,L2,L4	L5,L2,L4,L7,L10
*Relative Water Content	L5	L1

Table 4: Selected Hybrids for specific traits based on mean values, *sca*(specific combining ability) and standard heterosis.

Traits	Selected hybrids	
	Irrigated	**Moisture stress**
*Plant height	L10XT2	L7XT3,L6XT2
*100 Kernel weight	L5XT3,L10XT2	L5XT3,L6XT2
*Number of kernel rows per cob	L6XT2,L3XT1	L1XT3
*Number of kernels per row	L10XT2,L5XT3	L6XT2,L4XT3
Harvest index	L5XT3,L8XT1	L5XT3
*Grain yield/ Plant	L6XT2,L5XT3	L6XT2,L5XT3
AnthesisSilking Interval	L6XT2	L4XT2
*Root volume	L4XT2	L7XT2,L5XT3
*Chlorophyll Stability Index	L2XT1,L5XT3	L5XT3,L1XT1
*Relative Water Content	L8XT2,L5XT3	L5XT3

Table 5: Magnitude of heterosis over mid parent and better parent for morphological traits for drought in normal irrigated induced moisture stress condition

Character	Anthesissilking interval (NI)		Anthesissilking interval (IMS)		Root volume (NI)		Root volume (IMS)		Chlorophyll stability index (NI)		Chlorophyll stability index(IMS)		Relative water content (NI)		Relative water content (IMS)	
HYBRIDS	**di**	**dii**	**di**	**dii**	**di**	**di**	**dii**	**di**	**dii**	**di**	**dii**	**dii**	**di**	**dii**	**di**	**dii**
$L_1 \times T_1$	-	-	-	-	14.2	4.20	-	-	9.26	0.54	23.64	12.8	14.7	1.56	-	-
$L_1 \times T_2$	-	-	22.12	-	-	-	31.1	22.5	-	-	-	-	3.75	-	72.07	19.10
$L_1 \times T_3$	26.25	7.45	-	-	-	-	3.45	1.76	5.24	14.3	117.6	88.2	12.7	0.43	41.46	0.16
$L_2 \times T_1$	-	-	93.18	37.10	-	-	2.38	-	3.18	3.08	3.78	-	41.6	1.56	5.68	-
$L_2 \times T_2$	46.24		58.33	39.71	-	-	17.4	13.4	-	-	-	-	24.5	-	32.45	3.79
$L_2 \times T_3$	29.52		15.65	-	15.7	14.7	-	-	5.03	5.79	58.35	6.50	44.6	4.16	113.7	72.47
$L_3 \times T_1$		2.42	-0.47	-	4.05	-	-	-	-	-	-	-	37.4	4.66	7.76	-8.20
$L_3 \times T_2$	-	-	30.32	16.09	7.70	5.34	-	-	-	-	-	-	41.5	6.51	-	-
$L_3 \times T_3$	-	-	50.55	44.21	3.11	0.31	-	-	3.10	13.4	31.75	6.93	50.5	15.1	86.79	47.71
$L_4 \times T_1$	-	-	-6.08	-	-	-	-	-	-	-	-	-	18.0	4.29	-	-
$L_4 \times T_2$	-5.76	-	-	-	31.0	24.2	-	-	-	-	4.32	2.48	23.7	7.77	79.61	35.71
$L_4 \times T_3$	-	-	49.06	15.70	7.91	7.47	27.6	31.2	-	-	58.32	4.30	12.6	0.13	76.16	36.82
$L_5 \times T_1$	-	-	-	-	11.7	6.99	-	-	3.64	4.32	-2.35	-	15.5	7.16	-2.64	-
$L_5 \times T_2$	34.10		-	-	-	-	10.6	-	-	-	-	-	-	-	2.26	-
$L_5 \times T_3$			84.31	48.42	9.87	-	17.6	14.2	1.89	1.89	59.36	5.23	24.3	16.1	21.38	-4.13
$L_6 \times T_1$	-	-	83.87	83.87	18.2	-	-	-	2.99	-	5.48	-	1.54	1.09	33.09	1.81
$L_6 \times T_2$	34.00	3.08	95.83	51.61	11.9	-	0.62	-	1.84	-	16.22	-	-	-	156.5	119.7
$L_6 \times T_3$	-	-	18.72	4.84	34.0	16.4	-	-	-	-	37.44	13.1	1.90	0.73	117.7	92.97
$L_7 \times T_1$			0.00	-	19.6	3.72	20.7	-	-	-	-	-	-	-	69.53	17.55
$L_7 \times T_2$	14.29		-	-	42.6	27.7	62.6	45.1	-	-	-	-	-	-	189.5	186.2
$L_7 \times T_3$	2.25	-	-	-	23.4	15.6	-	-	-	-	51.20	2.13	13.3	12.2	67.28	62.70
$L_8 \times T_1$	4.76	-	100.0	65.32	9.87	-	-	-	-	-	-	-	21.9	6.77	17.53	9.99
$L_8 \times T_2$	50.94	34.83	8.72	0.00	-	-	16.8	16.5	-	-	-	-	27.5	10.0	-	-
$L_8 \times T_3$	32.24		106.8	91.58	-	-	-	-	8.65	8.83	38.11	9.74	15.5	1.83	-	-
$L_9 \times T_1$	-	-	90.35	75.00	-	-	-	-	7.54	26.4	-	-	2.21	1.96	-	-
$L_9 \times T_2$	18.64	-	-	-	-	-	10.4	6.29	12.3	-	17.15	13.8	-	-	20.00	-
$L_9 \times T_3$	10.45	3.74	21.61	16.35	-	-	-	-	14.3	-	125.9	86.5	4.34	3.35	-	-
$L_{10} \times T_1$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$L_{10} \times T_2$	-	-	-	-	9.19	4.01	3.24	-	3.72	-	9.68	4.84	6.40	2.68	67.11	15.04
$L_{10} \times T_3$	-	-	4.05	-5.26	20.2	20.1	12.2	8.73	0.87	4.82	56.12	4.29	3.65	2.39	39.07	-2.10

di-relative heterosis(over mid parent)dii-heterobeltiosis (over better parent)**** significant at 1% level * significant at 5 % level**

NI- Normal Irrigation IMS – Induced Moisture Stress

REFERENCES

Barrs, H.D. & Weatherley, P.E. (1962) A re-examination of the relative turgidity technique for estimation of water deficits in leaves. Australian Journal of Biological Sciences. 15: 413-428.

Bruce, W.B., Edmeades, G.O. & Barker, T.C. (2002) Molecular and physiological approaches to maize improvement for drought tolerance. *J Exp Bot*. 53: 13-25.

Burke, J.J. (2001) Identification of genetic diversity and mutations in higher plant acquired thermotolerance. *Physiol Plantarum*. 112: 167-170.

Dadheech, A. & Joshi, V.N. (2007) Heterosis and combining ability for quality and yield in early maturing single cross hybrids of maize (Zea mays L.). *Indian J Agric Res*. 41: 210-214.

Dahiya, S.B. Coarse cereals need government support. TribuneIndia...AgricultureTribune. 2009.

Fonesca, S. & Paterson, F.L. (1968) Hybrid vigour in seven parental diallel cross in common wheat. (*Triticum aestivum L.*). Crop Science: 85-88.

Frova, C., Krajewski, P., Di Fonzo, N., Villa, M. & Sari-Gorla, M. (1999) Genetic analysis of drought tolerance in maize by molecular markers. I. Yield components. *Theor Appl Genet*. 99: 280-288.

Fukai, S. & Cooper, M. (1995) Development of drought-resistant cultivars using physiomorphological traits in rice. *Field Crops Res*. 40: 67-86.

Ganunga, R.P. (2007) Genotypic and phenotypic chacterization of maize test cross hybrids under stressed and non stressed conditions.

Harrigan, G.G., Stork, L.G., Riordan, S.G., Ridley, W.P., Macisaac, S., Halls, S.C .et al. (2007) Metabolite analyses of grain from maize hybrids grown in the United States under drought and watered conditions during the 2002 field season. *J Agric Food Chem*. 55: 6169-76.

Hillel, D. & Rosenzweig, C. (2002) Desertification And Its Relation To Climate Variability And Change. *Adv Agron*. 77: 2-39.

Kempthorne, O. (1957) An introduction to genetic statistics.Wiely, New York.

Kiani,P. S , Grieu, P , Maury, P. , Hewezi, T. , Gentzbittel, L. & Sarrafi, A. (2007) Genetic variability for physiological traits under drought conditions and differential expression of water stress-associated genes in sunflower (Helianthus annuus L.). *TAG.Theoretical and applied genetics.Theoretische und angewandte Genetik*. 114: 193-207.

Murthy,K.S. and Majundar,S.K. (1962) Modifications of the techniques for determination of chlorophyll stability index in relation to studies of drought resistance in rice. Curr. Sci., 31:470-471.

outlookindia. (2009) news.outlookindia.com | 'India to Face Severe Water Stress by 2020'.

Panse, V.G. & Sukhatme, P.V. (1961) Statistical Methods for Agricultural Workers.

Reynolds, M.P., Mujeeb-kazi, A. & Sawkins, M. (2005) Prospects for utilising plant-adaptive mechanisms to improve wheat and other crops in drought- and salinity-prone environments. *Ann Appl Biol*. 146: 239-259.

Ribaut, J.M & Ragot, M. (2007) Marker-assisted selection to improve drought adaptation in maize: the backcross approach, perspectives, limitations, and alternatives. *J Exp Bot*. 58: 351-60.

Rohlf, F.J. (1997) NTSYS-PC, E. Setauket, NY. . 2.1 ed, Exeter Software.

Sokal, R.R. & Michener, C.D. (1958) A statistical method for evaluating systematic relationships. . University of Kansas, Lawrence.

Srikanthbabu, V., Ganeshkumar, Krishnaprasad, B.T., Gopalakrishna, R., Savitha, M. & Udayakumar, M. (2002) Identification of pea genotypes with enhanced thermotolerance using temperature induction response technique (TIR). *J Plant Physiol*. 159: 535-546.

Tambussi, E.A., Bort, J., Guiamet, J.J., Nogues, S. & Araus, J.L. (2007) The Photosynthetic Role of Ears in C3 Cereals: Metabolism, Water Use Efficiency and Contribution to Grain Yield. *Crit Rev Plant Sci*. 26: 1-16.

Tuberosa, R., Salvi, S., Giuliani, S., Sanguineti, M.C., Bellotti, M., Conti, S. et al. (2007) Genome-wide Approaches to Investigate and Improve Maize Response to Drought. *Crop science*. 47: S120.

Waseem, M., Athar, H.& Ashraf, M. (2006) Effect of salicylic acid applied through rooting medium on drought tolerance of wheat. *Pakistan journal of botany*. 38: 1127-1136.

Wilkinson, D. (1992) Proceedings of the Forty-Seventh Annual Corn & Sorghum Research Conference 1992: [held in Chicago, Illinois, December 9 - 10, 1992]. . American Seed Trade Assoc., Washington, DC.

VALUE ADDITION TO UNDERUTILIZED FRUITS AND ENTREPRENEURSHIP PROSPECTS FOR RURAL WOMEN

Neeta Khandelwal[1], Harish Gupta[2]
[1]ASPEE College of Home Science and Nutrition, Sardarkurshinagar Dantiwada Agriculture University Gujarat, [2]Department of Applied Geochemistry, Osmania University, Hyderabad
Email: 1-neeta.udr@gmail.com

Received: 20.05.16
Accepted: 20.07.16

ABSTRACT

India enjoys a prominent position on the pomological map of the world. However several fruits like Aonla, Custard Apple, Bael, Wood Apple, Jamun and Tamarind etc. have limited market value due to acidic and perishable nature and astringent taste. These fruits are generally categorized as underutilized fruits, however due to nutritive, therapeutic and medicinal values, these fruits hold potential for value addition through processing. These fruits are usually used to prepare several value added products for domestic use and with limited efforts, these product can be promoted for commercial production and marketing. Women being traditionally aware about value addition processes, could prepare Squash, Jelly, Jam, Syrup, Pickle, Chutney, Preserved Pulp, Blended Beverage, Churan Powder, Barfi, Laddoo, Sugar Syrup etc. with limited efforts and small investments. In this paper we review literature on production, uses and value addition techniques etc., developed by various research organizations and scientists. Thus, promoting value addition of underutilized fruits may not only bring a change in financial status of scores of farm women but can improve profit margins, reduce post-harvest loss, increase export and contribute to economic growth of country.

1. Background and Rationale

India has been bestowed with wide range of climate and physio-geographical conditions (16 agro-climatic zones), which allow to grow various kinds of fruits and vegetables. India is tenth among the plant rich countries of the world and fourth among the Asian countries. The total production and economic value of horticultural produce, such as fruits, vegetables and nuts has doubled in India over the 10 year period from 2002 to 2012. In the year 2012, for the first time, the total production from horticulture exceeded grain output. Now, India ranks second after China in horticulture production and accounts for about 15 per cent of worlds production of vegetable. This segment has recorded a growth of 30 per cent in the last five years. Statistics of National Horticulture Board suggest that in the year 2012-13 India produced about 81,285 MT of fruits (area: 6.98 M ha), 162,187 MT of Vegetables (area: 9.1 M ha) and 5744 Mt of Spices (area: 3.1 M ha). Despite farm-level gains, due to lack of awareness, transportation issues and in absence of cold-storage facilities, the losses between farm and consumer also increased. Ludhiana based Central Institute of Post-Harvest Engineering and Technology (CIPHET), estimated the wastage of fresh horticultural produce to be up to 18 per cent. However according to Ravani and Joshi (2014) the total losses from harvest to the consumer point are as high as 30-40%, which is worth thousands of crores rupees. To achieve rural prosperity, the development strategy so far remained focused on improving agricultural production, but ignoring post-harvest management of produce.

Fruit processing is necessary not only to ensure fair returns to the growers to improve their economic condition but also to mitigate the problem of under-employment during off-season in the agricultural sectors. Besides, due to market glut during harvesting season, farmers are forced to sell their produce at throw away prices, thus adding to the misery of marginal farmers. To generate gainful self-employment for small farmers and weaker sections of the rural society, value addition through food processing could be one of the easiest and low investing, yet promising alternative. A strong food processing industries can help farmers not only to prevent the wastage but also to get sure income for their produce and also avoid market glut. Besides, it help farmer to survive drought years. The Indian food processing industry

targets of raising the level of processing perishable products to 20 per cent by 2015 (www. http://mospi.nic.in/). In contrast to China, which processed about 30 per cent of the food (fruits and vegetables) in 2009, hardly 2 per cent of perishable horticultural produce is processed to value added products in India. Besides, this compares very unfavorably with countries like Malaysia (83 per cent), Philippines (78 per cent), Brazil (70 per cent) and US (70 per cent)(Sidhu, 2005). Hence, processing of fruits and vegetables remains a scope-full business. And these underutilized tropical fruits, have an important role to play in satisfying the demand for nutritious, delicately flavored and attractive natural foods of high therapeutic value (Ravani and Joshi, 2014).

Food processing has been known from time immemorial, ever since human evolution began. India, especially, has been a forerunner in giving diverse facets to this art of food processing. Using salt and oil to pickle surplus vegetables and sun-drying brined vegetables and fruits to increase their shelf life, and survive scarcity and unfavorable conditions is common practice in Indian households. It would not be an exaggeration to say that food processing started in the kitchen of every household, as a result of the traditional knowledge of our women.

3. Value addition through processing

Value addition through processing is a kind of intervention with the available raw produce of agricultural or horticultural origin, thereby adding to its value. By adding values to produce, food processing industry connects the farmers with their consumers. The basic principles of food processing includes, dehydration, pulverizing of raw material for easier cooking and extending shelf life of the product for the convenience of consumption over a longer period.. If processed properly, these products might have multiple advantages of being hygienic, free from pathogens, tastier and healthier. With the rise of neo-middle class food consumption patterns are changing towards more convenient – ready to eat – yet healthy products. It is necessary to employ modern methods to extend storage life for better distribution and also processing techniques to preserve them for utilization in the offseason in both large and small scale (Bhattacharyya and Bhattacharjee, 2007; Jena et al., 2013).

4. Prospective Underutilized Produce

India has a rich heritage of indigenous fruit types. Although some fruits have already been recommended for commercial planting, it is apparent that there are a lot more fruit types that await future exploitation (Chakraborty et al., 2004). There are quite a large number of indigenous and underutilized fruit crops, which are being used by the local inhabitants. In fact for people living in villages, these underutilized fruits are not only the source of protective food to meet their vitamins and minerals requirements in their poor diet but use as herbal medicine too (Chakraborty et al., 2004). In spite of these quality attributes most have not undergone any conscious phase of domestication and human selection, till recently. Their cultivation is very restricted and they grow mainly wild. Being tolerant to biotic and abiotic stresses, these fruit species are suitable for growing in the disaster and drought-prone areas (Hiwale, 2015). In recent years, there has been steady increase in area and production of most of the fruits as result of identification and development of suitable varieties and production technologies. Vast stretches of Indian landmass (12%; 31.8 M ha of land) fall under arid zone category, covering parts of Andhra Pradesh, Gujarat, Haryana, Karnatka, Maharastra, Punjab, and Rajasthan (Bhandari et al., 2014). These are potential area for production of fruits like Aonla, Bael, Ber, Custard Apple, Jamun, Karonda, Tamarind, Wood Apple etc. These fruits are rich in vitamins, minerals (Hiwale, 2015) and dietary fiber and therefore, are an essential ingredient of a healthy diet (Table 1). Besides Anthocyanin and phenolics rich fruits like Aonla, Jamun, Bael and Ber, are good source of dietary antioxidants (Kaur and Kapoor, 2003). There is great scope for processing and value addition to the underutilized fruits into various products like jam, jelly, preserve, candy, confectionery, pickle, fruit drinks, dried products etc. Here we provide review on

production, uses and value addition techniques developed by various research organizations and scientists to popularize value addition as a substitute to improve the financial faith of farmer women, particularly from dry regions of country.

4.1 Aonla (*Emblica officinalis*)

Aonla (amla) or *Indian gooseberry* is indigenous to Indian sub-continent and grows in tropical and subtropical region of India. It is grown in all over Asia for its nutritional, pharmacological and commercial significance (Goyal et al., 2007). It is the richest source of ascorbic acid (Vitamin C) and also contains tannin, polyphenol, pectin, gallic acid and fiber. About 600–900 mg of vitamin C is found in 100 g of Aonla pulp (Pokharkar, 2005). India is the largest producer of Aonla and data (http://eands.dacnet.nic.in) suggest that the production area of Aonla has increased from 67,000 hectare in the year 2010-11 to 108,000 hectare in the year 2012-13. Similarly, against 0.67M tons (2010-11), a record amount (1.27 M tons) of Aonla production was recorded during the year 2012-13. In addition to increased crop area, improved yields (10 ton/ hectare in 2010-11 and 11.7 ton/ hectare in 2010-11) also led to increase in production. For the year 2013-14, 1.22 M ton of Aonla was produced from 103,550 hectare land (http://nhb.gov.in). According to National Horticulture Board (http://nhb.gov.in) for the year 2013-14, states of Uttar Pradesh (0.36 M ton), Madhya Pradesh (0.37 M ton), Gujarat (0.11M ton), Tamil Nadu (0.19M ton), Andhra Pradesh (0.055 M ton) and Jharkhand (0.034M ton) together contribute about 90% of annual Aonla production.

Despite the fact that Aonla is a very valuable fruit, the postharvest losses in Aonla is vary from 30% to 40% due to its perishable nature, which reduces the market value (T Kore et al. 2013). . The fruit, due to its sour and astringent taste, therefore offers very limited table value. However, once it come to processed forms, it holds great potential and also due to growing health consciousness. It has been traditionally used as pickle and preserve by employing traditional knowledge. Besides, aonla has been an important components of *chavanprash* (Goyal et al., 2008). Aonla fruits are used in traditional Indian system of medicines, like *ayurvedic* and *unani*, due to its therapeutic values (Agarwal and Chopra, 2004). Medicinal properties of Aonla are known by way of *kayakalp* in our country for more than 3000 years ago. It is traditional practice to use Aonla for treating common cold, gastric troubles, headache, constipation, enlarged liver, etc (Chadha, 2001), therefore it is considered to be a “wonder fruit for health” (T Kore et al., 2013). . In recent years increased attention has been paid on preparation of different value added products and now Aonla fruits are highly value added among indigenous drugs. Increasing demand from industry, especially for *ayurvedic* formulations and appreciation of its nutraceutical and medicinal for house hold consumption resulted in growing of this tree as cultivated crop.

In recent years many scholars have studies various aspects of Aonla value addition (Gaikwad et al., 2013; Manjuantha et al., 2012; Murthy and Joshi, 2007; Pathak, 2003; Prasad et al., 1999; Rai et al., 2012; Singh et al., 2014a). Gaikwad et al. (2013), studied development and shelf life of low calorie herbal Aonla-ginger RTS beverage by using artificial sweeteners. Murthy and Joshi (2007), investigated fluidized bed drying of Aonla. Manjuantha et al. (2012), probed the rheological behavior of enzyme clarified from Aonla juice. Effect of blanching on thin layer drying kinetics of aonla (Emblica officinalis) shreds were looked into by Gupta et al. (2012). T Kore et al. (2013), explored packaging, storage and value addition. Barwal et al. (2010) probed development and quality evaluation of Aonla mouth freshener. Study on oraganoleptic quality on Aonla murabba during storage was taken by Patel et al. (2014). Kaushal and Sharma (2012) carried out a study to examine processing potential of newly introduced Aonla cultivars grown in lower Himalayan Region of Himachal Pradesh. Studies on development of value added Aonla candy with rose extract (Mishra et al., 2011), development and storage studies of therapeutic ready to serve made from blend of aloe vera, aonla and ginger Juice (Sasi Kumar et

al., 2013), preparation of mixed toffee from Aonla and ginger (Nalage et al., 2014) and Kinnow-Aonla blended ready to serve beverage (Balaji and Prasad, 2014) were also taken.

4.2 Bael (*Aegle Marmelos linn*):

Roy and Singh (1978) provided greater details on history, nutritive values, medicinal properties, cultivation, harvesting, packing and storage of Bael. According to them, Bael is a very hardy subtropical, deciduous tree that can thrive well in various soil-climatic conditions. Bael is widely cultivated particular in Uttar Pradesh and Bihar (Sharma et al., 2007) and in parts of Odisha, Madhya Pradesh, Andhra Pradesh, Maharashtra and West Bengal. Despite being rich in nutritive, therapeutic and medicinal values, it remains an underutilized because of eating difficulties and to popularize it suitable processing is required.

Indelible medicinal properties of Bael have been described in the ancient medicinal treatise in Sanskrit, Chakra Samhitha. Importance has been realized in vedic period and it is one of the ingredient in the Dasmul of Ayuraveda (Prakash, 1961). It is highly nutritious, as all part of this fruit tree i.e. root, leaf, trunk, seed and even its latex are used for various therapeutic purposes (Elavarasi and Saravanan, 2012). Its parts can be used treatment of asthma, anemia, fracture, healing of wound, swollen joints, high blood pressure, jaundice etc. (Sharma et al., 2011). In India, fresh Bael pulp is popularly used to prepare 'sharbat' given it's their mild laxative, tonic and digestive effects. This fruit is used in ayurvedic medicine to cure Vatha and Kaphay disturbances in the body (Kumar et al., 2012). The ripe fruit is sweet aromatic, nutritious and palatable, which help to regeneration of skin, coolant, laxative and good for the heart, brain and in dyspepsia (Parichha, 2004). A decoction of the flowers is used as eye lotion & given as an antiemetic. The decoction of the root and root bark is useful in intermittent fever, hypo-chondriasis & palpitation of the heart (Shamkuwar et al., 2012). This fruit also possess hypoglycemic activity and anticancer effect. Bael leaf enhance ability to utilize the external glucose load in the body by stimulation of glucose uptake similar to insulin (Dahanukar et al., 2000).

In order to commercialize cultivation and processing, in last two decades several efforts have been made, to study cultivation issues (Sharma et al., 2007; Singh and Roy, 1984); specify the medicinal uses (Baliga et al., 2011; Sharma et al., 2011; Sharma et al., 2007) and antioxidant activity (Kaur and Kapoor, 2003); optimizing the processing of pulp (Bag et al., 2011; Roy and Singh, 1979); to isolate neutral polysaccharide (Basak et al., 1981); to identify the biological activities of crude extracts and chemical constituents (Maity et al., 2009); ethnobotany and ethno-conservation aspects (Kala, 2006); to study bioactive and volatile compounds (Charoensiddhi and Anprung, 2008); to investigate the effect of Bael fruit extract on tissue antioxidants in streptozotocin diabetes (Kamalakkannan and Prince, 2005; Kamalakkannan and Stanely Mainzen Prince, 2003); in removal of Cr (VI) from aqueous solution using Bael fruit shell as an adsorbent (Anandkumar and Mandal, 2009); antidiarrhoeal activity of root extract (Mazumder et al., 2006) and unripe fruit (Brijesh et al., 2009); evaluation of the radio-protective effect of bael leaf extract (Jagetia et al., 2004a) and radiation-induced lethality aspects (Jagetia et al., 2004b) in mice. Rao et al. (2011), investigated nutritional quality, fatty acids, amino acids and functional characteristics of Bael Seed Protein Concentrate.

Several study pertaining to value addition also carried out. Roy and Singh (1978, 1979 a and b) carried out initial studies on preparation and preservation of Bael fruit products. According to Bhardwaj and Pandey (2011) blending of guava pulp with Bael pulp may supplement a beverage made with these two fruits with vitamins, especially vitamin C and minerals, besides improving their taste, flavor, and overall acceptability. Study on blended RTS beverage includes, Bael-Papaya (Tandon et al., 2007), Bael-Guava (Nidhi et al., 2008), Bael-Aloe Vera (TIWARI and DEEN, 2014) and Bael-Aonla (Singh et al., 2014b).

4.3 Custard Apple (*Annona squamosa*)

Custard Apple (popularly known as *sitafal*) is widely grown on marginal lands with minimum inputs in parts of Rajasthan, Andhra Pradesh and Karnataka states. For the year 2013-14, 165,150 tons of Custard Apple was produced from 21,770 hectare of land (http://nhb.gov.in). Gujarat (52,000 ton), Chhattisgarh (36,650 ton), Madhya Pradesh (34,000 ton), Andhra Pradesh (13,580 ton), Karnataka (12,170 ton) and Telangana (10,060 ton) contribute about 95% of production. It contains, soft, granular, juicy sweet edible pulp with mild flavor and slight acidity (Morton, 1987). Fruit is well recognized given it balanced food proteins, fibers, minerals, vitamins and little fat contents (Mariappan and Saxena, 1983). It poses excellent medicinal properties and used to prepare dessert – with milk – such as ice-cream and other confectionary items (Butani, 1976). It is highly perishable and cannot be stored for long time. The fruit pulp can be used in preparation of various value added food products like syrup, ready to serve beverages, milkshakes, jelly, squash, jam, ice cream etc. (Bray, 1981). Extraction of pulp is major constraint followed by limited shelf-life due to polyphenol oxidase activity which causes discoloration or browning that result in deterioration of commercial quality of pulp.. Therefore, processing of custard apple fruits into different value added product is the prime need. However, compared to the products processed from other fruits custard apple products are far cheaper and lower cost of production is attributable to the low cost of basic raw material. Hari Babu et al. (1989), carried out a study on post-harvest storage of custard apple.

In comparison to Aonla and Bael, studies on value addition and related aspects of custard apple are rather few. Bhatia et al. (1961), described the methods for preservation pulp. Effect of steam blanching on quality of pulp were studied by Kamble and Soni (2010). Shashirekha et al. (2008), investigated the influence of processing conditions on flavor compounds of custard apple. Other main studies are, preparation of ready-to-serve beverage and wine (Joshi and Attri, 2005; Kotecha et al., 1995); phenolic composition and antioxidant capacity of wine prepared from custard apple (Jagtap and Bapat, 2014); antioxidant activity (Kaur and Kapoor, 2003); studies on frozen pourable custard apple pulp using cryoprotectants (Chikhalikar et al., 2000). Another study (Chandraju et al., 2012) performed qualitative chromatographic analysis of sugars present in non-edible rind portion of custard apple.

4.4 Jamun (*Syzgium cumini*)

Jamun commonly known as *Indian blackberry*, is an evergreen tropical tree is native to the subtropical Himalayas, India, Sri Lanka, Malaysia and Australia. It is considered to be indigenous to India and West Indies. India ranks second largest producer of Jamun in the world. World production of Jamun is estimated at 13.5 million tones out of which 15.4% is contributed by India (Patil, 2012). Maharashtra State is the largest Jamun producer followed by Uttar Pradesh, Tamil Nadu, Gujarat, Assam and others (Patil, 2012). It is consumed by all sections of people in India because of its ease availability and low-priced. Jamun having promising therapeutic value with its various phytoconstituents such as Tannins, Alkaloids, Steroids, Flavonoids, Terpenoids, Fatty acids, Phenols, Minerals, Carbohydrates and Vitamins (Jadhav et al., 2009). Ripped Jamun is delicious in taste and edible portion comprises approximately 80% water with almost solids 14%. containing a mixture of fermentable sugar which can be used for alcoholic fermentation (Shrikant Baslingappa et al., 2012). Red wine and vinegar, with a pleasant aroma and mild flavor have also been made throughout India from the fermented fruit. Various traditional practitioners in India use all parts of Jamun tree such as bark, leaves, fruit and seeds for treatment of a range of ailments like diabetes, blisters in mouth, cancer, colic, and diarrhea, digestive complaints, dysentery, piles, pimples and stomachache (Jain, 1991). Different parts of the tree were also reported for its antioxidant, anti-inflammatory, neuropsycho-pharmacological, anti-microbial, anti-bacterial, anti-HIV, antifugal, nitric oxide scavenging, free radical scavenging, anti-diarrheal, antifertility, anorexi-genic, gastroprotective

antidiabetic, antioxidant, anticancer and anti-ulcerogenic and redio-protective activities (Sagrawat et al., 2006). This wide range of health promoting compounds makes them a suitable produce to be used as a nutraceutical (Jaiswal et al., 2015). Its seed has traditionally been used in India for the treatment of diabetes (Benherlal and Arumughan, 2007; Rizvi and Mishra, 2013).

In spite of major production and abundant qualities, tremendous quantities off Jamun are lost either through rain fall or in sorting and grading to meet quality standards for the fresh fruit export market, which could be otherwise be used for processing. Processing of Jamun fruit into value-added products result in a wide variety of exotically flavored product with better nutritional and sensory qualities like health drinks, making preserves, squashes, sharbat, jellies and wine may unveil new market for export. According to Chaudhary and Mukhopadhyay (2012) fruits are also processed to make jam, jellies, squash, vinegar and ice cream for its beautiful and attractive purple color. Chemical nature, stability and bioefficacies of anthocyanins from fruit peel were investigated by Veigas et al. (2007). Research by Srimathi (1997) focused on seed collection, processing and storage. Chowdhury and Ray (2007) studied aspect of forming Red Wine from Jamun fruit.

4.5 Karonda (*Carissa Carandas Linn*.)

Karonda is an evergreen plant that grows widely in tropical and subtropical climates. The plant bears abundant fruits which can be processed commercially. The Karanda is native and common throughout much of India, Burma and Malacca and dry areas of Ceylon; is rather commonly cultivated in these areas as a hedge and for its fruit and the fruit is marketed in villages (Jain, 1991). It is a fruit of dry areas containing fair amount of vitamin C and minerals. Karonda is a good appetizer and it has been used as a traditional medicinal plant over thousands of years in the ayurvedic system of medicine (Devmurari et al., 2009). Tribes in the Western Ghats use the fruit as a blood sugar stabilizer and as a guard against liver damage. Medicinal values of different parts such as roots (for bitter stomachic and vermifuge and itching), leaves (intermittent fever, diarrhea, oral inflammation, earache and furnished fodder for the tussar silkworm) and fruits (astringent) are detailed by Devmurari et al. (2009). Phyto-therapeutic significance of Karonda were documented by Raaz Maheshwari and Verma (2012).The fruit is an astringent, antiscorbutic and as a remedy for biliousness and useful for cure of anemia. The juice can be applied to the skin to relieve any skin problems. The fruits are utilized in curries, tarts, puddings and chutney, jelly and pickles, all of which have great demand in international and domestic markets.

The modern scientific studies on value-addition aspect of Karonda dates back to year 1970s, Sethi and Anand (1977) studied the methods to dry Karonda for making their preserve. Later Pawar (1988) worked on post-harvest handling and preparation of different products. During last decade there have been several studies to investigate preservation, storage, quality of value-added products and nutritive aspect of Karonda. Joshi and Jain (2006) documented chemical composition and product development from Karonda. Manivasagan et al. (2006b), investigated the nutritive value of Karonda grown under Haryana conditions; whereas Rai and Misra (2005) examined the processing and marketing feasibility. Studies on preparation and storage/ quality of Karonda and its value-added product includes, preparation and storage (Jadhav et al., 2004), candy (Manivasagan et al., 2006a; Patil et al., 2014a, b), pickles (Manivasagan et al., 2007), jams (Wani et al., 2013b, a), jelly (Chaudhary et al., 2007) effect of blanching and potassium metabisulphite on solar dried fruits (Lal, 2009) and osmo-air dried (Duhan et al., 2008). Study on effect of temperature on viscosity of kokum, Karonda, mango pulp and cashew apple syrup was taken up by Swami et al. (2013).

4.6 Tamarind (*Tamarindus indica*)

Tamarind is one of the important evergreen tree legumes in tropical and sub-tropical countries, now distributed all over the world. Tamarind is nutritious fruit of immense food value, which grows abundantly in the dry tracts of Central and South Indian States. India is the world

largest producer of Tamarind (300,000 tons) (Shankaracharya, 1998). India is major exporter of Tamarind, mainly to Europe and Arab countries and lately to the United States where over 10,000 tons are exported annually (El-Siddig et al., 2006). It has several valuable properties and virtually every part (i.e. fruit, flower, leaves, bark and seed) of the tree has been utilized, particularly in traditional medicines to treat various ailments, worldwide. The fruit pulp (30-50% of ripe fruit) is the richest natural source of tartaric acid (8-18%) and forms the Tamarind of commerce, which finds extensive use in culinary preparations (Shankaracharya, 1998). According to Shankaracharya (1998), the major industrial use for the seeds is in the manufacture of Tamarind kernel powder (TKP), which is an important sizing material for the jute and textiles. TKP usually contains at least 50–60% of the polysaccharides, which is the active hydrocolloid principle (Marathe et al., 2002). Tamarind seed polysaccharide has the ability to form gels in the presence of sugar or alcohol, therefore can be used to form pectin-like gels in products such as jams, jellies, marmalades and preserves (Marathe et al., 2002). Tamarind is rich in vitamins, minerals and electrolytes and being "coolant", it is largely consumed in Middle-East desert countries. Tamarind fruit contains a biologically important source of mineral elements and with a high antioxidant capacity associated with high phenolic content can be considered beneficial to human health (El-Siddig et al., 2006).

Right from primary level Tamarind has a tremendous scope for value-addition. Unripe fruits mainly used to extract tartaric acid. Tamarind comes in two main varieties; sweet and sour. Sweet Tamarind is harvested ripe and usually consumed fresh, while the sour Tamarind is usually processed into a range of value added products (Daniel and Dudhade, 2007). Some of the most common products produced from Tamarind include juice, pulp, powder, chutney, pickles, sauces, sugar coated candies, jam, jellies, marmalade and TKP (Shankaracharya, 1998). According to Ishola et al. (1990) edible pulp of ripe fruit use as flavoring agent of soup, jams, chutney, sauces and juices. Manohar et al. (1991), investigated physical properties of Tamarind juice concentrates. Immuno-modulatory effects of a polysaccharide was investigated by (Sreelekha et al., 1993), whereas Marathe et al. (2002) documented gelling behavior of polyose from Tamarind kernel polysaccharide. Functional and nutritional properties of Tamarind kernel protein were documented by Bhattacharya et al. (1994). Maiti et al. (2004), carried out a study to understand antidiabetic effect of aqueous extract of seed of Tamarind in streptozotocin-induced diabetic rats. Packaging and storage studies on Tamarind products was also taken (Pura Naik et al., 2004). Biosorption of aqueous chromium (VI) by Tamarind seeds was investigated by Agarwal et al. (2006), whereas Ushanandini et al. (2006) taken study on anti-snake venom properties of Tamarind seed extract. Antimicrobial and antibacterial activities of pulp extract were taken up by Doughari (2007) and Abukakar et al. (2008), respectively. Siddhuraju (2007), studied antioxidant activity of polyphenolic compounds extracted from defatted raw and dry heated seed coat. Bhadoriya et al. (2011), explored the phytochemical constituents, commercial utilization of the parts, and medicinal and pharmacologic activities to understand multipurpose potential of Tamarind. Prabhu and Teli (2014), developed techniques of eco-dyeing using seed coat tannin as a natural mordant for textiles with antibacterial activity.

4.7 Wood Apple (*Limonia acidissima*)

The Wood Apple is native to the dry plains of India, Pakistan and Sri Lanka, where it grows in the wild and is also cultivated along roads, the edges of fields and occasionally in orchards. Besides Wood Apple, it may be called as Elephant Apple, Monkey fruit, Kath bel and other dialectal names in India (Jayakumar and Geetha, 2012). The fruit is a hard-shelled many seeded berry with its pinkish brown aromatic sour – sweet pulp being the edible portion, the seeds embedded in it (Poongodi Vijayakumar et al., 2013). Wood apple's texture and taste are quite similar to Tamarind. Its flavor is sweet, pungent, lemony and acidic with a pleasantly

fermented aftertaste It is an ideal tree to be exploited for growing in wasteland (Veeraraghavathatham, 1996). The Wood Apple is a cheap, highly nutritious and seasonally available fruit that can be preserved for human consumption throughout the year. The Wood Apple is high in oxalic, malic, citric and tannic acids. It also has a good mixture of vitamins and minerals including calcium, iron, phosphorus, carotene, thiamine, riboflavin and niacin. The Wood Apple is rich in Beta carotene, a precursor of vitamin A which also contains significant quantities of the B vitamins such as thiamine and riboflavin and small amounts of vitamin C. Wood apple fruit contains flavonoids, glycosides, saponins and tannins (Ilango and Chitra, 2009). The fruit may be eaten raw but it has a resinous taste and requires sweetening.

It is a well-known fruit which contains several known and unknown medicinal properties and hence is viewed as one of the most valuable medicinal plants in India. Traditional healers have also prescribed the fruit to fight breast and uterine cancer. Every part of the fruit i.e. pulp, seed and oil has got its medicinal property (Ramakrishna et al., 1979). The fruit is much used in India as a liver and cardiac tonic and when unripe, as a means of halting diarrhea and dysentery and for effective treatment for hiccough sore throat and disease of the gums (Mondal et al., 2002). Mashed seedless pulp of the raw fruit is beneficial in the treatment of dysentry, diarrhoea and piles. Wood Apple in the form of chutneys or sherbet is useful in treating hiccups (Ratnayake et al., 2009). According to Saha et al. (2014) it is an antiscorbutic, carminative, and digestive stimulant and leaves are used for indigestion, diarrhea, dysentery and haemorrhoids. According to Pullaiah (2006) the pulp mixed with cardamom, honey and cumin seeds remedy liver cirrhosis of malnourished children, piles, and diarrhea.

Traditionally, it is used for making chutney and pickles or is blended with coconut milk and palm-sugar syrup and drunk as a beverage. Wood apple pulp is excellent for making jelly, sharbat (by pulverizing the pulp in a bit of water), milkshake (by blending the pulp juice with soy or nut milk. According to Veeraraghavathatham (1996) the ripe fruit pulp makes excellent chutney. Chowdhury et al. (2008), carried out study on preparation and shelf-life of mixed juice based on wood apple and papaya. Study on conservation, multiplication and utilization of Wood Apple in context of West Bengal were done by (Ghosh et al., 2011). Vidhya and Narain (2011), provided detailed account of fruit selection, preservation method for preparation of jam, jelly, preserves, candies and fruit bars.. Jam prepared from Wood Apple is rich in flavor (MacLeod and Pieris, 1981). Fruit bar is a nutritious product, has a chewy texture, similar to dried raisins and is a good source of dietary fiber and natural sugar. Sonawane and Arya (2013), studied antioxidant activity of Wood Apple; whereas Senthilkumar and Venkatesalu (2013) investigated chemical constituents, in vitro antioxidant and antimicrobial activities of essential oil from the fruit pulp of Wood Apple. Drying characteristics and quality evaluation of Wood Apple fruit pulp powder were taken up by Poongodi Vijayakumar et al. (2013). Manthena and Mythili (2014) developed Wood Apple pickle. Minh (2015) examined various factors impacting to Wood Apple beverage production.

CONCLUSION

Fruits are amongst the first food items known consumed prehistorically by human beings. Fruits whether fresh, dried or processed have always formed a part of the staple diet of human beings because they are rich in nutrients and provide some of the essential minerals, vitamins, and the like, apart from that, they also help in curing a number of diseases. Preservation is a way to keep fruits for longer duration as it prevents the food from decay and spoilage. According to 2011 Census data nearly 98 million Indian women have agricultural jobs, but around 63 per cent of them, or 61.6 million women, are agricultural laborers. These farm women are engaged in labor intensive but unskillful works and in absence of proper training, this large chunk of human resource

remains underutilized. It means that there is a huge potential for promoting value addition and entrepreneurship development to this segment. With proper training and guidance these women could easily become entrepreneurs by processing farm products, growing organic products, through direct selling, agri-tourism and on-farm education. In recent years, the processing and value addition of several agriculture produce are showing promising growth due to increase in its shown area, annual production and demand of value added products. It is appreciably contributing in improving the economic status of farming communities through commercial orcharding, nursery production and processing of herabal products/ processed fruit products. There is great scope to involve the women to prepare value added products from above mentioned underutilized fruits like squash, jelly, jam, syrup, pickle, chutney, preserved pulp, blended beverage, churan powder, barfi, laddoo, sugar syrup etc. With help of value addition in these fruits, we can improve quality, selling, profit, reduce post-harvest loss, increase export and generate employment for rural women. It is particularly, doable as raw material is locally sourced and processed product can also be locally supplied. Again it would require relatively low investments and space and simple training to start a small scale business. Most of women can do it from home or in group during leisure time. Local agriculture universities/ institutions can play vital role in identifying locally abundant fruits for value additions and can also providing product specific trainings. Scores of studies have reported formation of several self-help groups, societies and small scale industries by women in recent time. It indicates that women are becoming conscious about entrepreneurship and proper guidance can yield rich dividends. Processed food in India and around the world will continue to stay so long as we see changing lifestyles, increasing numbers of working women, disposable incomes and trendy attitudes. Besides, the government is keen on encouraging this industry by promoting joint ventures, giving industrial licenses, introducing schemes for technology upgrade, and establishing and modernizing processing industries. Women entrepreneurs not only create new jobs for themselves and others and by being different also provide society with different solutions to management, organization and business problems as well as to the exploitation of entrepreneurial opportunities. The world needs women entrepreneurs, and women entrepreneurs need all of us. It is time to provide the support and tools to ensure that, in coming years women-led businesses flourish.

Table: 1 Composition of important underutilized fruits (Gopalan et al., 1971)

Fruits	Moisture (%)	Fiber (g)	Fat (g)	Minerals (g)	Protein (g)	Carbohydrates (g)	Carotene (µg)	Vitamin (mg)
Bael (Aegle marmelos)	61.5	1.8	0.3	1.7	2.9	31.8	55	8
Aonla or Amla (Emblica officinalis)	**81.8**	**0.5**	**0.1**	**0.5**	**3.4**	**13.7**	**9**	**600**
Custard Apple (Annona squamosa)	70.5	1.6	0.4	0.9	3.1	23.5	-	37
Jamun (Syzygium cumini)	83.7	0.7	0.3	0.4	0.9	14.0	48	18
Tamarind* (Tamarindus indica)	20.9	3.1	0.1	2.9	5.6	67.4	-	-
Karonda	91	1.5	2.9	6	1.1	2.9		**9-11**
Wood apple	64.2	7.1	3.7	1.9	5.0	18.1	61	3

* Tamarind is the richest sources of Tartaric acid (8-18%)

REFERENCE

Abukakar, M., Ukwuani, A., Shehu, R., 2008. Phytochemical screening and antibacterial activity of Tamarindus indica pulp extract. Asian J. Biochem 3, 134-138.

Agarwal, G., Bhuptawat, H.K., Chaudhari, S., 2006. Biosorption of aqueous chromium (VI) by Tamarindus indica seeds. Bioresource Technology 97, 949-956.

Agarwal, S., Chopra, C., 2004. Studies on changes in ascorbic acid and total phenols in making aonla products. Beverage and Food world 31, 32-34.

Anandkumar, J., Mandal, B., 2009. Removal of Cr (VI) from aqueous solution using Bael fruit (Aegle marmelos correa) shell as an adsorbent. Journal of hazardous materials 168, 633-640.

Bag, S.K., Srivastav, P.P., Mishra, H.N., 2011. Optimization of process parameters for foaming of bael (Aegle marmelos L.) fruit pulp. Food and bioprocess technology 4, 1450-1458.

Balaji, V., Prasad, V., 2014. Studies on Value Added Kinnow-Aonla Blended Ready to Serve Beverage. J Food Process Technol 5, 2.

Baliga, M.S., Bhat, H.P., Joseph, N., Fazal, F., 2011. Phytochemistry and medicinal uses of the bael fruit (Aegle marmelos Correa): A concise review. Food Research International 44, 1768-1775.

Barwal, V.S., Garg, V., Sharma, R., 2010. Development and quality evaluation of aonla mouth freshner. Journal of food science and technology 47, 697-699.

Basak, R.K., Mandal, P.K., Mukherjee, A.K., 1981. Studies on a neutral polysaccharide isolated from bael (Aegle marmelos) fruit pulp. Carbohydrate Research 97, 315-321.

Benherlal, P.S., Arumughan, C., 2007. Chemical composition and in vitro antioxidant studies on Syzygium cumini fruit. Journal of the Science of Food and Agriculture 87, 2560-2569.

Bhadoriya, S.S., Ganeshpurkar, A., Narwaria, J., Rai, G., Jain, A.P., 2011. Tamarindus indica: Extent of explored potential. Pharmacognosy reviews 5, 73.

Bhandari, D., Meghwal, P., Lodha, S., 2014. Horticulture Based Production Systems in Indian Arid Regions, Sustainable Horticultural Systems. Springer, pp. 19-49.

Bhardwaj, R.L., Pandey, S., 2011. Juice blends—a way of utilization of under-utilized fruits, vegetables, and spices: a review. Critical reviews in food science and nutrition 51, 563-570.

Bhatia, B., Sastry, L., Krishnamurthy, G., Nair, K., Lal, G., 1961. Preservation of custard apple (Anona squamosa) pulp. Journal of the Science of Food and Agriculture 12, 529-532.

Bhattacharya, S., Bal, S., Mukherjee, R., Bhattacharya, S., 1994. Functional and nutritional properties of tamarind (Tamarindus indica) kernel protein. Food chemistry 49, 1-9.

Brijesh, S., Daswani, P., Tetali, P., Antia, N., Birdi, T., 2009. Studies on the antidiarrhoeal activity of Aegle marmelos unripe fruit: Validating its traditional usage. BMC complementary and alternative medicine 9, 47.

Butani, D.K., 1976. Insect pests of fruit crops and their control-custard apple. Pesticides 10, 27-28.

Chadha, K., 2001. Handbook of horticulture. Handbook of horticulture.

Chakraborty, I., Mitra, S., Pathak, P., 2004. Potential underutilized tropical fruits of India, III International Symposium on Tropical and Subtropical Fruits 864, pp. 61-68.

Chandraju, S., Mythily, R., Kumar, C., 2012. Qualitative chromatographic analysis of sugars present in non-edible rind portion of custard apple (Annona squamosa L.). Journal of Chemical and Pharmaceutical Research 4, 1312-1318.

Charoensiddhi, S., Anprung, P., 2008. Bioactive Compounds and Volatile Compounds of Thai Bael Fruit (Aegle Marmelos (L.) Correa) as a Valuable Source for Functional Food Ingredients. International food Research journal 15, 287-295.

Chaudhary, B., Mukhopadhyay, K., 2012. Syzygium cumini (L.) skeels: a potential source of nutraceuticals. International Journal of Pharmacy and Biological Sciences 2, 46-53.

Chaudhary, R., Yadav, M., Singh, D., 2007. Changes in physico-chemical characteristics of karonda jelly during storage period. Plant Archives 7, 885-887.

Chikhalikar, N.V., Sahoo, A.K., Singhal, R.S., Kulkarni, P.R., 2000. Studies on frozen pourable custard apple (Annona squamosa L) pulp using cryoprotectants. Journal of the Science of Food and Agriculture 80, 1339-1342.

Chowdhury, M., Islam, M., Islam, M., Islam, A.T., Husain, M., 2008. Study on preparation and shelf-life of mixed juice based on wood apple and papaya. J. Soil Nat 2, 50-60.

Chowdhury, P., Ray, R., 2007. Fermentation of Jamun (Syzgium cumini L.) Fruits to Form Red Wine. ASEAN Food Journal 14, 15-23.

Dahanukar, S., Kulkarni, R., Rege, N., 2000. Pharmacology of medicinal plants and natural products. Indian Journal of Pharmacology 32, S81-S118.

Daniel, J.N., Dudhade, P., 2007. Analysis of economic characteristics of value chains of three underutilised fruits of India. Study commissioned by The International Centre for Underutilised Crops (ICUC), Colombo, Sri Lanka, and BAIF Development Research Foundation, Pune, India. Available online at: www. icuc-iwmi. org/files/Publications/ICUCRR% 20Issue% 203_Final. pdf.

Devmurari, V., Shivanand, P., Goyani, M., Vaghani, S., Jivani, N., 2009. A review: Carissa congesta: phytochemical constituents, traditional use and pharmacological properties. Pharmacognosy Reviews 3, 375.

Doughari, J., 2007. Antimicrobial activity of Tamarindus indica Linn. Tropical Journal of Pharmaceutical Research 5, 597-603.

Duhan, R., Godara, R., Gupta, R., Goyal, R., Singh, A., 2008. Storage studies on osmo-air dried karonda (Carissa carondas Lim.). Haryana Journal of Horticultural Sciences 37, 252-254.

El-Siddig, K., Gunasena, H., Prasad, B., Pushpakumara, D., Ramana, K., Vijayanand, P., Williams, J., 2006. Tamarind: Tamarindus Indica L. Crops for the Future.

Elavarasi, S., Saravanan, K., 2012. Ethnobotanical study of plants used to treat diabetes by tribal people of Kolli Hills, Namakkal District, Tamilnadu, Southern India. International Journal of PharmTech Research, 404-411.

Gaikwad, K.K., Singh, S., Shakya, B., 2013. Studies on the development and shelf life of low calorie herbal aonla-ginger RTS beverage by using artificial sweeteners. J Food Process Technol 4, 2.

Ghosh, S., Banik, A., Banik, B., Bera, B., Roy, S., Kundu, A., 2011. Conservation, multiplication and utilization of wood apple (Feronia limonia)-a semi-wild fruit crop in West Bengal (India), I International Symposium on Wild Relatives of Subtropical and Temperate Fruit and Nut Crops 948, pp. 279-283.

Gopalan, C., Rama Sastri, B., Balasubramanian, S., 1971. Nutritive value of Indian foods. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, New Delhi

Goyal, R., Patii, R., Kingsly, A., andPradeep Kumar, H.W., 2008. Status of Post harvest Technology of Aoiila in India-A Review. American Journal of Food Technology 3, 13-23.

Goyal, R.K., Kingsly, A.R.P., Kumar, P., Walia, H., 2007. Physical and mechanical properties of aonla fruits. Journal of Food Engineering 82, 595-599.

Gupta, R., Sharma, A., Kumar, P., Vishwakarma, R., Patil, R., 2012. Effect of blanching on thin layer drying kinetics of aonla (Emblica officinalis) shreds. Journal of Food Science and Technology, 1-8.

Hari Babu, K., Zaheeruddin, M., Prasad, P., 1989. Studies on post harvest storage of custard apple, Symposium on Tropical Fruit in International Trade 269, pp. 299-300.

Hiwale, S., 2015. Value Addition in Underutilized Fruits, Sustainable Horticulture in Semiarid Dry Lands. Springer, pp. 375-387.

Ilango, K., Chitra, V., 2009. Antidiabetic and antioxidant activity of Limonia acidissima Linn. in alloxan induced rats. Der Pharmacia Lettre 1, 117-125.

Ishola, M.M., Agbaji, E.B., Agbaji, A.S., 1990. A chemical study of Tamarindus indica (Tsamiya) fruits grown in Nigeria. Journal of the Science of Food and Agriculture 51, 141-143.

Jadhav, S., Joshi, G., Garande, V., 2004. Studies on preparation and storage of karonda. Carissa carandas, 46-48.

Jadhav, V., Kamble, S., Kadam, V., 2009. Herbal medicine: Syzygium cumini: a review. Journal of Pharmacy Research 2, 1212-1219.

Jagetia, G., Venkatesh, P., Baliga, M., 2004a. Evaluation of the radioprotective effect of bael leaf (Aegle marmelos) extract in mice. International journal of radiation biology 80, 281-290.

Jagetia, G.C., Venkatesh, P., Baliga, M.S., 2004b. Fruit extract of Aegle marmelos protects mice against radiation-induced lethality. Integrative cancer therapies 3, 323-332.

Jagtap, U.B., Bapat, V.A., 2014. Phenolic composition and antioxidant capacity of wine prepared from custard apple (Annona squamosa L.) fruits. Journal of Food Processing and Preservation.

Jain, S.K., 1991. Dictionary of Indian folk medicine and ethnobotany.

Jaiswal, S.G., Patel, M., Naik, S., 2015. Physico-chemical properties of Syzygium cuminii (L.) Skeels jam and comparative antioxidant study with other fruit jams. Indian Journal of Natural Products and Resources 6, 9-15.

Jayakumar, A., Geetha, K., 2012. Wood Apple: Uses and Benefits, FACTS FOR YOU. EFY Enterprises Pvt Ltd New Delhi, pp. 23-24.

Joshi, P., Jain, S., 2006. Chemical Composition and Product Development From Karonda (Carissa Carandas). INDIAN FOOD PACKER 60, 66.

Joshi, V., Attri, D., 2005. Panorma of research and development of wines in India. Journal of Scientific and Industrial Research 64, 9-18.

Kala, C.P., 2006. Ethnobotany and ethnoconservation of Aegle marmelos (L.) Correa. Indian Journal of Traditional Knowledge 5, 537-540.

Kamalakkannan, N., Prince, P.S.M., 2005. The effect of Aegle marmelos fruit extract in streptozotocin diabetes: a histopathological study. Journal of herbal pharmacotherapy 5, 87-96.

Kamalakkannan, N., Stanely Mainzen Prince, P., 2003. Effect of Aegle marmelos Correa.(Bael) fruit extract on tissue antioxidants in streptozotocin diabetic rats. Indian journal of experimental biology 41, 1285-1288.

Kamble, K., Soni, S., 2010. Effect of steam blanching on quality of custard apple pulp. Journal of Horticulture and Forestry 2, 104-107.

Kaur, C., Kapoor, H., 2003. Antioxidant activity of some fruits in Indian diet, VII International Symposium on Temperate Zone Fruits in the Tropics and Subtropics-Part Two 696, pp. 563-565.

Kaushal, M., Sharma, S.K., 2012. Processing potential of newly introduced Amla cultivars grown in lower Himalayan Region of Himachal Pradesh. International Journal of Food and Fermentation Technology 2, 93-97.

Kotecha, P., Adsule, R., Kadam, S., 1995. Processing of custard apple: Preparation of ready-to-serve beverage and wine. Indian Food Packer 49, 5-12.

Kumar, K.S., Umadevi, M., Bhowmik, D., Singh, D.M., Dutta, A., 2012. Recent Trends in Medicinal Uses and Health Benefits of Indian Traditional Herbs Aegle Marmelos. The Pharma Innovation 1.

Lal, G., 2009. Physico-chemical qualities of solar dried fruits of karonda (Carisa carandus L.) as affected by blanching and potassium metabisulphite. Annals of Arid Zone 48, 71-73.

MacLeod, A.J., Pieris, N.M., 1981. Volatile flavor components of Wood Apple (Feronia limonia) and a processed product. Journal of Agricultural and Food Chemistry 29, 49-53.

Maiti, R., Jana, D., Das, U., Ghosh, D., 2004. Antidiabetic effect of aqueous extract of seed of Tamarindus indica in streptozotocin-induced diabetic rats. Journal of Ethnopharmacology 92, 85-91.

Maity, P., Hansda, D., Bandyopadhyay, U., Mishra, D.K., 2009. Biological activities of crude extracts and chemical constituents of Bael, Aegle marmelos (L.) Corr. Indian J Exp Biol 47, 849-861.

Manivasagan, S., Kumar, G., Joon, M., 2006a. Qualitative changes in karonda (Carissa carandas Linn.) candy during storage at room temperature. Haryana Journal of Horticultural Sciences 35, 19.

Manivasagan, S., Rana, G., Joon, M., Godara, A., 2007. Study on qualitative changes in pickles prepared from karonda (Carissa carandas Linn.) during storage. Haryana Journal of Horticultural Sciences 36, 44-45.

Manivasagan, S., Rana, G., Kumar, S., Joon, M., 2006b. Nutritive value of karonda (Carissa carandas Linn.) grown under Haryana conditions. HARYANA JOURNAL OF HORTICULTURAL SCIENCES 35, 65.

Manjuantha, S., Raju, P., Bawa, A., 2012. Rheological behaviour of enzyme clarified Indian gooseberry juice. International Agrophysics 26, 145-151.

Manohar, B., Ramakrishna, P., Udayasankar, K., 1991. Some physical properties of tamarind (Tamarindus indica L.) juice concentrates. Journal of Food Engineering 13, 241-258.

Manthena, J.S.K., Mythili, K., 2014. Development of wood apple pickle. International Journal of Food Safety, Nutrition and Public Health 5, 1-6.

Marathe, R., Annapure, U., Singhal, R., Kulkarni, P., 2002. Gelling behaviour of polyose from tamarind kernel polysaccharide. Food Hydrocolloids 16, 423-426.

Mariappan, V., Saxena, R., 1983. Effect of custard-apple oil and neem oil on survival of Nephotettix virescens (Homoptera: Cicadellidae) and on rice tungro virus transmission. Journal of Economic Entomology 76, 573-576.

Mazumder, R., Bhattacharya, S., Mazumder, A., Pattnaik, A., Tiwary, P., Chaudhary, S., 2006. Antidiarrhoeal evaluation of Aegle marmelos (Correa) Linn. root extract. Phytotherapy research 20, 82-84.

Minh, N.P., 2015. Various Factors Impacting to Wood Apple Beverage Production. Int. J. Pure App. Biosci 3, 116-122.

Mishra, S., Verma, A., Prasad, V., Sheikh, S., 2011. Development of value added amla candy with rose extract. The Allahabad Farmer Journal 66, 20.

Mondal, S.K., Ray, B., Thibault, J.F., Ghosal, P.K., 2002. Cell-wall polysaccharides from the fruits of Limonia acidissima: isolation, purification and chemical investigation. Carbohydrate polymers 48, 209-212.

Morton, J.F., 1987. Fruits of warm climates. JF Morton.

Murthy, Z., Joshi, D., 2007. Fluidized bed drying of aonla (Emblica officinalis). Drying technology 25, 883-889.

Nalage, A., Chavan, U., Amarowicz, R., 2014. STUDIES ON PREPARATION OF MIXED TOFFEE FROM AONLA AND GINGER. Italian Journal of Food Science 26.

Nidhi, G.R., Singh, R., Rana, M., 2008. Changes in chemical components of RTS bael-guava blended beverages during storage. J Food Sci Technol 45, 378-380.

Parichha, S., 2004. Bael (Aegle marmelos) nature's most natural medicinal fruit. Orissa Review 9, 16-17.

Patel, K., Gupta, R., Kuchi, V.S., 2014. Study of oraganoleptic quality on aonla murabba during storage. Asian Journal of Dairying & Foods Research 33, 67-70.

Pathak, R., 2003. Status report on genetic resources of Indian Gooseberry-Aonla (Emblica officinalis Gaertn.) in South and Southeast Asia. New Delhi: International Plant Genetic Resources Institute.

Patil, R., Raut, V., Wankhade, R., 2014a. Sensory quality and economics of preparation of karonda candy. International Journal of Processing and Post Harvest Technology 5, 169-172.

Patil, R., Raut, V., Wankhade, R., 2014b. Studies on preparation of karonda candy. International Journal of Processing and Post Harvest Technology 5, 136-140.

Patil, S.S., Thorat, R. M. and Rajasekaran, P., 2012. Utilization of Jamun Fruit (Syzygium Cumini) for Production of Red Wine. Journal of Advanced Laboratory Research in Biology III, 200-203.

Pawar, C., 1988. Studies of post-harvest handling and preparation of different products of karonda (Carissa carandas L.) fruits. M. Sc.(Agri.) Thesis.

Pokharkar, S., 2005. Development and performance evaluation of aonla shredding machine. Beverage and Food world 32, 52-53.

Poongodi Vijayakumar, T., Punitha, K., Banupriya, L., 2013. Drying characteristics and quality evaluation of wood apple (Limonia acidissima L.) fruit pulp powder. International Journal of Current Trends in Research 2, 147-150.

Prabhu, K., Teli, M., 2014. Eco-dyeing using Tamarindus indica L. seed coat tannin as a natural mordant for textiles with antibacterial activity. Journal of Saudi Chemical Society 18, 864-872.

Prakash, O., 1961. Food and drinks in ancient India: From earliest times to c. 1200 AD. Munshi Ram Manohar Lal Delhi.

Prasad, R.A.M., Das, S., Sinha, S., 1999. Value addition options for non-timber forest products at primary collector's level. The International Forestry Review 1, 17-21.

Pullaiah, T., 2006. Encyclopaedia of world medicinal plants. Daya books.

Pura Naik, J., Nagalakshmi, S., Balasubrahmanyam, N., Shankaracharya, N., 2004. Packaging and storage studies on tamarind (Tamarindus indica L.) pulp. Journal of Food Science and Technology 41, 348-351.

Raaz Maheshwari, A.S., Verma, D., 2012. Phyto-therapeutic Significance of Karaunda. Bull. Env. Pharmacol. Life Scien. Volume 1, 34-36.

Rai, A., Gandhi, S., Sharma, D., 2012. Ergonomic evaluation of conventional and improved methods of Aonla pricking with women workers. Work: A Journal of Prevention, Assessment and Rehabilitation 41, 1239-1245.

Rai, R., Misra, K., 2005. Micropropagation of Karonda (Carissa carandas) through shoot multiplication. Scientia horticulturae 103, 227-232.

Ramakrishna, G., Azeemoddin, G., Ramayya, D.A., Rao, S.T., Devi, K.S., Pantulu, A., 1979. Characteristics and composition of Indian wood apple seed and oil. Journal of the American Oil Chemists' Society 56, 870-871.

Rao, G.N., Balaswamy, K., Rao, P.P., Rao, D.G., Satyanarayana, A., 2011. Nutritional Quality, Fatty Acids, Amino Acids and Functional Characteristics of Bael (Aegle marmelos L.) Seed Protein Concentrate. Journal of Food and Drug Analysis 19, 528-535.

Ratnayake, R., Sumithra, H., Fernando, M., Palipane, K.B., 2009. Effect of GRAS compounds on Aspergillus rot of wood-apple (Feronia limonia). Phytoparasitica 37, 431-436.

Ravani, A., Joshi, D., 2014. Processing for Value Addition of Underutilized Fruit Crops.

Rizvi, S.I., Mishra, N., 2013. Traditional Indian medicines used for the management of diabetes mellitus. Journal of diabetes research 2013.

Roy, S., Singh, R., 1978. Studies on utilization of bael fruit (Aegle marmelos Correa) for processing. I. Physicochemical characteristics of different cultivars. Indian food packer.

Roy, S.K., Singh, R., 1979. Bael fruit (Aegle marmelos)—a potential fruit for processing. Economic Botany 33, 203-212.

Sagrawat, H., Mann, A., Kharya, M., 2006. Pharmacological potential of Eugenia jambolana: A review. Pharmacognosy magazine 2, 96.

Saha, M.R., Raihan, S.Z., Rahman, A.S., 2014. Antinociceptive activity of methanolic extract of the leaves of Feronia limonia Linn. Bangladesh Journal of Physiology and Pharmacology 26, 21-24.

Sasi Kumar, R., Ray, R.C., Paul, P.K., Suresh, C., 2013. Development and Storage Studies of Therapeutic Ready to Serve (RTS) Made from Blend of Aloe vera, Aonla and Ginger Juice. J Food Process Technol 4, 2.

Senthilkumar, A., Venkatesalu, V., 2013. Chemical constituents, in vitro antioxidant and antimicrobial activities of essential oil from the fruit pulp of wood apple. Industrial Crops and Products 46, 66-72.

Sethi, V., Anand, J., 1977. Drying Karonda for making their preserve. Indian Food Pack 31, 20-23.

Shamkuwar, P.B., Shahi, S.R., Pawar, D.P., 2012. Efficacy of Aegle marmelos L. Corr.(Rutaceae) in Ayurvedic antidiarrhoeal formulation. European Journal of Experimental Biology 2, 194-198.

Shankaracharya, N., 1998. Tamarind-Chemistry, technology and uses: A critical appraisal. Journal of food science and technology 35, 193-208.

Sharma, G.N., Dubey, S.K., Sharma, P., Sati, N., 2011. Medicinal values of bael (aegle marmelos)(L.) corr.: a review. Int J Curr Pharm Rev Res 2, 12-22.

Sharma, P.C., Bhatia, V., Bansal, N., Sharma, A., 2007. A review on Bael tree. Natural product radiance 6, 171-178.

Shashirekha, M.N., Baskaran, R., Rao, L.J., Vijayalakshmi, M.R., Rajarathnam, S., 2008. Influence of processing conditions on flavour compounds of custard apple (Annona squamosa L.). LWT-Food Science and Technology 41, 236-243.

Shrikant Baslingappa, S., Nayan Singh J, T., Meghatai M, P., Parag M, H., 2012. Jamun (Syzygium cumini (L.)): A review of its food and medicinal uses. Food and Nutrition Sciences 2012.

Siddhuraju, P., 2007. Antioxidant activity of polyphenolic compounds extracted from defatted raw and dry heated Tamarindus indica seed coat. LWT-Food Science and Technology 40, 982-990.

Sidhu, M., 2005. Fruit and Vegetable Processing Industry in India: An Appraisal of the Post-Reform Period. Economic and Political Weekly, 3056-3061.

Singh, B.K., Singh, S., Yadav, S., 2014a. Packaging, Post Harvest Treatments, Storage and Protection of Aonla and their Role in Health Care: An Overview. Research Journal of Microbiology 9.

Singh, O., Singh, R., Singh, P., 2014b. Development and evaluation of bael-aonla low calorie ready-to-serve (RTS) drink. Asian Journal of Horticulture 9, 364-367.

Singh, R., Roy, S.K., 1984. The Bael: cultivation and processing. Publications and Information Division, Indian Council of Agricultural Research.

Sonawane, S., Arya, S., 2013. Antioxidant activity of Jambhul, wood apple, ambadi and ambat chukka: an indigenous lesser known fruits and vegetables of India. Adv J Food Sci Technol 5, 270-275.

Sreelekha, T., Vijayakumar, T., Ankanthil, R., Vijayan, K., Nair, M.K., 1993. Immunomodulatory effects of a polysaccharide from Tamarindus indica. Anti-cancer drugs 4, 209-212.

Srimathi, P., 1997. Research focus on seed collection, processing and storage of Amla (Emblica offinalis), Jamun (Syzygium cuminii) and Ber (Zizyphus mauritiana). Ph. D. Thesis, Tamil Nadu Agricultural University, Coimbatore, India.

Swami, S.B., Thakor, N.S., Wagh, S.S., 2013. Effect of temperature on viscosity of kokum, karonda, mango pulp and cashew apple syrup. Agricultural Engineering International: CIGR Journal 15, 281-287.

T Kore, V., Lembisana Devi, H., Kabir, J., 2013. Packaging, storage and value addition of aonla, an underutilized fruit, in India. Fruits 68, 255-266.

Tandon, D., Kumar, S., Dikshit, A., Shukla, D., 2007. Storage study on bael-papaya blended RTS beverage. Indian Food Packer 61, 91.

TIWARI, D.K., DEEN, B., 2014. PREPRATION AND STORAGE OF BLENDED READY-TO-SERVE BEVERAGE FROM BAEL AND ALOE VERA.

Ushanandini, S., Nagaraju, S., Harish Kumar, K., Vedavathi, M., Machiah, D., Kemparaju, K., Vishwanath, B., Gowda, T.V., Girish, K., 2006. The anti-snake venom properties of Tamarindus indica (leguminosae) seed extract. Phytotherapy research 20, 851-858.

Veeraraghavathatham, D., M. Jawarharlal, S. Jeeva and K. Rabindran., 1996. Underutilized and underexploited horticultural crops, in: K.V., P. (Ed.), Scientific Fruit Culture. Sur associate, Coimbatore.

Veigas, J.M., Narayan, M.S., Laxman, P.M., Neelwarne, B., 2007. Chemical nature, stability and bioefficacies of anthocyanins from fruit peel of Syzygium cumini Skeels. Food Chemistry 105, 619-627.

Vidhya, R., Narain, A., 2011. Development of preserved products using under exploited fruit, wood apple (Limonia acidissima). Am. J. Food Technol 6.

Wani, R., Prasad, V., Hakeem, S., Sheema, S., Angchuk, S., Dixit, A., 2013a. Shelf life of Karonda jams (Carissa carandas L.) under ambient temperature. African Journal of Agricultural Research 8, 2447-2449.

Wani, R., Prasad, V., Hakeem, S., Sheema, S., Angchuk, S., Dixit, A., 2013b. Shelf life of Karonda jams (Carissa carandas L.) under ambient temperature. African Journal of Agricultural 8, 2447-2449.

A COMPARATIVE STUDY ON THE INTERGENERATIONAL ATTITUDE OF URBAN AND RURAL FEMALE TOWARDS GIRL CHILD

Raman Jodha[1] and Archana Raj Singh[2]
[1]Ph.D scholar , EECM Deptt., HAU Hisar
[2]Professor &Former Dean ,CHSC, SKRAU, Bikaner (Rajasthan)

Received: 19.06.16
Accepted: 28.07.16

ABSTRACT

A study was conducted in Bikaner panchayat samiti. For selection of samples, from each village or ward 20 male and 20 female would be parents were selected randomly. 5 male and 5 female parents and 5 male and 5 female grandparents were selected purposely to getting total sample size of 240. The study revealed that significant difference was observed between urban and rural area on most of the parameters related to attitude of the female would be parents towards girl child like education, career, household responsibilities, decision making. There was no significant difference found between urban and rural female parents in attitude parameters like career, household responsibilities, health and nutrition, Personality Development, saving and deposit, media exposure and mobility.

***Key words*:** Panchayat samiti, urban and rural.

Discrimination against the girl child occurs in every strata of society - rich or poor - having different forms of manifestation. One of the crudest forms of discrimination is the one which takes place subtly and is sanctioned in the name of culture. A girl is made to fit in a culturally defined role - be it at home or outside. Traditions have portrayed girls as less important than boys, less deserving of basic quality of life. Some of these retrograde traditions have "become so deeply internalized that they have come to stand for what is 'right' and 'natural', and the girls themselves have frequently come to endorse their own second-class status" **(Glover, 1995)** .Such deliberate discrimination of the girl child patently violates the right to equality and the right to life as guaranteed by the Constitution of India.

METERIALS AND METHODS

The present study was conducted in Bikaner district. Descriptive research design was used for

conducting the present study, keeping in mind purpose of the study interview schedule (attitude scale) developed by Singh (2013) was used for data collection. t-test was applied for testing difference between attitude of urban and rural female. The present paper has assessed to compare the intergenerational attitude of urban and rural female towards girl child in Bikaner district. The present study was designed with the following specific objective:

1. To compare the intergenerational attitude of urban and rural female towards girl child.

There are six panchayat samities in Bikaner district. Out of which one Panchayat Samiti viz., Kolayat Panchayat Samiti was selected randomly. One ward from each zone i.e. east and west zone of Bikaner city was selected .For this selection of rural respondents Kolayat Panchayat Samiti was selected randomly. Out of 229 villages of Kolayat Panchayat Samiti, two villages Chandasar and Kotra were also selected randomly bychit method. Thus, total two villages were selected for the present investigation.

For selection of urban respondents Bikaner city was selected. Bikaner city was divided into four zones like East, West, North and South. Two zones east and west was selected randomly. From selected zone one ward selected by chit method. Ward No. 52 from east zone and Ward No. 16 from west zone were included. Thus, two wards were selected from Bikaner city. For the selection of rural and urban respondents a comprehensive list of respondents was taken from anganwadi/help of ward member. From each village/ ward 20 male and 20 female would be parents selected randomly. In most of the families parents and grandparents live

together in a family, so 5 male and 5 female parents and 5 male and 5 female grandparents were selected purposely from same families to get reliable information at a time, hence total sixty respondents from each village /ward were selected randomly by using chit method. Thus, total 240 respondents were selected for present investigation (120 rural and 120 urban respondents). Interview method was used to collect data from the respondents. For this rapport was first established by informal discussion with the respondents. Respondents were interviewed individually at their homes.

After collection of the data from 240 respondents, coding was done and then data were compiled and tabulated for analysis and interpretation in light of the objectives of study.

RESULTS AND DISCUSSION

Area wise Comparative Attitude of Urban and Rural Female Would be Parents Towards Girl Child

Data presented in Table 1 depicts that majority that significant difference was observed between urban and rural area on most of the parameters related to attitude of the female would be parents towards girl child like education, career, household responsibilities, decision making, personality development, social obligation, saving and deposit, and sex preference, whereas no significant difference was found on attitude parameters health and nutrition, media exposure and mobility. The findings are in concordance with the findings of Singh (2013), who reported that significant difference was observed between rural and urban would be parents on most of the parameters like social obligation, sex preference and girls' career.

The findings are also accordance with the findings of Verma *et al.* (2009), who found that urban parents are more in favour of property right to girl child and sending girl child to hostel for further studies in comparison to rural parents

Table 1: Area wise comparative attitude of the female would be parents towards child

Attitude parameters	Female would be parents
Education	2.326*
Career	2.128*
Household responsibilities	2.280*
Decision making	2.130*
Health and nutrition	1.714 NS
Personality development	2.004*
Social obligation	2.409*
Saving and deposit	2.652**
Media exposure	1.674 NS
Sex preference	3.280**
Mobility	1.625 NS

Area wise Comparative Attitude of Urban and Rural Female Parents Towards Girl Child

It is clear from the Table (2) that significant difference in attitude of the parents towards girl child was found between urban and rural areas regarding education, decision making, social obligation and sex preference. There was no significant difference found in attitude parameters career, household responsibilities, health and nutrition, Personality Development, saving and deposit, media exposure and mobility. Similar findings has also been reported by Kotwani (2012) who found that parents from urban and rural localities do not differ significantly in their attitude towards girls education due to having same culture.

Table 2: Area wise comparative attitude of the parents towards child

Attitude parameters	Female would be parents
Education	2.287*
Career	2.046 NS
Household responsibilities	0.701 NS
Decision making	2.488*

Attitude parameters	Female would be parents
Health and nutrition	0.663 NS
Personality development	0.610 NS
Social obligation	2.236*
Saving and deposit	1.631 NS
Media exposure	1.508 NS
Sex preference	2.144*
Mobility	0.619 NS

Area wise Comparative Attitude of The Grandparents Towards Girl Child

The findings in Table (3) clearly reveals that significant difference in attitude of the grandparents towards girl child was found between urban and rural areas regarding education, decision making, social obligation and sex preference. There was no significant difference found in attitude parameters career, household responsibilities, health and nutrition, personality development, saving and deposit, media exposure and mobility. Because tradition, customs, socio-cultural values, ethics and motherhood instincts are same in both urban and rural area and low literacy level of grandparents in both urban and rural area had played a crucial role for having same attitude towards some parameters.

Table 3: Area wise comparative attitude of the grandparents towards child

Attitude parameters	Female would be parents
Education	2.490*
Career	1.146 NS
Household responsibilities	0.735 NS
Decision making	2.126*
Health and nutrition	0.648 NS
Personality development	0.620 NS
Social obligation	2.840*
Saving and deposit	1.222 NS
Media exposure	1.873 NS
Sex preference	2.546*
Mobility	0.610 NS

CONCLUSION

The study has indicated that significant difference was observed between urban and rural area on most of the parameters related to attitude of the female would be parents towards girl child like education, career, household responsibilities, decision making. There was no significant difference found between urban and rural female parents in attitude parameters like career, household responsibilities, health and nutrition, Personality Development, saving and deposit, media exposure and mobility. A significant difference in attitude of the grandparents towards girl child was found between urban and rural areas regarding education, decision making, social obligation and sex preference.

REFERENCES

Ababa, A. 2008. Gender inequality and women's empowerment. *Ethiopian Society of Population Studies.*

Glover, J., Nussbaum, M.1995. Women, Culture and Development – A study of Human Capabilities Edited by Martha.

Kotwani, S. 2012. "Attitude of parents towards girls education" International Indexed and referred Research Journal, April, 2012. ISSN – 0975-3486, Vol. III ISSVE – 31.

Verma, A., Jain, A., Gulia, A., Rath, A. 2009. Study of attitude towards girl child in rural and urban area.

Singh, A. 2013. Gender Disparity and Intergenerational Attitude towards Girl Child in Harayan District, Ph.D. Thesis, (HECM Deptt.), College of Home Science, CCHAU, Hisar (Haryana).

KNOWLEDGE OF FARMERS ABOUT IMPROVED GINGER (*Zingiber officinale L.*) PRODUCTION TECHNOLOGY IN UDAIPUR DISTRICT OF RAJASTHAN

Vikas Kumar[1] and S.S. Sisodia[2]

[1]M. Sc. Student and [2]Professor, Department of Extension Education, Rajasthan college of Agriculture, Udaipur-313001 (Rajasthan)

Email:veer5agri@gmail.com

Received: 21.06.16
Accepted: 02.08.16

ABSTRACT

Ginger is an important spice and medicinal crop. The present study was conducted in Udaipur district of Rajasthan. There are total eleven tehsils in Udaipur district, out of which two tehsils namely, Jhadol and Gogunda were selected on the basis of maximum area under ginger cultivation. Five villages from each identified tehsil were selected on the basis of maximum area under ginger cultivation. For selection of respondents, 100 ginger growers were randomly selected from identified villages (10 from each village) for data collection. The study revealed that 56.00 per cent of the total respondents possessed medium level of knowledge while, 28.00 and 16.00 per cent ginger growers had high and low level of knowledge about improved ginger production technology. In overall farmers had more knowledge about irrigation management, soil and field preparation and harvesting and curing, whereas, less knowledge regarding plant protection measures and improved varieties.

Key words: - Spice, Ginger, Knowledge, Production and Technology.

Ginger the underground stem, or rhizome, of the plant has been used as spice and medicine to help digestion and treat stomach upset, diarrhea, and nausea. Ginger has also been use to help treat arthritis, colic, and heart conditions. Ginger is an aromatic spicy-swollen rhizome often dried and grounded to a yellow powder and widely used as a flavor in biscuits, cake, cookies or preserved in syrups. Ginger is an underground stem called rhizome of the plant, it is rich in starch, volatile oil and protein. It contains 2-3% proteins, 0.9% fats, 2.4% fiber, 12.3% carbohydrates and is good source of vitamins, minerals and trace elements.

In Rajasthan, ginger crop is cultivated mainly in Udaipur, Dungarpur and Baran districts, producing total of 246 tons in 122 ha. The climatic conditions of the Udaipur district are most suitable for cultivation of ginger but the production of this crop is very less and production decreases year after year very rapidly. Keeping this view in mind, the present investigation entitled **"Adoption Behaviour of Ginger (*Zingiber officinale L.)* Cultivators in Udaipur District of Rajasthan"** was undertaken in the potential area with the following specific objective.

METERIAL AND METHODS

The present investigation was conducted in Udaipur district of Rajasthan because of the selected district has the highest area and great potential of increasing production and productivity under ginger crop. The selected district consists of eleven tehsils, out of which two tehsils, namely jhadol and gogunda with maximum area under ginger crop were selected for the study purpose. Five villages from each tehsil were identified on the basis of maximum area under ginger crop. Thus, in all ten villages were selected for the present investigation. A comprehensive list of ginger growers prepared with the help of village patwari and agriculture supervisor of respective village, out of list 10 farmers were selected from each village on the basis of random sampling technique. Thus, total 100 farmers were selected for present investigation. Data were collected by personnel interview technique through suitable structured schedule. Thereafter, data were tabulated, analysed and inferences were drawn in light of the objective

RESULTS AND DISCUSSION

Knowledge of farmers about improved ginger production technology:

It was tried to find out the level of knowledge of farmers about improved ginger production

technology. Knowledge as a body of understood information possessed by an individual is one of the important components of behavior and plays an important role in adoption of an innovation. Keeping this view in mind, the level of knowledge of farmers about improved ginger production technology was assessed. The results are presented in subsequent tables.

Distribution of respondents according to their knowledge about improved ginger production technology

To get an overview of the knowledge level, the respondents were grouped into (i) low (<21.79), (ii) medium (21.79 to 31.99) and (iii) high (> 31.99) knowledge level on the basis of calculated mean and standard deviation of the obtained knowledge scores. The distribution of respondents in each category is given in table 1.

Table 1 reveals that out of 100 respondents, majority of respondents 56.00 per cent fell in medium level knowledge group whereas, 28.00 per cent ginger growers were observed in the high knowledge level group and remaining 16.00 per cent respondents possessed low level of knowledge about improved ginger production technology.

Analysis of table further reveals that 14.00 and 18.00 per cent respondents were observed in low knowledge level group in Jhadol and Gogunda tehsils respectively. While, 54.00 and 58.00 per cent respondents were observed in medium knowledge level group in Jhadol and Gogunda tehsils respectively. Whereas, 32.00 and 24.00 per cent respondents were observed in high knowledge level group in Jhadol and Gogunda tehsils respectively.

Aspect-wise knowledge of respondents about improved ginger production technology

To get a clear picture of knowledge possessed by ginger growers, aspect-wise knowledge of ginger growers was works out. For this mean per cent scores for each practice was calculated and ranks were accorded. Knowledge of the respondents was assessed under ten major aspects of improved ginger production technology: The results of the same have been presented in Table 2.

A perusal of the Table 2 explicate that the selected ginger growers had high knowledge about irrigation management was 69.50 MPS and ranked first by the ginger growers. The extent of knowledge about soil and field preparation was 60.60 MPS and this practice ranked second by the ginger growers.

The extent of knowledge about Harvesting and curing was 53.75 MPS and this practice was ranked third by the ginger growers. The extent of knowledge regarding mulching was 52.50 MPS and this practice ranked fourth by the ginger growers. The extent of knowledge regarding seed and sowing was 49.82 MPS and ranked fifth by the ginger growers.

The extent of knowledge regarding weed control was 48.66 MPS and ranked sixth by the ginger growers. The extent of knowledge regarding manures and fertilizer application was 41.16 MPS and ranked seventh by the ginger growers. The knowledge of the respondents about seed storage was 28.28 MPS and ranked eight by the ginger growers.

Further analysis of table shows that extent of knowledge about Plant protection measures was 13.33 MPS and ranked ninth by the ginger growers and ginger growers possessed minimum knowledge about improved varieties with MPS 11.31 and ranked last by the ginger growers.

Comparison of knowledge of farmers about improved ginger production technology

In order to find out the significance of difference between the farmers of selected tehsils with respect to the knowledge possessed by them, 'Z' test was applied. For this purpose, the following null hypotheses were tested and results of which are presented in Table 3.

NH_{01} : There is no significant difference between the ginger growers of two selected tehsils with respect to knowledge of improved ginger production technology.

RH_{01} : There is significant difference between the ginger growers of two selected tehsils with respect to knowledge of improved ginger production technology.

Table shows that the calculated value of 'Z' (1.57) is less than its tabulated value at 5 per cent level of significance. Thus, null hypothesis (NH_{01}) is accepted and research hypothesis is rejected. So we conclude that there is no

significant difference between the ginger growers of two selected tehsils with respect to the knowledge of improved ginger production technology.

CONCLUSION

It was concluded from the study, that, majority of respondents 56.00 per cent fell in medium level of knowledge group whereas, 28.00 per cent ginger growers were observed in the high knowledge level group and remaining 16.00 per cent respondents possessed low level of knowledge about improved ginger production technology. The findings of the study indicated that majority of ginger growers had adequate knowledge regarding irrigation management followed by soil and field preparation, harvesting and curing and mulching, whereas they had less knowledge regarding improved varieties, plant protection measures and seed storage. There was no significant difference in knowledge between the respondents of selected tehsils about improved ginger production technology.

Table 1: Distribution of respondents according to their knowledge level about improved ginger production technology:

Knowledge Level	Jhadol Tehsil		Gogunda Tehsil		Total	
	F	%	F	%	F	%
Low (<21.79)	7	14.00	9	18.00	16	16.00
Medium (21,79 to 31.99)	27	54.00	29	58.00	56	56.00
High (>31.99)	16	32.00	12	24.00	28	28.00
Total	50	100	50	100	100	100

f = frequency, % = per cent

Table2: Aspect-wise knowledge of respondents regarding improved ginger production technology

n = 100

Aspect	MPS	Rank
Improved varieties	11.31	10
Soil and field preparation	60.60	2
Seed and sowing	49.82	5
Manures and Fertilizer Application	41.16	7
Mulching	52.50	4
Irrigation management	69.50	1
Weed control	48.66	6
Plant protection measures	13.33	9
Harvesting and curing	53.75	3
Seed storage	28.28	8

MPS = Mean per cent score

Table 3: Comparison of knowledge between ginger growers of selected tehsils

Category of sample	Mean	S.D.	'Z' value
Respondents of Jhadol Tehsil	33.56	11.53	1.57 NS
Respondents of Gogunda tehsil	30.42	8.43	

NS - Non-significant

REFERENCES

Meena D. K., Bareth L. S. and Badhala B. S. 2012 Association between Knowledge level of Respondents about Coriander Production Technology, Rajasthan, *Indian Journal of Extension Education* **48** (1&2): 100-102.

Kumara N. 2015. Comparative study on knowledge and adoption of improved practices by tomato grower in chikmagalore and Raichur Districts of Karnataka *Current Advances in Agricultural Sciences* **7**(2): 192-194.

Ramakant Sharma and BD Tyagi, 2015. A study of ammal farmers knowledge for potato production technology, TECHNOFAME, Vol. 4(2):104-106.

Patel, V. T., Prajapati, M.R., Chaudhari, N.V. and Joshi, K.M. 2004. Knowledge and adoption recommended cumin production technology by the farmer of North Gujarat. *Gujarat Journal of Extension Education* **9**: 37-40.

POPULATION DYNAMICS AND EXTENT OF DAMAGE DUE TO PEST COMPLEX ON CAPSICUM (*Capsicum annum* L.) UNDER SHADE NET HOUSE

J. K. Gupta*, Ashok Bhatnagar, V. K. Agrawal, S. Mukherjee and B. K. Sharma
Division of Entomology, Rajasthan Agriculture Research Institute, Durgapura, Jaipur (Raj.)
* E-mail : guptajitendra43@gmail.com

Received: 24.06.16
Accepted: 05.08.16

ABSTRACT

Field experiments were carried out to study the population dynamics and extent of damage due to pest complex on capsicum under shade net house during summer 2014 and 2015. Results revealed that the yellow Mite, *Polyphagotarsonemus latus* Banks, Thrip, *Scirtothrips dorsalis* Hood, White fly, *Bemisia tabaci* Gennadius, Aphid, *Aphis gossypi I* Glover and beat army worm, *Spodoptera exigua* (Hubner) infested the capsicum crop. The peak population of yellow mite (10.73 and 11.80 per three leaves) was recorded in third week of May during the years, 2014 and 2015. The peak population of thrips (6.60 and 6.93 per three leaves) was observed in last week of April in both the years. The peak population of aphid (2.80 and 3.07 per three leaves) was found in first week of May in 2014 and last week of April in 2015. The peak population of whitefly (5.80 and 7.27 per three leaves) was recorded in third week of April and last week of April in 2014 and 2015, respectively, while the peak population of beet armyworm (2.00 and 1.47 per plant) was noticed in second and third week of May in 2014 and 2015, respectively. The abiotic factors were found to have non- significant correlation with whitefly population. Likewise maximum temperature, minimum temperature and rainfall had non- significant correlation with mite, thrips and beet armyworm infestation, however maximum temperature had significant positive correlation with mite infestation. Rainfall had significant negative correlation with beet armyworm infestation in 2015. Maximum and minimum relative humidity had significant negative correlation with mite, thrips and beet armyworm population, whereas, maximum and minimum relative humidity had non-significant correlation with aphid infestation. Minimum temperature showed significant negative correlation with aphid populations. During the studies the crop damage started on second fortnight of March and highest was in second fortnight of May, first fortnight of May and second fortnight of April due to mite, thrips and beet armyworm, respectively.

Capsicum is one of the most popular and highly remunerative vegetable crops grown in most parts of the world, *viz.,* China, Spain, Mexico, Romania, Yugoslavia, Bulgaria, USA, India, Europe, Central and South America are the major countries producing capsicum. In India, capsicum is extensively cultivated in Andhra Pradesh, Karnataka, Maharashtra, Tamilnadu, Himachal Pradesh, and hilly areas of Uttar Pradesh. In the world, the area and production of capsicum (bell pepper) is merged with that of hot peppers. Hence, the statistics related to pepper / chilli as a whole is given. Annual world production in the year 2010-2011 amounted to 29.9 million tons from an area of 1.9 million ha. China is the major producer in the world with an area of 0.707 million ha with a production of 15546(000 t), India's contribution was estimated to be 65.9 (000 t) from an area of 7,700 thousand hectares with productivity of 8.6 tones/ha. Andhra Pradesh stands first in area of 171.450 thousand ha with a production of 537.7 thousand tons. While, Karnataka stands second in production of about 94.5 thousand tons with area of about 69.8 thousand ha. Rajasthan is also important producer in India with an area 17720 ha with production of 17530 tones (Anon., 2013 a). Due to increase in day to day consumption of capsicum by the more consumer preferences and demand is mostly driven by hotel and catering industry, therefore it is urgent need to increase the production of this crop. It is known that the production of any crop is higher in the protected cultivation as compared to normal open field; it is the best option for the farmers for the same reason (Singh *et al.* 2012). The farmers of Rajasthan are taking capsicum crop under protected cultivation to gain higher profit; therefore it is an important high value crop of the state. This vegetable is low in calories and contains 0 grams of fat and a good supplier of vitamins and minerals. Its mildly sweet flavor makes green bell peppers versatile enough to

include a wide variety of nutritious recipes. It is rich in Vitamin A (8493 IU), Vitamin C (283 mg) and minerals like Calcium (13.4 mg), Magnesium (14.9 mg) Phosphorus (28.3 mg) Potassium, (263.7 mg) per 100 g fresh weight (Anon., 2011). About 35 species of insect and mite pests reported in capsicum, a few viz., thrips (*S. dorsalis* Hood), aphids (*aphis gossypi* glover., *Myzus persicae* Sultzer), white fly (*Bemisia tabaci* Gennadius), fruit borer (*Helicoverpa armigera* Hubner), mites (*Polyphagotarsonemus latus* Banks) and other minor pest (Vos and Frinking, 1998, Berke *et al.* 2003) under Punjab condition pose sever problems. Sunitha (2007) has also revealed the occurrence of aphids, thrips and mites as major pest in capsicum. Reddy and kumar (2006 a) reported that *S. dorsalis* was serious pest of chilli on sweet pepper in India. Similarly Reddy (2005) reported that chilli mite *P. latus* and thrips, *S. dorsalis* as the major pest of infesting sweet pepper both under protected and open field condition.

MATERIALS AND METHODS

The study was carried out under shade net house at Hi-Tech Horticulture farm, Rajasthan Agriculture Research Institute (Sri Karan Narendra Agriculture University, Jobner) Durgapura, Jaipur, (Rajasthan) to know the pest scenario of capsicum during summer 2014 and 2015. The seed of capsicum PSO 26 were sown in portrays using coco peat as growing media for nursery production. The trays were tapped gently to fill the cells properly and the seeds were sown after treating with bavistin, one per cell, to a depth of 0.5 cm and the seeds were covered with a thin layer of growing medium and watered lightly. Simultaneously, full length beds with one meter width separated with half meter path were prepared, under naturally ventilated shade net house by applying farm yard manure. The seedlings of 30 days old, vigorous and uniform size were selected and transplanted in the beds measuring 3.5 X 1 m, keeping row to row and plant to plant distance of 0.50 m and 0.40 m on 22nd and 15th March during 2014 and 2015, respectively. Watering was done immediately after transplanting. All the recommended routine horticultural practices except plant protection were followed for raising the crop. The experiment plots were kept free from insecticide application. Weekly data of atmospheric temperature in ^{0} C (maximum and minimum), relative humidity (%) were recorded in shade net house by using digital thermo humidity clock and data on total rainfall (mm) were obtained from meteorological observatory, Division of Agronomy, Rajasthan Agriculture Research Institute, Durgapura, Jaipur. The population of all the insect and mite pests infested the crop during experimental period was recorded at weekly intervals right from transplanting to harvesting of the crop. The Insect pests were counted on five randomly selected tagged plants per plot during early hours of the day when they remain less active. Observations on pest population of thrips (*Scirtothrips dorsalis),* mite (*Polyphagotarsonemus latus), Aphid (Aphis gosspii) and whitefly (Bemisia tabaci)* were taken on three leaves from upper, middle and lower portion of each tagged plant. Beet armyworm caterpillar was recorded by taking count on per plants. Number of mites was counted by using binocular in laboratory and thrips were count by magnifier lens and no. of beet armyworm caterpillar, whitefly and aphids were counted as visual. The Damage by major insect and mite pests viz., mite, thrips and beet armyworm were recorded at fortnightly interval right from transplanting to harvesting of the crop. The damage were recorded on five randomly selected tagged plants per plot during early hours of the day when the plants remained freshly appear. The damage due to mites, thrips and beet armyworm were recorded based on visual score as per the method described by Niles (1980) and the percent damage was calculated.

Table 1: Scoring procedure for pests (mites, thrips and beet armyworm) damage

Score	Symptoms
0	No symptoms
1	1 to 25% leaves per plant showing curling or damage
2	26 – 50% leaves showing curling in a plant – moderately damaged or leaf skeletonizing
3	51 to 75% leaves per plant showing curling, heavily damaged, malformation of growing points, and reduction in plant height or leaf skeletonizing
4	>75% leaves per plant showing curling, severe and complete destruction of growing points, drastic reduction in plant height, skeletonizing and severe malformation

Fruit damage caused by larvae of beet armyworm were recorded at each picking (Total five picking) by counting total and damaged fruits on five randomly selected tagged plants in each plot and per cent fruit damage was calculated. The fruits with appearance of caterpillars or insect exit hole were considered as damaged fruit.

Statistical Analysis

Following formula will be used for calculating correlation coefficient.

$$r\,x_1y_1 = \frac{\sum x_1y_1 - \sum x_1 \sum y_1/n}{\sqrt{[\sum x_1^2 - (\sum x_1)^2/n]\,[\sum y_1^2 - (\sum y_1)^2/n]}}$$

Where,

rx_1y_1 = Simple Correlation coefficient between x_1 and y_1

x_1 = Independent variable i.e. abiotic component

y_1 = Dependent variable i.e. Pest

n = Number of observation

The correlation coefficient (r) values were subjected to the test of significance using t test

$$t = \frac{r}{\sqrt{1-r^2}} \times \sqrt{n-2}$$

RESULTS AND DISCUSSION

The data presented in Table 2, revealed that capsicum crop was infested by yellow mite, thrips, aphid, whitefly, and beet armyworm.

Yellow mite, *P. latus* was observed as serious pest of capsicum attacking the crop throughout the crop season. The infestation of yellow mites commenced in the field in the first week of April (two week after transplanting) in 2014 and fourth week of March (one week after transplanting) in 2015 and remain throughout the crop season during both the years. The population gradually increased and reached to its peak (10.73 mite/three leaves) in third week of May (8 week after transplanting) and then started to decline gradually during the year 2014. The same trend was noticed in the year 2015 as the population reached maximum level (11.80 mite/three leaves) in third week of May (11 week after transplanting) and then gradually declined. Reddy and Kumar (2006b) also reported that mite (*P. latus*) was serious pest of sweet pepper under both protected and open field conditions. The present results are in agreement with those Gupta (1985), Lingeri **et** *al*. (1998), Patil and Nandihali (2009) and Meena *et al*. (2013) who reported the incidence of mite on chill throughout the crop period. The present results corroborate with the observations of Mote (1976), Anon (1996), Ram *et al.* (1998) and Patil and Nandihali (2009) who reported the peak population of mite in the month of April-May and at flowering stage. Siddiqui and Singh (2006) recorded the peak of mites in the second week of May support the present finding. The mite population exhibited significant negative correlation with maximum and minimum relative humidity, whereas, the correlation between maximum temperature, minimum temperature and rainfall were observed to be non-significant during 2014. During, 2015, the mite population exhibited significant positive correlation with maximum temperature, whereas, maximum and minimum relative humidity showed significant negative correlation similarly rainfall and minimum temperature were observed to be non-significantly correlated with mite population. The present findings get support from the observation of Patil and Nandilahi (2009) who reported that mite population showed negative correlation with maximum and minimum relative humidity, whereas, maximum

temperature showed significant and positive correlation, which support the present finding.

Thrips, *S. dorsalis* was observed as serious pest of capsicum attacking the crop. The infestation of thrips commenced in the field in the first week of April (two week after transplanting) in 2014 and fourth week of March (one week after transplanting) in 2015. The population of thrips gradually increased and touched its peak in last week of April (five weeks after transplanting and six week after transplanting) during 2014 and 2015, respectively. Thereafter, the population declined gradually, Singh *et al*. (2004) and Kaur *et al*. (2010) reported the thrips was prominent pest in net house conditions on sweet paper. Kumar *et al.* (2010) also reported that thrips was severe pest on sweet pepper. The present findings are agreement with the observation of Meena *et al.* (2013) who reported that the incidence of thrips started at first week after transplanting which gradually increased on the crop. The present finding partially supported by Baroat *et al*. (2012) who reported that incidence of thrips started from first week after transplanting and reach to peak in 11 week after transplanting. In present study maximum and minimum relative humidity showed significant and negative correlation($r = -0.579$ and $r = -0.642$) with the thrips population, whereas, the correlation between maximum temperature, minimum temperature and rainfall were observed to be non-significant during 2014. During, 2015, the abiotic factors had no significant effect on the population of thrips. The present finding get support with the observation of Pathipati *et al*. (2014) and Roopa and Kumar (2014) who reported non-significant correlation between thrips population with minimum temperature, maximum and minimum relative humidity and rain fall.

The incidence of aphids commenced in the field in the first week of April (two week after transplanting) in 2014 and in last week of March (two week after transplanting) in 2015. This gradually increased and touched its peak with mean population 2.80 aphids per three leaves in first week of May during 2014 and 3.07 aphids per three leaves in last week of April during 2015. The present findings are in conformity with Sharma (2004) and Yadav (2012) who reported that abundant number of aphid in field during March to May. Meena *et al.* (2013) also support the present results with initial infestation, peak and decline phase in respect to transplanting week.The aphids population exhibited significant negative correlation with minimum temperature during both the years, whereas, it was non-significant correlation between maximum temperature, maximum relative humidity, minimum relative humidity and rainfall during both the years. The result are in partially agreement with that of Meena *et al*. (2013) who recorded the non-significant correlation with maximum and minimum temperature, minimum relative humidity while relative humidity showed significant and positive correlation. Yadav (2012) also support the present findings.

The incidence of White fly, *B. tabaci* was observed to start in the 13 SMW (first week of April) and 12 SMW (last week of March) in 2014 and 2015, respectively. The population increased gradually and reached its peak (5.80 and 7.27 whitefly per three leaves) in third week of April and last week of April in 2014 and 2015, respectively, and declined thereafter. The present results are in conformity with that of Butani and Jotwani (1983) who reported that whitefly is polyphagous pest of chilli, brinjal and okra. Yasaraknc and Hncal (2000), Singh *et al*. (2004) and Halala Z seller (2008) also support present findings who reported that whitefly is a important pest of capsicum. The present results are in agreement with those of Anitha and Nandihalli (2008) observed that incidence of whitefly occurred from first week of April and its peak was recorded during last week of April. The present results are in agreement with those of Anitha and Nandihalli (2008) observed that incidence of whitefly occurred from first week of April and its peak was recorded during last week of April.

The incidence of beet armyworm started in the 13 SMW (first week of April) and 12 SMW (last week of March) in 2014 and 2015, respectively. The population increased gradually and reached its peak (2.00 and 1.47 beet armyworm per plant) in second week of

May and third week of May in 2014 and 2015, respectively, and declined thereafter. The beet armyworm population exhibited significant negative correlation and with maximum and minimum relative humidity in 2014 and 2015, respectively, whereas, the correlation between maximum temperature and minimum temperature was observed to be non-significant during both the years. Correlation between rainfall and its population was showed non-significant during 2014. Whereas, significant negative correlation (r = -0.545) was observed during 2015. The present results conformity with the observation of Pathipati *et al*. (2014) who reported non-significant correlation between beet armyworm population and minimum temperature,

Extent of damage

Extent of damage of capsicum by prominent insect and mite pests, were recorded during experiment period in 2014 and 2015 at fortnightly interval.

During the studies yellow mite was observed prominent pest of capsicum. Mites feed on mainly on leaves and suck saps which in turn cause downward curling of leaves. The size of leaves, fruits and plants gets reduced with flower and fruit dropping and affecting the market value of the produce. Leaf curling due to mites commenced in the field in the second fortnight of March (three week after transplanting) and remained throughout the crop season in both the years. Initially, the per cent leaf curling was 6.67 and 10 per plant during 2014 and 2015, respectively, which gradually increased as, the crop age advanced, leaf damage due to yellow mites also increased and reached to maximum (31.67 per cent per plant) in the second fortnight of May during 2014 and 36.67 per cent /plant in the second fortnight of May during 2015. Thereafter, the leaf damage gradually decreased to 10 and 11.67 per cent during 2014 and 2015, respectively. These observations inferred that as the crop advance in age, it gives time for mite to multiply in number and attaining more leaf curling. The present results are agreement with those of Alatawi *et al*. (2007) and Nandini *et al*. (2012 a) who reported that older plants exhibited greater damage than younger plants.

During the studies thrips was also observed prominent pest of capsicum. Nymph and adults feed on leaves, bud and fruits and suck sap from plant parts which in turn cause upward curling of leaves and reduce leaf growth, plant growth, yield and market value of produce. The leaf curling due to thrips commenced in the field in the second fortnight of March (three week after transplanting) and remained throughout the crop season in both the years. Initially, the per cent leaf curling was 5 and 8.33 per plant during 2014 and 2015, respectively, which gradually increased as, the crop age advanced, damage due to thrips also increased and reached to maximum (23.33 per cent per plant) first fortnight of May during 2014 and 21.67 /plant in the first fortnight of May during 2015. Thereafter, the damage gradually decreased to 6.67 per cent and 8.33 per cent / plant in the first fortnight of July (harvesting stage) in 2014 and 2015, respectively. It seems that as he crop attained more foliage and food, the plants exhibited greater damage than younger plants. The present results are agreement with those of Alatawi *et al.* (2007) and Nandini *et al*. (2012a) who reported that older plants exhibited greater damage than younger plants.

During the studies, beet armyworm was also observed as a major damaging pest. The larvae feed on leaves and caused heavy destruction of the crop. The leaf damage commenced in field in the second fortnight of March (three week after transplanting) and remained throughout the crop season in both the years. Initially, percent leaf damage was 11.67 and 13.33 per cent per plant during 2014 and 2015, respectively, which gradually increased as the crop advanced in age. Damage due to beet army worm increased and reached to maximum (33.33 per cent leaf damage) in the second fortnight of April during 2014 and 30 per cent /plant in the second fortnight of April during 2015. Thereafter, the damage gradually decreased to 8.33 per cent and 10 per cent / plant in the first fortnight of July (harvesting stage) in 2014 and 2015, respectively. Decrease in armyworm damage may be due to maturity of

leaves. The present results are agreement with those of Nandini *et al.* (2012) who reported that luxuriant vegetative growth exhibited greater damage than older plants due to caterpillar's preference for younger leaves compared to mature one

The infestation of fruit damage due to beat armyworm commenced in field in the first fortnight of May (ten week after transplanting) and remains throughout the crop season in both the years. Initially, fruit damage was 14.50 per cent and 16.98 per cent during 2014 and 2015, respectively, Which gradually increased as, the crop age advanced, Damage due to beet army worm also increased and reached to maximum (16.98 per cent) in the first fortnight of June during 2014 and 19.24 per cent /plant in the first fortnight of June during 2015.

REFERENCES

Anonymous, 2013. Vegetables Statistics. Technical bulletin No 51, *IIVR, Varanasi* (Uttar Pradesh).

Berke,T. G., Block, L. l., Morris, R. A., Telekar N. S. and Wang J. F. 2003. Suggested cultural practices for sweet pepper. *AVRDC*, January, 2003 P5.

Gupta, S.K. 1985. Handbook Plant mites of india. Zoological Survey of India Calcutta p 520.

Kaur, Sandeep and Singh Subash 2013. Efficacy of some insecticide and botanicals against sucking pest on capsicum under net house. *Agriculture for Sustainable Development (2013)39-44.*

Kumar, M., Chinaman, M,. Monorana O. K and Prasad B. 2010. Relative efficacy of different insecticide against chilli pod borer Spodoptera litura Fabr in Manipur. *Journal of experimental science* 1(10):23-24

Lingeri, M. S. Awaknavar, J. S. Lingappa, S., and Kulkarni, K. A. 1998. Seasonal incidence of chilli mites, *Polyphagotarsonemus latus* (Banks) and thrips, *Scirtothrips dorsalis* (Hood). *Karnataka Journal of Agricultural Sciences*, 11:380-385.**Meena, R. S. Ameta, O. P. and Meena B. L. 2013**. Population dynamics of sucking pests and their correlation with weather parameters in chilli, *Capsicum annum* L. Crop. *The Bioscan* 8 (1):177-180

Mote, U. N., 1976. Seasonal fluctuation in population and chemical control of chill mites, *Polyphagotarsonemus latus* (Banks).*Veg. Sci.,* 3(1): 54-61.

Niles, G.A., 1980, breeding cotton for Resistance to insect pests. In Macwell F.G and Jennings, P.R. (Eds.) Breeding plants resistance to insects, John Wiley and Sons, New York, pp. 337-369.

Patil, R. S. and Nandihalli, B. S., 2009. Seasonal incidence of mite pests on brinjal and chilli. *Karnataka J. Agric. Sci.,* 22: 729 -731.

Pathipatil, V.L., Vijaya Lakshmi, T., Ramana, C.V., kumar, S. Surya and Naidu, L. Naram. 2012. Evalution of certain new acaricides/ insecticides for the management of chilli mite in Andhra Pradesh. Pest Management Hort ecosystems 18(1) 111-113.

Ram, S., Patnaik, M. C., Sahoo, S. And Mahapatra, A. K. B., 1998. Population fluctuation of chilli thrips, *Scirtothrips dorsalis* Hood and the yellow mite, *Polyphagotarsonemus latus* Banks on chillies at Semiliguda, Orissa. *The Andhra agric.J., 45:79-82.*

Reddy, S. G. E and Kumar, N. K.K. 2006b. Integrated management of yellow mite, *Polyphagotarsonemus latus* (Banks), on sweet pepper grown under polyhouse. *J. Hort. Sci.,* 1(2): 120-123.

Roopa, M. and kumar, C. T. Ashok, 2014. Bio-efficacy of new insecticide molecules against capsicum fruit borer, *Helicoverpa armigera* (Hubner). *Global J. Bio. Agriculture and Health Sciences* 3(3):219-221.

Siddiqui, l. and Singh, J. 2006. Population dynamics of red spider mite (Tetranychus urticae Koch.) on brinjal as affected by abiotic factor. *Environment and Ecology*., 24:297-298

Singh, A. K., Balraj Singh., Sindhu, S. S., Singh, J. P.and Naved Savir. 2012. Study of protected v/s open field conditions on insect-pest incidence to minimize insecticide application for quality production of high value horticultural crops. *International Journal of Plant Protection;* 5(1):75-80.

Venkateshalu, Srinivas, A. G., Sushila, N and Hanumantharaya, L., 2009. Bio-efficacy of plant product, Stanza against chilli, thrips, *Scirtothrips dorsalis* (Hood) and chilli mite, *Polyphagotarsonemus latus* (Banks). *Karnataka J. Agric.Sci*., 22: 559-560.

Vos, J. G. M. and Frinking H. D 1998. Pest and disease of hot pepper (capsicum Spp) in tropical low land of java. *Indonasia. Journal of Plant Protection Tropical* 11:53-71

Yadav, A. K., 2012. Ecofriendly management of major sucking pest of chili Capsicum annum L. M.Sc. (Agri.) thesis submitted to Rajasthan agricultural University, campus-Bikaner

INFORMATION SOURCES AND UTILIZATION BEHAVIOUR OF VEGETABLE GROWERS

Prashant Maratha[1] and S.K. Badodiya[2]
M.Sc. Scholar[1] and Programme Coordinator[2], R.V.S.K.V.V., Gwalior (MP)
Email: prashantmaratha@gmail.com

Received: 16.07.16
Accepted: 18.08.16

ABSTRACT

The study was undertaken to determine the sources of agricultural information utilized by vegetable growers of Morar block of Gwalior district in Madhya Pradesh. Simple analytical tools such as percentages, frequency and tabulation were used for analyzing the data collected. The analyses revealed that most (57.50%) of vegetable growers preferred extension agents as their source of information while the least (5.00%) source was libraries. The major constraint indicated by vegetable growers in sourcing information was financial problem. It was recommended that credit facilities and subsidies or incentives be provided to farmers to purchase radio receivers to enhance information sourcing. Also more extension agents be recruited and properly trained as they are main information source used by vegetable growers. Also, in planning any agricultural information dissemination programme, suggestions by vegetable growers should be taken into consideration.

***Key words*:** Agricultural information source, sourcing constraints and utilization.

The importance of agriculture in the economy of India is profound. Despite the growth of industries and commerce it continues to be the principal economic activity of the people of India. Thus approx 70 percent of the people are engaged in agriculture but more than 70 percent of these farms at subsistence level. The Food and Agriculture Organization, FAO (1993) suggested that in order to enhance agricultural development, new commodities and new methods of production must be developed. In India, there are various agencies, research institutes, agricultural universities/colleges and non-governmental organizations that generate innovations and improved farm practices or technologies. The primary function of dissemination component (agricultural extension, agricultural change agencies, private extension organizations, etc.) is the transformation of agricultural sector of national economy through promotion of rapid adoption and utilization of improved farming technologies by the utilization component – the farmers (Desai, 1998).

According to Reddy (2003) the quantum of agricultural technology information available in the Indian systems developed by research institutes, and faculties of agriculture in universities is quite enormous. The problem therefore, lies with effective dissemination of information about these innovations by the dissemination agencies. Research institutes must disseminate their findings to the target group – the farmers, while receiving feed back to indicate that communication was successful. The feedback is expected to expose areas requiring modification or further enquiry.

Information source is an institution or individual that creates or brings about a message (Statrasts,2004). The characteristics of a good information source are relevance, timelessness, accuracy, cost effectiveness, reliability, usability, exhaustiveness and aggregation level (Statrasts, 2004). According to Singh (1999), the efficiency of technologies generated and disseminated depends on effective communication which is the key process of information dissemination.

The development of agricultural technologies requires among other inputs, a timely and systematic transmission of useful and relevant agricultural information (message) through relatively well educated technology dissemination (extension) from formal technology generation system (research) via various communication media (channels) to the intended audience – farmers (Oladele, 1999). It is expected that the message from the client (effect) be passed back to the source or research

(feedback) for the communication process to be complete.

Despite the attempt at technological innovation transfer, the wide gap at the level of production which the research contends is attainable and that which the farmers achieve, suggests a missing link. Also, weak linkages between the farmer, extension and researcher mean that the farmers are not included in the planning of the innovation and hence do not know where to get their technologies despite the fact that they are the end users. Agricultural information disseminated by different information sources need to be determined. It is imperative therefore to identify the sources of agricultural information utilized by vegetable growers.

Some questions readily come to mind such as: What are these information sources? What are the channels through which the vegetable growers get information on agricultural practices? What are the sources preferred by these vegetable growers?

The purpose of the study is to determine the agricultural information sources utilized by vegetable growers at Morar block of Gwalior district in Madhya Pradesh. The specific objectives are to: determine the sources of agricultural information disseminated in the study area; identify the sources of information preferred by vegetable growers; identify the constraints to sourcing information.

METERIALS AND METHODS

The study was conducted purposively in Morar block of Gwalior district due to highest vegetable production among the other blocks of the district. A list of villages where vegetable crops are grown was prepared with the help of RHEO/RAEO and local leaders and 10 villages were selected randomly. After that from each selected village, twelve vegetable growers were selected by using simple random sampling method. Thus, a total of 120 vegetable growers were formed the sample for the study. The primary data were collected from the respondents by using a semi-structured interview schedule, which was pre-tested before actual application. The respondents were interviewed individually by the investigator. Secondary data were collected from records & statistical office. Statistical tools like- mean, SD, percentage and frequency were used for analysis of data.

RESULTS AND DISCUSSION

Sources of Agricultural Information used by Farmers

The result from Table 1 reveals that 24.16 per cent of the respondents source their information from Radio while 8.33 per cent source their information from libraries. It was also noted that 38.33 per cent source their information from friends while most (40.83%) of vegetable growers depend on extension agents for agricultural information. This may be as a result of the cosmopolitan nature of the study area where tertiary institutions are located and the potential application of technology by vegetable growers to improve agriculture. Agricultural information transfer, sourcing and usage thrive better in places where farmers are highly educated (FAO, 1993). On the other hand, it should also be noted that internet and library are still an elitist communication media for most people.

Table 1: Distribution of respondents by sources of agricultural information used by vegetable growers.

Sources	Frequency	Percentage
Radio	29	24.16
Libraries	10	8.33
Friends	46	38.33
Extension Agents	49	40.83

Note: Multiple responses were recorded

However, it is expected that these communities may probably use internet and library more frequently as computer and mobile literacy level of respondents improve to source for information due to the high literacy level of the respondents.

Information Source Preference:

The result from Table 2 shows that most (57.50%) of the vegetable growers preferred extension agent as source of information.

Table2: Distribution of Respondents by Source Preference

Source preference	Frequency	Percentage
Radio	15	12.50
Friends	44	36.66
Libraries	6	5.00
Extension Agents	69	57.50

Note: Multiple responses were recorded.

The high percentage of vegetable growers who preferred extension agents and friends could be as a result of the ability of these vegetable growers to have face-to-face contact with these sources. It is also probable that they participate and observe the demonstrations conducted by the extension agents. Moreover, these sources allow a two-way process of communication. On the other hand, low percentage of use of Radio and Libraries could be attributed to inaccessibility of libraries and non availability of radios due to cost of procuring them. It could also be due to the fact that both are one-way processes of communication. It is also probable that farmers may be on the fields all day long and would become too tired to listen to radio after the day's toil. This agrees with Singh (1999) who noted that often farmers get tired after a day's work to be able to listen to radios due to inappropriate timing of the programs.

Agricultural information disseminated by Different Information Sources:

The result from Table 3 shows that extension agent ranked highest as source of information on all the innovations introduced. The least source of information was libraries. The choice of extension agent could probably be as a result of farmers' observation and participation in result demonstrations, carried out by extension agents. This agrees with Singh (1999) that farmers do better in what they see and practice than what they hear only. On the other hand, the low percentage preference for libraries as information source could be as a result of the elitist nature of libraries and lack of two-way process of communication inherent in libraries. The result shows low patronage of other information sources for technological information dissemination. This has poor implication for adoption of innovation. According to Patel (1996), limited access to agricultural information has, in fact, been identified as one of the most serious constraint to agricultural information sourcing.

Constraints to the Use of the Information Sources:

From the survey, nine problems were identified. Results in Table 3 reveal that majority (41.66%) of the vegetable growers suffered from financial difficulty. This probably affected the sourcing of information from such sources. It also probably prevented them from trying some of the innovations available.

Also 25.00 per cent of vegetable growers indicated inadequacy of facilities/professionals which also affected the efficiency of agricultural practice and information use, while the least (5.00%) number of respondents indicated the language barrier/understanding as constraint. Therefore inadequate funds, (41.66%), inadequate facilities/professionals (25.00%) and incomplete/irrelevant information (20.00%) were ranked as 1st, 2nd and 3rd constraints respectively to information sourcing. This implies that only fund is a major problem to information sourcing in the study area. It is also probable that the availability of fund may resolve most of the constraints identified. Moreover, the problem of fund probably explains why respondents indicated that they source for information mainly from the extension agents who they regard as credible source and who usually visited them to offer free services.

Conclusion and Recommendation

The main sources of agricultural information in the study area are extension agent, friends and radio. From the findings it is also evident that extension agent is still the most preferred source amongst the sources of agricultural information available. The major constraint faced by vegetable growers to the use of these sources was financial difficulty. Therefore, agencies interested in agricultural information dissemination should support farmers financially in form of loans and subsidies to purchase radio receivers and provide incentives to farmers to source for information on agricultural practices and innovation through

libraries by providing adult and computer literacy programs. In the same vein, more extension professionals should be recruited and trained to improve the farmer-extension ratio and effectiveness.

Table 3: Distribution of respondents by agricultural information disseminated by different information source:

	SOURCES OF INFORMATION							
Farm innovation	**Radio**		**Friends**		**Libraries**		**Extension Agents**	
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**
a) Mechanized system of farming	19	15.83	58	48.33	2	1.67	27	22.50
b) Fertilizer application	15	12.50	59	49.16	2	1.67	55	45.83
c) Spacing and planting dates	3	2.50	46	23.00	4	3.33	76	63.33
d) Soil test	2	1.67	27	22.50	1	0.83	58	48.33
e) Improved seed varieties	18	15.00	32	26.67	0	0.00	44	36.67
f) Vaccines and hygienic standard	3	2.50	5	4.17	1	0.83	17	14.17
g) Improved method of weed management	19	15.83	22	18.33	1	0.83	27	22.50
h) Improved method of Management of pest & disease	16	13.33	15	12.50	1	0.83	71	59.17

*Multiple responses

Table 4: Distribution of respondents by Constraints to use of information sources:

Constraints	**Frequency**	**Percentage**	**Rank**
Inadequate fund	50	41.66	1
Wrong farming/repetition	20	16.66	4
Inconsistency	11	9.16	7
Improper awareness	16	13.33	5
Incomplete/irrelevant information	24	20.00	3
Complexity	14	11.66	6
Disruption/uncertainties	12	10.00	8
Language barrier/understanding	6	5.00	9
Inadequate facilities/professionals	30	25.00	2

*Multiple responses recorded.

REFERENCES

Desai, S.C., 1998, A study on knowledge, adoption and marketing pattern of pomegranate growers in Bagalkot district, Karnataka state. *M.Sc.(Agri.) Thesis*, Univ. Agric. Sci., Dharwad (India).

Oladele, O. J., 1999. Analysis of the Institutional Research – Extension Farmers Linkage System in South Western Nigerian. An Unpublished Ph.D Thesis in the Development of Agricultural Extension and Rural Development, University of Ibadan, Nigeria (Internet).

Patel, K.N., 1996, A study on adoption of improved cultivation practices of chrysanthemum. *M.Sc.(Agri.) Thesis*, Univ. Agric. Sci., Bangalore (India).

Singh, P.S., 1999. A study on extent of adoption of sustainability of horticultural crops advocated by horticultural department. *M.Sc.(Agri.) Thesis*, Marathwada Agric. Univ., Parbhani (India).

Starasts, A. M., 2004. Battling the Knowledge factor: A Study of Farmers' Information Seeking Learning and Knowledge Process with an online environment in Queensland. Unpublished Ph.D Thesis.

Reddy, C., 2003. A study on knowledge and adoption behaviour of turmeric growers in Erode district of Tamil Nadu state. *M.Sc.(Agri.) Thesis*, Univ. Agric. Sci., Dharwad (India).

EFFECT OF GAMMA IRRADIATION ON SEED QUALITY, INSECT INFESTATION AND FUNGAL INFECTION IN SORGHUM *(Sorghum bicolor* L. *Moench)*

Ram Swaroop Meena*, Vilas A. Tonapi, Bharathi Bhat and K. Jhansi Rani
Dept. of Seed Science & Technology, PJTSAU, Rajendranagar and Indian Institute of Millets Research (IIMR), Hyderabad-500030, Telangana, India.
Email: meenadsr08@gmail.com

Received: 23.07.16
Accepted: 22.08.16

ABSTRACTS

Influence of five gamma radiation doses generated from Co^{60} source of Gamma chamber 5000 in combination with control on seed quality parameters of sorghum parents line and variety C43, CSH14 and CSV 29 was studied. Seed quality parameters viz., germination percentage, field emergence, speed of germination, peak value of germination and coefficient of velocity of germination, root, shoot, seedling length, vigour index, electrical conductivity, seed moisture and seed health were evaluated immediately after irradiation and up to nine months under storage at ambient conditions. The experiment was laid out in a Completely Randomised Design with factorial concept. Marked significance of interaction effects was recorded for various seed quality parameters studied immediately after exposing the seed to selected doses of gamma rays. The results indicated that gamma doses up to 2000 Gy were found to exercise positive influence in enhancing all the germination, seedling and biochemical parameters. However, this gamma radiation differed significantly in their response registered variable values for seed quality parameters. The doses beyond 2000 Gy had detrimental effect by interfering with various seed quality attributes. The analysis of bimonthly data at four intervals on seed storage potential up to nine months indicated significant influence of storage period on all the seed quality parameters including seed health However, The results also indicated that among germination and seedling traits studied, peak value of germination, vigour index and root length were the most sensitive seed quality parameters affected by ageing due to storage under ambient conditions. The study revealed that, combinations viz., control / 200, 600 Gy, Glutathione / 200, 400 Gy and Zinc oxide / 800 Gy performed better for various germination, seedling, biochemical, seed moisture and seed health parameters (weevil infestation) evaluated during storage.

Key words: Gamma radiation, Completely Randomised Design, Vigour index, Germination and Seed moisture.

Sorghum (*Sorghum bicolor* L. *Moench*) is the fifth most consumed stable cereal globally and over 80% of its cultivation lies in resource poor ecosystems. Sorghum is inherently high in protein and yields well in subsistence farming environments. The crop is capable of tolerating lower inputs and more marginal field conditions. World area under sorghum is 42.12 m ha with a production of 61.38 m t and productivity of 2.66 t/ha. India leads the world in acreage and 1/3 global sorghum area is in India, comprising of 10.9 m ha with a production of 8.0 m t and average yield of 0.73 t ha^{-1} Given its natural tolerance to heat and drought stress, sorghum is a key crop in providing food security for millions of people in developing world. Recent projections of sorghum based foods by health care professionals as an alternative to check life style diseases, have further enhanced the importance of this crop. The nutrient composition of sorghum indicates that it is a good source of energy, proteins, carbohydrates, vitamins and minerals.

Among other constraints influencing the storability of sorghum seed, pest incidence is of paramount importance. Rice weevil *(Sitophilus oryzae)* is a primary pest capable of feeding on grains, reducing not only germination capacity but also nutritional and commercial value. The weight loss in stored sorghum is caused by both larval and adult feeding, with the major damage being done by larvae eating inside the kernel. In granaries, this weevil can induce up to 75 % of losses to the stored seed. The annual losses of grains due to weevils in storage are estimated to be 25 to 40 % after 6 months of storage.

Maintenance of seed viability and vigour during storage is a matter of prime concern in tropical and subtropical countries. Owing to the prevailing tropical climate, seeds of most crop species show rapid deterioration and jowar is no exception. In this context, effective and environmentally friendly storage methodologies

with minimum interference with seed quality and storability parameters would be of immense practical utility. However, such applications are ridden with disadvantages like toxic residue accumulation leading to potential environmental hazards and altering storage potential of seed. Hence, gamma radiation administered at selective sub lethal doses can be projected as an effective technology to sanitize the seed before storage and to minimize deterioration of seed quality and storability. Gamma rays possess high penetrating characteristics and prevent re-contamination or re-infection of sterilized sample. Effectiveness of selected sub lethal gamma dose in maintaining the sorghum seed quality parameters during an extended period of ambient storage under farmer's condition need to be ascertained.

Further, to improve the efficiency of gamma rays in terms of extending shelf life, the side effects of stress created by radiation exposure needs to be countered. The free radical generation associated with radiation stress may have to be curtailed by appropriate seed enhancement technology. Therefore, the present study is proposed to investigate changes in both seed quality and storability parameters of promising jowar variety at different doses of gamma radiation stored under farmer's conditions.

MATERIAL AND METHODS

Crop variety

Breeder seed of sorghum varieties are CSV 29R, C 43, and CSH 14 was used for the experimental purpose, which was procured from Indian Institute of Millet Research, Rajendranagar.

Radiation treatments

Gamma chamber 5000 was used for giving radiation treatments. It is compact shelf shielded Cobalt^{60} gamma irradiator providing an irradiation volume of approximately 5000cc. The material for irradiation was placed in an irradiation chamber located in vertical drawer inside the Lead flask. Seeds of sorghum variety are CSV 29R, C 43 and CSH 14 was weighing 400 g for each treatment was packed in HDPE bag (400 guage) was exposed to selected doses of gamma radiation in GC 5000 radiation chamber with CO^{60} source having 1.96 KGy hr^{-1} dose rate.

Initial data on seed quality was generated immediately after irradiation during 1st month and four periodical observations at bi-monthly intervals on storability parameters were generated during 3rd, 5th, 7th and 9th month for a period of nine months after storage and the changes during storage.

Germination test and Peak value

Germination test was conducted in three replicates of 100 seeds each by adopting top paper method. Daily germination counts were performed until no further germination was observed for seven days. Peak value of germination was then calculated by following formula.

$$\text{Peak value} = \frac{\text{Cumulative number of seeds newly germinating on each day}}{\text{Number of days elapsed since initial}}$$

Ten normal seedlings were selected at random from each replication on the 10th day (final count) from germination test and used for measuring root and shoot length. The root and shoot length measured between collar region and tip of the primary root and apical bud, respectively. The seedlings used for recording root and shoot length from each replication were subsequently used for measuring seedling length.

Vigour index of the seedlings obtained from the germination test was calculated using the formula.

$$\text{Seedling vigour index} = \text{Percentage of Seed germination} \times \text{Mean seedling length (cm)}$$

Electrical conductivity of seed leachates

Electrical conductivity of seed leachate was estimated as described by Presley (1958). Four replications of 25 seeds from each treatment was drawn and pre-washed thoroughly with distilled water to remove the adhering chemicals and then soaked in 50 ml of distilled

water for 16 h at room temperature. After soaking, the seed steep water was decanted to obtain the seed leachate.

Seed moisture

Moisture content of seed was determined as per ISTA rules. Five grams of seed was weighed, ground and put in aluminium cups. The aluminium cups along with ground seed material was dried in hot air oven maintained at 130 $\pm$ 1^0C temperature for two hours. The moisture content was determined on dry weight basis using the following formula.

$$\text{Moisture content (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where, W_1 - Weight of empty container with its cover

W_2 - Weight of container with its cover and ground seeds before drying

W_3 - Weight of container with its cover and ground seeds after drying.

α- amylase and Dehydrogenase enzyme activity

The α- amylase activity was analyzed as per method suggested by Simpson and Naylor (1962), whereas Dehydrogenase enzyme activity was determined as described by Kittock and Law (1968) using 2,3, 5-triphenyl tetrazolium chloride solution at 0.1 per cent concentration prepared by using Sorenson's buffer solution as solvent.

Insect infestation

During storage period of nine month, periodical observation on pest incidence ware recoded in term of damaged seeds. Observation ware recorded at initial and bimonthly intervals form the seeds of all treatments store in HDPE bags under ambient condition. During each periodical observed, 50 g of seeds was drowning from each treatment separately. The seeds ware observed for damage caused by storage pest. The percentage of damage seeds was worked out using the following formula.

$$\text{Insect infestation (\%)} = \frac{\text{Total No. of damaged seeds}}{\text{Total No. of seeds observed}} \times 100$$

Fungal invesion

During storage period of nine month, periodical observations on pathogen infectivity were recorded in terms of infected seed. Observations were recorded at initial and bimonthly intervals form the seed of all treatments stored in HDPE bags under ambient conditions. Pathogen infectivity in seed sample was determined by using standard blotter method. Discs of blotter paper (90 cm diameter) were dipped in sterile distilled water and placed in Petri plates of same diameter and 25 seeds of each sample

were placed equidistantly using forceps. These plates were labeled and kept in incubator at 25+1^0C for seven days and the infected seeds were counted. Percentages of total infected seeds were calculated for each sample in all the three replication.

$$\text{Fungal infectivity \%} = \frac{\text{Total No. of infected seed}}{\text{Total No. of seeds kept for germination}} \times 100$$

Subsequently, Ash contain of seed, Starch, fat Protein content was estimated by slandered methods.

Statistical analysis

The data generated were be subjected to analysis of variance as per Factorial experiment laid out in CRD to test the significance of various treatments evaluated in the experiment as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The results indicated significant differences among the treatments in comparison to general mean for all the parameters studied (Table: 1).

Germination parameters

Germination percentage decreased with increasing gamma dose but was not proportional to the increase in the gamma dose. Speed of germination provides good validation of seed vigour enabling categorisation of strong and weak seedlings. Eleven treatments *viz.*, Glutathione and Zinc oxide / 0 Gy, 400Gy, control, Glutathione and Zinc oxide / 600Gy, 800Gy and Zinc oxide / 200 Gy. were

significantly superior over general mean of 25.2 (Table: 3). Results indicated that for Glutathione and Zinc oxide 0, 400 Gy doses were superior to their corresponding 0 Gy. Highest speed of germination (43.37) was recorded in the treatment Glutathione/ 600 Gy and lowest (2.84) was noticed at 0 Gy in Glutathione encapsulated Zinc oxide Results are presented in Table: 3.

Significance of gamma doses in influencing speed of germination was evident from the results. Maximum mean speed of germination 43.3 was recorded in Glutathione at 600 Gy followed by Glutathione (40.0) at 0 Gy. However 0 Gy, 200 Gy, 400 Gy, 600 Gy and 800 Gy in Glutathione encapsulated Zinc oxide recorded much lower speed of germination of 2.84, 3.00, 4.46, 6.58 and 3.18 respectively. (Table: 3) Gamma doses influence speed of germination significantly, highest speed of germination recorded at 600 Gy (30.54) lowest in case 200 Gy (21.67).

The results revealed that the speed of germination at 600 Gy was higher than 0 Gy in all nano scale particles and decreased with increasing gamma dose up to 400 Gy in all nano scale particles. The results were in conformity with research findings of Silva *et al*. (2011) in which rice seeds of BRS Querência and BRS Fronteira were irradiated at the doses of 0, 50, 100, 150 and 200 Gy and the former showed a higher speed of germination in comparison to the latter variety at lower radiation doses 50 and 100 Gy.

The speed of germination showed increasing trend in all the nano scale particles with increasing dose of gamma radiation from 200 Gy to 600 Gy and declined beyond 600 Gy. Similar results was recently reported by Borzouei *et al.* (2010) in which the effect of gamma radiation on speed of germination in seeds of cvs. Roshan and T-65-58-8 of wheat revealed that speed of germination had decreased with increasing irradiation dose for both genotypes when irradiated with higher doses of 100, 200, 300 and 400 Gy.

Seedling parameters

Eight treatments *viz*., control / 0 Gy, Glutathione/ 0, 200, 400 Gy, Zinc oxide / 0, 200 Gy and Glutathione encapsulated Zinc oxide / 0, 200 Gy recorded significantly higher root length than general mean of 7.32 cm (Table: 4). The values ranged from 3.36 cm (Glutathione encapsulated Zinc oxide / 800 Gy) to 11.53 cm (control / 0 Gy). Interaction effects presented in Table: 4 were significant for root length.

Significant influence of gamma doses was observed in the expression of root length. But all doses exhibited inhibitory effect on root length, which was less than that of 0 Gy. Maximum root length of 10.68 cm was observed at 0 Gy and lowest mean root length was recorded at 600 and 800 Gy (6.05 cm). Significant influence of nano scale particles was also observed for root length. Gamma radiation showed inhibitory effect on root length at all gamma doses in comparison to non irradiated sample. Root length had decreased with increasing dose of gamma in all interactions which could be due to reduced mitotic activity in meristematic tissues and cell arrest at G2 / M phase during somatic cell division.

Shoot length for all doses was less than 0 Gy (10.65 cm). However, maximum shoot length of 10.65 cm was observed at 0 Gy and lowest mean of shoot length was recorded at 800 Gy (4.75 cm) indicating the inhibitory effect of gamma dose on progress of shoot growth.

Vigour index

Vigour index quantifies the early efficiency of the seedling to optimum utilisation of available resources and finally gives an indication about probable plant height at later crop phenology. Further, this parameter captures the variability encountered during the process of germination and early seedling growth. In the present investigation highest vigour index (Table: 5) was recorded at 0 Gy in control (2263) followed by Glutathione / 0 Gy (1993). Nine treatments *viz*., control / 0, 200 Gy, Glutathione / 0, 200,400 Gy and Zinc oxide / 0, 200, 400, 800 Gy were significantly superior (Table: 5).

As observed in other seedling parameters, vigour index was significantly influenced by gamma doses. Highest seedling vigour index was noticed at 200 Gy (1326) which was inferior to 0 Gy (1698). However, higher

gamma dose of 800 Gy recorded significantly lower vigour index value of 756 (Table: 5).

Seed moisture

The influence of gamma dose for this parameter was non-significant. The results indicated that seed moisture percentage was low in 4 treatments which have documented less than 8.5 per cent. Which ranged from 8.4 (control and Glutathione / 800 Gy) to 9.6 (Glutathione encapsulated Zinc oxide / 0 Gy) per cent.

Significant influence of nano scale particles was observed for seed moisture (Table: 6). Significantly lower moisture was observed in control (8.74 %) than other nano scale particles and highest moisture was recorded in Glutathione encapsulated Zinc oxide (8.86 %).

Among significant interaction effects (Table: 7), higher peak value of 18.9 was registered for control at 200 Gy at 1st bi-month and retained value (15.9) at the end of the 4th bi-month and was followed by Glutathione/ 400 Gy (18.3) which got reduced to 17.1, and Glutathione / 200 Gy (13.4) and Zinc oxide / 800 Gy (11.9) recorded 17.1 and 16.7 respectively at the end of 4th bi-month storage. These treatments were significantly superior to their corresponding 0 Gy and remaining treatments. Among all the Gamma doses, lower peak value of germination was observed for Glutathione encapsulated Zinc oxide (2.8, 2.9, 4.6, 3.1, 3.4) at the end of 4th bi-month storage indicating the deleterious effect of these specific nano scale particles and Gamma dose on the process of germination. Similarly, for coefficient of velocity, interaction effects (Table: 5, Fig. 2), control at 200 Gy showed 71.2 %at 1st bi-month and recorded co-efficient of velocity of germination (40.6%) at the end of the 4th bi-month of storage. Coefficient of velocity of germination for all nano particles at all doses decreased at 4th bi month compare to 1st bi month respectively after nine months of storage. These treatments were significant to remaining treatments during first and fourth bimonthly studies.

Further, it was observed that, the parameter peak value was significantly influenced by period of storage which was found to be non significant for coefficient of velocity of germination. The peak value of germination (11.9) after 1st bi-month under the influence of storage got increased to 16.7 after 4th bi-month of storage in Zinc oxide / 800 Gy (Table: 7). The highest co-efficient of velocity of germination (71.2%) after 1st bi-month of storage had reduced significantly after 4th bi-month of storage (40.6%). The results are presented in Table: 2.

Similarly, gamma doses also exercised significant influence on peak value and coefficient of velocity of germination (Fig.1). Highest figures for peak value of germination at 200 Gy and 400 Gy doses 12.7 and 12.0, the values 44.6 (0 Gy), 45.9 (200 Gy), 42.5 (600 Gy) per cent for coefficient of velocity were documented. Lowest peak value of germination was recorded at 800 Gy (10.3). Lowest co-efficient of velocity of germination was recorded at 800 Gy (40.4 %).

The results indicated that sorghum variety with different nano scale particles like Glutathione and Zinc oxide completed the process of germination in comparatively quick time than control and Glutathione encapsulated Zinc oxide, thus confirming the greater ability to buffer the effects of storage under the influence of gamma radiation.

Biochemical parameters

Assessment of membrane integrity through estimation of electrical conductivity of seed leachates and super oxide dismutase by tetrazolium test gives a reflection about changes in seed vigour associated with storage under the influence of seed treatments like Nano scale particles and gamma ray exposure.

At the end of 1st bi-month of storage the mean EC values ranged from 25.7 µS cm^{-1} (Zinc oxide / 800 Gy) to 54.9 µS cm^{-1} (Glutathione encapsulated Zinc oxide / 200 Gy). The mean values ranged from 43.1 µS cm^{-1} (Glutathione / 800 Gy.) to 113.3 µS cm^{-1} (Glutathione encapsulated Zinc oxide / 600 Gy) at the end of 2nd bi- month of storage while, after 3rd bi-month highest EC of 122.30 µS cm^{-1} was recorded in respect of Glutathione encapsulated Zinc oxide / 600 Gy and lowest value of 88.1 µS cm^{-1} at Glutathione / 600 Gy. After nine months of storage the leakage of leachets was low (122.9 µS cm^{-1}) in case of

control / 600 Gy. Elite combinations control, Glutathione and zinc oxide / 200, 600 recorded significantly lower EC values during final storage evaluation in comparison to untreated controls.

Another important enzyme, Super oxide dismutase also observed in this Nano scale particles treated and gamma irradiated storage experiment. The activity of enzyme is directly correlated with seed vigour.

First bimonthly storage studies indicated that Super oxide dismutase ranged from 0.8 U mg^{-1} protein (Zinc oxide / 600 Gy) to 1.9 U mg^{-1} protein (Glutathione encapsulated Zinc oxide / 0 Gy). Treatments *viz*., control / 200, 400, 600 Gy, glutathione / 200, 400 Gy, Zinc oxide / 200, 400 and 800 Gy, recorded significantly higher mean Super oxide dismutase than others and maintained highest Super oxide dismutase upto 4th bi-month. Results are furnished in Table: 9 and depicted in Fig. 3. At the end of 1st bi-month of storage,

Seed moisture and seed health parameters

Significant increases in seed moisture content during storage period was observed as indicated in Table: 10. The seed moisture content increased from 9.1 per cent at1st bi-month to 9.7 per cent after 4th bi-month of storage. Gamma dose of 800 Gy recorded lower seed moisture content of 9.3 per cent which was significant over other doses. Higher seed moisture content (9.6 %) was observed at 0 Gy. Influence of nano scale particles on seed moisture content was significant. Highest seed moisture content was recorded in Glutathione encapsulated Zinc oxide (9.5 %) followed by Glutathione and Zinc oxide (9.4 %). Lowest was noticed in Control (9.3 %). The results are presented in Table: 10. The influence of nano scale particles, gamma doses and storage are graphically represented in Fig. 4.

The present investigation also revealed that the moisture content had increased from 9.3 per cent at the end of second month to 9.7 per cent after nine months of storage. Seed moisture content was found to be increasing after every bimonth of storage in all nano scale particles and Gamma doses.

The grain traits such as hardness, fat and protein content imparting resistance to rice weevil were studied and correlated with weevil damage. Considering the adult weevil population, colonization, oviposition and seed damage, the genotypes *viz*., CSV 15, SPV 1330, SPV 462, SPV 1231, CSV 13, 296 B and Local Yellow were found the least susceptible to *S. oryzae*. The higher quantities of protein imparting resistance to rice weevil oviposition and its adult colonies with SPV 1330, SPV 462, SPV 1231, SPV 1328, CSV 13, CSV 11, CSH 5, CSH 16, SPH 821 indicating antibiosis for dominant component of resistance among the sorghum genotypes.

As per the results from the experimentation it could be concluded that gamma doses up to 600 Gy were found to exercise positive influence in enhancing all the germination, seedling, biochemical parameters in all nano scale particles except Glutathione encapsulated Zinc oxide. The higher doses had detrimental effect by interfering with various seed quality attributes. Among the interactions control at 200 Gy and 600 Gy, Glutathione at 200 Gy and 400 Gy Zinc oxide at 800 Gy performed better than other combinations in all seed quality parameters during nine months of storage. Gamma doses of 200 and 400 Gy showed superiority in influencing positively all the seed quality parameters during storage. Control, Glutathione and Zinc oxide exhibited better performance than Glutathione encapsulated Zinc oxide to irradiation during storage in terms of maintenance of seed quality. Glutathione and Zinc oxide are more amenable for storage after gamma treatment without any loss in seed quality compared to Glutathione encapsulated Zinc oxide

Considering all the germination, seedling, biochemical and seed health parameters it could be obviously concluded that nano scale particles Glutathione at 200 Gy and 400 Gy, Zinc oxide at 800 Gy were superior along with control at 200 Gy and 600 Gy. These Five combinations have retained optimum storability parameters at the end of nine months of storage period without adversely affecting the seed quality of stored sorghum seed under ambient conditions.

REFERENCES

Borzouei, A., Kafi, M., Khazaei, H., Nasariyan, B and Majdabi, A. 2010. Effects of gamma radiation on germination and physiological aspects of wheat seedlings. *Pakistan Journal of Botany.* 42 (4): 2281-2290.

Gomez, K. A and Gomez, A. A. 1984. *Statistical procedures for agricultural research.* Published by John Wiley and Sons, Singapore. 680.

Presley, J.T. 1958. Relationship of protoplast permeability of cotton seed viability and pre disposition of seedling disease. *Plant Disease Reporter*. 42: 582.

Silva, A.S., Danielowskf, R.D., Braga, E.J.B., Deuner, S., Magathaes Junior, A.M and Peters, J.A. 2011. Development of rice seedlings grown from pre-hydrated seeds and irradiated with gamma rays. *Ciência Agrotechnology.* 35 (6): 1093-1100.

Simpson, G.M and Naylor, J.M. 1962. Dormancy studies in seeds of *Avena testa.* 3. A relationship between maltase, amylase and gibberellins. *Canadian Journal of Botany*. 40: 1659-1673.

Kittock, P.A and Law, A.G. 1968. Relationship of seedling vigour to respiration and tetrazolium Chloride reduction of germinating wheat seeds. *Agronomy Journal*. 60 **:** 286-288.

EVALUATING GAPS IN TRANSFER OF TECHNOLOGY IN WHEAT THROUGH FRONT LINE DEMONSTRATIONS IN JHUNJHUNU DISTRICT OF RAJASTHAN

Dayanand, R.K.Verma, R.S.Rathore, A.Choudhary and S.M.Mehta
Krishi Vigyan Kendra, Jhunjhunu-333001, Rajasthan
Email: dr.dayanand04@gmail.com

Received: 23.07.16
Accepted: 10.09.16

ABSTRACT

Total 70 Front line demonstrations on wheat variety Raj-4037 & Raj-4120 were conducted at farmers fields in district Jhunjhunu (Rajasthan) during Rabi seasons of the year 2013-14, 2014-15 and 2015-16. On three years overall average basis about 08.45 per cent higher grain yield was recorded under demonstrations than the farmers traditional practices. The extension gap, technology gap and technology index were 295.7 kg per ha, 682.3 Kg per ha and 14.94 %, respectively. An additional investments of Rs.948 per ha coupled with scientific monitoring of demonstrations and non-monetary factors resulted in additional return of Rs. 5122 per ha. Fluctuating MSP sale price of wheat during different years influenced the economic returns per unit area. On three years overall average basis Incremental benefit: Cost ratio was found as 5.48.

Key words: Demonstration, Economics, Gap analysis, Grain yields, Wheat

Wheat is the second most important staple cereal food grain in Indian diet and main source of protein & calories that contributes substantially to the national food security by providing more than 50 % of the calories for larger section of population. By 2020, India will have a population of about 1.3 billion & there will be a substantial pressure on land to produce more food. In India wheat is grown under 25.48 lakh ha area with production and productivity is 85.47 lakh ton and 33.54 q/ha, respectively. Improvement in its productivity has played a key role in making the country self sufficient in food production. However in the past decade there has been marginal increase in the productivity of wheat [Nagarajan(2005) and Joshi *et al* (2007)]. The average productivity of wheat in Rajasthan is less than 3.0 t/ha, which is substantially lower compared to ~ 4.0 t/ha in adjoining states like Haryana and Punjab. Stagnation in wheat production, productivity and inferior quality of the produce are due to various constraints including inadequate and imbalanced nutrient application (Prasad, 2012). Efforts are being made at various levels to sustain food security through wheat production but as on date the result is not satisfactory and worthy.

In Jhunjhunu district, wheat is a major rabi crop grown in more than 0.88 lakh ha area with 3.10 lakh ton production and 35.00 q/ha productivity (Anonymous, 2015). The productivity level of Wheat crop in the Jhunjhunu district is low because farmers are not following the full recommended package of practices. Therefore, on the basis of 'seeing is believing' principle it is very essential to demonstrate the latest technologies at farmers field so that the farmers may see the results and adopt it. A wide gap exists in wheat production between the available techniques and its actual application by the farmers which is reflected through poor yield at the farmer's fields. There is a tremendous opportunity for increasing the production and productivity of wheat crop by adopting the improved technologies. There are so many appropriate technologies generated at agricultural universities and research stations but the productivity of wheat is still very low due to poor transfer of technology from the points of its development to the points of its utilization and only a little new knowledge percolates to the farmers fields, hence a wide gap has been observed between knowledge production & knowledge utilization.

To increase the production and productivity of wheat as well as to demonstrate the scientific cultivation of wheat, front line demonstrations may be laid out at farmer's field. The basic objective of FLDs is to demonstrate improved proven technology of recently released technologies at farmer's field through KVKs to bring in enhanced application of modern technologies to generate yield data & collection

of farmer's feedback. Keeping the importance of FLDs, the KVK, Jhunjhunu laid out demonstrations on wheat crop at farmers field under irrigated situations in Rabi 2013-14, 2014-15, & 2015-16. The objectives were as follows:

- To exhibit the performance of recognised & recommended high yielding wheat variety with full recommended package of practices
- To compare the yield levels of FLD fields with local check
- To analyse the economics of FLDs on wheat.

MATERIALS AND METHODS

Front line demonstrations on wheat were conducted at farmers field in district Jhunjhunu (Rajasthan) to assess its performance during three consecutive Rabi seasons 2013-14, 2014-15, & 2015-16. The soils of the demonstration sites were sandy loam, low in organic carbon (0.2-0.3) low to medium in phosphorus (22-45 kg/ha.) and medium to high in potash (320-350kg/ha.) with alkaline reaction (pH 8.1-8.4). The demonstrations were laid out on irrigated fields with cluster bean-wheat, cowpea-wheat and green gram-wheat rotations which are most prevalent in the area. Each demonstration was of one acre area and recommended package was provided to the farmers with two days on campus training at KVK. The sowing was done during mid November to last week of November and harvested during first fortnight of April. The demonstrations on farmers fields were regularly monitored by Krishi Vigyan Kendra, Jhunjhunu scientists right from sowing to harvesting & threshing. The grain yield of demonstration crop was recorded & analyzed. Different parameters as suggested by Yadav et al. (2004) and Dayanand et al (2014) were used for calculating gap analysis, costs and returns. The detail of different parameters is as follows:

- Extension gap = Demonstration yield - Farmers practice yield
- Technology gap = Potential yield - Demonstration yield
- Technology index = Potential yield - Demonstration yield x 100/ Potential yield
- Additional return = Demonstration return - Farmers practice return
- Effective gain = Additional return - Additional cost
- Incremental B:C ratio = Additional return / Additional cost

RESULTS AND DISCUSSION

During the period of study, a total no. of 70 FLDs were conducted at farmer's field as per the allotment by ICAR, New Delhi. Out of 70 demonstrations, 17 (24.29 per cent) were in the yield range of more than 4000 kg/ha, 47 (67.14 per cent) in range of 3500-4000 kg/ha and remaining 06 (08.57 per cent) were found in the low yield category i.e. less than 3500 kg/ha which might be attributed to biotic and abiotic stresses during different years (Table 1)

Grain yield

The increase in grain yield under demonstration was 6.78 to 11.00 per cent over the farmers local practices. On the basis of three years, 8.45 per cent yield advantage was recorded under demonstrations carried out with improved cultivation technology as compared to farmers traditional way of wheat cultivation.

Gap analysis

An extension gap of 265-317 kg per hectare was found between demonstrated technology and farmers practices during different three years and on average basis the extension gap was 295.7 kg per hectare (Table 2). The extension gap was lowest (265 kg/ha) during 2015-16 and was highest (317 kg/ha) during 2014-15. Such gap might be attributed to adoption of improved technology in demonstrations which resulted in higher grain yield than the traditional farmers practices. Wide technology gap were observed during these years and this was lowest (170kg/ha) during 2013-14 and was highest (1305 kg/ha) during 2014-15. On three years average basis the technology gap of total 70 demonstrations was found as 682.3 kg per hectare. The difference in technology gap during different years could be due to more feasibility of recommended technologies during different years. Similarly, the technology index for all the demonstrations during different years were in accordance with technology gap.

Higher technology index (29.00 %) reflected the inadequacy of proven technology for transferring to the farmers and insufficient extension services for transfer of technology.

Economic Analysis

Different variables like seed, fertilizers, herbicides and pesticides were considered as cash inputs for the demonstrations as well as farmers practice and on an average an additional investment of Rs. 948 per ha was made under demonstrations. Economic returns as a function of grain yield and MSP sale price varied during different years. Maximum returns (Rs. 5597 per ha) during the year 2014-15 was obtained due to higher grain yield. The higher additional returns and effective gain obtained under demonstrations could be due to improved technology, non-monetary factors, timely operations of crop cultivation and scientific monitoring. The lowest and highest incremental benefit: cost ratio (IBCR) were 4.89 & 6.01 in 2014-15 and 2015-16, respectively (Table 3) depends on produced grain yield and MSP sale rates. Overall average IBCR was found as 5.48. The results are in conformity with the findings of Yadav *et al* (2004), Lathwal, O.P.(2010), Verma *et al* (2014) and Dayanand *et al* (2014)

CONCLUSION

The study on Front line demonstration on wheat concluded that there is 8.45 per cent increase in yield over local check. Such increase was recorded with extra expenditure of Rs.948/ha. This amount is so less that even small and marginal farmers can also afford it. This proved that it is not the cost factor that deters the farmers from adoption of latest technology but ignorance is the primary reason and it is quite appropriate to call such yield gap as extension gap. The extension gap was found to be 295.7 kg/ha. The IBCR (5.48) is sufficiently high to motivate the farmers for adoption of the technologies. Therefore, FLD program was effective in changing attitude, skill and knowledge of farmers towards improved / recommended practices of wheat cultivation including adoption. This also improved the relationship between farmers and scientists and built confidence between them. The demonstration farmers acted also as primary source of information on the improved practices of wheat cultivation and also acted as source of good quality pure seeds in their locality and surrounding area for the next crop. The concept of Front line demonstration may be applied to all farmer categories including progressive farmers for speedy and wider dissemination of the recommended practices to other members of the farming community. This will help in the removal of the cross-sectional barriers of the farming population.

Table 1. Details of demonstration under different yield range in wheat

No. of demonstrations conducted during 2013-14 to 2015-16		**No. of demonstrations in different yield range (kg/ha)**		
Allotted	Conducted	<3500	3500-4000	>4000
70 (100)	70 (100)	6 (08.57)	47 (67.14)	17 (24.29)

*Figures in parentheses indicates the percentage

Table 2. Grain yield and gap analysis of front line demonstrations on Wheat at farmers field

Year	**No. of demos**	**Variety**	**Potential yield (Kg/ha)**	**Demonstration yield (Kg/ha)**	**Farmers practice yield (Kg/ha)**	**Increase over Farmers practice (%)**	**Extension gap (Kg/ha)**	**Technology gap (Kg/ha)**	**Technology index (%)**
2013-14	20	Raj-4037	4500	4330	4025	07.58	305	170	3.78
2014-15	20	Raj-4037	4500	3195	2878	11.00	317	1305	29.00
2015-16	30	Raj-4120	4750	4178	3913	06.78	265	572	12.04
Overall average	23.3	-	4583.3	3901	3605.3	08.45	295.7	682.3	14.94

Table 3. Economic analysis of front line demonstrations on Wheat at farmers field

Year	Cost of cash input (Rs./ha)		Additional cost in demonstration(Rs./ha)	Sale price (MSP) of grain (Rs./qtl.)	Total returns (Rs./ha)*		Additional return in demonstration (Rs./ha)	Effective gain (Rs./ha)	Incremental B:C ratio (IBCR)
	Demos	FP			Demos	FP			
2013-14	2745	1820	925	1550	79515	74388	5127	4202	5.54
2014-15	3445	2300	1145	1450	57828	52231	5597	4452	4.89
2015-16	2813	2040	773	1525	81715	77073	4642	3869	6.01
Overall average	3001	2053.3	947.7	1508.3	73019.3	67897.3	5122	4174.3	5.48

*indicates returns from grain and straw

REFERENCES

Anonymous, 2015. ZREAC report of rabi season, DOA-Jhunjhunu: 2-3.

Dayanand, Rathore,R.S. Verma, R.K. and Mehta, S.M. 2014. Yield gap and economic analysis of castor production through Front line demonstrations. Int .J. Agriculture Stat. Sci.. **10(1):**193-195.

Joshi, A.K., B. Mishra, R.Chatrath, G. Ortiz Ferrara and R.P. Singh 2007. Wheat improvemrnt in India: present status, emerging challenges and future prospects. Euphytica,**157:**431-446.

Lathwal, O.P. 2010. Evaluation of front line demonstrations on blackgram in irrigated agro ecosystem. *Annals of Agricultural Research*, **31(1&2)**:24-27.

Nagarajan, S. 2005. Can India produce enough wheat even by 2020? Current Science, **89:**1467-1471.

Prasad,R. 2012. Fertilizers and Manures. Current Science.102(6):894-898.

Verma, R.K; Dayanand; Rathore, R.S; Mehta, S.M. and Mahendra Singh 2014. Yield and gap analysis of wheat productivity through front line demonstrations in Jhunjhunu district of Rajasthan. Ann, Agric. Res. 35(1):1-4.

Yadav, D.B., Kamboj, B.K. and Garg, R.B. 2004. Increasing the productivity and profitability of sunflower through front line demonstrations in irrigated agroecosystem of eastern Haryana. *Haryana Journal of Agronomy*, **20(1&2)**: 33-35.

GROUNDNUT (*Arachis hypogaea*) PRODUCTIVITY AS INFLUENCED BY SH BIOREGULATOR AND FERROUS SULPHATE SPRAY IN STANDING CROP

B. L. Jat, J. K. Gupta, M. R. Dhaker, D. S. Bhati and R. N. Sharma
Krishi Vigyan Kendra, Dausa (Rajasthan) India : 303 303
(SKN Agriculture University, Jobner)
Email: drbljat70@gmail.com

Received: 28.07.16
Accepted: 12.09.16

ABSTRACT

A field experiment was conducted during Kharif 2011 at farmers' fields in different locations of Dausa district of Rajasthan, which falls in agroclimatic zone IIIa (Semi arid eastern plain zone). Soils of the experimental sites were sandy to sandy loam in texture, slight alkaline (pH 7.6) in reaction, low in nitrogen and phosphorus and medium in potassium status. The study consists four treatments namely T_1- Control (No spray), T_2- 0.5% ferrous sulfate spray at vegetative, T_3- 500 ppm thiourea spray at vegetative and reproductive stage, T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray vegetative and reproductive stage. The above four treatments were replicated 20 times in the year 2011 at farmers fields of Khatwa village in Lalsot block of Dausa. The groundnut variety GG-20 was grown in the first to second week of June. The crop was irrigated at critical growth stages and as and when needed. The crop was raised with the recommended dose of major nutrients in the zone IIIa i.e. 15 kg N and 60 kg P_2O_5 per hectare. The crop was harvested in the third week of September.

The results of the experiment indicated that number of pods per plant, pod and haulm yield was found significantly superior in treatment T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray vegetative and reproductive stage by the tune of 14.89, 16.54 and 20.11 per cent higher over control, respectively. The yield attributes and yield of groundnut was also increased significantly in treatment T_2- 0.5% ferrous sulfate spray at vegetative stage pod yield, haulm yield and number of pods per plant were increased by 11.82, 13.97 and 8.51 per cent higher over control or no spray that recorded 15.90 q/ha, 17.90 q/ha and 47 , respectively.

Overall study revealed that the treatment T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray vegetative and reproductive stage found significantly superior and farmer can increased their yield of groundnut by adopting this technology and gave their input in changing the scenario of green revolution to evergreen revolution.

***Key words*:** Groundnut, Ferrous sulphate, Thiourea, Productivity

With increasing population growth and diminishing water availability Indian agriculture facing severe challenge to produce more crop per drop of water. Use of high yielding varieties and higher dose of macro nutrients and growing of groundnut year after year has resulted in depletion of micro nutrients like zinc and iron resulting declining or stagnating productivity of groundnut due to unfavorable climatic condition especially cloud cover during reproductive stage and interveinal chlorosis resulted in stagnating or decline the productivity even after the increasing the seed rate and macro nutrients application. For sustainable agriculture it is imperative to renewable inputs which can maximize the ecological benefits and minimizing the environmental hazards. One possible way of achieving this is to decrease dependence on use of macro nutrients by foliar application of SH bioregulators (thiourea) and iron sulfate which helps in better transportation mechanism in the plants phloem system and increasing the yield potential of groundnut.

Groundnut or peanut or earthnut or monkeynut is an important edible oil crop in Rajasthan both from the point of view of gross hectarage cultivated and pod outturn. The groundnut was cultivated in 5.53 mha area with 9.67 m.t. production having 1750 kg/ha productivity. Similarly in the state of Rajasthan the area, production and productivity of groundnut was 0.47 mha, 0.91 m.t. and 1943 kg/ha, respectively (Anon, 2014). The triennial average data (2011-13) of area, production and productivity indicate that annually 42.1 m.t. of groundnut are produced in the world from a cropped area of 24.9 m ha with an average productivity of 16.88 q/ha. Though, considering the cultivated area (5.11 m ha) India ranks first, followed by China and Nigeria, the production and productivity are comperatively less. In comparison, China helds the most promising in

production (16.63 m.t.) and USA in 43 q/ha of groundnut. Consequently, China had maximum share (Aproximate 40%) followed by India(Approximate 17%) in global groundnut production. (Anon, 2015). After successful story of green revolution the country has made an impressive progress in enhancing productivity of wheat. However, today itself a major poetion of foreign money has to invest to import of edible oil by India government. This calls for renewed efforts for analyzing the production constraints and evaluating location specific monetary and non monetary technology for improving the existing productivity level. The mineral fertilizer application went so high that it has shown its ill effect like soil fertility degradation adverse effects on soil physical properties over exploitation of natural resources ground water pollution and eutrophication. Soils have not only become hungry for major plant nutrients (NPK&S) but are also showing deficiency symptoms of base elements like zinc manganese and ferrous. The concentration of the ferrous in the soil is lower than that present in the material from which they are derived which resulted in yield stagnation and/or depletion. The foliar application of the micro nutrients is more effective than soil application (Sahu and Singh, 1995 & Narang *et al* 1977). Thiourea is one of the options to combat the adverse climatic conditions such as drought stress, and maintain or increase the productivity of wheat Abdelkader et al 2012 and Anjum et al 2008 find that field use of thiourea is feasible for enhancing crop yield under stress full condition To overcome this problem a study has been conducted by Krishi Vigyan Kendra, Dausa (Rajasthan) by framing a on farm testing at farmers fields at different locations in Dausa district of Rajasthan during Kharif 2011.

MATERIALS AND METHODS

The field experiment was conducted during kharif 2011 at farmers' fields in Khatwa village of Lalsot block of Dausa district of Rajasthan, which falls in agroclimatic zone IIIa (Transitional plain zone of inland drainase). Soils of the experimental sites were sandy to sandy loam in texture, slight alkaline (pH 7.6) in reaction, low in nitrogen and phosphorus and medium in potassium status. The study consists four treatments namely T_1- Control (No spray), T_2- 0.5% ferrous sulfate spray at vegetative, T_3- 500 ppm thiourea spray at vegetative and reproductive stage, T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray vegetative and reproductive stage. The above four treatments were replicated 20 times in the year 2011 at farmers fields of Khatwa village in Lalsot block of Dausa. The groundnut variety GG-20 was grown in the first to second week of June. The crop was irrigated at critical growth stages and as and when needed. The crop was raised with the recommended dose of major nutrients in the zone IIIa i.e. 15 kg N and 60 kg P_2O_5 per hectare. The crop was harvested in the third week of September. The harvesting and threshing was done in separate strips of treatments. The observations of yield attributes and yield like number of pods per plant were recorded treatment and replication wise at every location and then statistical analysis for the test of significance were done. Observations of ten competitive plants at maturity stage from each treatment and replication were randomly selected; average of these plants in respect of different plant characters like number of pods per plant was taken. After separate threshing of different treatments the pod, haulm and biological yield was recorded and then converted in to q/ha for further statistical analysis. For the calculation of economics the cost of inputs like ferrous sulphate and thiourea only was included because the spray was done by farmers themselves so the cost of spray was not included in all the treatments under study and pods were sold @ Rs 34/kg and the haulm was sold by the respective farmers @ Rs 2000/ha.

RESULTS AND DISCUSSION

Data in Table 1 revealed that the number of pods per plant was increased by all the three treatments as compared to control or no spray. Significantly the highest number of pods per plant (54) was recorded in treatment T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray at vegetative and reproductive

stage followed by T_2- 0.5% ferrous sulfate spray at vegetative and T_3- 500 ppm thiourea spray at vegetative and reproductive stage which is 14.89, 8.51 and 4.26 per cent higher over control, respectively. However, treatment T_2 and treatment T_3 were found statically at par. The pod yield (q/ha) was found significantly superior of all the treatments over control. The highest yield (18.53 q/ha) was found in the treatment T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray at vegetative and reproductive stage followed by treatment T_2- 0.5% ferrous sulfate spray at vegetative and treatment T_3- 500 ppm thiourea spray at vegetative and reproductive stage 16.54, 11.82 and 4.72 per cent higher over control, respectively. All the treatments were found comparable to each other in respect of pod yield of groundnut. Lokanath and Parameshwarappa, 2006 also reported similar results by organics in spanish bunch groundnut. In respect of haulm yield (q/ha) of groundnut was found significantly superior of all the treatments over control. The highest yield (21.50 q/ha) was found in the treatment T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray at vegetative and reproductive stage followed by treatment T_2- 0.5% ferrous sulfate spray at vegetative and treatment T_3- 500 ppm thiourea spray at vegetative and reproductive stage 20.11, 13.97 and 8.94 per cent higher over control, respectively. Similarly, biological yield (q/ha) of groundnut was found significantly superior of all the treatments over control. The highest biological yield (40.03 q/ha) was found in the treatment T_4- 500 ppm thiourea+ 0.2 % ferrus sulfate (mixed solution) spray at vegetative and reproductive stage followed by treatment T_2- 0.5% ferrous sulfate spray at vegetative and treatment T_3- 500 ppm thiourea spray at vegetative and reproductive stage 18.43, 12.96 and 6.95 per cent higher over control, respectively. All the treatments were found comparable to each other in respect of pod yield of groundnut. Dayanand *et al*. 2013 also recorded 5.7,10.4 and12.7% higher grain yield over control with two foliar spray of,500 ppm thiourea, 0.5% Zinc sulphate and + 500 ppm thiourea+ 0.2 % Zinc sulphate (mixed solution) spray at tillering and grain initiation stage . Sahu and Singh, 1995 also found similar results that thiourea spray at both tillering and flowering increased the grain yield, biological yield and harvest index. Grain yield increased by 23.9% over control.

Data in Table 2 revealed that the maximum cost of cultivation (Rs. 27840) of groundnut was recorded in treatment T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray at vegetative and reproductive stage followed by treatment T_2- 0.5% ferrous sulfate spray at vegetative and treatment T_3- 500 ppm thiourea spray at vegetative and reproductive stage that was 9.18, 8.24 and 2.81 per cent higher over control or no spray (Rs 25500). Similarly, gross returns were also the maximum (Rs. 65002) with treatment T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray at vegetative and reproductive stage followed by treatment T_2- 0.5% ferrous sulfate spray at vegetative and treatment T_3- 500 ppm thiourea spray at vegetative and reproductive stage that was 15.95, 11.40 and 4.55 per cent higher over control (Rs. 56060). Net returns were maximum (Rs. 37162) in treatment T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray at vegetative and reproductive stage followed by treatment T_2- 0.5% ferrous sulfate spray at vegetative and treatment T_3- 500 ppm thiourea spray at vegetative and reproductive stage and recorded 21.60, 14.04 and 6.18 per cent higher over control (Rs. 30560). The highest B:C ratio was recorded with treatment T_4- 500 ppm thiourea+ 0.2 % ferrus sulfate (mixed solution) spray at vegetative and reproductive stage (2.33) followed by treatment T_2- 0.5% ferrous sulfate spray at vegetative (2.26) and treatment T_3- 500 ppm thiourea spray at vegetative and reproductive stage (2.24). The lowest B:C ratio was recorded with control or no spray (2.20). Overall study revealed that the treatment T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray vegetative and reproductive stage found significantly superior and farmer can increased their yield of groundnut by adopting this technology and gave their input in changing the scenario of green revolution to evergreen revolution.

Table-1 Effect of ferrous sulfate and thiourea spray on yield attributes and yield of groundnut

Treatments	Number of pods/plant	Haulm yield (q/ha)	Pod yield (q/ha)	Biological yield (q/ha)
T_1- Control (No spray)	47	17.9	15.90	33.8
T_2- 0.5% ferrous sulfate spray at vegetative stage	51	20.4	17.78	38.18
T_3- 500 ppm thiourea spray at vegetative and reproductive stage	49	19.5	16.65	36.15
T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray vegetative and reproductive stage	54	21.5	18.53	40.03
SEm +_	0.73	0.25	0.23	0.34
CD (P=0.05)	2.08	0.72	0.66	0.97

Table-2 Effect of ferrous sulfate and thiourea spray on economics of groundnut

Treatments	Cost of cultivation (Rs/ha)	Gross returns(Rs/ha)	Net returns (Rs/ha)	B:C ratio
T_1- Control (No spray)	25500	56060	30560	2.20
T_2- 0.5% ferrous sulfate spray at vegetative stage	27600	62452	34852	2.26
T_3- 500 ppm thiourea spray at vegetative and reproductive stage	26160	58610	32450	2.24
T_4- 500 ppm thiourea+ 0.2 % ferrous sulfate (mixed solution) spray vegetative and reproductive stage	27840	65002	37162	2.33

REFERENCES

Abdelkader, A.F. Hassanein, R.A. and Ali, H. 2012. Studies on effects of salicylic acid and Thiourea on biochemical activities and yield production in wheat (*Triticum aestivum* var. Gimaza 9) plants grown under drought stress. African J. Biotech. 11 (54): 12726-12739.

Anjum,F., Wahid A., Javed F. and Arshad M. 2008. Influence of foliar applied thiourea on flag Leaf gas exchange and yield parameters of bread wheat (*Triticum aestivum)* Cultivars under salinity and heat stresses. Int. J. Agri. Biol. 10: 619-626

Anonymous 2014. Agricultural Statistics at a glance, 2014-15)

Anonymous 2015. ICAR-DGR News Letter, Vol 14 No. 1-2 January-June2015

Dayanand.,Mehta S.M,; Verma R.K,.and Rathore V.S.:2013. .Effect of foliar applied thiourea and zinc on the productivity and economics of wheat *(TRITICUM AESTIVUM* L) *Int.j.agricult.stat.sci*., 9 (1):339-344,

Loknath, H. M. and Parameshwarappa, K.G. 2006. Effect of organics on the productivity of Spanish bunch groundnut under rainfed farming situations. In. Proceedings of 18th World Congress of Soil Science pp: 62-63, Pennsylvania, USA.

Narang, R.S.,Mahal,S.S., Bedi Seema,Gosal K.S and Bedi S.1997. Response of wheat to potassium fertilization under maximum yield research strategies. Env. Eco. 15(2): 474-477.

Sahu, M.P. and Singh, D. 1995. Role of thiourea in improving productivity of wheat (*Triticum aestivum* L.). J. Plant Growth Regul. 14: 169-173.

EFFECT OF FERTILITY LEVELS AND BIOFERTILIZERS ON YIELD OF SPROUTING BROCCOLI (*Brassica oleracea* L. var. italica)

D.K. Kumawat, A.K. Soni and S.P. Singh
Department of Horticulture, S.K.N. College of Agriculture, Jobner, S.K.R.A.U., Bikaner, Rajasthan- 303328, India
Email: singhsp072 @gmail.com

Received: 14.06.16
Accepted: 03.08.16

ABSTRACT

A field experiment to study of fertility levels and biofertilizers on the growth and yield of sprouting broccoli (Brass/ca oleracea L. var. italica) was conducted at S.K.N. College of Agriculture, Jobner (Rajasthan) during kharif-season-2008-09. The application of different fertility levels and biofertilizers under the treatment combination 75 per cent recommended dose of NPK along with PSB resulting in biological yield, average weight of .central, secondary and total head per plant, yield of total head per plot, per hectare significantly higher over control and application of fertilizers and biofertilizers alone. However, it was statistically at par with 100 per cent RD of NPK in combination with other biofertilizers inoculation which indicate saving of 25°A\ RD of NPK due to inoculation of different biofertilizers.

The world "broccoli" is an Italian word taken from the Latin ‘brachcum', meaning an arm or branch. Broccoli is commonly known as *Hari gobhi* in Hindi. Broccoli is a closely resembles with cauliflower. Broccoli has thick clusters of flower buds that form edible "heads". These heads are green, purple and white in colour and are more branched and open than tight and round. It is being cultivated in Italy since ancient roman times and about from the year 1720 in England. In India, broccoli is cultivated on a limited area. However, due to increase in it's popularity, there is an increasing trend of its cultivation by farmers as well as consumption by the consumers in metropolitan cities.

MATERIALS AND METHODS

The filed experiment was conducted at Experimental Farm, Department of Horticulture, S.K.N College of Agriculture, Jobner during rabi season of 2008-09. The experiment consisted of 16 treatment viz., four levels of fertility [control (Fo), 50% (F1), 75% (F2) and 100% recommended dose of NPK (F3)] and four different biofertilizers inoculations [control (Bo), Azotobacter (B1), PSB (B2) and VAM (B3)] alone and incornbination with different fertility levels and was laid out in RBD with three replications. iv) .-71)ˇ14

RESULTS AND DISCUSSION

The data reported in Table 1 revealed that different fertility levels significantly influenced the average weight of central, secondary and total head. The maximum weight of central head (0.294 kg), secondary head (0.165 kg) and total (0.456 kg) per plant was recorded with 100% RDF (F_3) which was found to be significantly higher over control (F_0) and 50% RDF (F_1) but statistically at par with 75% RDF (F_2). The inoculation of seedlings with various bio-fertilizers also affected significantly the weight of central, secondary and total head per plant significantly. The maximum weight of central head (0.286 kg), secondary head (0.163 kg) and total head (0.449 kg) were recorded with B_2 i.e. PSB inoculation which was found to be higher over Bo and B1 but statistically at par with B_3. However, the interaction of fertility levels and biofertilizers found to be non-significant.

The perusal of data in Table 1 revealed that the biological yield was significantly increased with the application of different fertility levels over control. The maximum biological yield (1.58 kg) was recorded with 100% RDF (F_3) which was found to be significantly higher over F_0 and F_1 but statistically at par with F_2. The inoculation of broccoli seedling with different bio-fertilizers also significantly affected the biological yield per plant. The maximum biological yield (1.57 kg) per plant was recorded with PSB application (B_2) but was statistically at par with B_3.

The perusal of data in Table 1 revealed that yield per plot was significantly influenced by different fertility levels. The mean maximum

yield per plot (7.29 kg) was recorded with F_3 treatment while minimum (5.90 kg) under control. The yield per plot under the treatment F_3 was found significantly more over F_0 and F_1 but it was statistically at par with F2 treatment. Data further showed that effect of the inoculation with different biofertilizers on yield per plot was found significant. The maximum yield per plot (7.18 kg) obtained with PSB treatment (B_2) while minimum (6.16 kg)was observed in control. However, the treatment B2 found to be superior than Bo and B1 but statistically at par with B_3.

Data pertaining to total yield per hectare presented in Table 1 revealed that different fertility levels significantly influenced the total yield per hectare. The mean maximum total yield per hectare (225.06 q) was recorded with the treatment F_3 (100% RDF), which was found to be significantly more over F_0 and F_1 but it was statistically at par with F2. Inoculation of seedling with of various biofertilizers also significantly affected the total yield per hectare over control. Maximum total yield (221.48 q) was recorded with the treatment B2 while minimum was in B_0 (190.12 q). The treatment B2 was found significantly superior than control and B_1 but statistically at par with B_3.

Application of 75% RD of NPK significantly increased the weight of central, secondary and total head per plant, per plot and per hectare, biological yield per plant over control and low levels of fertility (Table 1). The significantly higher values for all these yield attributing characters and yield were recorded with the application of F_2 (75% RDF). However, it was statistically at par with 100% RD of NPK (F_3). The increase in yield with the availability of sufficient amount of nutrients through direct addition in soil which might have in turned into better yield attributing traits and finally higher yield of broccoli. As stated earlier, the adequate supply of phosphorus along with starter dose of nitrogen play a vital role in metabolic process of photosynthesis and carbohydrate metabolism that results in increased flowering and average weight of central, secondary and total head per plant and finally total yield per hectare. The adequate availability of nutrients regulates the starch / sucrose ratio in the reproductive organs and also influenced the stomata] resistance and activity of ribulaze bi-phosphate carboxylase. Choudhary (2006) reported that maximum weight of central, secondary and total head per plant (0.311 kg, 0.160 kg, 0.472 kg), per plot (4.98 kg, 2.57 kg, 7.75 kg), per hectare (153.80 q, 79.12 q, 232.89 q), respectively and biological yield (1.55 kg / per plant), per plant with the application of 125% RD of NPK per hectare in broccoli. The application of increasing fertility levels favoured the metabolic as well as hormonal activities in plants, which ultimately resulted into increased central head, secondary head, biological yield and finally the yield. Thus, the present findings also corroborate the results of Choudhary (2006).

Data on various yield attributes and yields revealed that inoculation with PSB and VAM significantly increased central, secondary, total head, biological yield per plant, yield per plot and total yield per hectare over control, Azotobactor. Phosphorus solubilizing bacteria (PSB) nourishes the crops and soil by liberating the growth promoting substances and vitamins whereas Vasicular Arbuscular Mycorrhizae (VAM) improves the uptake of N, P, K and Zn to plants. It also helps in stabilization of soil aggregates through binding the sand particles by VAM mycelium (Khalil *et al.*, 1992). The improvement in yield characters in cabbage with inoculation of PSB is due to solubilization and increased availability of phosphorus from insoluble or otherwise fixed phosphorus for its plant availability (Hedgi *et al.*, 1999). The beneficial effects of PSB along with other nutrients increased yield of crop might have resulted due to higher rate in partitioning of different reproductive structure and yield attributes which might have ultimately inturned to higher yield of the crop. These findings corroborate the results of Vimala and Natrajan (2000), Kadlag et al. (2007), Singh (2008), Kumawat (2008) and Kumawat (2009).

Table 1. Effect of different fertility levels and bio-fertilizers on average weight of central head (kg), secondary head (kg), total head (kg) per plant and yields

Treatments	Central head	Secondary head	Total head	Biological yield per plant	Yield per plot	Total yield per Ha.
Fertility levels						
Control (Fo)	0.228	0.141	0.369	1.33	5.90	188.22
50% RDF (F1)	0.266	0.151	0.416	1.46	6.66	205.55
75 % RDF (F2)	0.285	0.161	0.446	1.55	7.13	220.00
100% RDF (F3)	0.294	0.165	0.456	1.58	7.29	225.06
S.Em+	0.006	0.004	0.010	0.03	0.16	4.86
CD (P = 0.05)	0.018	0.010	0.028	0.09	0.45	14.04
Bio-fertilizers						
Control (Bo)	0.242	0.143	0.385	1.37	6.16	190.12
Azotobacter (B1)	0.268	0.153	0.420	1.48	6.71	207.16
PSB (B2)	0.286	0.163	0.449	1.57	7.18	221.48
VAM (B3)	0.276	0.158	0.434	1.50	6.94	214.02
S.Em+	0.006	0.004	0.010	0.03	0.16	4.86
CD (P = 0.05)	0.018	0.010	0.028	0.09	0.45	14.04

REFERENCES

Choudhary, S. 2006. Effect of organic and inorganic sources of nutrients of growth, yield and quality of sprouting broccoli (Brass/ca oleracea L. var. italica Plenck) cv.. C.B.H. M.Sc. Thesis, submitted to Rajasthan Agricultural University, Bikaner, Campus-Jobner.

Hedgi, D.M., Dwivedi, B.S. and Sudhakarbabu, S.S. 1999. Biofertilizers for cereals production in India : A review. Indian Journal of Agriculture Science, 69 73-83.

Kadlag, A.D., Jadhav, A.B. and Raina Bharti 2007. Yield and quality of tomato fruit as influenced by biofertilizers. *Asian Journal of soil Science*, 2 (2) : 95-99.

Khalil, S., Loynachann, T.E. and McNabb, Jn. H.S. 1992. Colonization of soybean by mycorrhizal fungi and spore population in soils. *Agronomy Journal*, 84 : 832-836.

Kumawat, A. 2008. Response of mungbean to biofertilizers under different fertility levels. M.Sc. (Ag.) Thesis, Submitted to Rajasthan Agricultural University, Bikaner.

Kumawat, G. 2009. Effect of Different Fertility Levels and Biofertilizers on Growth and Yield of Cabbage (Brassica oleracea var. capitata L.). M.Sc. (Ag.) Thesis, Submitted to Rajasthan Agricultural University Bikaner, Campus Jobner.

Singh, J.P. 2008. Effect of NPK and biofertilizer on growth and yield of cauliflower (Brass/ca oleracea var. botrytis L.) cv. Snowball-16. M.Sc. (Ag.) Thesis, submitted to Rajasthan Agricultural University, Bikaner, Campus-Jobner.

Vimala, B. and Natarajan, S. 2000. Effect of nitrogen, phosphorus and biofertilizers on pod characters, yield and quality in pea (*Pisum sativum* L. spp. hortense). South Indian Horticulture, 48 : 60-63.

PROBLEM PERCEIVED BY THE RURAL ENTREPRENEURS OF VIDISHA BLOCK OF VIDISHA DISTRICT (M.P)

Aparna Jaiswal
Assistant Professor
College of Agriculture,Ganjbasoda,JNKVV,Jabalpur
Email: rituparnika@gmail.com

Received: 18.09.16
Accepted: 03.10.16

ABSTRACT

India is the country of villages. Around three fourth of its population lives in rural areas where agriculture and allied activities are the main source of their income.As majority of population resided in rural areas so rural entrepreneurship is the best alternative for employment. Rural entrepreneurship through the development of rural entrepreneur seems to be the answer of poverty and unemployment. It will not only harness the women and youth vigour but also increase the national production. The study was conducted to know the major problem faced by the rural entrepreneur of Vidisha block of Vidisha district in 2015.Complex legal formalities, scarcity of funds, competition were the major problem faced by them. The respondents suggested skill based training programmes are essential for the improvement of their entrepreneurial abilities.

In 2015-16, agriculture contributed 17.4% to India's GDP, as compare to 18.3% in 2013-14. As against the twelfth five year plan (2012-17) target of 4 percent growth for the agriculture and allied sectors, the growth registered was 4.2 per cent in 2013-14,-0.2 in 2014-15, and an estimated 1.1 in 2015-16. (India Economic Survey 2015-16)

Now the question arises why the contribution of agriculture to India's GDP is declining year by year?

The answer is very simple. We failed in providing work to mass population. As we know 65 to 70% of our population resides in rural areas. Agriculture is playing vital role in employment generation in Indian economy, with nearly half of the Indian population dependent on the agriculture and allied activities for livelihood. As per the National Sample Survey Office(NSSO), in 2011-12 the share of agriculture in employment was 48.9 per cent. So, this problem can be solved by encouraging the concept of rural entrepreneurship. It will play a significant role in socio-economic fabric of India.

Entrepreneurship requires comprehensive understanding. It is a wide concept. The entrepreneurship process starts when an individual recognizes an opportunity in the environment. From the point of view of economist it is the fourth factor of production along with land, labour and capital, whereas sociologists feel that it is cultured by certain communities because they are innovative and have risk bearing capacity. On the one extreme, an entrepreneur is a person of very high attitude who pioneers change. On the other extreme anyone who wants to work for himself/herself. It is the need of time to correct the sorry picture of unemployment at least to work for himself/herself.

As majority of population resided in rural areas so rural entrepreneurship is the best alternative for employment. It will not only harness the women and youth vigour but also increase the national production. Rural entrepreneurship primarily deals with industries of micro and tiny structures. As the gestation period of these industries is less than the large industries, we find them quick yielding. At the same time, most of them are labour intensive industries so a large number of local unemployed labours may be benefitted.

Rural entrepreneurship may be in the form of individual entrepreneurship, group entrepreneurship, cluster entrepreneurship and co-operatives. Cluster and co-operatives may be suitable forms of rural entrepreneurship. Cluster is a formal or non-formal group of people formed with a common objective or goal. Non-governmental organizations, voluntary organizations and self-help groups are generally form the cluster.

Agriculture is the biggest occupation undertaken by majority of people in India. However, entrepreneurship has not been adequately developed in agricultural sector. Now a days farming is done in traditional

manner in rural areas as way of life rather than an enterprise. Therefore efforts are being made to develop farmers into agripreneurs by inculcating the qualities of an entrepreneur in them. Agri-horti entrepreneurship, food processing, dairy, bee keeping, poultry etc. have immense potential for rural entrepreneurship development.

Keeping above things in mind, the present study was conducted in Vidisha block of Vidisha district of M.P to know the major problems perceived by the rural entrepreneurs.

Objective

1. To analyze the problems perceived by the rural entrepreneurs.
2. To find out the remedies to solve the problems of rural entrepreneurs

METERIAL AND METHODS

The study was conducted in Vidisha block of Vidisha district of M.P in 2015.Ten villages were purposively selected from the block which were well connected by the road. Eight respondents from each villages were selected randomly. Total 80 rural entrepreneurs were personally interviewed with the help of pre tested interview schedule.

RESULTS AND DISCUSSION

Table 1: Management Problems Perceived by the Rural Entrepreneurs

N=80

Problems	Rank	Percentage
Legal Formalities	I	88.75
Lack of knowledge (IT ,Marketing)	III	50
Lack of technical knowledge	II	75
Purchasing of raw material	V	22.5
Poor quality of products	IV	35

The table 1 shows that majority (88.75%) of the respondents perceived that legal formalities are the most challenging problem for them. Task like obtaining Licenses, providing guarantor etc is very difficult for them due to illiteracy and ignorance. Lack of technical knowledge is the next major problem perceived (75%) by the rural entrepreneurs. It mainly occurs due to lack of training facilities and extension services. The result further revealed that half of the respondents perceived that lack of knowledge specially in information technology and marketing is another big issue for them. Entrepreneurs have to rely on internal linkages for the flow of goods, services, information and ideas which is not successful everytime. Around 35% of respondents perceived that poor quality of products is also responsible to hinder their growth. Inferior quality of products produced due to lack of availability of standard tools and equipment and poor quality of raw materials. It was reported that 22.5 percent of respondents perceived that purchase of raw materials is the next major problem. Poor quality of raw material, unavailaibility of storage, warehouse and transportation facilities are associated with it.

Table 2: Financial Problems Perceived by the Rural Entrepreneurs

N= 80

Problems	Rank	Percentage
Low Risk bearing capacity	III	56.25
Scarcity of fund	I	81.25
Difficulty in understanding financial statements	V	12.5
Complex procedure for loan	II	68.75
Dependency on money lenders	IV	27.5

Table 2 indicates that majority of respondents (81.25%) found that scarcity of fund is the major financial problem for them. Rural entrepreneurs fail to get external funds due to absence of tangible security and credit in the market. Complex procedure for loan is the next financial problem perceived by the (68.75%) of the rural entrepreneurs. The procedure to avail the loan facility is too time-consuming that its delay may cause disappoints the rural entrepreneurs. Around 56.25% of respondents felt that low risk bearing capacity is another big problem. It is due to lack of external support and poor background. The table further revealed that 27.5% of respondents perceived dependency on money lenders as the major difficulty. As these lenders charge high interest rate. It was reported that 12.5% respondents found difficulty in understanding financial statements. Financial statements are difficult to

be maintained and understood by rural entrepreneur, stringent tax laws, lack of guarantees for raising up of loans.

Table 3: Marketing Problems Perceived by the Rural Entrepreneurs

N=80

Problems	Rank	Percentage
Middleman	III	17.5
Absence of marketing survey	II	68.75
Competition	I	75

Table 3 revealed that 75% of respondents faced competition as the most challenging financial problem. They face the problem in fixing the standards and sticking to them. Competition from large scale units creates difficulty for the survival of new ventures. Absence of marketing survey is perceived as the next major problem by the (68.75%) rural entrepreneurs who cause many blunders. Rural entrepreneurs are not so aware to know the importance of marketing survey in order to find out the customer preferences, priorities, taste and culture. Middleman was the next financial problem perceived by the (17.5%) rural entrepreneurs. The rural entrepreneurs are heavily dependent on middlemen for marketing of their products who pocket large amount of profit.

Table 4: Remedies suggested to overcome the problems by the Rural Entrepreneurs

N=80

Problems	Rank	Percentage
Separate financial funds	II	62.5
Skill based training	I	73.75
Modern infrastructural facilities	III	50
Motivation	IV	27.5

Table 4 shows that 73.75% of respondents suggested that skill based training programmes are essential for the improvement of their entrepreneurial abilities. The next suggestion was there should be separated financial funds for rural entrepreneurs suggested by 62.5 % of the respondents. Further modern infrastructural facilities is also considered as important suggestion given by half of the respondents.27.5 % of respondents suggested that time to time motivational sessions should be conducted for emerging entrepreneurs.

CONCLUSION

Rural entrepreneurship is milestone in economic progress of India. It was clearly concluded from the study to reduce the unemployment the rural youth need to be motivated to take up entrepreneurship as a career, with skill based training and sustaining support systems providing all necessary assistance. There is a need to aware them and educate them so that they can able to understand the timely updates going on market. There should be efficient regulated market. Grading and standardization should be promoted so that the product of rural market can stand equally with urban market. Common production-cum-marketing centers should be set up with modern infrastructural facilities. Government should make simple process for loan to attract the rural entrepreneur. If once all these happen, no one can stop converting India from developing country to developed country.

REFERENCES

Kumar Ashish, 2015. Entrepreneurship in Agriculture Development with Special Reference to Indian Agricultural Sector.*Research Front3(1):85-94*

Aparna Jaiswal and M.M.Patel, 2012. Entrepreneurial behavior of rural women entrepreneur. *Indian Research Journal of Extension Education.* 12(1): 55-59

Saxena Sandeep, 2012) .Problems Faced By Rural Entrepreneurs and Remedies to Solve It, *Journal of Business and Management (IOSRJBM) 3(1): 23-29* www.iosrjournals.org

Reddy P.V.R.N.,P.R.S.Moorthy and K,Sarjan, 2003.Constraints in dairy farming in Prakashan district of A.P. *Indian J. Ext. Edun*39 (1- 2):25 – 28

INTEGRATION OF CHEMICAL AND MECHANICAL WEED MANAGEMENT TO ENHANCE THE PRODUCTIVITY OF SOYBEAN (Glycine Max)

Mahender Singh[1*], T.S.Dudwe[2] and A.K.Verma[3]
[1]Scientist (Agronomy), KVK Jhabua, RVSKVV, Gwalior (M.P.)
[2]Field Extension Officer, ZARS Jhabua , RVSKVV, Gwalior (M.P.)
[3]Scientist (Agronomy), KVK, Jhalawar, Agriculture University, Kota (Raj.)
Email: msjadon2000@rediffmail.com

Received: 17.08.16
Accepted: 18.09.16

ABSTRACT

Soybean (Glycine max) is one of the most important crops of India but the productivity of the soybean is poor due to heavy weed infestation in rainy season. Therefore field studies were conducted during Kharif 2014 to evaluate the losses caused by weeds and their control measure to enhance the productivity of soybean. Lowest weed density and dry matter were observed in twice hand weeding (20 & 40 DAS) however it was found at par with tank mix herbicides i.e., Chlorimuron Ethyl @ 09gm /ha + Quizalofop-p-ethyl @ 50 g /ha and Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha . As per economics, combined application of Chlorimuron Ethyl (POE) @ 09gm /ha + Quizalofop-p-ethyl @ 50 g /ha was found more remunerative, as they fetched higher net monetary returns (Rs 42978)and benefit cost ratio (3.26:1) followed by Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha .

Key words: Soybean, Imazethapry, Quizalofop-p-ethyl, Weed density, Weed control efficiency

Losses due to weeds have been one of the major limiting factors in soybean production. Weeds impact soybean yields by competing primarily for light, water and nutrients especially during the first 40 days after sowing and causes substantial losses in the yield to the range of 25 to 70% depending upon the weed flora and intensity (Chandel and Saxena 1998, Kewat et at., 2000, Singh 2007). Now a days pre-emergence herbicides are not very popular among the farmers due to short time span for sowing during kharif season. Therefore, farmers are using post emergence herbicides for weed control in soybean. Hand weeding is the efficient mean to control weeds but due to intermittent rainfall during rainy season and scanty labour, manual weeding at right stage is difficult and time consuming and expensive. Hence, the use of suitable herbicides appears to be an alternative option to minimize the weed problem. Therefore, in this study possibility of pre-emergent or post-emergent herbicides for effective weed control in soybean was exploded.

MATERIAL AND METHODS

A field experiment was conducted at Zonal Agricultural Research Station, Jhabua (M.P.) during kharif 2014. The soil of the experimental field was loamy sand in texture, normal in soil reaction (pH 7.6), low in organic carbon (0.47%) and available nitrogen (229 kg/ha), medium in available phosphorus(13.2 kg/ha) and potassium (294 kg/ha). The field experiment was laid out in Randomized Block Design (RBD) with three replications. The experiment consisted of nine treatments viz., Weed free (Twice weeding at 20 & 40 DAS), Weedy check, Pendimethilene PE, Chlorimuron Ethyl as post emergence (POE) @ 09gm /ha, Imazethapyr as post emergence (POE) @ 100 g /ha, Quizalofop-p-ethyl as post emergence @ 50 g /ha, Interculture after 20 days sowing + Pendimethilene PE @ 1.0 kg/ha, Chlorimuron Ethyl (POE) @ 09gm /ha + Quizalofop-p-ethyl @ 50 g /ha., Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha. All the herbicides were applied by manually operated knapsack sprayer fitted with the flat fan nozzle using spray volume of 500 L/ha. Soybean variety JS 335 was sown in first week of July and harvested in second week of October with recommended packages of practices. Fertilizers were applied uniformly at 20, 60 and 20 kg N, P and K/ha. The observation on weed density and dry weight were recorded at 50 DAS and using quadrate of 0.25 square meter (0.5 m X 0.5 m) was randomly placed at two places in each plot. The data on weed count and weed biomass were subjected to square root transformation i.e (X +0.5), before carrying out analysis of variance and comparisons were made on transformed value.

RESULTS AND DISCUSSION

Effect on weed parameters

Dicot weeds were dominated in the experimental field. Major dicot weed species observed in the experimental field were Digera arvensis, Euphorbia hirta, Portulaca oleracea, Tridex procumbans, Ageratum conyzoides, Amaranthus viridis, Celosia argentia and Xanthomonas strumarium while monocot weed species observed were Commelina benghalensis, Echinochloa colonum, E. crusgalli, Dinebra spp. Cyperus rotundus, C. irria, Cynodon dactylon and Dactyloctenium aegyptium

All the weed management practices caused the significant reduction in density and dry matter of weeds at 50 DAS. Significantly lower density of weeds were recorded in twice hand weeding done at 20 and 40 DAS, however it was statistically at par with Chlorimuron Ethyl (POE) @ 09 gm /ha + Quizalofop-p-ethyl @ 50 g /ha (Table:1)

Among herbicidal treatments, tank mix herbicides i.e., Chlorimuron Ethyl @ 09gm /ha + Quizalofop-p-ethyl @ 50 g /ha (weed density 5.48/m^2) and Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha (weed density 6.13/m^2) are more effecting in reducing the weed population as compared to alone application of Pendimethilene PE, Chlorimuron Ethyl as PoE, Imazethapyr as PoE and Interculture after 20 days sowing + Pendimethilene PE and found at par with each other, whereas all the weed control treatments were significantly superior to weedy check in respect to reduce the weed population of weeds at 50 DAS stage of crop growth. However among sole herbicides Quizalofop-p-ethyl effectively control monocot weeds while Imazethapyr controls dicots weeds as compared to other sole herbicides.

Weed dry matter were also effectively reduced by tank mix herbicides i.e., Chlorimuron Ethyl @ 09gm /ha + Quizalofop-p-ethyl @ 50 g /ha (26.62 /m^2) and Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha 26.00g/m^2)and found at par with weed free treatment (Table:1). Lowest total weed dry matter (22.35 g/m2) was recorded in weed free (twice hand weeding) treatment and it was closely at par with Chlorimuron Ethyl /ha + Quizalofop-p-ethyl (26.62 g/m2) and Imazethapyr + Imazamox (26.00 g/m2). The maximum weed control efficiency of 59.67 recorded in weed free treatment followed by tan mix herbicides of Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha (53.08%) and Chlorimuron Ethyl @ 09gm /ha + Quizalofop-p-ethyl @ 50 g /ha (51.97%). Post emergence application of imazethapyr is responsible for inhibition of acetolactate synthase (ALS) or acetohydroxyacid synthase (AHAS) in broad leaf weeds which caused destruction of these weeds at 3-4 leaf stage (Chandel and Saxena 2001). Quizalofop-ethyl inhibits the activity of the acetyl CoA carboxylase enzyme, which is necessary for fatty acid synthesis in grassy weeds. These effects of quizalofop for controlling weeds in soybean were in confirmation with the earlier results reported by Pandey et al. (2007).

Table 1. Effect of weed management practices on weed density, dry matter and weed control efficiency at 50 DAS in soybean

Treatments	Weed density (no./m2)	Weed dry weight (g/m2)	Weed control efficiency (%)
Weedy check	10.77 (57.28)*	55.42	0.00
Weed free (2 hand weeding at 20 & 40 DAS)	4.91 (11.36)	22.35	59.67
Pendimethilene PE	8.59 (36.20)	42.08	24.06
Chlorimuron Ethyl as post emergence (POE) @ 09 gm /ha	8.22 (33.00)	36.63	33.89
Imazethapyr as post emergence (POE) @ 100 g /ha	7.54 (27.69)	37.11	33.03
Quizalofop-p-ethyl as post emergence @ 50 g /ha.	7.78 (29.97)	37.30	32.69
Interculture after 20 days sowing + Pendimethilene PE @ 1.0 kg/ha	7.36 (26.38)	32.43	41.47
Chlorimuron Ethyl (POE) @ 09 gm /ha + Quizalofop-p-ethyl @ 50 g /ha.	5.48 (14.19)	26.62	51.97
Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha	6.13 (17.88)	26.00	53.08
LSD (P=0.05)	**0.78**	**5.88**	**-**

*Figures in the parentheses are the original value

Effect on Yield attributes and yield

Taller plants and higher numbers of yield attributes characters *viz*., pods per plant, number of seeds per pod and seed yield (Table 2) were recorded significantly higher under two hand weeding at 20 and 40 DAS and statistically at par with combined application of Chlorimuron Ethyl @ 09gm /ha + Quizalofop-p-ethyl @ 50 g /ha and Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha over rest of the treatments. This might be due to providing favourable environment for crop with controlling weeds, which reduces the competition of crop with weeds for space, air sunlight, moisture and nutrients.

Almost similar results were obtained by Raghuwanshi *et at*. (2005) and Shete *et al*. (2008). Combined application of Chlorimuron Ethyl @ 09gm /ha + Quizalofop-p-ethyl @ 50 g /ha and Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha produced better yield attributing character as compared to sole herbicide applications.

The seed yield was lowest in the plots under weedy check (1091 kg/ha) due to severe competition stress right from crop establishment up to the end of critical period of crop growth, leading to poor growth parameters and yield attributing traits and finally the yield. All the treated plots receiving either manual weeding or herbicidal treatments produced higher yield over weedy check plots. Twice hand weeding treatment produced the maximum seed yield and proved its superiority over all the treatments. Sharma and Shrivastava (2002), Vyas and Jain (2003) and Halvankar et al. (2005) also reported that hand weeding as an effective method of weed control for achieving the maximum yield of soybean.

Among the sole herbicides treatment Imazethapyr as post emergence @ 100 g /ha recorded the highest yield, however in herbicidal treatment combinations, combined application of Chlorimuron Ethyl @ 09 gm /ha + Quizalofop-p-ethyl @ 50 g /ha recorded the highest yield (1723 kg/ha) followed by Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha (1697 kg/ha) and being at par to hand weeding twice (1782 kg/ha). Excellent weed free conditions, provided congenial environment for better growth and development of growth parameters, yield attributes and in turn the seed yield. The improvement in yield and economical parameters which resulted from better weed control with different weed management practices in soybean was also earlier reported by sharma (2000) and Raskar and Bhoi (2002)

Table 2: Effect of weed management practices on plant height, yield attributes , yield and economics of soybean

Treatments	Plant height (cm)	Pods/ plant (No.)	Seeds/ pod (No.)	Seed yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
Weedy check	30.1	18.0	1.33	1091	22176	2.30
Weed free (2 hand weeding at 20 & 40 DAS)	53.8	32.5	2.32	1782	44172	3.21
Pendimethilene PE	41.3	23.9	1.64	1430	33060	2.79
Chlorimuron Ethyl as post emergence (POE) @ 09 gm /ha	45.5	25.3	1.71	1471	35406	3.02
Imazethapyr as post emergence (POE) @ 100 g /ha	47.5	26.8	1.73	1558	37188	2.97
Quizalofop-p-ethyl as post emergence @ 50 g /ha.	43.3	24.5	1.63	1542	36912	2.98
Interculture after 20 days sowing + Pendimethilene PE @ 1.0 kg/ha	52.2	27.8	1.83	1584	37614	2.94
Chlorimuron Ethyl (POE) @ 09 gm /ha + Quizalofop-p-ethyl @ 50 g /ha.	53.1	32.0	2.23	1723	42978	3.26
Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha	51.5	31.5	2.05	1697	42142	3.22
LSD (P=0.05)	**3.49**	**3.03**	**0.28**	**73.96**	**-**	**-**

Economics: Minimum net returns was fetched under weedy check plots as a result of lower seed yield. Among the herbicidal treatments, combined application of Chlorimuron Ethyl (POE) @ 09gm /ha + Quizalofop-p-ethyl @ 50 g /ha was found more remunerative, as they fetched higher net monetary returns (Rs 42978)and benefit cost ratio (3.26:1) followed by Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha . The low investment under combined application of herbicides coupled with good economic yield might be the reason for higher net monetary return and Benefit Cost ratio over alone application of Pendimethilene PE , Chlorimuron Ethyl , Imazethapyr , Interculture + Pendimethilene and even to two hand weeding as advantage of net monetary returns was nullified due to higher cost for control of weeds. Similar findings have also been reported by Kewat *et at*. (2000) and Tiwari *et al*. (2007). It was concluded that Chlorimuron Ethyl (POE) @ 09gm /ha + Quizalofop-p-ethyl @ 50 g /ha was found more remunerative on net return and benefit cost basis followed by Imazethapyr @ 35 g /ha + Imazamox @ 35 g/ha and two hand weeding at 20 & 40 DAS as compared to rest of the treatments.

REFERENCES

Annonymous. 2014. Agricultural Statistical at a Glance, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Government of India, New Delhi.

Chandel A.S. and Saxena, S.C.1998. Technology for raising soybean productivity in Uttar Pradesh. *Indian Farm*. **38**: 10-12.

Chandel A.S. and Saxena, S.C. 2001. Effect of some new post- emergence herbicides on weed parameters and seed yield of soybean. *Indian Jr Agronomy* **46** (2): 332-338

Kewat M.L., Pandey J., Yaduraju N.T. and Kulshreshthra, G. 2000. Economic and eco-friendly weed management in soybean. *Indian J.Weed Sci*. **32** (3&4): 135-139

Pandey A.K., Joshi O. P. and Billore, S. D. 2007. Effect of herbicidal weed control on weed dynamics and yield of soybean (Glycine max (L.) Merrill). *Soybean Research* **5**: 26-32.

Raghuwanshi O.P.S., Deshmukh S.C. and Raghuwanshi, S.R.S. 2005. Effect of some new post-emergence herbicides on weed parameters and seed yield of soybean. *Research on Crops* **6** (3): 448-451

Shete B.T., Patil H.M., and IIhe, S.S. 2008. Effect of cultural practices and post-emergence herbicides against weeds control in soybean. *Journal of Maharashtra Agricultural University* **33** (1): 118-119

Sharma, P.B. 2000. Quizalofop ethyl: An efficient herbicides, against grassy weeds of soybean. *Pestologogy* **24** (4): 60-62

Raskar B.S. and Bhoi P.G. 2002. Bio-efficacy and phytotoxicity of pursuit plus herbicides against weeds in soybean. *Indian Jr Weed Sci.* **34** (1&2): 50-52.

Singh Guriqbal. 2007. Integrated weed management in soybean (Glycine max). *Indian J.Agri. Sci.* **77** (10): 675-676

Tiwari D.K., Kewat M.L., Khan J. A. and Khamparia, N. K. 2007. Evaluation of efficacy of post emergence herbicides in soybean. *Indian Jr Agronomy* **52** (1): 74-76.

SAFETY EVALUATION OF CERTAIN CONVENTIONAL INSECTICIDES AT SUBLETHAL DOSE TO EUROPEAN HONEYBEE, *Apis mellifera* LINNAEUS

Ratnakar.V*, Koteswara Rao.S.R[2] , Sridevi. D and Vidyasagar.B[1]

Department of Entomology, [1]Department of Plant Pathology, College of Agriculture, Prof. Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad- 500 030, India.*
[2]Department of Entomology, S. V. Agricultural College, Acharya N.G. Ranga Agricultural University, Tirupati-517 502, India.
Email: ratnakar.ento@gmail.com

Received: 12.05.16
Accepted: 10.07.16

ABSTRACT

The toxicity of eight conventional insecticides *viz.*, acephate, chlorpyriphos, dichlorvos,dimethoate, profenophos, triazophos, cypermethrin and neem oil at half of the recommended dosewas tested on honeybee *Apis mellifera* L using the dry film method. Foragers were released into treated jars at different intervals *i.e.,* 0, 12 and 24 hours after dry film formation. Acephate, cypermethrin and dimethoate were found to be highly toxic to honeybees, while dichlorvos and neem oil were least toxic.

***Key words*:** Honeybee, *Apis mellifera,* Sublethal, Insecticides, Toxicity

Honeybees *(Apis spp.)* are the most beneficial insectsin agriculture which apart from providing directvaluable products (honey, beeswax, venom etc.) help in pollinationof field crops and other plants. The increasing pest problems in crops have led to an increasein pesticide usage. Unfortunately these two practicesare not always compatible resulting in imbalancebetween insect pollinatorsand flowers, thereby affecting honey production directly and crop production indirectly (Rehman *et al.,* 1993). Exotic honeybee, *Apis mellifera* L. and indigenous *Apis cerana indica* F. are the potential pollinatorsof a wide diversity of agro-horticultura1 crops (Abrol,1997). The use of insecticides for management of insect pests of agro-horticultural crops adversely affects theinsect pollinators Moreover, honey bees together with other pollinators provide the pollination of the spontaneous and wild vegetation, thus playing a major role in landscape and natural resource preservation and domestic honey bees strongly contributed to that (Klein *et al.,* 2007).Use of pesticides for pest management on one hand and the role of honeybees for crop pollination on the other, have become essential components of modern agriculture. Unfortunately, these two practices are not always compatible, as honeybees are susceptible to many of commonly used pesticides (Sundararaju, 2003 and Brittain*et al*., 2010). Conservation of honeybees for crop pollination is vital to agricultural production (Kremen*et al.* 2002). In India, 90% of the pollination of crops grown across 50 million hectares was done by bees. Although poorly studied, a harmonious compromise between pest management and honeybee pollination of crops in India is clearly important.Widespread use of pesticides in modern agriculture throughout the world has become necessary for protection of crops against insect pests and diseases to avoid crop losses and to meet the food requirement of increasing population, but the injudicious use of pesticides has resulted in contamination of not only the agroecosystem and agricultural produce, but also of nectar and pollen causing heavy losses to honeybees and other pollinators.Knowledge of relative safety of insecticides during flowering is essential to obtain maximum benefits from bee pollination. With this prelude,an experiment was conducted to evaluate the safety of certain insecticides to European honeybee, *Apismellifera* L.

MATERIAL AND METHODS

Conventional insecticides *viz.,*acephate, chlorpyriphos, dichlorvos, dimethoate, profenophos, triazophos, cypermethrin and neem oil were evaluated at half of the recommended doses for their toxicity to European honeybee *A.mellifera* in the laboratory of Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad during August 2014 to May 2015 (Table.1). Forager honeybees were collected at the entrance of the hive with the cone type muslin hand net (30 cm diameter), put in plastic

jars and were immobilized by keeping them in deep freezers / refrigerator for about 5 minutes.(Sharma and Abrol, 2005).They were allowed to recover from cold treatment before exposure to insecticides.The test insecticides were evaluated for their toxicity by dry film method. In this method, half of the recommended doses of insecticides formulation were diluted in one litre of distilled water to make the spray solutions. One ml each of the respective test insecticide was transferred to a clean dry rearing jar of size 10 X 7 cm diameter. The jar was gently rotated and left for drying so that a thin dry film of the chemical was formed inside the jar. Tenforage adult bees were released into the each jar at different intervals *i.e.*0, 12and 24 hours of after dry film formation and within each interval, data on mortality of the bees was recorded at 2, 4, 6, 12, 24 and 48 hours.These intervals were considered since bees could be exposed to insecticides in the field any time after their spray and it is necessary to understand the residual toxicity of these insecticides on the bees. A cotton pad soaked in sugar solution (20%) was provided inside the jar and it was covered using muslin cloth. Each treatment was replicated thrice and a jar with a dry film of water served as control. The data obtained was analyzed statistically (Sokal and Rholf, 1981) using WINDOWSTAT package. Abbott's (1925) formula was used to arrive at the corrected natural mortality. Bees were recorded as dead when gentle pressure upon the abdomen did not bring any twitching movement or positive response over a half an hour inspection period.

RESULTS AND DISCUSSION

Effect of certain conventional insecticides at half of the recommended dose on mortality of honeybees exposed 0 hours after dry film formation (Table: 1)

Highest mortality of 79.99 per cent was exhibited in dimethoate which was on par with cypermethrin (76.81%). Acephate and triazophos recorded each 70.33 per cent mortality which was on par with cypermethrin (76.81%). Chlorpyriphos recorded 40 per cent mortality which was significantly different from other treatments. However, lowest mortality was recorded by neem oil (10.02%).

After 4 hours, highest mortality was recorded by dimethoate (90%) which was on par with cypermethrin (86.99%). Profenophos and chlorpyriphos recorded 63.40 and 40 per cent mortality, respectively and were significantly different from each other and from other treatments. Neem oil was found to be least toxic with 10.02 per cent mortality. Cent per cent mortality was recorded by dimethoate after 6 hours. Cypermethrin, acephate and dichlorvos registered 90.00, 80.68 and 80.68 per cent mortality.Evenafter 12 hours, cent per cent mortality was observed in acephate, dichlorvos, and dimethoate treatments. Cypermethrin recorded 98.49 per cent which was on par with above three insecticides. Neem oil found to be with least toxic (11.10%).After 24 hours, cypermethrin joined the list of insecticides which caused cent per cent mortality. Chlorpyriphos recorded 78.47 per cent mortality and was on par with profenophos. No further mortality was observed in neem oil.After 48 hours all treatments reached cent per cent except neem oil which recorded only 14.45 per cent mortality of honeybees, *A. mellifera*.

Dimethoate caused cent per cent mortality after 6 hours while acephate and dichlorvos registered 100 per cent mortality after 12 hours. Cent per cent mortality in cypermethrin was noticed after 24 hours, while triazophos,chlorpyriphos and profenophos caused cent per cent mortality after 48 hours. Neem oil was found to be the safest with only 14.45 per cent mortality after 48 hours.

Effect of certain conventional insecticides at half of the recommended dose on mortality of honeybees exposed after 12 hours of dry film formation(Table: 1)

After 2 hours of treatment, triazophos exhibited 60.00 per cent mortality followed by cypermethrin (56.69%) and was on par with triazophos. However, no mortality was recorded in neem oil after 2 hours. After 4 hours, triazophos recorded highest mortality of 50.77 per cent and the other treatments in descending order of toxicity were profenophos (39.23%), dichlorvos (33.22%), chlorpyriphos (31.00%) and acephate (21.16%). After 6 hours dimethoate and profenophos recorded 66.74 and 63.40 per cent mortality, respectively and they were on par with each other. Chlorpyriphos and dichlorvos recorded each 50.00 per cent

mortality which however,were on par with acephate (43.31%). Neem oil recorded least mortality of 1.41 per cent.

After 24 hours, cent per cent mortality was exhibited by acephate, cypermethrin and dimethoate. Triazophos and profenophos with 85.50 per cent each were on par with chlorpyriphos and dichlorvos which recorded 78.47 and 77.74 per cent mortality, respectively. Neem oil treatment ranked last in terms of per cent mortality.After 48 hours, 100 per cent mortality was recorded by acephate, cypermethrin and dimethoate. Chlorpyriphos recorded 85.49 per cent mortality which was significantly different from above treatments but was on par with profenophos. Neem oil recorded least11.10 per cent mortality of honeybees, *A. mellifera*.

Among all treatments cent per cent mortality was first reached by dimethote after 12 hours. Cypermethrin and acephate recorded cent per cent mortality after 24 hours. Dichlorvos, triazophos, chlorpyriphos and profenophos were close behind in terms of toxicity. Neem oil was found to be least toxic.

Effect of certain conventional insecticides at half of the recommended dose on mortality of honeybees exposed after 24 hours of dry film formation(Table: 2)

After 2 hours significantly highest mortality was recorded by triazophos (60%) followed by dimethoate (50%). Cypermethrin recorded 23.19 per cent mortality while acephate, chlorpyriphos, dichlorvos and profenophos recorded each 10.02 per cent mortality. Neem oil did not record any mortality.

After 4 hours, triazophos recorded highest mortality of 63.37 per cent followed by dimethoate (50.00%) and cypermethrin (26.50%) mortality which were significantly different from each other. Triazophos recorded slightly increased mortality of 63.40 per cent followed by dimethoate (60%) which was on par with triazophos after 6 hours.Chlorpyriphos and profenophos recorded lesser mortality of 20.02 and 10.02 per cent, respectively and were significantly different from each other and other treatments. No mortality was recorded in neem oil treatment.After 12 hours, cypermethrin recorded highest mortality (85.50%). Acephate, triazophos anddimethoate recordedeach 66.63 per centmortality. After 24 hours, cent per cent mortality was recorded by acephate, cypermethrin and dimethoate. Profenophos, dichlorvos and neem oil recorded 59.29, 33.31 and 1.55 per cent mortality, respectively which were significantly different from each other.After 48 hours, chlorpyriphos, profenophos, dichlorvos and neem oil recorded 81.78, 66.63, 44.41 and 1.55 per cent mortality, respectively and differed significantly from each other.

Among all treatments, acephate, dimethoate and cypermethrin caused cent per cent after 24 hours, while the rest of the treatments did not cause complete mortality after 48 hours of treatment to honeybees, *A.mellifera.*Neem oil did not record any mortality till 6 hours but after 12, 24 and 48 hours recorded 1.41, 1.55 and 1.55 per cent mortality, respectively.

Cypermethrin recorded cent per cent mortality after 48 hours which is in agreement with the findings of Sharma and Abrol (2005) who reported cent per cent mortality of *A. mellifera* with sublethal dose of cypermethrin.

Profenophos recorded cent per cent mortality after 48 hours which are similar to the findings of Melisia*et al*. (2015) who observed that all the tested insecticides including profenophosare toxic to the *A.mellifera*. Similar findings were reported by Pastagia and Patel (2007) reported that profenophos at 0.05 per cent caused cent per cent mortality after 48 hours of treatment.

Neem oil recorded per cent mortality ranging from 10.02 to 14.45 and these findings conform with the results of previous studies by Akca*et al.* (2009).

The present study helped to understand the extent of safety of different insecticides to honey bees. Though insecticides are indispensable for crop protection, timing the sprays especially in the flowering stage of the crop helps avoid intervention with the natural activity of forager bees.

Table 1. Details of insecticides used in the present investigation

Common name	Trade name	Insecticide group	Chemical name	Source of supply
Acephate	Starthene 75 SP	Organo-phosphates	(RS)-(O,S-dimethyl acetylphosphoramidothioate)	Swal Corporation Ltd Hyderabad.
Chlorpyriphos	Dursban 20 EC	Organo-phosphates	O,O-Diethyl O-3,5,6-trichloropyridin-2-yl phosphorothioate	DowAgro Science. Dhamandevi,Maharashtra.
Cypermethrin	Cypermil 10 EC	Synthetic pyrethroids	Cyano (3-phenoxyphenyl) methyl 3(2,2 – dimethyl cyclopropane carboxylate	Insecticides (India) Limited. Delhi.
Dichlorvos	Nuvan 76 EC	Organo-phosphates	2,2-Dichlorovinyl dimethyl phosphate	Insecticides (India) Limited, Delhi.
Dimethoate	Tafgor 30 EC	Organo-phosphates	O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] dithiophosphate	Rallis India Ltd. Mumbai.
Neem oil	Neemban 300 ppm	Botanical	Azadirachtin	Pest Control (India) Ltd Mumbai
Triazophos	Trizo 40 EC	Organo-phosphates	O,O-diethyl O-1-phenyl-1H-1,2,4-triazol-3-yl phosphorothioate	GSP, Crop Science Ltd. Ahmedabad
Profenophos	Curacron 50 EC	Organo-phosphates	(RS)-(O-4-bromo-2-chlorophenyl O-ethyl S-propyl phosphorothioate)	Syngenta Crop Protection Pvt Ltd. Mumbai

Table .2 Effect of certain conventional insecticides at half of the recommended dose on mortality of European honeybee, *Apis mellifera* L

Treatments	Dose (ml or g / l)	Per cent mortality of honey bees exposedimmediately,12 and 24 hours after dry film formation											
		Immediately after dry film formation						12 hours after dry film formation					
		2 hr	4hr	6hr	12hr	24hr	48hr	2hr	4hr	6hr	12hr	24hr	48hr
Acephate	0.75 g	70.33(56.9)	73.47 (59.0)	80.68 (63.93)	100 (90)	100 (90)	100 (90)	10.02 (18.4)	21.16 (13.0)	43.31 (41.1)	70.49 (57.0)	100 (90)	100 (90)
Chlorpyriphos	1.25 ml	40 (39.3)	40 (39.2)	66.74 (54.78)	66.74 (54.7)	78.47 (62.3)	100 (90)	20.02 (26.5)	31 (26.5)	50 (45)	63 (52.5)	78.47 (62.36)	85.49 (67.6)
Dichlorvos	0.5 ml	63.40 (52.7)	76.81 (61.2)	80.68 (63.93)	100 (90)	100 (90)	100 (90)	13.03 (21.1)	33.22 (30.0)	50 (45)	66.63 (54.7)	77.74 (61.85)	98.49 (82.9)
Dimethoate	1 ml	79.99 (63.3)	90 (71.5)	100 (90)	100 (90)	100 (90)	100 (90)	43.31 (41.1)	45 (50)	66.74 (54.7)	100 (90)	100 (90)	100 (90)
Profenophos	2 ml	63.40 (52.7)	63.40 (52.)	66.74 (54.78)	78.47 (62.3)	85.50 (67.6)	100 (90)	40.00 (39.2)	39.23 (40)	63.40 (52.7)	63.40 (52.7)	85.50 (67.62)	88.86 (70.5)
Triazophos	1.25 ml	70.33 (56.9)	70.33 (56.9)	70.33 (56.99)	81.78 (64.7)	92.25 (73.8)	100 (90)	60.00 (50.7)	50.77 (60)	76.81 (61.2)	77.74 (61.85	85.50 (67.62)	98.49 (82.9)
Cypermethrin	0.75 ml	76.81 (61.2)	86.99 (68.8)	90 (71.57)	98.49 (82.9)	100 (90)	100 (90)	56.69 (48.8)	48.83 (56.6)	79.99 (63.4)	85.50 (67.6)	100 (90)	100 (90)
Neem Oil	2.5 ml	10.02 (18.6)	10.02 (18.4)	10.02 (18.46)	11.10 (19.4)	11.10 (19.4)	14.45 (19.4)	0 (0)	0 (0)	1.41 (6.81)	1.55 (7.15)	1.55 (7.15)	11.10 (19.4)
S.Em ±		2.23	2.08	2.69	2.91	3.43	1.01	1.36	1.41	2.51	2.77	3.07	3.27
C.D (0.05)		6.74	6.29	8.14	8.80	10.37	3.08	4.10	4.26	7.60	8.38	9.28	9.89

Treatments	Dose (ml or g / l)	Per cent mortality of honey bees exposedimmediately,12 and 24 hours after dry film formation					
		24 hours after dry film formation					
		2hr	4hr	6hr	12hr	24hr	48hr
Acephate	0.75 g	10.02 (18.4)	10.02 (18.46)	50 (45)	66.63 (54.72)	100 (90)	100 (90)
Chlorpyriphos	1.25 ml	10.02 (18.4)	10.02 (18.46)	20.02 (26.58)	44.41 (41.79)	74.2 (59.47)	81.78 (64.74)
Dichlorvos	0.5 ml	10.02 (18.4)	10.02 (18.46)	29.68 (33.01)	33.31 (35.25)	33.31(35.25)	44.41(41.79)
Dimethoate	1 ml	50 (45)	50 (45)	60 (50.77)	66.63 (54.72)	100 (90)	100 (90)
Profenophos	2 ml	10.02 (18.4)	10.02 (18.46)	10.02 (18.46)	44.41 (41.79)	59.29 (50.35)	66.63 (54.72)
Triazophos	1.25 ml	60 (50.7)	63.37 (52.75)	63.40 (52.77)	66.63 (54.72)	81.78 (64.74)	94.72 (76.72)
Cypermethrin	0.75 ml	23.19 (28.7)	26.50 (30.98)	33.26 (35.22)	85.50 (67.62)	100 (90)	100 (90)
Neem Oil	2.5 ml	0 (0)	0 (0)	0 (0)	1.41(6.82)	1.55 (7.15)	1.55(7.15)
S.Em ±		1.41	1.06	1.64	2.46	2.66	3.25
C.D (0.05)		4.27	3.19	4.95	7.44	8.05	9.84

Figures in parentheses are angular transformed values

Mean followed by same alphabet do not differ significantly by DMRT (P = 0.05%)

REFERENCES

Abbott, W.S. 1925. A method of computing the effectiveness of insecticides.*Journal ofEconomic Entomology*. 18:265-267.

Abrol, D.P. 1997. *Bees and beekeeping in India*.Kalyani Publishers, Ludhiana, India. 450pp.

Akca,I., Tuncer, C., Guler, A and Saruhan, I. 2009. Residual toxicity of 8 different insecticides on honeybee (*Apismellifera* Hymenoptera: Apidae). *Journal of Animal and Veterinary Advances* 8(3): 436-445.

Brittain, C., Bommarco, B., Vighi, M., Barmaz, S., Settele, J and Potts, S.G. 2010. The impact of an insecticide on insect flower visitation and pollination in an agricultural landscape.*Agricultural and Forest Entomology* 12: 259–266.

Kremen, C., Williams, N.M and Tharp, R.W. 2002. Crop pollination from native bees at risk from agricultural diversification.*Proceedings of the National Academy of Sciences* USA.99(26): 16812-16816.

Klein, A.M., Vaissière, B.E., Cane J.H., Steffan-D.I., Cunningham S.A., Kremen, C and Tscharntke, T.2007.Importance of pollinators in changing landscapes for world crops. doi:10. 1098/ rspb. 2006. 3721.

Rehman, A., Kalita, H., Goswami, M.M and Baruah, A.K. 1993. Toxicity of certain insecticides to honeybee, *Apisceranaindica. Pesticide Information* 32: 40-41.

Pastagia, J.J and Patel, M.B. 2007.Relative contact toxicity of some insecticides to worker bees of *Apiscerana* F.*Journmal of Plant Protection and Environment*. 4(2): 89-92.

Sharma, D and Abrol, D.P. 2005.Contact toxicity of some insecticides to honeybee *Apis mellifera*(L.)and *Apiscerana*(F.). *Journal Asia-Pacific Entomology*.8(1): 113-115.

Sokal, R.R and Rholf, F.J. 1981.*Biometry*.2nd Edition. W.H.Freeman &Co., San Francisco

Sundararaju, D. 2003. Occurrence of bee fauna and extent of pollination in insecticide sprayed ecosystem of cashew. *Journal of Palynology*.39: 121-125.

Melisia, D., Demte, T and Thakur A.K.2015. Effect of some insecticidal chemicals under laboratory to honeybees, *Apismellifera* (Hymenoptera-Apidae) that forage on onion flowers. *African journal of Agricultural Research*. 10(11): 1295-1300.

PERFORMANCE OF FRONT LINE DEMONSTRATIONS UNDER ATMA TO ENHANCE THE PRODUCTIVITY OF WHEAT IN JHALAWAR DISTRICT

Arjun Kumar Verma[1], Mahender Singh[2], J. R. Verma[3], K. L. Jeengar[4] and Navab Singh[5]
[1]Scientist (Agronomy), [4]Sr. Scientist and Head and [5]Scientist (Ag. Extn. Edn.), KVK, Jhalawar
[2]Scientist (Agro.), KVK, Jhabua (RVSKVV, Gwalior) and [3]PC, KVK, Gudamalani,(AU, Jodhpur).
Email: arjunkumarverma@gmail.com

Received: 03.06.16
Accepted: 17.09.16

ABSTRACT

Wheat possesses a good position in cereal crops providing 20% of peoples' dietary energy supply along with serving as the main source of protein in developing nations (Braun *et al*. 2010). It is second important staple food crop, plays an important role in food security of the country. Wheat is the major growing cereal crop during *Rabi* in the district also with low productivity i.e. equal or less than 3.3 t/ha. The major reason behind low yield of Wheat was wide gap between improved package of practices (IP) & farmers practice (FP). To identify the gap and performance of the FLDs conducted by Krishi Vigyan Kendra, Jhalawar, the present study was done. The average yield and B:C ratio under IP was 3.3 t/ha and 1.31. The per cent increase in yield with IP over FP was recorded 15.62.

***Key words**: Frontline demonstration (FLD); Improved package of practices (IP); Farmer practice (FP).*

One of the most important food crops in the world is Wheat (*Triticum aestivum* L emend. Fiori & Paol) providing 20% of peoples' dietary energy supply along with serving as the main source of protein in developing nations (Braun *et al*. 2010). It is an important staple food crop, plays an important role in food security of the country. It occupied 28.82 million ha area spread over in Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Bihar, Haryana, Maharashtra and Gujarat are the major growing states with a total production of 93.0 million tones and the national average productivity of 2.9 tones/ ha (Economic Survey 2012). The crop productivity of Wheat varies widely from location to location. In the Jhalawar district, it is nearly about 3.3 t/ha. The government of India/ICAR is operating various schemes for quick and effective transfer of technology to farmer's field. Among these schemes, Front line demonstrations (FLD's) is one, which emphasis to increase production by supplying critical inputs along with improved packages of practices proved by the scientists of state agricultural university (SAU). Use of improved seed, recommended dose of fertilizer, plant protection and weed control measures, sowing time, seed rate and treatment increased the yield of Wheat by compared to the traditional practices followed by farmers. Keeping the above facts in view a study was carried out with following objectives:-

To find out the barriers influencing the production gap of Wheat.

To assess the performance of the FLDs conducted on Wheat during study period.

MATERIAL AND METHODS

During 2008-09 total 60 front line demonstrations (FLDs) of wheat were sanctioned under ATMA scheme by the Project Director, ATMA, Jhalawar. These front line demonstrations were laid out at purposively selected 36 villages from different blocks *viz.* Jhalrapatan, Manoharthana, Khanpur, Sunel (Pidawa) and Bakani of Jhalawar district in South Eastern Humid plain Zone (Aone V) of Rajasthan state by the Krishi Vigyan Kendra, Jhalawar. The farmers were also purposively selected from selected villages based on their followed practices. Before front line demonstrations lay down, a RRA survey was done in the villages. Views of officials of the department of Agriculture, Jhalawar and line departments were also collected for finalization FLDS. On the basis of RRA survey, Farmers practices (FP) were identified and finalize the interventions points in FLDs under ATMA schemes.

Table 1 : Details of FLD location under ATMA.

Crop	Variety	Area (ha)	Numbers of FLDs	Name of Blocks	Name of villages
Wheat	Raj-4037	24.00	60	Jhalrapatan	Gadiamer, Aktasa, Badodiya, Akodiya, Ruparel, Undal, Khanpuriya, Lawasal, Asnawar, Mandawar, Gadiran, Bhopatpura, Malipura, Govindpura, Piplod, Binda, Junakheda, Donda, Jhalrapatan, Jhumaki, Vrindawan, Ralayati, Dhobani and Asnawar
				Manoharthana	Borda, Saredi and Chachorani
				Khanpur	Bharatpur, Chamlasa, Mundla and Golana
				Sunel (Pidawa)	Sunel, Dawal and Suwasa
				Bakani	Nasirabad and Measr

In RRA survey, the major reasons behind low productivity of wheat in the district identified were the use of old varieties, imbalance use of chemical fertilizer, higher seed rate, no seed treatment, irregular sowing time, defective method of sowing, no weed management and no plant protection measures in the village. Keeping in view of above reasons, farmers of varied size holding were selected. The intervention viz. use of high yielding varieties, proper seed rate, seed treatment, proper sowing time, suitable sowing method, timely irrigation, weed management and plant protection measures were demonstrated at farmer's field along with control (farmer's practice) (Table-2).

Table 2. Intervention points for lower yield of Wheat and recommended solution.

Intervention points	Recommended potential Solutions
High yielding variety	Raj - 4037
Seed rate	100 Kg /ha (Timely sowing)
Seed treatment	Carbendazim @ 1 g/kg seed
Time of sowing	2nd to 3rd week of November
Method of sowing	Using seed cum ferti drill
Manures & Fertilizers	10 t FYM, 120:40:30 (N:P:K) kg/ ha and 5 kg/ha Zinc sulphate
Hoeing & Weeding	Hoeing after 1st irrigation, 2,4-D @ 500g/ha (Ester) at 30-35 DAS for BLW, Sulfosulfuron @ 25g/ha after 1st irrigation for grassy weeds, Isoproturon / Metaxiron / Manzobenzathiozuron @ 1.25 kg/ha in heavy soil at 30-35 DAS.
Irrigation Management	Four Irrigation (Due to heavy soils)- 1st (CRI-20-25 DAS), 2nd (Later stage of tillering-50-60 DAS), 3rd (Ear Formation-75-80 DAS) and 4th (Milking stage-95-100 DAS).
Termite	Chloropyriphos 20 EC @ 4.0 liter in standing crop
Frost Management	Spray of 0.1 % sulphuric acid before possibility of frost occurrence

The critical inputs like improved seed of variety and fertilizer wre supplied by the Krishi Vigyan Kendra, Jhalawar in FLDs and Intervention techniques demonstrated in one acre area alongwith farmers practice. Yield data were recorded by using crop cutting survey. Wheat crop was sown during 2nd to 3rd week of November at all selected farmers field. Location, soil texture and average weather parameters of the district are presented in Table-3.

Table 3. Characteristic of experimental site of Jhalawar district.

Parameters	Jhalawar District
Latitude	23^0 4' to 24^0 52' N
Longitude	75^0 29' to 76^0 56' E
Altitude	258 meter above mean sea level
Annual rainfall (Average)	954.70 mm
Maximum temperature ^{0}C	43-48 ^{0}C
Minimum temperature ^{0}C	01-2.6 ^{0}C
Soil texture	Black shrink soil

The data on output of Wheat and input used per hectare have been collected from the front line demonstrations (FLD) and farmers practices (FP). Technology gap, extension gap and

technology index were calculated by collected data using the formulae as suggested by Samui *et a.l* (2000).

Technology gap = Potential yield (PY) – Demonstration yield (DY)

Extension gap = Demonstration yield (DY) – Farmers' yield (FY)

Technology index = Potential Yield(PY) – Demonstration Yield(DY) / Potential Yield(PY) x 100

RESULTS AND DISCUSSION

It is evident from table 4 and fig.-1 that the yield of improved practice (IP) of wheat and percent increase over farmer practice (FP) was 3.7 t/ha and 15.63, respectively by adopting variety Raj-4037. It is also evident from data that average Net returns Rs./ha 10000 and B:C ratio 1.31 was found higher in IP over FP conducted by the KVK, Jhalawar. The yield levels are considerably low under farmer practice because of considerable variation in the extent of adoption of recommended package and practices depending upon the amount of risk involved in terms of cost, skill and knowledge about the concerned practices. Besides these the factors responsible for the yield difference were improved variety, timely sowing, appropriate sowing method, use of fertilizers, irrigation at critical stages of irrigation, etc with scientific backup by the help of KVK scientists.

Table 4. Performance of Wheat under FLDs (Improved practice - IP) & farmer practice (FP) of the Jhalawar district.

Particulars	Farmer Practice (FP)	Improved practice (IP)	Percent increase over Farmer practice (FP)
Average Yield (t/ha)	03.20	03.70	15.63
Cost of cultivation (`/ha)	31,800	32,000	0.63
Gross return (`/ha)	33,500	42,000	25.37
Net return (`/ha)	1,700	10,000	488.23
B:C Ratio	1.05	1.31	24.76

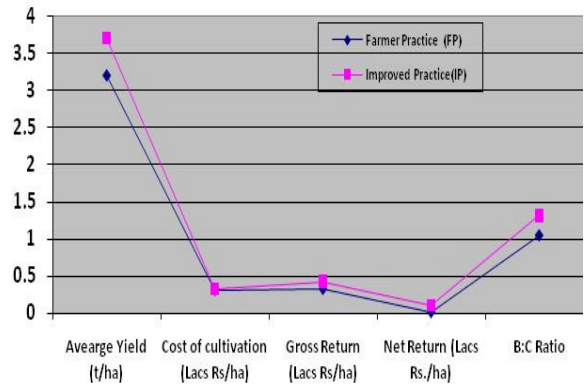


Fig -1 : Performance of Wheat under FLDs (Improved practice- IP) & farmers practice (FP) of the Jhalawar district.

The data presented in table-5 showed the technology gap (t/ha), extension gap (t/ha) and technology index was 1.30, 0.50 and 10.00, respectively. An average increase of 0.49 t/ha over the average yield of the district, which is 15.27 percent. Thus the performance of front line demonstrations further confirms that there is a wide gap between potential of front line demonstration and yield of farmers field (FP). This gap can be filled by dissemination of process of technology of soybean cultivation by various extension ways including the block/village demonstrations in larger area along with the timely supply of quality inputs and technical guidance. Similar findings were also observed by Dhaka *et al*. (2010) at Bundi, Chand Suresh *et al.* (2002) at Udaipur, Verma *et al.* (2008-09) and Verma *et al.* (2014) at Jhalawar.

Table 5. Technology gap, Extension gap and Technology Index of FLDs (Improved Practices).

Particulars	Value
Average Yield of FLDs (t/ha)	03.70
Average yield of district (t/ha)	03.21
Percent increase over average yield of district	15.27
Potential Yield (t/ha)	05.00
Technology gap (t/ha)	01.30
Extension gap (t/ha)	00.50
Technology Index (%)	10.00

The technology index shows the feasibility of the improved technology at farmers' field (table 5 and fig - 2). The lower value of technology index indicates more feasibility of the technology. The technology index is lower i. e. 10.00; the adopted technology is more feasible at farmers' level. These results confirmed by the similar findings of Dhaka *et al.* 2010, Kumar *et*

al. (2005), Verma *et al.* (2008-09) and Verma *et al.* (2014).

CONCLUSION

On the basis of the results of front line demonstrations (FLDs) conducted under ATMA, It was concluded that yield gap can be bridged to make the Wheat more remunerative through the wide publicity of the improved practices (IP) by adoption of various extensions methodologies, methods including front line demonstrations with technology backup need to be done.

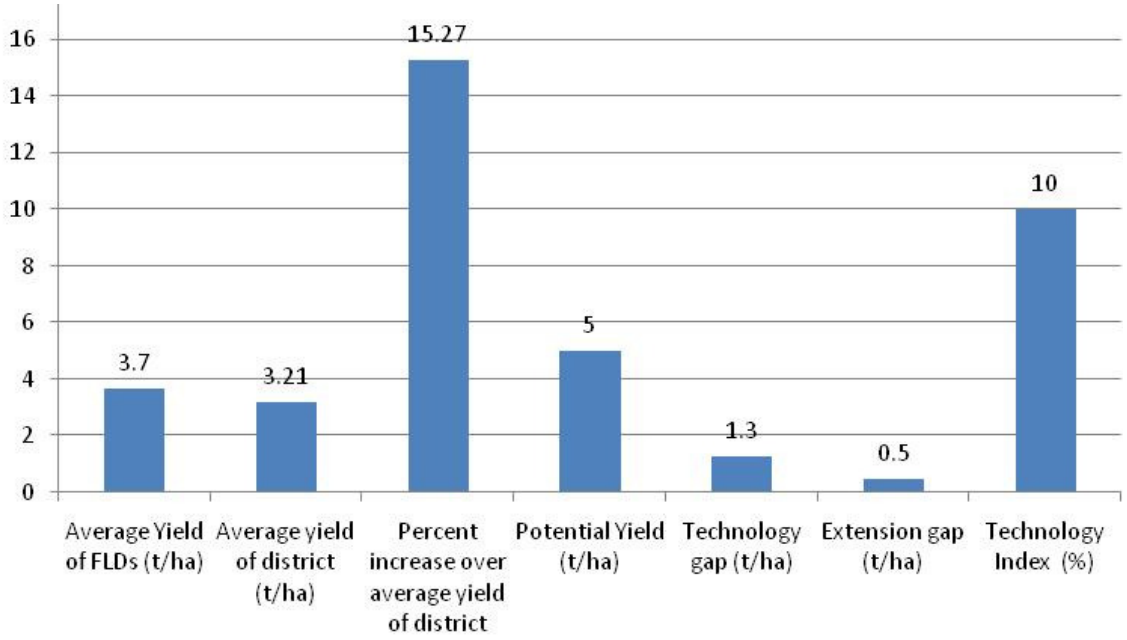


Fig. 2. Technology gap, Extension gap and Technology Index of FLDs (Improved Practices) under wheat.

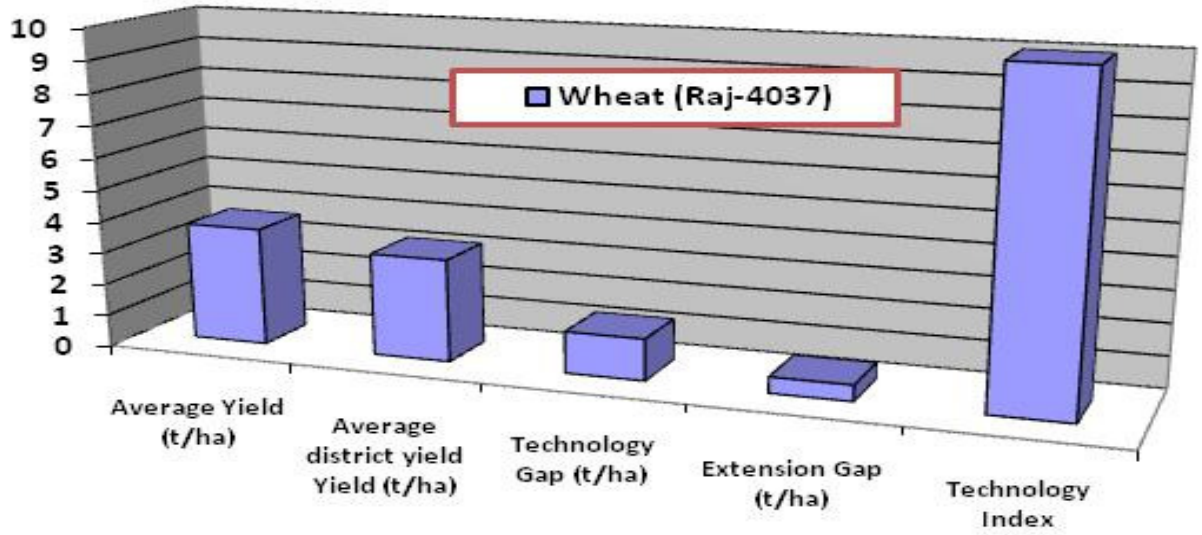


Fig. 3. Technology gap, Extension gap and Technology Index of FLDs (Improved Practices) of wheat.

REFERENCES

Balai, C. M.; Meena, R. P.; Meena B. L. and Bairwa, R. K., 2012. Impact of Front Line Demonstration on Rapeseed Mustard Yield Improvement. Indian Res.J.Ext.Edu.12(2) : 113-116.

Braun H J, Atlin G and Payne T. 2010. Multi location testing as a tool to identify plant response to global climate change. (*In*) *Climate Change and Crop Production*, pp 115–38.

Chand Suresh; Dangi, K.L.; and Bansal Vishakha; 2002. Constraints in adoption of improved mustard technology. *Indian journal of extension education*. 1 and 2, 90-94.

Chattopadhyay, C.; Meena, P. D.; Sastry, R. K. and Meena, R. L., 2003. Relationship among photological and Agronomic attributes for soil borne diseases of three oilseed crops. *Indian J. Plant Protection,* **31**,127-128.

Chaudhary B.N., 1999. KVK-A guide for KVK managers. Publication, Divi. Of Agril. Ext., ICAR. pp73-78.

Dhaka, B. L.; Meena, B. S. and Suwalka, R. L., 2010. Popularization of improved maize production technology through front line demonstration in south-eastern Rajasthan. *J. Agri. Sci. I* (I) : 39-42.

Gurumukhi D.R. and Mishra Sumit, 2003. Sorghum FLD - A success story. *Agril. Ext. Review.* **15** (4) : 22-23.

Kumar, Surendra ; Sharma, Saurabh ; and Singh, M.P., 2005. A study of gap in improved in Sugarcane production technology and constraints faced by the farmers in minimizing the gap. *J. farming system Research & development* 11 (2) : 230-233.

Manju Nath, B.L.; Wasnik, H.M. and Korekanthimath, V.S., 2007. Selection of sugarcane varieties for higher yield and recovery in west coast region. *J. Farming system Research and Development*. 13 (2) 266-268.

Mitra B. and Samajdar T., 2010. Yield gap analysis of rapeseed–mustard through FLD. *Agril. Ext. Review.* **22** (2):16-17.

Mukharjee N.. 2003. Participatory learning and action. Concept publishing company, NewDelhi, India. pp 63-65.

Samuai, S.K.; Miha, S.; Roy, D.K. ; Mandal, A.K. ; and Saha, D., 2000. Evaluation of front line demonstration on ground nut. *Journal of Indian Society of Coastal Agricultural Research,* 18 (2) : 180-183.

Sharma O.P., 2003. Mothbean yield improvement through frontline demonstrations. *Agril. Ext. Review.* **15**(5):11-13.

Verma A. K., Meena R. R. and Dhakar S. D. 2009-10. Knowledge empowerment through participatory trials of soybean in Jhalawar district. Raj. J.Extn. Edu. 17&18: 70-73.

Verma A. K., Meena R. R. and Bhim Singh 2014. Soybean Frontline Demonstations in Jhalawar Distrtict of Rajajsthan for minimizing the yield Gap. Plant Archives Vol 3 No. 2, Pp 715-718.

SHORT COMMUNICATION

ADOPTION OF IMPROVED BLACK GRAM CULTIVATION PRACTICES BY FARM WOMEN

Seema Jat[1], Asha Godawat [2] and K.L. Dangi[3]

[1]Assistant Professor, Dayanand College, Ajmer, SKNAU Jobner,
[2]Associate Professor Dept of H.Sc. Ext. and Comm. Mgt., College of Home Science, MPUAT Udaipur.
[3]Professor Dept of Extension Education, Rajasthan College of Agriculture, MPUAT Udaipur.
Email: jatseema1991@gmail.com

Received: 06.09.16
Accepted: 29.09.16

ABSTRACT

The study was conducted in Bhilwara district, Rajasthan. In all,100 respondents (Black gram growers) selected for the study purpose. The maximum percentages of the respondents were found having medium level of adoption, which the respondents were distributed accordingly to the adoption categories viz. low, medium and high. Out of 9 improved agricultural practices of black gram production, adoption of soil and land preparation was ranked at first (77.12%) followed by irrigation management (67 %) and harvesting (55.62%) ranked at second and third respectively. The medium to low adoption was found in practices viz. manure and fertilizer application (41.34%), sowing (31.81%), weed management (27.11%), intercropping (21.75%), improved variety (12.5%) and plant protection measures (11.44%). The overall adoption was found to be 38.41 per cent.

***Key words*:** Adoption, Improved cultivation practices.

India grows a variety of pulse crop under a wide range of agro-climatic conditions and has a pride of being the world's largest producer of pulses. Major pulse crops grown in the country are black gram, chickpea, pigeonpea, green gram, lentil, fieldpea, lathyrus, mothbean and horsegram in which India produces 70 per cent of worlds' black gram production and accounts for 10 per cent of country's total pulse production (Gowda *et al*, 2013). Black gram produces 22.10 Kg of Nitrogen/ha, which is equivalent to 59 thousand tons of urea annually.

In Rajasthan State black gram is grown in 1, 96 lakh/ ha. area with a production of 70,561 tonnes, with average yield of 360 kg/ha. Bhilwara occupies first position with respect to area 50,089 ha with annual production of 17,111 tonnes and an average yield of 342 kg/ha. Agriculture is main occupation of majority of the population in the rural area of Bhilwara district.

According to the Commissionerate of Agriculture, Govt. of Rajasthan, Jaipur (2013-14) the average yield of black gram is only 360 kg/ha. as against the recommended average yield of the crop is 15-20 quintals/ha. (Panda, 2012).

The Government of India initiated several developmental programmes to accelerate growth in pulse production. However, technological advancements have not stretched out to this important segment of the farming population. They are still using traditional practices in crop cultivation and there exists a spacious technological gap with respect to adoption of different improved practices. Therefore, it is imperative was undertaken to know whether the farm women are aware about improved black gram cultivation practices or whether these technologies have been adopted by them. Therefore, find out the Adoption of improved black gram cultivation practices by farm women.

RESEARCH METHODOLOGY

The study was conducted in two Panchayat Samities of Bhilwara district namely Mandalgarh and Jahazpur of Rajasthan state having large area under black gram cultivation. Two villages from each Panchayat Samiti were selected randomly. Twenty five respondents were selected from each village by random sampling method, making a sample size of 100 in total. The data were collected with the help of interview schedule. The data collected from the respondents was scored, tabulated and analyzed, mean percent scores were calculated with the help of following formula.

$$MPS = \frac{\text{Sum of scores obtained by respondents in an item}}{\text{Maximum obtainable scores}} \times 100$$

RESULTS AND DISCUSSION

It is clear from Table 1 that the majority of respondents possessed medium level adoption of improved black gram cultivation practices as indicated by the overall mean percent adoption scores (38.41). Data in Table 1 reveal that respondents used improved practices of black gram cultivation with respect to suitable soil and land preparation and irrigation management in black gram cultivation was placed at first and second position in the adoption continuum as reflected from (77.12% and 67%). Whereas adoption of harvesting practices and manure and fertilizer application was found at third and fourth rank with (55.62% and 41.35%) respectively.

Table 1. Distribution of respondents according to their adoption of various black gram cultivation practices **n=100**

Aspects	MPS	RANK
Soil and land preparation	77.12	I
Irrigation management	67.00	II
Harvesting	55.62	III
Manure and fertilizer application	41.35	IV
Sowing	31.81	V
Weed management	27.11	VI
Intercropping	21.75	VII
Improved seed variety	12.5	VIII
Plant protection measures	11.44	IX

Overall Mean Per Cent adoption Score – 38.41

The other practices viz. sowing (31.81%), weed management (27.11%), inter cropping (21.75%), improved seed variety (12.5%) and plant protection measures (11.44%) were ranked at fifth, sixth, seventh, eight and nine respectively. The overall adoption was concerned, it is evident from Table 2 that majority (53%) of the respondents were having medium level of adoption of improved cultivation practices of black gram and 42 per cent as well as 5 per cent were found in low and high category, respectively.

Table 2. Distribution of respondents according to their overall adoption of improved black gram cultivation practices **n= 100**

Categories	f /%
Low (>33.33)	42
Medium (33.34 to 66.67)	53
High (<66.67)	5

CONCLUSION

It may be concluded that the overall adoption, which was 38.41per cent, seems to be medium adoption of black gram cultivation practices. Hence, there is a need to providing special training programme about improved black gram practices and motivated them participating in training programs of improved cultivation practices.

REFERENCES

Commissionerate of Agriculture, Rajasthan –Jaipur, 2013-14. Rajasthan Krishi retrieved from articles.www.krishi.rajasthan.gov.in Crop Production. Pdf on July 23rd, 2014.Pp 4-5.

Gopi Chand Singh and Gyanendra Singh 2015. On Farm Testing- An effective technology transfer tool for adoption of potato production technology in UP, TECHNOFAME, vol. 4 (2): 77-81.

Gowda, C. L. Laxmipathi, Srinivasan, S., Gaur, P. M. and Saxena, K. B, 2013. Enhancing the Productivity and Production of Pulses in India. *International Journal of Scientific and Research Publications*. 19: 11-13.

Panda S.C, 2012. Crop Production and Management. The Hand Book of Agriculture. Pp 349-350.

Raj, A. D., Yadav, V. and Rathod, J. H, 2013. Impact of Front Line Demonstrations (FLD) On the Yield of Pulses. *International Journal of Scientific and Research Publications*. 3: 1-3.

Khare, A.L., Wakle P.K. and Mankar D.M., 2013. Farmers Knowledge in Improved Cultivation Practices of Gram. *Indian Journal of Applied Research.* 10: 1-4.

Singh, B., 2010. Adoption of Mungbean Production Technology in Arid Zone of Rajasthan. *Indian Research journal of Extension Education.* 10: 1-13.

SHORT COMMUNICATION

DOOARS INDIA: A POTENTIAL PLACE OF FARM OR RURAL TOURISM: A REVIEW

Ganesh Das
Cooch Behar Krishi Vigyan Kendra, Uttar Banga Krishi Viswavidyalaya
Pundibari, Cooch Behar
Email: ganesh.ext@gmail.com

Received: 12.05.16
Accepted: 18.07.16

ABSTRACT

Farm tourism is the Farm households engage in rural tourism by offering small-scale, high-quality accommodations and/or by developing tourist attractions, such as farm tours, rural festivals and more. Rural tourism will emerged as an important instrument for sustainable human development including poverty alleviation, employment generation, environmental regeneration and development. The study was conducted at dooars area of Jalpaiguri, Alipurduar and Coochbehar District of West Bengal, India. The respondents were selected from rural people and from the tourist. The sample sizes were 200 in case of selection rural people and 50 in case of selection of tourist. The objective of the study was to identify the threat and opportunity of the dooars area for making farm tourism place. Descriptive research design was followed to obtain pertinent and precise information.

Key words: Farm, Rural, Tourism, employment, sustainable

Tourism is the largest service industry in the world employing the most number of people and generating the most revenues. Tourism is the only industry which can allow the wealth of developed nations to flow directly into the hands of the most under-developed people in the world. Worldwide tourism is ranked second highest revenue generating industry next to the oil industry. According to Lane (1994), any activity that is not an integral part of the rural fabric and does not employ local resources cannot be considered rural tourism. The farm tourism industry can be categorized by its products, such as Farm Tourism, Agritourism, Green Tourism and Ecotourism, each relating to a different aspect of the rural setting. Within the framework of rural tourism, farm tourism enterprises are more closely related to agriculture than other farm tourism operations. Farm tourism is the Farm households engage in rural tourism by offering small-scale, high-quality accommodations and/or by developing tourist attractions, such as farm tours, rural festivals and more. It will not only generating employment for the people but it can also develop social, cultural and educational values. Farm tourism is not a new phenomenon: farms in Austria and other countries have been hosting tourists for over a hundred years (Frater, 1982). In recent years, however, farm tourism in Europe has experienced enormous growth accompanied by structural change. Today, England, France, Germany and Austria dominate the global farm tourism market with 20,000 to 30,000 enterprises per country (Weaver and Fennel, 1997). Over 23% of the farms in the UK are involved in tourism (Denman 1994). Lane (1994) suggested that rural tourism is tourism located in rural areas i.e. that are rural in scale, character and function reflecting the unique patterns of the rural environment, economy, history and location. Tosun (2001) highlighted that most models of sustainable tourism development have originated from developed countries and hence do not take into account the socioeconomic, political and legislative conditions of the developing world. This raises questions regarding the applicability of these conceptual models to the context of the developing world, where governments often view tourism development as a panacea to economic concerns. However, such a myopic orientation fails to account for the other significant issues involved in sustainable development, namely the human, socio-cultural and environmental categories of capital stock (Fletcher, 2005). In addition, the desire for short term economic benefits may lead to high expectations among the host communities. Perception is the process of filling in, enabling us to interpret a series of fragments as a whole when sensory data are incomplete. Perception organization is dependent upon the characteristics of the stimuli object such as nearness, likeness, inclusiveness and part or whole relationship. Different

perception have affected agricultural programmes in many villages. After independence government was focusing on development of the key areas like agriculture, industry, infrastructure, etc in rural India. Tourism was never seen as a potential business, it was growing at its own space. Although tourism has started receiving some attention from last decade, but farm tourism was never given any priority.

Dooars-The place where nature has kept its doors open. Derived from the word 'doors'(doors to Bhutan), this region, located in the district of jalpaiguri, Alipurduar and Coochbehar, forms a gatewayto the hill stations of North Bengal,S ikkim, Bhutan and North Eastern states. The dense natural forests, interwoven with lush green tea garden,criss-crossed by teesta, raidak, torsha, jaldhaka, kaljani and other rivers and their innumerable tributaries rolling down the hills up your senses with sublimity.The average rainfall of the area is about 3,500 mm. Monsoon generally starts from the middle of May and continues till the end of September. Winters are cold with foggy mornings and nights. Summer is mild and constitutes a very short period of the year.The native people of this region generally have Mongoloid features. They are composed of numerous tribes, including the Bodo in Assam, and the Rabha, the Mech, the Toto, the Koch, the Tamang/Murmi, the Limbu, the Lepcha and the Rajbongshi in Bengal. Apart from the tribal population, a large Bengali population (mostly displaced from the then East Pakistan (now Bangladesh) by the Partition of Bengal) also populate the Dooars. Jhallong, Samsing, Totopara, Rajabhatkhawa, Jayanti, Baneswar and Nagrakata were the major place of attraction in Dooars.

Latimer (1985) found that in the Himalayas, farmers have adapted to visitors' demands by producing higher value products, such as pineapple, macadamia nuts, papaya and guava. English Tourist Board (1991) conducted a study in four rural regions in England showed that on average, 44% of visitors' expenditures remain in the local Economy. Cox and Fox (1992) described the relations between rural tourism and agriculture as symbiotic: after its introduction, rural tourism makes use of the resources and infrastructures already available in agricultural areas. As it develops, it further extends the infrastructures and creates more resources. The latter become available to the agricultural industry as well. Stevens (1993) found that income of the farmers from tourism had been very substantial and was far greater than that obtained from their original agricultural activities. Lane (1994) concluded from his studied that the rural tourism industry was vulnerable to market failure results to a great extent. The massive development of tourist attractions and the large number of visitors can damage or even ruin the same amenities that define the attractiveness of the rural environment. Rural tourism development must therefore maintain a balance between the conflicting aims of conservation and development. Forsyth (1995) researched the adoption of tourism by agricultural communities in northern Thailand. He found that tourism was only adopted by those with available cash and labor, and did not present a viable alternative to agriculture. Most of the poorest households did not have the resources to adopt rural tourism; instead, they intensified land cultivation. Clarke (1996) claimed that there was a difference between tourism on farms and farm tourism. When accommodations were divorced from the farm environment then it is 'farm tourism', while in 'tourism on the farm', the farm environment and its essence are incorporated into the product. Clough (1997) extended this argument further by claiming that most of the visitors would be happy not seeing the working farm. Oppermann (1996), who studied rural tourism in Germany, claims that it was hardly a serious second foothold for farm operators. It was, therefore, only a temporary alternative for farmers facing declining profits from agriculture. Ilbery et. al., (1998) found out a comparison of farmers who were not willing to diversify to those who had diversified revealed that the latter run a larger farm business, earn a higher net income, were younger, continue full-time education after school and receive formal agricultural training. Beeton,(1999) investigated the public intervention in rural areas affected the tourism industry either directly or indirectly. Even in the absence of a specific rural tourism policy, government decision-making in such fields as zoning, transportation, communication and

other infrastructures, land and water resource management, among others, had implications for rural tourism. Busby and Rendle (2000) described the transition from 'tourism on the farm' to 'farm tourism'. This transition occurs as farmers who become engaged in tourism on their farms slowly divorce themselves from agricultural activities. With this transition, the farm activities are no longer a necessary component. García Henche, (2003) found that agri-tourism had to be related to the agricultural activities and to complement the revenue of farmers. Sandeep Das (2011) in his article explained that tourism provides opportunities of job creation directly and indirectly. So this sector should be provided with incentives for sustainable and overall economic growth along with creation of jobs. Barna maulick(2012) in his article highlighted about the tourism as strategy for rural development. He had given more priority of tourism sector and it was contribution to earn foreign exchange and the accelerating trend of this sector towards attracting the foreign tourist arrival in India from 2001 to 2010. Parmar Jaysingh (2012), in his article explained tourism as an engine for economic growth. In his study he basically focuses on the rural economy of Himachal Pradesh with the findings that this state is emerging as a favorite destinations for the tourists i.e., both domestic and foreigners which helps for the growth of the state.

MATERIALS AND METHOD

The potential area for farm tourism in Dooars area of Alipurduar, Jalpaiguri and Coochbehar districts were to be identified in consultation with tourism department of Government of West Bengal as well as private tour. The respondents were cover the rural stakeholder, functionaries and tourists at the survey time. Both primary and secondary data were collected. Purposive as well as simple random samplings were followed. For selection of district, block, villages purposive sampling method were followed and for selection of respondents random sampling method was followed. In this way total of 200 rural respondents and 50 number of tourist respondent were selected. A structured interview schedule was prepared for collection of data. Descriptive research design was followed to obtain pertinent and precise information concerning the current status of the phenomena and to draw a valid conclusion.

RESULT AND DISCUSSION

It was found from the study that majority of the respondent directly or indirectly associated with the eco-tourism and rural tourism. Tourist was interested to staying with rural people, to show their daily activity, participated different cultural programme. Road of the rural area were well connected with main road. Tea was the major crop cultivated by different organization. Majority rural women were involved as tea labor. Majority of the male respondent were affection on drug. The house was mainly maid by wood and Tin. Majority of the respondent were primary school pass followed by middle school pass. Majority of the rural respondent annual income level were less than Rs. 1,00,000. Respondent perception on alternative source of income was very low. It may causes danger of the respondent if tea garden unfortunately closed their production. So proper policy may be taken by govt. and private organization to change the motivation of the dooars rural people, empower the rural women by formation of SHGs, established different rural tourism spot, involvement of rural people for guiding tourist, arranging fooding and lodging, training of the rural youth on handicraft making and marketing at rural tourism place .If a proper marketing plan is done Rural tourism, it could bring lots of benefit to our society. It could be a sustainable revenue generating project for rural development programme of the government.

REFERENCE

Barnaa Maulick, 2012, "Enlarging the Potential of Rural Tourism in India". *Kurukshetra* May edition: 13-16.

Beeton, S.1999, Rural tourism policy: cross-sectional land-use regulation and government policy in Australia. In Daugherty, C.M. (Ed.)**,** *Proceedings of Sustaining Rural Environments: Issues in Globalization, Migration and Tourism,* Department of Geography and Public Planning. Flagstaff, AZ: Northern Arizona University.

Bowler, I.R., 1985, Some consequences of the industrialization of agriculture in the EEC. In

Healey, M.J. and Ilbery, B.W. (Eds.), *Industrialization of the Countryside,*75-98, Norwich: GeoBooks.

Busby, G. and Rendle, S.,2000, The transition from tourism on farms to farm tourism, *Tourism Management*, **21**(8): 635-642.

Clarke, J., 1996, Farm accommodation and the communication mix, *Tourism Management*, **17**(8): 611-620.

Clough, M.,1997, Profiting from farm tourism. *Western Morning News*, 11 June.

Commission of the European Communities.,1986, Action in the field of tourism, *Bulletin of the European Communities*, Supplement 4/86, European Commission,Brussels.

Cox, L.J. and Fox, M., 1992, Linkages between agriculture and tourism. In Khan, M. A. et al. (Eds.), *VNR'S Encyclopedia of Hospitality and Tourism*, New York: Van Nostrand Reinhold.

Das, Sandeep., Sep,2011, "*Indian Tourism Sector: A Growth Story",* Yojana:49-51.

Denman, R.: 1994b, The farm tourism market, *Insights,* March: 49-64.

Dernoi, L.,1983, Farm tourism in Europe, *Tourism Management*, 4:155-166.

Dernoi, L.,1991, Prospects of rural tourism: needs and opportunities, *Tourism Recreation Research*, **16**(1): 89-94.

English Tourist Board., 1991, *Tourism and the Environment—Maintaining the Balance*, Report of the Countryside Working Group, London

Evens, N.J. and Ilbery, B.W., 1989, A conceptual framework for investigating farm based accommodation and tourism in Britain, *Journal of Rural Studies*, 5 :257-266.

Evens, N.J. and Ilbery, B.W., 1992, The distribution of farm-based accommodation in England*, The Journal of Royal Agricultural Society of England*, 153: 67-80.

Fleischer, A. and Tchetchik, A., 2005, Does rural tourism benefit from agriculture?

Tourism Management, 26: 493-528.

Fletcher, J., 2005, Sustainable Tourism. In C. Cooper, J. Fletcher, A. Fyall, D. Gilbert & S. Wanhill (Eds.), *Tourism Principles and Practice*. Harlow: Pearson Education Limited.

Forsyth, T., 1995, Tourism and agricultural development in Thailand, *Annals of Tourism Research*, **22**(4): 877-900.

Frater, J.M., 1982, Farm tourism in England: planning, funding, promotion and some lessons from Europe, *Tourism Management*, **4**(3) :167-179.

Garcia Henche, B., 2003, Marketing del tourism rural. Madrid, Spain, Piramide.

Hjalager, A., 1996, Agricultural diversification into tourism—evidence of a European Community development program, *Tourism Management*, **17**(2): 103-111.

Ilbery, B.W., Bowler, I., Clark, G., Crockett, A. and Shaw, A.,1998, Farm-based tourism as an alternative farm enterprise: a case study from the Northern Pennies, England, *Regional Studies*, **32**(4): 355-364.

Lane, B.,1994, What is rural tourism? In Bramwell, B. and Lane, B. (Eds.), *Rural*

Tourism and Sustainable Rural Development, Channel View Publications, Clevedon.

Latimer, H., 1985, Developing island economies—tourism vs. agriculture, *Tourism Management*, 16: 32-42.

Oppermann, M., 1996, Rural tourism in South Germany, *Annals of Tourism Research*, 23, 86-102

Parmar, Jaisingh., 2012, "Tourism: An Engine to Economic Growth In The Rural Economy of Himachal Pradesh", Kurukshetra, Vol **60**(7), 17-20.

Ribeiro, M. & Marques, C., 2002, Rural tourism and the development of less favoured areas – between rhetoric and practice. *International journal of tourism research*, 4: 211- 220.

Slee, B., Farr, H. and Snowdon, P., 1997, The economic impact of alternative types of rural tourism, *Journal of Agricultural Economics*, **48**(2) : 179-192.

Stevens, S. F., 1993, "Tourism, change, and continuity in the Mount Everest region, Nepal." Geographical Review. **83**(4): 410-428.

Tosun, C., 2001, Challenges of sustainable tourism development in the developing world: the case of Turkey. *Tourism Management*, *22*: 289-303.

Vanslembrouck, I., Huylenbroeck, G.V. and Meensel, J.V, 2005, Impact of agriculture on rural tourism: a hedonic pricing approach, *Journal of Agricultural Economics*, **56**(1):17-30.

Weaver, D.A. and Fennel, D.A., 1997, The vacation farm sector in Saskatchewan: a profile of operations, *Tourism Management*, **18**(6): 357-365.

Website: wbtourism.gov.in/ guest/ QZlRVRF WS JVV w g n NT xGaa RmashUVn1TP

APPLICATION OF ICTs IN AGRICULTURAL EXTENSIÓN TO ADOPT THE IMROVED CROP PRODUCTION TECHNOLOGY IN RICE CROP BY THE FARMERS IN VINDHYNAN REGION OF UTTAR PRADESH

Sunil Kumar Rajpoot[1] and V. K. Dixit[2]

Research Scholar and Supervisor, Department of Adult, Continuing, Education & Extension, Faculty of Social Science, University of Delhi, Delhi – 110007

Received: 26.07.16
Accepted: 22.08.16

ABSTRACT

A study was conducted in Sonbhadra, Mirzapur and Varanasi district of Uttar Pradesh, where the eSagu ("Sagu" means cultivation in Telugu language) projected was implemented with the Gram Gyan Kendra (GGK), running by Instute of techonology, Banaras Hindu University, Varanasi. The Gramin Gyan Kendra is the repository of scientific knowledge for agriculture and allied activities and it is being transmitted through effective use of ICTs (Information and Communication Technology) mediated agricultural extension services to the farmers who, in turn can use this knowledge to improve the production and productivity in their farm operations. In this study, extent of knowledge and adoption of 10 selected improved crop production practices for Rice crop were measured. To measured the extent of knowledge and adoption, and to compare the impact of ICTs mediated agricultural extension services, 150 numbers of respondents were selected from the project area. Study was conducted in three different ways, firstly all respondent were interviewed and categorized in to three groups of High, Medium and Low category of farmers, on the basis of knowledge gained and adoption level regarding improved crop production techonology for Rice crop. Secondary overall knowledge gain and level of adoption was measured in terms of frequency percentage and mean with standard deviation and lastly the Paired t-test were used to acces the difference in knowledge gain and adoption level over the time before and after the use of ICTs mediated agricultural extensión services. After the use of ICTs, In the farmers of high level category, the knowledge gain was seen to increase from 13.33% to 20% and adoption level was seen to increase from 16.66% to 26.66%. The majority of the farmers were found in medium category regarding Extension contact, social participation and innovativeness. However the impact of ICTs Mediated Agricultural Extension Services on knowledge and adoption level of the respondents regarding selected "package of crop production practices" for Rice crops was found significant.

***Key words*:** Agricultural Extension, ICTs, impact assessment, knowledge, adoption.

Indian farming community is facing a huge number of problems to maximize crop productivity. In spite of successful research on new agricultural practices, the majority of farmers is not getting upper-bound yield due to several reasons. One of the reasons is that expert/scientific counsel regarding crop cultivation is not getting to the farming community in a judicious manner. It is true that India possesses a valuable agricultural knowledge and expert advice. However, a wide information gap exists between the research levels and put into practice. Indian farmers need timely expert advice to make them more productive and competitive.

To bridge the information gap between the agricultural expert and the farmer, International Institute of Information Technology (IIIT), Hyderabad (http://www.iiit.ac.in) has built the eSagu ("Sagu" means cultivation in Telugu language) system (http://www.esagu.in), which is an IT-based personalized agricultural extension system to improve agricultural productivity by disseminating a fresh expert agricultural advice to the farmers, both in a timely and personalized manner. In e-Sagu, the agricultural experts generate the expert advice based on the information about the crop situation received in the form of both text and digital photographs. These photographs are sent by some educated and experienced farmers in the village. In 2004,

ICT (Information and Communication Technology) *is an umbrella term that includes computer hardware and software, digital broadcast and telecommunications technologies as well as digital information repositories online or offline* **(Selwyn, 2002).** It represents a broad and continually evolving range of elements that further includes television (TV), radio, mobile phones, and the policies and laws that govern these media and devices**.** The word ICT is often used in plural sense (ICTs) to mean a range of technologies instead of a single technology**.** ICT will bring new information services to rural areas on which, farmers, as users, will have much greater control than ever over current information channels.

Agricultural Extension: Extension stands for the action or process of enlarging or extending something. It could be Extension of area, time or space. Agricultural Extension relates to the process of carrying the Technology of scientific agriculture to the farmer in order to enable him to utilize the knowledge and better the economy. Agriculture extension service seeks to impart the necessary skills to the farmers for undertaking improved agricultural operations, to make available to them timely information improved practices in an easily understandable form, suited to their level of literacy and awareness, and to create in them a favourable attitude for innovation and change **(Benor *et al.* 1984).**

ICTs in the Context of Extension: From the perspective of agricultural knowledge and information systems (AKIs), ICTs can be seen as useful in improving linkages between the research and the extension sub systems. The experience of rural telecenters in the developing world shows that ICT can help in enabling rural development workers to gather, store, retrieve, adapt, localise and disseminate a broad range of information needed by rural families **(Davison *et al.*2005).**

The Need of ICTs in Agricultural Extension Education: Extension agent to farmer ratio in India is estimated at 1:2,000. Public agricultural extension services were criticized for being technically weak, providing insufficient coverage of and contacts with farmers **(Qamar, 2002).** Less than one-third of the technologies generated by Agricultural Universities and ICAR institutes in India were transferred to the farmer‘s field due to the lack of an appropriate extension model **(Katyal, 2001).** Direct contact by agricultural experts with all the needed farmer clients cannot be established practically with the available technical manpower and budget in India. Hence the research challenge is to identify an effective means to provide quality and timely technical advice to all the needed farmers using the available experts and their time efficiently. Developments in ICTs offer ample opportunities to accomplish this challenge. Given the complex nature of agriculture and the challenges being faced, the use of multidisciplinary expertise is more appropriate to address agricultural information needs to empower farming community. Hence ICTs will not only help a nation to become a part of emerging global economy, but will also enable the citizens to avail themselves of the benefits arising out of recent and innovative technology.

Statement of the problem: The specific objectives of the current study are to see whether ICTs mediated Agricultural Extension service was used by the farmers as learning tool for getting the timely and precise Agricultural information or not. Against this backdrop a range of issues were raised to provide satisfactory answers to the question like:

a) What about the present condition and socio-economic status of the farmers?
b) What about their innovativeness, social participation and extension contact?
c) What about the change in their knowledge and adoption after ICTs mediated Agricultural Extension service?
d) How they can improve their socio-economic status and get benefitted by ICTs mediated Agricultural Extension service?
e) Are they facing any problem in understanding and applying the ICTs mediated Agricultural Extension services?

Objectives of the study

1. To study the profile of the respondents in project area
2. To study the Impact of ICTs mediated Agricultural Extension Service on knowledge gain and adoption level of respondents.

METERIALS AND METHODS

Locale of the study: the study was conducted in Sonbhadra, Mirzapur and Varanasi district of Uttar Pradesh, This region is also known as Vindhyan region of Uttar Pradesh. where the eSagu ("Sagu" means cultivation in Telugu language) projected was implemented with the Gram Gyan Kendra (GGK), running by Instute of techonology, Banaras Hindu University, Varanasi. The esagu project was implemented at the 9 centre of GGK spread over 75 villages of 3 districts, one centres were selected randomly from each district viz. Yuva Gram Vikas Samiti Babatpur Basani **(Varanasi),** Bhartiya Lok Vikas Evam Sodh Sansthan Bahuti **(Mirzapur)** Kasi Yog Evam Mulya Siksha Sansthan Pasahi Kala Robertsgang

(Sonbhadra). There are about 25 villages under each ICTs/GGK centre. So five villages from each centre were selected, from these three centres, 150 farmers were selected randomly as 50 farmers from each centre were selected. The criteria for selection of farmers were that they should have registered in the GGK centre and getting eSagu/ICTs mediated Extension service through the coordinators on regular basis.

Selections of Variables and their measurement: For the purpose of study two dependent variables, namely knowledge level and adoption level of the farmers before and after eSagu service, and 11 independent variables were selected. The selected independent variables were Age, Education, Cast, Land holding, Family income (Annual), Family type, Occupation, Source of finance, Extension contact, Social participation and Innovativeness. In order to measure the impact of ICTs mediated extension service, the interview scheduled was prepared.

Formulation of Hypothesis: The scientific hypothesis is a formal affirmative statement predicting a single research outcome, explaining the relationship between two or more than two variables.

Null Hypothesis (H_o): there is no difference between the level of knowledge and level of adoption of the respondents before and after ICTs Mediated Extension service

Alternative Hypothesis (H_1): there is significant difference between the level of knowledge and level of adoption of the respondent before and after ICTs Mediated Extension service

Developing Tools and techniques for data collection:

1.0 Interview schedule: Interview schedule is the popular record and appropriate device to collect first hand information. **Goode and Hatt (1983)**. The interview schedule for this study will consists with of both close ended and open ended questions. Part I, of the schedule include questions relating to the socio personal, socio economic, extension contact Social participation and innovativeness. And Part-II of the schedule included 10 questions relating to the package of improved cultivation practices for Rice crop were prepared so that the knowledge and adoption of specific cultivation practices can be evaluated.

2. Observation and interpersonal discussion with respondents: Observation is basic and popular technique in all the social science. According to **Goode and Hatt (1983)** science begins with observation and must ultimately return to observation for its validation. According to **P.V.Young** 'observation is the systematic viewing coupled with consideration of the seen phenomenon. The consideration must be given to the larger unit of activity in which the specific observed phenomenon occurs.

3. Collection of data: The data was collected with the help of personal interviews from registered farmers in the GGK centre. After data collection, the primary data were arranged, classified and tabulated.

4. **Statistical analysis of the data**: The collected data was analized with subjected to suitable statistical techniques, viz. Frequency, and Percentage, Mean, S.D., and Paired t-test.

RESULTS AND DISCUSSION

The entire findings of the investigation along with discussion which have been arrived after subjecting the obtain data to statistical analysis and interpretation, in view, the objective of the study. For the convenience of the presentation, the finding and concerned discussions have been grouped under following heads:

1. The profile of the respondents in project area.
2. To study the Impact of ICTs mediated Agricultural Extension Service on knowledge gain and adoption level of respondents.

The profile of the respondents in project area: An attempt has been made to describe the profile of the farmer in terms of age, education, caste, land holding, family income, family type, Occupation, source of finance, Extension contact, Social participation and Innovativeness.

Table 4.1: Distribution of respondents according to their age

Category	No. of respondents (F)	Percentage (%)
Young (15-35)	17	11.33
Middle (36-55)	94	62.66
Old (above 55)	39	26.00
Total	**150**	**100**

The overall mean distribution of the respondents in the **table 4.1** which reveals that maximum number of respondents (62.66%)

were of middle age followed by old age group (26%) and young age group (11.33%).

Table 4.2: Distribution of respondents according to their educational status.

Category	No. of respondents (F)	Percentage (%)
Illiterate	61	40.66
Primary	27	18.00
Middle	36	24.00
High school	18	12.00
Intermediate	5	3.00
Graduate	3	2.00
Total	**150**	**100**

The distribution of the respondent according to their level of education has been presented in the **table 4.2,** it is evident from the table that only 40.66% of respondent were illiterate. There were only about 2.00% graduates who accepted agriculture as their profession. The higher number of the educated respondents were in the category middle school (24.00%) followed by primary (18.00%), about 12.00% respondents standard up to high school and 3.00%intermediate.

Table 4.3: Distribution of respondents according to their caste

Category	No. of respondents (F)	Percentage (%)
General	37	24.66
OBC	65	43.33
SC/ST	48	32.00
Total	**150**	**100**

Above **Table 4.3** shows that majority of the respondents (43.33%) were from OBC category, followed by the SC/ST caste (32.00%). The general casts' respondent was 24.66%.

Table 4.4: Distribution of respondents according to Land holding

Category	No. of respondents (F)	Percentage (%)
Small (up to-5)	102	68.00
Medium (5-10)	44	29.33
Large (>10)	4	2.00
Total	**150**	**100**

Above **Table 4.4** reveals that majority of the respondents (68.00%) had small land holding followed by (29.33%) of the respondents having medium sized land holding and only about 2 percent farmers was recorded as large land holding. It indicates that most of the respondents had less than 5 acres of land.

Table 4.5: Distribution of respondents according to their Family income

Category	No. of respondents (F)	Percentage (%)
Up to 50000	5	3.33
50000- 3.0 lakh	116	77.33
Above 3.0 lakh	29	19.33
Total	**150**	**100**

Above **Table 4.5**, reveals that 77.33% farmer's annual income was between 50 thousands to 3 Lakh, followed by 19.33% of the respondents annual income having more than 3 Lakh and only 3.33% farmers were recorded less than 50 thousands of annual income of the family.

Table 4.6: Distribution of respondents according to Family type

Category	No. of respondents (F)	Percentage (%)
Joint	31	20.66
Nuclear	119	79.33
Total	**150**	**100**

Above **Table 4.6** clearly depicts that in the project area, most of the respondents belonged to the nuclear family 79.33 percent and 20.66 percent were from joint family.

Table 4.7: Distribution of respondents according to their Occupation

Category	No. of respondents (F)	Percentage (%)
Only farming	40	26.00
Farming+ Allied	103	68.66
Farming + employee	7	4.00
Total	**150**	**100**

A careful perusal of **table 4.7** indicates that most of the respondents (68.66%) who were interviewed carried out Agriculture as the main occupation with livestock production and allied like poultry and fisheries. The findings of the study indicate that only 26% of the respondents were dependent only farming alone as the occupation and 4% respondents are those who support their families as private or government employee with farming as a main source of income.

Table 4.8: Distribution of respondents according to Source of finance

Category	No. of respondents (F)	Percentage (%)
Commercial Bank	139	92.66
Money lender	5	3.00
Relatives	6	4.00
Total	**150**	**100**

Above **Table 4.8** shows that majority of the respondents (92.66%) were used the 4.00 % respondents go for relatives followed by money lender only (3.00%). commercial bank as source of finance. And only

Table 4.9: the Distribution of the Respondents according to their Extension contact

Variables	Categories	Freq. (N=150)	(%)
Personal locolite	Low (<6.35)	25	16.66
Mean=8.35	Medium	111	74
S.D.=2.00	(6.35-10.35)		
	High (>10.35)	14	9.33
Personal Cosmopolite	Low (<3.49)	8	5.26
Mean=6.85	Medium	120	78.94
S.D.=3.36	(3.39-10.21)		
	High (>10.21)	24	15.78

It is clear from the **table 4.9,** that in the personal locolite contact, majority of respondents (74.00 percent) had medium extension contact, followed by low extension contact (16.66 percent) and high extension agency contact (9.33 percent). In the personal cosmopolite contact majority of respondents (78.94 percent) had medium extension contact followed by 15.78 percent and 5.26 percent of respondents having high and low extension contact.

Table 4.10: the Distribution of the Respondents according to their Social participation

Variables	Categories	Freq. (N=150)	(%)
Member	Low (<5.96)	21	13.54
Mean= 8.06	Medium(5.96-10.16)	121	78.06
S.D.= 2.10	High (>10.16)	13	8.38
Office Bearer	Low (<-0.11)	135	22.29
Mean=2.02	Medium(0.11-4.15)	103	65.60
S.D.=2.13	High (>4.15)	19	12.10

As shown in **Table 4.10**, the social participation as a member, majority of respondents (78.06 percent) have Medium participation in the social organization followed by (13.54 percent) and (8.38 percent) had low and high social participation respectively. The social participation as a office bearer majority respondents (65.60 percent) have medium participation in social organization followed by 22.29 percent and 12.10 percent had low and high social participation respectively.

Table 4.11: The Distribution of the Respondents according to their Innovativeness

Categories	Frequency (N=150)	Percentage (%)
Low (<7.19)	18	11.25
Medium(7.19-18.15)	107	66.87
High (>18.15)	35	21.87
S.D.=5.48 , Mean=12.67		

Above table reveals that a majority (66.87%) of respondents had medium level of innovativeness towards the developmental activities and new agricultural technologies. while 21.87 percent respondents showed high level of innovativeness followed by 11.25 percent who showed low level of innovativeness. As majority of the respondents were found to have medium level of innovativeness it is because of their education, better mass media exposure, responsiveness and development oriented outlook. Bhave and Reddy (1998) and Greger and Peterson (2000) also reported that the same result in accordance with the present findings and found that innovativeness significantly affect the leadership qualities in the process of development. The findings are in line with the results reported by Murali and Jhamtani (2003), Nagabhushnam (2003), Tyagi *et al.*(2003) and Palmurugan(2006), who pinpointed that majority of the respondents had medium level of innovativeness.

4.2 The Impact of ICTs mediated Agricultural Extension Service on knowledge gain and adoption level of respondents regarding the Rice crops:

An attempt has been made to describe the impact of ICTs mediated agricultural extension service on knowledge gain and adoption level of respondents regarding the Rice crops: With the help of the knowledge and adoption indices, level of the farmers was measured about the knowledge and adoption of different package of practices for the selected crop "before and after" the ICTs mediated agricultural extension service. The entire "package of practices" from sowing to harvesting) for rice crop was grouped under ten stages. The stages are viz. crop variety, land preparation, sowing (time, seed rate, method), manures and fertilizer, intercultural operations irrigation method, plant protection, harvesting yield and storage.

4.2.1 Rice crop

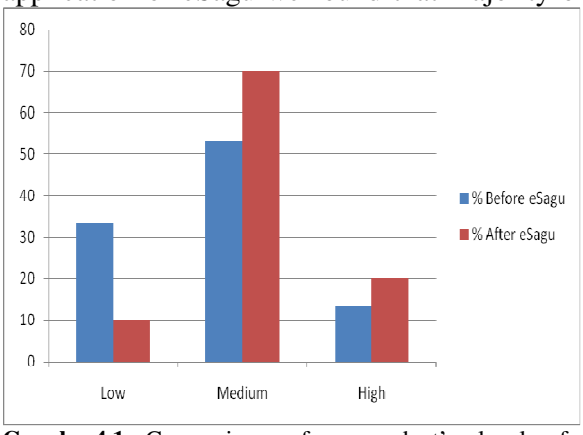
Rice is the important Kharif crop of the Vindhyan region of Uttar Pradesh, most of the farmers having knowledge about the cultivation practices of the Rice crop. The main problem in the rice cultivation was reported the raising of nursery and control of insect pest and diseases.

Level of knowledge

Table 4.12 Distribution of the respondents on the basis of level of knowledge gained regarding "package of practices" of Rice crop before and after the ICTs mediated extension service.

Variables	Categories	Freq. (N=150)	(%)
Before eSagu: Mean=5.8 S.D.=1.18	Low (<4.62)	50	33.33
	Medium (4.62-6.98)	80	53.33
	High (>6.98)	20	13.33
After eSagu: Mean=6.8 S.D.= 1.34	Low (<5.46)	15	10
	Medium (5.64-8.14)	105	70
	High (>8.14)	30	20

Above **table (4.12)** and below **Graph (4.1)** reflect that before application of eSagu a large number of farmers (53.33 %) having medium level of knowledge about "package of practices" in Rice crop. followed by the 33.33 % and 13.33 % farmers having high and low level of knowledge respectively. But after application of eSagu we found that majority of the farmers (70.00%) were still under medium level of knowledge but percentage were increased which shows the positive impact of eSagu service. While 20 percent farmer was having high level of knowledge which is 6.67% more than before eSagu service and 10 percent farmers were found with the low level of knowledge but percentage was reduced.



Graph 4.1 Comparison of respondent's level of knowledge before and after ICTs mediated extension service under Rice crop.

Table 4.13 Difference in the level of knowledge gained by the respondents regarding "package of practices" of the Rice crop before and after the ICTs mediated extension service.

N	AVERAGE		Mean Difference	
	Before	After		
150	5.8	6.8	1.0	
S. D.		D. F.	t.cal	t.tab. (5%)
Before	After			
1.18	1.34	149	9.3071	1.699

$t_{cal.}$ = t calculated value, t_{tab} = 1.699 (at 5 % level of significance)

D.F. = degree of freedom (149), **S.D.** = standard deviation.

As **table 4.13** depicts, the mean score of the Respondents before eSagu was 5.8 with a standard deviation of 1.18 and the corresponding figure after eSagu service was 6.8 and 1.34.it shows that there is significant mean difference (1.0) between the means score of the respondent before eSagu and after eSagu service. The t-test result in **table 4.13** shown that the existing difference was statistically significant because at 149 degree of freedom, $t._{cal.}(9.30) > t._{tab.}(1.69)$, at 5% level of significance. It rejected the null hypothesis (H_O) i.e. There is no difference between the level of knowledge gain by the farmers before eSagu and after eSagu service. Then it accepts the alternate hypothesis (H_1) i.e. there is significant difference between the level of knowledge gain by the farmers before eSagu and after eSagu service. It is concluded that the impact of eSagu service on the level of knowledge gain by the farmers is significant.

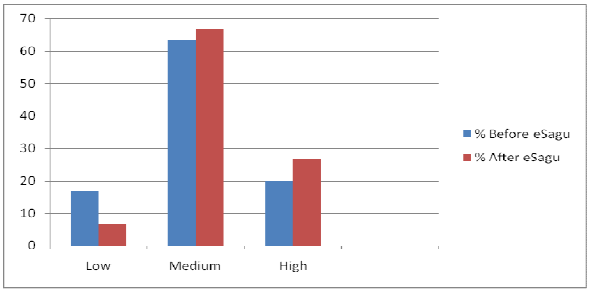
The above result and significant difference in level of knowledge gain by the respondents after eSagu service is clearly shows that the ICTs mediated extension service has positive impact on the knowledge level of respondents. Here, it is essential to mention that there are many factors like age, education, time duration and extension contact also affect the knowledge level of respondents however, and these results are presented according to the objectives of the study.

Level of Adoption:

Table 4.14 Distribution of the respondents on the basis of level of adoption regarding "package of practices" of Rice crop before and after the ICTs mediated extension service.

Variables	Categories	Freq. (N=150)	(%)
Before eSagu: Mean=5.3 S.D.=1.34	Low (<3.96)	30	20.00
	Medium (3.96-6.64)	95	63.33
	High (>6.64)	25	16.66
After eSagu: Mean= 6.7 S.D.= 1.08	Low (<5.62)	10	6.66
	Medium (5.62-7.78)	100	66.66
	High (>7.78)	40	26.66

Above **table (4.14)** and below **Graph (4.2)** reveals that before application of eSagu, majority of the farmers (63.33%) having medium level of Adoption of the "package of practices" in Rice crop. followed by the low (20.00%) and High (16.66%) level of knowledge. But after delivering the eSagu service we found that majority of the farmers (66.66%) were still under medium level of Adoption. While 26 percent farmer was having High level of Adoption but percentage were increased and 6.66 percent farmers were found with the low level of Adoption but percentage were reduced which shows the positive impact of ICTs mediated extension service.



Graph 4.2 Comparison of respondent's level of Adoption before and after ICTs mediated extension service under Rice crop.

Table 4.15 Difference in the level of Adoption regarding "package of practice" of Rice crop before and after the ICTs mediated extension service.

N	AVERAGE		Mean Difference	
	Before	After		
150	5.3	6.7	1.4	
S. D.		D. F.	t.cal	t.tab. (5%)
Before	After			
1.34	1.08	149	11.715	1.699

$t._{cal.}$ = t calculated value, $t._{tab}$ = 1.699 (at 5 % level of significance)

D.F. = degree of freedom (149), S.D. = standard deviation.

As **table 4.15** revealed that the mean score of the Respondents before eSagu was 5.3 with a standard deviation of 1.34 and the corresponding figure after eSagu service was 6.7 and 1.08. There was highly mean difference (1.4) between the means score of the respondents before and after eSagu service. The t-test result in **table 4.15** shown that the existing difference was statistically significant because at 149 degree of freedom, $t._{cal.}(11.71) > t._{tab.}(1.69)$, at 5% level of significance. It rejected the null hypothesis (H_O) i.e. there is no difference between the level of adoption by the farmers before eSagu and after eSagu service. Then it accepts the alternate hypothesis (H_1) i.e. there is significant difference between the level of adoption by the farmers before eSagu and after eSagu service. It is concluded that the impact of eSagu service on the level adoption by the farmers is significant.

The above result and significant difference in adoption level of respondents after eSagu service is clearly shows that the ICTs mediated extension service has positive impact on the adoption level of respondents. The level of adoption is also controlled by many factors like family income, land holding, occupation etc. but the result is presented by keeping in mind the objectives of the study. The level of adoption is also increased after eSagu service because farmers are able to get timely information on the particular crop by personal interaction with eSagu coordinators hence; they were able to get solution of problems related to seed, fertilizer, and crop protection marketing and other improved technology applied at field level. Consequently their level of adoption was increased.

The above result shows that after eSagu service the percentage of lower group of respondents were decreased up to 3.34 % and the percentages of high category respondents were increased up to 3.33 % but the percentage of medium category were remain same as before (66.66 %). Thus this result revealed that low and high category respondents are more interested to adopt new package of practice under the Brinjal crop. Hence the above result and significant difference in adoption level of low and high category respondents after eSagu service is evidently shows that the ICTs mediated extension service has positive impact on the adoption level of respondents.

SUMMARY AND CONCLUSION

In this age of information technology revolution, extension can empower the farming community with latest knowledge electronic media for development of agriculture sector. Obviously, the physical distance and logistic problems are the major impediments in personal contact between farmers and extension field staff. In this context, strengthening extension services with effective use of electronic media seems indispensable. Thus the research was conducted to assess the impact of "ICTs Mediated Agricultural Extension Service" on knowledge and adoption level of the respondents under the study area. The research was conducted in Varanasi, Mirzapur and Sonbhadra district of Uttar Pradesh. Random sampling technique was used. The total sample size comprised 150 respondents. The data collected through interview schedule then tabulated data were analyzed through computer software (Microsoft office Excel). The majority of the farmers were found in medium category regarding Extension contact, social participation and innovativeness. However the impact of ICTs Mediated Agricultural Extension Service on knowledge and adoption level of the respondents regarding "selected package of practices" for Rice crop was found significant.

Conclusion: On the basis of the major findings of the study it can be concluded that impact of "ICTs mediated Agricultural Extension service" on gain in knowledge and level of adoption of respondents, regarding the selected package of cultivation practiceso for Rice crops was found significant. The results depicted that majority of the respondents dominated by middle age group, OBC category and belonged to the nuclear family.The result from data analysis of socio-economic status of the farmers revealed that majority of the respondents having small land holding and caring out Agriculture as the main occupation, used the commercial bank as the source of finance. Majority of the respondent was medium category regarding social participation, Extension contact and innovativeness.

Implications: The findings of the study opened some opportunities and challenges for the

programme planners, policy makers and administrator working for the successful execution of project and can coordinate with each others for increasing the Rice crop production through implementation of ICTs mediated Agricultural Extension services, some implications emerged as follows:

The findings of the personal and socio economic characteristics of the farmers registered under ICTs based project will be much useful for the extension and social workers in understanding the characteristics of the farmers. It will helpful in designing the location specific and content based component or strategy. As majority of the farmers were found to have low to medium level of extension contact, social participation, and innovativeness. It creates a communication gap between the organization and beneficiaries Therefore there is need for planning systematic, organized and continuous efforts should be applied to increase the awareness and inventiveness of the farmers. he study will give a clear picture of the level of knowledge gain and level of adoption of the respondents before and after implementation of the eSagu project. It indicates the impact of eSagu mediated Extension service on knowledge and adoption of the respondents. Hence, all findings revealed that use of ICTs mediated Agricultural Extension service is beneficial for the farmers for the Vindhyan region of Uttar Pradesh.

REFERENCES

Anuranjan aqnd kumar, S. (2008). Constraints of opportunities for IT in Agriculture and Rural Development. Lead paper of National Seminar on IT in Agricultue and Rural Development, 2008.

Benor, D., Harison, J.Q. and Baxter, M. (1984). Agricultural Extension: the Training and visit system Washington D.C.: the World Bank.

Davison, R.M., Harris R.W., Qureshi S., Vogel D.R., and de Vreede G.H., (2005). Information Systems in Developing Countries: Theory and Practice, City University of Hong Kong Press, 289pp.

De, D. and Jirli, B. (2008). Role of information and communication technologies (ICTs) in communication of Extension system. Lead papers of national seminar on IT in agriculture and rural development, 2008.

Davison, R.M., Harris R.W., Qureshi S., Vogel D.R., and de Vreede G.H., 2005. Information Systems in Developing Countries: Theory and Practice, City University of Hong Kong Press, 289pp.

Hussain, M. (1997). Mass media. *In*: Memon, R.A. and E. Basir (eds.), *Extension Methods*. Pp: 208–61. National Book Foundation, Islamabad Pakistan.

Jha, P.N. (2008). Constraints, Challenges and opportunities for IT in Agriculture and Rural Development. Lead paper of National Seminar on IT in Agricultue and Rural Development,2008.

Kumar, S. (2008). Constraints and opportunities for IT in Agriculture and Rural Development. Lead paper of National Seminar on IT in Agricultue and Rural Development,2008.

Katyal, J.C. (2001). State of Technology Transfer: Proposal of a New Extension Model. CCS Haryana Agricultural University, Hisar, India.

Meera, Shaik N. (2003). A critical analysis of information technology in agricultural development: impact and implications. Unpublished Ph.D. Thesis, IARI, New Delhi.

Qamar, M.K. (2002). Global trends in agricultural extension: Challenges facing Asia and the Pacific Region. Keynote paper presented at the FAO Regional Expert Consultation on Agricultural Extension, Research-Extension-farmer Interface and Technology Transfer, held in Bangkok, 16 19 July

Rajput, A. and kumar, B. (2008). role of ICTs for accelerating communication with hand to reach farmer. Abstract of national seminar on IT in agriculture and rural development , 2008, p.122.

Rao, Siriginidi Subba. (2004). "Role of ICTs in India's rural community information systems", info, Vol. 6 Iss: 4 pp. 261 – 269, retrieved from: www.emeraldinsight.com/1463-6697.htm

R.K.Verma, Dayanand, RS Rathore, SM Mehta and D.S.Bhati, 2016. Impact of adoption of scientific intervention in moong bean on grain yield and farmers income: An assessment by FLDs in Jhunjhunu district of Rajasthan. Jr. of Progressive Agriculture. Vol. 7(1): 87-90.

Saravanan, R. and Devi, I. (2008). ICTs for promoting livelihood security of many tribal farmers of nourth east india . compodium of international semnar on straitgy for improving livelihood security of rural poor . held goa , during 24-27 september, 2008 . pp. 94

Satyanarayana, T.Kausik Majumdar and Biradar, D.P. (2011). Karnataka Journal of Agricultural Sciences. 2011. 24:1,86-90.9 ref.

Srinivasa, P. (2004). "ISP float 'win-win' plan to slash costs", Hindustan Times, 1 June, p.19.

Selwyn, N. (2002) defining the 'Digital Divide': developing a theoretical understanding of inequalities in the information age.

CHARACTERISTICS OF REGISTERED INDIGENOUS HORSE AND PONY BREEDS OF INDIA: A REVIEW

Alok Kumar Yadav[1] and Jitendra Singh[2]
Ph.D. Scholar, ICAR-National Dairy Research Institute, Karnal-132001
Veterinary Officer, Department of Animal Husbandry, Lucknow (U.P.)
Email: alokvet1000@gmail.com

Received: 07.05.16
Accepted: 10.07.16

According to the National Commission on Agriculture (1976), horses (Equus caballus) in India can be placed broadly in two classes viz. the slow moving pack ponies and the fast running saddle horses used for riding or for drawing carriages. The indigenous breeds of horses/ponies include Marwari, Kathiawari, Manipuri, Spiti, Bhutia and Zanskari. Among these, Marwari and Kathiawari are considered as 2 distinct breeds or types although they have several characteristics in common. Kathiawar (Gujarat) and Rajasthan are the homes of Kathiawari and Marwari breeds, respectively. These breeds have been selected both for utility and beauty. Bhutia, Spiti and Zanskari ponies, mainly found in the hilly areas of Himalayan ranges are slow moving horses. The Manipuri horses having qualities of both hill and plain breeds of horses have been bred over centuries in the Manipur area of the northeast. Manipuri horses reputed for their intelligence are used for polo and racing. Three other breeds of India namely Deccani, Chummarti and Sikang are considered to be on the verge of extinction. Besides horses asses (Equus asinus) include Asiatic Indian wild asses comprising of Kulan in the Rann of Kutchh in Gujarat and Kiang in upper Himalayan ranges. It is believed that all the indigenous breeds of the horses are rapidly deteriorating in quality as a result of lack of organized systematic breeding and availability of good specimen animals. Unless huge financial commitment is made, there is a possibility of the breeds losing their identity even in their home tract.

1. Marwari horses

The Marwari or Malani breed is derived from the Marwar region of the Rajasthan - the natural habitat of the breed. The Marwar region includes Udaipur,Jalor, Jodhpur and Rajasamand districts of Rajasthan and some adjoining areas of Gujarat. The Marwari horses are reared mainly for riding and sports and no attempts are being made to prepare them as thoroughbred race animals. The Marwari known for its inward-turning ear tips, it comes in all equine colours although pinto patterns tend to be the most popular with buyers and breeders. It is known for its hardiness, and is quite similar to the Kathiawari, another Indian breed from the Kathiawari region southwest of Marwar. Many breed members exhibit a natural ambling gait. The Marwari are descended from native Indian ponies crossed with Arabian horses, possibly with some Mongolian influence and even the Australian Whalers. The Marwari averages between 15 and 16 hands (60 and 64 inches, 152 and 163 cm) high. Horses originating in different parts of India tend to be of different heights, with the breed having an outside range of 14 to 17 hands(56 to 68 inches, 142 to 173 cm) high. The Marwari horses are longer and taller than Kathiawari horses. They can be bay, grey, chestnut, palomino, piebald or skewbald. Although white horses are bred specifically for religious use in India, they are generally not accepted into Marwari stud books. Gray horses are considered auspicious, and tend to be the most valuable, with piebald and skewbald horses the second-most favoured. Black horses are considered unlucky, as the colour is a symbol of death and darkness. Horses that have the white markings of a blaze and four white socks are considered lucky. Marwaris are also used to play plo, sometimes playing against Thoroughbreds. Within the Marwari breed was a strain known as the Natchni, believed by local people to be "born to dance". The Marwari was distinguishable from the other breeds in terms of both physical

characteristics (mainly height) and environmental adaptability. The physical differences were attributed to differing ancestries: the Marwari are closely associated with the Arabian horse, while the other breeds are supposedly descended from the Tibetan Pony. The Marwari is used for riding, packing and light draught, and agricultural work. Marwaris are often crossed with Thoroughbreds to produce a larger horse with more versatility. Decorated in silver, jewels, and bells, these horses were trained to perform complex prancing and leaping movements at many ceremonies, including weddings. Although the Natchni strain is extinct today, horses trained in those skills are still in demand in rural India.

Improvement and conservation strategies of Marwari horses:

1. Establishment and maintenance of breeding herd in the breeding tract, Marwar region with a minimum strength of 20-30 stallion and 100 mares.
2. Maintenance of this number over different years.
3. Selective breeding among the animals true to the breed.
4. Exclusive use of semen of pure bred stallion in the breeding tract.
5. Registration of true to the breed horses.

2. Kathiawari horses

The Kathiawari breed horse is accepted throughout the India as the purest and oldest of all horse breeds. The breeding tract of the breed is Saurashtra province of Gujarat which comprises of Rajkot, Bhavnagar, Surendranagar Junagarh and Amreli districts of Gujarat. The most prominent body colour in Kathiawari horses is chestnut followed by bay (body chestnut, Foreleg up to knee and fetlock are black, Keshwali black, Hairs of tail and neck are black), grey (complete white colour) and dun (light chestnut). The Kathiawari breed horse averages 13 hands to 14-5 in height and odd Stallions goes up to the 14-5 hands to 15-2 hands in height. The height, body length and heart girth are 130-150, 140-146 and 137-152 cms respectively. The physical characteristics of Kathiawari horses are concave profile, long neck, short leg and squared quarters. Face is dry and short, triangular from pale to forehead and small muzzle, big nostrils, edge of nostril is thin; small, fine and ears are small and maximum of 14 to 17 cms, narrow at base; tips are curved inward and touching or almost touching like a 'Sting of a Scorpion', with rotation of 180 degrees backward. To these must be added dense flat bone, hard feet and hoofs with double in-sole, acute eyesight and hearing, purity and prepotency coupled with a gentle temperament and ability to survive. Black Eel Stripe on back and Zebra markings on front legs are seen in these breed too. These are the hallmarks of the Kathiawari breed. Tail is long, not bushy, curved well and touching to the ground, foot round and broad.

Improvement and conservation strategies of Kathiawari horses:

1. Strengthening of Breeding farm “Gujarat State Animal Husbandry Department Equine Farm Junagarh” to act as nucleous herd.
2. Selective Breeding in true to the breed horses.
3. Efforts should be made to increase herd strength of 20-30 stallions and 100 mares.
4. Exclusive use of semen of purebred stallion in the breeding tract.
5. Registration of true to breed horses.

3. Spiti horses

The Spiti horses are bred in the northern state of Himachal Pradesh in India. The name Spiti has been taken from the famous Spiti river. The Spiti horses are distributed in Spiti valley and adjoining areas of Kullu and Kinnaur divisions of Himachal Pradesh. These horses are smaller in height. The Spiti horses are used for riding and as pack animals. The predominant body colour is grey (complete white) followed by black, black flay bone (white body with black patches), brown and bay. The Spiti horses are hardy and surefooted.

Body is well developed with fairly strong bones. The legs are thick and covered with long coarse hairs. The mane is longer having 20 to 30 cm long hairs. Solid and compact body, convex face, erect ears, black eyes, straight back, long and straight tail, alert looking and short height are some of the important breed characteristics. The horses are nervous in temperament. The Spiti horses have on average 97 cm body length, 127 cm height, 150 cm paunch girth, 15 cm long ear, 49 cm face length and 20 cm face width. It has been observed that females have shorter body, height, heart girth and paunch girth.

Improvement and conservation strategies of Spiti horses:

1. Strengthening of Breeding farm "Himachal Pradesh State Government Horse Farm Karmand (Mandi) to act as nucleus herd.
2. Selective Breeding in true to the breed horses.
3. Efforts should be made to increase herd strength of 20-30 stallions and 100 mares.
4. Exclusive use of semen of purebred stallion in the breeding tract.
5. Registration of true to breed horses.

4. Zanskari horses

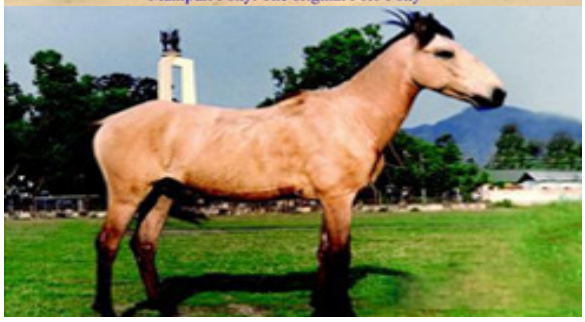
Zanskari horses are bred in the high altitude Zanskar region of Ladakh in eastern Jammu and Kashmir State of India. The predominant body colour is grey followed by black and copper. The horses are known for their ability to work, run adequately and carry loads at high altitude. Horses are medium in size, well built and 120 to 140 cm high. The Zanskari horses have predominant eyes, heavy and long tail and uniform gait. The body hairs are fine, long and glossy. Only a few hundred horses at present exist in the Zanskar and other valleys of Laddakh. Large scale breeding with non descript ponies has endangered this breed. The Animal Husbandry Department, Jammu and Kashmir has recently established a Zanskari horse Breeding farm at Padum Zanskar in Kargil district of Ladakh for breed improvement and conservation through selective breeding.

Improvement and conservation strategies of Zanskari horses:

1. Strengthening of Jammu and Kashmir Government Horse Farm at Leh to act as nucleus need with 20-30 stallion and 100 mares.
2. Maintenance of this number over different years.
3. Selective breeding among the animals true to the breed.
4. Exclusive use of semen of pure bred stallion in the breeding tract.
5. Registration of true to the breed horses.

5. Manipuri horses

Manipuri Pony: The original Polo Pony



The Manipuri horses are bred in the north - eastern state of Manipur in India. The Manipuri has the best claim to fame, for it was the original polo pony. In the 1850's the English planters discovered this native game in India. They then took up and spread around the world. Physique of this horse is typical like that of pony but is very quick and maneuverable. The animals are medium build standing 112-132 cms at withers. The common body colours are bay, brown, grey and chestnut. The ears are alert and almond shaped. Average body weight is 300 kg.

Improvement and conservation strategies of Manipuri horses:

1. Establishment and maintenance of breeding farm in Manipur with a minimum strength of 100 mares and 20-30 stallions.

2. Maintenance of this number over different years.
3. Selective breeding among the animals true to the breed.
4. Exclusive use of semen of pure bred stallion in the breeding tract.
5. Registration of true to the breed horses.

6. Bhutia horses

Bhutia horses are distributed in Sikkim and Darjeeling. They are usually grey or bay coloured and similar to the Tibetan pony. Height at withers is 130-134 cms and body weight 275-340 kg. These horses have strong legs and long hair on neck and tail.

Improvement and conservation strategies of Bhutia horses:

1. Establishment and maintenance of breeding farm in Sikkim/Darjling to act as a nucleus herd with minimum strength of 100 mares and 20-30 stallions.
2. Maintenance of this number over different years.
3. Selective breeding among the animals true to the breed.
4. Exclusive use of semen of pure bred stallion in the breeding tract.
5. Registration of true to the breed horses.

REFERENCE

Behl, R. Behl, J.Gupta, N. Gupta, S.C., 2007. Genetic relationships of five Indian horse breeds using microsatellite markers. *Animal*, **1** (04): 483–488.

Edwards, Elwyn Hartley, 1994. The Encyclopedia of the Horse (1st American ed.). New York, NY: Dorling Kindersley. pp. 162–163.

Gupta, A.K., Chauhan, M., Tandon, S.N., 2005. Genetic diversity and bottleneck studies in the Marwari horse breed. *Journal of Genetics*, **84** (3): 295–301.

Hendricks, Bonnie. International Encyclopedia of Horse Breeds. University of Oklahoma Press. pp. 280–281. ISBN 978-0-8061-3884-8.

ICAR, 2002. Handbook of Animal Husbandry. 3rd Edition, Indian Council of Agricultural Research, New Delhi, pp. 364-383.

Indigenous Horse Society of India. horsemarwari.com. Retrieved March 30, 2009.

Tomar, S. S., 1998. Test book of animal breeding. Voll III, Kalyani publishers, Ludhiana.

अजमेर के जैनों का व्यापार एवं वाणिज्य में योगदान

सुमन राठौड़

व्याख्याता–इतिहास, राजकिय कन्या महाविद्यालय, खैरवाडा

प्राप्ति : 16.07.16

स्वीकारयता : 03.09.16

सारांश

वर्तमान शोध में जैन धर्मावलम्बियों का व्यापार वाणिज्य में योगदान का वर्णन किया गया है। भारत की आर्थिक स्थिति को उन्नत बनाने में जैन समाज सर्वाधिक अग्रणी रहा है। चीन, बर्मा, श्याम तथा पश्चिम में अरब की खाड़ी व यूनान तक जैन साहुकारों का व्यापार होता था। जैन साहूकार मुख्य रूप से आढ़त, हुण्डी, गल्ला, खजांची, कपड़ा, रूई व अफीम का व्यापार करते थे। इस भाग में मध्यकालीन प्रमुख व्यापारियों एवं फर्मो का परिचय भी दिया गया है। जिनमें अजमेर का सोनी परिवार (जुहारमल–गम्भीरमल फर्म) अन्तरर्राष्ट्रीय व्यापार प्राप्त था। उन्नीसवीं शताब्दी में किशनगढ़ जीरा, आढ़त, रूई व सूति कपड़े के व्यापार का मुख्य केन्द्र था। कुछ फर्मो का व्यापार गोटा–किनारी व सर्राफ का भी था। अजमेर मे जैन समाज की जनसंख्या कम होते हुये भी इन्होनें अधिक धन उपार्जित कर वृहद स्तर पर लोक कल्याणकारी कार्य करवाये।

मुख्य शब्द :– अजमेर, जैन संस्कृति, व्यापार एवं वाणिज्य

जैन धर्मावलम्बियों का व्यापार एवं वाणिज्य में योगदान

जैन समाज प्रारम्भ से ही व्यापार प्रधान रहा है। भारत के व्यापारिक और औद्योगिक क्षेत्र में जैनो का प्रमुख स्थान रहा है। प्राचीन काल में जब यातायात के साधनों का पूर्ण अभाव था, तब भी जैन समाज के व्यापार परायण व्यक्ति सुदूर देशों के व्यापार के लिए आवागमन करते थे। जहाजों द्वारा विदेशों से माल का आदान–प्रदान करते थे। विदेशों में व्यापार के साथ–साथ प्रत्यक्ष व परोक्ष रूप से जैन संस्कृति का भी प्रचार–प्रसार करते थे। जैन धर्म के सम्बन्धित अवशेष इस बात को दर्शाते है।

जैनों ने अपनी दूरदर्शिता, बुद्धिमता, व्यवसायिक दृष्टिकोण और अदम्य साहस से व्यापार द्वारा विपुल धन–सम्पति अर्जित की थी। जैन धर्मावलम्बी अल्पसंख्यक होते हुए भी सर्वांगीण समृद्वि की दृष्टि से सर्वोपरी थे।

प्राचीन काल के यातायात की कठिनाईयों की परवाह न करते हुए, जैन व्यापारी घर से लोटा–डोरा लेकर निकलते थे तथा भाषा और सभ्यता से अनभिज्ञ होने पर भी, धर्म और साहस का अवलम्बन लेकर व्यवसाय करते रहे, और अंनतः हिन्दुस्तान के एक छोर से दूसरे छोर तक सभी छोटे–बड़े व्यापारिक केन्द्रों में अपने पैर मजबूती से जमा दिये थे।

जैनियों का व्यवसाय किसी एक क्षेत्र में ही सीमित नही रहा, बल्कि हर क्षेत्र में पूर्ण व्यापक हो गया। संसार का ऐसा कोई देश नही है, जहाँ जैन व्यापारियों का प्रवेश न हुआ हो। अमरीका, इग्लैण्ड, फ्राँस, जर्मनी, अफ्रीका, जापान, रूस, चीन, बर्मा, मलाया, सिंगापुर, लंका, श्याम आदि देशों से तो बहुत, प्राचीन काल से ही जैन व्यापारियों का व्यापारिक सम्बन्ध रहा है।

प्रमुख जैन श्रेष्ठि

राजपूत राजाओं के काल में श्रेष्ठि वर्ग की स्थिति बड़ी ही उल्लेखनीय रही। उस समय में जैन श्रेष्ठियों का राजाओं पर बड़ा प्रभाव था। इन लोगो को राज्य की तरफ से कई प्रकार की सुविधाऐं प्रदान की जाती थी। नगर महन्त को पंचकुल का सदस्य भी माना जाता था। राजाओं द्वारा नगर सेठ की उपाधि देने के बारहवीं शताब्दी तक के वृतान्त भी मिलते है। जैन श्रेष्ठियों में दो प्रकार के वर्ग मिलते है :– 1– राजमंत्री और 2– व्यपारी। राजमंत्री अधिकांशतः राजसेवा में रहते थे। व्यापारी वर्ग अपना विशेष महत्व रखता था। [1]

व्यापार–वाणिज्य वैश्य वर्ण का मुखय कार्य था। जिस प्रकार वैदिक सभ्यता में व्यक्ति की पहचान कर्म से होती थी वैसे ही वर्णो के जातीय स्वरूप ग्रहण करने पर विशेष कार्य–व्यापार के कारण कई वैश्य जातियों का जन्म हुआ था। जो व्यवस्था और कार्य बदल जाने पर आज भी उन्ही प्राचीन नामों से जानी जाती है।

वस्त्र का व्यापार करने वाले 'दोषी' कहलाते थे। जो आज भी राजस्थान गुजरात व मध्यप्रदेश में बहुतायत से पाये जाते है। कपास की खेती व व्यापार करने वाले कपासि, कुम्मट वृक्ष के गोंद का व्यापारी कुम्मट, अनगढ़ सोने का व्यापार करने वाले 'हिरण' सिक्कों के व्यापारी 'नानावाटी', घी बेचने वाले 'धोया' नमक के व्यापारी 'लूणिया' और 'हिंग' के हिंगड़ तथा आभूषणों का व्यापारी (सोनी), सोने के 'कबड्डिया', 'फदिया', 'गदैया' कहलाते थे। ये सभी जैने गोत्र आज भी जैन समाज में ज्यों की त्यों देखने को मिलती है।

संस्कृत में जहाज को 'बौहित्थ' कहा गया है। जहाज के स्वामी एवम् संचालक को 'बोथरा' और 'बोहितरा' कहा जाता था। ये सभी जातियाँ जैन समाज में विद्यमान है। इसी प्रकार तलेसरा, गांधी व पटुआ जातियाँ भी व्यापार विशेष के कारण ही बनी थी। 'पटवा' जाति कपड़ो पर जरी का पक्का काम या कसीदे का काम करने के कारण पटवा कहलाते थे। ये जैन समाज की बापना गोत्र के अन्तर्गत आते है। व्यापार में विशेष सहयोगी कार्य करने से भी जातियों का प्रादुर्भाव हुआ था, जैसे :– हिरण की भांति वस्तुओं को गिनती कर, कर का निर्धारण करने वाले लोग हिरण्य गणक अथवा गन्ना कहलाते थे। हीरे–जवाहरात की परख करने वाले 'पारख' कहलाते थे। ये जातियाँ अजमेर में आज भी मौजूद है। [2]

मध्यकालीन राजस्थान के व्यापार–वाणिज्य की उन्नति में उसकी भौगोलिक स्थिति का भी महत्वपूर्ण योगदान रहा था। देश के उत्तरी, उत्तर–पश्चिमी और दक्षिणी भारत के अधिकांश व्यापारिक मार्ग, राजस्थान से होकर गुजरते थे। इस प्रकार राजस्थान का भारत के उत्तरी एवं दक्षिणी दोनो प्रमुख क्षेत्रों से घनिष्ठ व्यापारिक सम्पर्क बना रहा।

राजस्थान के इतिहास में उन्नीसवीं सदी संक्रमणकाल के रूप में मानी जाती है। सदी के प्रारम्भ मे राजपूत राज्यों को जहाँ मराठों, पिंडारियों एवम् पठानों की लूट–खसोट का सामना करना पड़ा, वहीं सामन्तों एवं शासकों के आपसी संघर्ष का विनाशकारी परिणाम भी देखना पड़ा था। सन् 1818 में राजपूतानें के नाम मात्र के स्वतन्त्र राज्य भी ईस्ट इण्डिया कम्पनी के आश्रित बन गये थे। फिर भी शान्ति और व्यवस्था कायम होने में काफी समय लग गया। सदी के अन्त तक अंग्रेजो ने राज्यों के आन्तरिक प्रशासन पर भी अपना पूर्ण नियंत्रण स्थापित कर लिया था। राजनैतिक उथल–पुथल एवम् अव्यवस्था के वातावरण में भी राजस्थान के जैन सेठ–साहुकारों ने राज्यो के आर्थिक जीवन को पंगु नही बनने दिया और व्यापार–वाणिज्य तथा लेन–देन के कार्य को सुचारू रूप से जारी रखा था।

साहूकारी एवं बैंकर्स का व्यापार

व्यवसायिक दृष्टि से रूपयों का लेन–देन और व्यापार–वाणिज्य जैन साहूकारों का परम्परागत व्यवसाय था। बहुत से जैन परिवार खालसा भूमि के राजस्व और सायर (चुंगी) का इजारा लेने का कार्य करते थे। साहूकार के रूप में साधारण किसान से लेकर शासकों तक को ब्याज पर ऋण देना, इनका मुख्य व्यवसाय था। उन्नीसवीं सदी में कई जैन साहूकारो के घराने राज्यों के खजांची तथा बैकर्स बने हुये थे।

हुडियों का व्यापार

उन्नीसवीं सदी के मध्यकाल तक वस्तुओं के आयात–निर्यात का लेन–देन मुख्यतया हुंडियों द्वारा ही किया जाता था। राजपूत राज्यों का आपसी लेन–देन व ब्रिटिश सरकार को दिये जाने वाले खिराज का भुगतान भी हुंडियों के द्वारा ही किया जाता था। सामान्य सैनिक और राज्य कर्मचारी अपने–अपने घर रूपये भिजवाने के लिए भी हुंडियों का सहारा लेते थे। इस व्यवसाय में जैन साहूकारों ने अपनी अच्छी साख बना ली थी। कोटा राज्य का खिरा मुख्यतः मंगनीराम जोरावरमल की हुंडियों के द्वारा ही जमा होता था। अंग्रेज सरकार ने सेठ मंगनीराम जोरावमल को चार प्रतिशत कमीशन पर उदयपुर राज्य का खिराज हुंडियों के द्वारा अजमेर के खजाने ने जमा कराने की आज्ञा दे रखी थी। अजमेर के कमलनयन हमीरसिंह, पदमसी नैनसी और लूनकरण रिद्धकरण फर्म आदि हुंडियों के व्यवसाय हेतु प्रसिद्ध थी। [3]

उन्नीसवीं सदी के उतरार्द्ध में राजस्थान की आर्थिक स्थिति में बहुत ज्यादा परिवर्तन हुये थे। अंग्रेजो ने राजपूताना को अपनी आर्थिक साम्राज्यवादी नीति में लपेट लिया था। राज्यों में खानों का उत्खनन बन्द हो गया व नमक–उद्योग पर ब्रिटिश आधिपत्य हो गया ओर रेल मार्गो के खुल जाने से पुराने व्यापारिक केन्द्रों का महत्व समाप्त हो गया, भू–राजस्व ओर सायर वसूली प्रथा समाप्त हो गयी थी। राज्यों में आधुनिक खजानों की स्थापना ने राज्यो के साथ लेन–देन और ब्याज व्यवसाय को भी काफी सीमित कर दिया। इस प्रकार धन सम्पति अर्जित करने के परम्परागत साधन सीमित होते गये। ऐसी स्थिति में व्यापारियों और सेठ साहूकारों ने राजस्थान के बाहर ब्रिटिश प्रान्तों तथा

अन्य देशी रियासतों में अपना भाग्य आजमाने का प्रयत्न किया। यह क्रम बीसवीं सदी में भी जारी रहा। सुदूर अनजाने प्रदेशों मे जाना और वहाँ बसना सरल काम नही था, फिर भी उन्होंने अदम्य साहस का परिचय देते हुए, बंगाल, आसाम, मद्रास आदि प्रान्तों में अपनी गद्दियां स्थापित की। प्रारम्भ में वे लोग बेनियन हुए। फिर मुत्सदी, मुनीम और दलाल हुए। लेकिन बीसवीं सदी के प्रारम्भ तक में बैंकर्स, कपड़े के व्यापारी प्रधान जूट बेलर, लोहे के, चाय बगानों के स्वामी व अफीम के प्रतिष्ठित व्यापारी के रूप में दिखाई देने लगे। इस तरह अनेकों जैन परिवारों व्यापार–वाणिज्य के लिए राजस्थान छोड़कर अन्य प्रान्त एवं विदेशों में बस गये और अच्छी सम्पत्ति का अर्जन किया व साथ ही साथ जैन संस्कृति का प्रचार–प्रसार भी किया। [4]

चर्म, मांस–मद्य आदि घृणित उद्योगों को छोड़कर अन्य इसी तरह के उद्योगों में जैनों ने प्रवेश किया था। वस्त्र, सोना, चाँदी, जवाहरात, किराना, अनाज, रूई–ऊन आदि उद्योगो में इनकी ज्यादा रूचि रही। अपनी व्यापारिक प्रतिभा और द्रव्यराशि के बल पर, उन्होनें कुछ उद्योगो पर तो एकाधिपत्य कर लिया था। वे भारत ही नहीं बल्कि अन्तर्राष्ट्रीय बाजारों में भी उथल–पुथल मचा देने की क्षमता रखते थे। सेठ हुकमीचंद ने रूई के व्यवसाय में इतना प्रभुत्व प्राप्त कर लिया था कि उनके रूख पर अमेरिका के बाजारों में उथल–पुथल हो जाया करती थी। जैनों में कई व्यापारी, "कॉटनकिंग", "सिल्वर किंग" तथा "शेयर किंग" के नाम से व्यापार में प्रतिष्ठित हुए थे। देश की औद्योगिक सम्पत्ति को बढ़ाने में भी जैन व्यापारी पीछे नहीं रहे थे। वस्त्रोद्योग, तेल उद्योग, जिनिंग एवम् प्रेसिंग फैक्ट्रियाँ प्रिटिंग प्रेस, सीमेंट, रबर एवं प्लास्टिक बर्तन उद्योग इत्यादि। अनेक उद्योग जैन व्यापारियों द्वारा संचालित थे। सर सेठ हुकमीचंद, कस्तूरभाई, लालभाई, शांतिलाल–मंगलदास, कैन्हयलाल भण्डारी, डालमिया साहू, श्रेयास प्रसाद आदि अनेक प्रसिद्ध उद्योगपति थे। सर चुन्नीलाल भागचंद तो अन्तर्राष्ट्रीय ख्याति प्राप्त जैन उद्योगपति थे। अजमेर क्षेत्र में अजमेर, ब्यावर, किशनगढ़, केकड़ी आदि मुख्य जैन व्यापारिक केन्द्र रहे है।

प्रमुख व्यापारिक केन्द्र

अजमेर के जैन साहुकारों का व्यापार जयपुर, जोधपुर, टोंक, कोटा, उदयपुर, इन्दौर, उज्जैन, ग्वालियर, झांसी, पूना, हैदराबाद, कलकत्ता, फरूखाबाद, मिर्जापुर, कानपुर, सितामऊ, मुम्बई, मालवां, भोपाल, मद्रास, आसाम, पंजाब एवं विदेशों में रंगून, हागंकांग, इंग्लैण्ड, जापान, चीन आदि क्षेत्रों तक फैला था। [5]

अजमेर क्षेत्रा के प्रमुख जैन व्यापारी

मेहता गंभीरमल

अजमेर के मेहता गंभीरमल के घराने के कई वर्षो तक कई राज्यों के लिए खजाने तथा बैंकर्स का काम किया था। मेहता प्रतापमल के समय, इस घरानें का राजस्थान की बहुत सी रियासतों के साथ लेन–देन का कार्य होता था। अजमेर के जैन साहूकारो में मेहता प्रतापमल के घरानें की दुकानें कलकत्ता हैदराबाद, पूना, जयपुर, जोधपुर, उदयपुर, इन्दौर, टोंक, उज्जैन आदि स्थानो पर थी। मेहता लालचन्द की ग्वालियर, झांसी, फरूखाबाद, मिर्जापुर, भोपाल, जयपुर आदि स्थानो पर सराफ की दुकानें थी। इस घराने की प्रसिद्व फर्म "लूनकरण रिद्धकरण" की 25–30 शाखाएं उत्तरी भारत में फैली हुई थी। इनका मुख्यतः बैकर्स, हुंडियों तथ सराफ का व्यापार था।

सेठ कमलनयन हमीरसिंह लोढ़ा

सेठ कमलनयन–हमीरसिंह लोढ़ा के घराने की गिनती अजमेर में ही नहीं राजस्थान के प्रमुख व्यापारियों में की जाती है। बैंकर्स व हुंडियों का व्यापार करने वालों में, इस घराने की बहुत प्रतिष्ठा थी। इनका जयपुर, जोधपुर, किशनगढ़ टोंक आदि रियासतों के साथ लेन–देन का कार्य होता था। इस घराने के सेठ समीरमल को अलवर, कोटा, जोधपुर, रेजीडेन्सियों तथा वेदली और एरनपुरा की अंग्रेज सैनिक छावनियों के खजानें का काम भी सौंपा गया था। 'कमलनयन–हमीरसिंह' फर्म की दुकानें जयपुर, जोधपुर, किशनगढ़, फरूखाबाद, टोंक, सीतामऊ, कलकत्ता, बम्बई, कोटा, अलवर, सिरोज आदि अनेक स्थानों पर कायम थी। सेठ हमीरसिंह लोठा ने ब्यावर में एडवर्डमिल की स्थापना करके वस्त्र उद्योग को एक नया आयाम दिया था। [6]

पदमसी नेनसी ढ़ढ्ढ़ा

अजमेर में बस जाने वाले सेठ पदमसी नेनसी ढ़ढ्ढ़ा के घराने ने भी बैंकिंग व्यवसाय तथा हुंडियो के व्यवसाय में काफी ख्याति अर्जित की थी। इस घराने का कई देशी रियासतों के साथ लेन–देन का व्यापार था। इसी घराने के सेठ 'अमरसी ने हैदराबाद दक्षिण में प्रसिद्ध "अमरसी सुजानमल" फर्म कायम की थी। इस फर्म ने दक्षिण भारतीय शासकों के साथ लेन–देन का काम किया था। अजमेर की प्रसिद्ध फर्म "पदमसी नेनसी" हुंडी का व्यवसाय करने में अग्रणी थी, जिसकी शाखाऐं

दक्षिण भारत में मद्रास और पूर्व में आसाम तथा उत्तर में पंजाब तक फेली हुई थी।

सेठ सौभाग्यमल जी सा.लोढ़ा

अजमेर का लोढ़ा परिवार राजस्थान के ख्याति प्राप्त एवम् प्रतिष्ठित परिवारों में से था। इस परिवार के सेठ उम्मेदवाल जी बड़े ही नामी लोकप्रिय व धर्मनिष्ठ व्यक्ति हुऐ। व्यापार के क्षेत्र में बड़े ही दक्ष थे। सन् 1901 में इनको भारत सरकार द्वारा 'दीवान बहादुर' की पदवी से शुशोभित किया गया था। इनके द्वारा सेठ समीरमलजी के दूसरे पुत्र अभयमल को गोद लिया था। सेठ अभयमल बड़े ही लोकप्रिय और कार्यदक्ष थे। इन्होने अपने पूज्य पिताजी की स्मृति में इम्पीरियल रोड़ पर एक विशाल एवम् आरामदायक धर्मशाला बनवाई, 29 वर्ष की आयु में ही इनका देहावसान हो गया था। इस घराने का उम्मेदमल जी अभयमल जी फर्म के नाम से व्यापार होता है। इसके अलावा ये मेवाड़ टेक्सटाइल मिल्स लि0 भीलवाड़ा के मैनेजिंग डायरेक्टर भी रहे थे। मैसर्स "उम्मेदमल अभयमल" के नाम से अजमेर, बम्बई व कोटा आदि अनेक स्थानो पर इनकी फर्म स्थापित है। [7]

सेठ रामलाल जी लूणिया

अजमेर के सबसे बड़े सराफ (सोने चांदी के व्यापारी) तथा बैंकर्स के रूप में इनका प्रतिष्ठित स्थान था। अजमेर के सार्वजनिक क्षेत्रों में इनका बड़ा ही सम्मान था। इनके विचार बड़े सुलझे हुए, गम्भीर, सुधारपूर्ण व जनहित से ओतप्रोत थे। जिस प्रकार ये धनी थे, उसी प्रकार यशस्वी भी थे। ये अब तक कई संस्थाओं के सभापति के खजांची रह चुके थे। इनका "सेठ रामलाल लूणिया बैंकर्स" के नाम से अजमेर में सोने–चांदी का व्यवसाय था। इनके पुत्र अमरचन्द भी एक सद्विचारवान, सार्वजनिक कार्यो में उत्साही एवं सक्रिय सहयोगी थे। ये नवोदित उत्साही व्यापारी युवक समाज में बहुत प्रतिष्ठित थे।

सेठ इन्दरचन्द बड़जात्या

इनका मूल निवास स्थान साखून, रियासत जयपुर में था। वहाँ से बहुत लम्बें समय पहले, सेठ चम्पालाल बड़जात्या व्यापार करने हेतु अजमेर आये थे। इनके अमोलक चन्द नाम पुत्र हुए, जो बड़े ही धर्मात्मा और बुद्धिमान थे। जिनके सेठ इन्दरचन्द व धन्नालाला दो पुत्र हुए, जिनमें सेठ इन्दरचन्द ने अपनी तीव्र प्रतिभा व बुद्धि से अपने करोबार को चमकाया। प्रारम्भ में इनके द्वारा बड़ी–बड़ी फर्मो में मुनीमयत व खजांची की भी नौकरी की गई थी। उसके पश्चात् एक माहेश्वरी की साझेदारी में गोटे–किनारी की दुकान की, फिर धीरे–धीरे साधारण स्थिति से ऊँचे उठकर अजमेर के एक बड़े प्रतिष्ठित व्यवसायी माने जाने लगे थे। इनका अजमेर में गोटे–किनारी का सबसे बड़ा कारखाना है। कारखाने में पक्का व कच्चा गोटा बहुत बड़ी मात्रा में तैयार किया जाता है। भारत के कोने–कोने में यहाँ से गोटा भेजा जाता है। यह फर्म "सेठ इन्दरचन्द कुन्दलमल बड़जात्या" गोटे वाले फर्म के नाम से कार्य करती है। व्यापार के साथ ही इनका धार्मिक, सामाजिक व सार्वजनिक कार्यो में भी उदारता पूर्ण सहयोग रहता है। [8]

सेठ जवाहरमल जी सोनी

इनके पूर्वज किशनगढ़ के निवासी थे। फिर यह परिवार किशनगढ़ छोड़कर अजमेर आ गया। अजमेर में जाने पर ही 'जवहारमल–गंभीरमल' फर्म का श्री गणेश लगभग 200 वर्ष पूर्व किया गया था। इन्होने व्यापार जगत में अपनी बड़ी अच्छी साख जमाई थी। यहीं से प्रख्यात सोनी वंश की अभिवृद्धि प्रारम्भ हुई।

राय बहादुर सेठ मूलचन्द सोनी

राय बहादुर मूलचन्द सोनी ने व्यापार के क्षेत्र में अपनी बुद्धि, चातुर्य और साहस से ऐसा कार्य किया कि ये राजपूताने के श्रेष्ठ व्यवसायी माने जाने लगे थे। इनका जन्म 1830 ईस्वी व मृत्यु सन् 1901 में हुई थी। इन्होनें कई कोठियों का निर्माण कराया। लोकहित के अनेक कार्यो के कारण ये बहुत यशस्वी हुए थे।

राय बहादुर सेठ नेमीचन्द सोनी

इनका जन्म विक्रम संवत् 1913 (सन् 1856) में हुआ था। इन्होने अपने पिताजी द्वारा प्रारम्भ किये कलापों को पनपाने में अपना पूर्ण मनोयोग लगया। अपनी वंश परम्परागत धातियों का संरक्षण किया। आपको ब्रिटिश व देशी रजवाड़ो में बड़ी प्रतिष्ठा थी। जैन समाज का नेतृत्व तो इनको विरासत में मिला। ये मजिस्ट्रेट और म्यूनिसिपल कमिश्नर भी रहे। प्रथम महायुद्ध में इन्होनें ब्रिटिश सरकार की सहायता की थी। व्यावसायिक क्षेत्र में इन्होनें बहुत प्रगति की थी।

सेठ टीकमचन्द जी सोनी

सेठ टीकमचन्द सोनी का जन्म सन् 1882 (विक्रम संवत् 1939) में हुआ। ये बड़े धर्मात्मा, उदार, निरभियानी और सरल स्वभावी व्यक्ति थे। इनकी धार्मिक वृति एवं सेवा के कारण इनको 'धर्मवीर' की पदवी से भी अलंकृत किया गया था। व्यावसायिक क्षेत्र में इन्होने अपनी फर्म की प्रतिष्ठा को बहुत बढ़ाया। बी. बी.एण्ड.सी. आई रेल्वे के खजांची होने के साथ–साथ

कई देशी रेल्वे के खजांची भी रहे। कई देशी रजवाड़ो का खजाना, इनके द्वारा संचालित होता था। इनके समय में फर्म की नई कोठियाँ निर्मित कराई गई और व्यवसाय ने बहुत उन्नति की थी। सन् 1939 में इनका आकस्मिक स्वर्गवास हो गया था।

सर सेठ भागचन्द

श्री दानवीर जैन जाति शिरोमणि, धर्मवीर रायबहादुर सर सेठ भागचंद सेानी का जन्म 11 नवम्बर, सन् 1904 को हुआ था। इनके पूज्य पिताजी के स्वर्गवास के बाद, जीवन के तीन दशक समाप्त होने पर, सर सेठ जुहारमल–गंभीरमल फर्म के उत्तराधिकारी बने थे। छोटी अवस्था में ही सारा कार्य भार इनके उपर आ गया। इनकी बहुमुखी प्रतिभा के कारण व्यवसाय जगत में अच्छी प्रतिष्ठा प्रापत की तथा देश के प्रमुख नगरों में इनका व्यापार फैला था। इनका मुख्य व्यवसाय हुंडी, बैकिंग व सहकारीता का रहा था। इन्होनें टैक्साटाइल मिल व जीनिंग प्रैसिंग फैक्ट्री का संचालन भी किया। इनके माइनिंग डिपार्टमेंन्ट में पन्ना व अभ्रक का उत्पादन होता था। भारत में पन्ने की खोज का श्रेय केवल इसी फर्म को है। संयुक्त राज्य अमरीकन से प्रकाशित एक पुस्तक 'वर्ल्ड' ज्वेलर्स डायरेक्टरी में यह स्वीकार किया गया है कि इस युग में भारत में पन्ना की खोजकर्ता सेठ भागचंदजी सोनी की फर्म रा.ब. सेठ मूलचन्द नेमीचंद माइनिंग डिर्पाटमेंट है। उन्होनें ही सबसे पहले उदयपुर व अजमेर में पन्ना की खानों का पता लगाया था। कई वर्षो तक इस उद्योग पर इन्हीं का एकाधिकार बना रहा। इस फर्म द्वारा भीलवाड़ा (मांडल) में अभ्रक व्यवसाय को भी गति प्रदान की गई तथा ये कई वर्षो तक राजस्थान ज्वेलर्स एशोसिएशन के अध्यक्ष भी रहे। अंग्रेजी शासनकाल में आप बी.बी. एण्ड सी.आई. रेल्वे के खजांची और देशी रियासती रेल्वे जोधपुर, उदयपुर राज्य की रेल्वे के खजांची रहे। राज्य सरकार इन पर बहुत विश्वास करती थी। अतएव ये भरतपुर, धौलपुर, शाहपुरा स्टेट के ट्रेजरार ओर ग्वालियर, जोधपुर, भरतपुर, रेजीडेन्सी के खजांची तथा भारत की कई प्रमुख कम्पनियों के डायरेक्टर भी रहे। सन् 1983 में इनका स्र्ववास हो गया था। [9]

एक क्रान्तिकारी व सुधारवादी विचारों के सज्जन थे। अजमेर के गोटा व्यवसाय में इनका प्रमुख स्थान है। सन् 1933 से यह अजमेर में रह रहे है। सरवाड़ और अजमेर में इनके गोटै के कारखाने है। [10]

पद–टिप्पणियाँ

1. सोमानी, रामवल्लभ – पूर्व मध्यकालीन जैन श्रेष्ठि, पृष्ठ संख्या 352, 355 357.
2. मेहता, बलवन्त सिंह – वही, पृष्ठ संख्या 350–352.
3. शर्मा, कालूरा – उन्नीसवीं सदी के राजस्थान के अधिक जीवन में जैन परिवारों का योगदान, पृष्ठ संख्यसा 361–364.
4. भानावत, नरेन्द्र – जैन संस्कृति और राजस्थान, पृष्ठ संख्या 365–366.
5. शर्मा, कालूराम – वही, पृष्ठ संख्या 361–364.
6. पाटनी, इन्द्रचन्द – व्यवस्थापक, सिद्धकूट चैत्यालय, अजमेर.
7. शर्मा, कालूराम – वही, पृष्ठ संख्या 362–366.
8. जैन, भानमल – जैन गौरव स्मृतियां, पृष्ठ सख्या 575–576, 663–64, 668.
9. सोनी, निर्मचन्द – जुहारमल गम्भीरमल फर्म उत्तराधिकारी (सोनी परिवार).
10. जैन, भानमल – वही, पृष्ठ संख्या 666.

DECLARATION
Form IV
(See Rule 8)

Statement about ownership and other particular of Journal of Progressive Agriculture

Place of publication	:	Ajmer, Rajasthan, India
Periodicity of publication	:	Half Yearly
Printer's Name	:	Shree Offset, Printing Press, Ajmer.
Nationality	:	Indian
Address Kesar Ganj, Ajmer (Raj.)	:	M/S Shree Offset, Printing Press,
Publisher's name	:	Sh. Ram Singh Bhati President of Samaj Kalyan Avam Samannvit Vikas Sanstha, Ajmer (Rajasthan)
Address	:	316/A, Christian Ganj, Ajmer (Raj.) India
Editor's name	:	Sh. Ram Singh Bhati President of Samaj Kalyan Avam Samannvit Vikas Sanstha, Ajmer (Rajasthan)
Nationality	:	Indian
Address	:	316/A, Christian Ganj, Ajmer (Raj.) India
Name and address of individual who own the newspapers/journal partners and shareholders holding more than 1% of the total capital		Samaj Kalyan Avam Samannvit Vikas Sanstha, Ajmer (Rajasthan) India

.

I, Ram Singh Bhati, publisher, printer and owner of this journal hereby declare that particular given are true to the best of my knowledge and belief.

Sd/-

Dated: 18th Oct., 2016 (Ram Singh Bhati)