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Physiological disorders in fruits in arid region- A review

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Abstract
Physiological disorder are distinguished from other disorders in that they are not caused by living organisms, but are caused by non-living, abiotic situations and cause a deviation from normal growth. Most of them are not reversible once they have occurred. The present review attempts to address this issue taking into account the fruit in general and fruits of arid region in particular.

Key words: Physiological disorder, ber, pomegranate, bael, fig

The arid region are having nutrients deficient sandy soils along with fragile edaphic and climatic conditions. Growing of annual crops during the most congenial part of the year is the only source of livelihood for the people of the arid region. These crops often encounter abiotic stresses like drought, hot and desiccating winds, nutrient deficiency during their growth period leading to poor productivity. These regions have tremendous potential for cultivation of perennial fruit trees. The arid regions have been identified for successful fruit production zones. The overall scenario of arid region in the country indicates three to four distinct production system. The parts of Rajasthan and Haryana adjoining to Punjab having a network of canal irrigation with predominance of light textured sandy soil are being utilized for fruit production like citrus, kinnow, ber, anola, grape, pomegranate, date palm, etc. The southern part of Rajasthan and northern part of Gujarat adjoining Madhya Pradesh having comparatively heavier soil and moderate rainfall are being utilized for cultivation of different arid and sub-tropical fruits. The plateau region of Madhya Pradesh, Maharashtra, Karnataka and Gujarat having semi-arid climate with predominance of light textured rocky soils having poor water holding capacity are being utilized for production of various arid, semi-arid, subtropical and tropical fruit crops. The western part of Rajasthan, parts of Punjab and Haryana and Kachchh region of Gujarat are suitable for date palm cultivation (Singh and Dhandar, 2007).

Sustainable fruit production under these fragile agro-ecosystem encounter different kinds of biotic and abiotic stresses. The effects of these abiotic stresses are expressed in forms of different physiological disorders. The physiological disorders observed in different fruit plants can be broadly categorized into nine types depending on the causal factors inducing them. However, the interaction of different factors plays major roles in inducing some of the most important physiological disorders. Physiological disorders in fruit crops can be grouped as given in table 1.

Table 1: Major physiological disorders of fruit crops.

Disorder groups	Physiological disorders	Fruit crops affected
Nutrient related disorders	Necrosis/internal browning	Aonla
	Black tip	Mango
	Fruit cracking	Pomegranate, ber, bael
	Gummosis	Peach, Mango, lemon
	Leaf scorch	Mango
Temperature related disorders	Scorching	Litchi
	Puffiness in citrus	Citrus
	Unfruitfulness	Aonla
	Spongy tissue	mango
	Chilling injury of rind	Pomegranate
	Internal browning	Pomegranate
	Frost/low temperature injury	Aonla, Lasoda, ber,
Water/moisture stress related disorders	Fruit cracking	Pomegranate, litchi, lemons,

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Water/moisture stress related disorders	Fruit cracking	Pomegranate, litchi, lemons,
	Granulation of juice vesicles	Citrus
	Shrinking of fruits	Grapes
Heat/Radiation related disorders	Sun burn, scorching	Pomegranate, Bael
Disorders due to harmful gases	Black tip	Mango
Disorders related to genetic factors	Short berries in grapes	Grapes
	Fruit cracking	Ber
Disorders due to lack of pollination	Jhumka in mango	Mango
	Misshaped fruits	Custard apple
	Fruit drop	Mango, Date palm
Disorders due to plant conditions	Alternate bearing	Mango
Disorders due to phenolic oxidation	Husk scald	Pomegranate
	External browning	Pomegranate

Fruit drop

Fruit drop is a serious disorder of many fruit species. In general, large fruit set has been observed initially out of which only few remain till the maturity. Fruit drop start just after fruit set and continue till the maturity. The mechanism of fruit drop is considered to be the formation of abscission layer at the stalk end of the fruit. The amount of drop varies with environmental condition, cultural operation and more so ever with the cultivars in different fruit crops. Three stages of fruit drop *i.e.* initial fruit drop, advanced fruit drop and pre mature fruit drop has been very common. The complex of situations like lack of pollination and fertilization, embryo abortion, internal nutrient imbalance, hormonal imbalance, moisture stress due to high temperature, low humidity and strong winds are considered as the principal factor for the fruit drop. The major fruit crops suffered with fruit drops are mango, litchi, citrus among tropical and sub tropical fruits, apple, peaches, pears and stone fruit among temperate fruit, aonla, ber, bael, date palm, wood apple, tamarind among the fruit grown under fragile agro ecosystem of arid and semi arid regions. The problem of fruit drop become sometime alarming under the poor soil moisture, high temperature, low humidity and strong winds situations which is a common feature in the arid region. Therefore, the understanding of the problem and its timely management has special significance in sustainable fruit production under fragile agro ecosystem.

The detail account of information regarding fruit drop has been generated in important crops like mango, ber, bael, custard apple and aonla. Mishra *et. al.* (1973) has also noticed two distinct phase of drop, found a complex of a number of internal (failure of fertilization, embryo abortion, hormonal imbalance) and external factor (mineral nutrition, high temperature, low humidity, strong winds and attack of insect) along with, stage of the plant (older plants encounter higher drop) associated with fruit drop. In case of mango, it has mentioned three distinct phase i.e. pinhead drop (fruit measuring 4mm diameter and below during April), post setting drop and May drop under north Indian condition. The different factor considered for this physiological disorder in mango include deficient nutrition, lack of cross pollination, poor pollen transference, low stigmatic receptivity, defected perfect flower, self incompatibility competition between developing fruit lets, drought condition, inadequate irrigation, high wind velocity and natural calamities like hail storms, severe biotic pressure like powdery mildew, mango hopper along with varietal characteristic . Similarly in case of aonla, it has been mentioned three stages of fruit drop based on the fruit growth. The July drops takes place when the fruit are at pea size stage. The main region for this drop is due to lack of pollination, and imbalance of nutrient. The August-September drop of the developing aonla fruit is mainly due to attack of fruit borers and incomplete fertilization. The October drop which is more harmful for the orchardist is mainly due to moisture stress and internal necrosis due to micro nutrient deficiency.

Thus, it has been found that fruit drop is a serious physiological disorder in many fruit crops leading to 15-20% loss of crop in many fruit. A suitable strategy is need of the hour to manage this malady. Attempts have been made to control the fruit drop. In litchi spray of 20-25ppm GA, and NAA have been found effective in minimize the fruit drop (Singh and Lal, 1980). Mishra *et al* (1973) reported that two sprays of NAA (20ppm), first at the time of fruit set and the second at pea size stage reduced the fruit drop considerably. Xiang *et. al.* (1994) stated that pollination and fertilization stimulate cytokinin, IAA and GA content and decreases abscissic acid content in the ovary after anthesis which is conducive for good fruit set. Lin (1994) reported that the fruit drop can be reduced by flower panicle thinning and reducing the density of flower buds during early stage of flowering. In case of mango, foliar

application of NAA (10ppm), 2,4-D (20ppm), Zinc sulphate (0.2%), Boric acid (0.4%), during April has been found effective to control the fruit drop. In case of aonla two sprays with NAA (10ppm) + Boric acid (0.4%), 1st-at pea stage during July and 2nd-after one month of the 1st spray reduces the fruit drop and improves the quality of aonla fruit.

Fruit cracking

Fruit cracking or fruit splitting is a serious problem in many tropical, subtropical and arid fruit, like litchi, mango, citrus, pomegranate and bael. The fruit cracking generally occur during last stage of fruit development due to environmental factor. Splitting of fruit skin occurs due to differences in growth of mesocarp and pericarp. The developing mesocarp exerts an internal pressure on pericarp causing the cell to stretch. Since no cell division takes place in the pericarp at the last phase of development, the skin can't bear the internal pressure and finally cracks. Nutritional and water deficiency, genetical factor, anatomical factor, environmental factor, hormonal factor, nutritional and soil moisture factor also play an important role in the many fruit. In mango infection due to bacterial canker and black tip also aggravates the pericarp splitting. In arid fruits like pomegranate, ber and bael fluctuation of soil moisture and existence of dry weather condition are considered as the main cause for fruit cracking. Under these circumstances due to high moisture content, the mesocarp develops rapidly than the pericarp due to more diversion of water from to main sink (mesocarp) than skin. Simultaneously, due to more water absorption the pericarp become more turgid and prone to splitting under environmental stress. In litchi and pomegranate fruit cracking causes more than 20% loss the detail factor responsible of fruit cracking in litchi have been discussed.

(1) Genetical factor- The various cultivars of litchi varies with respect to fruit cracking.

Chadha and Rajput (1969) observed that fruit cracking in litchi varies from 0.3% (Seedless) to 27.4% (Dehradoon). It has been observed that early maturing cultivars of litchi are more susceptible to fruit cracking than late maturing cultivars. Cultivar like, Swarna Roopa, Hong Kong and China are found to be moderately resistant to resistant against cracking.

(2) Anatomical factor Teaotia and Singh (1970) suggested that during drought period strengthened tissue developed in xylem and phloem. Loss of their ability to divide and enlarge soon after a dry spell if water supply is increase, the meristematic tissues quickly resume growth owing to differential growth rate and harder tissue raptures. It was also suggested the some incipient cracks originate on hypertrophied lenticels. The lenticels hypertrophy may be caused by excessive retarded transpiration accompanied by more water supplies to regions of hypertrophy. During the growth phase, the rapid flush growth synchronized with the period of high temperature and low humidity resulting in localized light brown blotches on the fruit skin directly faces the sun rays. The blotches become more intense and dry up gradually leading to a small radial rapture on the skin

(3) Environmental Factor- Environmental condition like temperature, relative humidity and rain fall are also associated with fruit cracking. Hot dry condition along with desicating wind at the time of ripening are the main cause of fruit cracking. Temperature more than 38°C coupled with relative humidity less than 60 % is the most favorable conditions for fruit cracking. Sharp fluctuation in day and night temperature along with heavy irrigation after dry spell causes fruit cracking. High temperature and low humidity at maturity and prolonged rains at maturity also cause cracking in litchi, mango and lemon.

(4) Hormonal factor- Lower level of auxin in skin and seed and higher level of auxin in the aril are found responsible for fruit cracking in litchi.

(5) Nutritional factor- Micro nutrients such as zinc and boron are associated with the fruit cracking in litchi and other fruits. The low level of these micro nutrients causes the fruit cracking in litchi because the spray of these micro nutrients is effective in reducing the fruit cracking in litchi.

(6) Soil moisture- The loss of soil moisture and prolonged irrigation interval during fruiting season have been found to be associated with severe fruit cracking in litchi. Inadequate moisture during early growth period of fruit results in hard and inelastic skin resulting in the cracking at the time of rapid aril growth after irrigation (Menzel, 1984).

Water berries in grapes

The disorder is characterized by shriveling of berries in the beginning followed by drying. Shrivelling is usually at the tip of the bunch however, it may be scattered within bunch also. Affected berries look like cellophane bags, half filled with sap and remains hanging from the bunch. The berries become soft, watery and dull in colour though almost normal in size. Frequent irrigation and nitrogen application during berry growth period lead to development of water berries. Injury of wood due to faulty girdling and water stress during the course of healing of girdle also contribute towards this disorder.

In this condition berries lack normal sugar, flavor and keeping quality. The disorder is mainly due to overbearing and inadequate nourishment to the affected berries in a cluster. Avoid injury to wood while girdling, which is recommended to improve fruit quality in grapes.

Spongy tissue

Spongy tissue is a serious physiological disorder of mango in Maharashtra, Karnataka, Gujarat and Andhra Pradesh. It is characterized by development of non edible, sour, yellow sponge like patches with or without air pocket in mesocarp of fruit during ripening. It is also known as internal breakdown. The fruit become unpalatable and affected tissues are visible when ripe fruits are cut. The severity of disorder is up to 30% in some varieties of mango.

The disorder is associated with different factors like cultivar susceptibility, location of orchard, age of plants, nutritional conditions of the plant, etc. Alphanso is the most affected cultivar. Cultivars like Pairi, Neelam, Dashehari are almost free from the disorder. Alphanso

orchards near coastal belts are found to be more affected by spongy tissue. Trees near base of hills are more affected than those on slops and at the higher altitudes. Older plants have more severity than young plantations. Lower content of calcium and magnesium in the leaves are associated with more severity of spongy tissue (Joshi and Roy, 1985). Intense solar radiation particularly at the time of fruit maturity is considered to be the most important factor for spongy tissue. Gunjate *et al* (1979) noticed that sod culture and mulching of orchard floor with dry grasses during fruit development and maturity reduces the incidence of spongy tissue in fruit of Alphanso mango. They also suggested that removal of field heat from the fruits by dipping the harvested fruits in cool water containing calcium chloride (2%) also checks the spongy tissue.

Black tip

Black tip is a nutrient and harmful gas related disorder of mango particularly in north India and does not occur in any other country. It has been reported to occur in regions of West Bengal, Uttar Pradesh, Bihar and Punjab in orchards located in close proximity of a brick kiln. South India is free from this disease. The symptoms manifest as small etiolated area at the distal end of the fruit, which gradually spreads, turns nearly black and covers the tip completely. Before the etiolation is complete, isolated grayish spots appear which become dark brown, enlarge and coalesce into a continuous necrotic area. The brown discoloration spreads to the neighboring parenchyma and the deposits also appear in the ducts. The browning and deposits gradually spread throughout the mesocarp and the affected cells disintegrate and coalesce into a dead tissue. In severe cases, the necrosis extends to the endocarp and affected fruit drops from the tree. The control measure lies in keeping the brick kilns away from the mango orchards. The use of telescoping chimney 12-15 m high has also been recommended. Spraying of borax (0.6%) at 10-15 day intervals has been recommended (Reddy and Kapoor, 1965) to control black tip problem in mango.

Alternate bearing

Alternate bearing, irregular bearing and erratic bearing are a major problem in many fruits in India and abroad. The problem is more severe in ever green fruits like mango, litchi, etc. the deciduous fruit plants which respond to pruning and bearing takes place on comparatively new shoots, this problem is quite low. However the health of plants particularly the internal nutrient content plays a crucial role in regular bearing. Fruits are the great sink and major source of nutrients removal from the tree. Generally after good crop the plants are exhausted which may yield low in the next season if they are not fed properly and the problem of irregular or alternate bearing exist. Factors like genetically, nutritional, crop load, hormonal (florigen formation) are also found to be associated with alternate bearing.

Appropriate cultural practices like nutrition (dose, period and method), pruning (period and severity), thinning of fruits and flowers at early stage may bring the plant in uniform bearing every year.

Gummosis

The occurrence of gummosis is a serious problem in citrus, mango and other fruits but is more severe in citrus in all the citrus growing areas especially in the high rainfall areas. Even there is no comprehensive survey of the disorder has been made so far. There are some reports on the prevalence of this disorder, in South India by Rajan and Aiyappa (1944), Ramakrishnan (1954) in Maharashtra, by Cheema and Bhat (1928) in Gujarat; by Frazer and Singh (1966) in Mysore; in Punjab by Kapoor and Bakshi (1967); and in Assam by Chowdhuri (1951). It is caused by more than one species of *Phytophthora,* i.e., *P. nicotianae* var. *parasitica* (Dastur) Comb, is widespread in Assam and is often associated with *Fusarium lateritium* Nees (Chowdhuri 1951). *P. nicotianae* var. *parasitica* is also predominant in Karnataka, whereas *P. palmivora* (Butl) is prevalent throughout. *Phytophthora* produces symptoms of decline through: (1) a rotting of the rootlets, (2) a girdling of the trunk and a dropping of blighted leaves. The plants usually blossom heavily and die before fruits mature. The fruits lying on the ground are liable to invasions by the pathogens and develop brown rot. *P. citrophthora* has also been reported to cause the foot and root rot. In mango and temperate fruits the problem is caused due to deficiency of nutrients particularly copper and calcium.

Symptoms: Certain parts of trees are more susceptible to Gummosis than others and the different expressions of the disorder syndrome vary accordingly. The disease manifests itself in the form of large water soaked patches on the basal portion of the stem near the ground level or it may spread further. Bark on the lower part of trunk is more susceptible to infection than the bark below the ground level. In some very wet areas, the infection is observed quite high on the trunk and even on limbs. The gumming is sometime noticed on higher branches also. Initially, the bark is firm but with ageing of the lesion it shrinks and cracks, leading to shredding in lengthwise strips as it dries. The necrotic area is at first flush with the healthy bark, but with time it shrinks and becomes sharply delimited. The live bark at the advancing margins frequently develops a callus roll that checks further spread particularly in an upward direction. Symptoms on leaves are similar to those produced by *Phytophthora infestans* on the foliage of potato. Blighted leaves drop, and if defoliation is heavy the impression is given that the tree is in decline. Penetration of trunk tissue may be by way of wounds or by way of growth on cracks that develop with the emergence of adventitious shoots near the bud union.

Role of root stock: The predominance of resistant and moderately resistant clones was observed in pummelo, sweet lime, trifoliate orange and trifoliate orange hybrids (Grimm and Hutchinson 1977). In their earlier studies conducted in 1973, it is reported that *Citrus macrophylla, C. miaray; Severinia buxifolia,* Cuban shaddock, Ogami Pummelo and Sour orange were rated resistant. In Turkey, Carrizo Citrange has been reported to be highly resistant (Cinar and Tuzcu 1976).

Control measures: Adoption of tolerant rootstocks like sour orange, Cleopatra mandarin, trifoliate orange, Rangpur lime, etc., had been observed. A variety resistant in one region may be susceptible in other. The use of nursery stock grown under *Phytophthora* free conditions and prevention of water standing in contact to the susceptible portions of the bark above the bud union by way of good drainage. The disease can further be prevented to some extent by dusting of walls and bottom of planting pits with zinc-copper lime in ratio of 5:1:4 (Ramakrishnan 1954). The exposed wood can also be covered with zinc copper lime (3:1:3.5) wash or bordeaux paste which should be followed by application of white lead or any wound dressing agents (Ramakrishnan 1954). Desai *et al* (1966) achieved complete control of spraying Khagzi lime trees infected with *P. citrophthora* with aureofungin 3 g/30 ml of liquid soap/30 gallons of water applied 2-3 times. Somani and Patel (1970) got good control of gummosis incited by *P. nicotianae* var. *nicotianae* by Aureofungin as soil drench and spraying of foliage twice at an interval of one month. Drenching of Ridomil MZ (0.2%) has also been found effective against gummosis. Captafol (3 g/l), copper ammonium carbonate and cupric hydroxide are effective for foot rot (Timmer 1977). Dipping of seedlings in captan solution before planting is recommended in U.S.A. (Grimm and Whidden 1966). Fumigation of nursery bed with methyl bromide has proved most effective to avoid nursery infection (Grimm and Alexander 1971). Leaf fall and fruit rot could be controlled by spraying bordeaux mixture (1%) or bordeaux mixture plus tin sulphate or difolatan (0.3%) . In addition, spraying of Ridomil MZ and Aliette (0.2%) have also been reported effective (Rawal 1990). Diseased leaves and fruits may be collected and burnt or burried deeply.

Malformation

It is the most important malady of mango and was first reported by Burn (1910). It causes the losses from 50-80 per cent. It is also reported to be due to other disorders like physiological and acarological, however, the role of fungus *Fusarium moniliforme* var. *subglutinans* Sheldon has been widely accepted. Indications of its viral origin has also been postulated (Vasudeva 1959). The maximum incidence of the disease has been recorded in the north, north-west and north-east parts of the country. The incidence is, however, less in western and southern India. There are two types of symptoms, namely, floral malformation and witches broom or bunchy top or vegetative malformation with a proliferation of infected tissue. The flowering panicles turn into a compact mass of flowers. This compact mass is very hard and not soft like normal panicle. Individual flower is greatly enlarged and has a large disc. The percentage of bisexual flowers in malformed panicles is very low. In bunchy top, compact leaves are formed in a bunch at the apex of shoot or in the leaf axil. A similar bunch consisting of small rudiments crowded together on short shootlets is seen in vegetative malformation in which the growth of shootlet is arrested. Vegetative malformation is more pronounced in young seedling and seedling trees. The malformed heads dry up in black masses and persist on the trees for a long time. The malformed inflorescences contain more of endogenous cytokinins than healthy ones (Nicholson and van Staden 1988).

The variety Zebda has been reported to be resistant in Egypt (El Ghandour *et al.* 1979). Considerable incidence reduction has been reported by spraying 100-200 ppm NAA during October (Majumdar 1977). Use of disease free planting material and prophylactic spray of insecticides and fungicides can keep the orchards healthy. In areas with less than 5-10 per cent infection, pruning of diseased plants should be made compulsory; pruning of diseased parts along the basal 15-20 cm apparently healthy portions. This is followed by the spraying of Bavistin (0.1%) or Captaf (0.2%). Partial control of malformation has been achieved by spraying Mangiferin-Zn2 and Mangiferin-Cu2+chelates (Chakrabarti and Ghosal, 1988).

Physiological disorders of arid zone fruit crops

Ber (*Ziziphus mauritiana* Lamk.)

Fruit drop and cracking

In ber cv. Seb, fruit drop as well as cracking has been observed, which can be controlled by twice foliar spray of zinc 0.5 and 1.0% and borax (0.5%) and urea 1.0 per cent at 10 days interval (Singh and Vashishtha,1997) in semi- arid conditions. Immediately after fruit set, a heavy drop occurs which is largely due to the lack of fertilization or degeneration of ovule. During the early stage, the drop was mainly due to shriveling of fruit which occurred up to December (Singh 1976). After December shriveling was negligible. The maximum fruit drop took place up to 26 October in the early fruiting cultivars 'Gola', 'Seb', 'Mundia'and 'Jogia', up to 16 November in 'Ponda'and up to 23 December in the late maturing Íllaichi'.

In western Rajasthan, very heavy drop of 68.6 per cent and 60.2 per cent occurred respectively in Íllaichi'and Áliganj'and the lowest in 'Ponda' (24.1 per cent). At Hissar, 55.29 per cent drop was observed in 'BanarsiKaraka'(Singh *et. al.*, 1970). The maximum amount of drop was recorded between the last week of January and the last week of February just before a sharp increase in weight of the developing fruit was registered.

Exogenous applications of growth regulator have been very effective in controlling fruit drop. Dhillon and Singh(1968) found 2,4-D at 10 ppm to be the most effective in reducing fruit drop (from 60-61 per cent in control to 50.8-56 per cent) whereas 25 ppm GA and 2,4,5-T at 5 and 10 ppm showed little promise in 'Dandan', 'Kaithili'and Úmran'. Singh *et. al.*(1970) found that the percentage drop was not influenced by GA and NAA treatments. Singh (1976) found that sprays of NAA, 2, 4-D and MENA at 10,20,30 ppm did not reduced drop in 'Banarasi'exept 30 ppm, 2,4,5-T where the reduction over the control was 14.19 per cent.

The intensity of fruit cracking, a physiological disorder was recorded in different genotypes of ber. The incidence of fruit cracking was observed in all the majopr varieties of ber such as 'Gola', 'Seb', 'Mehrun. 'Badami',

'Maharwali', 'Bagwadi', 'Narikeli', 'Surati', 'BS-75-2'etc. The occurrence varied from 2- 8 % in ripe fruits. However, it was recorded to the tune of 60% in ripe fruits of variety Kathaphal. The severity of cracking increased with the advancement of maturity in ber varieties. The nature of cracking was predominantly radial combined with flesh cracking except in variety 'Surati', wherein the nature varied from skin cracking to transverse and oblique types of cracking (Anonymous 2012).

Pomegranate (*Punica granatum* L.)

Husk Scald

Husk scald is a temperature related disorder of pomegranate which limits the opportunities to store and market pomegranates.

Symptoms: Scald is a brown superficial discoloration restricted to the husk. There are no internal changes of the arils or the white segments as occurs with chilling injury. At advanced stages, the scalded areas became moldy. The scald symptoms became evident after 8 weeks of storage at 2°C(36°F) on the cultivar 'Wonderful'. Symptoms will appear earlier at higher storage temperatures. Husk scald development of pomegranate may be due to phenolic oxidation.

Control: Late harvested fruit is less susceptible than earlier harvested fruit. Scald development may be delayed up to 6 weeks on 'Wonderful' stored at 2°C(36°F). Other potential treatments must be evaluated under California conditions before commercial recommendations can be made.

Fruit cracking

Pomegranate is a drought resistant fruit species and is well adapted to the arid and semi arid parts of the world including Mediterranean region. Fruit cracking is a most serious physiological disorder in pomegranate which limits its cultivation. In young fruits it could be due to boron deficiency but fully grown fruits crack due to moisture imbalances as these are very sensitive to variations in soil moisture and humidity. Prolonged drought causes hardening of peel and if this is followed by heavy irrigation or down pour then the pulp grows and the peel cracks. This problem can be overcome by a) Maintaining soil moisture and not allowing wide variations in soil moisture depletion, b) Cultivation of tolerant varieties, c) Early harvesting and not allowing the fruits to crack and d) Spray of calcium hydroxide on leaves and on fruit set.

Hepaksoy, *et. al.* (2000) studied the differences among the cultivars in respect to fruit cracking, the most important physiological disorder and reported significant differences among genotypes. Studies conducted on six pomegranate varieties out of which two classified as sensitive to cracking (Koycegiz and Siyah), two resistant to cracking (Kadi and Lefon) and two intermediate (Cekirdeksiz Seedless and Feyiz). Primary nutrients (leaf and fruit), leaf gas exchange properties, leaf water potential and fruit characteristics were investigated and correlated with the ratio and tendency of cracking.

Six-year-old pomegranate cv. Jodhpur Red trees sprayed with 0.2, 0.4 or 0.6% H_3BO_3 and $ZnSO_4$; and 10, 20 or 40 ppm 2,4-D and NAA 15 and 30 days after fruit set in Haryana, to determine the effects of micronutrients and plant growth regulators on fruit cracking in pomegranate. In general, the percentage of premature cracking was higher compared to mature cracking. $ZnSO_4$, H_3BO_3, NAA and 2,4-D application resulted in lower mean percentage of mature, premature and total fruit cracking compared to the control, with 10 ppm 2,4-D recording the lowest values for premature cracking (5.2%), mature cracking (3%) and total fruit cracking (8.3%).

Thirteen pomegranate cultivars (Jalore Seedless, Ganesh, P26, Mridula, Jodhpur Red, GKVK, Dholka, P23, Bassein Seedless, Malta, Bedana Suri, G 137 and Kandhari) were screened to determine their suitability for better growth, yield and fruit quality under arid ecosystem. Inter-varietal differences were highly significant for vegetative growth, yield, and fruit size, cracking of fruits, number of arils, total soluble solids, acidity and juice. Plant height was highest in Jalore Seedless (2.86 cm) whereas spread was highest in Jodhpur Red (2.6 cm). G 137 recorded the highest tree girth (4.9 cm). The highest yield was recorded in Jalore Seedless (10.5 kg/tree. Fruit length was highest in Jalore Seedless (1.18 cm). Fruit cracking was highest in Jodhpur Red (72.4%) and lowest in Malta (5.2%). G 137 had the highest aril number per fruit (186), while Kandhari recorded the highest total soluble solids (19.7 °Brix). Jodhpur Red had the highest acidity percentage (1.68%). The highest juice content was recorded in Jalore Seedless (51.3 kg). Based on the best performance for desired characters, Jalore Seedless, P 23, G 137, Ganesh and Mridula are the most suitable for cultivation in arid and semiarid regions for table purpose and local market.

The experiment conducted in arid parts of Rajasthan on six-year-old plants of pomegranate with four levels of drip irrigation (4, 8 and 12 litres water h-1 applied for 3 h daily at flowering and fruiting time and a control with basin irrigation system) based on pan evaporation at 60 litres m^{-2} of basin. The results reveal that plants treated with drip irrigation were more vigorous than those treated with basin irrigation. Drip irrigation at 8 litres h-1 day-1 for 3 h increased the yield from 17.7 kg plant-1 under the control to 28.2 kg plant-1, with a considerable reduction in cracking. Fruit quality in terms of weight, size and juice content was better in drip-irrigated plants than that in the control plants. However, the TSS of the juice was slightly reduced in drip-irrigated plants compared with the control plants.

A study conducted in Rajasthan, to find out the effect of spray of boron (0.1, 0.2, 0.3 and 0.4%) and GA, (10, 20, 50, 100 ppm) spray on control of fruit cracking and its intensity during different pickings in pomegranate var. Jalore Seedless. The least cracking was obtained with the application of boron at 0.2% which in turn produced the highest average yield of 13.4 kg/tree. Intensity of cracking was highest in fruits picked during December and lowest in fruits picked during January however fruits harvested during January did not develop aril colour. The evaluation

of germplasm against fruit cracking showed that 150 germplasm were susceptible to cracking but percentage varied from 10-40% among genotypes/cultivars under Bikaner conditions. Better flowering/ fruiting were observed in ambe bahar but proper aril colour was not developed because of high temperature. Fruit cracking was low in this bahar but quality of fruits was not good with respect to colour of arils, juice and sweetness (Annon, 2011). Mohamed (2004) reported that percentage of fruit splitting gradually increased from the early waves of fruit set time to the later one. All the treatments greatly decreased the fruit splitting percentage comparing to the control. The most effective treatment in this respect was spraying with GA_3 at 150 ppm where it led to the lowest fruit splitting percentage followed by spraying with mixture of GA_3 at 100 ppm+ BA at 40 ppm. The average fruit weight was gradually decreased from the early fruit set times to the later waves. Most treatments led to increase of fruit weight. Spraying with GA_3 gave the heaviest fruit weight. Concerning rind weight percentage (attributed to the fruit weight), differences among early and later waves of fruit set were not observed. The effect of treatments on increasing rind weight percentage was little during the two years. The percentage of total soluble solids (TSS) was decreased in the later times of fruit set compared to the early ones. The treatments had slight effect on the TSS percentage. The total acidity percentage was gradually increased from the early fruit set times to the later one. All the treatments caused high increase of acidity percentage. As concentration of GA_3 or BA increased, the acidity percentage increased.

Chilling Injury

The incidence and severity of chilling injury depend upon storage temperature and duration. The minimum safe temperature is 5°C (41°F) for up to 8 weeks. Chilling injury can be a major cause of deterioration of pomegranates during marketing following exposure to temperatures below 5°C (41°F) during storage and transport for longer than 4 weeks.

Symptoms: External symptoms include brown discoloration (scald) of the skin, pitting, and increased susceptibility to decay. Internal symptoms include brown discoloration of the white segments separating the arils and pale color (loss of red color) of the arils.

Physiology: Pomegranate are susceptible to chilling injury if stored longer than one month at temperatures between their freezing point (-3°C or 26.6°F) and 5°C (41°F). Upon transfer to higher temperatures, respiration and ethylene production rates increase and other chilling injury symptoms appear: their severity increases with lower temperatures and longer durations of chilling exposure. External and internal browning is related to oxidation of phenolics by polypherol oxidase. Storage in a 2% oxygen atmosphere at temperatures below 5°C (41°F) reduces severity of chilling injury symptoms.

Control: Avoid exposure of pomegranates to temperatures below 5°C (41°F).

Frost injury

Pomegranate plants are susceptible to frost or low temperature under hot arid environment and leaves and thin branches dried. Fruits skin becomes black after two days of frost injury. The affected plants recovered fast after employing irrigation and fertilizer with increasing temperature during month of February.

Blackening of arils

The browning of arils in pomegranate has been identified as problem which is believed to be a genetical, environmental and soil moisture related disorders. In this disorder, some of the mature grains of healthy fruits become soft and brown which reduces the market value of the fruits. The problem is similar to that of spongy tissue of mango in which the disorder appears after cutting of fruits. Solar radiation and fluctuation in temperature during fruit development and ripening are believe to be the main cause of the disorder. Some cultivars have been found less affected with the disorder. No varieties are free from this problem however; intensity is varied from variety to variety. Concentrated research on causal factor and its management is under progress.

Bael (*Aegle marmelos* Correa.)

Fruit cracking

The fruit cracking is the major physiological disorder in bael and its degree of damage depends according to genotype/varieties and locality (Singh *et al*, 2011). It has been takes place twice in a year *i.e.* winter season (December-January) in developing immature fruits and during summer season (March-April) when fruits are mature and in ripening phase. Mishra (2000) reported that in some genotypes of Bael cracking occurs just before ripening. Moisture fluctuations in the environment during the fruit development stage are the main cause of fruit cracking in bael besides skull thickness. It is genetic feature in some genotypes. However, application of boron has minimizes the cracking in bael besides maintenance of soil moisture in arid region. Saini *et al* (2004) reported that cracking can be minimized by maintaining optimum soil moisture regime and by provision of wind breaks against hot desiccating wind. Organic mulches like paddy straw, subabul loppings can effectively utilized in maintaining soil moisture in tree basin particularly during summer under rainfed conditions in semi arid region.

Fruit drop

Fruit drop is natural phenomenon, but its extent of damage is a matter of concern. The extent of fruit drop varied according to genotypes/ varieties and locality. Immature fruit drop (marble size) has also been observed. Sometimes ball size fruits also fall down. The extent of fruit drop in bael can be reduced effectively by adopting better orchard management practices and application of growth hormones like NAA (15-20 ppm / litre).

Fig (*Ficus carica* L.)

The status of fig production in the Black Sea Region of Turkey was studied using a questionnaire in the provinces of Artvin, Rize, Trabzon, Giresun and Ordu revealed that 182 122 fig trees were established in these areas, 165 317 of which were fruit-bearing. The total production was 3243 tonnes and the yield per tree was 19.62 kg. Fifteen local cultivars were grown in the region, with cultivars Patlican, Siyah and Beyaz being the most common. Fig was cultivated in a mixed cropping system with other fruit trees established as border trees. Fruit ripening commenced on 15 July-15 September and continued for 1.5 to 2.0 months. Harvested fruits were intended for fresh consumption. Crop damage by rain was lower in Ardu and Ordu (50%) than in the other provinces (80-100%). The incidence of fruit skin cracking due to rain was high in cv. Sari grown in Artvin but low in cv. Ipek grown in Giresun. In general, pruning and irrigation was not practiced and fertilizers were not applied. The economic maturity of fig was attained in approximately 25-30 years. Fruits that were sold in the local markets comprised 30-40% of the fruits harvested. Fig jam was highly preferred in the region except in Artvin. Fig trees were mainly propagated from cuttings (90%). Some of the most common physiological disorders of fig are:

Fruit cracking

Fruit cracking in fig is a serious problem in Middle East countries where it is being grown at commercial scale. The problem is mainly nutrient and cultivar related. Studies were carried out in a private orchard in Al-Abbasyia, Najaf, Iraq, for two growing seasons during 2000/01 to investigate the effects of spraying nitrogen (N), iron (Fe), zinc (Zn) and/or potassium (K) in 0.3% concentration on fig (cv. Asowd Diala) trees when the fruit of third crop reaches 30 days after fruit bud appearance. The results indicated that trees treated with nutrient elements, alone or in combination, had increased leaf area, total leaf chlorophyll content, weight, volume, number of days to fruit ripening and reduced the percentage of fruit drop, fruit cracking, anthocyanin, total soluble solids (TSS) and acidity. Treatment with N + Fe + Zn + K recorded the longest time to fruit ripening, the highest average leaf area, total chlorophyll, weight and volume of fruit, but the lowest percentage of fruit drop, fruit cracking, anthocyanin, TSS and acidity for both growing seasons.

A foliar spray of 1% $CaCl_2$ was applied to fig cultivars Bursa Black, Goklop and Sarilop (synonym Calimyrna) (which differ in their susceptibility to fruit cracking) towards the end of the second phase of fruit development. Leaf N content increased significantly in the latter 2 cultivars only. Leaf Ca content increased in Bursa Black and Sarilop but not in Goklop, which had the highest Ca content. Leaf Fe, Zn and Mn contents were all reduced by $CaCl_2$ application but Cu contents increased. Significant responses to $CaCl_2$ application were found only in fruit Na and Fe contents. The number of both severely and moderately cracked fruits decreased significantly on treated trees.

Aonla (*Embelica officinalis* Gartn.)

Necrosis or internal browning

Necrosis is the main disorder of aonla in sodic soil where many micro nutrients become unavailable to plants. It is mainly nutrient related disorder however some newly developed cultivars have been found comparatively free from the disorder. Francis cultivar is severely affected with this malady. Evaluation of aonla cultivars NA-6, NA-7, NA-10, Kanchan and Chakaiya at NDUAT, Faizabad (Singh *et al*, 2003) reveal that these cultivars exhibited higher productivity and fruits were free from necrosis or internal browning, indicating their suitability for fruit processing. Cultivar Francis and NA-9 was most affected with necrosis. Data were also recorded for average fruit weight, acidity, and pulp, fibre, seed, total soluble solids (TSS), ascorbic acid and phenol contents. NA-6 recorded the lowest fibre content, high pulp and TSS contents, and moderate fruit size and ascorbic acid content. NA-7 showed average physico-chemical composition with high content of ascorbic acid.

To control the necrosis, an experiment with foliar feeding of $ZnSO_4$ (0.5%), borax (0.2%), $CuSO_4$ (0.4%) and their combinations on the growth, fruit quality and yield of aonla cv. Francis (most susceptible cultivar) resulted the highest plant height (19.67 m), trunk girth (26.10 m), plant spread (23.39 m), fruit length (3.98 cm), fruit width (4.43 cm), fruit weight (47.97 g), total soluble solids (11.67%), acidity (1.70%), and ascorbic acid content (589.0 mg/100 g) with the combined spray of $ZnSO_4$ + borax + $CuSO_4$. Fruit yield was highest (43.0 kg/tree) with borax + $CuSO_4$ treatment. The percentage of fruit necrosis was lowest (1.21%) with $ZnSO_4$ + borax + CuSO4 treatment which was at par with borax + $CuSO_4$, $ZnSO_4$ + $CuSO_4$, and $ZnSO_4$ + borax treatments. Thus, it is confirmed that necrosis is a micro nutrient deficiency related physiological disorder.

Off season flowering

Recently, off season flowering has been a serious problem in aonla production. Survey of aonla growing areas of Uttar Pradesh reveals that few cultivars like Chakaiya, Kanchan and NA-7 are the most affected cultivars in Pratapgarh, Sultanpur, Faizabad and Varanasi districts. The problem has also been noticed in Jharkhand and Madhya Pradesh. The study conducted by Rai *et al* (2002) reveal that a complex of situation are responsible for this malady. They reported an economical loss of 30-40% due to off season flowering in aonla. The main reason of this disorder would be global warming or due to some disturbance/ interruptions in the tree physiology due to externally governed internal mechanisms. The condition leads to non-occurrence of distinct phase of dormancy after fruit harvest. Plant comes in partial flowering with predominance of male flowers which do not set fruits but exhaust the plants and disturbs the physiology and reduce the crop load in the main season crop. In any case if some fruit sets, they do not develop properly and drops subsequently.

The off season flowering can be controlled by

forcing the plant to enter in dormancy by spraying 10% urea after fruit harvest. Restricting soil moisture build up near root zone can help plant to enter in to dormancy.

Lemon (*Citrus* sp.)

The disorder occurs mostly on mature fruits due to excessive absorption of moisture by the plant and it is more severe when a period of drought is followed by rains or heavy irrigation. In addition to water imbalance, bioregulators, nutrients and weather conditions which promote differential growth rates of peripheral and cortex tissue, may also result n cracking of lemon fruits.

Two sprays of 20 ppm NAA or 40 ppm GA_3 or 8.0% potassium sulphate during second fortnight of May also reduce fruit cracking.

Date palm (*Phoenix dactylifera* L.)

In date palm, drop of berries at initial stage after fruit set has been observed which is vary from variety to variety .Thinning of berries are required in date palm for improvement in fruit quality, hence drop of berries in small amount is not much harmful but high percentage of dropping decrease the bunches' yield. Proper soil moisture is essential in plants basin during fruit growth and development period in summer months to reduce dropping of berries.

Custard apple (*Annona squamosa* L.)

Misshapen fruits

In custard apple, about 15-20 per cent fruits do not attain the characteristic feature of the distinct cultivar. This is mainly due to improper pollination and fertilization and non favorable environmental conditions at the time of fruit development. Since custard apple is an aggregate fruit in which development of false areoles in higher number is considered good for commercial yield, however the misshapen fruits fetch less price in the market. Proper pollination and maintenance of high relative atmospheric humidity (80-90%) should be ensured at the time of fruit development. Hand pollination is a simple and fast technique that results not only good fruit set but also produces big size and attractive uniform shape fruits with no loss in edible attributes (Anon 2009).

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Performance of ber (*Ziziphus mauritiana* Lamk.) to saline water with different irrigation schedules under drip irrigation

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Abstract

An experiment to study the performance of ber (*Ziziphus mauritiana* Lamk.) to saline water using drip irrigation was started in 2005-06 on four years old plants planted in 2002. Yield and yield attributes were recorded from 2005-06 to 2008-09. The maximum average yield (43.6 kg/plant) was obtained in the treatment 0.8PET+canal water with mulch and the yields were at par with saline water in this treatment (39.6 kg/plant). Similar trend was also observed in case of average fruit diameter and average weight of fruits. The average per day water requirement by the ber plant from 2005-06 to 2008-09 at 1.0 and 0.8PET was maximum in the month of May i.e. 54.25 and 43.40 l/day and was minimum in the month of January i.e. 11.87 and 9.47 l/day, respectively. The average water required by the ber plant in a crop season from 2005-06 to 2008-09 were 8655 and 6927 liters at 1.0 and 0.8PET, respectively. Application of saline water resulted in salt accumulation in lower depth of the soil profile due to high hydraulic conductivity of sandy soils. Minimum salt accumulation in the soil profile existed just below the emitters. Comparatively, higher salinity levels existed in treatments with 0.8PET+without mulch conditions at almost every point of observation. This could be attributed to lower moisture level in soil profile as compared to 1.0PET thereby, increasing the salinity status. Application of plastic mulch resulted in lower salt concentration in surface soil.

Key words: Ber, saline water, drip irrigation, mulch

Introduction

Agriculture in western Rajasthan is faced with challenges such as extremely high summer temperatures, low relative humidity, strong winds, rapidly depleting groundwater resources and highly saline irrigation water. Farmers have to rely on the use of brackish water for irrigation. Perennial irrigation with brackish water without proper water management practices has resulted in severe salt buildup in the soil. Therefore, irrigation-induced salinization has become a widespread problem in irrigated agriculture in western Rajasthan. Consequently, application of simple, efficient salinity management strategies, such as use of freshwater to leach excess salts from the root zone and use of salt-tolerant crops have become increasingly important. Salinity tolerance of various fruit crops, including *Zizyphus*, has been investigated by several researchers (Dhankar *et al.*, 1978; Patil and Patil, 1983; Hooda *et al.*, 1990; Singh and Singh, 1994). *Ziziphus mauritiana* improved varieties of Ber (Gola, Seb and Mundia), have made a big impact in arid and semi-arid regions. It provides reasonable income to farmers even during drought years. Further, under arid and semi arid regions in the scenario of scarcity of good quality water the use of poor quality waters for agriculture is inevitable. The crops requiring more water for production are to be discouraged. *Ziziphus mauritiana* could be raised successfully having low water requirement. Therefore, the present investigation was undertaken to find out effect of saline water, irrigation schedules and mulching on water saving, yield attributes and yield of Ber and to determine salt accumulation in soil profile.

Materials and Methods

An experiment was undertaken to evaluate the Performance of ber (*Ziziphus mauritiana* Lamk.) to saline water using drip irrigation with irrigation schedules with mulch and without mulch was started in 2005-06 on four year plants planted in 2002. Yield and yield attributes were recorded from 2005-06 to 2008-09. The objectives of the experiment was to find out the effect of saline water, irrigation schedules and mulching on water saving, yield attributes and yield and to determine salt accumulation in soil profile. The treatments consisted of two levels of water application as per water requirement i.e. 1.0 and 0.80PET, two levels of water salinity i.e. canal water (EC 0.25 dSm^{-1}) and saline water (EC 8.0 dSm^{-1}) and two levels of mulching i.e. with mulch and without mulch. Four plants were planted for each treatment. Total 96 plants of Ber variety Gola were planted with three replications under split plot design with spacing of 8 x 8 m in the sandy soil of ARS, Bikaner in the year 2002. The observations recorded were plant growth, yield, and yield attributes, quantity of water applied and periodic soil sampling for pH, and EC_e. pHs and ECe of soil and water were determined by the methods outlined by Richards (1954).

The soil of the experimental field was alkaline in nature and sandy in texture with poor fertility status. pH and ECe of soil ranged from 8.31 to 8.70 and 0.53 to 0.71 dSm^{-1}, respectively in the soil profile up to 150 cm depth. Organic

carbon content was very low (0.09 %). Available nitrogen (105.0 kg N/ha), available phosphorus (14.6 kg P_2O_5/ha) and potash (198 kg K_2O/ha) was also of low magnitude. $CaCO_3$ in surface soil was 1.17 per cent whereas, at 150 cm depth it was 3.75 per cent. The texture of the soil was sand, and the hydraulic conductivity ranged from 7.2 to 7.9 cm h^{-1} thus, the drain ability of these soils is high whereas, the water holding capacity was only 6.18 cm m^{-1}, thereby the irrigation frequency was of short duration. Bulk density ranged from 1.52 to 1.57 Mgm^{-3}. The sand, silt and clay content ranged from 90.2 to 86.3, 2.1 to 3.7 and 6.4 to 5.7 per cent in the soil profile, respectively.

The water requirement of ber crop (Table 1) at different stages and for different period of the year was estimated by using open pan evaporation and FAO guidelines. The volume of water required is calculated by the formula as under:

$$V = Ep. \times Kc. \times Kp. \times Sp. \times Sr. \times Wp$$

Where,

V = Volume of water required litre/day/plant

Ep = Pan evaporation (mm/day)

Kc = Crop coefficient

Kp = Pan coefficient

Sp = Plant to plant spacing (m)

Sr = Row to row spacing (m)

Wp = Wetted area (0.3 for widely spaced crops)

The daily water requirement is presented in Table 1 revealed that average per day water requirement by the ber crop for the seasons from 2005-06 to 2008-09 at 1.0 and 0.8PET was maximum in the month of June i.e. 55.45 and 44.30 l/day and was minimum in the month of January i.e. 11.87 and 9.47 l/day, respectively.

Results and Discussion

Yield

In 2005-06 the maximum yield i.e.35.87 kg/plant was recorded in the treatment 0.8PET+plastic mulch with canal water. With saline water this treatment yielded 32.63 kg/plant. In 2006-07 also the maximum average yield i.e. 37.08 kg/plant was obtained in treatment 0.8PET+plastic mulch with canal water. Even under saline water this treatment resulted in maximum yield of 35.40 kg/plant. In 2007-08 the maximum average yield i.e.40.05 kg/plant was recorded in the treatment 0.8PET+plastic mulch with best available water. Under saline water this treatment yielded average fruit yield of 38.03 kg/plant. Similarly in 2008-09 the maximum average yield i.e.52.2 kg/plant was obtained in treatment 0.8PET+canal water with mulch. Even under saline water this treatment resulted in maximum yield of 44.5 kg / plant. The average of all four years (Table 2) showed that the maximum average yield of 43.6 kg/plant was obtained in the treatment 0.8PET+canal water with mulch. Even under saline water this treatment resulted in maximum yield of 39.6 kg/plant. Singh and Singh (1994) and Avasthi *et al.* (1997) also reported that *Z. mauritiana* grew well under moderate sodicity and salinity levels. In general, higher yields were obtained in treatment of 0.8PET as compared to 1.0PET under both canal and saline application. Comparatively higher yields were recorded under mulch conditions irrespective of water quality. Data presented in Table 4 showed that maximum increase in the ber fruit yield was 45.7 and 32.4 per cent in the treatment 0.8PET+canal+mulch and 0.8PET+saline+mulch respectively, over 1.0PET+canal+without mulch.

Yield parameters

In 2005-06 the average fruit diameter varied from 2.60 to 3.90 cm in different treatments with highest in 0.8PET + canal water with plastic mulch and lowest in 1.0PET+ saline water without mulch. In 2006-07 the average fruit diameter varied from 2.66 to 3.96 cm in different treatments highest being in 0.8PET+canal water with mulch and lowest in 1.0PET+saline water without mulch. Similar trend was also observed in case of average fruit weight. Similarly in 2007-08 the average fruit diameter varied from 2.82 to 3.74 cm in different treatments with highest in 0.8PET+canal water with plastic mulch and lowest in 1.0PET+saline water without mulch. In 2008-09 also the average fruit diameter varied from 2.84 to 3.77 cm in different treatments highest being in 0.8PET+canal water with mulch and lowest in 1.0PET+ saline water without mulch. Similar trend was also observed in case of average weight of fruits. The average of all four years showed that average fruit diameter varied from 2.84 to 3.77 cm in different treatments highest being in 0.8PET+canal water with mulch and lowest in 1.0PET+canal water without mulch. The average fruit weight was also recorded highest 36.7g in treatment 0.8PET+canal water with mulch. In general higher values of yield attributes were recorded in treatment of 0.8PET as compared to 1.0PET under both canal and saline application. Comparatively higher values of yield attributes were recorded under mulch conditions irrespective of water quality (Table 3).

Water Use Efficiency

In the treatments of 1.0PET the volume of water applied was 11.48 lac l/ha/year, whereas it was 9.19 lac l/ha/year in 0.8 PET treatments. The maximum water use efficiency i.e. 7.40 g/l was in 0.8+canal+mulch treatment and followed by 6.72 g/l in the treatment 0.8+saline+mulch. The minimum WUE was 4.06 g/l in 1.0PET+canal+without mulch treatment.

Salt build-up in soil profile

The distribution of salts in the soil profile after completion of harvesting of fruits in the month of April 2009 is presented in Table 5. It is clear that application of saline water resulted in salt accumulation in lower depth of the soil profile. Bhat *et al.* (2009) also reported that saline water application resulted in salt build-up in the soil profile. The salts leached from the upper layers are being piled up in the lower depths. Minimum salt accumulation in the soil profile existed just below the emitters. Comparatively, high salinity levels existed in treatments with 0.8PET in without mulch conditions at almost every point of observation. This could be attributed to lower moisture level in soil profile as compared to 1.0PET, thereby, increasing the salinity status.

Application of plastic mulch resulted in lower salt concentration in the soil profile. This might be due to the fact that since equal amount of water was given to plants at one irrigation level irrespective of considering the plastic mulch and under mulching soil evaporation is restricted to considerable extent, hence higher moisture existed causing less concentration of salts.

It can be concluded that the highest yield and yield attributes and WUE were obtained at 0.8PET for both saline and canal water. Further, no significant difference was observed in yield levels for saline and canal water both with mulch and without mulch conditions. It can be inferred that saline water up to 8.0dSm^{-1} can be successfully used for ber cultivation under drip irrigation without any significant reduction in yield and without much salt accumulation in the upper layers of these sandy soils. The results are in corroboration with the findings of Dhankar *et al.*, 1978; Patil and Patil, 1983; Hooda *et al.*, 1990; Singh and Singh, 1994.

Table 1: Volume of water applied (litres) per day/plant

Months	2005-06		2006-07		2007-08		2008-09		Average	
	1.0 PET	0.8 PET	1.0 PET	0.8 PET	1.0 PET	0.8 PET	1.0 PET	0.8 PET	1.0 PET	0.8 PET
June	47.4	37.9	50.2	40.2	64.9	51.6	59.3	47.5	55.45	44.30
July	36.3	29.0	36.4	29.1	48.7	38.9	40.1	32.0	40.37	32.25
August	32.4	25.9	31.2	25.0	42.9	34.3	37.2	29.8	35.92	28.75
September	27.0	21.6	24.4	19.5	36.2	28.9	31.4	25.1	29.75	23.77
October	23.4	18.7	22.0	17.6	27.4	21.9	21.6	17.3	23.60	18.87
November	19.2	15.4	16.2	13.0	17.0	13.6	19.1	15.3	17.87	14.32
December	18.1	14.5	14.6	13.7	11.2	8.9	10.4	8.3	13.57	11.35
January	12.4	9.9	11.3	9.0	12.5	9.9	11.3	9.1	11.87	9.47
February	14.0	11.2	13.0	10.4	13.7	10.9	14.3	11.4	13.70	11.00

Table 2: Yield of Ber fruits per plant under different treatments of canal and saline water applications and mulching

Treatment	Fruit yield / plant (kg)				
	05-06	06-07	07-08	08-09	Mean
1.0PET+Canal+Without Mulch	27.9	28.1	32.5	31.2	29.9
1.0PET+Canal+Mulch	30.0	31.6	39.4	37.3	34.6
1.0PET+Saline+Without Mulch	26.4	27.0	41.2	33.7	32.1
1.0PET+Saline+Mulch	28.7	29.9	39.4	35.3	33.6
0.8PET+Canal+Without Mulch	31.1	34.9	44.2	42.9	38.3
0.8PET+Canal+Mulch	35.9	39.5	46.8	52.2	43.6
0.8PET+Saline+Without Mulch	30.4	32.2	49.9	41.2	38.4
0.8PET+Saline+Mulch	32.6	38.2	43.3	44.5	39.6
S.Em ±	1.4	1.7	1.3	3.2	1.9
CD (5%)	4.3	5.1	3.9	9.6	5.7

Table 3: Effect of different treatments of canal and saline water applications on average weight and average diameter of Ber fruits

Treatment	Average weight of fruits(g)					Average diameter (cm)				
	05-06	06-07	07-08	08-09	Mean	05-06	06-07	07-08	08-09	Mean
1.0PET+Canal+Without Mulch	29.0	30.7	28.1	30.3	29.5	2.71	2.84	2.92	2.91	2.84
1.0PET+Canal+Mulch	30.5	32.3	26.3	30.7	29.9	3.10	3.30	2.77	3.02	3.05
1.0PET+Saline+Without Mulch	27.5	29.1	30.1	28.7	28.8	2.60	2.71	3.27	2.97	2.89
1.0PET+Saline+Mulch	30.0	31.8	29.9	31.5	30.8	2.83	2.94	3.27	2.93	2.99
0.8PET+Canal+Without Mulch	33.0	34.3	32.9	34.1	33.6	3.51	3.72	3.45	3.60	3.57
0.8PET+Canal+Mulch	37.5	39.7	32.8	37.0	36.7	3.90	4.01	3.37	3.79	3.77
0.8PET+Saline+Without Mulch	31.0	32.8	35.3	34.4	33.4	3.40	3.60	3.90	3.70	3.65
0.8PET+Saline+Mulch	34.5	36.5	35.0	35.1	35.3	3.65	3.84	3.73	3.81	3.76
S.Em ±	1.5	1.3	1.2	0.8	1.2	0.16	0.18	0.20	0.13	0.17
CD (5%)	4.7	3.8	3.6	2.4	3.6	0.50	0.54	0.61	0.39	0.51

Table 4: Fruit yield, water applied and water use efficiency as influenced by drip irrigation in ber

Treatment	Yield (q/ha)	Increase in yield (%)	Water use (lac. l/ha/y)	WUE g/ht
1.0PET+Canal+Without Mulch	46.64	-	11.48	4.06
1.0PET+Canal+Mulch	53.98	15.6	11.48	4.70
1.0PET+Saline+Without Mulch	50.07	7.3	11.48	4.36
1.0PET+Saline+Mulch	52.41	12.4	11.48	4.56
0.8PET+Canal+Without Mulch	59.74	28.0	9.19	6.50
0.8PET+Canal+Mulch	68.01	45.7	9.19	7.40
0.8PET+Saline+Without Mulch	59.90	28.4	9.19	6.51
0.8PET+Saline+Mulch	61.71	32.4	9.19	6.72

Table 5: Salinity (ECe) distribution in soil profile under drip with saline water (8.0dSm^{-1}) for ber crop

Distances from emitter (cm)	Soil depths	1.0PET+without Mulch	0.8PET+without Mulch	1.0PET+Mulch	0.8PET+Mulch
15	0-15	2.28	2.00	2.02	1.83
	15-45	2.68	2.46	2.22	2.33
	45-75	2.80	2.71	2.61	2.56
	75-105	3.42	3.26	2.95	2.91
30	0-15	2.88	2.50	2.53	2.28
	15-45	3.06	3.09	2.88	2.81
	45-75	3.36	3.25	3.17	3.00
	75-105	3.14	3.30	2.97	2.91
60	0-15	3.01	2.89	2.69	2.50
	15-45	3.38	3.31	3.08	2.91
	45-75	3.68	3.49	3.47	2.98
	75-105	3.44	3.51	3.34	3.21
90	0-15	3.35	3.09	2.91	2.52
	15-45	3.95	3.67	3.44	2.78
	45-75	3.97	3.04	3.68	3.59
	75-105	3.97	3.59	3.96	3.75

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Genetic variability studies for improvement in bottle gourd under hot arid agro-climate

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Abstract

Variability studies in bottle gourd indicated that a good amount of genetic variation is present in the evaluated germplasm. Characters like number of fruits/plant, fruit yield/plant, fruit weight and number of seeds/fruit exhibited high estimates of GCV. High estimates of heritability accompanied with high genetic gains observed for number of fruits/plant, fruit yield/plant, fruit weight and fruit length indicated additive type of gene action, hence possibilities for effective improvement by selection for these traits. The characters association studies revealed that number of fruits/plant has strong correlation with yield/plant. On the basis of fruit quality, shape and marketable yield, the line AHLs-11, AHLS-12, AHLS-24 and AHLS Round-1 were found to be the most potential for exploitation under arid agro-climate.

Key word: *Genetic variability, Lagenaria siceraria, bottle gourd, arid environment.*

Introduction

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is a potential cucurbitaceous vegetable of arid and semi-arid region of north-western India. This is because of easiness in its cultivation, short duration and good market demand throughout the year. The region specific varieties from favourable agro-climate are not performed well under extremes of high temperature and abiotic stresses of arid environment. In absence of suitable long fruited genotypes, the framers of arid areas are compelled to use seeds of open pollinated varieties or hybrids of this cross pollinated crop as available in the market and resulted in to poor quality marketable fruits and low yield potential due to environmental susceptibility. However, on the basis of preliminary work the long fruited varieties such as Pusa Naveen and PSPL were recommended for the cultivation (Samadia, 2002). Very limited systematic studies were done under the conditions of abiotic stresses and therefore, the present investigations were undertaken to understand the nature and magnitude of variability in the evaluated germplasm in order to identify the desirables lines based on *per se* performance and to select promising donors for various characters which could be used in hybridization programme to obtain useful recombinants and to create additional variability.

Materials and Methods

The study was conducted under hot arid agro-climatic conditions at Central Institute for Arid Horticulture (CIAH), Bikaner (28° N latitude and 73° 18' E longitude and altitude of 235 m above mean sea level). The agro-climate of location of study is characterized by low and erratic rainfall (150 - 350 mm restricted during July September) in a few spells, extremes of temperature (-4° C in winter to 48° C in summer), high solar radiation, high wind speed (12-16 km/hr) with several dusty days and also the summer season is for prolong duration. Beside, the sandy soil is with poor fertility and water holding capacity. Twenty germplasm (18 land races collected from tribal area of Rajasthan and Gujarat and two lines) were assessed in randomized block design over the seasons both during rainy and summer from 2004 to 2007. The experimental material was grown in channels of 10 m length spaced at 2.5 m apart accommodating to 20 plants of each germplasm with three replications. The observations were recorded on five plants selected per replication for each germplasm on 25 quantitative and quality characters. To categorize the germplasm, important characters of plant, fruit, quality and seed were also recorded. The important characters are days to appearance of first male flower (DFMF) days after sowing (DAS), days to appearance of first female flower, DAS (DFFF), node to first fruit set (NFF), days to first harvest, DAS (DFH), fruit length, cm (FL), fruit diameter, cm (FD) and marketable fruit weight, kg (FW), number of fruits/plants (NF/P), fruit yield/plant, kg (FY/P), vine length, m (VL), leaf length, cm (LL), leaf width, cm (LW), mature fruit length, cm (MFL) and number of seeds/fruit (NSF). The data were compiled and analyzed adopting standard statistical procedures using computer based INDOSTAT packages.

Results and Discussion

In the present study the analysis of variance revealed significant genotypic difference for all the characters exhibiting greater diversity in the experimental material (Table-1 & 2). The data on plant growth, flowering and fruiting behaviour and fruit yield are presented in Table-1 and 2 for performance studies. The period taken for appearance of first male and female flower ranged from 38.46 - 50.26 and 43.83 - 55.26, respectively. The first

marketable fruit harvest ranged from 61.46 to 71.77 days from sowing. Among the evaluated lines, the earliest harvest (< 65 days) was in AHLS Round-1 (61.46) followed in order by AHLS-12, AHLS-14, AHLS-15, AHLS-16, AHLS-17 and AHLS-23. The number of marketable fruits/plant ranged from 1.95 - 7.54. The line AHLS Round-1, AHLS-22, AHLS-23 and AHLS-24 recorded higher number of fruits (6.0) per plant exhibiting better yield potential under arid conditions. The marketable fruit yield/plant ranged form 1.174 - 4.270 kg with a population mean of 2.544 kg. The line AHLS Round-1, AHLS Long-1, AHLS-12, AHLS-21 and AHLS-22 recorded higher yield (> 3.0 kg) compared to the lowest yield in AHLS-15 (1.18 kg). On the basis of quality, shape and marketable characters of fruit the line AHLS-11, AHLS-12, AHLS-24 and AHLS Round-1 were found to be the most potential. The landraces/genotypes exhibited diversity and thus provide great potentiality for improvement in fruit quality and yield characters. The genotypes giving more number of fruits at lower nodes along with very early fruit set and harvest should result in higher and early yields. The selected genotypes should also tolerate high temperature and stresses of arid environment during later stage of crop growth and fruit yield on secondary and tertiary branching (Samadia, 2002; Samadia, 2005).

The absolute variability in different characters cannot be the criteria for deciding the character showing the highest degree of variability. In the present study, the estimates of genotypic and phenotypic coefficient of variation (GCV and PCV) indicated an ample scope for crop improvement (Table-2) because the estimates of PCV in general were higher than GCV for all the characters. The GCV ranging from 4.82 (days to first harvest) to 45.13 per cent (number of fruits/plant) gives a picture of the extent of genetic variability in the population. These estimates were considerably high (> 30 %) for characters such as number of fruits/plant, fruit yield/plant, fruit weight, mature fruit length and number of seeds/fruit and moderate for characters such as tender fruit length and diameter and leaf size and length. A close correspondence between PCV and GCV value in respect of all the characters indicate that environment has very little influence on the expression of the characters. In such situation, selections on the basis of the phenotypic characters alone will have equal probability of success.

However, with the help of GCV alone, it is not possible to determine the amount of variation that is heritable. Heritable variation can be determined with greater degree of accuracy when heritability (h^2, broad sense) is taken into consideration along with genetic advance (GA). Hence, both heritability and genetic advance were determined to get a clear picture of the scope of improvement in various characters through selection. Very high heritability estimate values were observed for all the characters. The genetic advance in the present study ranged from 9.85 to 92.93 % of mean (genetic gain). Thus the investigation revealed that economic characters like number of fruits/plant could be improved by 3.54 units at 5 % selection intensity (SI) which would be 92.93% higher to the mean. High heritability values accompanied with high genetic gain were observed for number of fruits/plant, fruit yield/plant, fruit weight, fruit length, mature fruit length and number of seeds/fruit and were moderate for fruit diameter. This indicates additive type of gene action. Simple selection, therefore, could be effective for the improvement of these traits. High heritability estimates along with low genetic gain in respect of days to first harvest, days to appearance of first male and female flower were probably due to non-additive type of gene action. Thus, direct selection for these characters will be less effective (Panes and Sukhatme, 1957). The present findings with regards to genetic variability are in agreement with those of Abusaleha and Dutta (1990a) in cucumber and of Narayana *et al.* (1996) in bottle gourd. It is clear from data of Table-2 that the characters like number of fruits/plant, fruit yield/plant, mature fruit length and number of seeds/fruit possessing high estimates of GCV, heritability and genetic gain and thus could be used for effectively selection. Johnson *et al.* (1955) suggested that characters with high heritability coupled with high genetic gain would respond to selection better than those with high heritability and low genetic gain. The high variability and heritability along with high genetic advance as percentage of mean expressed by the above mentioned traits indicate that the genotypes could be tested in multi-location trials and selected as donors for these characters or can be used as parents in hybridization programme.

In general, the magnitude of genotypic correlation coefficient were slightly higher than their corresponding phenotypic correlation coefficient for the important characters (Table-3) indicating, there by, a strong inherent association between the traits under study. The results are in agreement with the findings of Dahiya *et al.* (2000) in round melon and Abusaleha and Dutta (1990b) in ridge gourd. Yield is a dependent character and is highly influenced by the environment and therefore, information of its association with its main components is beneficial in formulating breeding strategy for crop improvement. The positive and significant association of number of fruits/plant (0.682) with yield indicates that effective improvement through this character could be achieved in bottle gourd. Fruit length and diameter exhibited positive but non-significant association with yield/plant. Days taken for first harvesting, an indication for earliness or late maturing has positive and significant association with days to appearance of first male and female flower clearly depicted mutual association of these characters. Negative and significant association of fruit weight and length with number of fruits/plant clearly indicates that smaller sized fruits results in more number of fruits/plant. Thus, it is suggested that for higher yield in bottle gourd selection should be based on number of fruits/plant.

Table 1: Flowering and fruit yield characters in bottle gourd germplasm under arid agro-climate

Genotype	Days to first male flower (DAS)	Days to first female flower (DAS)	Node number to first fruit set	Days to first harvest (DAS)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (kg)	Number of fruits/plant	Fruit yield /plant (kg)	Vine length (m)
AHLS 11	41.36	51.36	15.40	65.06	37.10	7.35	0.83	3.53	2.95	3.11
AHLS 12	46.43	49.43	20.40	63.50	51.73	6.71	1.44	3.13	3.59	3.14
AHLS 13	47.43	53.30	19.50	66.33	42.96	7.35	1.22	2.26	2.78	3.31
AHLS 14	38.46	43.83	21.76	62.26	51.73	6.06	0.74	3.84	2.86	3.12
AHLS 15	44.63	48.80	19.36	61.76	33.23	5.14	0.51	2.31	1.18	3.16
AHLS 16	45.56	50.36	18.50	62.36	41.03	7.35	1.08	2.11	2.31	2.46
AHLS 17	45.30	51.33	19.56	63.20	32.16	6.45	0.72	2.29	1.66	2.79
AHLS 18	44.60	52.86	18.20	65.33	31.30	5.42	0.41	2.81	1.17	3.15
AHLS 19	47.26	53.43	18.33	65.90	50.50	9.38	0.92	1.94	1.80	2.82
AHLS 20	41.90	52.30	19.76	62.80	39.13	5.73	0.56	2.83	1.60	2.94
AHLS 21	43.73	52.26	20.40	71.03	51.36	5.77	0.75	4.17	3.17	2.53
AHLS 22	49.26	53.23	18.43	68.80	24.80	7.05	0.51	6.56	3.34	2.64
AHLS 23	50.26	54.33	16.36	69.13	25.30	7.37	0.45	6.23	2.83	3.15
AHLS 24	38.63	48.30	16.13	62.96	21.70	7.47	0.40	6.44	2.59	2.58
AHLS 25	44.60	51.76	18.50	65.33	52.43	5.73	0.89	3.24	2.91	2.77
AHLS 26	43.30	52.16	21.53	64.60	34.03	7.48	0.72	4.06	2.94	2.75
AHLS 27	47.40	53.40	20.76	70.40	22.23	5.78	0.42	2.94	1.24	2.83
AHLS 28	46.16	55.26	20.36	71.76	43.26	6.14	0.57	2.41	1.38	2.63
AHLS Long-1	45.30	49.43	18.40	65.50	38.86	5.71	0.75	5.56	4.22	3.25
AHLS Round-1	38.70	47.06	16.50	61.46	18.00	10.70	0.56	7.54	4.27	2.45
CD 5%	0.72	1.01	0.85	1.22	1.59	0.22	0.06	0.14	0.23	0.17

Table 2: Genetic variability component for various characters in bottle gourd

Characters	Range		Mean	CV (%)	GCV (%)	PCV (%)	h^2 (broad sense)	Genetic Advance (GA)	GA as percentage of mean (5 %SI)
	Minimum	Maximum							
DFMF	38.46	50.26	44.52	0.98	7.49	7.51	88.43	6.85	15.39
DFFF	43.83	55.26	51.21	1.19	5.32	5.37	98.35	5.57	10.87
NFF	15.40	21.76	18.91	2.73	9.32	9.45	97.22	3.58	18.93
DFH	61.46	71.77	65.47	1.13	4.82	4.87	98.19	6.45	9.85
FL	18.00	52.43	37.14	2.81	29.82	29.86	99.75	22.79	61.35
FD	5.15	10.71	6.81	1.99	20.01	20.04	99.67	2.80	41.14
FW	0.401	1.224	0.712	5.42	34.69	34.83	99.19	0.51	71.17
NF/P	1.95	7.54	3.81	2.29	45.13	45.15	99.91	3.54	92.93
FY/P	1.174	4.270	2.544	5.59	37.78	37.92	99.28	1.97	77.55
VL	2.45	3.31	2.88	3.73	9.36	9.61	94.97	0.54	18.80
LL	14.35	25.81	20.84	0.71	15.14	15.15	99.93	6.50	31.19
LW	13.74	30.04	21.66	0.49	16.78	16.79	99.97	7.49	34.57
LS	210.13	775.69	461.42	0.87	29.67	29.68	99.97	282.03	61.12
FPL	8.44	19.28	13.15	0.56	23.13	23.14	99.95	6.26	47.64
MFL	26.14	91.04	54.48	2.79	32.24	32.28	99.75	36.14	66.34
NS/F	83.87	319.67	203.62	2.96	35.19	35.23	99.76	147.45	72.41
SL	1.396	1.793	1.615	3.28	7.77	8.01	94.37	0.25	15.58
SW	0.606	0.917	0.777	6.26	9.71	10.36	87.81	0.15	18.74
STW	14.55	23.87	18.13	1.01	15.66	15.67	99.86	5.84	32.24

Table 3: Genotypic and phenotypic correlation coefficient in bottle gourd

Characters		DFFF	NFF	DFH	FL	FD	FW	NF/P	FY/P	VL
DFMF	G	0.737	0.100	0.586	0.035	-0.148	0.143	-0.230	-0.187	0.217
	P	0.730**	0.097	0.582**	0.036	-0.150	0.142	-0.230	-0.186	0.207
DFFF	G	—	-0.013	0.738	-0.039	-0.101	-0.056	-0.277	-0.386	-0.029
	P		-0.014	0.729**	-0.037	-0.100	-0.057	-0.274	-0.383	-0.035
NFF	G		—	0.150	0.457	-0.460	0.185	-0.480	-0.246	0.079
	P			0.144	0.452*	-0.451*	0.183	-0.474*	-0.240	0.055
DFH	G			—	0.028	-0.208	-0.191	0.011	-0.123	-0.104
	P				0.029	-0.209	-0.189	0-011	-0.122	-0.103
FL	G				—	-0.267	0.697	-0.563	0.037	0.210
	P					-0.267	0.695**	-0.562**	0.038	.0199
FD	G					—	0.166	0.390	0.403	-0.383
	P						0.164	0.389	0.402	-0.373
FW	G						—	-0.437	0.306	0.173
	P							-0.435*	0.311	0.165
NF/P	G							—	0.684	-0.245
	P								0.682*	-0.238
FY/P	G								—	-0.048
	P									-0.050
VL	G									—
	P									

*, ** Significant at 5% and 1% level, respectively.

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Efficacy of urea and zinc on sweet orange cv. Sathgudi under hot semi-arid environment of western India

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Abstract

An experiment was conducted on sweet orange cv. Sathgudi to study the effect of urea and zinc, alone and in different combinations, on growth, yield and quality of Sathagudi sweet orange during the year 2002 and 2004 under semi-arid conditions of Panchmahals district of Gujarat. Treatments comprised of zinc as foliar spray (0.5%) alone and in combination with different nitrogen doses in the form of urea in soil as well as foliar spray. Soil application of urea was given in the last week of June and first week of September during both the years of experimentation. Results of the experiments revealed that the growth of plants in terms of plant height, stem girth and plant spread, yield in terms of weight of fruits, fruit size, and quality with respect of juice content, TSS, total sugar and vitamin C increased with the soil application of urea 350 g per tree over control. The parameters further showed an increasing trend when urea was sprayed in addition to soil application. An increase in the percentage of urea in solutions for spray from 0.5 to 1.5 % increased the growth, yield and quality of sweet orange fruits. Among the various treatment combinations evaluated, urea in soil (350 g) + zinc (0.5%) +Urea as foliar spray (1.5%) was found to be the best to increase the growth and yield of quality fruits under semi-arid ecosystem of western India.

Keywords: Sweet orange, zinc, urea, quality, TSS

Introduction

The sweet orange (tight skinned orange) commonly known as *Mosambi* is an important citrus fruit of India. Under humid environment, fruits turned insipid and there is more chance of attacking insect, pests and diseases. However, taste is superior under dry condition of semi-arid ecosystem. Sweet orange is popular for its juice which is rich in vitamin C, but for want of scientific cultivation practices, the orchards are fast declining. Among the factors responsible for citrus decline, plant nutrition occupies an important role. The necessity of maintaining proper nutrition balance in citrus orchard to ensure tree health and productivity has been highlighted by Chapman and Kelly (1943). There are several reports of existence of micro nutrient deficiencies in different part of India and it may be considered to be one of the factors to be associated with low productivity and poor quality fruits. Zinc ranks next only to nitrogen and it also plays role in nucleic acid metabolism, protein and chlorophyll synthesis, and acts as catalyst in oxidation and reduction process (Childers, 1954). Hence there is essentiality of maintaining proper nutrient balance in citrus orchard to ensure proper tree health. Keeping these points in view, an attempt was made to see the effect of urea and zinc on growth, yield and quality of sweet orange under semi-arid ecosystem of western India.

Materials and Methods

The experiment with ten treatments *viz.*, T_1, control; T_2, urea 350g in soil; T_3, zinc 0.5 per cent; T_4, urea in soil plus urea 0.5 per cent foliar application; T_5, urea in soil plus urea 1.0 per cent foliar spray; T_6, urea in soil plus urea1.5 per cent foliar spray; T_7, urea in soil plus zinc 0.5 per cent foliar spray; T_8, urea in soil plus zinc 0.5 per cent plus urea 0.5 per cent foliar spray; T_9, urea in soil plus zinc 0.5 per cent plus urea 1.0 per cent; T_{10}, urea in soil plus zinc 0.5 percent plus urea 1.5 per cent foliar spray; was conducted at Central Horticultural Experiment station, Vejalpur, Panchmahals, Gujarat under the project NATP-HFNS during the 2002-2004. The soil was analyzed for organic carbon, EC, pH, N, P and K following methods used by Bhargava and Raghupati (1993) and soil bulk density and hydraulic conductivity following the methods as suggested by Page *et al.* (1982) before the initiation of the experiment. The soil type was clay-to-clay loam with available N (150.25 kg/ha), P (6.23 kg/ha) and K (145.50 kg/ha) and organic carbon (0.31%), having EC and pH, bulk density and hydraulic conductivity of soil as 0.14 dS m^{1}, 7.95, (1.43g/cc) and (0.27 cm/hr), respectively. The soil depth ranges from 0.75-1.0 m, derived from mixed alluvial basalt, quartzite, granite and layers of limestone, and falls under semi-arid hot climate. The experiment was conducted on seven-year-old sweet orange plants in Randomized Block Design with ten treatments, which were replicated thrice. The urea 350 g was applied in soil twice in a year during June and September. Zinc was applied as foliar application (0.5%) alone and in combination with nitrogen treatments, the required amount of fertilizer was dissolved separately, the pH of zinc

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solution was adjusted by lime and sprayed twice in year in the months of May and September. The total soluble solids and acidity were measured and analyzed using standard methods. Ascorbic acid from juice was determined by methods suggested in AOAC (1990).

Results and Discussion

Soil application of urea 350 g alone and also as foliar application and zinc 0.5 per cent increased the plant height significantly. The plants treated with urea in soil plus urea as foliar sprays in combination with zinc sulphate increased the growth over control (Table 1). Application of 350 g urea and subsequent foliar application of 1.5 per cent urea and 0.5 per cent zinc sulphate recorded maximum increase in plant height (46.54 cm), stem girth (3.78 cm) and plant spread (E-W 48.50 and N-S-43.46 cm) which was closely followed by T_9 (urea 350g in soil + urea 1.0 per cent foliar spray + zinc 0.5 per cent), while minimum increase in plant height (29.70 cm), stem girth (2.56 cm) and plant spread (E-W, 32.10 cm and N-S, 32.95 cm) were recorded under control. These finding are in close conformity with result of several earlier workers like Chanturiya (1974) in mandarin, Samolades (1964) in Unshiu mandarin, Arora and Singh (1970) in guava and Singh and Singh (2005) in grapefruit.

The treatments, which were effective in promoting the vegetative growth, were also found to be responsible for more yield and yield attributing characters (Table 2). Yield more yield and yield attributing characters (Table 2). Yield per plant (54.05 kg and 58.90 kg) was recorded maximum in the plants treated with urea 350 g in soil plus urea 1.5 per cent foliar spray and zinc sulphate 0.5 per cent during both the year of experimentation, which was followed by urea 350 g in soil plus urea as foliar spray(1%) plus zinc (0.5%) (51.12 mg and 52.75 kg) and the same was recorded the lowest in control. The maximum fruit weight (143.50 g and 147.27 g), fruit length (6.86 cm and 6.92 cm), fruit diameter (6.68 cm and 6.70 cm), TSS (12.85 and 13.00) and vitamin C (55.60 and 57.50 mg/100g fresh juice) were recorded with the treatment T_{10} (urea 350g in soil plus zinc 0.5 % plus urea 1.5 % foliar spray), which was closely followed T_9 (urea 350g in soil plus zinc 0.5% + urea 1.0 % spray). These findings are similar to those reported by Ram and Bose (1994) in mandarin orange, Arora and Singh (1970) in guava and Singh and Agrawal (1961) in citrus. Juice content (44.05% and 41.20%) and total sugar (6.82% and 6.84%) were recorded high in the plants which were treated with urea in soil (350g) as well as foliar spray (1.5%) and zinc (0.5%) followed by T_8, urea in soil + urea as foliar spray and zinc 0.5% and it was recorded the lowest in control (table-2). Similar findings have earlier been reported by Ram and Bose (1994) in mandarin and in grapefruit.

Table 1: Effect of urea and zinc on annual growth extension of sweet orange cv Sathgudi (average of two years 2002-04).

Treatments	Plant height (cm)	Stem girth (cm)	Plant spread (cm)	
			E-W	N-S
T1	30.70	2.56	32.10	32.95
T2	32.18	2.62	40.89	39.00
T3	36.76	2.75	34.00	33.15
T4	37.90	2.98	39.14	36.00
T5	40.13	3.20	40.47	41.15
T6	42.02	3.10	40.32	38.95
T7	39.00	3.09	38.86	37.18
T8	44.15	3.28	41.81	39.90
T9	46.85	3.52	43.30	42.00
T10	46.54	3.78	48.50	43.46
C D at 5%	1.87	0.35	2.48	2.32

Table 2: Effect of urea and zinc on yield and physical attributes of sweet orange cv. Sathgudi

Treatments	Yield (kg) /plant		Fruit weight (g)		Fruit length (cm)		Fruit diameter (cm)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
T1	35.00	36.10	159.00	160.42	5.50	5.52	5.54	5.52
T2	38.18	37.25	160.00	162.27	5.53	5.54	5.58	5.59
T3	36.17	38.00	163.23	165.85	5.45	5.59	5.47	5.50
T4	40.15	42.28	178.00	180.18	6.10	6.15	6.09	6.10
T5	43.42	45.00	180.72	182.25	6.00	6.12	6.05	6.17
T6	45.19	43.07	170.00	174.27	5.94	5.98	6.00	6.12
T7	39.15	40.00	164.87	167.15	5.85	5.88	5.90	5.95
T8	49.12	48.15	185.24	190.62	6.33	6.41	6.40	6.39
T9	51.12	52.75	185.93	189.84	6.35	6.44	6.39	6.40
T10	54.05	58.90	198. 50	200.25	6.86	6.92	6.68	6.70
C D at 5%	4.28	4.37	9.67	8.90	0.42	0.51	0.38	0.45

Table 3: Effect of urea and zinc on chemical attributes of sweet orange cv. Sathgudi

Treatments	Juice content (%)		TSS (^{0} Brix)		Total sugar %(fresh weight)		Acidity (%)		Vitamin C (mg/ 100 g fresh juice)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
T1	38.25	36.18	11.30	11.37	5.95	6.12	1.20	1.29	50.15	51.72
T2	40.00	43.18	11.62	11.57	6.65	6.57	1.34	1.27	52.12	50.15
T3	39.12	36.00	12.82	11.90	6.61	6.68	1.31	1.37	51.12	52.27
T4	41.15	43.15	11.90	12.85	6.50	6.61	1.30	1.34	52.40	51.19
T5	40.18	45.08	12.15	12.90	6.50	6.57	1.40	1.47	53.75	54.12
T6	41.00	44.95	12.18	12.25	6.54	6.32	1.36	1.40	54.14	55.12
T7	42.47	42.45	11.95	12.10	6.62	6.70	1.38	1.38	54.12	55.00
T8	43.15	41.18	12.95	12.64	6.75	6.80	1.43	1.45	52.87	52.19
T9	43.95	42.18	12.92	12.75	6.78	6.89	1.45	1.45	53.29	55.15
T10	44.05	41.20	12.85	13.00	6.95	7.00	1.46	1.47	55.60	54.15
C D at 5%	3.00	3.12	1.34	1.45	N S	N S	N S	N S	4.15	4.20

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In-vitro propagation studies of virus tolerant citrus rootstock Cleopatra Mandarin (*Citrus reshnii* Tanaka)

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Abstract

Studies on virus tolerant, citrus rootstock Cleopatra (*Citrus reshnii* Tanaka) were carried out by using nodal segments of seedlings as explants. The maximum survival of explants (90 per cent) and minimum time required to bud breaking (19.50 days) was recorde on BAP 0.5mgl^{-1} + kinetin 0.5 mgl^{-1}. However, maximum number of shoot (7.30) was there on BAP 2.0 mgl^{-1} + kinetin 1.0 mgl^{-1} and maximum length shoot (2.40 cm) on BAP 0.5 mgl^{-1} + kinetin 2.0 mgl^{-1}. The maximum (90 per cent) survival of micro shoot for rooting and length of root (6.28 cm) were recorded on M S medium modified with NAA 0.5 mgl^{-1}+ IBA 0.5 mgl^{-1}. The minimum time taken to root induction (22.00 days) was on NAA 0.5mgl^{-1} + IBA 0.1 mgl^{-1} and maximum number of root (5.60) was on NAA 0.5 mgl^{-1} + IBA 1.0 mgl^{-1}. *In-vitro* propagated plantlets were successfully acclimatized by transferring then in pots containing a potting mixture of soil: perlite: vermiculite in equal proportion. Plantlets survival ofv90 per cent was observed in this mixture.

Key words: Cleopatra, *in-vitro*, multiplication, nuceller, BAP, kinetin, NAA and IBA

Introduction

Cleopatra (*Citrus reshnii* Tanaka) is an important citrus species of Rutaceae family and commercially grown for rootstock. It is the important rootstock for mandarin, sweet orange, acid lime etc. because it renders good graft compatibility, productivity, fruit quality, dwarf stature of plant and also tolerance to viruses (Tristiza, Xyloporosis, Exocortis and Gumosis (Chadha, 1970), fungi (*Phytopthora*) and bacterial canker. It is the most salt tolerant citrus rootstock due to ability to exclude sodium and chloride taken up by the foot system (Broembsen, 1984).The production of uniform large number of plant is not possible through seed because of cross pollination nature of citrus. Hence, the maintenance of genetic makeup of genotype in successive generation is not possible through seed propagation. The production of uniform large number of plant is not possible through seed. Tissue culture offers an advantage over conventional methods of propagation (seed) in producing large number of genetically uniform healthy plant within a short period. In tissue culture Plant Growth Regulators (PGRs) play important role on different regeneration parameters. In this perspective studies were carried out to standardize the optimum concentration of PGRs for particular organ regeneration from nodal segments.

Material and Methods

Present investigation was carried out at the Tissue Culture Laboratory, Agricultural Research Station, Sriganganager during 2007-08. Nodal segments of seedlings were used as explants. For this, healthy fruits were collected from citrus repository of the station. They were washed in running tap water for 2-3 hours. The seeds were extracted, washed thoroughly and treated with 0.2 per cent Bavistin. The seed testa was removed under aseptic condition. These decoated seeds were first quick rinsed with 70 per cent ethanol followed by mercuric chloride ($HgCl_2$) @ 0.1 per cent) for five minutes and inoculated in culture tubes (25 x 150 mm) containing 15-20 ml MS basal medium modified with 3 per cent and 0.8 per cent sucrose. All the cultures were incubated in BOD at 25 ± 2° C. After one and half month of inoculation the seedlings were cut into segments, each segment having at least two buds and then inoculated on MS medium (Murashige and Skoog,1962) supplemented with BAP, Kinetin @ 0.0, 0.5, 1.0, 2.0 mg l^{-1} alone or in combinations for axillary shoot proliferation. All the cultures were sub- cultured in fresh medium after 25-30 days. The *in-vitro* generated shoots

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were used as micro cuttings. The dried, under sized leaves and multiple shoots were removed. The micro shoot about 2-3 cm were inoculated in culture tube (25 x 150 mm) containing 15-20 ml MS medium supplemented with various concentrations of IBA and NAA @ 0.0,0.1,0.5,1.0 and 2.0 mg l^{-1} alone or in combination. The rooted plantlets were removed carefully from the culture tubes and their roots were thoroughly washed under running tap water and cleaned with fine brush to remove adhering agar. The plantlets were covered with sterilized cotton wetted with half strength MS medium for 24 hours in culture room. The plantlets were treated with Bavistin @ 0.1 per cent for 10 minutes to prevent fungal contamination. These plantlets were transferred to pots containing sterilized soil, vermiculite, and perlite in equal proportion. These pots were kept in green house at 90 per cent humidity with temperature 26 ± 2°C. The humidity was continuously lowered within 8-10 weeks upto 60 per cent. During this period the plantlets were irrigated with Hoglands solution at three days interval for one month. After that, these were irrigated with Hoglands solution and simple water at an interval of 2-3 days alternately. The observations were recorded for per cent survival of explants, time required to bud break, number of shoot, length of shoot, per cent micro shoot responding to root ,time required to root induction, number of root, length of root and number of plantlets survival after 60 days of planting in pots and incubated in green house. The recoded data was statistically analyzed by C.R.D. (Completely Randomized Design) Cochran and Cox (1957).

Results and Discussion

Per cent survival of explants

The per cent survival of explants was significantly affected by BAP and kinetin levels (Table-1). Among alone levels of BAP and kinetin the maximum 980 per cent) survival of explants were observed when MS culture medium modified with 2.0 mgl^{-1} and 1.0 mgl^{-1} respectively was used. In case of combination of BAP and kinetin the maximum survival of explants (90 per cent) was recorded on BAP 1.0 mgl^{-1} + kinetin 0.5 mgl^{-1}. The results of the studies are concurrent with the findings of Parthasarathy and Nagaraju (1993b) they reported significant interaction between levels of values for plantlet induction. Similar finding were also reported by Baruah *et al.*, 1996a.

Time required to bud break

BAP and Kinetin levels significantly affected the number of days required to bud break. The increasing concentration of BAP and Kinetin significantly decreased time needed to bud break and further, increase in concentration delayed it (Table-1). Among different levels of BAP and kinetin (0.5, 1.0 and 2.0 mgl^{-1}) the minimum (20.30 days) and 22.0 days were recorded on 0.5 mgl^{-1} and 1.0 mgl^{-1} respectively. It is revealed from the data that BAP was better cytokinin than kinetin for reducing time for bud break. The similar findings are also reported by Singh *et al.*(1994) who reported that the mean minimum number of days required to bud beak was directly dependent on citrus species and medium combination. They also reported minimum days to bud beak in *Citrus reticulata* and *Citrus limon* as 17 and 18 days respectively, when explants of both species were cultured in MS medium modified by BAP 1.0 mgl^{-1} + kinetin 0.5 mgl^{-1} + NAA 0.5 mgl^{-1}.

Number of shoot

Among individual levels of BAP, MS medium modified with 2.0 mgl^{-1} BAP gave maximum number of shoot per explants 5.70 (Table-2). It may be due to more responsiveness of the Cleopatra explants to higher concentration of BAP. The result of present study is in line with the reports of Rahaman *et al.* (1996) who reported 2.80 shoots in Cleopatra when explant was inoculated in MS medium containing 1.0 mgl^{-1} BAP. In case of kinetin a maximum of 5.10 shoots were observed, when explants were inoculated on MS culture medium modified with 2.0 mgl^{-1} kinetin. These findings are similar to those reported by Al-Khayri and Al-Bahrany (2001) who reported that a maximum of 7.0 shoots per explants were observed in MS medium modified by 1.0 mgl^{-1} BAP. This may be due to suppressed apical dominance by cytokinin. It is proved from the study that the rate of shoot multiplication was significantly affected by the concentration of BAP and kinetin. BAP play important role in shoot multiplication, lack of BAP in medium mostly produced single shoot but addition of 0.25 mgl^{-1} BAP significantly increased shoot multiplication. The rate of shoot multiplication on MS media supplemented by kinetin was low. In present study it was observed that BAP was superior cytokinin for shoot multiplication than kinetin. These findings are also supported by Otoni and Teixeira (1991) in Sweet orange. According to them cytokinin promotes shoot proliferation by inducing cell division and enlargement. The similar results was also reported by Bowman (1994) in citrus rootstocks. In interaction effect of BAP and kinetin, the maximum number of shoots (9.30 per explant) were recorded when MS culture media was supplemented by BAP 2.0 mgl^{-1} + kinetin 0.5 mgl^{-1} (Table-2, Fig.-1 and Plate-1A). This may be due to better synergetic effect of the cytokinins. The results of present studies are in line with the report of Karwa (2003) who reported that in Nagpur mandarin the maximum (9.11 ± 0.26) shoots were observed when explants were inoculated on MS medium supplemented with BAP (8.88 µl) + kinetin (2.32 µl). Similar findings have also been reported by Bowman, 1994 in citrus rootstocks, Al-Bahrany (2002) and Al-Khayri and Al-Bahrany (2001) in lime.

Length of root

The length of root was significantly influenced by different concentrations of NAA and IBA. The length of root significantly increased with increasing concentration of IBA up to 1.0 mgl^{-1} level and higher than this had reverse effect. The maximum length of roots (4.20 cm) was observed when MS medium was modified by 1.0 mgl^{-1} IBA, (Table-2). Similar results are also reported by Syamal *et al.* (2007). The increase in level of NAA significantly increased length of root upto 0.5 mgl^{-1} and further increase

in concentration decreased it. The maximum length of roots (2.71cm) was observed when micro shoots were cultured on MS medium modified with 1.0 mgl^{-1} NAA. Kitto and Young (1981) in Carrizo obtained 2.30 cm length of roots when micro shoot inoculated in MS medium fortified by 1.0 mgl^{-1} NAA was usesd. In interaction effect of IBA and NAA, for length of root, maximum length of root (6.28 cm) was observed on MS culture medium supplemented with NAA and IBA each 0.5 mg l^{-1} (Table-2, Fig.-2 and Plate-1D). Syamal *et al.* (2007) reported maximum length of root (2.16 cm) when micro shoots were cultured in MS medium supplemented with IBA 1.0 mgl^{-1} NAA 0.5 mgl^{-1}. The findings of present study are in agreement with Al-Khayri and Al-Bahrany (2001).

Acclimatization

In-vitro regenerated plantlets were successfully acclimatized by transferring them in small pots containing a potting mixture of soil: Perlite: vermiculite in equal proportion. Survival of plantlets upto 75 per cent was observed. It may be due to higher number of roots, high porosity, cation exchange capacity (CEC) and water

Table 1: Effect of BAP & Kinetin, added singly and in combination on basal medium, on different regeneration parameters of Cleopatra

Treatments ($mg\ l^{-1}$)		Per cent survival of explants	No. of days to bud break	No. of shoots	Length of shoot (cm)
BAP	Kinetin				
0.0	0.0	50 (45.00)	22.30	1.60	1.42
0.0	0.5	70 (56.79)	22.10	2.30	1.90
0.0	1.0	80 (63.43)	22.00	3.60	2.10
0.0	2.0	60 (50.77)	23.10	5.10	1.62
0.5	0.0	70 (56.79)	20.30	3.70	1.20
1.0	0.0	70 (56.79)	21.30	4.10	1.50
2.0	0.0	80 (63.43)	21.80	5.70	0.72
0.5	0.5	70 (56.79)	19.50	5.70	1.71
0.5	1.0	70 (56.79)	20.80	4.60	2.00
0.5	2.0	60 (50.77)	20.00	3.60	2.40
1.0	0.5	90 (71.57)	21.20	4.50	1.90
1.0	1.0	60 (50.77)	21.10	6.60	1.71
1.0	2.0	50 (45.00)	21.90	4.30	1.65
2.0	0.5	60 (50.77)	21.10	6.30	1.50
2.0	1.0	60 (50.77)	21.40	7.30	1.82
2.0	2.0	50 (45.00)	23.20	4.30	1.32
S. Em.		0.33	0.26	0.16	0.10
CD (0.05%)		0.99	0.71	0.44	0.27

*Figures given in parentheses are angular transformed values

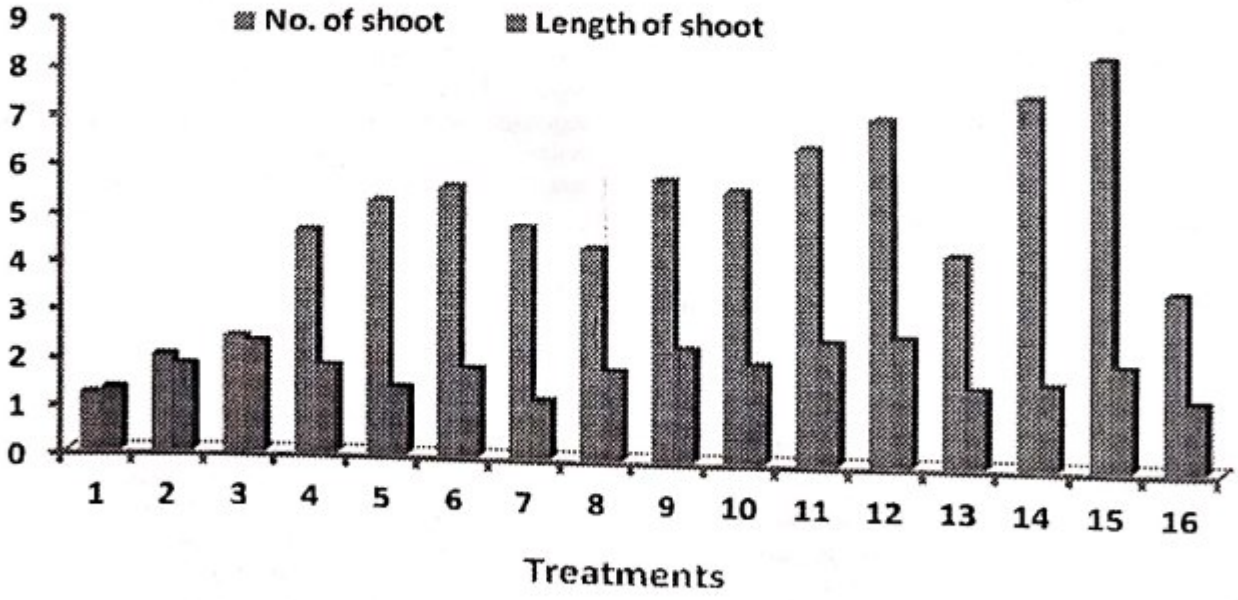

Fig. 1 Effect of cytokinin (BAP and Kinetin) added singly and in combination in MS basal medium on no. of shoot and length of shoot (cm) in Cleopatra

Table 2: Effect of NAA and IBA added singly and in combination in basal medium on different root parameters of root in Cleopatra

Treatments (mg l^{-1})		Treatments (mg l^{-1})	No. of days taken to root induction	No. of roots	Length of root (cm)
NAA	IBA				
0.0	0.0	0.0 (0.00)	0.0	0.00	0.00
0.1	0.0	60 (50.77)	25.10	1.20	1.80
0.5	0.0	70 (56.79)	22.60	2.20	2.29
1.0	0.0	80 (63.43)	26.20	3.60	2.71
2.0	0.0	70 (56.79)	27.90	2.20	2.21
0.0	0.1	60 (50.77)	26.20	1.40	1.26
0.0	0.5	70 (56.79)	24.30	1.90	2.16
0.0	1.0	80 (63.43)	23.50	2.50	4.20
0.0	2.0	50 (45.00)	26.20	2.30	3.69
0.1	0.1	70 (56.79)	23.50	3.00	1.85
0.5	0.1	70 (56.79)	22.00	3.30	3.12
1.0	0.1	80 (63.43)	28.10	3.30	2.38
2.0	0.1	70 (56.79)	27.10	3.00	1.91
0.1	0.5	80 (63.43)	23.70	4.00	4.13
0.5	0.5	90 (71.57)	23.80	4.40	6.28
1.0	0.5	70 (56.79)	26.70	3.70	3.30
2.0	0.5	60 (50.77)	28.60	2.90	1.82
0.1	1.0	70 (56.79)	23.30	3.90	3.30
0.5	1.0	70 (56.79)	25.80	5.60	2.81
1.0	1.0	60 (50.77)	26.10	4.10	2.38
2.0	1.0	60 (50.77)	27.50	4.10	1.90
0.1	2.0	60 (50.77)	25.40	3.80	2.61
0.5	2.0	50 (45.00)	25.70	4.20	2.79
1.0	2.0	50 (45.00)	27.40	3.20	2.42
2.0	2.0	40 (39.23)	28.20	2.50	1.25
S. Em.		0.45	0.40	0.45	0.16
CD (0.05%)		1.27	1.13	1.27	0.44

*Figures given in parentheses are angular transformed values

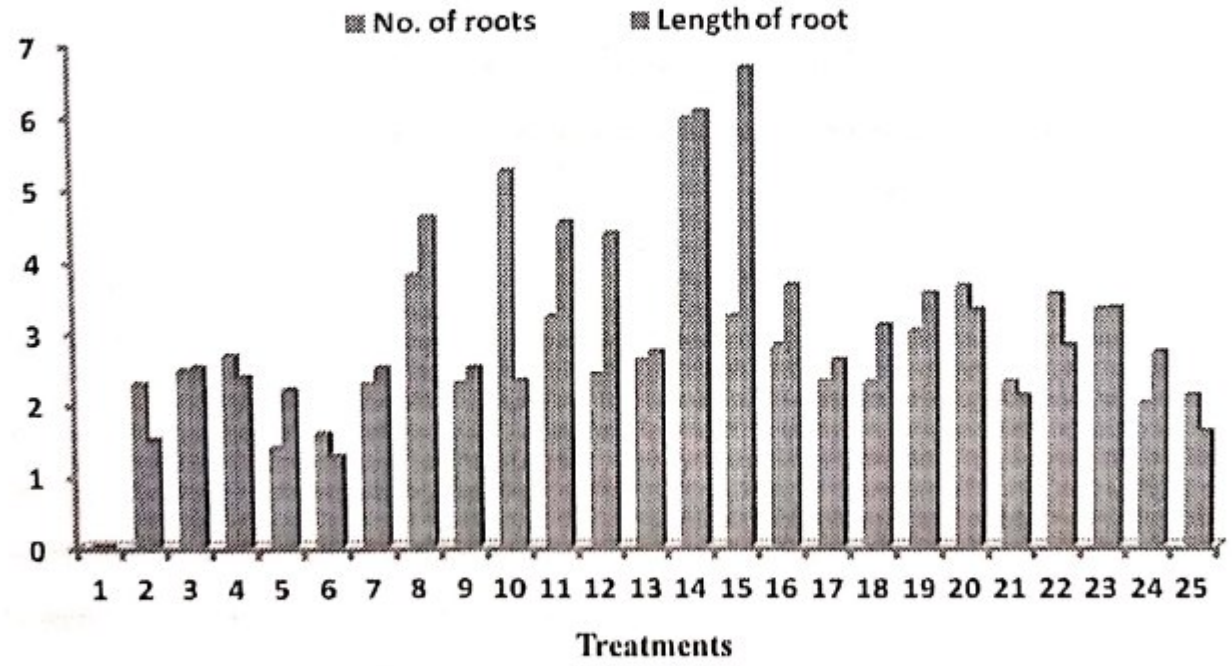

Fig. 2. Effect of auxin (NAA and IBA) added singly and in combination in MS basal medium on no. of roots and length of roots (cm) in Cleopatra

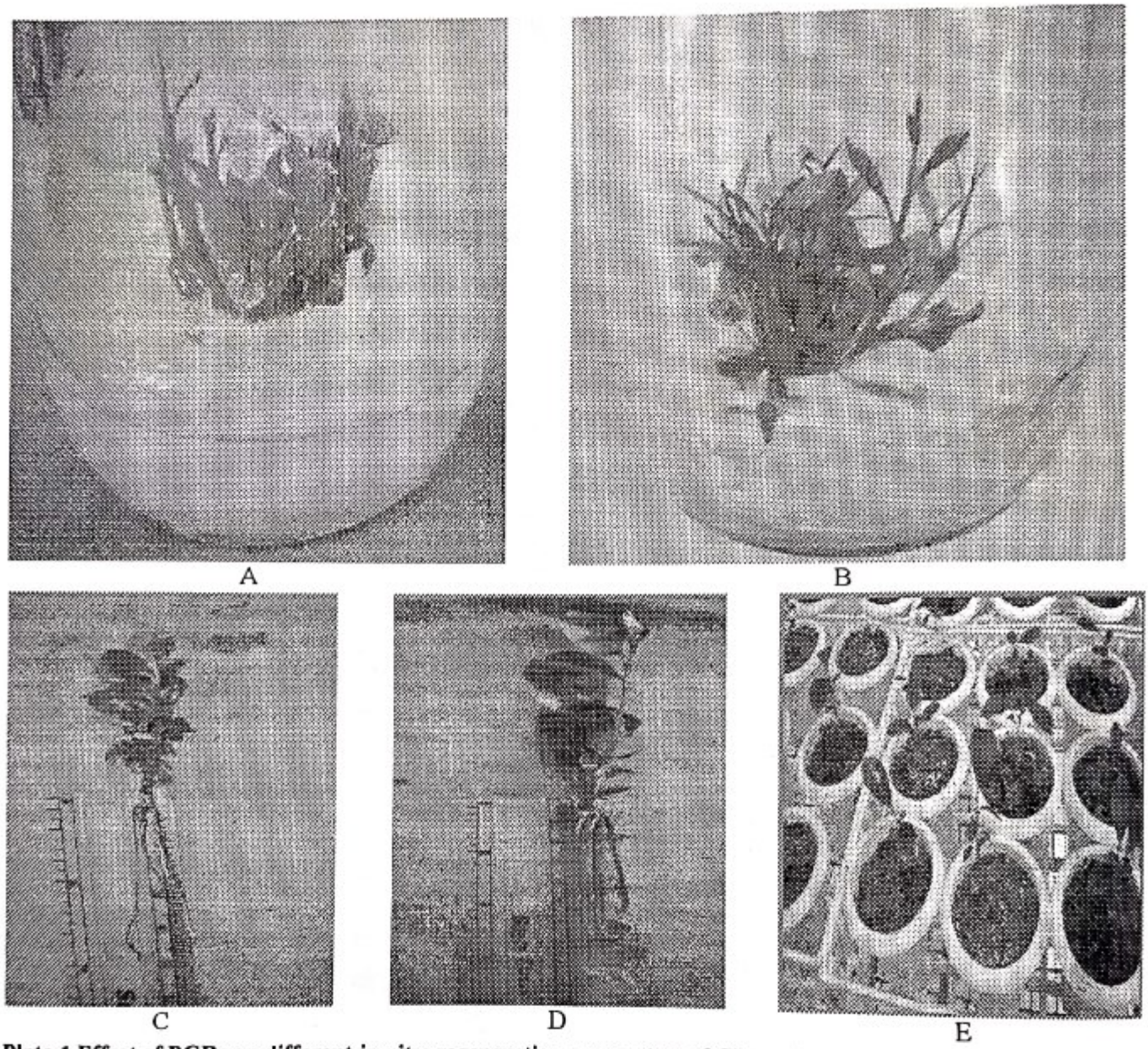

Plate-1 Effect of PGRs on different *in-vitro* regeneration parameters of Cleopatra
A- No. of shoot (BAP 2.0 mgl^{-1} + kinetin 1.0 mgl^{-1}), **B-**Length of shoot (BAP 0.5 mgl^{-1} + kinetin 2.0 mgl^{-1}) **C-** No. of root (NAA 0.5 mgl^{-1} +IBA 1.0 mgl^{-1}), **D-** Length of root (NAA 0.5 mgl^{-1} +IBA 0.5 mgl^{-1}) **E-** Hardening of *in-vitro* regenerated plantlets.

holding capacity of potting medium (Plate-1E). According to Gill *et al.* (1995 and Baruah, *et al.*, 1996b) survival per cent of *in-vitro* plantlets is directly related to number of roots. The results of the present study are in line with earlier reporters. Singh *et al.* (2007) reported 92.00 per cent success of *in-vitro* plantlets *in vivo* condition when vermiculite and coco peat @ 3:1 ratio were used as potting medium. Singh *et al.* (1994) reported 60 per cent establishment of plants when planted in soil in case of khasi mandarin. In case of Rough lemon Singh *et al.* (1999a) reported 80 per cent survival of plantlets in soil upon planting..

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Response of different drip irrigation volumes and mulches on yield of fennel (*Foeniculum vulgare*) in western part of Rajasthan

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Abstract

A field experiment was conducted at Research Farm College of Agriculture, S.K. Rajasthan Agricultural University, Bikaner to evaluate the different drip irrigation volume and mulches on growth and yield of fennel. The experiment was carried out in split plot design with three replications. There were five treatment viz. drip at 1.0, 0.85, 0.70 and 0.55 and surface irrigation in main plots and mulches viz. organic mulch, polythene mulch and with out mulch were used in sub plots. The height of plant was maximum (130 cm) with 1.0 volume of drip than the other volume of drip and surface irrigation. When water volume of drip was decrease from 1.0 to 0.55 the plant height was similarly reduced and height was also recorded maximum with polythene mulch. The highest yield and water use efficiency was obtained under the 0.55 volume of drip (14.72q/h) however it was recorded minimum (8.62q/h) in surface irrigation. In mulches, yield and water use efficiency was recorded in Polythene mulches.

Key Words: Fennel, drip irrigation, mulch

Introduction

Fennel (*Foeniculum vulgare*) is a member of the Umbelliferae (Apiaceae) or carrot family. Fennel has a thick, spindle-shaped taproot that produces a pithy, smooth or finely-fluted round stem that may reach to 6 ft (1.8 m) in height. The seeds, leaves, and roots of fennel are safe and edible. Fennel has been widely used in culinary and medicinal preparations for centuries. The herb acts as a carminative, and was traditionally employed as a digestive aid and remedy for flatulence. An infusion or decoction of the dried seeds is anti-spasmodic and will ease stomach pains and speed up the digestion of fatty foods. Fennel is a proven remedy for colic in infants, and is safe when administered as a mild infusion of the leaf and seed. It is also used for coughs and colds. Fennel exerts a calming influence on the bronchial tissues. The seeds contain large amounts of the photochemical alpha-pinene, which acts as an expectorant and helps to loosen phlegm in the lungs. The herb is rich in potassium - an essential mineral which helps decrease the high blood pressure that can cause a heart attack. The major producer countries of this crop are India 110000, Mexico 49688 and China 40000 tones per year. In India it is mainly cultivated in Gujarat and Rajasthan (51.47 and 9.1 in thousand ha.) with production 84.20 and 14.88 thousand tones, respectively. Due to high medicinal use of this spice crop, the area should increase but due to adverse climatic conditions of Western Rajasthan .The area under this crop is negligible. However area and production both can increase if the modern irrigation techniques will involve in irrigating the cultivated area of this crop in arid part of Rajasthan. Under such circumstances micro irrigation, an approach for irrigation water management has played a most significant role to bring more area under increasing the productivity of crop and water use efficiency (Sivanappan, 2004) .Drip irrigation is one of the important and most efficient method of irrigation, which is becoming increasingly popular in areas of water scarcity. The response of fennel to irrigation in yield improvement was found to be different in different agro-climatic and soil conditions in India. Besides, in order to mitigate the adverse effect of water stress, efficient In-Situ moisture conservation is one of the common practices to reduce evaporation loss from the soil and prolong the moisture availability of water resulting in higher yield per unit of water applied. The use of mulches have found to conserve soil moisture ,control weeds, moderate soil temperature and increase in yield of different vegetable and spices crops (Singh and Kumar,2007). Therefore, more attention is required towards integration of drip irrigation and mulching to harness full advantage of improved efficiencies. Thus, a study was undertaken to evaluate the performance of Fennel with drip irrigation and mulch grown in hotarid climate of Rajasthan.

Materials and Methods

An experiment was conducted on fennel during the *Rabi* season of the year of 2006-07 at College of Agriculture, S.K. Rajasthan Agriculture University, Bikaner (28°01' N, 73°22'E and 234.7 m above mean see level).The climate of this zone is typical arid characterized

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by aridity of the atmosphere and deep, sandy and coarse loamy, saline desert soil with low water holding capacity and extreme of temperature both during summer and winter. The average rainfall of this tract is about 250mm. The soil of the field was loamy sand, low in organic carbon and nitrogen, medium in phosphorus and high in available potassium and had pH 8.2 ,electrical conductivity 0.2 ds/m with field capacity of 7.4% and permanent wilting point 5.0. The experiment was laid out in split plot design and replicated thrice with levels of irrigation viz. drip at 1.0, 0.85, 0.70 and 0.55 pan evaporation fraction and surface irrigation at 1.0 IW/CPE ratio as main plots. In sub plots; three mulching treatment viz., no mulch, organic mulch (*Aerva persica*) and polyethylene (25micron) were applied after germination of plant. The volume of water required under drip irrigation system was computed using the equation V=Ep x Kp x Kc x A x Wp. Where , V-volume of water required in liter/day, Ep-Mean pan evaporation for the month in mm/day, Kp-Pan coefficient (0.7for class A pan), Kc-Crop coefficient , A-plant to plant x row to row spacing (0.4 x 0.4 m) , Wp-Wetting fraction (0.9).The seed were sown at 40 x 40 cm row to row and plant to plant spacing. Seed was sown in field in 1st week of October. In drip irrigation water was applied alternatively on the basis of equation, while in surface method water was applied at weekly interval. FYM (150q/h) was applied at the time of field preparation. A required dose of fertilizer 100 kg N and 50kg P_2O_5 were applied in the form of urea and DAP. Half dose of N and full dose P was applied at the time of seed sowing and remaining dosse of nitrogen were applied with irrigation water. Harvesting is done by cutting the umbels as and when they reach to physiological maturity (when seeds are fully filled up & green in colour). After cutting the umbels they are dried in partial shade. The observations on various yield attributes and yield were recorded as per standard procedures. All the data generated were subject to analysis of variance and least significant difference (LSD) at 5 % probability level was obtained.

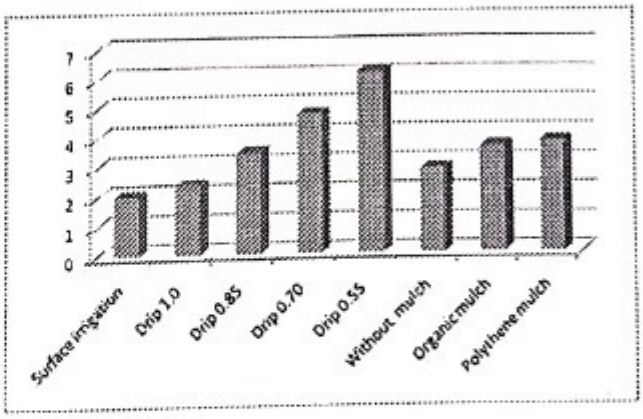
Results and Discussion

The results of experiment revealed that the treatment of water volume and mulches significantly influenced the growth, yield nutrient content of fennel. The height of plant was significantly maximum (130 cm) with 1.0 volume of drip than the other volume of drip and surface irrigation. When water volume of drip was decrease from 1.0 to 0.55 the plant height was similarly reduced. It is well known fact that sufficient moisture for progressive plant growth is maintain by drip irrigation which, tends to better development of photosynthetic area and accelerate photosynthetic rate. Thus, as a consequence, plant growth is accelerated. High frequency of water application by drip irrigation minimizes soil moisture losses, provides at least daily requirements of water to a portion of the root zone of each plant, and maintains high soil water metric potential in the rhizosphere to reduce plant water stress (Tiwari et.al. 1988, Singh and Rajput 2007) . Amongst the mulches treatment, the maximum height (116.95 cm) was observed under the polythene mulch than the organic mulch (112.14 cm) and without mulch (104.12 cm). The height of plant was higher mainly due to more availability of water in both treatments. The Number of branches /plant was significantly increased with decreasing the water volume up to 0.70 after that the branches were decreased with 0.55 volume of drip but there was not observed any significant difference between 0.70(13.74) and 0.55 volume of water(13.38). Further, more number of branches was observed under polythene mulch (13.98) and it was 9.34 under without mulch .It is oblivious that mulching leads to better plat growth by changing micro-climate by conserving more moisture through reduced evaporation , modifying soil temperature ,controlling weeds and thus economizing the use of irrigation water (Yadav,2005). Chlorophyll content at 70 DAS was recorded maximum (1.85 mg/g) in treatment 0.70 volume of drip and it was noticed minimum in surface irrigation (1.46 mg/g) it might be higher due to appropriate of plant growth under drip treatments. In mulches, both organic and polythene mulch recorded higher chlorophyll content over without mulch (1.63 mg/g).

The yield and yield parameters were observed significantly higher under drip irrigation and mulches over surface irrigation and with out mulches. The highest yield was recorded under the 0.55 volume of drip (14.72q/h) however it was recorded minimum (8.62q/h) in surface irrigation. It is a high irrigation efficiency of drip irrigation method which can fulfill the requirement of plants with comparatively less application of water providing over excessive vegetative growth during crop development stage .The yield was increased by increased the umbels per plant .This was also due to better utilization of water and easy uptake of nutrient by plant and excellent soil air water relationship with higher oxygen concentration in the root zone (Gornat et.al,1973,Jadhav et.al, 1990 and Sivanappam ,1992). Singh and Kumar (2007) reported that it may also be due to the optimum moisture condition in the entire root zone of the crop which reflects in better physiological activities of plants. Among mulches, polythene mulch was received maximum yield (13.35q/h) than the without mulch (10.09q/h).The higher yield under black plastic mulch may be ascribed to reduced nutrients losses due to weed control and improved hydrothermal regimes of soil over control(Saikia,etal,1997).

Nitrogen and phosphorus content were received highest with application of drip treatment over surface irrigation. The nitrogen and phosphorus content 1.75 % and 0.31%) were recorded maximum, respectively with the application 0.55 volume of drip might be attributed to adequate and balanced supply of nutrient. It well established fact that nutrient uptake by the crop depend primarily on dry matter accumulation and secondary

nutrient concentration at cellular level. The increased photosynthetic efficiency resulting in more dry matter accumulation might be the major factor responsible for higher N and P content in plant under the application of 0.55 volume of drip .Similar results were respectively by Bacchane and Sabale 1996, Thanunathan etal., 2002 and Das et.al, 2002.Mulches treatment were also influenced the both nitrogen and phosphorus content in plant, the maximum value were received 1.71and 0.28 %, respectively under polythene mulch and it were minimum with out mulch. The maximum water use efficiency (6.18 q/h-cm) was recorded with 0.55 volume of drip. It is due to the fact that at this volume of drip, the yield was maximum and water used was relatively less (306.06 mm). Bisides, 0.55 volume of drip checked excessive vegetative growth. However, water use efficiency declined with successive increase in irrigation levels due to greater expense of water by evapo-traspiration as a result vegetative growth without proportion increase in yield (Saikia etal., 1997,; Yadav,etal., 2007 and Singh and Kumar 2007).



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Combining ability analysis for quantitative traits in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]

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Abstract

Combining ability analysis was carried through diallel mating design (excluding reciprocals) involving eight parents for fourteen characters. The analysis revealed highly significant differences among the genotypes for all the parameters studies. The variances due to sca were higher than the gca for vine length, days to first fruit harvest, harvest duration, fruit length, average weight of first three harvested fruits, number of marketable fruits, fruit yield per plant, size of seed cavity and flesh thickness indicating the predominance of non-additive gene effects. None of the parents was found good general combiner for all the characters consistently, however, parent Pusa Naveen, NDBG-104, NDBG-140, and Bharatpur Local showed higher combining ability for yield and yield attributing traits. The best specific cross for days to first female flower and days to first fruit harvest was Pusa Naveen x NDBG-132 and Pusa Naveen x RS-1, respectively. The crosses Pusa Naveen x NDBG-104 and Pusa Naveen x UL-6 were identified as best specific combiners for average weight of first three harvested fruits, number of marketable fruits and fruit yield per plant.

Key words: *Bottlegourd, Genotype, Combining ability, GCA effects, SCA effects, GCA variance, SCA variance*

Introduction

Bottlegourd [*Lagenaria siceraria* (Mol.) Standl.] is one of the most important cucurbitaceous vegetables grown in warmer climatic regions of the world. Being a monoecious crop cross pollination is a general rule. A wide range of genetic variability is available in bottlegourd with respect to yield and its components, which may be exploited through heterosis breeding. Choice of parents is considered an important aspect in any breeding programme aimed improving yield and its related attributes. The analysis of combining ability helps in selecting suitable parents for hybridization and for characterizing the nature and magnitude of gene action. The selection of parents for production of F_1 hybrids has to be based on genetic information and knowledge of combining ability. Hence, the present investigation was undertaken to study combining ability for yield and other quantitative traits in selected genotypes.

Materials and Methods

The experimental material comprised of eight elite inbred lines *viz.*, Pusa Naveen, RS-1, Pusa Summer Prolofic Long (PSPL), UL-6, NDBG 104, NDBG 132, NDBG 140 and Bharatpur Local and 28 hybrids derived from the diallel mating (excluding reciprocals). The parents and hybrids were evaluated in randomized block design with three replications at Horticulture Farm, SKN College of Agriculture, Jobner, Rajasthan. The experimental material was sown on 29th June, 2003 in rows of 2.5m apart with a spacing of 0.75m between plants. Observations were recorded on five competitive plants in each parents and hybrids for each treatment in each replication for fourteen quantitative traits. The combining ability variances and effects were worked out following the Model I and Method II of Griffing, 1956.

Results and Discussion

The analysis of variance for combining ability revealed significant mean square due to general combining ability (gca) and specific combining ability (sca) for characters studied, indicating the additive and non-additive gene action for these traits. The analysis of variance for combining ability showed highly significant gca difference for all the characters under study (Table-1). The sca effects among hybrids were also significant for all the characters, which indicated the importance of both additive and non-additive gene action. Sirohi *et al.*, 1986; Sirohi *et al.*, 1988; Sreevani, 2005 and Dubey and Maurya, 2006 have reported almost similar results. The gca ($\hat{\sigma}^2_g$) variances were higher than the sca ($\hat{\sigma}^2_s$) variances for number of branches per plant, days to first female flower, severity of powdery mildew, severity of downy mildew and incidence of fruit fly. This indicated the limited scope of heterosis breeding for these characters and population improvement through selection should be adopted for exploiting the genetic variances (Kushwaha and Ram, 1996). Other characters *viz.*, vine length, days to first fruit harvest, harvest duration, fruit length, average weight of

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first three harvested fruits, number of marketable fruits, fruit yield per plant, size of seed cavity and flesh thickness where gca variances were lower than the sca variances may be improved through hybridization (heterosis) indicating the predominance of non-additive gene effects, these findings are in line with those of Sivakami *et al.*, 1987; Maurya and Singh, 1994; Dubey and Maurya, 2006 and Sit and Sirohi, 2008.

The gca effects of parents were significant for most of the characters studied which indicated the existence of variability among the parents selected for hybridization (Table-2). The information regarding gca effect of the parent is of prime importance as it helps in successful prediction of genetic potentiality of crosses. Estimate of gca effect showed that it is difficult to pick up good general combiner for all the characters. The parent Pusa Naveen was the best general combiner as it has shown significant gca effects in desirable direction for most of the traits except vine length, fruit length, average weight of first three harvested fruits and harvest duration indicating its superiority over the rest of the parents and suitability in using such parent in bottlegourd breeding programme to improve yield potential. The parent Bharatpur Local exhibited significant positive gca effect for vine length (0.61) followed by RS-1 (0.25). For days to first female flower and days to first fruit harvest Pusa Naveen, PSPL and NDBG-104 expressed significant negative gca effects indicating their good general combining ability for early fruiting. PSPL (2.83), Bharatpur Local (2.35) and RS-1(1.10) were good general combiners for fruit length. Similarly NDBG-104 (0.06), NDBG-140 (0.05) and Bharatpur Local (0.03) for average weight of first three harvested fruits and NDBG-104 (0.98) and Bharatpur Local (0.44) for harvest duration recorded significant positive gca effects indicating good general combining ability for these traits. It was also observed that parents which showed high gca effects for fruit yield and its attributes were also found to produce high *per se* yield and yield components. Such parents can be exploited through heterosis breeding for developing high yielding hybrids. The results are in close conformity with the findings of Sirohi *et al.*, 1986; Janakiram and Sirohi, 1987; Sivakami *et al.*, 1987; Janakiram, 1988; Sirohi *et al.*, 1988; Janakiram and Sirohi, 1991; Maurya *et al.*, 1993; Maurya and Singh, 1994; Singh *et al.*, 1996; Kumar *et al.*, 1998; Maurya *et al.*, 1998; Sreevani, 2005 and Dubey and Maurya, 2006.

In the present study, the magnitudes of non-additive variances were also higher for most of the traits. The *per se* performance may not be real indicative for their gca effects. The estimates of sca effects were higher and significant (Table-3). The cross combinations Pusa Naveen x NDBG-132 (-3.29), UL-6 x NDBG-132 (-2.60), NDBG-104 x NDBG-140 (-2.52), PSPL x Bharatpur Local (-2.30) and RS-1 x UL-6 (-1.74) for days to first female flower, Pusa Naveen x RS-1 (-5.27), UL-6 x NDBG-132 (-3.14), RS-1 x UL-6 (-3.12), PSPL x Bharatpur Local (-2.93), Pusa Naveen x NDBG-132 (-2.44), NDBG-104 x NDBG-140 (-1.90) and PSPL x NDBG-104 (-1.75) for days to first fruit harvest, UL-6 x NDBG-132 (-3.19), Pusa Naveen x NDBG-104 (-2.36), NDBG-104 x NDBG-140 (-2.06) and Pusa Nusa Naveen x Bharatpur Local (-1.08) for severity of powdery mildew, RS-1 x NDBG-140 (-2.10), Pusa Naveen x RS-1 (-1.89), UL-6 x Bharatpur Local (-1.36), NDBG-104 x Bharatpur Local (-1.13) and PSPL x NDBG-104 (-1.02) for severity of downy mildew and RS-1 x Bharatpur Local (-3.39), PSPL x Bharatpur Local (-3.05), UL-6 x NDBG-132 (-2.59), UL-6 x NDBG-104 (-2.05) and RS-1 x NDBG-140 (-1.16) for incidence of fruit fly were found to exhibit negative sca effects.

A total of six crosses out of 28 crosses exhibited significant sca effect for number of marketable fruits. The combinations Pusa Naveen x NDBG-104 (1.90), Pusa Naveen x UL-6 (1.85), Pusa Naveen x NDBG-140 (1.29), RS-1 x Bharatpur Local (1.16), NDBG-104 x NDBG-132 (1.01), RS-1 x NDBG-140 (0.82), PSPL x NDBG-140 (0.63) RS-1 x UL-6 (0.61) and PSPL x NDBG-104 (0.57) and were found to register significant positive sca effects for fruit yield per plant, indicating the presence of dominance and epistatic (non-additive) type of gene actions. Ten crosses for vine length, five crosses for number of branches per plant, twelve for fruit length, eight for average weight of first three harvested fruits, five for harvest duration and three for flesh thickness depicted significant positive estimates of specific combining ability effects. None of the cross combination showed significant sca effects in desirable direction. Similar results were reported by Sirohi *et al.*, 1986; Sivakami *et al.*, 1987; Janakiram and Sirohi, 1991; Maurya *et al.*, 1993; Maurya *et al.*, 1994; Singh *et al.*, 1996; Kumar *et al.*, 1998); Sreevani, 2005 and Dubey and Maurya, 2006. These combinations can be advanced in further generations for selecting superior segregants.

Most of the crosses included high x high and high x medium type of general combiners. The desirable cross combinations with medium x medium and poor x poor type of general combiners were also obtained which may be due to complimentary gene effects. The crosses involving parents with good gca effect can be exploited effectively by conventional breeding producer like pedigree method. However, the crosses involving one good general combiner and other medium and poor combiner could produce desirable transgressive segregants if additive genetic system was operating in good combining parents and epistatic effect also act in the same direction. Non-additive gene action was however pre-ponderant for all the traits studied, indicating the need for heterosis breeding for improvement of the traits. The pre-dominant role played by non-additive gene action in bottle gourd for fruit yield and yield component characters has also been reported by Sirohi *et al.*, 1986; Sivakami *et al.*, 1987; Janakiram and Sirohi, 1988; Kumar *et al.*, 1988; Sirohi *et al.*, 1988; Janakiram and Sirohi, 1991; Maurya *et al.*, 1993; Singh *et al.*, 1996; Maurya and Singh, 1998; Dubey and Maurya, 2006 and Sit and Sirohi, 2008.

It is apparent from the foregoing discussion that in almost all the hybrids, which showed the best results, at least one of the outstanding parental lines namely Pusa Naveen, NDBG-104, NDBG-140 and Bharatpur Local, were involved. These lines have high gca effects for one or

more of the characters contributing towards yield. This indicated that there was a strong tendency of higher gain to be transmitted from parents to off spring. In the present study almost all the characters are governed by non-additive gene action thus it can be concluded that improvement in bottle gourd for yield and its contributing traits may be brought out either by exploiting heterosis or recurrent selection in the succeeding generations.

Table 1: Analysis of variance for combining ability in bottlegourd (pool of two years).

Characters	Source of variation			Model I		
	gca	sca	Error	σ^2_g	σ^2_s	σ^2_g/σ^2_s
d.f.	7	28	70			
Vine length (m)	0.827**	0.208**	0.005	0.082	0.203	0.404
Branches/plant	0.961**	0.149**	0.038	0.923	0.111	8.31
Days to 1st female flower	23.943**	2.580**	0.760	2.318	1.82	0.498
Days to 1st fruit harvest	27.356**	3.979**	0.805	2.655	3.174	0.836
Harvest duration (days)	3.207**	2.431**	0.472	0.273	1.959	0.139
Fruit length (cm)	33.520**	10.272**	0.378	3.314	10.23	0.323
Marketable fruits/plant	1.198**	0.406**	0.060	0.114	0.346	0.329
Avg. wt. of 1st three harvested fruits (kg)	0.018**	0.013**	0.001	0.0017	0.012	0.142
Yield/plant (kg)	1.994**	0.882**	0.083	0.191	0.799	0.239
Size of seed cavity (cm)	0.319**	0.060*	0.031	0.028	0.029	0.965
Flesh thickness (cm)	0.036**	0.001**	0.001	0.0035	1.000	0.0035
Severity of powdery mildew (%)	56.729**	1.622**	0.182	5.695	1.44	3.904
Severity of downy mildew (%)	99.942**	2.182**	0.301	9.964	1.881	5.297
Incidence of fruit fly (%)	93.074**	2.621**	0.152	9.292	2.469	3.763

* Significant at 5% probability level
** Significant at 1% probability level

Table 2: Estimate of general combining ability (gca) effects of parents in diallel population (pool of two years).

Parents	Vine length (m)	Branches/ plant	Days to 1st female flower	Days to 1st fruit harvest	Fruit length (cm)	Avg. wt. of 1st three harvested fruits (kg)	Marketable fruits/plant	Yield/ plant (kg)	Harvest duration (days)	Size of seed cavity (cm)	Flesh thickness (cm)	Severity of powdery mildew (%)	Severity of downy mildew (%)	Incidence of fruit fly (%)
Pusa Naveen	-0.04*	0.41**	-1.94**	-2.85**	-1.70**	-0.02*	0.36**	0.28**	0.33	-0.28**	0.06**	-1.63**	-1.19**	-1.39**
RS-1	0.25**	-0.21**	1.15**	0.43	1.10**	-0.04**	-0.32**	-0.46**	-0.58**	-0.04	-0.07**	2.61**	3.97**	3.66**
PSPL	-0.20**	-0.15**	-1.52**	-1.27**	2.83**	0.01	-0.11	-0.09	-0.20	0.01	-0.00	-0.67**	-1.03**	2.84**
UL-6	-0.20**	-0.23**	1.00**	1.53**	-1.77**	-0.05**	-0.14	-0.38**	-0.65**	0.06	-0.08**	4.03**	5.81**	2.53**
NDBG-104	-0.15**	0.00	-1.68**	-1.13**	-0.73**	0.06**	0.10	0.43**	0.98**	0.01	0.08**	0.60**	-2.00**	-0.26*
NDBG-132	-0.08**	0.06	0.77**	1.06**	-0.90**	-0.03**	0.15*	-0.05	0.07	-0.02	0.01	-0.64**	-0.31	-1.75**
NDBG-140	-0.19**	0.49**	0.00	0.12	-1.16**	0.05**	0.50**	0.74**	-0.40	-0.09	0.05**	-0.84**	-2.43**	0.03
Bharatpur Local	0.61**	-0.37**	2.22**	2.11**	2.35**	0.03**	-0.54**	-0.47**	0.44*	0.36**	-0.05**	-3.47**	-2.82**	-5.67**
S.E. (g_i)±	0.02	0.06	0.26	0.27	0.18	0.01	0.07	0.09	0.20	0.05	0.01	0.13	0.16	0.12
S.E. ($g_i - g_j$)±	0.03	0.09	0.39	0.40	0.28	0.01	0.11	0.13	0.31	0.08	0.01	0.19	0.25	0.17

* Significant at 5% probability level
** Significant at 1% probability level

Table 3: Estimate of specific combining ability (sca) effects of 28 F_1 crosses of bottle gourd (pool of to years).

Crosses	Vine length (m)	Branches/ plant	Days to 1st female flower	Days to 1st fruit harvest	Fruit length (cm)	Avg. wt. of 1st three harvested fruits (kg)	Marketable fruits/plant	Yield/ plant (kg)	Harvest duration (days)	Size of seed cavity (cm)	Flesh thickness (cm)	Severity of powdery mildew (%)	Severity of downy mildew (%)	Incidence of fruit fly (%)
Pusa Naveen x RS-1	0.12	0.39*	1.33	-5.27**	2.33**	-0.06*	0.12	-0.27	-1.32*	-0.15	-0.03	-0.16	-1.89**	-1.91**
Pusa Naveen x PSPL	1.00**	-0.01	0.47	0.10	5.30**	-0.07*	-0.55*	-0.85**	-0.10	-0.06	-0.03	-0.08	0.19	0.38
Pusa Naveen x UL-6	-0.15*	0.53**	-1.32	0.22	2.54**	0.24**	0.74**	1.85**	1.98**	-0.00	0.11**	0.54	1.74**	3.08**
Pusa Naveen x NDBG-104	0.29**	0.23	0.96	1.16	3.50**	0.18**	0.97**	1.90**	-0.62	0.03	0.00	-2.36**	-0.78	-0.71*

Pusa Naveen x NDBG-132	-0.17**	-0.15	-3.29**	-2.44**	-2.74**	-0.03	-0.68**	-0.82**	-1.44*	-0.18	0.04	0.71	-0.05	-0.24
Pusa Naveen x NDBG-140	-0.41**	0.08	1.14	1.37	-1.08	-0.03	1.63**	1.29**	-2.44**	0.15	0.03	-0.22	0.91	-0.35
Pusa Naveen x Bharatpur Local	-0.26**	0.21	-0.54	-0.36	-0.92	-0.03	-0.32	-0.28	2.18**	0.19	-0.02	-1.08**	-0.22	1.97**
RS-1 x PSPL	-0.59**	-0.05	-0.09	0.96	1.20*	0.00	0.05	0.02	0.01	-0.10	0.01	0.11	-0.24	1.20**
RS-1 x UL-6	0.11	-0.17	-1.74*	-3.12**	-1.27*	0.08**	0.41	0.61*	0.13	0.01	-0.01	-0.31	-0.07	0.72*
RS-1 x NDBG-104	0.38**	0.26	-0.94	-0.52	2.56**	0.04	-0.02	0.02	-0.77	0.01	-0.00	-0.55	4.51**	1.52**
RS-1 x NDBG-132	0.06	0.07	0.62	1.42	1.86**	-0.01	0.13	0.03	1.27*	0.74**	-0.01	0.08	-0.91	1.06**
RS-1 x NDBG-140	0.01	0.24	0.05	0.83	3.79**	0.17**	0.11	0.82**	0.74	-0.19	0.01	1.89**	-2.10**	-1.16**
RS-1 x Bharatpur Local	0.35**	-0.10	-0.64	0.37	2.75**	0.05	0.95**	1.16**	1.97**	-0.04	0.02	1.48**	0.81	-3.39**
PSPL x UL-6	-0.74**	0.03	-0.94	-0.42	6.27**	-0.04	0.14	-0.06	-0.98	-0.15	0.03	0.08	2.06**	-0.14
PSPL x NDBG-104	-0.60**	-0.00	-0.93	-1.75*	-1.04	0.07**	0.31	0.57*	-0.35	-0.12	0.04	0.58	-1.02*	-0.05
PSPL x NDBG-132	0.21**	0.01	1.29	1.26	1.13*	-0.08**	0.45*	0.03	0.29	0.73**	-0.01	-0.25	-0.70	-0.40
PSPL x NDBG-140	-0.40**	0.18	0.39	0.13	-3.08**	0.14**	-0.03	0.63*	-0.64	-0.14	-0.02	0.20	-0.09	-0.94*
PSPL x Bharatpur Local	0.60**	0.17	-2.30**	-2.93**	-1.92**	-0.10**	0.48*	0.10	0.52	-0.00	-0.00	1.21**	0.00	-3.05**

* Significant at 5% probability level
** Significant at 1% probability level

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Morphological variability of *bael* varieties under rainfed conditions of hot semi-arid environment of western India

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Abstract

Bael is an indigenous hardy fruit tree, its fruits are very rich source of riboflavin (Vitamin B_2) with high nutraceutical and medicinal value. Every part of *bael* tree is used in one way or the other. During recent years, its importance has been highlighted in north India but, adequate attempts have not been made for its exploitation in Western India. A study keeping this fact in view was carried out to evaluate the *bael* genotypes for their growth behaviour and floral traits at Experimental Farm of Central Horticultural Experiment Station (CIAH), Vejalpur, Panchmahals, Gujarat during the years 2008 and 2010. Among the varieties evaluated for growth characters, plant height was recorded in CISH B-1, while plant spread, root stock and stem girth were recorded maximum in the variety NB-7. All the varieties exhibited significant difference with respect tofor most of the growth characters. Studies on floral biology revealed that the flower bud emergence started from 20th April and continued up to 23rd June, while anthesis initiated from 12th May and completed by last week of June. Bud length and width varied from 10.00 to13.00 mm and 7.00 to 9.50 mm while length and width of flower size ranged between 12.00 to 19.00 mm and 24.00 to 35.00 mm, respectively among the evaluated varieties. Number of petals in different varieties varied from 4 to 6 but majority of flowers showed only four petals. Stamen length varied from 7.00 mm (NB-7) to 9.00 mm (CISH B-2), whereas ovary length was recorded maximum in the genotype Pant Aparna (8.00 mm). Stigma length was recorded highest (3.50 mm) in the four varieties namely CISH B-2, Pant Aparna, NB-7 and NB-16, among the evaluated genotypes of *bael*. Pollen viability was observed more than 94 per cent in almost all the varieties.

Key words: *Bael*, varieties, variability, morphology, flower

Introduction

Bael (*Aegle marmelos* Correa) occupies an important place among the indigenous fruit of India not only because of its religious significance but also due to its high medicinal, nutritive values and ability to grow under harsh agro-climatic conditions. It is considered to be one of the richest sources of riboflavin and known to provide lots of minerals and vitamins to diet (Barthakur and Arnolds, 1989). Because of its hardy nature, *bael* can be grown successfully in wider range of habitats of arid, semi-arid to mesophytic conditions (Arya, 1986). Its cultivation can be done successfully in even alkaline and stony soils having pH range 5-10 (Jauhari and Singh, 1971; Ram and Singh, 2003; Srivastava and Singh, 2000; Pal and Mishra, 2005). In western India, a wide range of varieties of naturally grown trees is available contributing to wide genetic diversity in their morphology. In order to initiate any crop improvement programme, it would be imperative to generate information regarding growth and flowering behaviour as identification of suitable varieties has become necessary for promoting its productivity, production and quality of the produce under semi-arid tropics of western India. Keeping these points in view, attempts were made to evaluate the *bael* varieties for their growth pattern and floral biology under semi-arid ecosystem of western India.

Materials and Methods

An investigation was carried out on newly established block of *bael* genotypes collected from different institutes/universities and elite genotypes selected from diversity rich areas of country, which were planted at distance of 10 m x10 m in square system. The experiment was carried out using twelve varieties *viz.*, CISH B-1, CISH B-2, NB-5, NB-7, NB-9, NB16, NB-17, Pant Aparna, Pant Sujata, Pant Urvashi, Pant Shivani and Goma Yashi and studied for growth and flowering behaviour under semi-arid ecosystem. The experiment was led out in randomized block design with four replication considering two trees per unit. Annual extension of growth was recorded and data of both the year were pooled and subjected to statistical analysis. The period between emergence of first and last flower was considered as duration of flowering. The opening of 70-80% flowering was indicative of the tree in full bloom stage (peak period). Twelve shoots were randomly selected from four directions on each tree were tagged and detail observation was recorded on floral traits. The pollen viability percentage was carried out using 1% acetocarmin stain test (Johansen, 1940). Pollen that stained deeply and appearing normal and symmetrical was considered being viable.

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Results and Discussion

The results of various observations for growth behaviour are presented in Table-1. A perusal of data collected from various varieties grown in semi-arid ecosystem of Gujarat revealed that the different genotypes varied widely in growth and flowering attributes. Results of the study on growth characters revealed that the different genotypes showed significant differences in their growth behavior under semi arid ecosystem of western India (Table 1). Plant height (53.50 cm) was recorded significantly maximum in the CISH B-1, while rootstock girth (5.00 cm), scion girth (3.40 cm) and plant spread (E-W-48.95 and N-S-43.40 cm) were recorded maximum in NB-7 whereas these parameters were recorded minimum in Goma Yashi (plant height-13.00 cm, rootstock girth-3.55cm, scion girth-2.42, E-W-34.95 and N-S- 34.40 cm). These findings are in consonance with results on *bael* as reported by Singh *et. al.* (2006a) and Singh ((1989).

Terminal and lateral leaf size was recorded maximum in NB-7. The terminal and lateral leaf length was recorded lowest in NB-9, while terminal and lateral leaf breadth was recorded lowest in Goma Yashi. As regards to floral characters, the earliest flower bud emergence took place in CISH B-1 (20 April), whereas it took maximum time in case of Pant Urvashi (8 May), where the flower bud emergence continued up to June. The earliest flowering was recorded in CISH B-1(12 May) and Goma Yashi (12 May) and it continued up to 24th June. The longest duration of flowering was recorded in NB-9, whereas the shortest duration of the same was observed in the variety Goma Yashi (Table-2). Similar trends with respect to bud and flower emergence were reported by Singh and Singh (2006) in *bael* and also in other crops like mango (Hoda *et. al.* 2003), *litchi, mahua* and *jamun* (Singh and Singh, 2005a). There were marked variations in flower size and bud size in most of the genotypes (Table-2). Variety CISH B-2 revealed maximum flower length (18.00mm) while width was the maximum in NB-7 (35.00 mm), whereas minimum flower length and width were recorded in Goma Yashi. Equal bud length and width (13.00 mm and 9.50 mm) was recorded in CISH B-2 and NB-7. The range of petal length and width was recorded in between11.00 to 19.00 mm and 7.00 to 10.00, respectively. Petal length (19.00mm) was recorded highest in NB-7 while petal width was the maximum with Pant Aparna. These results on *bael* are in agreement with findings by other workers also (Singh and Singh, 2006; Singh and Mishra, 2004). Mean values of floral traits showed wide range of variations *i.e.* pedicel length (4.00-10.50 mm) and width (2.00-2.50 mm), stamen length (6.75-9.00 mm), filament length (2.75-5.00 mm) and width (0.40-0.80 mm), anther length (3.50-4.00) and width (0.50-0.80 mm), ovary length (4.00 to 6.50 mm), width (3.00-5.00 mm), style length (1.00-1.50 mm) and width (1.50-2.50 mm), stigma length (2.00-3.50 mm), and stigma width (2.00-3.00 mm). Among the evaluated varieties, pedicel length was recorded maximum in NB-5, whereas petal width was 2.50 mm in NB-5, NB-7, NB-16, Pant Sujata and Pant Urvashi. Singh and Mishra (2004) and Singh *et. al.* (2006) evaluated different varieties of *bael* for growth and flowering behavior and recorded the variability in the floral traits in *bael* under conditions of north and western India, respectively. Variation in soil and genetic makeup might have caused the variability in the different genotypes. Earlier Das *et. al.* (2004) in case of litchi, Hoda *et. al.* (2003) and Singh (2002) in mango, Kausal *et. al.* (2001) in plum, McArtney *et. al.* (2001), McLaughlin *et. al.* (1991) in Apple, Singh and Singh (2006) in grapefruit and Singh *et. al.* (2004) in tamarind also observed the existence of such variation under different agro-climatic conditions. Similar trends in the variability in the underutilized fruits like, *khirni, jamun*, have also been reported by Singh *et. al.* (2006), Singh and Singh (2005) under semi-arid tropics of western India, respectively. Pollen viability was recorded more than 94 per cent in all the varieties. Pollen diameter ranged from 41.25-45.00 micron maximum being in NB-7 and Goma Yashi. More or less similar findings with respect to pollen viability have been reported in the various under exploited fruits including by Singh and Singh (2005) in *mahua*, Suranyi (1991) in apricot, Sharma and Bist (2003) in pomegranate, Thimmaraju *et. al.* (1997), Usha and Singh (1994) and Singh *et. al.*(2006) in tamarind. Thus, the present study corroborates their findings.

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Regulation of flowering in aonla (*Emblica officinalis* Gaertn.) cv. NA-7

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Abstract

The cultural operations like stop of irrigation during winter season and binding of main trunk up to 5 cm width by jute thread and spraying of ethrel at 500 and 1000 ppm concentration increased the fruit set %, yield and take minimum time to mature the fruit than control during the both the year 2007-08 and 2008-09. The interaction all treatment (T_{13}) i.e. stop of irrigation during December to February, girdling by the binding of main trunk up to 5 cm width with the help of jute thread, spraying of 500 ppm and of 500 ppm ethrel was most effective to increased the fruit set (69.41 to71.02 %), yield (140.58 to 145.23 kg/tree) and take minimum time (215.26 -216.71 days) to mature the fruit during both the year. The treatment (T_{13}) was also most effective to increase the fruit weight (46.02 to 46.52 g), TSS % (10.54 to 10.55) and shelf life (15.01 to 15.23 days) of fruit than other treatment and control.

Key words: *Aonla, binding of main trunk, ethrel, girdling, shelf life*

Introduction

Aonla (*Emblica officinalis* Gaertn.) is an important and high remunerative arid fruit plant that grows under wide range of agro-climatic conditions like central U.P., some parts of central and western U.P (Ram, S. 1974) and also cultivated in Gujrat, Maharastra, Haryana and Rajasthan without much care. The aonla fruit has been recognized throughout the world as health care drug, valued to restore vitality and remedy of a number of body ailments. The fair amount of polyphenols and tannins (gallic acid, elagic acid and glucose), found in fresh and dried aonla fruit, retard the oxidation of vitamin C and functions as antiscorbutic element. In spite of being such a valuable crop, most of the aonla orchards of Baran district of Rajasthan are becoming irregular in flowering and fruiting due to sole reason of poor management and intact of older leaves for a longer time due to the heavy soil of the district. Hence, there is dire need to improve the health and regular productivity of such irregular unproductive/senile orchards through application of growth regulators and efficient cultural operation practices. With these objectives an investigation on response of growth regulator and cultural operations to aonla cv. NA-7 has been conducted during two consecutive years 2007-08 and 2008-09.

Material and Methods

The field experiment was conducted during two consecutive years 2007-08 and 2008-09 at Krishi Vigyan Kendra, Anta to standardize the cultural operations and efficacy of growth regulators on flowering and fruiting of aonla. Thirty nine plants of aonla cv. NA-7 of uniform in size and growth, planted at a distance of 7X7 m were selected for experiment. The treatment consisting of stop of irrigation during December to February, girdling by the binding of main trunk up to 5 cm width with the help of jute thread, spraying of 500 and 1000 ppm ethrel and it suitable treatment combinations were laid down in randomized block design with three replications. The binding of main trunk by jute thread and spraying of different concentration ethrel were done in the first fortnight of December. Ten fruits of uniform physiological age from each treatment were randomly selected for the observation of fruit weight, TSS % and shelf life of fruit. Total soluble solids content was determined by hand refractometer. The treatment details and its symbolic representation are given below.

1. Control (T_1)
2. Stop of irrigation during December to February (T_2)
3. Girdling by the binding of main trunk up to 5 cm width with the help of jute thread (T_3)
4. Spraying of 500 ppm ethrel (T_4)
5. Spraying of 1000 ppm ethrel (T_5)
6. $T_2 + T_3$ (T_6)
7. $T_3 + T_4$ (T_7)
8. $T_2 + T_4$ (T_8)
9. $T_3 + T_5$ (T_9)
10. $T_2 + T_5$ (T_{10})
11. $T_4 + T_5$ (T_{11})
12. $T_2 + T_3 + T_4$ (T_{12})
13. $T_2 + T_3 + T_4 + T_5$ (T_{13})

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Results and Discussion

The data presented in table 1 showed that all the treatment increased the fruit set %, yield and take minimum time to mature the crop than control during both the year 2007-08 and 2008-09. Stop of irrigation during winter period slightly increased the fruit set % and yield of aonla during both the year. Similarly the treatments girdling by the binding of main trunk up to 5 cm width with the help of jute thread, spraying of 500 and 1000 ppm ethrel were respectively increased the fruit set % , yield of aonla and takes minimum time to mature the crop than control plant. The interaction all treatment (T_{13}) i.e. stop of irrigation during December to February, girdling by the binding of main trunk up to 5 cm width with the help of jute thread, spraying of 500 ppm and of 500 ppm ethrel was most effective to increased the fruit set (69.41 to71.02 %), yield (140.58 to 145.23 kg/tree) and take minimum time (215.26 -216.71 days) to mature the crop during both the year. The treatment T_{13} was effective to increase the yield due to leaves fall occurrence during the winter season and binding of main trunk by jute thread regulate the flowering by the increase of C:N ratio. Maximum number of flower/ shoot (7.63) and minimum days taken to harvesting (115) were observed in 500 ppm ethrel treatment in guava reported by Jain and Dashora, 2006. The cultural practices influenced the flowering characters to an appreciable extent (Tripathi, and Maity, 2007).

The data on quality of fruit parameter was presented in table 2, indicated that the interaction of all treatment (T_{13}) i.e. stop of irrigation during December to February, girdling by the binding of main trunk up to 5 cm width with the help of jute thread, spraying of 500 ppm and of 500 ppm ethrel was most effective to increased the fruit weight (46.02 to 46.52 g), TSS % (10.54 to 10.55) and shelf life (15.01 to 15.23 days) of fruit than other treatment and control. Higher TSS content in aonla increased the shelf life of fruit (Singh, et al., 2008). Chandra and Govind (1995) found maximum fruit yield (9.18 kg/tree) with 75% pruning in the month of February where as, good quality was obtained with 25% crop pruning in guava. The leaves falling in winter season favours the flowering, fruiting and quality production of aonla.

Table 1: Effect of cultural operations and growth regulators on fruiting of aonla cv. NA7

Treatment	Fruit set (%)		Days taken to fruit maturity		Fruit Yield (Kg/tree)	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T_1	54.37	58.49	230.14	229.28	67.32	99.58
T_2	59.89	60.12	230.01	229.11	78.45	79.11
T_3	64.11	64.94	228.56	228.23	112.01	112.48
T_4	64.18	65.17	227.11	225.12	113.21	114.27
T_5	64.78	65.93	226.45	225.07	114.56	115.21
T_6	65.11	66.23	224.47	223.78	117.44	117.56
T_7	66.08	68.51	221.46	223.41	118.21	118.98
T_8	66.89	68.92	220.89	219.63	124.10	124.47
T_9	67.28	69.41	220.11	219.18	125.24	125.78
T_{10}	67.27	69.01	220.02	218.57	125.08	125.01
T_{11}	67.30	69.99	218.78	218.27	127.45	128.32
T_{12}	69.41	71.02	217.65	216.46	131.14	132.45
T_{13}	69.55	72.01	216.71	215.26	140.58	145.23
CD at 5 %	1.654	1.541	2.012	2.141	2.851	2.791

Table 2: Effect of cultural operations and growth regulators on fruit quality of aonla cv. NA-7

Treatment	Fruit weight (g)		TSS (%)		Shelf life (days)	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T_1	41.10	41.12	8.73	8.74	9.3	9.98
T_2	41.54	41.60	8.88	8.91	10.11	10.56
T_3	41.65	41.78	8.98	8.99	10.18	10.78
T_4	41.68	41.81	9.12	9.45	11.12	11.56
T_5	42.01	42.15	9.45	9.51	11.25	11.91
T_6	42.13	42.33	9.49	9.51	11.78	12.08
T_7	42.35	42.56	9.89	9.94	11.89	12.45
T_8	42.44	42.75	9.99	10.12	12.01	12.89
T_9	42.45	42.89	10.11	10.23	12.32	13.11
T_{10}	42.56	42.98	10.45	10.47	13.45	13.67
T_{11}	42.78	43.02	10.48	10.53	13.25	13.99
T_{12}	44.53	44.68	10.49	10.53	14.41	15.01
T_{13}	46.02	46.52	10.54	10.55	15.01	15.23
CD at 5%	1.012	1.0531	1.0023	0.994	0.899	0.9178

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Screening of Amaranths genotypes for yield and quality under hot climatic condition of semiarid ecosystem of western India.

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Abstract

An experiment on the "Screening of Amaranthus genotypes for yield and quality under semiarid condition of western India" was conducted using twenty eight accessions including released varieties were collected from diversified areas. The experiment was laid out in a randomized complete block design with three replications. The experiment results revealed that the significant differences among the genotypes for all the characters under study indicating the wide variability present in the germplasm. Among the genotypes studied in the present experiment, the highest plant height was recorded in IC-4469674 followed by IC-469676. The leaf size is considered an important character which decided by the leangth and breadth of the leaf. Arka Suguna, IC-469646, IC-469620, IC-469601 and IC-464521 recorded the lengthiest leaves over 10.0cm against IC-469645 (5.0cm). Arka Suguna, IC-469646, IC-469620 recorded the higher leaf breadth over 7.0cm against IC-469624 (2.6cm). The highest total leaf yield per plot was recorded in Arka Suguna (5.66 Kg) followed by Arka Arunima and IC-469646. This result indicate that the Arka Suguna, IC-469646, IC-469620 are broader leafy type and would be preferred by consumers. Study on quality parameters indicated that the highest protein (3.8g) and Fe (0.521mg) per 100 g has been recorded in IC-469646. Hence, Arka Suguna (Green type) and Arka Arunima (purple type) have exhibited a high yielding genotypes and IC-469646 (Green type) has registered high yield coupled with high protein and high Fe content under semiarid condition.

Key words: *Amaranthus, yield, quality, Semi arid ecosystem*

Introduction

Amaranthus sp is an important leafy vegetable grown in every part of India. It has centers of diversity in central and South America, India and South East Asia (Randle, 1959). Its cultivation believed to started back 7000 and 2000 years for grain and vegetable purpose respectively. Due to its anatomical feature, C4 metabolism and cheapest source of minerals and vitamins, Amaranthus occupied a predominant position in the diet for both grain and leaves (Brenner *et al*, 2000). The leaves of amaranths are nutritionally significant sources of carbohydrates, several vitamins and minerals, and dietary fiber (Betschart *et al.* 1981, Teutonico and Knorr 1985, Tucker 1986). Unlike other leafy vegetables, vegetable amaranth is cultivated during hot summer months when no other green vegetables are available in the market (Singh & Whitehead, 1996) and suits for cultivation under varied soil and agro climatic conditions (Katiyar *et al.*, 2000; Shukla & Singh, 2000) and reasonable yields can be produced even in poor soils (Afolabi et al. 1981, Dean 1986, Uzo and Okorie 1983). However, the consumer acceptability and preference varies from region to region depending on its leaf colour. Xiao *et al* (2000) also used stem and leaf color as a useful indices in classifying 31 vegetable amaranthus for 17 biological characters in the evaluation. Varalaksmi (2004) reported wide genetic variability existing in amaranthus for most agronomic traits evaluated under Bangalore condition. So far not much work has been done for its genetic improvement (Shukla et al., 2003, 2004a), recently the emphasis for its genetic improvement to enhance potentiality for foliage yield through different contributing traits has been put up. Hence, identification of genotypes with high yield and quality for semiarid region is a prerequisite. In order to identify a high yielding leafy type a preliminary investigation was designed as there is little information available for this region.

Material and Methods

An experiment was carried out at the Central Horticultural Experiment Station (CIAH), Vejalpur.. The experimental site is located at 22 °41 33 and 73 °33 22 and lies between 110-115m above mean sea level. The annual rainfall mainly is confined to three months (July to September) with an average of 35 rainy days a year. The annual maximum and minimum temperature ranged from 42-43C in May and 6-7C in January, respectively. The annual potential evapo-transpiration ranged from 1500-1600mm against the annual precipitation of 750 mm.

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Twenty eight accessions including released varieties were collected from, NBPGR, New Delhi, IIHR, Bangalore, UAS, Bangalore. The experiment was laid out in a randomized complete block design with three replications. The raised seed beds of 2 m length, 1 m width and 20 cm height were prepared. Well decomposed farmyard manure @ 5 Kg was applied to each bed and mixed well. Seeds were sown in a raised bed for subsequent transplanting where plants are to be grown. Seeds were sown about 4 mm deep at 5 cm apart and covered with 4 mm of soil for good germination. The beds were then mulched with paddy straw and watered daily with rose can. Because of the shallow depth, special care has been taken to prevent drying out of the soil until plants are established. Transplanting has been done in about four weeks old seedlings in a 2.0 X 3.0m plot. Granulated fertilizer 15:15:15 of NPK was applied at 62.5 kg/ha as basal at sowing. Urea was top dressed at 250 kg/ha at 28 DAS. Furrow irrigation was carried out once in a week. The crop was harvested at 40 DAT by clipping of shoots from ground level and the fresh shoot yield was recorded (Alfaro *et al*, 1987). Collection of data was based on 5 randomly selected plants per genotypes and five measurements for each character trait per plant. Five plants were removed with roots from each treatment for recordings on plant and root weight. In the present study, twenty two characters have been studied including four quality parameters.

Results and Discussion

The experiment results revealed that the significant differences among the genotypes for all the characters under study indicating the wide variability present in the germplasm. Among the genotypes studied in the present experiment, the highest plant height was recorded in IC-4469674 followed by IC-469676. The lowest height was registered by IC-469558. The mean plant height of the genotypes observed was 25.78cm. Number of branches per plant is thought to be character which differentiates the grain and leafy types. It was also observed that there are two types of branches ie. Long ,Thick branch having sparsely arranged leaves and Short , thin branch having densely arranged leaves. In the present study, the highest number of branches per plant was recorded in Arka Suguna and IC-469705 producing more than eleven branches of later types. The lowest branches were recorded in IC-469677 (3.3). The internode length is a commercially important parameter which decides whether the genotype fits for ratoon type or clipping type. In the field observation, the plant with longer internode produced generally smaller sized leaves indicating its suitability for clipping. Whereas the plant with smaller internode length produced larger leaves shows its fitness to ratooning. In the present study, IC-469558, IC-469703, Arka Arunima and Kannara local showed lower inter node length indicating its possibility of ratooning. IC-469676 and IC469601 showed internode length over 5.0cm indicating its clipping nature. From the consumer point of view, the ratooning type is most preferred that of clipping type. However, it further depends on leaf size and leaf yield of the genotype.

The number of leaves per plant is an important economical character's consequently reflects on yield, however, it cannot decide the consumer preference from the fact that small size leaf is an unpreferable character in terms of handling in preparation. The higher number of leaves were observed in IC-469676 (272.6) followed by IC-469678 are found to smaller leafy types. Leaf length is an important and preferred character by the consumers uniformly in every region. Arka Suguna, IC-469646, IC-469620, IC-469601 and IC-464521 recorded the lengthiest leaves over 10.0cm against IC-469645 (5.0cm). The similar trend was observed for leaf breadth too. Arka Suguna , IC-469646, IC-469620 recorded the higher leaf breadth over 7.0cm against IC-469624 (2.6cm). This result indicate that the Arka Suguna, IC-469646, IC-469620 are broader leafy type and would be preferred by consumers. Bola Oboh (2007) also reported wide variability for leaf length, width among the sixteen accessions of Amaranthus.

In Amaranthus, leaf, succulent stem are also been used for edible purpose, hence, observation on plant weight, shoot weight, leaf weight, petiole weight are imperative to assess the total yield of the plant. The highest plant weight was observed in Arka Suguna (142.0g) followed by Arka Arunima and IC-469646 against IC-469558 and IC-469692. The leaf weight per plant indicated the genotypes Arka Suguna (43.79g) followed by Arka Arunima, IC-469646, IC-469678 are high producer of edible part producing more than 30.0g per plant. The highest petiole weight per plant was recorded by IC-469646 (7.72g) followed by IC-469658 and Arka Suguna. The total shoot weight per plant indicates that Arka Suguna, Arka Arunima and IC-469646 (more than 50.0g) are producer of higher succulent stem among the genotypes. Considering its medium height coupling with higher stem weight indicates its worthiness of succulent stem for consumption. The similar trend was observed for total shoot weight per plant too. Arka Suguna, Arka Arunima and IC-469646 produced highest shoot weight (more than 86.0g) against IC-469708 (9.28g). The highest total yield per plot was recorded in Arka Suguna (5.66Kg) followed by Arka Arunima and IC-469646. This result is in concordance with finding of Sudhir Shukla *et al* (2006). Alfaro *et al* (1987) also reported the differential yield, quality on stage of harvest and harvesting at 40 days after transplanting found appreciable for high quality in Amaranthus.

In order to ensure succulence, and therefore, quality, vegetative growth should be rapid and un-interrupted for which the rooting growth is considered to be very important. The semiarid region is highly prone to moisture stress deficit. Further, the success of a genotype under prevailing climatic condition is based on its adaptability. In order to assess the rooting ability of genotypes to tackle the moisture stress has been studied. The result indicate that the highest root weight too was recorded in Arka Suguna (13.38g), followed by Arka Arunima and IC-469646, IC-469658 (more than 8.20g) under summer season of semiarid condition. Total fresh matter partition of each genotype has been studied. The

lowest total shoots to root ratio observed in IC-469646,Arka Arunima, IC-4696708, and Arka Suguna . The leaf to stem ratio is an indicator that the genotype with lowest value shows the biomass partitioned towards leaf yield. Among the genotypes studied, IC-469624, IC-469678, IC-469645, IC-469677 and IC-469676 showed value more than 1.00. Though, IC-469558 showed more shoots to root ratio, the major partitioned towards stem rather than leaf indicated the probable reason for low yielding under semiarid condition. Akando (2006) also reported that root growth and development had positive effect on yield of Amaranthus.

Four quality parameters have been analyzed during this study. The results indicate that the highest protein has been recorded in IC-469646(3.8g/100g) followed by IC-469624 and IC-469678. The lowest protein was observed in IC-469658 (1.1). The highest Ca was recorded in IC-469545 (322.0 mg/100g). Arka Suguna, IC-469703, IC-469528 showed Ca at par value. As regard to Fe, the highest value was recorded in IC-469646 (0.521) followed by Dharwad Local, Panchmahal Local, and IC-469620. Vit-C content showed the highest value in IC-469545 (150.5) followed by IC-469703 and IC-469521. The high yielding genotypes Arka Suguna, Arka Arunima and IC-469646 did not showed higher value for Vit-C. Zafar *et al*, (2006) have also been opined that qualitative character to be important for plant description and are mainly influenced by the consumers preference, socio economic scenario and natural selection. Shudir Shukla *et al* (2006) also reported the variability of mineral content and their differential accumulation based on leaf size and foliage yield of Amaranthus. Ghafoor and Ahmad (2003) reported that these characters are useful in separating varieties especially when the range of quantitative characters is limited. The study on mineral content not only exhibits the nature of varital quality but also guide the breeder to choose the variety based on the region where the particular mineral is deficient. In the present study too, ICC-469646 had exhibited higher Fe compared to other commercially released varieties under this climatic condition.

It is concluded from the result that Arka Suguna and Arka Arunima have exhibited a high yielding genotypes and IC-469646 has registered high yield coupled with high protein and high Fe content under semiarid condition. Hence, these genotypes can be recommended for semiarid ecosystem.

Table 1: Characterization of Amaranthus germpalsm collected from diversified sources.

Sl.No	Accession	Plant habit	Stem color	Petiole color	Leaf shape	Stem surface	Leaf surface	Venation	Leaf color
1	IC- 469558	Erect	Deep purple	Purplish green	Oblong	Ridged	Smooth	Green	Dark green
2	IC- 469530	Erect	Purplish green	Green	Broad ovate	Smooth	Smooth	Green	Dark green
3	IC- 469521	Erect	Greenish purple	Greenish purple	Broad ovate	Smooth	Smooth	Green	Green
4	IC- 469708	Erect	Yellowish green	Green	Obovate	Smooth	Smooth	Green	Green
5	IC- 469645	Erect	Green	Green	Obovate	smooth	Smooth	Green	Dark green
6	IC- 469601	Erect	Yellowish green	Green	Ovate	Smooth	Smooth	Green	Green
7	IC- 469692	Erect	Purplish green	Green	Ovate	Smooth	Smooth	Green	Green
8	IC- 469658	Erect	Deep purple	Purplish green	Broad ovate	Smooth	Smooth	Green	Green
9	IC- 469646	Erect	Green	Green	Ovate	Smooth	Smooth	Green	Green
10	IC- 469620	Erect	Greenish purple	Purplish green	Ovate	Angular	Smooth	Green	Green
11	IC- 469546	Erect	Greenish purple	Green	Broad ovate	Smooth	Smooth	Green	Dark green
12	IC- 469624	Erect	Greenish purple	Green	Ovate	Smooth	Smooth	Green	Dark green
13	IC- 469605	Erect	Green	Green	Ovate	Smooth	Smooth	Green	Dark green
14	IC- 469705	Erect	Purplish green	Green	Ovate	Smooth	Smooth	Green	Dark green
15	IC- 469703	Erect	Green	Green	Ovate	Smooth	Smooth	Green	Dark green
16	IC- 469677	Erect	Purplish green	Green	Broad ovate	Ridged	Smooth	Green	Dark green
17	IC- 469679	Erect	Green	Green	Ovate	Smooth	Smooth	Green	Green
18	IC- 469678	Erect	Purplish green	Green	Ovate	Smooth	Smooth	Green	Dark green
19	IC- 469674	Erect	Purplish green	Green	Ovate	Smooth	Smooth	Green	Dark green
20	IC- 469676	Erect	Green	Green	Oblong	Smooth	Smooth	Green	Green
21	IC- 469545	Erect	Purplish green	Green	Broad ovate	Smooth	Smooth	Green	Green
22	Arka Arunima	Erect	Dark purple	Dark purple	Broad ovate	Ridged	Smooth	Purple	Purplish green
23	Arka Suguna	Erect	Green	Green	Broad ovate	Smooth	Smooth	Green	Green
24	IC- 469528	Erect	Purplish green	Greenish purple	Triangular	Ridged	Smooth	Green	Dark green
25	Kannara local	Erect	Deep purple	Dark purple	Broad ovate	Angular	Smooth	Deep purple	Greenish purple
26	Panchmahal local-2	Erect	Purplish green	Green	Ovate	Ridged	Smooth	Green	Green
27	Panchmahal local	Erect	Greenish purple	Green	Broad ovate	Ridged	Smooth	Green	Dark green
28	Dharwad collection	Erect	Green	Green	Ovate	Angular	Smooth	Green	Green

Table 2: Morphomatric parameters of Amaranthus germplasm evaluated under summer season.

Sl.No	Accessions	Plant height (cm)	No of branches per plant	Internode length (cm)	No of leaves per plant	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	Node to flower initiation	Plant weight (g)	Leaf weight per plant	Root weight (g)
1	IC-469558	5.9	5	0.66	41.3	7.6	3.2	3.3	4.1	17.01	5.62	2.60
2	IC-469530	7.6	3.6	3.65	10.3	5.9	3.9	1.9	3.6	24.68	6.96	2.90
3	IC-469521	17.9	4	2.23	27.3	10.1	5.5	3.6	3.6	37.04	5.33	2.46
4	IC-469708	38.6	5.6	2.83	41.6	6.7	5.1	3.6	3.6	31.56	12.91	1.86
5	IC-469645	15.4	5.3	3.43	21.3	5.0	3.7	2.9	3.7	27.90	13.72	2.16
6	IC-469601	13.9	4.3	5.16	33.4	10.2	5.4	5.7	2.3	26.83	8.36	2.92
7	IC-469692	17.5	5.3	1.16	34.6	5.6	3.4	2.7	2.3	24.11	6.76	3.22
8	IC-469658	12.1	6.6	1.66	43.3	9.3	5.4	2.7	4.1	72.89	27.06	8.20
9	IC-469646	12.3	4.3	1.74	28.6	12	7.9	3.3	2.3	94.54	34.22	8.34
10	IC-469620	24.1	8.6	2.22	41.6	11.7	7.1	4.1	3.6	49.98	12.98	3.53
11	IC-469546	22.2	5.3	1.93	27.7	8.3	5.1	3.6	3.3	45.23	12.58	4.01
12	IC-469624	39.7	4.6	3.73	30.3	5.7	2.6	2.0	4.3	25.87	13.73	3.96
13	IC-469605	23.5	5.1	2.53	96.3	9.3	5.9	3.6	3.4	43.55	12.12	5.36
14	IC-469705	26.7	11.2	1.46	35.3	7.1	4.4	4.0	7.3	26.03	9.64	3.31
15	IC-469703	25.3	5.3	0.63	48.3	7.3	4.5	3.1	6.3	40.05	14.61	3.39
16	IC-469677	46.5	3.3	1.53	48.3	7.7	5.7	4.4	6.3	33.12	14.27	4.69
17	IC-469679	42.5	9.6	6.21	272.6	5.6	4.1	2.9	2.6	42.52	16.37	3.99
18	IC-469678	45.4	4.1	3.43	117.3	7.7	3.9	4.0	4.3	56.97	31.32	5.29
19	IC-469674	53.5	4.3	1.43	52.4	6.5	4.6	2.9	1.3	41.90	19.36	4.89
20	IC-469676	47.3	6.3	3.96	129.3	5.8	4.2	3.6	1.3	29.58	12.63	2.91
21	IC-469545	11.5	5.3	2.16	51.3	7.0	4.0	2.7	5.4	51.19	16.90	5.56
22	Arka Arunima	10.6	4.6	0.53	32.8	5.2	2.8	3.2	2.6	96.53	33.95	8.28
23	Arka Suguna	22.8	11.2	1.71	98.4	12.5	9.3	4.8	4.6	142.09	43.79	13.38
24	IC-469528	18.4	7.33	1.06	57.3	7.3	4.2	3.3	5.2	55.20	16.38	6.43
25	Kannara local	9.2	7.3	0.83	50.3	9.3	5.0	3.7	8.1	38.66	19.64	3.46
26	Panch mahal local-2	34.9	5.4	4.44	43.3	5.9	3.5	1.8	3.8	72.68	17.31	6.07
27	Panchmahal local	40.6	3.3	1.92	81.1	5.9	3.4	3.1	5.2	45.34	21.60	5.13
28	Dharwad collection	36.0	5.3	2.76	38.3	6.1	3.8	3.5	5.2	36.32	12.74	4.07
	Mean	25.78	5.71	2.37	58.25	7.61	4.73	3.37	3.96	47.47	16.88	4.80
	SE	7.26	1.54	0.73	24.0	1.53	1.09	0.65	0.92	4.53	1.93	0.65

Table 3: Morphomatric parameters of Amaranthus germplasm evaluated under summer season.

Sl.No	Accessions	Petiole weight	Stem weight (g)	Shoot weight (g)	Yield per plot (kg)	Shoot /plant ratio	Root /Shoot ratio	Leaf/ Stem ratio	Protein (g/100g)	Ca (mg/100g	Fe	Vit-C (mg/100g)
1	IC-469558	1.22	7.55	14.41	0.634	0.844	0.190	0.838	2.7	182.6	0.357	66.2
2	IC-469530	1.23	13.59	21.78	0.958	0.882	0.133	0.526	1.9	210.3	0.278	81.3
3	IC-469521	1.30	27.97	34.58	1.521	0.933	0.072	0.197	2.7	280.8	0.224	148.5
4	IC-469708	1.11	15.81	29.71	1.306	0.941	0.062	0.819	3.1	235.7	0.214	85.8
5	IC-469645	2.13	9.88	25.73	1.132	0.922	0.084	1.396	3.3	156.4	0.198	66.6
6	IC-469601	1.39	14.17	23.93	1.053	0.891	0.121	0.603	2.8	143.7	0.246	52.3
7	IC-469692	1.88	12.25	20.92	0.919	0.866	0.155	0.556	2.5	122.3	0.314	44.1
8	IC-469658	6.61	31.00	64.68	2.846	0.885	0.130	0.871	1.1	148.2	0.218	48.3
9	IC-469646	7.72	44.27	86.19	3.792	0.911	0.096	0.797	3.8	167.2	0.521	59.3
10	IC-469620	3.54	27.92	44.45	1.955	0.889	0.125	0.468	2.4	218.9	0.411	78.4
11	IC-469546	3.06	25.56	41.21	1.813	0.911	0.097	0.496	3.2	165.8	0.262	16.0
12	IC-469624	3.28	4.89	21.90	0.963	0.845	0.183	4.017	3.7	243.8	0.367	77.6
13	IC-469605	3.90	22.18	38.19	1.680	0.873	0.146	0.555	2.4	128.0	0.351	38.0
14	IC-469705	1.86	11.22	22.73	1.000	0.867	0.153	0.984	1.9	298.5	0.340	123.8
15	IC-469703	3.67	18.37	36.65	1.612	0.914	0.093	0.838	2.2	312.2	0.288	149.3
16	IC-469677	2.46	11.68	28.42	1.250	0.857	0.166	1.368	2.9	187.9	0.318	67.7
17	IC-469679	2.32	19.83	38.53	1.695	0.906	0.103	0.873	2.8	213.3	0.237	85.8
18	IC-469678	4.43	15.92	51.67	2.273	0.906	0.103	2.064	3.6	125.8	0.289	44.3
19	IC-469674	3.23	14.44	37.01	1.628	0.883	0.132	1.368	3.2	150.2	0.295	52.6
20	IC-469676	3.73	10.30	26.67	1.173	0.901	0.110	1.457	2.4	213.5	0.215	71.4
21	IC-469545	3.23	25.48	45.62	2.007	0.890	0.123	0.671	3.1	322.1	0.211	150.5
22	Arka Arunima	3.59	50.71	88.24	3 882	0.914	0.093	0.685	3.1	273.6	0.185	67.3
23	Arka Suguna	4.53	80.38	128.71	5.663	0.904	0.105	0.569	3.4	312.4	0.321	44.4
24	IC-469528	3.37	29.01	48.77	2.145	0.883	0.132	0.594	2.9	312.9	0.394	86.5
25	Kannara local	2.76	12.79	35.23	1.548	0.910	0.098	1.625	3.1	286.8	0.323	93.8
26	Panch mahal local-2	2.83	46.47	66.61	2.931	0.915	0.092	0.374	2.0	176.4	0.378	63.9
27	Panchmahal local	4.22	14.38	40.20	1.769	0.885	0.131	1.569	2.5	216.9	0.417	71.0
28	Dharwad collection	3.10	16.38	32.22	1.418	0.888	0.125	0.903	2.6	205.2	0.443	78.4
	Mean	3.13	22.66	42.67	1.887	0.893	0.120	1.000	2.34	198.5	0.236	75.50
	SE	0.34	4.48	4.59	0.41	0.01	0.09	0.31	0.23	1.23	0.02	0.59

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Effect of saline water irrigation through drip method on yield of okra and salt build-up in sandy soil of western Rajasthan

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Abstract

Effect of saline water irrigation on Okra through drip system was evaluated on sandy soils having high hydraulic conductivity (7.2-7.9 cmh^{-1}) and low moisture holding capacity (6.18 cm m^{-1}). Maximum yield of Okra (4.80 t/ha) was recorded at ECiw 3.0 dSm^{-1} with drip irrigation method. Irrigation with saline water 6.0 dSm^{-1} drastically decreased the yield (2.97 t/ha) and yield attributes of crop. Looking to the average yield of all three years under ECiw 0.25, 3.0 and 6.0 dSm^{-1} treatments drip method was superior with 50.37 % higher yield compared to flood irrigation method. The increasing levels of salinity of irrigation water increased the EC_e of soil profile. The salinization pattern in soil with saline water irrigation under drip system showed that the zone of minimum salt accumulation existed just below the emitters. The salt concentration in soil profile increased with increase in lateral as well as vertical distance from the emitters. This is due to differences in moisture content of ponded, wetted and wetting zone of area irrigated by a particular emitter. The ponded zone had always higher moisture both laterally and vertically which started decreasing toward wetted zone with minimum at the end of wetting zone. This moisture variation caused movements of salts from the near vicinity of emitter, creating comparatively much less saline zone (ECe 1.30 dSm^{-1}with ECiw 6.0 dSm^{-1}) in which root performed their activity providing better growing conditions. Salt concentration was highest (ECe 2.71) at 30 cm distance from emitter with saline water irrigation of ECiw 6.0 dSm^{-1}.

Key words: Okra, Saline water, Drip irrigation, Salt build-up

Introduction

Okra (*Abelmoschus esculentus* L.) is one of the important vegetables grown throughout the tropics and subtropics. India is the topmost country, producing 4.18 million tonnes of okra annually, which is around 70% of global okra production (FAO, 2008). The nutritional value of 100 g of edible portion of okra contains 1.9 g protein, 0.2 g fat, 6.4 g carbohydrate, 0.7 g minerals and 1.2 g fiber (Gopalan *et al.*, 1989). The crop is also used in paper industry as well as for the extraction of fiber. Okra has a great scope in world trade. The crop is grown year round under varied soil and climatic conditions of India.

The sustainable use of scarce water resources in western Rajasthan is a priority for agricultural development. Further, in arid areas the underground water is saline in nature (> 1.5 dSm^{-1}) and its quality ranges from marginal (1.5 to 3.0 dSm^{-1}) to highly saline (> 6.0 dSm^{-1}). The agricultural and horticultural activities in the area are limited and on small commercial basis. Vegetables like okra, gourds, spinach, cauliflower, green chillies, radish and brinjal etc. are grown on small scale. The pressure of using water in agriculture sector is increasing to create ways to improve water use efficiency and taking a full advantage of available water. Therefore, adoption of modern irrigation techniques is needed to be emphasized to increase water use efficiency. Further, drip irrigation makes cultivation of saline land possible and makes saline water usable for irrigation. Today drip irrigation irrigates more than 55,000 ha. in India. However, as the underground water is saline which ranges from marginal to hazardous quality should be used for cultivation of vegetable crops through conducting research. Thus, keeping in view the importance and benefits of drip irrigation and to use marginal quality ground water for growing okra in the arid area, this research study was formulated and conducted to achieve the objectives.

Material and Methods

To evaluate the effect of saline water irrigation on okra crop and to determine the salinization pattern under drip irrigation a field experiment was conducted at Agricultural Research Station, Bikaner in kharif seasons from 2006 to 2008. The soil of the experimental field was alkaline in nature and sandy in texture with poor fertility status. pH and ECe of soil ranged from 8.31 to 8.30 and 0.51 to 0.74 dSm^{-1}, respectively up to 30 cm depth. Organic carbon content was very low (0.08 %). Available nitrogen (115.0 kg N/ha), available phosphorus (17.2 kg P_2O_5/ha) and potash (205 kg K_2O/ha) was also of low magnitude. The texture of the soil was sand, and the hydraulic

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conductivity ranged from 7.6 to 7.9 cm h^{-1} thus, the drain ability of these soils is high whereas, the water holding capacity was only 6.23 cm m^{-1} , thereby the irrigation frequency was of short duration. Bulk density ranged from 1.52 to 1.57 Mgm^{-3}. The sand, silt and clay content ranged from 90.1 to 86.4, 2.1 to 3.6 and 6.4 to 5.9 per cent in the soil profile, respectively.

Treatments comprised of three salinity levels of irrigation water (EC 0.25, 3.0 and 6.0 dSm^{-1}) under two methods of irrigation i.e. drip and flood. The experiment was laid out in factorial randomized block design with three replications in plot size of 3m X 3m. The drip lateral was installed in the centre of each plot with on line drippers (PC types) of 4.0 lph discharge. The healthy seeds of okra high variety Malav-27 were sown by dibbling method with spacing 60 x 30 cm in the last week of June during all three years of experimentation. The standard recommended agronomic practices were followed. In order to maximize the yield about 10 t of FYM and recommended dose of fertilizer (80 kg Nitrogen, 60 kg P_2O_5 and 75 kg K_2O/ha.) was applied. Nitrogen was applied through fertigation in three split doses.

Sintex tanks of 1000 litres capacity each were used to supply water of required salinity. The water available from the tube well was used as basic source of saline water having EC 4.1 dSm^{-1}. The required salinity was achieved by adding the pre calculated amount of salts (Table 1). Sodium was the dominant cation, whereas, chloride was the dominant anion. The SAR, Mg : Ca ratio and Cl : SO_4 ratio of 3.0 and 6.0 dSm^{-1} irrigation water was 14.10 and 19.64, 3.0 and 2.8, 2.88 and 2.74, respectively.

Around sixteen irrigations were given each year. Twelve to thirteen pickings of fruits were done up to first week of December. The treatments were evaluated in terms of yield and yield attributing parameters. For analysis of salinity build up in soil profile due to saline water irrigation under drip and flood methods, soil samples were also taken at three points which were located horizontally at 0, 15 and 30 cm apart from the either side of emitter. At each of these three locations soil samples were collected from four depths i.e. 0-15, 15-30 and 30-45 cm. Similarly, in case of flood irrigation soil samples were taken from the same three depths but at only one location. Soil samples were collected at sowing and harvesting of crop and analyzed as per method outlined by Richards (1954).

Results and Discussion

Yield and Yield attributes

The yield data of three year from 2006 to 2008 presented in Table 2 showed that average fruit yield of okra was significantly influenced by salinity of water as well as method of irrigation. Significantly higher yield was observed under drip irrigation which was 66.5 per cent higher compared to flood method of irrigation. Singh *et al. (2004)* also reported 40% reduction in yield of tomato at ECiw 8.0 dSm^{-1} in *rabi* season. Kadam and Kartikeyan (2004) also advocated superiority of drip method over surface method. Similarly, Tiwari *et al.* 1998a in tomato, Tiwari *et al.* 1998b in okra and Tiwari *et al.* 2003 in cabbage recorded significantly higher yields under drip method of irrigation.

As regards salinity of water maximum yield was observed with water having ECiw 3.0 dSm^{-1} which was at par with canal water irrigation (0.25 dSm^{-1}). A significant decrease in yield was observed at ECiw 6.0 dSm^{-1} (2.51t/ha) which was 65.5 and 70.1 per cent lower than ECiw 0.25 and 3.0 dSm^{-1} respectively. The interaction between method of irrigation and salinity of water was also significant (Table 3). Maximum yield of okra 4.79 t/ha was observed under drip with ECiw 3.0 dSm^{-1} which was significantly higher compared to rest of the treatments. Minimum yield of 2.04 t/ha was recorded under flood with ECiw 6.0 dS m^{-1}. Singh and Singh (1978) reported that drip method resulted in increased yields in case of long gourd, round gourd and water melon by 41-47 % when same level of saline water is used.

Like yield, yield parameters were also recorded of higher values under drip method compared to flood method of irrigation. Under drip method average plant height (68.61 cm) and average number of fruits per plant (19.02) were recorded which were 84.1 and 76.1 per cent higher compared to flood method of irrigation. Under different salinity levels maximum plant height (68.05 cm) and no. of fruits (18.45) were recorded with 3.0 dSm^{-1} water, however, it was at par with 0.25 dSm^{-1} water. A significant decrease in plant height and no. of fruits was observed at ECiw 6.0 dSm^{-1} which was 80.2 and 81.6 percent lower for plant height and 76.3 and 79.4 per cent lower for no. of plants than ECiw 0.25 and 3.0 dSm^{-1} respectively. (Table 2).

Water Use Efficiency

Maximum water use was observed in flood method of irrigation which was 31.98 % higher than drip method of irrigation. The highest mean water use efficiency of 83.2 kg/ha-cm was observed with ECiw 3.0 dSm^{-1} under drip method of irrigation whereas, the lowest mean water use efficiency of 25.9 kg/ha-cm was observed with ECiw 6.0 dSm^{-1} under flood irrigation method (Table 4). Drip irrigation is the most effective way to apply directly water and nutrients to plants and not only save water but also increases yields of vegetable crops (Tiwari *et al.*, 1998a,b; Tiwari *et al.*, 2003). In a FAO report (1997), it has been stated that major benefit of drip irrigation is its high water application efficiency which can reach values of 90%, although 80% is practicable. This can be compared with surface irrigation schemes which normally have an efficiency of 50%.

Salinity build-up

The resulting ECe at harvest as affected by salinity levels of irrigation water in 0-45 cm soil profile at 0, 15 and 30 cm lateral distances from the emitter are shown in Table 5. In general, the soil salinity increased

with increase in salinity of irrigation water at all depths and locations. With 3.0 dSm^{-1} water irrigation the resultant ECe in the soil profile ranged from 0.94 to 1.85 dSm^{-1} whereas, with 6.0 dSm^{-1} water irrigation the resultant ECe in the soil profile ranged from 1.30 to 2.71 dSm^{-1}. Zone of minimum salt concentration existed just below the emitter in studied soil profile (ECe 0.94 and 1.30 dSm^{-1} with 3.0 and 6.0 ECiw, respectively. The trend clearly indicate that the salt concentration in soil profile increased with increase in lateral as well as vertical distance from the emitters. This was due to differences in moisture content of ponded, wetted and wetting zone of area irrigated by a particular emitter. The ponded zone had always higher moisture both laterally and vertically which started decreasing as one moved toward wetted zone with minimum at the end of wetting zone. This moisture variation caused movements of salts from the near vicinity of emitter, creating comparatively much less saline zone (ECe 1.30 dSm^{-1} with ECiw 6.0 dSm^{-1}) in which root performed their activity. In other words it can be inferred that the salts were leached away from the active root zone of plant providing better growing conditions. Salt concentration was highest at 30 cm distance from emitter (ECe 2.39, 2.63 and 2.71 dSm^{-1} at 0-15, 15-30 and 30-45 cm depth respectively with ECiw 6.0 dSm^{-1}). This may be due to the fact that salts had moved with water away from active root zone. Thus, it can be concluded that Okra can be grown successfully with moderate saline water up to 3.0 dSm^{-1} on sandy soils of western Rajasthan under drip method of irrigation.

Table 1: Composition of ions of irrigation waters used to irrigate okra crop

S No	Characteristics	Unit	ECiw (dSm^{-1})		
			0.25	3.0	6.0
1	Ca^{2+}	me l^{-1}	0.8	2.0	4.2
2	Mg^{2+}	me l^{-1}	0.9	6.0	11.8
3	Na^{+}	me l^{-1}	0.8	22.0	44.0
4	$CO_{3^{2-}}+HCO_{3^{-}}$	me l^{-1}	1.2	4.0	8.0
5	Cl^{-}	me l^{-1}	0.7	19.3	38.1
6	$SO_{4^{-}}$	me l^{-1}	0.6	6.7	13.9
7	SAR	-	0.87	14.10	19.64
8	Cl : SO_4	-	1.16	2.88	2.74
9	Mg : Ca	-	1.12	3.0	2.8

Table 2: Effect of different salinity levels of irrigation water on yield and yield attributes of okra under drip and flood irrigation

Treatments	Okra yield (t/ha)				Plant Height (cm)				No. of Fruits/plant			
	2006	2007	2008	Mean	2006	2007	2008	Mean	2006	2007	2008	Mean
Irrigation Methods												
M_1 - Drip	3.19	4.96	3.76	3.97	61.63	68.77	75.43	68.61	16.13	20.73	20.20	19.02
M_2 - Flood	1.62	3.76	2.54	2.64	49.83	58.63	64.67	57.71	13.43	16.10	13.87	14.47
SEm ±	0.10	0.16	0.16	0.08	1.26	1.43	1.63	0.83	0.44	0.69	0.96	0.42
CD at 5%	0.32	0.49	0.51	0.24	3.97	4.49	5.12	2.41	1.40	2.18	3.02	1.22
Salinity Levels (dSm^{-1})												
S_1 - 0.25	2.53	4.59	3.62	3.58	61.10	68.20	71.30	66.87	15.75	19.90	17.50	17.72
S_2 - 3.0	2.82	5.09	3.58	3.83	60.20	68.80	75.15	68.05	16.10	19.45	19.80	18.45
S_3 - 6.0	1.87	3.41	2.25	2.51	45.90	54.10	63.70	54.57	12.50	15.90	13.80	14.07
SEm ±	0.12	0.19	0.20	0.10	1.54	1.75	1.99	1.02	0.54	0.85	1.17	0.52
CD at 5%	0.39	0.60	0.63	0.29	4.87	5.50	6.28	2.95	1.71	2.68	3.70	1.49

Table 3: Interactive effect of methods of irrigation and salinity of water on Okra yield (t/ha) on pooled basis (three years)

Treatment	Irrigation Methods	
Salinity Levels (dSm^{-1})	Drip (M_1)	Flood (M_2)
S_1 - 0.25	4.14	3.01
S_2 - 3.0	4.79	2.87
S_3 - 6.0	2.98	2.04
	S.Em. ±	C.D. (5%)
Method	0.08	0.24
Salinity	0.10	0.29
M x S	0.14	0.41

Table 4: Water Use (mm) and WUE (Kg/ ha /cm) through drip and flood method (Average of three years)

Treatments	Water Use (mm)				WUE (Kg/ ha-cm)			
	2006	2007	2008	Mean	2006	2007	2008	Mean
Drip method ECiw (dSm^{-1})								
0.25	583	641	566	597	57.6	76.7	73.3	69.2
3.0	566	611	543	574	66.8	101.1	81.8	83.2
6.0	596	652	586	611	41.1	58.1	45.9	48.4
Average	581	634	565	594	55.2	78.6	67.0	66.9
Flood method ECiw (dSm^{-1})								
0.25	760	810	745	771	22.4	52.6	41.3	38.8
3.0	790	835	760	795	23.8	47.9	35.8	35.8
6.0	775	790	787	784	16.6	38.2	23.0	25.9
Average	775	812	764	783	20.9	46.2	33.4	33.5

Table 5: Salinity (ECe) build -up in the soil profile with saline water irrigation through drip system after harvesting of okra

Distance from emitter (cm)	Soil depth (cm)	ECiw (dSm^{-1})					
		Drip			Flood		
		0.25	3.0	6.0	0.25	3.0	6.0
0 cm distance from emitter (Just below emitter)	0 15	0.45	0.94	1.30	0.53	1.21	1.63
	15 30	0.51	1.39	1.69	0.62	1.59	2.17
	30 - 45	0.53	1.56	2.11	0.71	1.80	2.90
15 cm distance from emitter	0 15	0.58	1.08	1.83			
	15 30	0.63	1.51	2.07			
	30 - 45	0.67	1.71	2.34			
30 cm distance from emitter	0 15	0.60	1.39	2.39			
	15 30	0.58	1.84	2.63			
	30 - 45	0.70	1.85	2.71			

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Responses of different cucurbits stem cuttings to IBA

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Abstract

An experiment was conducted to examine the efficacy of different doses of IBA (250 and 500 ppm) on stem cuttings of cucumber, sponge gourd and tinda commonly grown in Baran district of Rajasthan. The stem cuttings treated with 500 ppm IBA induced earlier, profuse rooting and maximum survival percentage than 250 ppm IBA and rainy season was found favourable for rooting in all cucurbits i.e. cucumber, sponge gourd and bitter gourd. Highest dose of IBA also produced maximum branching and takes one week lesser time to induce flowering and fruits were harvested slightly earlier than other treatment. Flower induction was slightly earlier in summer season than rainy season in all the cucurbits. The response of 500 ppm IBA was more effective to increased the yield (219.51 - 254.01 q/ha) in the entire cucurbit crop and harvested about one week earlier than other treatment.

Key words: *Cucurbits, cucumber, indole butyric acid, sponge gourd, stem cutting and tinda.*

Introduction

High cost and unavailability of true to true type cucurbit seed in the market are the major constraints of its cultivation. However, rapid multiplication of cucurbits by stem cuttings has been the answer to such problem in cucurbits. Some perennial cucurbits like pointed gourd and kundru etc. (Choudhary, 1996), pumpkin (Singh, 1997), bottle gourd and bitter gourd (Singh, 2004) has been successfully propagated by stem cuttings.

The application of plant growth regulators increased the rooting and fruiting in tomato, pumpkin, bottle gourd and bitter gourd (Singh, 1999, Singh, 1997 and Singh, 2004). The present experiment was taken to examine the efficacy of different doses of IBA on vegetative propagation of different cucurbits commonly grown in Baran district of Rajasthan.

Material and Methods

The experimental material which consisted of 15-20 cm long cuttings (1.0 to 1.25 cm thick with 4-5 nodes) were harvested with the help of sharp knife from the tip portion of two month old available mother plants of cucumber (*Cucumis sativus* L.), sponge gourd (*Luffa cylindrica* Roem) and tinda (*Praecitrullus fistulosus* Pang.) varieties Pusa Sanyog, Pusa Chikni, Arka Tinda respectively on 10 August, 2008 and 10 March 2009. The 4 to 5 cm basal portions of 25 cuttings were treated with the solution of either 250 or 500 ppm indole butyric acid and these cutting were compared with control constituted water treatment only. The treated cuttings were subsequently planted in field at a distance of 2.5m X1.0 m on the eastern side of ridges. The treatments were replicated thrice in factorial randomized block design. Uniform cultural operations were adopted during the course of investigation. The survival of cuttings were recorded after one month of planting and presented as per cent of total cutting planted. Subsequently, 5 cuttings were randomly tagged in each treated plots.

All shoots emerging from these cuttings were counted and these cuttings were then uprooted for the counting of number of roots and its length. The number of days taken to flowering was counted at the time of first flower emergence. Yield was recorded at the time harvesting done at green tender stage.

Results and Discussion

Data revealed a profuse rooting and survival of cutting treated with IBA (Table1). The total number of roots and its length was higher in 500 ppm IBA treated stem cuttings than 250 ppm IBA in all the cucurbits and required 2 to 3 day lesser time to induce rooting. Maximum rooting was recorded in rainy season sponge gourd followed by cucumber and tinda. The survival percentage of 500 ppm IBA treated stem cuttings was higher in sponge gourd (78.73- 94.15), cucumber (78.22-93.75) and tinda (35.93-49.87) in both the season than 250 ppm IBA. Probably maximum survival percentage was recorded due to increase of roots in plant growth regulator treated cutting (Singh, D.K.2004). Maximum survival of cuttings was also due to the presence of differential level of endogenous rooting cofactors (Pandey *et.al.*, 1983) and carbohydrates (Hartmann and Kester, 1989) and C: N ratio (Bose and Som, 1986) implicated in rooting of plant species.

The number of branches and yield were better (table 2) in IBA treated stem cuttings of cucurbits. The cuttings treated with highest dose of IBA (500 ppm) produced maximum branching and takes one week lesser time to induce flowering. Flower induction was slightly earlier in summer season than rainy season in all cucurbits. The mature vines of all cucurbits take minimum time to induce flowering. The response of 500 ppm IBA was more effective to increase the yield (219.51 - 254.01 q/ha) and

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harvested slightly earlier than other treatment. The increase in yield was due to the induction of early flowering, fruiting and number of branch per plant. Similar increase in yield was reported in pumpkin, bottle gourd, bitter gourd and tomato (Singh, 1997, Singh, 1999) stem cuttings. The earlier crops in treated cuttings fetches good price in market and save the seed cost of cucurbits. The costs of other cultural operations were similar to seed crops.

Table 1: Performance of different cucurbits stems cuttings to IBA on rooting and survival of plants

Treatment IBA (ppm)	No. of root/plant		Length of root (cm)		Days required for rooting		Survival %	
	Rainy	summer	Rainy	summer	Rainy	summer	Rainy	summer
Cucumber								
Control	31.24	23.28	08.82	08.14	13.44	15.72	85.32	72.35
250	37.88	32.49	10.41	09.22	10.32	14.23	91.81	76.82
500	42.98	36.38	11.84	11.23	10.12	13.74	93.75	78.22
Sponge gourd								
Control	31.51	23.53	08.93	08.97	12.93	15.48	89.22	72.47
250	38.34	32.77	10.35	09.34	10.32	14.05	92.25	76.48
500	43.8	36.13	11.89	11.35	10.05	13.35	94.15	78.73
Tinda								
Control	22.35	15.74	06.37	05.87	16.12	18.39	41.18	33.47
250	28.25	21.01	07.94	06.14	14.37	16.47	46.52	35.54
500	29.41	22.49	08.01	06.58	13.68	15.89	49.87	35.93
CD(0.05)								
Treatment	2.14	2.16	0.98	0.88	1.22	NS	3.47	3.10
Cucurbits	2.46	2.21	0.99	0.94	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Performance of different cucurbits stem cuttings to IBA on growth and yield of plants

Treatment IBA (ppm)	No. branch/plants		Days required for flowering		No. of days taken to harvest		Yield (Q/ha)	
	Rainy	summer	Rainy	summer	Rainy	summer	Rainy	summer
Cucumber								
Control	9.53	6.31	44.46	44.21	54.19	52.16	201.41	200.12
250	11.14	8.53	39.27	38.71	49.01	47.58	244.85	244.11
500	11.90	9.32	37.12	35.12	47.59	45.13	254.01	252.45
Sponge gourd								
Control	9.59	6.55	44.54	42.31	50.84	48.47	208.52	207.15
250	11.54	8.63	39.48	37.11	44.12	41.68	214.28	214.07
500	11.95	9.38	37.58	36.26	42.15	41.18	228.35	227.48
Tinda								
Control	6.05	4.33	44.31	43.41	50.09	48.47	191.48	190.98
250	7.53	4.99	40.12	38.98	44.75	43.08	201.47	200.96
500	7.97	5.64	39.10	38. 09	42.07	41.86	220.14	219.51
Treatment	0.48	0.69	2.15	2.14	2.04	2.18	1.01	0.98
Cucurbits	0.61	0.71	2.34	2.87	2.27	2.68	2.41	1.86
Interaction	NS	NS	2.14	2.21	NS	NS	NS	NS

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Studies the physico-chemical characteristics of guava (*Psidium guajava*) fruits in Chittorgarh district of Rajasthan

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Abstract

The nutritional survey was conducted on guava fruit orchards at different locations in Chittorgarh district of Rajasthan. Variation in different characteristics of fruits was observed. The fruit weight is varied from 167.51 to 185.64g. The pooled average polar fruit diameter and equatorial fruit diameter varied from 5.58 to 6.01 cm and 6.03 to 6.51 cm, respectively. The seed weight varied from 3.53 to 5.11g, pulp to stone ratio from 87.83 to 115.67g, fruit yield per tree from 50.73 to 69.83 kg plant^{-1} were recorded. The total soluble solids content varied from 10.76 to 11.78° Brix, total acidity from 1.85 to 1.93 per cent, ascorbic acid content from 411.65 to 581.50 mg/100g pulp, total sugar from 1.71 to 2.10 per cent, reducing sugar from 4.97 to 6.28 per cent and TSS/acidity ratio from5.58 to 6.35 recorded.

Key words: *Guava, physico-chemical characteristics, nutrition, yield.*

Introduction

Guava (*Psidium guajava* L.), belongs to the family Myrtaceae. It is native of tropical America and is widely grown in tropical and sub-tropical parts of India. Guava is a very common fruit, popular among rich and poor alike due to its moderate price, nourishing value and good taste. The fruit is rich in vitamin 'C' which ranges from 75-260 mg per 100 g pulp and pectin which ranges from 0.5 to 1.8 per cent and a good source of thiamine and riboflavin which range from 0.03 to 0.07 mg per 100g and 0.02 to 0.04 mg per 100 g pulp, respectively. Guava being hardy and with ability to grow under arid and semi-arid condition is becoming most potential fruit crop of Rajasthan. At present in Rajasthan, it is third most important fruit crop, The major guava growing districts in Rajasthan are Udaipur, Bundi, Kota, Chittorgarh, Ajmer, Swaimadhopur and Bhilwara.

Materials and Method

Studies were conducted on healthy and vigorously growing trees of guava at farmer's fields during 2009-10 to 2010-11. The uniform age five orchards were selected for investigation. The fruits were harvested during October to January. The details of fruit orchards taken in the present study are given as under.

Table 1: Location of guava fruit orchards

Name of fruit grower	Location
Sh. Ramlal Salvi	Surjana I
Sh.Bheru Lal Salvi	Surjana II
Sh.Parmanand Teli	Aonwalheda
Sh. Harshvardhan Singh	Ochadi
Sh.Madan Lal Baldi	Laljee kakheda

Ten trees were selected for assessing the physico-chemical characteristics of fruits from each orchard. From each tree ten fresh fruits were randomly plucked from all four directions. Observations were recorded for fruit weight, polar diameter, equatorial diameter, seed weight, pulp to seed ratio, yield, TSS, TSS : acidity ratio, ascorbic acid, total sugar and reducing sugar. Fruit diameter polar and equatorial was taken with the help of vernier caliper and expressed in centimeter. From each tree, 10 ripe fruits were selected randomly and their weight was measured separately and means weight was recorded. From ten randomly selected fruits skin was peeled out with the help of peeling knife and weighed on electronic balance and weight was recorded in gram. Then seeds were extracted from fruits and weighed on electronic balance and recorded and then pulp weight was measured by the subtracting peeled fruit weight from seed weight and average was recorded. The ratio was obtained by dividing the weight of pulp with weight of seed of randomly selected fruits and average was worked out. The TSS content was directly measured on "Zeiss" Hand refrectometer (0-32°) on percentage basis at 20 °C room temperature. Total acidity was determined by diluting the known volume of juice and titrating the same against N/10 sodium hydroxide solution using phenolphthalein as an indicator. It was expressed on percentage basis (A.O.A.C., 1990). TSS/Acidity ratio was estimated by dividing the total soluble solids to total acidity. The ascorbic acid (Vitamin C) content of juice was determined by diluting the known volume of juice with 3 per cent Metaphosphoric acid and titrating it against 2,6-dichlorophenol-indophenol dye solution (A.O.A.C.,1970) until a faint pink colour was obtained. The results are expressed as vitamin C in mg/100 g pulp. Total sugar content was determined using anthrone reagent method (Dubois *et al.*, 1951). Reducing sugar content was measured by following 'Nelson's modification' of 'Somogyis method' (Somogyis, 1952) using arsenomolybdate colour forming reagent and two copper reagent 'A' and 'B'.

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Results and Discussion

The data on physico-chemical characteristics of guava fruit are presented in table. 2 to 5. A significant variation in respect to physical characteristics and yield was noticed in different orchard location. The maximum polar and equatorial fruit diameter (pooled) i.e. 6.01 and 6.51 cm, respectively were recorded on orchard at Ochadi location as compared to minimum (5.58 cm and 6.03 cm) in orchard at Aonwalheda I location. The maximum fruit weight and pulp weight i.e. 185.64 g and 115.67 g were observed in orchard at Ochadi location and minimum i.e. 167.51 and 87.83 g were recorded orchard at Aonwalheda I location. The maximum seed weight and seed index i.e. 5.11 g and 1.101 respectively were observed at Ochadi location while minimum i.e. 3.53 g and 1.079, respectively were recorded in Aonwalheda I village. The maximum pulp stone ratio (25.68) was recorded at Surjana I location followed by Aonwalheda I and Surjana II location. The minimum (22.64) was recorded in Ochadi location. The maximum fruit yield (69.83 kg plant^{-1}) was observed at ochadi location followed by laljee ka kheda and Aonwalheda I, while lowest yield (50.73 kg plant^{-1}) was recorded at Surjana I location. Ecological specific variation with regard to physical parameter and yield were also observed by Bhatnagar and Chandra (2003), Rohitash (2007) and Singh and Chandra (2010). Application of proper nutrition and adoption of appropriate management practice might have created the difference in physical characteristics and yield of guava plants.

The chemical parameters like TSS, total acidity, TSS/acidity ratio, ascorbic acid, reducing sugar and total sugar also showed difference in different orchards. The maximum TSS (11.77° Brix) was recorded at Ochadi location and minimum (11.35 ° Brix) at Surjana II location. The lowest total acidity (0.325 %) was recorded at Surjana I while maximum acidity (0.380 %) was recorded at Aonwalheda I location. The maximum TSS/acidity ratio (35.67) were recorded at Ochadi location whereas lowest (30.16) at Aonwalheda I location. The maximum ascorbic acid, reducing sugar and total sugar i.e. 139.35 mg/100 ml pulp, 3.43 (%) and 7.72 (%) respectively were recorded at Ochadi location whereas minimum i.e. 132.64 mg/100 ml pulp, 3.08 % and 7.36 % respectively were recorded at Surjana II location. Difference in chemical parameters might be due to variation in nutrient status of the orchards. These chemical parameters appears directly related with nutrient status of plants. Similar finding were reported by Ram and Rajput (2000), Lal *et al.* (2001) and Singh and Chandra (2010).

Table 2: Physical characteristics of guava fruits cv. Allahabad Safeda from different orchards of Chittorgarh district

Location of the orchard	Fruit diameter in cm (Polar)			Fruit diameter in cm (Equatorial)			Fruit weight (g)			Pulp weight (g)		
	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled
Surjana I	5.81	5.97	5.89	6.21	6.35	6.28	179.77	181.15	180.46	106.98	109.70	108.34
Surjana II	5.61	5.77	5.69	6.10	6.19	6.15	172.65	176.58	174.62	96.35	101.13	98.74
Aonwalheda I	5.53	5.63	5.58	5.98	6.08	6.03	165.28	169.74	167.51	85.86	89.80	87.83
Ochadi	5.96	6.05	6.01	6.44	6.58	6.51	183.56	187.72	185.64	113.92	117.42	115.67
Laljee ka kheda	5.99	6.01	6.00	6.29	6.39	6.34	179.36	183.52	181.44	109.64	112.88	111.26
Mean	5.78	5.89	5.83	6.20	6.32	6.26	176.12	179.74	177.93	102.55	106.18	104.37
SEm	0.126	0.08	0.0738	0.103	0.089	0.0679	3.604	2.814	2.2864	2.997	2.801	2.0509
CD at 5 %	0.359	0.219	0.2074	0.292	0.253	0.1908	10.267	8.016	6.4239	8.536	7.978	5.7623

Table 3: Physical characteristics and yield of guava fruits cv. Allahabad Safeda from different orchards of Chittorgarh district

Location of the orchard	Seed weight (g)			Pulp : Stone ratio			Seed Index			Yield (Kg plant^{-1})		
	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled
Surjana I	4.15	4.29	4.22	25.78	25.57	25.68	1.091	1.097	1.094	48.80	52.65	50.73
Surjana II	3.97	4.13	4.05	24.27	24.49	24.38	1.086	1.090	1.088	53.10	56.95	55.03
Aonwalheda I	3.48	3.59	3.53	24.67	24.94	24.81	1.076	1.082	1.079	55.30	59.15	57.22
Ochadi	5.06	5.16	5.11	22.51	22.76	22.64	1.098	1.104	1.101	67.90	71.75	69.83
Laljee ka kheda	4.59	4.75	4.67	23.89	23.76	23.82	1.093	1.099	1.096	65.95	69.13	67.54
Mean	4.25	4.38	4.32	24.22	24.30	24.27	1.089	1.094	1.092	58.21	61.93	60.07
SEm	0.113	0.102	0.0761	0.409	0.413	0.2906	0.013	0.012	0.0089	4.942	4.911	3.484
CD at 5 %	0.322	0.289	0.2137	1.164	1.177	0.8164	0.038	0.034	0.0250	14.076	13.989	9.787

Table 4: Chemical characteristics of guava fruits cv. Allahabad Safeda from different orchards of Chittorgarh district

Location of the orchard	TSS (°B)			Total acidity (%)			TSS/Acidity ratio		
	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled
Surjana I	11.47	11.68	11.58	0.330	0.320	0.325	34.76	36.50	35.63
Surjana II	11.27	11.43	11.35	0.380	0.370	0.375	29.66	30.89	30.27
Aonwalheda I	11.42	11.49	11.46	0.370	0.390	0.380	30.86	29.46	30.16
Ochadi	11.68	11.85	11.77	0.336	0.323	0.330	34.66	36.67	35.67
Laljee ka kheda	11.60	11.72	11.66	0.359	0.351	0.355	32.31	33.39	32.85
Mean	11.488	11.63	11.56	0.355	0.351	0.353	32.45	33.38	32.92
SEm	0.128	0.127	0.0900	0.006	0.005	0.0038	0.728	0.802	0.5417
CD at 5 %	0.361	0.362	0.2527	0.016	0.015	0.0108	2.075	2.284	1.5218

Table 5: Chemical characteristics of guava fruits cv. Allahabad Safeda from different orchards of Chittorgarh district

Location of the orchard	Ascorbic acid (mg/100 ml pulp)			Reducing sugar (%)			Total sugar (%)		
	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled	2009-10	2010-11	Pooled
Surjana I	132.67	135.29	133.98	3.19	3.27	3.23	7.35	7.38	7.37
Surjana II	131.98	133.30	132.64	3.07	3.09	3.08	7.34	7.37	7.36
Aonwalheda I	132.92	134.72	133.82	3.09	3.11	3.10	7.51	7.67	7.59
Ochadi	138.23	140.47	139.35	3.41	3.45	3.43	7.69	7.75	7.72
Laljee ka kheda	136.76	138.32	137.54	3.34	3.37	3.35	7.65	7.68	7.66
Mean	134.51	136.42	135.47	3.22	3.26	3.24	7.51	7.57	7.54
SEm	1.717	1.487	1.1356	0.034	0.035	0.030	0.079	0.083	0.0575
CD at 5 %	4.889	4.236	3.1905	0.098	0.101	0.069	0.227	0.236	0.1614

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Genetic analysis in ridge gourd [*Luffa acutangula* (Roxb.) L.] under hot arid conditions

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Abstract

The present investigation was conducted to determine variability, heritability, genetic advance and correlation of different yield and yield contributing characters of ridge gourd. The range of variation was higher in fruit length (3.66-26.93cm). The highest GCV (29.40) and PCV (32.29) was recorded in node at which first female flower appeared. The heritability estimate values in broad sense were higher for all the traits except number of branches/ plant, days to first female flower and days to first fruit harvest. The marketable fruit yield per plant had positive and significant correlation with fruit weight (0.786) and fruit length (0.448) at phenotypic level.

Key words: *Ridge gourd, variability, GCV, PCV, heritability, genetic advance, correlation.*

Introduction

Ridge gourd [*Luffa acutangula* (Roxb.) L.] is one of the important warm season vegetable crop which belong to cucurbitaceae family and grown in different parts of India. The immature fruits are consumed as vegetable and used in the preparation of chutneys and curries (Chandra, 1995). The fruits contain good amount of calcium, phosphorus, ascorbic acid, iron and fibre content (Aykroyd, 1963). Being a warm season vegetable crop, it has the ability to tolerate high temperature which ensures its adaptability for widespread cultivation throughout the tropics. Due to monoecious condition, it is a highly cross pollinated and had wide variability in quantitative characters (Richharia, 1948). Yield is polygenic which is highly influenced by environment and thus complicate the selection processes therefore, the knowledge of correlation is necessary for effective selection (Chowdhury *et al.*, 2002 and Choudhary *et al.*, 2008). The existence of wide genetic diversity in ridge gourd in arid region provides ample scope to screen the best genotypes for specific traits. Keeping in view, the present investigation was carried out with the objectives to determine variability, heritability, genetic advance and correlation among growth and yield traits in ridge gourd.

Material and Methods

The experimental material consisted of 20 diverse genotypes of ridge gourd and evaluated in Randomized Block Design with three replications at Research Farm, Central Institute for Arid Horticulture, Bikaner, Rajasthan during summer season of 2011 and 2012. The spacing maintained between rows was 2.5m and between plants 0.60m. Fertilization, drip irrigation, other cultural practices and need based plant protection measures were followed as per recommendation. The data were recorded on 12 qualitative characters on five randomly selected plants from each replication. The recorded data were pooled and statistically analyzed using INDOSTAT statistical package (Indostat Services, Hyderabad).

Results and Discussion

The analysis of variance showed highly significant mean sum of square estimates for all quantitative traits under study which indicate a wide range of variability exists in genotypes (Table 1).

Table 1: Analysis of variance (mean sum of squares) for growth, flowering andyield traits of ridge gourd

S. No.	Characters	d.f.	Replication	Treatment	Error
			2	19	38
1.	Number of branches/ plant		1.62	1.66**	0.64
2.	Vine length (m)		0.63	1.09**	0.26
3.	Internodal length (cm)		13.91	17.87**	4.35
4.	Days to 1st female flower		32.08	29.35*	12.65
5.	Node at which 1st female flower appeared		9.51	58.99**	3.79
6.	Ovary length (cm)		0.42	4.43**	0.87
7.	Fruit length (cm)		10.83	71.90**	4.41
8.	Fruit diameter (cm)		0.63	3.58**	0.47
9.	Days to 1st fruit harvest		6.85	34.16**	11.77
10.	Marketable fruits/ plant		0.69	95.65**	6.50
11.	Fruit weight (g)		148.38	1198.34**	46.74
12.	Marketable yield/ plant (kg)		0.10	0.42**	0.06

*and ** indicate significant at 5 and 1 per cent probability level, respectively.

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The extent of variability among 20 genotypes was measured in terms of mean, range, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in broad sense (h^2), genetic advance (GA) and genetic advance as per cent of mean (Table 2). The range of variation was higher in fruit length (3.66-26.93cm) followed by node at which first female flower appeared (2.93-20.27) and fruit weight (18.25-112.16g). The minimum range of variability was recorded in days to first female flower (42.27-53.60). The highest GCV was recorded in node at which first female flower appeared (29.40) followed by number of marketable fruits per plant (25.48) and PCV was highest for node at which first female flower appeared (32.29) followed by ovary length (29.04). High magnitude of GCV is an indication of high genetic variability among the genotypes which provides ample scope for improvement of these characters through simple selection. These findings are in close agreement with the results of Varalakshmi *et al.* (1995), Singh *et al.* (2002) and Choudhary *et al.* (2008). The heritability estimates in broad sense were higher for all the traits except number of branches/ plant, days to first female flower and days to first fruit harvest indicating substantial improvement can be made using standard selection criteria. Similar findings have also been reported by Varalakshmi *et al.* (1995), Karuppaiah *et al.* (2002) and Singh *et al.* (2002). High heritability along with high GA and high GA as per cent of mean was observed for node at which first female flower appeared, fruit length, marketable fruits/ plant and fruit weight, indicating the presence of additive gene action thus these characters could be used in selection on the basis of phenotypic performance.

Table 2: Mean, range, variability, heritability and genetic advance for growth, flowering and yield traits of ridge gourd

Characters	Mean	Range	GCV	PCV	h^2	Genetic advance (GA)	GA as % of mean
No. of Branches/ plant	4.53	3.47-6.33	12.88	21.86	34.71	0.71	15.63
Vine length (m)	3.50	2.16-4.69	15.05	20.87	51.98	0.78	22.35
Internodal length (cm)	14.08	6.47-16.85	15.08	21.13	50.91	3.12	22.16
Days to 1 st female flower	48.60	42.27-53.60	4.85	8.78	30.56	2.69	5.53
Node at which 1 st female flower appeared	14.59	2.93-20.27	29.40	32.29	82.91	8.04	55.14
Ovary length (cm)	4.92	1.53-8.27	22.20	29.04	58.43	1.72	34.95
Fruit length (cm)	20.85	3.67-26.93	22.74	24.88	83.60	8.93	42.84
Fruit diameter (cm)	4.70	3.47-7.10	21.67	26.13	68.78	1.74	37.02
Days to 1 st fruit harvest	54.60	48.27-61.13	5.00	8.03	38.81	3.51	6.42
Marketable fruits/ plant	21.40	16.67-42.80	25.48	28.12	82.05	10.17	47.54
Fruit weight (g)	84.16	18.25-112.16	23.28	24.67	89.09	38.12	45.27
Marketable yield/ plant (kg)	1.72	0.77-2.21	19.94	24.76	64.86	0.57	33.09

In general the magnitude of genotypic correlation coefficients was higher than respective phenotypic correlation coefficients (Table 3) which establish inherent relationship among the characters as also shown by the findings of Chowdhury *et al.* (2002), Prasanna *et al.* (2002) and Hanumegowda *et al.* (2011). The marketable fruit yield per plant had positive and significant correlation with fruit weight (0.786) and fruit length (0.448) at phenotypic level. Days to first fruit harvest exhibited positive and highly significant correlation with days to first female flower opening (0.850) and node at which first female flower appeared (0.469) at phenotypic level.

The traits like node at which first female flower appeared, fruit length, marketable fruits/ plant and fruit weight exhibited high heritability along with high GA and high GA as per cent of mean which could be improved through selection. Fruit weight and fruit length had positive and significant effect on yield per plant thus these traits could be utilized in selection of high yielding genotypes of ridge gourd.

Table 3: Genotypic (G) and phenotypic (P) correlation among growth, flowering and yield traits in ridge gourd

Trait		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1.	G	-	0.328**	0.402**	0.016	0.539**	-0.260*	0.105	0.011	0.237	-0.184	0.084	0.051
	P	-	-0.010	-0.100	0.074	0.150	-0.029	0.024	0.050	0.152	-0.048	0.069	0.092
2.	G		-	-0.062	-0.504**	-0.055	-0.309*	-0.228	0.403**	-0.268*	0.195	-0.348**	-0.299*
	P		-	-0.036	-0.196	-0.041	-0.094	-0.076	0.214	-0.175	0.046	-0.219	-0.221
3.	G			-	0.330**	0.450**	0.432**	0.525**	0.570**	0.408**	-0.645**	0.559**	0.617**
	P			-	0.026	0.426**	0.090	0.419**	0.233	0.042	-0.360**	0.439**	0.487**
4.	G				-	0.826**	0.214	0.434**	-0.348**	0.943**	-0.188	0.495**	0.586**
	P				-	0.381**	0.216	0.254*	-0.071	0.850**	-0.040	0.187	0.248
5.	G					-	0.541**	0.731**	0.101	0.795**	-0.620**	0.730**	0.606**
	P					-	0.252*	0.630**	0.010	0.469**	-0.511**	0.606**	0.422**
6.	G						-	0.828**	-0.108	0.494**	-0.814**	0.887**	0.611**
	P						-	0.555**	0.063	0.250*	-0.567**	0.665**	0.412**
7.	G							-	0.209	0.510**	-0.853**	0.824**	0.617**
	P							-	0.156	0.288*	-0.704**	0.697**	0.448**
8.	G								-	-0.289*	0.029	0.055	0.236
	P								-	-0.173	0.067	0.013	0.194
9.	G									-	-0.336**	0.613**	0.655**
	P									-	-0.155	0.257*	0.226
10.	G										-	-0.781**	-0.447**
	P										-	-0.646**	-0.139
11.	G											-	0.856**
	P											-	0.786**
12.	G												-
	P												-

Critical r value=0.3 25 at 1 per cent and 0.250 at 5 per cent.
*and ** indicate significant at 5 and 1 per cent probability level, respectively.

1. Number of branches/ plant	5. Node at which 1st female appeared	9. Days to 1st fruit harvest
2. Vine length (m)	6. Ovary length (cm)	10. Marketable fruits/ plant
3. Internodal length (cm)	7. Fruit length (cm)	11. Fruit weight (g)
4. Days to 1st female flower	8. Fruit diameter (cm)	12. Marketable yield/ plant (kg)

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Studies on utilization of small size kinnow fruits for preparation of squash

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Abstract

Kinnow mandarin is an important fruit crop of sub-tropical and hot arid region. It is being grown in about 6500 ha in western parts of Rajasthan where irrigation facilities are available. It is sour- sweet in taste and fruits are available during November to January months. The fruit is generally used for fresh consumption and juice preparation. The post harvest losses in kinnow fruits has been faced by growers because of improper marketing and processing. The under size fruits are not suitable as such for fresh consumption because of small size and low percentage of juice recovery. The selling price of such fruits is also low in the markets. Therefore, the under sized kinnow fruits can be properly utilized for value addition purpose. The small sized unmarketable kinnow fruits can be used for making juice and ready-to- serve drinks. The physico-chemical characters of under size and normal fruits and its post harvest utilization studies were carried out at CIAH, Bikaner during 2010-11.

The fruits were cut down in halve and juice was extracted by juicer. The recovery of juice was 35-40 per cent. To the filtered juice, sugar @ 700 g per litre of juice was added to prepare the delicious drink. The squash was stored in bottle at ambient temperature for a period of 45 days with and without mixing of KMS as preservative. Organoleptic testing was done at 15 days interval with a panel of ten people on score basis. The squash was mixed with water in ratio of 30:70 for sensory evaluation of product. The sensory evaluation revealed that squash mixed with 30: 70 ratio water was acceptable by the panel of judges. In this paper, post harvest utilization of undersized kinnow mandarin fruits for value addition has been discussed.

Key words: *Kinnow mandarin, Juice, Value addition, Squash, Undersized fruits, storage, physico chemical properties*

Introduction

Kinnow, a mandarin hybrid of King orange (*Citrus nobilis* Lour) and Willow leaf mandarin (*Citrus deliciosa* Tenore), belongs to the family Rutaceae. Among the citrus species kinnow is an economically important sub-tropical fruit, which is grown almost all over the arid and semi-arid regions of India, where assured irrigation facilities are available. In view of its prolific bearing quality coupled with relative tolerance to diseases and pests. Kinnow has gained popularity amongst the growers and now, it is commercially cultivated in Punjab, Haryana, Rajasthan and to some extent in the states of H.P., Karnataka and Tamil Nadu.

It is one of the most important fruit because of its pleasant flavor, juicy and sour-sweet taste. It is a sub acidic fruit, freshly eaten and also used for preparing commercial pectin, refreshing drink and in making cosmetics (Bose and Mitra, 1996). The composition of citrus fruit juice is beneficial with respect to its mineral and ascorbic acid contents. In Rajasthan, total area under fruit crops is 30,601 ha with a production of 5,00,171 MT. In kinnow cultivation, Sri Ganganager district is on prime position with 6500 ha area and 143000 MT production followed by Hanumagrah and Bikaner district of north- west Rajasthan (Anonymous, 2010).

Kinnow fruits are not only delicious and refreshing but also have great nutritive value and used as a dessert fruit. It contains 20-30 mg/100g vitamin C, 11.5 to 13.5% T.S.S., 0.50-.56% acidity, 87.8% moisture, 50.0 mg calcium, 20.2 mg phosphorus and 100 mg iron. Presently 95% of the production goes for fresh fruit market and due to poor post harvest infrastructure wastage of kinnow is around 25-30% and only 5% of the total production is processed presently (Ahmed *et al.*,2008). There is a great potential to use this fruit in value added products such as diet drinks. Thus, in order to fully utilize the high production of kinnow, the only alternative is to make it feasible to process it into juice and other juice based products. The proper attention has not been given on post harvest utilization and marketing of kinnow fruits which is being faced by the kinnow growers for successful and profitable production. However, very limited information is available on the post harvest utilization of kinnow fruits and particularly no work has been conducted for utilization of under size and unmarketable fruits which is about 15-20% of the produce. Therefore, it seems essential to find out the way of utilization of small size kinnow fruits which is unmarketable and considered waste in arid parts of western Rajasthan.

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Material and Methods

The experiment on post harvest utilization of small size kinnow fruits was carried out at CIAH, Bikaner during 2010-11. The undersized fruits were sorted out from freshly harvested fruits which were not sold from produce. The morphological and physiochemical characters of fruits were recorded. Fruits were washed in tap water and cut into halves to extract juice by small juice extractor. Juice was filtered and used for preparation of squash. TSS and acidity was estimated as per standard procedure described by Rangana (1991). The squash was prepared during last week of December and stored in clean glass bottles in refrigerator at 7^0 C for organoleptic testing. The sensory evaluation of squash was carried out at 15 days interval. TSS was observed of the drink at every time of testing. Hedonic scale method was used for the organoleptic evaluation of drink for colour, flavour, taste and appearance by a panel of 10 person at 0, 15, 30, 45 and 60 days storage period. The mean data of 10 people was assessed for sensory evaluation of drink prepared.

Results and Discussion

The data on morphological characters of normal and under size fruits has been presented in Table-1 which revealed that the undersized fruit are comparable with normal size fruit w.r.t. TSS, acidity, ascorbic acid, reducing and non reducing sugars contents. However, they differ with respect to size, fruit weight, peel weight and seed content. It is clear from data that quality of fruit is good except morphological characters of fruits. Since the preference in market for fresh consumption is large size fruits, these small sized fruits are treated as waste and unmarketable.

The data on organoleptic testing of squash is presented in Table 2. The colour of product is an important character of any value added product. The initial colour of product was dark orange and attractive to lure consumers. The maximum scores (7.56) for colour was observed when it was fresh. Storage had an effect on colour perception of drink. As the storage period increased, a slight decline in colour score was observed. The gradual loss in colour over the entire period was due to action of different kinds of enzymes present in the drink. The minimum score for colour was obtained at 60 days of storage *i.e* .6.10, which showed the decrease in quality of product. Hence based on colour, the squash was rated high upto 45 days of storage. The change in colour during storage of beverage has been reported by Jain *et al* (2003).

In addition to colour, flavour also has a key role in sensory evaluation. The highest score (7.83) was accorded to the squash on 15th day of storage. Its flavour scored high upto 45 days after storage and then its score declined to 6.80. The finding is similar with the earlier results on sensory evaluation of ready to serve drink prepared from kinnow juice (Kaushik and Rajorhia, 1998)

The appearance of product was attractive in packed glass bottle at fresh stage and then it declined gradually during storage period. The appearance of fresh squash was dark orange and scored highest (7.54) by the panel of evaluator. Thereafter, a decreasing trend in score was recorded with increase in the storage period. The minimum score was recorded at 60 days of storage and discarded. Sweetness character of drink was also recorded similar trend as for appearance. The appearance and taste of ginger blended squash was good. Similar trend was also observed by Nath and Yadav (2002).

TSS of squash was monitored periodically but there was a marginal decrease in TSS of squash during storage period. The colour and acceptability of drink gradually declined with increasing period of storage. This may possibly be due the chemical reactions in carbohydrates and different type of acids. During storage, physico-chemical changes are common in any value added product. The findings is similar with the results reported by Jain *et al.* (2003) and Singh *et al.* (2007).

Thus, based on the above parameters, it can be argued that acceptability of kinnow squash was highest when it was fresh. However, the acceptability remained high upto storage period of 45 days, but by 60 days it had poor acceptability.

The sensory evaluation was indicative of high acceptance of product. By this way, small undersized fruits can be utilized for making delicious drink. Further, it can be stored up to 45 days under refrigerated condition without major change in quality of product.

Table 1: Morphological and physiochemical characters of kinnow fruits

Fruit Characters	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	No. of sac	No of seed/ fruit	Peel weight g.	Juice %	TSS ^{0}Brix	Acidity %	Ascorbic acid (mg/ 100g)	Total sugar %	Reducing sugar	Non reducing sugar
Normal fruits	136.20	5.45	5.85	9.6	6.8	40.10	44.0	11.0	0.68	23.50	6.88	3.48	3.40
Under size fruits	44.63	3.96	4.31	9.4	11.2	13.50	37.5	11.4	0.70	20.26	6.50	3.24	3.26

Table 2: Sensory evaluation of squash prepared from small size kinnow fruits on score basis (out of 10 marks).

Storage	Colour	Taste	Appearance	Sweetness	Flavour	Acceptability
0 day	7.56	7.78	7.54	8.05	7.95	8.25
15days	7.45	7.83	7.45	7.99	7.72	8.05
30days	7.49	7.82	7.20	7.73	7.97	7.89
45days	7.00	7.00	6.60	7.60	7.92	7.80
60days	6.10	6.80	6.00	7.20	7.00	6.80

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Response of okra [*Abelmoschus esculentus* (L.) Moench.] to weed management under fertility levels in north Gujarat conditions

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Abstract

A field experiment was carried out during summer season at Regional Research Station, S D A U, Sardarkrushinagar to find out the suitable weed management practices for Okra cultivation in Gujarat. The highest green fruit yield (96.48 q ha^{-1}) was recorded under the treatment of hand weeding at 20, 40 and 60 days after sowing *i.e.*, Weed free (W_1) and it was at par with Pre-emergence application of Pendimethalin @ 1.0 kg a.i./ha (Blanket application) + Hand Weeding at 40 DAS (W_7) and Hand weeding at 20 and 40 DAS (W_2). The highest plant height, number leaves per plant, number of branches per plant, stem girth and number of nodes per main stem was recorded with application of 100 per cent recommended dose of fertilizers *i.e.*, 150:50:50 N, P_2O_5 and K_2O kg/ha. Monocot, dicot, sedge and total weeds population at 20 DAS were found significantly lowest under treatment (W_1) *i.e.*, pre-emergence application of pendimethalin @ 1.0 kg a.i./ha (W_4) + Hand Weeding at 40 DAS (3.20, 2.75, 2.99 and 5.07 per m^2, respectively) as compare to rest of treatments but it was found at par with treatment (W_5) *i.e.*, W_4 + interculturing at 20 DAS (3.22, 2.77, 3.04 and 5.13 per m^2), W_6 *i.e.*, W_4 + interculturing at 40 DAS (3.26, 2.84, 3.05 and 5.20 per m^2) and W_4 *i.e.*, pre-emergence application of pendimethalin @ 1.0 kg a.i./ha (3.27, 2.85, 3.06 and 5.21 per m^2), respectively. The highest Benefit : Cost Ratio (4.04) was noted with weed free treatment (*i.e.*, Hand Weeding at 20, 40 and 60 DAS) (W_1), followed by W_2 *i.e.*, Hand weeding at 20 and 40 DAS (3.90) and W_7 *i.e.*, Pre-emergence application of Pendimethalin @ 1.0 kg a.i./ha (Blanket application) + Hand Weeding at 40 DAS (3.77). Application of 100 per cent recommended dose of NPK fertilizers proved beneficial (BCR of Rs.3.15) over 75 per cent of the recommended dose. The results revealed that higher summer okra green fruit yield of cv. Parbhani Kranti can be acheived by adopting hand weeding at 20, 40 and 60 DAS or hand weeding at 20 and 40 DAS or with pre-emergence application of pendimethalin @ 1.00 kg a.i./ha (Blanket application) coupled with hand weeding at 40 DAS.

Key words: *Okra, weed management, pre-emergence, weedicide, North Gujarat.*

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench.] belongs to the family Malvaceae, is one of the important vegetable crop of subtropical and tropical regions. It is widely grown all over India for its immature tender fruits, which are used as vegetable in a variety of ways. India produces around 3.5 million tonnes from 0.36 million hectares of land with productivity of 9.72 t ha^{-1}. According to Aykroyd (1941) okra fruit contains carbohydrate 7.7%, protein 2.2%, fat 0.2%, fibre 1.2%, mineral matters 0.7%, calcium 0.09%, phosphorus 0.04%, iron 0.0015%, vitamin A 58 I.U., vitamin B 63 I.U. and vitamin C 16 mg/100 g. Among agronomic factors, known to augment crop yield, the fertilization and weed management are considered the most productive inputs. Weed management is one of the most serious problems in modern intensive farming, as the total loss of crop yield, increased cost of cultivation would cause a greater economic loss. Crop yield losses due to weeds have been estimated to the tune of 49 to 100 per cent (Adejonwo *et al.*, 1991).Fertilizers, though costly inputs of production, is essential for securing higher yields. The optimum doses of fertilizers suggested by research workers are variable due to soil and climatic condition of the region. The extent of nutrient competition differs with the dose, time and method of fertilizer application. The benefit of added fertilizers increased markedly with better weed control. Ambare *et al.* (2005) observed that yield loss caused by weeds is greater at low and high rates of applied nitrogen than at intermediate leaves. Since there is lack of information on aforesaid aspects particularly for this region, therefore a field experiment on weed management in Okra under two fertility levels in North Gujarat conditions was conducted during summer season to find out suitable weed management treatment for higher Okra production.

Materials and Methods

Experiment was carried out during summer season of 2008 at Regional Research Station, Sardarkrushinagar Dantiwada Agricultural University.

Sardarkrushinagar, (Gujarat). The treatments comprised eight weed management practices *i.e.*, Unweeded control (W_0), Weed free (*i.e.*, Hand Weeding at 20, 40 and 60 DAS) (W_1), Hand weeding at 20 and 40 DAS (W_2), Interculturing at 20 and 40 DAS (W_3), Pre-emergence application of Pendimethalin @ 1.0 kg a.i./ha (Blanket application) (W_4), W_4 + Interculturing at 20 DAS (W_5), W_4 + Interculturing at 40 DAS (W_6) and W_4 + Hand Weeding at 40 DAS (W_7) along with two fertility levels *i.e.*, 75 % recommended dose of NPK (*i.e.*, 112.5 - 37.5 - 37.5 NPK kg/ha) (F_1) and 100 % recommended dose of NPK (*i.e.*, 150 50 - 50 NPK kg/ha) (F_2) in Factorial Randomized Block Design with four replications. The experimental soil was loamy sand in texture, low in organic carbon and available nitrogen, medium in available phosphorus and potash. The seeds of okra variety 'Prabhani Kranti' were dibbled manually on 28th February, 2008 @10 kg ha^{-1}. Two seeds per hill were dibbled at 30 cm apart in the same furrow in which fertilizers were band placed. The fertilizers were applied as per the treatments. Half dose of the nitrogen and entire dose of phosphorus and potash were applied in the form urea, DAP and MOP, respectively. The fertilizers were applied before sowing in previously opened furrow by manual labour in each plot, keeping the spacing of 45 cm between two rows. The remaining half dose of nitrogen was applied as top dressing in the form of urea after 30 DAS when irrigation was given. The green and tender marketable fruits were picked up by manual continuously at every Monday and Thursday after the first picking (*i.e.*, 17-04-2008). Five tagged plants were harvested separately for taking observations. Observations on plant height, number of leaves/plant, number of branches/plant, stem girth, number of nodes/main stem, days required for 50 per cent flowering, number of fruits/plant, yield/plant, fruit length, fruit girth, average fruit weight, weeds (monocots, dicots and sedges)/m^2 at 20 and 40 DAS, dry weight of weeds/m^2 at 60 and 80 DAS, weed control efficiency, economics and Benefit : Cost Ratio (BCR) were recorded and analysed as per the statistical methods.

Results and Discussion

Effect on weed population

Prusal of data in Table 1 showed that lowest monocot (2.84 per m^2), dicot (2.72 per m^2), sedge (2.58 per m^2) and total weeds (4.60 per m^2) were noted under pre-emergence application of pendimethalin @ 1.0 kg a.i./ha + Inter culturing at 20 DAS (W_5) but it was found at par with treatments W_1 (H.W. at 20, 40 and 60 DAS) and W_2 (H.W. at 20 and 40 DAS) (Table 1). Lower monocot weed population was found in these treatments due to effective control of weeds by pendimethalin and hand weeding and interculturing. In addition to this dense crop canopy might have and smothering effect on weeds. The lowest dicot weeds were observed under pendimethalin treated condition at this stage of crop growth due to complete elimination of weeds by herbicide. The lowest sedge weeds were observed under treatment W_5 might be due to effective control of sedge weeds by pendimethalin as pre-emergence since beginning and weeds those escaped from herbicidal control were removed by interculturing at 20 DAS. The lowest total weeds were observed under pendimethalin treated condition at this stage of crop growth due to complete elimination of weeds by herbicide (Kumar and Choudhary 2004).

Effect on growth parameters

Plant height, Number of leaves per plant, Number of branches per plant, stem girth (cm) and Number of nodes per main stem were recorded highest at 80 DAS weed free treatments W_1 (H.W. at 20, 40 and 60 DAS) and it was at par with treatments W_2 (H. W. at 20 and 40 DAS) and W_7 (W_4 + H.W. at 40 DAS) (Table 2). Weeds were effectively controlled under these treatments and hence there was no severe competition by weeds for moisture and nutrients resulted into comparatively taller plant and as result of higher number of inter node the higher number of leaves per plant were recorded. Effective and timely weed control in these treatments resulted in lesser competition for resources and which become easily available to plant nutrient supply system, and which have accelerated the metabolic activities of plant and ultimately enhanced plant growth. Similar results with weed control in okra are also reported by Singh and Batra (1994). The maximum number of nodes per main stem under these treatments mainly ascribed to better control of weeds throughout the growth period, which may have resulted in better availability of moisture and nutrients to the crop which may be increase the growth attributes of the okra crop. (Tiwari *et al.* 1985). The data on plant height, number of leaves per plant, number of branches per plant, stem girth and number of nodes per main stem significantly influenced by fertility levels at all the stage of crop growth. The highest value of growth parameters were noted with application of 100 per cent recommended dose of fertilizers *i.e.*, 150: 50 : 50 N, P_2O_5 and K_2O kg/ha. The increase in growth parameters with 100 per cent recommended dose of fertilizers might be due to favorable function of fertilizers to produce more and large cells which promote the vegetative growth and encourage the formation of more foliage by producing more carbohydrates. Further, fertilizers might have increased the photosynthetic efficiency of leaves (Saimbhi *et al.* 1991).

Effect on yield and yield attributing characters

The maximum fruit length (14.80 cm), fruit girth (5.60 cm) and average fruit weight (13.99 g) (Table 3) were obtained under weed free treatments W_1 (H.W. at 20, 40 and 60 DAS) due to complete removal of weeds throughout crop growth period by hand weeding which might have resulted in maintaining high soil fertility status by way of removing less plant nutrients through weeds might have favourable effect on yield attributes. W_2 (H.W. at 20 and 40 DAS) and W_7 (W_4 + H.W. at 40 DAS) were also found at par in respect of fruit length, fruit girth and average fruit weight. The increase in fruit length under treatments W_1, W_2 and W_7 was to the extent of 43.69, 35.15 and 31.55 fruit girth, 48.15, 36.24 and 35.98 and average fruit weight 67.14, 57.71 and 57.11 per cent respectively as compared to W_0 (control) might be due to effective control of weeds

resulting in lesser competition of weeds which might have ultimately resulted in the better utilization of nutrients and moisture available in the soil by the crop, which reflects in terms of increased yield attributes of okra. (Kumar and Choudhary, 2004). Highest green fruit yield of okra (96.48 q ha^{-1}) was recorded under weed free treatments W_1 (H.W. at 20, 40 and 60 DAS) which was at par with treatments W_2 (H.W. at 20 + 40 DAS) and W_7 (W_4 + H.W. at 40 DAS). Increase in green fruit yield of okra under treatments W_1, W_2 and W_7 over W_0 (control) to the tune of 216.95, 195.34 and 198.86 per cent, respectively. Higher green fruit yield obtained under these treatments might be due to effective control of weeds which in than of significantly increase the values of growth and yield attributes like days to 50 per cent flowering, number of fruits per plant, fruit yield per plant, fruit length, fruit girth and average fruit weight under these treatments. In addition to this the least weed population and dry weight of weeds were recorded under these treatments are also responsible for better green fruit yield. These findings are in accordance with the results reported by Patel *et al.* (2004). Fruit length, fruit girth, fruit weight, number of fruits per plant and fruit yield per plant (Table 3) were significantly increase with application of 100 per cent recommended dose of fertilizers (F_2) than 75 per cent of recommended fertilizers (F_1). Higher dose of fertilizers tends to increase the vegetative growth in terms plant height, number of leaves per plant, number of branches per plant, stem girth and number of nodes per main stem which resulted in increase photosynthate surface, consequently more production of photosynthates and carbohydrates, might have resulted in increased fruit length, fruit girth, fruit weight, number of fruits per plant. The combine effect of all these parameters finally increase the green fruit yield per plant is in agreement of results reported by(Meena *et al,*. 2008).

Table 1 : Weed population/m^2 at 40 DAS and dry weight of weeds in okra cv. Parbhani Kranti as influencedby weed management and fertility levels

Treatments	Weed population /m^2 (X + 0.5)				Dry weight of weeds (g/m^2)	
	Monocot	Dicot	Sedge	Total	At 60 DAS	At 80 DAS
Weed management						
W_0 : Unweeded control	9.95 (98.67)	6.55 (42.48)	6.38 (40.20)	13.48 (181.35)	210.80	1004.65
W_1 : Weed free (*i.e.*, Hand Weeding at 20, 40 and 60 DAS)	4.92 (23.78)	3.35 (10.78)	3.50 (11.75)	6.84 (46.31)	(82.04)* 37.87	(77.03)* 230.76
W_2 : Hand weeding at 20 and 40 DAS	4.93 (23.80)	3.37 (10.85)	3.51 (11.80)	6.85 (46.45)	(79.24) 43.76	(73.07) 270.54
W_3 : Interculturing at 20 and 40 DAS	6.64 (43.67)	5.49 (29.76)	4.55 (20.26)	9.68 (93.49)	(61.73) 80.67	(50.18) 500.50
W_4 : Pre emergence application of Pendimethalin @ 1.0 kg a.i./ha	6.73 (44.90)	5.74 (2.54)	5.54 (32.45)	10.50 (109.89)	(52.25) 100.65	(38.20) 620.87
W_5 : W_4 + Interculturing at 20 DAS	2.84 (7.60)	2.72 (6.90)	2.58 (6.15)	4.60 (20.65)	(56.89) 90.87	(46.77) 534.76
W_6 : W_4 + Interculturing at 40 DAS	6.72 (44.76)	5.57 (30.55)	4.37 (18.67)	9.71 (93.98)	(61.69) 80.76	(58.12) 420.76
W_7 : W_4 + Hand Weeding at 40 DAS	6.72 (44.65)	5.57 (30.55)	4.28 (17.86)	9.66 (93.06)	(78.91) 44.45	(72.44) 276.87
S.Em.±	1.34	0.81	0.64	1.38	2.93	16.71
C.D. at 5 %	3.80	2.30	1.82	3.91	8.32	47.45
Fertility levels (NPK kg ha^{-1})						
F_1 : 75 % of recommended dose	6.45 (41.14)	4.96 (24.10)	4.50 (19.74)	9.24 (84.95)	78.87	478.03
F_2 : 100 % recommended dose	6.50 (41.82)	5.00 (24.50)	4.53 (20.05)	9.26 (85.35)	93.59	486.89
S.Em.±	0.67	0.41	0.32	0.69	1.46	8.35
C.D. at 5 %	NS	NS	NS	NS	4.16	NS

Table 2 : Growth parameters in okra cv. Parbhani Kranti as influenced by weed management and fertility levels

Treatments	Plant height (cm) at 80 DAS	Number of leaves per plant at 80 DAS	Number of branches per plant 80 DAS	Stem girth (cm) 80 DAS	Number of nodes per main stem at 80 DAS	Days to 50 per cent flowering
Weed management						
W_0 : Unweeded control	52.41	8.08	0.75	2.30	5.22	52.20
W_1 : Weed free (*i.e.*, Hand Weeding at 20, 40 and 60 DAS)	74.46	18.08	2.10	4.50	13.08	50.70
W_2 : Hand weeding at 20 and 40 DAS	69.81	16.82	1.98	4.20	12.20	51.98
W_3 : Interculturing at 20 and 40 DAS	63.16	14.65	1.63	3.66	9.97	50.80
W_4 : Pre emergence application of Pendimethalin @ 1.0 kg a.i./ha	59.11	13.80	1.59	3.31	7.99	51.30
W_5 : W_4 + Interculturing at 20 DAS	65.27	15.33	1.67	3.81	9.98	52.10
W_6 : W_4 + Interculturing at 40 DAS	66.30	14.03	1.68	3.76	9.78	52.09
W_7 : W_4 + Hand Weeding at 40 DAS	68.71	16.80	1.95	4.18	12.15	51.95
S.Em.±	2.19	0.51	0.06	0.13	0.34	1.74
C.D. at 5 %	6.23	1.45	0.17	0.36	0.97	NS
Fertility levels (NPK kg ha^{-1})						
F_1 : 75 % of recommended dose	63.10	14.28	1.62	3.61	9.76	50.22
F_2 : 100 % recommended dose	66.71	15.11	1.72	3.82	10.33	53.06
S.Em.±	1.10	0.26	0.03	0.06	0.17	0.87
C.D. at 5 %	3.11	0.73	0.08	0.18	0.49	2.47

Table 3: Yield parameters and yield in okra cv. Parbhani Kranti as influenced by weed management and fertility levels

Treatments	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (g)	Number of fruits per plant	Fruit yield per plant (g)	Green fruit yield (q ha^{-1})
Weed management						
W_0 : Unweeded control	10.30	3.78	8.37	3.09	58.94	30.44
W_1 : Weed free (*i.e.*, Hand Weeding at 20, 40 and 60 DAS)	14.80	5.60	13.99	8.12	160.24	96.48
W_2 : Hand weeding at 20 and 40 DAS	13.92	5.15	13.20	7.55	151.36	89.90
W_3 : Interculturing at 20 and 40 DAS	12.70	4.99	12.08	6.23	143.73	84.25
W_4 : Pre emergence application of Pendimethalin @ 1.0 kg a.i./ha	11.80	4.70	9.12	5.60	96.89	49.55

W_5 : W_4 + Interculturing at 20 DAS	13.00	4.90	9.65	5.90	108.13	57.88
W_6 : W_4 + Interculturing at 40 DAS	12.89	4.98	10.02	6.10	112.64	61.22
W_7 : W_4 + Hand Weeding at 40 DAS	13.55	5.14	13.15	7.51	151.10	89.45
S.Em.±	0.45	0.17	0.38	0.22	4.25	2.53
C.D. at 5 %	1.28	0.48	1.07	0.62	12.07	7.19
Fertility levels (NPK kg ha^{-1})						
F_1 : 75 % of recommended dose	12.38	4.77	10.88	6.07	119.39	66.11
F_2 : 100 % recommended dose	13.36	5.04	11.51	6.42	126.37	71.43
S.Em.±	0.23	0.08	0.19	0.11	2.12	1.27
C.D. at 5 %	0.64	0.24	0.53	0.31	6.03	3.60

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SHORT COMMUNICATION

Pest management in mango by farmers of Central Gujarat

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Mango (*Mangifera indica* L.) nicknamed as king of fruits in India is the major fruit crop. It tops the list of preference of farming community for cultivation due to endless demand in domestic as well as international market. Mango cultivar 'Kesar' is one of the finest delicacies from Gujarat exported to Europe. In the package of practices of cultivation of mango to be followed by the farmers plant protection occupies a significant role. Negligence of this aspect brings about considerable loss of yield and quality. Mango malformation is still an unsolved mystery. Many insects and fungal pathogens attack mango. Keeping this in view, a survey was conducted to assess the adoption level of pest management in mango by the farmers of Central Gujarat.

A survey was conducted in Panchmahals and Vadodara districts. Sixty mango farmers were randomly selected. These farmers were interviewed at their farms during June August, 2005. Information regarding pest management measures practised in these orchards was collected in a structured interview schedule which encompassed the questions pertaining to the status of a pest/disease, its salient cause, symptoms, extent of damage, major management strategies, reasons for non-adoption of the recommended practices etc.

Results and Discussion

Insect pests

Leafhoppers

Leafhoppers were major pests sucking the sap of tender leaves, flowers and fruits. They secreted massive quantities of honeydew, which encouraged growth of fungi leading to growth of sooty mould. The leaf hoppers might be controlled with first spray with cypermethrin or fenvalerate (0.01%) at bud-burst stage, second spray with carbaryl (0.1%) at inflorescence emergence and NSKE (4%) spray after fruit set (Chadha, 2003). Majority of the farmers (82 %) noticed the leafhoppers infestation as an important pest but only 20 percent of the farmers sprayed Dimethoate, whereas 62 percent farmers did not spray any chemicals.

Termite

The food of termite included wood cellulose. Termite attacked mango branches and stem and formed soil channels under which they lived (Srivastava, 1997). For its control, drenching with chlorpyriphos @ 5ml/l were suggested. Majority of the farmers (49%) reported the infestation of termite. Twelve per cent farmers sprayed quinalphos on stem and applied drenching around collar region.

Fruit fly

The female adult punctured the mature fruit and laid eggs in mesocarp. The maggots fed the pulp and brown rotten patch appeared on the fruit surface. Singh (1989) used 0.1 per cent methyl eugenol combined with 0.1 per cent dichlorvos and obtained the maximum catch of 500 male adults per week during 24 June to 2 July. Methyl eugenol wooden block traps soaked in ethanol, methyl eugenol and malathion (6:4:1) might be hanged during fruiting period from April to August @ 10 traps/ha (Shukla and Misra, 2005). Carbaryl (0.2%) or fenthion (0.05%) with molasses might be sprayed commencing at pre-oviposition period and might be repeated at 15 days interval (Shukla and Misra, 2005). Few farmers (12 %) reported the incidence of fruit fly and followed the practice of trapping the adults by using methyl eugenol combined with dichlorvos.

Leaf gall midge

The eggs were laid in tender leaves and maggots fed within leaves inside gall. Jhala et.al. (1987) observed 47.70, 27.21 and 25.80 average percentage of leaves infested by *Procontarinia matteiana* in the mango cultivars alphonso, kesar and rajapuri. Jhala et.al. (1990) found the effectiveness of insecticides against *Procontarinia matteiana* in descending orders of phosphamidon (0.03%), monocrotophos (0.04%), dimethoate (0.03%), quinalphos (0.05%), malathion (0.05%), endosulphan (0.075%), methyl parathion (0.03%) and methyl-o-dematon (0.03%). The infestation was prominently visible during rainy season. However, only few farmers (20%) noticed the infestation of leaf gall midge and sprayed quinalphos.

Red tree ant

Ant was not a pest. However, it created nuisance by biting field workers. It constructed nests by sewing leaves with silken threads produced by larva. Few farmers (8%) reported the incidence of red tree ant and did not spray any chemicals.

Diseases

Mango malformation

Prakash and Misra (1993) expressed that mango malformation was a very serious threat to mango industry, particularly in northern India, the etiology of the disease remained obscure and diverse claims had been made about its causes e.g. physiological, viral, fungal, acarological and nutritional and the disease is serious in the north-west region where temperature was between 10 and 15°C during December-January (winter) before flowering. The most characteristic symptom of floral malformation was a reduction in the length of the primary axis and the secondary branches of the panicle which made the flowers

to appear in clusters. Frequently, the flower buds were transformed into vegetative buds and large number of small leaves and stems which were characterized by appreciably reduced internodes and were compacted together giving a false appearance of witches' broom. Deblossoming (plucking away the malformed panicle) alone or coupled with a spray of 200ppm NAA lowers the number of malformed panicles significantly (Chadha, 2003). All farmers reported the incidence of floral malformation. All farmers were cutting and burning the affected inflorescence.

Sooty mould

The fungus multiplied on the honeydew secreted by leafhoppers making the plant surface black. The saprophytic fungus was not pathogenic but interferes in the normal physiology of the plant by cutting off the effective photosynthesizing leaf area. Spraying insecticides and then removing the sooty mould growth in dry flakes by subsequent application of soluble starch was very effective method of control (Prakash and Misra, 1993). Majority of the farmers (82%) reported sooty mould infection. Few farmers (20%) sprayed Dimethoate.

Powdery mildew

It was manifested by development of a white coloured fungal coating on panicles and young leaves during December to March. Gradually the affected panicles turned brown, dried up, flowers and even well-set pea size fruits also shed. The disease caused by *Oidium mangiferae* was noticed by majority of farmers (80%) but only 25% farmers applied chemical spray of wettable sulphur. Spray of sulphur 80WP (0.2%) or carbandazim 50WP (0.1%) or thiophanate methyl 50WP (0.1%) or hexaconazole 10EC (0.1%) were suggested.

Anthracnose and other leaf spots

During rainy season, anthracnose and many minor leaf spots were seen but the farmers were not noticing them and no sprays were applied. One or two sprays with Carbendazim 50WP @ 1g/l at 15 days interval was suggested.

Dieback and Gummosis

After monsoon during October and November, main stem and branches showed vertical slits and oozing of amber coloured gum from them. This was accompanied by browning and distortion of leaves and dieback of the trees. Application of copper fungicides Bordeaux paste or copper oxychloride 50WP 10% pasting on main stem and 2-3 sprays at monthly interval with carbandazim 50WP (0.1%) or captan 50WP (0.2%) or blitox (0.3%) were suggested. However only 5% farmers were noticing and applying Bordeaux paste.

Plant parasite

Giant mistletoes

The seeds of the parasite were carried by birds and germinated when deposited at junction of branches with trunk and gave rise to haustoria. Few farmers (10%) reported the incidence of giant mistletoes. They did not spray any chemicals.

Farmers noticed the incidence of leafhopper, termite, fruit fly, red tree ant, malformation, sooty mould, powdery mildew, dieback and giant mistletoes. However only some farmers adopted the control measures. The prevalent mode of control was spraying chemicals. Large size of the tree, non-availability of power sprayers and seedling origin mango trees might be the cause of low adoption. The farmers might be persuaded to adopt integrated pest management in mango to realize better yield and quality.

Table 1: Pest management in mango by the farmers of central Gujarat

Pest	Management				Farmers	
	Chemical	Quantity (ml or gms / liter of water)	Number of sprays	Days of interval	No	Per cent
Insect pest						
Leafhopper (*Idioscopus clypealis, I. Nitidulus, Amritodus atkinsoni*)	Dimethoate	2.5	3	15	12 (37)	20 (62)
Termite (*Odontotermes obesus, O. wallonensis*)	quinalphos	3.0	3-4	30	7 (22)	12 (37)
Fruit fly (*Bactrocera dorsalis, B. zonata*)	Methyl eugenol + Dichlorvos soaked in cotton	2 drops each	3	30	7	12
Leaf gall midge (*Procontarinia mattelana, P. (Indodiplosis) mangifoliae, Amradiplosis allahabadensis*)	quinalphos	3.0	3-4	30	12	20
Red tree ant (*Oecophylla smaragdina*)	–	–	–	–	(5)	(8)
Disease						
Mango malformation	Cut & burn the affected inflorescence	–	–	–	60	100
Sooty mould (*Capnodium mangiferae, Meliola mangiferae*)	Dimethoate	2.5	3	15	12 (37)	20 (62)
Powdery mildew (*Oidium mangiferae*)	Wettable sulphur	2.5	2	30	48 (15)	80 (25)
Die-back and gummosis (*Botrydiplodia theobromae*)	Bordeaux paste	–	1	–	3	5
Anthracnose (*Colletotrichum* state of *Glomerella cingulata*)	–	–	–	–	–	–
Plant Parasite						
Giant mistletoes (*Dendrophthoe falcata*)	–	–	–	–	(6)	(10)

Figures in the parenthesis indicates the farmers who reported the pest but did not take up control measures.

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SHORT COMMUNICATION

Application of rock phosphate in composting improving the quality of compost

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Indian rock phosphate are of low grade and usually not suitable for the manufacture of phosphatic fertilizer (Manna *et al.*, 2003). Phosphocompost prepared by composting organic wastes with different graded dose of Missouri rock phosphate @ 1, 4 and 8 % of substrate, was reported to be comparable to single super phosphate in its effect on yield and phosphorus uptake in crops (Mishra *et al.* 1982, Banga *et al.* 1985). India has large deposit of rock phosphate but only 30% of it is in use. Direct application of rock phosphate has given good response in acid soil (Waigwa *et al.* 2003) but no effect in natural and alkaline soil (Hundal and Sekhon 1976, Rahman and Hajra, 2003). Mathur *et al.* (1980) observed that citrate soluble phosphorus content was increased on composting of Missouri rock. The P use efficiency is low as the water-soluble phosphate when applied to soil is quickly converted into unavailable forms by precipitation or adsorption with Al/ Fe in acidic (Chakravarti and Talibudeen 1962) and with Ca in alkaline condition. On the contrary organic forms of phosphorus immobilized in microbial cells are mineralized slowly (Dinesh *et al*, 2002) and made available to the plant regularly for a longer period increasing the P-use efficiency significantly. An attempt was made in the present study to quantify the quality improvement of compost by P enrichment through rock phosphate at different doses with decomposable organic matter during composting.

The experiment was conducted during 2000-01 and 2001-02 at the agriculture farm of Sheila Dhar Institute of Soil Science, Allahabad University, Allahabad. The detailed chemical analysis of compost and phosphocompost sample was carried out at Indian Institute of Vegetable Research, Varanasi during 2006-07. Composting pit of dimension 150 X 90 X 90 cm were made and filled with 750 kg raw material comprising 80 kg rice and wheat straw, 75 kg green water hyacinth and weeds and 595 kg cow dung and urine and decomposable farm waste. The decomposable substrate materials in each pit were moistening with 100 liters of water to maintain sufficient moisture. The mixture in pit on control, 1% P_2O_5 MPR, 4% P_2O_5 MPR, and 8% P_2O_5 MPR was added to study its effect on the efficiency of MPR solubilization and the change in chemical properties during composting. Nitrogen as urea @ 2% was added to the substrate to increase the C: N ratio, for quick decomposition. The contents of the pit were mixed after 4, 8, 15, 30, 60 and 90 days of composting and samples were drawn on these days for measurement of physico-chemical properties. The moisture content of the added substrate was maintained to the original level by sprinkling water. The loss in organic material during decomposition was measured by scaling the height and volume of the composting material in each pit at 30, 60, 90 and 120 days after composting and respective samples were taken out for chemical analysis. The sample were dried at room temperature, ground to pass through a 2 mm sieve and analyzed for pH, water soluble, organic and total phosphorus contents (Jackson, 1973). The percent solubilization of added rock phosphate was calculated at different time interval by the following equation: (Increased water soluble P + Increased organic P) - (water soluble P in control + organic P in control) / (total P- total P in control)* 100. Triplicate samples from the pits denoting different phosphorus enrichment levels were drawn by tube auger after specific days of incubation/ composting and analyzed for organic carbon, total nitrogen, total potassium and other micronutrients as described by Jackson (1973).

A steady decrease of substrate total biomass subjected to composting was noted with the progress of incubation days irrespective of phosphorus enrichment. The phosphorus enrichment up to 4 % P_2O_5 as phosphate rock with the substituted biomass significantly increased the rate of decomposition and lead to a faster loss of total substrate biomass. However at 8 % P_2O_5 enrichment the total biomass loss was less compared to phosphorus enrichment at 4 % P_2O_5 and recorded at par to 1 % enrichment (Table 1). The P enrichment level dependent biomass decomposition was in conformity with the earlier reports (Nazirkar *et al.*, 2004). A steady decrease in the pH value of the substrate biomass with the progress of decomposition was noted which eventually indicated the release of more acid forming ions particularly increase in H^+ concentration in the substrate biomass, corroborating the findings of Tian and Kolawole, 2004. A steady increase in total N % of decomposable substrate biomass was recorded with the progress of composing. The phosphorus enrichment @ 1 % P_2O_5 was more effective in increasing total N percentage of decomposable biomass as compared to 4 and 8 % enrichment (Table 1).

The enrichment of the compost with rock phosphate not only enhanced the availability of phosphorus

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from the insoluble source by its dissolution but also improved the quality of the final product. Mathur *et al.* 1980 observed similar phenomena during composting with varying phosphorus levels. The citrate soluble phosphorus content from charged compost of rock phosphate application had an increasing trend from 30 to120 days of incubation. The releases of phosphorus being slow at the initial stage and fast at later stage of composting. After 120 days of incubation the release of citrate soluble phosphorus was higher in compost treated with a higher amount of phosphorus enrichment compared to enrichment at a lower level (Vanden, 1996). There was a faster release of water-soluble phosphorus after 90 days of incubation. In all the stages of composting citrate soluble phosphorus was higher compared to water-soluble phosphorus in the compost mixture irrespective of level of enrichment with MPR compared to control (Table 2). Compost charged with either 1 % or 4% P_2O_5 and 8% P_2O_5 attained the highest level of citrate soluble phosphorus with the progress of composting at 120 DAI. Release of water-soluble phosphorus followed similar trend as citrate soluble phosphorus. The only difference was being lesser amount of phosphorus in water-soluble form than in citrate soluble form.

Organic carbon content in the raw material was as high as 40 per cent in the beginning of incubation, which considerably reduced after 30 days, and steadily decreased with time till reached a minimum value of 6.3 per cent after 120 days. The stimulation to the decomposition process could be due to the presence of phosphate and other nutrients ions available in the rock phosphate (Dash *et al*, 1988). Phosphorus enrichment with rock phosphate during composting also increased the calcium and magnesium content of compost. Enriching the compost with rock phosphate during composting also enhanced the concentration of micronutrients particularly Fe and Mn (Table 3). This was primarily due to the presence of calcium carbonates and salts of Fe, Mg, Zn, Cu and Mn, present in the rock phosphate, which during decomposition released from adsorbed form to ionic form in solution. The rate of decomposition of organic matter is directly correlated with the populations of thermophilic microorganism and release of CO_2 from the substrate biomass. A part of released CO_2 dissolved in the water and produce carbonic acid which initially solubilized not only PO_4^{-3} from calcium but also Mg, Fe, Zn, Mn and Cu salts of the rock phosphate (Sreenivas and Narayanasamy, 2003). In the presence of these essential nutrients the mesosphilic organisms also come into the reactions with the substrate that continues the decomposition of the organic matter and produces the organic acid (Singh *et al.* 1982, Singh and Amberger, 1991). Released organic acid and aerobic micro flora further mobilize the more insoluble compounds of the rock phosphate that subsequently, enhanced the soluble phosphorus percentage of decomposable substrate biomass together with total Ca, Mg, Fe, and Zn content in phosphocompost compared to normal compost. A significant increase in 42.6% water soluble phosphorus, 16.7% organic carbon, 28.6% total Ca, 50% total Mg, 1.5 to 2.8 fold increase in micronutrient Zn, Cu, Mn and Fe content was noted when composting was done with phosphorus enrichment @ 1% by Missouri rock phosphate compared to ordinary compost.

Table 1 : Effect ofphosphorus enrichment on biomass decomposition, pH and total N % during composting

Treatment	Loss of substrate (%)			pH			Total N % of substrate		
	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI
Control	12.17	24.17	30.2	7.6	7.3	7.2	0.21	0.34	0.49
1% P_2O_5 as MPR	14.2	25.57	34.63	7.5	7.3	7.1	0.25	0.50	0.62
4% P_2O_5 as MPR	20.77	32.17	44.17	7.4	7.3	7.1	0.21	0.47	0.54
8% P_2O_5 as MPR	17.53	23.37	33.27	7.4	7.2	7.2	0.20	0.39	0.50
$LSD_{0.05}$	0.65	0.32	2.72	0.54	0.45	0.34	0.07	0.03	0.09

DAI, days after incubation

Table 2 : Effect ofMPR on phosphate ion concentration during composting

Treatment	Water soluble phosphate %			Citric acid soluble P %			Total phosphate %		
	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI
Control	0.027	0.034	0.054	0.2	0.31	0.42	0.22	0.31	0.39
1% P_2O_5 as MPR	0.046	0.059	0.068	0.25	0.39	0.73	0.46	0.74	0.96
4% P_2O_5 as MPR	0.034	0.041	0.049	0.85	1.13	1.9	0.72	1.16	2.9
8% P_2O_5 as MPR	0.031	0.036	0.39	0.92	1.46	2.35	1.24	2.6	3.1
$LSD_{0.05}$	0.05	0.06	0.046	0.08	0.07	0.1	0.12	0.21	0.18

DAI, days after incubation

Table 3 :Properties of compost and phosphocompost at different levels of P enrichment

Nutrient status	Control	1% P_2O_5 as MPR	4% P_2O_5 as MPR	8% P_2O_5 as MPR
Organic matter loss (%)	33.20	36.63	46.80	48.6.0
Total phosphorus (%)	0.63	1.28	3.12	5.71
Water-soluble P (%)	0.061	0.087	0.073	0.066
Citrate soluble P (%)	0.069	1.07	3.21	4.61
pH	6.70	7.10	7.00	7.2
Total N (%)	0.58	0.76	0.71	0.64
Total K (%)	0.89	0.76	0.86	0.92
Organic Carbon (%)	13.76	16.07	10.75	8.56
Total Ca (%)	1.78	2.29	4.29	5.21
Total Mg (%)	0.32	0.48	0.54	0.60
Fe (ppm)	5072.00	12700.00	12864.00	13822.00
Mn (ppm)	178.00	498.00	693.00	829.00
Zn (ppm)	56.00	86.00	132.00	157.00
Cu (ppm)	9.00	22.00	28.00	39.00

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INDIAN JOURNAL OF ARID HORTICULTURE
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SHORT COMMUNICATION

Field evaluation of bottle gourd genotypes for resistance against *Alternaria* leaf blight in Western Rajasthan

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Rajasthan, though the largest state in the country, the area under vegetables in the state is merely 135682 ha with a production of 818900 million tons (Anon. 2009). The productivity in the state is 6.0 t/ha, which is quite lower than the national productivity of 16.1t/ha. Bottle gourd {*Lagenaria siceraria* (Mol.) Standl.} is a commonly grown vegetable in India. It is also grown in Ethiopia, Africa, Central America and other warmer regions of the world. It is also suitable for cultivation throughout in the Rajasthan state. The fruits can be used as a fresh vegetable. As a vegetable, it is easily digestible, even by patients (Thamburaj and Singh, 2000). It is gaining importance due to its high yield potential and steady market price throughtout the season. *Alternaria* leaf blight caused by *Alternaria cucumerina* (E.&E.) Elliot, is found throughout the world on various cucurbits (Ibrahim *et al.*, 1975). In Egypt, Prasada *et al.* (1972) found that the yield loss from a single plant was as high as 63% with early infection of *Alternaria* leaf blight in muskmelon when environmental factors were favourable for development of this disease. Bottle gourd is affected by many fungal diseases, of which *Alternaria* leaf blight caused by *Alternaria cucumerina* (E.&E.) Elliot is one of the most important diseases that quantitative and qualitative losses to the crop. Lesions tend to appear first on the older leaves as small, circular, light to dark brown spots and form concentric rings on the leaves of crop and spreads covering some leaf area. The cheapest, practical and economical control of the disease can be achieved by resistant varieties against the disease (Jadhav and Sharma, 1983). Plant resistance is an effective and environmentally safe means of reducing losses caused by the fungal disease. Keeping in view this important component of integrated disease management, efforts were made to screen bottle gourd genotypes for resistance against *Alternaria* leaf blight under hot arid conditions of Rajasthan.

A field trial was conducted during rainy season of 2011 to screen 17 bottle gourd genotypes/varieties such as Pusa Santushti, Pusa Sandesh, PSPL, Udaipur Local, Chomu Local, Azad Harit, Panchmahal Local, Arka Bahar, Pusa Naveen, Pusa Samridhi, Thar Samridhi, PN-22, IC-567538, Sriganganagar Local DBG-5, DBG-6 and Jodhpur Local against *Alternaria* leaf blight at Central Institute For Arid Horticulture, Bikaner with general agronomical practices. These genotypes were received from ICAR Institutes (IARI, New Delhi, NBPGR, IIHR, Bangalore), Agricultural Universities and farmer's field. The seeds were sown in the field in Randomized Block Design at a spacing 50 x 100 cm with three replications on 30th June, 2011. No plant protection measures were taken up in the present study. Susceptible germplasm 'Chomu Local' was sown after each five rows of the test genotypes as check and also grown around the border of the field to serve as infector rows. Isolation was made from the diseased bottle gourd leaves showing typical symptoms. The culture thus obtained was purified. Observations on disease intensity were recorded periodically. Disease intensity was calculated on the basis of percent leaf area covered by spots with some modifications (Prasada *et al.*, 1972). The reaction for resistance due to *Alternaria* leaf blight was categorized by using modified 0- 5 scale (Kumar and Rani, 2010): immune (I) = 0%, resistant (R) = 0.1 to 10%, moderately resistant (MR) = 10.1 to 25%, moderately susceptible (S) = 25.1 to 50%, susceptible (S) = 50.1 to 75% and highly susceptible (HS) = > 75%.

The results presented in Table 1 reveal that there was significant variation in all the genotypes evaluated against *Alternaria* leaf blight of bottle gourd. Out of seventeen genotypes, none was found immune, while six varieties such as Pusa Naveen, Pusa Samridhi, Pusa Santushti, Pusa Sandesh, PSPL and Arka Bahar were resistant having 5.258.75% disease intensity. Five genotypes *viz.*, PN-22, DBG-6, DBG-5, Azad Harit and IC-567538 were moderately resistant (11.5 to 21.25% disease severity) against this disease and remaining six genotypes such as Panchmahal Local, Sriganganagar Local, Jodhpur Local, Udaipur Local, Chomu Local and Thar Samridhi proved moderately susceptible with disease severity ranging from 25.50- 28.75%. Carmody *et al.* (1985) screened the muskmelon cultivars and found that three cultivars (TAM-Uvalde, TAM-Mayan Sweet and Greenflesh Honeydew) were resistant against *Alternaria* leaf blight of muskmelon. Kumar and Rani (2010) noted that three entries *viz.*, RAUP-32, RAUP-34 and Pusa (B)-35 were found to be resistant and twelve entries showed moderately resistant against *Alternaria* blight in pegionpea.

During the study period, none of genotypes were found susceptible due to prevailing dry atmospheric conditions, typical hot arid conditions, which is unfavourable for the disease appearance. However, keeping in mind the unpredictable and fluctuating weather

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conditions, particularly in view of global climate change, it is advisable to grow resistant varieties for the improved production of bottle gourd. *Alternaria* leaf blight may attain an alarming status and may havoc in bottle gourd growing areas if not taken care well in time. These findings confirm the performance of Institutional varieties are tolerant (Pusa Naveen, Pusa Samridhi, Pusa Santushti, Pusa Sandesh, PSPL and Arka Bahar) in context of disease severity as compared to other genotypes and local collections. Therefore, it is need of the hour to develop an effective management strategy to combat this dreaded diseases of bottle gourd.

Table 1 : Disease reaction for resistance of different genotypes of bottle gourd against *Alternaria* leaf blight

Disease reaction	*Alternaria* leaf blight
Immune (0.0%)	Nil
Resistant (0.1 to 10%)	Pusa Naveen, Pusa Santushti, Pusa Sandesh, Pusa Samridhi, PSPL an d Arka Bahar.
Moderately resistant (10.1 to 25%)	PN-22, DBG-6, DBG-5, Azad Harit and IC-567538.
Moderately susceptible (25.1 to 50%)	Panchmahal Local, Sriganganagar Local, Jodhpur Local, Udaipur Local, Chomu Local and Thar Samridhi.
Susceptible (50.1 to 75%)	Nil
Highly susceptible (> 75%)	Nil

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INDIAN JOURNAL OF ARID HORTICULTURE
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SHORT COMMUNICATION

Impact of fennel (*Foeniculum vulgare* Mill) variety (RF-125) under semi arid conditions of Nagaur, Rajasthan

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Fennel is an important high value seed spice crop belonging to family apiaceae. In India, the area under fennel is 74149 hectares with the total production of 114277 tonnes with an average productivity of 1541 kg ha^{-1} (Anwer *et al.* 2011). It is mainly grown in Gujarat, Rajasthan, Karnataka, UP, Punjab and Haryana. The Gujarat contributes 80% of the total production in the country followed by Rajasthan (10%). In state like Rajasthan, area under fennel is spreading in semi arid regions but the productivity of the crop is low as compared to Gujarat. The yield potential of fennel is low primarily due to less availability of better genotype for cultivation under the prevailing agro-climatic conditions and secondly due to poor management of production sites (Singh *et al.* 2012)

Improved agronomical practices along with good quality seed are the key factors to increase the productivity levels. Keeping these facts in view front line demonstrations were laid out by KVK, Nagaur to evaluate the impact of high yielding variety (RF-125) along with balanced fertilization during Rabi seasons of 2007-2008 to 2010-11.

The demonstrations were carried out at farmers field in village somana, Khiwtana, Nimbri, Chardas and sarasni of Nagaur during four Rabi season from 2007-08 to 2010-11. The soil of demonstration sites were mostly sandy loam in texture with low organic carbon (0.13 to 0.27 percent). The available NPK were 134 to 140, 12 to 14 and 168 to 192 kg ha-1 respectively. PH of irrigation water was +8.7 with high EC (± 4.68 dsm^{-1})

The sowing of fennel variety RF-125 was done in between second week October to last week of October in all the four seasons. The recommended dose of nitrogen and phosphorus (90:60 kg ha^{-1}) were applied through urea and SSP. Full dose of phosphorus and 1/3 rd of nitrogen was applied as basal dose and remaining dose of nitrogen was applied in two equal splits at 30 and 60 days after sowing. Seed treatment was done with carbendazim @2 g per Kg seed. The other crop management practices were preferred as per standard recommendation of the region. One block of farmer's practice (Local variety with ±50 kg N ha^{-1}) was also kept for comparison. Harvesting of crop was done during 2nd fortnight of April and grain yield was recorded.

The yield data presented in table-1 showed that the yield in demonstration plots increased from 15.40 to 33.85 percent over farmers practice during the study period. The variation in yield data during the years was due to aberrant weather condition like frost and sudden development of cold waves. However, owing to dry conditions, the arid region of north western parts of Rajasthan like Nagaur offers an excellent opportunity for high quality seed spices. This congenial weather condition together with quality input management like quality seed and recommended fertilization can be an effective tool to achieve better yield.

The higher yield in demonstration plots might be due to higher yield potential of the variety (RF-125) and direct role of balanced fertilization during crop season. Among the primary nutrients, nitrogen play an important role in grown and dry matter production of the crop (Patel et al, 2007). Basel & split application of nitrogen helped in better growth 7 yield. More over, the soils of experimental sites were inherently poor in phosphorus (12 to 14 kg/ha). Basel application of phosphorus helped in mitigation of phosphorus deficiency and higher grain yield.

The adoption of any technology in modern agriculture can only be feasible and acceptable to farmers if it is economically viable.

The cultivation of traditional crops has become uneconomical due to increasing cost of cultivation under such circumstances, farmers always look forward for more remunerative option. The economic analysis data of fennel (RF-125) presented in Table-2 indicated that fennel (RF-125) along with balanced fertilization gave higher B:C ratio and net additional return over farmers practice during all the four years of crop season. the study reveals that use of improved variety (RF-125) along with balanced fertilization may provide a net additional return upto Rs. 18207 per hectare.

Table 1 : Year wise Impact of fennel RF-125 on yield ha^{-1}

S.No.	Year	No. of Farmers	Area (ha)	Average yield q ha^{-1}		% increase in yield
				Demonstration	Farmers Practice	
1.	2007-08	10	5	12.17	10.31	18.04
2.	2008-09	10	5	21.05	17.11	23.00
3.	2009-10	10	5	14.38	12.46	15.40
4.	2010-11	15	6	17.40	13.00	33.85

Table 2 : Economic analysis of Fennel variety (RF-125) under semi arid condition of Nagaur

S.No.	Year	Demonstrations		Farmers practice		B:C Ratio		Net additional Return (Rs. ha^{-1})
		Cost (Rs. ha^{-1})	Return (Rs. ha^{-1})	Cost (Rs ha^{-1})	Return (Rs ha^{-1})	Demo	Farmers Practice	
1.	2007-08	16650	58416	15470	49488	1:3.51	1:3.19	7748/-
2.	2008-09	17800	86305	16100	70151	1:4.85	1:4.36	14454/-
3.	2009-10	17950	59520	16200	49840	1:3.32	1:3.08	8030/-
4.	2010-11	18720	78300	17127	58500	1:4.12	1:3.42	18207/-

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SHORT COMMUNICATION

Insect pest management in *aonla* (*Emblica officinalis* Gaertn.) by farmers of Gujarat

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Aonla (*Emblica officinalis* Gaertn.) also known as Indian gooseberry is a deciduous, hardy tree, native of India comes up well in salt affected soils and wastelands. Fruits are rich in vitamin-c of 600mg/100g of edible portion (Gopalan *et.al.*, 6). One hundred grams of edible portion of *aonla* contains 81.8g moisture, 0.5g protein, 0.1g fat, 0.5g minerals, 3.4g crude fibre, 13.7g carbohydrates, 58kcal energy, 50mg calcium, 20mg phosphorus, 1.2mg iron, 9µg carotene, 0.03mg thiamine, 0.01mg riboflavin, 0.2mg niacin, 256mg choline, 5mg sodium, 225mg potassium (Gopalan *et.al.*, 6). It has great medicinal value in treatment of dysentery, diarrhorea, haemorrhages, bilousness, digestive system disorders, jaundice, coughs, skin infections, cleaning wounds, snakebite, scorpion-stinging (Parmar and Kaushal, 8; Chadha, 3). Area, production and productivity of *aonla* in India are 49620ha, 150500t and 3.03t ha^{-1} (Dhandar and Saroj, 5). Emerging insect pests affect the productivity. Hence a study was conducted to assess the status of insect pest management by the *aonla* farmers of Gujarat.

A survey was carried out in the panchmahals and Vadodara districts of Gujarat. Sixty *aonla* growers were randomly selected and interviewed at their farms. The survey was done during June August, 2005. The data were collected in a structured interview schedule.

Majority of the *aonla* farmers (54%) reported the infestation of shoot-gall maker (Table 1). They cut and burnt the affected shoots. Moderate to high incidence of stem gall maker was observed in *aonla* orchards at Jobner, Rajasthan (AICRP on AZF,1). The caterpillar on hatching entered the shoots and fed within causing a gall on the tender shoots (Bagle,2). Carbaryl (0.1%) might be sprayed during August to kill the newly hatched larvae before they entered into shoots (Chadha,3).

Forty nine per cent *aonla* farmers reported the infestation of bark-eating caterpillar. Thirty per cent farmers adopted the practice of dipping monocrotophos in cotton and kept inside the hole and plugged the hole with cow dung. Even though monocrotophos was effective in controlling the pest, its usage had been banned in fruit crops. Nineteen per cent farmers did not take up any control measures. The larvae bore usually at the joints between twig and main stem and tunneled straight downward; presence of silken webs comprising of excreta of larvae indicated the damage (Bagle, 2). The silken galleries might be removed and chlorpyriphos (0.07%) or carbaryl (0.1%) might be sprayed on tree trunk. Dichlorvos (0.1%) might be injected into bored holes (Chadha, 3).

Nineteen per cent *aonla* farmers reported the incidence of aphid and they sprayed monocrotophos. Both nymphs and adults sucked the cell sap from tender shoots, leaves and devitalized the plants. They exuded honeydew on which sooty mould developed. (Bagle, 2). Dimethoate (0.03%) or phosalone (0.05%) might be spayed to manage the pest (Chadha, 3).

Fourteen per cent *aonla* farmers reported the incidence of mealy bug. Both nymphs and adults sucked the cell sap from tender shoots, leaves and devitalized the plants (Bagle, 2).

Few farmers (11%) reported the incidence of fruit borer in *aonla*. They sprayed dimethoate (0.2%) thrice at tri-weekly interval. *Aonla* cultivars NA-7, Krishna, Chakaiya, Banarasi, Kanchan, Francis, Anand-1 and Anand-2 were susceptible to borer (IIHR,7). Incidence was 30% in NA-7 (CIAH,4). The caterpillar bore into the fruits and fed within causing premature drop of fruits during monsoon season, maximum damage during July and August (Bagle, 2).

Nine per cent *aonla* farmers reported the incidence of hairy caterpillar. They sprayed dimethoate. The caterpillar on hatching fed voraciously and gregariously on tender leaves and defoliated the plants. The larvae later on migrated to entire plant and fed on leaves leading to defoliation (Bagle, 2).

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Table 1: Insect Pest Management in *aonla* by the Farmers of Gujarat.

Pest	Management				Farmers	
	Chemical	Quantity (ml or gms / litre of water)	Number of sprays	Days of interval	No	Per cent
Shoot-gall maker (*Betousa stylophora*)	Cut & burnt the affected shoots	--	--	--	38	54.29
Bark-eating caterpillar (*Inderbela terraonis* Moore)	Monocrotophos dipped in cotton kept inside hole & plugged with cow dung	2	1	--	21 (13)	30 (18.57)
Aphid (*Cerciaphis emblica*)	Monocrotophos	2	3	15	13	18.57
Mealy bug (*Nipaecoccus vastator*)	--	--	--	--	(10)	(14.29)
Fruit borer (*Virachola isocrates, Meridarchis scyrodes*)	Dimethoate	2	3	20-25	8	11.43
Hairy caterpillar (*Euproctis flava*)	Dimethoate	2	3	20-25	6	8.57

Figures in parenthesis indicate farmers who reported the pest but did not take up any control measure.

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SHORT COMMUNICATION

Organoleptic rating of various value added products of unripe mango cv. Rajapuri

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Mango (*Mangifera indica* L.) cv. Rajapuri is the most important and unique commercial fruit for processing industries. The demand of mango fruit fresh as well as processed products increase day by day because its excellent flavor, attractive fragrance, beautiful shades of color, delicious taste and high nutritive value. Mango processing is big industries which use both ripe and unripe fruits. Unripe fruits are used for preparation for chutney (salt or sugar added), pickle, amchur, mango pulp vegetable, green mango drink (*panna*) etc. The variety Rajapuri is originated and grown on large scale in this region and used as processed products. The recipe and methods used for preparation of various products are varying according to place to place and taste of consumer. The Panchmahals district of Gujarat is tribal dominant area. In the district mango is of time position in area (2200 ha.) as well as production (13200 MT) Anonymous (2011). The tribal used it for preparation of various products, but the products prepared by them spoil early. So, that the present study was carried out on preparation on various mango products and their organoleptic taste for tribal's of the area. To see the taste of consumer and make them understand through various extension tools like training, demonstration, advisory service, etc. for preparation of various products and how to increase the shelf life of products.

Present studies on organoleptic rating of various value added products of unripe Mango cv. Rajapuri was carried out during 2010-11 to knowing the consumer attitudes for products in Krishi Vigyan Kendra, Panchmahals- Gujarat. The Material and Methods used for preparation of various mango products were given in following sub heads.

Mango Pickle (with oil)

Unripe firm mango fruits-8 kg, Salt-1 kg, Chilli-250 g, fennel-250 g, Kalongi-100 g, Methi-250 g, Turmeric-50 g, Aestafodia-10 g, Coriander powder-250 g, Yellow mustard-250 g and mustard oil as per requirement. Firm mangoes were taken and washed thoroughly. The fruits were cut into small pieces and mixed with salt and turmeric powder and were left for overnight. Next day, these pieces were spread under sun along with the water of salt and turmeric in tub. Kabli grams were soaked in remaining water of salt and turmeric. When the water in mango pieces were dried up, mix the spices kabli gram (soaked) and mustard oil and fill them in container by pressing the whole mass. Keep it in sun for 2-3 days and after that fill up with more mustard oil. It takes about a month period for preparation of pickle.

Mango Pickle (without oil)

Unripe firm mango fruits-8 kg, Salt-1 kg, Chilli-250 g, Fennal-250 g, Kalongi-100 g, Methi-250 g, Turmeric-50 g, Aestafodia-10 g, Coriander powder-250 g and Yellow mustard-250 g. Firm mangoes were taken and washed thoroughly. The fruits were cut into small pieces and mixed with salt and turmeric powder and were left for overnight. Next day, these pieces were spread in sun along with the water of salt and turmeric in tub. When the water in mango pieces were dried up, mix the spices. Keep it in sun for 2-3 days. It became ready for consumption after 15-20 days of preparation.

Mango Chutney (sugar added)

The unripe firm fruits were taken. These were washed, peeled and grated. The following quantities were needed. Mango peeled pulp1-kg, Sugar-1 kg, Salt-45 g, Vinegar-180 ml, Spices (cardamom, cinnamon and cumin) 30 g each and Ginger-15 gm. To the grated mango pulp, add half of sugar and leave for 1 hour Cook the mixture in slow heat and add rest of sugar, salt and other spices. Cook the whole mass on gentle fire to the consistency of jam. Add vinegar and cook for about 5 minute.

Mango Chutney (Salt added)

The firm fruits were selected. These were washed, peeled and grated. The following quantities were needed. Mango peeled pulp-1 kg, Sugar-45 g ,Salt Vinegar-180 ml, Spices (cardamom, cinnamon and cumin) 30 g each, Ginger-15 gm and oil-100 ml. The grated mango pulp fried in oil, add half of sugar and leave for 1 hour cook the mixture on slow heat and add rest of sugar, salt and other spices. Cook the whole mass on gentle fire to the consistency of jam. Add vinegar and cook for about 5 minute.

Mango pulp vegetable

Green mango fruits are taken, washed, and cut in to pieces. Mango fruit (1 kg), sugar (100 g), onion (100 g), green chilli (20-25g), oil (100 ml), water (200 ml), salt (30

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g), cumin seeds (10 g), garlic (30 g), ginger (20 g),chilli powder (30-40 g), coriander powder (50 g) and turmeric powder (20 g). Spices are fried in oil and put the fruit pieces. It is boiled till the pieces are become soft and filled into bottles.

Green mango drinks (*panna*)

It is a popular beverage during the summer in this area. For preparation of Green mango drink (panna), the prescribed ingredients include mango slices (250 g), sugar (100 g), water (500 ml), salt (20 g), cumin seeds (10 g), black pepper (5 nos) and citric acid (8-10 g). The slices are boiled in water for 20-30 minutes and filtered. Powdered spices are extracted along with the fruit. The extracts are mixed along with sugar and boiled and filled into bottles.

Sensory evaluation of products

A portion of products was placed in dishes, which were covered. A panel of ten members, evaluated the sensory characteristics (appearance, taste, acceptability presentation and level for market) of various products using a 10 point hedonic scale ranging from dislike extremely (1) to like extremely (10) (Watts et al.,1989). The data statically calculated method as per given by Snedecor and Cochran, (1994).

The organoleptic score of panel for various mango products are presented in table- 1. Appearance is a major determinant of quality. So, color is the function, the different reflection of certain wavelengths and their visual perception. The data revealed that among all seven products the maximum score 8.90 for appearance was given to mango pickle (with oil) followed by mango chutney (sugar added) 8.60, mango pulp vegetable 8.50, green mango drink (*panna*) 8.33, mango chutney (salt added) 8.10, mango pickle (without oil) 6.83. It might be due to oil in mango pickle (with oil) was given an attractive look to the product. So, that the panel was given maximum score to mango pickle (with oil). Taste is one of the important sensory property which is attributed to the presence of certain soluble constituents of the food that reach to the sensitive taste buds through film of saliva covering of tongue and other soft internal surface of mouth. It is relatively simple sense producing only type of sensation those sweetness, saltiness, sourness and bitterness. The main chemical agents responsible for these sensation respectively sugar, salt, titratable acid and heterogeneous collection of bitter principle including alkaloids (Duckworth, 1966). The highest score (9.50) for taste was given to mango pickle (with oil) followed by mango pulp vegetable 8.80, mango chutney (sugar added) 8.70, mango pickle (without oil) 8.60, mango chutney (salt added) 8.40 and green mango drink (*panna*) 8.20. It might be due to mango pickle (with oil) is used worldwide. So, that the panel was given maximum score to mango pickle (with oil). The similar findings are also reported by Saka *et al* 2007. The acceptability of product is dependent on various parameters like appearance, color, taste etc. For acceptability the maximum score (9.90) was given to mango pickle (with oil) followed by green mango drink (*panna*) 8.70, mango pulp vegetable 8.60, mango chutney (sugar added) 8.25, mango pickle (without oil) 8.0, mango chutney (salt added) 7.70. The similar findings are also reported by Yunchalad *et al.* (2000) in mango products. The score for presentation is more or less similar maximum (8.80) and minimum (8.30) were given to pickle (with oil) and green mango drink (*panna*).

The score for level of market, maximum for mango pickle (with oil) followed by mango pickle (without oil), mango chutney (sugar added), mango chutney (salt added), mango pulp vegetable and green mango drink (*panna*) 9.80, 8.85, 8.75, 8.25, 8.20, 7.70 respectively. It might be due to mango pickle (with oil) is the most important product which was purchased in the most of the house and due to long duration storage life with minimum expenditure.

Table 1: Organoleptic rating of various value added products of unripe Mango cv. Rajapuri

Sr. No.	Name of product	Appearance	Taste	Acceptability	Presentation	Level for market
1	Mango pickle (with oil)	8.90	9.50	9.90	8.80	9.80
2	Mango pickle (without oil)	6.83	8.60	8.00	8.60	8.85
3	Mango chutney (sugar added)	8.60	8.70	8.25	8.65	8.75
4	Mango chutney (salt added)	8.10	8.40	7.70	8.30	8.25
5	Mango pulp vegetable	8.50	8.80	8.60	8.75	8.20
6	Green mango drink (*panna*)	8.33	8.20	8.70	8.40	7.00

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SHORT COMMUNICATION

Evaluation of ridge gourd hybrids for growth and yield attributes

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Ridge gourd [*Luffa acutangula* (Roxb.)L.] is an important cucurbitaceous vegetable grown during kharif and summer seasons in Andhra Pradesh. The tender fruits are used as vegetable and they are good source of vitamin A, B and C and also iron. Ridge gourd, being predominantly monoecious and is cross-pollinated crop and provides ample scope for utilization of the hybrid vigor (Hedau and Sirohi, 2004). The present era is of hybrids and moreover the glut due to monocropping of tomato over larger acreage demands for crop diversification to make the profession of vegetable production is an economic one. Abusaleha and Dutta (1994) and Kadem et al. (1995) have reported that hybrids were early and gave higher yields in ridge gourd. The hybrids are fast replacing the commercial varieties because the private seed industry is emerging on the scene whose survival essentially depends on F_1 hybrids as the vegetable growers are bound to purchase the seed every year. To conclude on the performance of any genotype is often inconclusive because of inconsistent performance across environments. The breeding work carried out at different Research Stations in our country has resulted in the identification of number of hybrids. Ridge gourd hybrids received from different All India Coordinated Centers and private seed companies were evaluated to identify the suitable hybrids for Andhra Pradesh.

The experiment was carried out at Vegetable Breeding Station, Agricultural Research Institute, Rajendranagar, Hyderabad during *Kharif* 2006 and 2007 to study the performance of thirteen hybrids developed at different places in India (Table-1) along with Pusa Nasdar as Check. The experimental site is situated at 17°19' Northern Latitude, 78° 23' Eastern Longitude and 542.3 m from Mean Sea Level. Pusa Nasdar is a national variety and high yielding hence, it was taken as Check to compare the hybrids. The experiment was laid out in Randomized Block Design with three replications in a plot size of 5.0 m x 2.5 m in clay loam soils. The plants were raised in channel adopting spacing of 5.0 m x 0.5m and vines were trailed on overhead pandals. As a basal application, FYM at 25t/ha, 40 kg nitrogen, 100 kg phosphorous and 20 kg potassium were applied. Further two split applications of 40 kg nitrogen and 20 kg potassium were applied at 30 and 45 days after sowing. Need based plant protection measures were taken up during crop growth period. Observations were recorded on vine length, number of laterals per vine, number of fruits per vine, node number at which first fruit appeared, and yield parameters like average fruit weight, fruit length, fruit girth and yield/ha. The data was statistically analyzed as per standard procedures given by Panse and Sukhatme (1985).

The observations recorded on growth, yield and yield attributing characters were presented in Table-2. Among the hybrids, the longest vine length was recorded in HYRGH-3 (5.0 m) which was on par with all hybrids except Sanchitha (4.2 m), Nidhi (4.2 m), VRGH-416 (4.0 m) and Pusa Nasdar (3.8 m). There was no significant difference observed in case of number of laterals per vine among the hybrids. Whereas number of fruits per vine exhibited significant difference among the hybrids tested. Significantly more number of fruits per vine was recorded in BSS-580 (9.1) followed by Pallavi (8.6), BSS-405 (8.1) and NRGH-22 (7.8). About eight hybrids were on par with Check Pusa Nasdar in terms of fruit weight. Among the eight hybrids, Pallavi recorded maximum fruit weight (229.2g) followed by BSS-580 (205.5g). A distinct variation was observed in case of fruit length among the hybrids. Maximum fruit length was observed in Sanchita (48.1cm) followed by Pallavi (46.0cm) which were significantly superior to other hybrids. Whereas minimum fruit length was recorded in HYRGH-5 (26.4 cm) and HYRGH-2 (26.8 cm). Fruit girth was recorded maximum in BSS-405 (16.8cm) and minimum in Harsha (11.1cm). A significant variation in total yield of different hybrids was observed and it varied from 4.2 to 7.8 t/ha. Among the hybrids evaluated, Pallavi recorded highest yield (7.8 t/ha) followed by BSS-580 (7.6 t/ha) which were significantly superior to all other hybrids. It could be due to more number of fruits per vine and fruit weight. Expression of hybrid vigour in ridge gourd with respect to increase in fruit length, fruit girth, number of fruits per vine, average fruit weight and node number at first female flower appeared were reported by Karuppaiah *et al.* (2002) and Hedau and Sirohi (2004).

From the study it can be concluded that the hybrid Pallavi and BSS-580 may be suggested for commercial cultivation in Souther Telangana zone of Andhra Pradesh. Now-a-days consumers preferred to select short length fruits rather than long fruits because they are easy to handle in carrying, packing and storage hence, HYRGH-5 and HYRGH-2 may also be suggested for cultivation.

Table 1: Preliminary information on hybrids/variety of ridge gourd under study

Sl. No.	Name of the hybrid	Source
1	NRGH-22	Nirmal Seeds Pvt Ltd.
2	Sanchita	Pandey Seeds Pvt Ltd.
3	Harsha	Century Seeds Pvt Ltd.
4	Nidhi	Century Seeds Pvt Ltd.
5	BSS-405	Bejo Sheethal Seeds Pvt Ltd.
6	BSS-580	Bejo Sheethal Seeds Pvt Ltd.
7	VRGH-416	Vivaswan Agritech Pvt Ltd.
8	HYRGH-2	ANGRAU, Hyderabad
9	HYRGH-3	ANGRAU, Hyderabad
10	HYRGH-5	ANGRAU, Hyderabad
11	Garima	Tokita Seeds Pvt Ltd.
12	NRGH-370	Nirmal Seeds Pvt Ltd.
13	Pallavi	Sungro Seeds
14	Pusa Nasdar (National Variety as Check)	IARI, New Delhi

Table 2: Performance of ridge gourd hybrids/variety for growth and yield

Hybrid/ Variety	Vine length (cm)	No. of laterals/ vine	Node No. at 1st fruit harvested	No. of fruits/ vine	Ave. fruit wt.(g)	Fruit length (cm)	Fruit girth (cm)	Fruit yield t/ha
NRGH-22	4.5	3.8	13.0	7.8	192.8	42.5	15.9	6.0
Sanchita	4.2	3.9	11.0	6.1	176.0	48.1	15.0	4.2
Harsha	4.3	2.5	11.0	6.2	199.1	32.9	11.1	5.0
Nidhi	4.2	3.4	13.0	6.8	192.1	39.3	14.6	5.4
BSS-405	4.7	3.6	14.5	8.1	189.9	39.7	16.8	6.0
BSS-580	4.5	3.5	11.0	9.1	205.5	37.4	13.4	7.6
VRGH-416	4.0	3.9	13.0	7.3	190.6	32.0	13.4	5.6
HYRGH-2	4.3	4.0	16.0	7.3	191.7	26.8	15.4	5.6
HYRGH-3	5.0	4.1	14.5	6.6	167.9	28.1	14.9	4.4
HYRGH-5	4.8	4.1	15.5	7.6	178.0	26.4	13.3	5.6
Garima	4.5	3.2	11.5	7.6	178.2	37.8	12.4	5.2
NRGH-370	4.8	3.4	16.5	7.3	174.2	34.1	14.6	5.2
Pallavi	4.8	3.7	15.0	8.6	229.2	46.0	13.4	7.8
Pusa Nasdar (C)	3.8	3.1	11.5	5.5	235.8	32.6	11.7	5.2
SEm±	0.2	0.4	1.2	0.5	17.5	1.8	1.0	0.4
C.D at 5%	0.7	NS	3.7	1.6	50.87	5.4	3.0	1.3
CV (%)	6.7	12.4	12.9	10.2	12.8	7.0	9.8	11.1

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SHORT COMMUNICATION

Effectiveness of postharvest treatment with salicylic acid and mineral nutrients in the control of gray mould rot of strawberry

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Strawberry (*Fragaria x ananassa*) is a non-climacteric fruit with a very short postharvest life. Loss of quality in this fruit is mostly due to its relatively high metabolic activity and sensitivity to fungal decay (Hernandez-Munoz *et al.*, 2008). Grey mold, caused by *Botrytis cinerea* Pers. Fr., is the most economically significant postharvest pathogen of strawberry fruits. The use of synthetic chemical fungicides has been the main method for reducing postharvest disease. However, consumer concern over pesticide residues on foods, along with pathogen resistance to many currently used pesticides, has increased the need to find alternative methods for decay control (Karlidag *et al.*, 2009).

Research has shown the promise for application of calcium (Ca) and boron (B) on resistance of fruits to pathogenic fungi during storage (Krishna *et al.*, 2012). It is well known that Ca plays a major role in maintaining the quality of fruits and vegetables. Increasing the Ca content in the cell wall of fruit tissue can help to delay softening and mold growth and decrease the incidence of pathogenic fungi (Hernandez-Munoz *et al.*, 2008). There are a few bio-regulators such as salicylic acid (SA), which is thought to affect the shelf life of fruits. Application of SA has been observed to improve fruit quality during storage, retard ripening and spoilage of fruits (Krishna *et al.*, 2012). SA, a natural compound, has a high potential in suppressing ethylene production and fungal decay in harvested fruits. SA is an acquired systemic resistance activator that can elicit activation of genes involved in plant defense and pathogenesis-related proteins (Karlidag *et al.*, 2009). The purpose of the present investigation was to determine the effects of different nutrients (Ca and B) and bio-regulator (SA) on strawberry shelf life and fruit quality at harvest and storage.

Fruits of strawberry cultivar Steel Master were harvested from the Experimental Farm of Central Institute of Temperate Horticulture-Regional Station, Mukteshwar, Uttarakhand. Strawberries were selected for the absence of any physical damage and fungal infection, uniformity in size and degree of ripening (2/3 red color on surface).

B. cinerea was isolated from an infected strawberry and cultured on a potato dextrose agar medium following the method of Zhang *et al.* (2007). Spore suspensions were prepared by removing the spores from the sporulating edges of a 12-week-old culture incubated at 27 °C with a bacteriological loop, and suspending them in sterile distilled water.

The experiment consisted of three postharvest treatments, besides control with 20 fruits per replication. The concentration of different nutrients and bio-regulators used in the experiment were SA @ 400 mgl^{-1}, Ca as Ca-EDTA @ 1000 mgl^{-1} and B as Boric acid @ 0.2 %. Strawberries were pooled together and randomized, and then immersed for 5 min. in a 5 L volume of the respective solutions. Strawberries immersed in deionised water were used as the control. After the treatments, the fruit were dried in air for 1 h followed by dip in spore suspension of fungus for 10s. Later, fruits were arranged in small plastic boxes. These were then stored for 3 days at 25 ± 1 °C, 7580% RH.

The pH of the fruit juice was determined using a pH meter (Inolab pH 730, Merck Specialities Pvt. Ltd., India). The soluble solids content (SSC) was determined in the juice of strawberries by means of Abbe's hand refractometer calibrated at 20 °C.

Fungal decay index was calculated as per the method suggested by Babalar *et al.* (2007). According to the amount of the fungal mold on fruit surface scales from 1 to 5 were given to the each treatment group where; 1 = normal (no decay on fruit surface), 2 = trace (up to 5% of fruit surface were decayed), 3 = slight (520% of fruit surface were decayed), 4 = moderate (2050% of fruit surface were decayed), and 5 = severe (>50% of fruit surface were decayed).

Overall quality (percentage of fruit surface area decayed, shrunken and adversely affected) was evaluated following the method of Babalar *et al.* (2007) using a 15 scale, where 1 = unacceptable (>50% surface affected), 2 = bad (2050% surface affected), 3 = acceptable (520% surface affected), 4 = good (up to 5% surface affected), and 5 = excellent (no decay, shrinkage or any other adverse effects on fruit surface were seen). Results were expressed as an overall quality index. The experiment was conducted with completely randomized block design with three replications. Data obtained were subjected to the analysis of variance.

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Changes in the SSC of strawberries over storage time are shown in Fig. 1. With the progress of time, SSC content was observed to increase in strawberry fruits, irrespective of treatments; however, the SSC of treated fruits fell slightly toward the end of the storage period. Increase in TSS content indicates conversion of polysaccharides presents in fruits into soluble sugars by the action of various hydrolyzing enzymes. The reduction in SSC at 3-day post-storage period may be attributed to the catabolism of sugars by respiration. Absence of reduction in SSC content at 3-day in salicylic acid treated fruits could be ascribed to inhibition of respiration rate by action of salicylic acid as reported by Krishna *et al.* (2012). As shown in Fig. 2, the pH of treated fruits increased during later stages of storage, irrespective of the treatments; while no significant differences were observed at first day. This has agreement with the findings of (Hernandez-Munoz *et al.*, 2008) with strawberries treated with calcium and chitosan. Hernandez-Munoz *et al.* (2008) reported that application of salicylic acid resulted in increased content of soluble solids and total acidity of strawberry fruits at the end of storage period without affecting the other vital parameters of fruit quality.

The progress of fungal decay was slower in treated fruits (Fig. 3). This was more conspicuous in SA treated fruits. Studies have shown that salicylic acid treatment can enhance disease resistance in treated fruits (Babalar *et al.*, 2007). In our study too, salicylic acid treatment prevented pathogenic infection as evidenced by less spoilage in treated fruits, confirming the fact that SA leads to plant defense system activation against pathogens. Pre or postharvest use of Ca and B has shown promise in

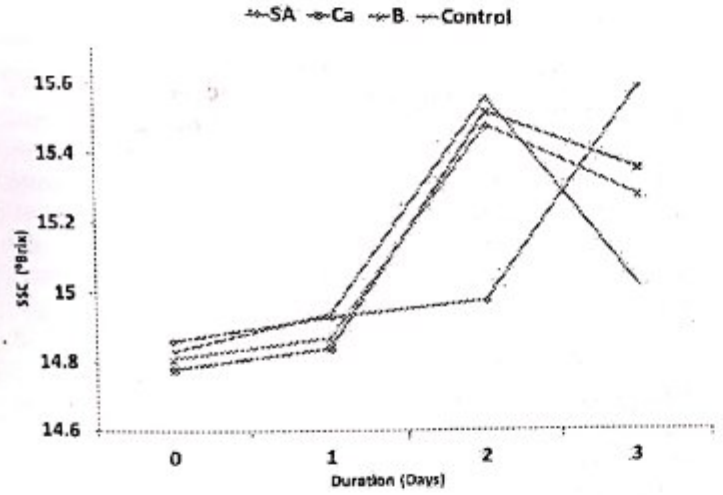

Fig. 1. Effect of different treatments on soluble solid content (°Brix) content of strawberry fruits at different storage periods.

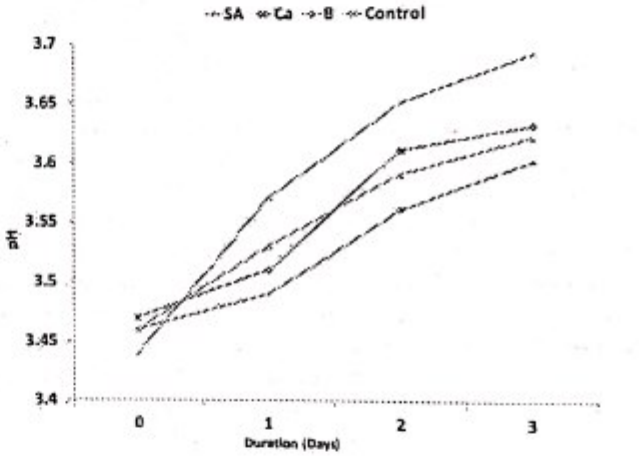

Fig. 2. pH of strawberries fruits as a function of storage time.

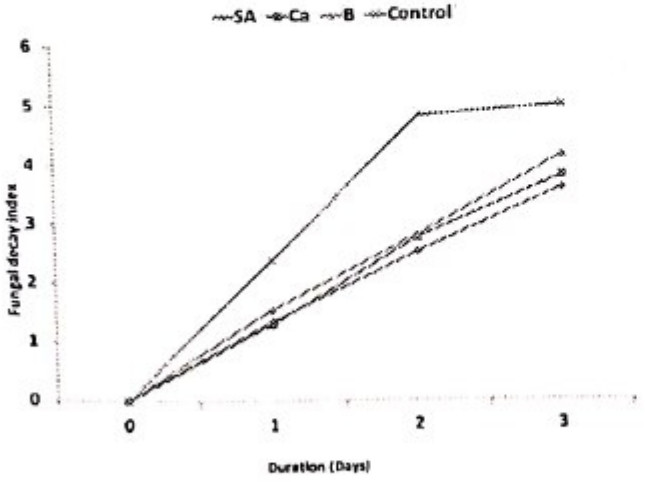

Fig. 3. Variations in fungal decay index as influenced by different treatments at various post-storage periods.

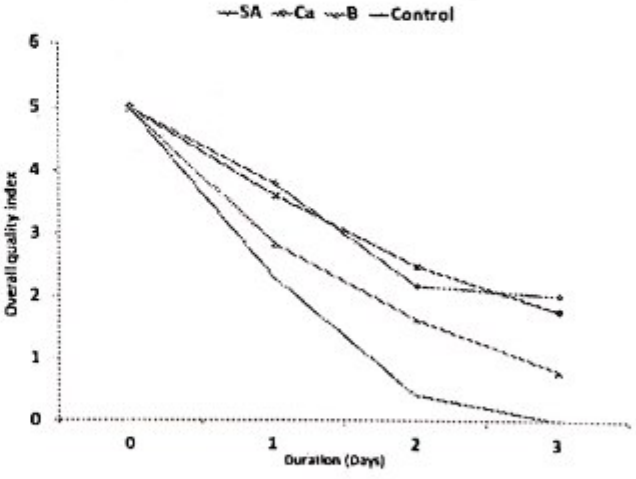

Fig. 4. Overall quality index of strawberry fruits as influenced by different treatments during storage.

reducing decay caused by diseases caused by various moulds (Babalar *et al.*, 2007; Hernandez-Munoz *et al.* 2008; Krishna *et al.*, 2012).

Likewise, SA significantly affected fruit overall quality index. This was followed by Ca and B treatments, respectively (Fig. 4). Overall quality is the most important factor in fruit marketability assessment. Fruits lacking any kinds of decay and shrivels with high red colour are considered as marketable. SA treatment effectively helped retaining the fruit overall quality. The effect of SA on fruit overall quality index retention could mostly be due to its adverse effect on fungal decay extension (Babalar *et al.*, 2007).

In summary, treatment with mineral nutrients like Ca & B and bio-regulator, SA was seen to delay fruit senescence and fungal decay of strawberry fruits stored at 25 ± 1 °C and 7580% RH. Least decay and improved overall quality index was noted in fruits treated with SA. Therefore, salicylic acid, a natural and safe phenolic compound, may be considered for its wide application in controlling postharvest losses of strawberry fruits.

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SHORT COMMUNICATION

Effect of salinity stress on seed germination of *Leucaena leucocephala: a multipurpose tree*

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Leucaena leucocephala is a highly drought and salinity tolerant plant species tolerating as high temperature as 48°C (Hocking, 1993). It is a species of small Mimosoid tree that is native to southern Mexico and northern Central America but now naturalized throughout the tropics. In India, it is also known as *Subabul* and grown for multiple uses, such as green manure, charcoal making, hedge plants besides being widely used in agro-forestry system and wind break plantation for its tremendous ability to survive amidst a wide range of environment and soil factors .Except being high in sodium and iodine content, it is a balanced livestock fodder that provides supplemental protein along with minerals in tropical areas. Its leaves have high nutritive fodder for live stock thriving in arid regions. Plant is used for soil conservation and crop intensification (Shelton and Brewbaker,1994). It is fast growing leguminous, nitrogen fixing multipurpose plant species (Halliday and Somasegaran, 1983).

The impact of various abiotic stresses in plants is important for understanding their physiology, ecology and to improve crop production under stress. Soil salinity is one of the most serious limiting factors for growth and production of plants in the arid regions. Salts are natural component of soil and salinity in soil comes from weathering of minerals, addition of inorganic fertilizers, manures and irrigation water. At present,11.22 lakh ha land is affected by salinity and sodicity in the state comprising districts of Pali, Jodhpur, Barmer, Bikaner, Ajmer, Nagaur, Sri Ganganagar and Hanumangarh (Verma *et al.*,2005). An excess of salt inhibits metabolic processes including protein synthesis. The toxic ions (Na^+ and Cl^-) interfere in balanced absorption of essential nutritional ions (Tester and Davenport, 2003) and with the acquisition of nitrates. Salinity stress adversely affects seed germination(Berrichi *et al.*, 2010). It causes growth inhibition, senescence and death of plant during prolonged exposure or extreme salinity shock. Effect of salinity is more realized by a plant in a particular stage of growth. A vast area of the western border of the India is protected by the Rajasthan's arid region, which is primarily barren. To provide a counterside of camouflage *Leucaena leucocephala* is considered a good alternate for the problem, for its ability to invade the clear wasteland areas forming dense thick covers, fast growth and weedy properties. Soil as well as water salinity is common in arid region, which inhibits growth and development in many plants. The EC of ground water of border districts of Rajasthan varies from 3.0 to 9.0dSm^{-1} and saline water is more problem in western Rajasthan (Verma *et al*, 2005).

Keeping in view, the fast growth of *subabul* over the slow growing indigenous plant species such as ker, babul and khejri, a study was undertaken to investigate the effect of different concentration of NaCl on seed germination, growth, physiological and biochemical responses of *Subabul*.

The experiment was conducted at DRDO Laboratory, Jodhpur during the year 2009 to investigate the effect of diffent concentration of NaCl on seed germination, growth and development of plant. Uniform size seeds of *Leucaena leucocephala* were randomly taken and washed with tap water, air dried at room temperature and then stored at 4°C before being used. Seeds were scarified by rinsing them in hot water at 75°C for 10 minutes, followed by concentrated sulphuric acid washing for 10 minutes. Seeds are then rinsed with distilled water. The experiment was laid out in completely randomized design (CRD) with 3 treatments having 3 replication each having 15 seeds. Seeds were salinized in petri dishes with moistened cotton of varying concentrations of 50 mM, 100 mM and 200 mM sodium chloride (NaCl) along with a suitable control (only distilled water). Petri dishes were kept in a temperature controlled incubator for germination of seeds. Number of seeds germinated were observed and noted everyday till seventh day. The final germination percentage was calculated according to the equation described by Elis and Roberts (1981).

$$\text{Germination (\%)} = \frac{\text{Number of germinated seeds}}{\text{Total number of seeds tested}} \times 100$$

For biochemical study, plantlets were uprooted carefully after seven days and were washed with distilled water. After recording length of shoot and root of each plantlet, were separated into root, shoot and cotyledon. Data for the following parameters were also recorded.

Growth analysis of germinated seeds

Plants germinated out of ten were observed for

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length of the root, shoot and cotyledon for different salt concentration for 7 days after which they were oven dried at 70°C for 4 days for recording dry weight.

Sample preparation for enzyme extraction

The required quantity (1 gm) each of *subabul* (*Leucaena leucocephala*) roots, shoots, cotyledons were separately crushed in prechilled mortar- pestle with acid washed sand in 1 ml Tris-HCl and centrifuged at 10,000 rpm for 10 mins. The supernatant was used for biochemical estimation of protein, peroxidase, acid phosphatase and proline activity.

Estimation of protein

Quantitative Estimation of Total Soluble Protein Using Bradford's Dye Binding Method (Bradford, 1976). The series for sample was made by taking sample from 0.1 to 1 ml. Volume was made to 1ml by Tris-Cl and 3ml dye was added in each tube. A blank was also prepared containing only Tris- Cl and CBBG dye. OD at 595 nm was recorded. Readings in the standard curve were marked and the amount of protein present was calculated.

Estimation of Peroxidase Activity

Enzyme was extracted as described in sample preparation and peroxidase was estimated using H_2O_2 oxidoreductase method (Putter, 1974). Series was made by taking 0.1ml sample extract, 3 ml Tris-HCL, 0.05 ml Guaiacol (20 mM), 0.5 ml H_2O_2 (1%). The assay mixture was shaken and then optical density at 436nm was taken.

Estimation of acid phosphatase

Enzyme was extracted as described in sample preparation. Series was made by taking 0.1ml sample extract and the volume was made upto 2 ml by adding reaction mixture, 2 ml sodium bicarbonate is also added. Tubes were shaken and incubated for 10 minutes. The optical density at 495nm was taken.

Estimation of proline

Free proline was estimated as per the method of Bates *al.* (1973). Enzyme was extracted as described in sample preparation. 0.1to 1ml of standard proline was taken and made up to 1ml by acetic acid. 1ml of Ninhydrin was added into it. The mixture was heated at 100°C. OD at 520nm was taken to draw a standard curve. 100µl of sample (shoot and roots extract) was taken in a vial. Then 1ml of Ninhydrin was added and volume was made to 2ml by glacial acetic acid. Heated for 1hour at 100°C and then the reaction was terminated in an ice bath. The reaction mixture was extracted with 1ml toluene (to stop the reaction). The chromophore containing toluene was warmed at room temperature (RT) and its OD was measured at 410 nm.

SDS-PAGE- Protein sample were resolved on SDS-PAGE as described by Laemmli (1970) and bands were stained with CBBG R - 250 dye in 50% methanol and 10% acetic acid solution and destained by frequently changing the same solution but without dye. The protein bands acquired blue color after sufficient staining and destaining procedure.

Native PAGE For detection of activity of isoenzyme-peroxidase native PAGE was carried out (without SDS) on 7% separating and 4% stacking gel. After the suitable migration of enzyme bands, they were incubated in benzidine solution for 2 minutes for the bands to turn brown. The gel was immediately transferred to distilled water to stop the reaction. The gel was then photographed (Fig. 7).

Seed germination

The data obtained on seed germination under different concentration of NaCl is presented in Table 1. Perusal of data on seed germination reveals that in control the seed germination was to the tune of 93.33% which dropped to 80.00% in 50 mM NaCl solution. Further increase in NaCl concentration affected the seed germination drastically and dropped to 53.33% at 100 mM and 0.06% at 200 mM. The results revealed that germination of seeds can be achieved upto 50 mM NaCl solution. The results are in line with these reported earlier in by Midaoui *et. al.* (2002).

Morphological parameters

After 7 days treatment of various concentrations of NaCl, the length of roots, shoots and cotyledons gradually decreased in *Leucaena leucocephala. Perusal of data in Fig. 1 reveals that the magnitude of shoot, root and cotyledon was maximum under control conditions. Subjecting the seeds to NaCl treatment demonstrated drop in magnitude of these parameters. This is illustrated by the fact that when seeds were subjected to the treatment of 50 mM NaCl solution, the magnitude of root, shoot and cotyledon was* from 8.4 cm to 2.8 cm, from 6.2 cm to 1.5 cm and from 5.2 cm to 1.9 cm respectively, 0.4 cm, 0.3 and 0.3 respectively when seeds were subjected to treatment 200 mM NaCl solution suggesting the toxic effects due to prolonged salt stress (Table 1).

The data on peroxidase activity in root, shoot and cotyledon at different concentration of NaCl is presented in Fig. 2. Perusal of data reveals that at 50 mM NaCl, the peroxidase activity was at par in all the three parts of the seedling. However, at 100 mM NaCl treatment the peroxidase activity in root and shoot are at par with those at 50 mM NaCl, but peroxidase activity is very high in cotyledon. Further, increase in NaCl concentration to 200 mM demonstrated increase in peroxidase activity in all the three parts of seedlings. The increase in peroxidase activity in cotyledon at 7 days after sowing may be on account of fact that this is the main center of biochemical activities and hence to protect the vital enzymes, there is an increase in antioxidant enzyme so that the metabolic activities may be performed at optimal rate. Similar findings have been reported by Bybordi *et.al.*(2010).

The data on proline content under different treatment in NaCl presented in Fig. 3. of data reveals that

proline content at 50mM treatment was lowest in roots, shoots and cotyledon. This increase slight at 100 mM but increased drastically at 200 mM. Accumulation of proline in response to stress has been reported from time to time. In the present study also accumulation of proline has been demonstrated which may be an adaptive mechanism to keep the pace of metabolic activity in the germinating seeds. Similar results have also been reported by Tyagi *et al.* (1999) in *Lathyrus*.

The data on acid phosphatase activity (Fig. 4) also revealed that at 50mM treatment, the acid phosphatase activity also high in root and lowest in cotyledon. However, at 100 mM NaCl treatment, it become at par in all the three parts, but at 200 mM concentration the maximum acid phosphatase activity was recorded in root followed by shoot and least in cotyledon. The increase in acid phosphatase activity in seedlings may be in order to metabolize the Pi in the plant system or may be due to starvation of plants in salinity stress which leads to *de novo* system of acid phosphatase in intra and extra cellular portion (Stephen *et. al.*, 1994).

The data on protein content in root, shoot and cotyledon at different concentration of NaCl demonstrated that total soluble protein drastically decreased from 70 µg/mg sample at 50mM to 36 µg/mg sample at 200mM NaCl, 66 µg/mg sample to 36 µg/mg sample and 64 µg/mg sample to 49 µg/mg sample in root, shoot and cotyledon of seedling respectively. However, at 50 mM NaCl, the root shows highest concentration of protein followed by shoot and least in root and shoot at 200 mM. Results illustrated that plant is able to maintain the protein biosynthesis at lower concentration of NaCl but at higher concentrations of NaCl the protein synthesis is hampered.

Thus, from the foregoing account, it can be concluded that during salinity stress, the physiological processes in the plant are affected as the proteins and acid phosphatase level decreases while there is a substantial increase in the level and activity of proline and isoenzyme peroxidase. The role of these enzymes can be attributed in a plant's defence response against abiotic (salinity) stress and can act as a stress marker in them. Higher salt concentration is also detrimental to the growth and germination of seedling.

Table 1: Germination percentage on different concentration of NaCl after 7 days.

S.No.	Conc. of NaCl (mM)	No. of seed germinated	Germination (%)
1.	Control	14	93.33
2.	50	12	80.00
3.	100	8	53.33
4.	200	1	0.066

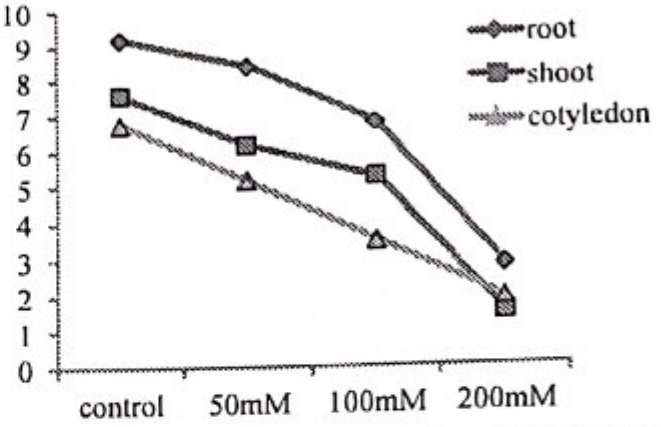

Fig. 1. Effect of various concentration of NaCl on roots, shoots and cotyledons (Y axis- length in cms, X axis- various NaCl concentrations)

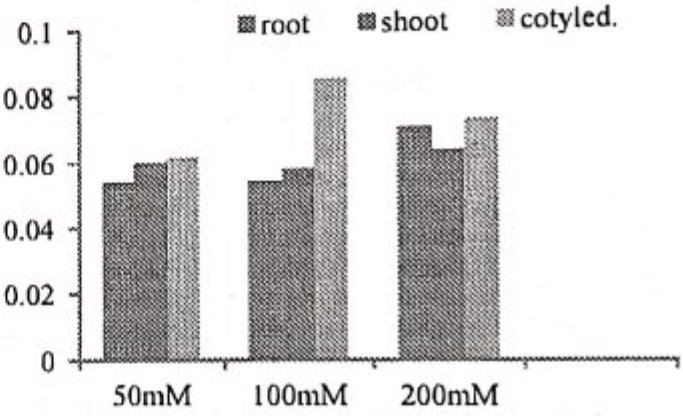

Fig. 2. Peroxidase activity [Y axis- absorbance at 436 nm, X axis- molarity of NaCl concentration]

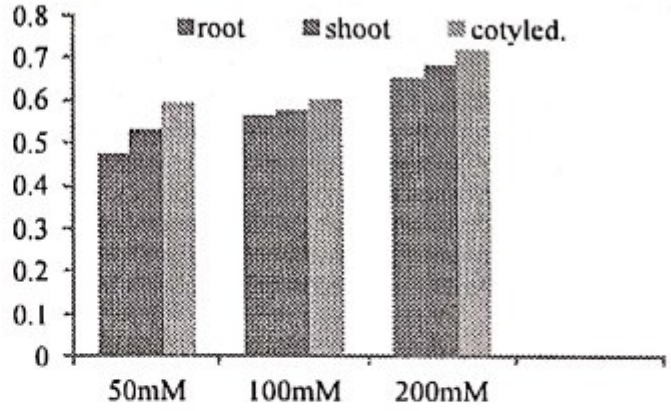

Fig.3. Proline activity (Y axis- absorbance at 520 nm, X axis- molarity of NaCl concentration)

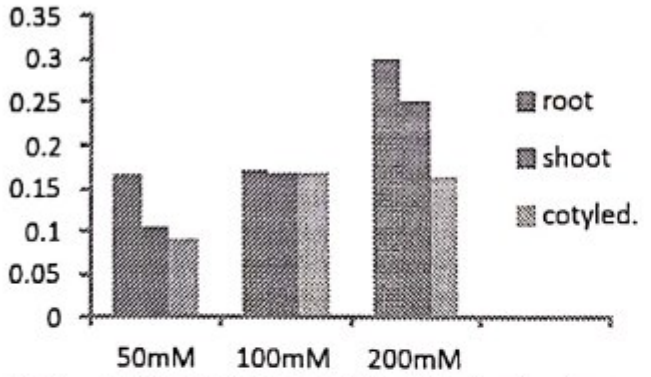

Fig. 4. Acid phosphatase activity (Y axis- absorbance at 495 nm, X axis- molarity of NaCl concentration)

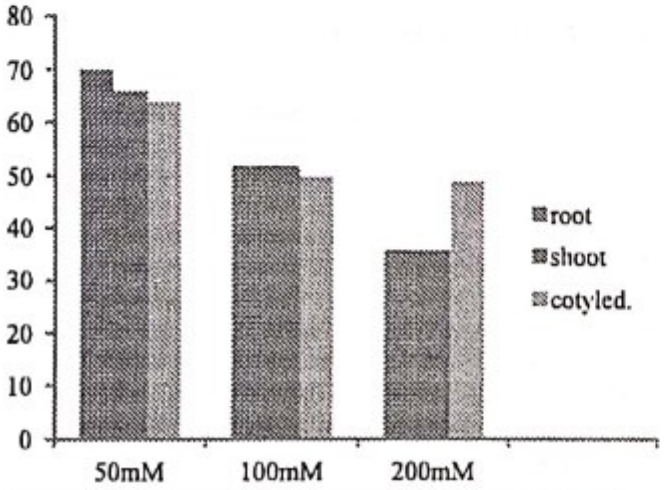

Fig. 5. Total soluble protein (Y axis- Protein µg/mg, X axis-molarity of NaCl concentration)

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