

# Exploitation of somaclonal variations in improvement of fruit crops - A review

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## Abstract

Clonal propagation through micropropagation is hailed as a revolutionary technology as it can be achieved in a short time and space with limited number of plant propagules. Recent studies have shown that cell or tissue cultures undergo frequent genetic changes. Variants selected in tissue cultures have been referred to "somaclonal variation". Though, genetic variations may be considered obstructive and worthless from the point of clonal fidelity, it opens a window of opportunity for increased genetic variability relatively rapidly and without applying a sophisticated technology, which may itself have numerous applications in plant breeding and genetic improvements. The recovery of novel variants can be enhanced by applying suitable *in vitro* selection pressure. Tissue culture induced somaclonal variation in fruit crops is similar to variations induced with chemical and physical mutagens, which proffers an opportunity to unearth natural variability for their potential utilization in crop improvement.

Key Words: *In vitro* propagation, genetic variation, Somaclones, crop improvement

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## Introduction

Vegetative propagation is primarily used to produce progeny plants, which is identical in genotype to a single source mother plant. The biological process of producing identical plants is referred as "cloning", while the resulting population of plants, derived through cloning, is termed as a "clone". The *in vivo* clonal propagation of fruit crops is often cumbersome, expensive and even unsuccessful. Alternatively, tissue culture methods or micropropagation can be employed as a means of vegetative propagation for clonal multiplication. Clonal propagation through micropropagation can be achieved in a short time and space (Razdan, 2003). The uniformity of individual plants within a clone population is a major advantage of clonal cultivars in commercial production. However, it is well known now that genetic variations occur in undifferentiated cells, isolated protoplasts, calli, tissues and morphological traits of regenerated plants. Recent advances have revealed that cell or tissue cultures undergo frequent genetic changes (polyploidy, aneuploidy, chromosomal breakage, deletion, translocation, gene amplifications and mutations) and that these are also expressed at biochemical or molecular levels. Variants selected in tissue cultures have been referred to "somaclonal variation". Variation of any kind, in particular, genetic variations may be considered obstructive and worthless; since, such variations may lead to loss of genetic fidelity and as a result, truncing of desirable characteristics

of *in vitro* raised plants. However, plant cell and tissue cultures provide increased genetic variability relatively rapidly and without applying a sophisticated technology, which may itself have numerous applications in plant breeding and genetic improvements. The recovery of novel variants can be enhanced by applying suitable *in vitro* selection pressure (Jain, 2001).

Genetic variation is a vital element of any traditional crop breeding programme. In general, a typical crop improvement cycle in fruit crops requires a minimum of 10-15 years in order to complete various stages of crop improvement such as germplasm manipulations, genotype selection and stabilization, variety testing, variety multiplication, intellectual protection and crop production stages. Plant tissue culture is an enabling technology from which many novel tools have been derived to help out plant breeders (Karp, 1991). Tissue culture induced somaclonal variation in fruit crops is similar to variations induced with chemical and physical mutagens (Jain, 2001), which proffers an opportunity to unearth natural variability for their potential utilization in crop improvement.

Like any other technology, *in vitro* induced somaclonal variation has its own intrinsic advantages and disadvantages, which have been indicated in Table 1.

Somaclonal variation has been most successful in crops with limited genetic systems (e.g., apomicts, vegetative reproducers) and/or narrow genetic bases. In ornamental plants, for instance, the exploitation of *in vitro*-generated variability has become part of the routine breeding practice of many commercial enterprises. In

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addition, somaclonal variation can become a part of plant breeding provided they are heritable and genetically stable. Only a limited numbers of promising varieties so far had been released using somaclonal variations. This is perhaps due to the lack of interaction between plant breeders and tissue culture scientists, and non-predictability of somaclones (Jain, 2001).

### Molecular basis of somaclonal variations

Several bases of somaclonal variation have been proposed by various researchers, which comprise changes in chromosome number (Mujib *et al.*, 2007), point mutations (D'Amato, 1985), somatic crossing over and sister chromatid exchange (Duncan, 1997), chromosome breakage and rearrangement (Czene and Harms-Ringdahl, 1995), somatic gene rearrangement, DNA amplification (Karp, 1995), changes in organelle DNA (Cassells and Curry, 2001), insertion or excision of transposable elements (Gupta, 1998), DNA methylation (Guo *et al.*, 2007), epigenetic variation (Kaeppeler *et al.*, 2000; Guo *et al.*, 2006) and segregation of pre-existing chimeral tissue (Brar and Jain, 1998; Vazquez, 2001).

### Sources of variations detected in plant tissue culture

Different factors such as explant/explant source (Sahijram *et al.*, 2003), mode of regeneration (Shen *et al.*, 2007), length of culture period and number of subculture cycles (Kuznetsova *et al.*, 2006; Mohanty *et al.*, 2008), culture environment (Chawla, 2002; Siragusa *et al.*, 2007) and genotype & ploidy (Hossain *et al.*, 2003; Thieme and

Griess, 2005) affect the frequency of development of somaclones under *in vitro* conditions.

### Recovery of somaclonal variants

Though the somaclonal variants are noted at several occasion during micropropagation, their frequency from the point of fetching new variations for breeding purpose is usually low. The recovery of variants can be improved by promoting the factors which are responsible for the development of somaclonal variations such as use of callus and cell suspension culture for several cycles and regeneration of large number of plants from long-term stored cultures. In addition, plant genotype is a major factor, which determines the type and frequency of somaclonal variation. The efficiency of recovering variants *in vitro* can further be enhanced by putting selection pressure through screening of desirable traits, e.g. *in vitro* selection for tolerance against abiotic and biotic stresses. This attains more significance in view of the fact that the selection of desirable traits takes several years and many generations under field conditions. *In vitro* selection can shorten considerably the time for the selection of desirable traits under *in vitro* selection pressure with minimal environmental interaction, and can complement field selection (Jain, 2001).

The recovery of somaclones can be further increased by combining micropropagation technique with *in vitro* induced mutagenesis. Kuksova *et al.* (1997) suggested that somaclonal variation and mutagens can be combined to enhance the frequency of induced mutations.

Table 1. Advantages and disadvantages of somaclonal variations

Advantages	Disadvantage
<ul style="list-style-type: none"> <li>Cheaper than other methods of genetic manipulation.</li> <li>Tissue culture systems are available for many plant species.</li> <li>Not necessary to have identified the genetic basis of the trait, or indeed, in the case of transformation, to have isolated and cloned it.</li> <li>Novel variants have been reported among somaclones.</li> <li>Variation may be generated from different locations of the genome than those, which are accessible to conventional and mutation breeding.</li> </ul>	<p>Inability to predict the outcome as they are random and lack reproducibility.</p> <p>The variations are usually negative.</p> <p>Positive changes are also altered in negative ways, sometimes.</p> <p>There are chances that the changes are not novel.</p> <p>The changes may not be stable after selfing or crossing.</p> <p>No <i>in vitro</i> selection methods exist for complicated traits such as yield, solids, sweetness, texture or shelf life</p>

Table 2. In vitro selection of desirable traits and development of some commercially exploited varieties through somaclonal variations in different fruit crops

S. No.	Horticultural Crop	Characteristic of somaclone	Reference
1.	Apple ( <i>Malus domestica</i> Borkh.)	Resistance to <i>Erwinia amylovora</i>	Chevreau <i>et al.</i> (1998)
2.	Apple rootstocks M 26 and MM 106 ( <i>Malus pumila</i> Mill.)	Resistance to <i>Phytophthora cactorum</i>	Rosati <i>et al.</i> (1990)
3.	Banana ( <i>Musa acuminata</i> L.)	Semi-dwarf and resistant to <i>Fusarium</i> wilt TC1-229	Tang <i>et al.</i> (2000)
		Var. CIEN-BTA-03, resistant to yellow Sigatoka	Gim nez <i>et al.</i> (2001)
		Larger bunch size var. TC2-425; Resistant to <i>Fusarium oxysporum</i> f. sp. cubense (Foc) race 4; bunch 40% heavier Formosana	Hwang (2002)
		Var. CUDBT-B1, reduced height and early flowering	Martin <i>et al.</i> (2006)
4.	Blackberry	Thornless var. Lincoln Logan	Hall <i>et al.</i> (1986)

5.	Citrus spp.	Resistant to <i>Phoma tracheiphila</i>	Deng <i>et al.</i> (1995)
		Salinity tolerance	Ben-Hayyim and Goffer (1989)
6.	Grapevine ( <i>Vitis vinifera</i> L.)	Resistant to <i>Botrytis cinerea</i> and <i>Plasmopara viticola</i>	Kuksova <i>et al.</i> (1997)
7.	Mango ( <i>Mangifera indica</i> L.)	Resistant to <i>Colletotrichum gleosporiense</i>	Litz <i>et al.</i> (1991)
8.	Peach ( <i>Prunus persica</i> L.)	Resistant to root-knot nematode ( <i>Meloidogyne incognita</i> Kofoid and White)	Hashmi <i>et al.</i> (1995)
		Resistant to bacterial canker ( <i>Pseudomonas syringae</i> pv. <i>syringae</i> )	Hammerschlag (2000)
9.	Pear ( <i>Pyrus</i> sp.)	Resistant to <i>Erwinia amylovora</i>	Viseur (1990)
10.	Pineapple ( <i>Ananas comosus</i> L., Merr.)	Spineless variant	Jaya <i>et al.</i> (2002)
		Cvs. P3R5 and Dwarf, variation in fruit colour, growth habit, fruit size and length of plant generation cycle	Perez <i>et al.</i> (2009)
		Improved size, shape, appearance, starch content and starch yield	Thieme and Griess (2005)
11.	Quince A ( <i>Cydonia oblonga</i> )	High soil pH	Dolcet-Sanjuan <i>et al.</i> (1992); Marino <i>et al.</i> (2000)
12.	Strawberry ( <i>Fragaria</i> sp.)	Resistant to <i>Fusarium oxysporum</i> f. sp. <i>fragariae</i>	Toyoda <i>et al.</i> (1991)
		Resistant to <i>Alternaria alternate</i>	Takahashi (1993)
		Resistant to <i>Phytophthora cactorum</i>	Battistini and Rosati (1991)

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# Status of stone weevil, *Aubeus himalayanus* Voss (Curculionidae: Coleoptera) in India: An emerging pest of *ber* (*Ziziphus mauritiana* Lamk)

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## Abstract

The Indian jujube, popularly known as *ber* (*Ziziphus mauritiana* Lamarck), is an important fruit crop grown in arid and semi arid regions of India and worldwide. Nutritionally, the fruits are rich in protein, phosphorus, calcium, carotene and vitamin C. In India, there are various factors responsible for yield losses in terms of quantity as well as quality. Of these, biotic stresses such as pests and diseases are of prime importance. Among the various insect-pests infesting *ber*, the stone weevil *Aubeus himalayanus* Voss (Curculionidae: Coleoptera) seems to be a new threat to *ber* cultivation in India as in recent years severe infestation has been reported in different *ber* growing region viz., Anantapur (Andhra Pradesh), Rahuri (Maharashtra), Jobner (Rajasthan), Bijapur (Karnataka) and Bikaner (Rajasthan). In addition, the infestation of this pest was also reported from Bangladesh. The adult female weevil, characterized by dark brown snout, usually lays eggs on the styler end of fruits and rarely on the distal end. The newly emerged white colour grubs enter into seed by making puncture in endocarp at immature stage and starts feeding on soft seed coat. Later it enters into endosperm moving downward and starts feeding upon inner content of the seed, and pupates within the seed by making hollow galleries. The weevil completes its life within a single fruit. The infestation results in severe fruit drop at initial stage of fruit set. The damage intensity of stone weevil varies with cultivars as varieties with larger stone are preferred over those, which have higher pulp content. Periodical monitoring of orchard for weevil incidence is essential for devising suitable strategies for efficient management of pest in time. Detection at advance stages of infestation would render it difficult to manage as pests enters into the seed.

Keywords: *Ber*, *Ziziphus mauritiana*, stone weevil, *Aubeus himalayanus*

## Introduction

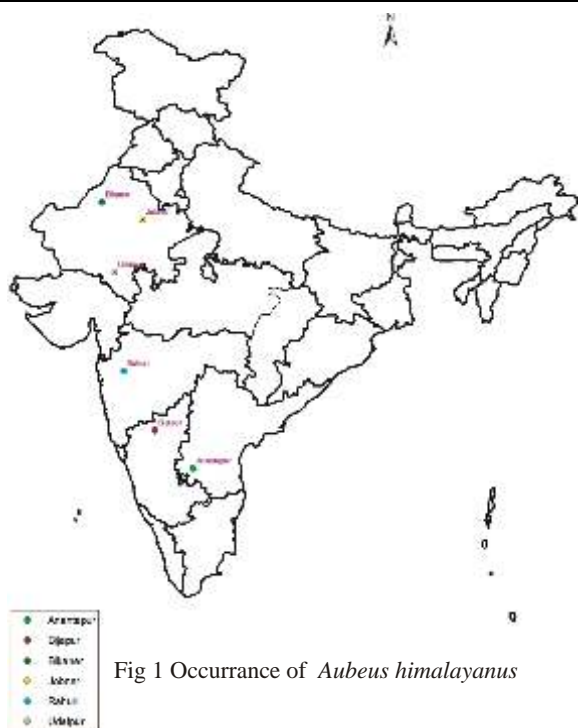
The Indian jujube or *ber* (*Ziziphus mauritiana* Lamarck) also called as desert apple, jujube, *Chines apple*, *Badari* (Sanskrit), *Kul* or *Boroi*, *Dongs*, *Boroi*, *Bor*, *Beri*, Indian plum, *Permseret* (Anguilla) is a tropical fruit tree species, belonging to the family *Rhamnaceae* (Balikai, 2013). In India, it occupies large area (22,000 ha) and/ is a popular dry land fruit crop for arid and semi-arid regions of India (Jamandar *et al.*, 2009). Most of the cultivated areas are confined to Rajasthan, Haryana, Punjab, Gujarat, Maharashtra and Uttar Pradesh states of India. To some extent, its cultivation is also practiced in the states of Tamil Nadu, Andhra Pradesh, Karnataka, Bihar, Chhattisgarh, Madhya Pradesh, Assam and West Bengal. The fruits are quite nutritious, rich in vitamin C, second only to aonla and guava and much higher than citrus and apple (Khera and Singh, 1976). The crop is gaining popularity among the growers because of its adaptability to adverse climatic condition and good returns. However, the avoidable loss is more due to insect-pests and diseases (Singh, 2008). The

introduction of improved varieties and irrigation leads unpredictable change in insect-pests in this eco-system. In India, more than 130 species of insect-pests are reported infesting *ber* (Lakra and Bhatti, 1985); however, very few have attained the pest status in terms of economic loss. Jothi and Tandon (1995) reported 17 insect species, while Balikai (1999) reported a total of 22 insects and non-insect species from Karnataka. Likewise, Kavitha and Savithri (2002) documented about 23 insect species on *ber* from Andhra Pradesh state of India. However, the pests such as fruit fly, *Carpomyia vesuviana* Costa; chafer beetles, *Holotrichia consanguinea* Blanch and bark eating caterpillars, *Indarbela tetraonis* Moore; *Indarbela quadrinotata* Walker and *ber* butterfly, *Tarucus theophrastus* Fabricius are the major pests of *ber* in India, which cause significant yield losses (Sharma and Bal, 2009; Karuppaiah *et al.*, 2010). Besides, in recent years stone weevil seem to be an emerging pest of *ber*, which has been reported from various regions of India (Balikai *et al.*, 1998; Karuppaiah *et al.*, 2010; Balikai *et al.*, 2013). The pest is an emerging threat for *ber* production in India, especially, in northern regions. However, the available literature indicates that in India only very few studies have been made on its management.

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Table 1 . Details of stone weevil incidence reported from different regions of India and Bangladesh

S.No.	Location	Reference
India		
1	Anantpur (Andhra Pradesh)	Gour and Sriramulu (1994)
2	Rahuri (Maharashtra)	Pareek and Nath (1996)
3	Bijapur (Karnataka)	Balikai <i>et al.</i> (1998)
4	Jobner (Rajasthan)	Pareek and Nath (1996) ; AICRP (2004)
5	Udaipur (Rajasthan)	Srivastava and Nanada (1983)
6	Bikaner, (Rajasthan)	Karuppaiah <i>et al.</i> (2010)
7	Bangladesh	Qumruzzaman <i>et al.</i> (2009)



Egg laid mark at stylar end



Fig 2 Damage symptoms of stone weevil, *Aubeus himalayanus*

Therefore, there is a need to systematically investigate biology of pest so as to devise a successful management strategy to counter this notorious pest. Keeping these facts in view, here authors have attempted to review the available information about this emerging pest, which would be useful to formulate suitable management strategies against this menacing pest in near future.

### Distribution

The heavy occurrence of *ber* stone weevil, *Aubeus himalayanus* has been reported from major *ber* growing region of the India (Fig 1). At first it was recorded as a new pest of *ber* for the first time from Andhra Pradesh state of India (Gour and Sriramulu, 1994). Later, from Rahuri, Maharashtra and Jobner, Rajasthan of India in 1996 (Pareek and Nath, 1996; AICRP, 2003) Karnataka state of India (Balikai *et al.*, 1998) and recently in Bikaner district of

Rajasthan, India during 2010 (Karuppaiah *et al.*, 2010 & 2012). Apart from India, the severe damage of this pest at early stage of fruit development has also been reported from Bangladesh (Qumruzzaman *et al.*, 2009) (Table 1).

### Nature of damage

The adult weevils are small dark in colour with snout. The grubs are white in colour with red colour marking on the body, which harbor inside the seeds (Balikai *et al.*, 2009; Karuppaiah *et al.*, 2010 & 2011). Grubs directly damage the fruits by tunneling inside seeds, while egg laying by adult weevil also blemishes mature fruit. The activity of adult beetle could be observed in the field during morning and evening hours. The adult female weevil lays their eggs mostly on the stylar end; rarely on the distal end of fruits and egg laid punctures covered with brown encrustation. Upon hatching, the grubs enter into seed by puncturing endocarp at immature stage and starts feeding on

soft seed coat. Later it enters into endosperm moving downward. After entering the seed, it starts feeding on inner content of the seed, and pupates within the seed by making hallow galleries. The weevil completes its life within a single fruit (Karuppaiah *et al.*, 2010) (Fig 2). The developing soft seed was completely eaten away by the pest. At the time of fruit maturity, in the hollowed area, infested fruits had a grub, a pupa or an adult. The infestation occurs in all the fruit stages; however, it is prevalent in pea to pebble size fruits. They are abnormal shape and nearly half portion of the fruit towards stalk turns reddish brown with rough surface and the remaining half portion towards stylar region remains greenish colour. The infested fruits fail to attain full maturity and never attain size more than the pebble. This is because of the fact that the pest feeds only on the seeds of developing fruit and arrests further development of infested fruit. The entry hole heals up and closes, while the exit hole remains open and can be seen easily. While looking onto the nature of damage and its incidence pattern, it can be concluded that the pest enters into the fruits at early stage of fruit development and the entry holes gets healed up subsequently (Balikai *et al.*, 2009), making it difficult to control the pest. The biology of this pest has not been studied so far.

### Seasonality

The activity of adult weevil starts from month of September and adults start egg laying from blooming stage onwards and severe damage could be observed during October month. The incidence could be noticed still at the end of fruiting i.e. till February. In western Rajasthan of India, the pest was initially recorded during the first fortnight of October on cv. Seb and second fortnight of October on cv. Gola. The greatest infestation was registered during the first fortnight of December. Immature fruit drop was most pronounced on the second fortnight of November. The damage was severe in cv. Seb (Karuppaiah *et al.*, 2010). The damage was noticed during July to August in Karnataka and maximum damage was observed during July to August months. Irrespective of varieties, the incidence was recorded during the months of July to November (Balikai, 2009). The extent of damage also found to be associated with the pruning dates. Severe infestation of stone weevil among early pruned *ber* cultivar Umran reported by Biradar *et al.* (2001). The intra tree distribution pattern of stone weevil incidence revealed non-significant difference with different directions of the plant; however, the incidence in different stratum of the plant showed significant difference. The branches which are examined just above the ground (0-1m), showed maximum (33%) infestation as compared to the branches at 1-2m and above 2m height from the ground. The branches near the ground might be suitable for adults, emerging from residues or surviving population on the tree. Generally infestation decreased from lower branches to top branches (Karuppaiah *et al.*, 2010). Correlation analysis

with abiotic factors reported to have the negative correlation between per cent infestation and temperature and positive correlation with the relative humidity and rainfall (Karuppaiah *et al.*, 2014).

### Varietal preference

The influence of biophysical factors of *ber* fruits plays a major role on the intensity of damage by *ber* stone weevil. The variety with high pulp: stone ratio is attracted more than the lower pulp: stone ratio and fruit shape also could be a reason. The varieties like Umran and Seb are preferred more for the egg laying. The mean damage was up to 23.63% in Gola and 43.28% in Seb. The fruit dropping was more in Seb (73.48%) than the Gola (48.52%) (Karuppaiah *et al.*, 2010). The maximum infestation of stone weevil was recorded in the cultivar Seb followed by Mundia and Umran and it caused about 10.3% loss in fruit yield (Srivastava and Nanda, 1983). The damage was severe in the cultivar Umran and the per cent abnormal fruits due weevil damage were up to 5 to 10. The higher seed content probably could be the reason for higher damage (Balikai, 2009). The severe infestation of nut weevil during the early stages of development in *Z. mauritiana* cv. Thaikul had also been reported from the Bangladesh (Qumruzzaman *et al.*, 2009). Among the seven different cultivars observed for fruit weevil incidence, the maximum infestation was recorded in the cultivar Umran (38.9%) followed by Thar Sevika (35.75%), Seb (35.08%), Thar Bhubhraj (28.18%), Gola (24.59%), Goma Kirti (21.65%) and Banarasi Kadaka (7.05%). The correlation between the bio-physical characters, pulp: stone ratio (PSR) of *ber* fruits reveals positive correlation with weevil infestation. The varieties with higher proportion of stone are more preferred by the adult weevil for egg laying and results suggests bio-physical characters of cultivars play major role in fruit weevil infestation (Karuppaiah *et al.*, 2014).

### Management

The pest feeds only on the seed portion of developing fruits and arrest further development of attacked fruit. The entry hole is healed up and closed while the exit hole can be clearly seen. As the damage is hidden in nature, the periodical monitoring of adult weevil activity will pave the way to detect the infestation at an early stage of infestation. For its management, the spray schedule must be started from flowering to fruit set stage only. Spraying of Carbaryl 50 WDP 0.1% just before the fruit setting and repeat the sprays at three weeks interval was found effective and showed least adverse effect on honey bees activity (AICRP, 2003). Collection and destruction of adult weevil immediately after detection can also reduce the population. Infested dropped fruits should be collected and burned to break the generation cycle (Karuppaiah, 2013). Application of spinosad 2.5 SC found to give significant reduction in weevil incidence and indoxacarb 14.5 EC, NSKE 5% and

azadirachtin 2000ppm and 1000ppm also found to be superior over control treatment in minimizing the weevil incidence (AICRP, 2012)

### Conclusion

*Ber* stone weevil is a new threat to *ber* production in India as it causes direct loss to the fruit yield. In last few decades, the sporadic incidence of this pest has been reported from various parts of the *ber* growing region of India. However, presently it seems to be regular pest of *ber* and severe damage has also been reported in few cultivation pockets. The distribution of stone weevil incidence reveals that the transport of planting material from one place to another place could be the reason for the pest dissemination and establishment in new areas (Qumruzzaman *et al.*, 2009). In India, very few studies have been conducted and little information is available about this notorious pest. While looking nature and intensity of damage, it needs to be studied critically and being the emerging issue, the detailed investigation on the biology and management protocol need to be developed for the successful management under changing climatic scenario.

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# Simple models for non-destructive leaf area prediction in fig (*Ficus carica* L.) cv. Deanna and Poona

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## Abstract

The edible fig (*Ficus carica* L.) has emerged as an important fruit in the world of commerce. Leaf area is an important parameter in fig research, especially for plant physiological studies. Most of the available methods for calculating plant leaf area are difficult to apply, expensive and destructive, which destroy the canopy, as a result of which it becomes difficult to perform further tests on the same plant. Therefore, an experiment was conducted to develop the statistical models for cv. Deanna and Poona of fig using regression analysis during 2010-11 for non-destructive estimation of leaf area. For this purpose the leaf area was recorded with the help of leaf area meter for 100 randomly selected leaves each for Deanna and Poona fig and leaf parameters were recorded for the same hundred leaves. Later, models for computing leaf area in non-destructive manner for cv. Deanna and Poona were developed separately by performing the regression analysis with regard to the relationship between leaf area and petiole length, left lobe (V2), middle lobe (V1) and right (V3) lobe. The statistical models for Deanna and Poona respectively were,

$$Y = -209.15 + 0.22 * P + 12.22 * V1 + 6.42 * V2 + 9.11 * V3 \quad (R^2 = 0.81) \text{ and}$$

$$Y = -157.39 + 4.76 * P + 3.98 * V1 + 6.57 * V2 + 9.84 * V3 \quad (R^2 = 0.85).$$

The models developed by using the central lobe alone for Deanna and Poona fig respectively were  $Y = -200.91 + 24.51 * V1$  ( $R^2 = 0.77$ ) and  $Y = -135.63 + 16.79 * V1$  ( $R^2 = 0.77$ ). Further, the optimized models revealed that length of central lobe is sufficient to predict leaf area to an extent of 77% in Deanna and Poona.

Keywords: Fig, leaf area, non-destructive, regression analysis, models

## Introduction

Leaf area is an important agronomical parameter as it is related to plant growth, photosynthetic activity and many times it is used to assess the effect of different plant treatments (Ali and Anjum, 2004). In fruit crops leaf area: fruit ratio determines the size and quality of fruits (Chacko, 1982). The optimum leaf number and area required for the development of individual fruit was worked out for mango (*Mangifera indica* L.) by Chacko (1982). The leaf area measurement is one of the most important parameter in agricultural research especially in plant physiology and nutrition. This parameter is a representative of plant growth and development. Its relationship with the absorption of light, respiration and photosynthesis is important. The leaf area index is a key structure for forest ecosystems properties and the reason is the roles that green leaves have on controlling physical and biological processes on vegetation cover. Therefore, accurate estimation of leaf area index is

necessary for studying ecophysiology, interaction of the atmosphere and ecosystems and global climate change (Chen *et al.*, 1997). Leaf area index is widely used to describe the vegetation photosynthesis and respiration levels. This index is also used extensively in ecophysiology, and water balance modeling and characterization of vegetation-atmosphere interactions (Rich *et al.*, 1995). Determination of the leaf area is necessary for knowing how the energy transfers and dry matter accumulation processes in the vegetation. Leaf area is very important in the analysis of vegetation and also as a factor that makes possible to determine the light interception, plant growth (Bhatt and Chanda, 2003). Many methods of measuring plants leaf area have been used but most of them are mix of several measurement models with complex and difficult mathematical equations. For example measuring leaf area by optical methods and image spectroscopy (Gosa *et al.*, 2007) cannot be carried out everywhere. It is difficult even in methods such as using digital cameras and calculating the surface by computer programs; although taking photos is fast and very accurate analysis, but because of vast number

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of leaves this process takes a long time and often equipments are very expensive (Bignami and Rossini 1996; Lu *et al.* 2004). Other methods include, blue printing, photographic and planimeter. They all need to be separated leaves from the plants which cause the destruction of vegetation (Cristofori *et al.*, 2007; Ugese *et al.*, 2008). Portable scanning planimeters can quickly, accurately and non-destructively measure a leaf area (Daughtry, 1990), but it is suitable for small plants with few leaves (Nyakwende *et al.*, 1997). Using a digital camera with image measurement and analysis software is also an alternative method of measuring leaf area. The capture of image by digital camera is rapid, but the processing procedure is time consuming and the facilities are generally expensive (Lu *et al.*, 2004). Developing a rather inexpensive, rapid, reliable and non-destructive method for measuring leaf area becomes imperative for horticulturists and physiologists. By clarifying the mathematical relationship between leaf area and one or more dimensions of the leaf, a method using just linear measurements to estimate leaf area would be advantageous than many of the aforementioned methods (Villegas *et al.*, 1981; Beerling and Fry, 1990). An equation was also developed for determination of leaf area in Thompson seedless grape using the recorded parameters of leaf like length of the main lobe ( $l_1$ ), superior right lobe ( $l_2$ ), superior left lobe ( $l_3$ ) and breadth of the leaf (b) (Shikhamany *et al.*, 1983).

The edible fig, *Ficus carica* L. cultivated since ancient times has emerged recently as an important fruit in world commerce. The highly nutritious fig fruits are habitually consumed dried or canned, but are also marketed fresh. Dried fig is high in calories, proteins, calcium and iron. Fresh fruits have a luscious taste and are wholesome, rich in carbohydrates and minerals, particularly iron. Figs

are also prized for their mild, laxative action and are employed in the preparation of laxative confections and syrups (Chithiraichelvan *et al.*, 2012). The Poona is a very popular Indian cultivar of fig. It gives small to medium size, purple colour fruits, suitable for table purpose, However, cv. Deanna introduced from U.S.A., is doing very well in India, particularly suitable as dried fig because of its yellowish green coloured fruits of medium to large size fruits. The objective of present study was to develop the statistical models for both the cultivars of fig for calculating the leaf area in non-destructive manner.

### Materials and methods

The experiment was conducted at Indian Institute of Horticultural Research, Hessaraghatta Lake post, Bangalore-560089, Karnataka, India during 2010-11. The experiment was done on cv. Deanna and Poona. The leaf area was recorded with the help of leaf area meter for 100 randomly selected leaves for Deanna and Poona fig each as well as leaf parameters like petiole length and the lengths of vein (lobe) one, vein (lobe) two and vein (lobe) three were also recorded for same hundred leaves. Correlation analysis of leaf area and the independent variables P, V1, V2 and V3 were calculated (Figure 1). The data generated were fitted to linear regressions to establish the best fitted regression model using MS Excel (2010).

The scatter plots of various parameters for leaf area (P vs LA, V1 vs LA, V2 vs LA and V3 vs LA) in Deanna fig are presented in Figure 2 to 5; correlation matrix, fully

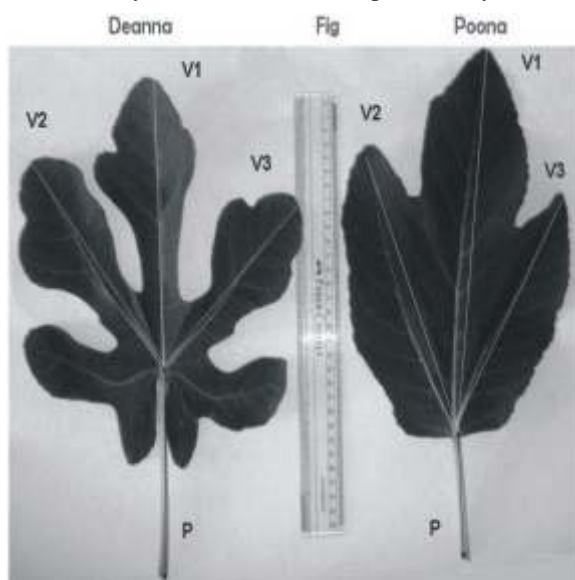


Figure 1. Leaf parameters for Cv. Deanna and Poona:

Table 1 : Regression models of leaf area estimation for Deanna fig in field conditions without destroying the plant, along with R<sup>2</sup> value

Parameters	Regression model	R <sup>2</sup>
Petiole length (P)	Y= 17.072x + 63.989	0.27
Leaf lobe one (V1)	Y= 21.799x - 155.8	0.73
Leaf lobe two (V2)	Y= 23.358x - 114.76	0.63
Leaf lobe three (V3)	Y= 21.361x - 73.829	0.65
Taken together (P, V1, V2, V3)	Y= -209.15+0.22*P+12.22*V1 +6.42*V2+9.11*V3	0.81
Taken central lobe (V1) only	y=-200.91+24.51*V1	0.77

Table 2 : Regression models of leaf area estimation for Poona fig in field conditions without destroying the plant, along with R<sup>2</sup> value

Parameters	Regression model	R <sup>2</sup>
Petiole length (P)	Y= 22.693x + 54.69	0.48
Leaf lobe one (V1)	Y= 16.788x - 135.63	0.77
Leaf lobe two (V2)	Y= 21.397x - 104.81	0.70
Leaf lobe three (V3)	Y= 21.627x - 111.2	0.77
Taken together (P, V1, V2, V3)	Y= -157.39+4.76*P+3.98*V1+6.57*V2+9.84*V3	0.85
Taken central lobe (V1) only	Y= -135.63+16.79*V1	0.77

optimized model with statistics (Leaf Area Vs P+V1+V2+V3) for Deanna are presented in table 3; residual plots for Deanna parameters in Figure 6 to 9; correlation, fully optimized model with statistics and residual output for Deanna fig (V1 vs Leaf area) in table 4; scatter plots of various parameters for leaf area in Poona fig (P vs LA, V1 vs LA, V2 vs LA and V3 vs LA) in Figure 10 to 13; correlation matrix, fully optimized model with statistics for Poona fig (Leaf area Vs P+V1+V2+V3) in table 5; residual plots for Poona parameters in Figure 14 to 17; correlation, fully optimized model with statistics and residual output for Poona fig (V1 vs Leaf area) in table 6.

The residuals are not either systematically high or low. They are centered on zero throughout the range of fitted values in all the models. In other words, the model is correct on average for all fitted values.

Under this study, the simple regression models were developed to estimate the leaf area of Deanna and Poona fig in non-destructive manner, which will be useful

for physiological and nutritional studies. The results indicate that the leaf area of fig with high speed and accuracy can be obtained by measuring the petiole length and lengths of lobe one, two and three of the leaf without separating from the plant. Models were time saving and easily predictable. It makes possible to measure leaf area without destruction of plants, so, the sufficient vegetation will be available for conducting further tests. These models can be convenient and quick alternative, especially at places where there is no access to modern equipment or other devices for measuring the leaf area. This can be made further effective by using only the central lobe without much affecting the accuracy.

**Acknowledgements**

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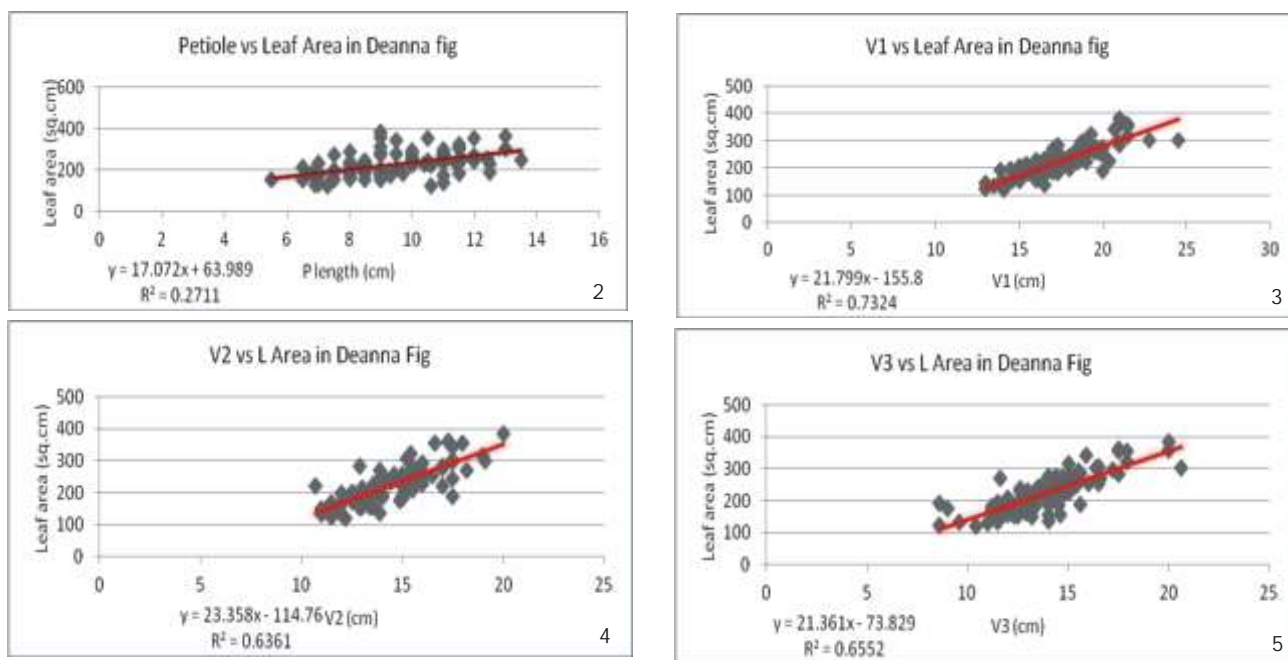


Figure 2 to 5: Scatter plots of various parameters for leaf area in Deanna fig

Table 3: Correlation matrix, fully optimized model with statistics (Leaf Area Vs P+V1+V2+V3)for Deanna fig

*Correlation matrix*

	Petiole	V1	V2	V3	L Area
Petiole	1				
V1	0.27838119	1			
V2	0.253681523	0.837132012	1		
V3	0.262215695	0.836754749	0.716021791	1	
L Area	0.287213435	0.875599586	0.798211824	0.83094418	1

Fully optimized modal  $Y = -209.15 + 0.22 * P + 12.22 * V1 + 6.42 * V2 + 9.11 * V3$  R2 (%) 81 SE 28.51

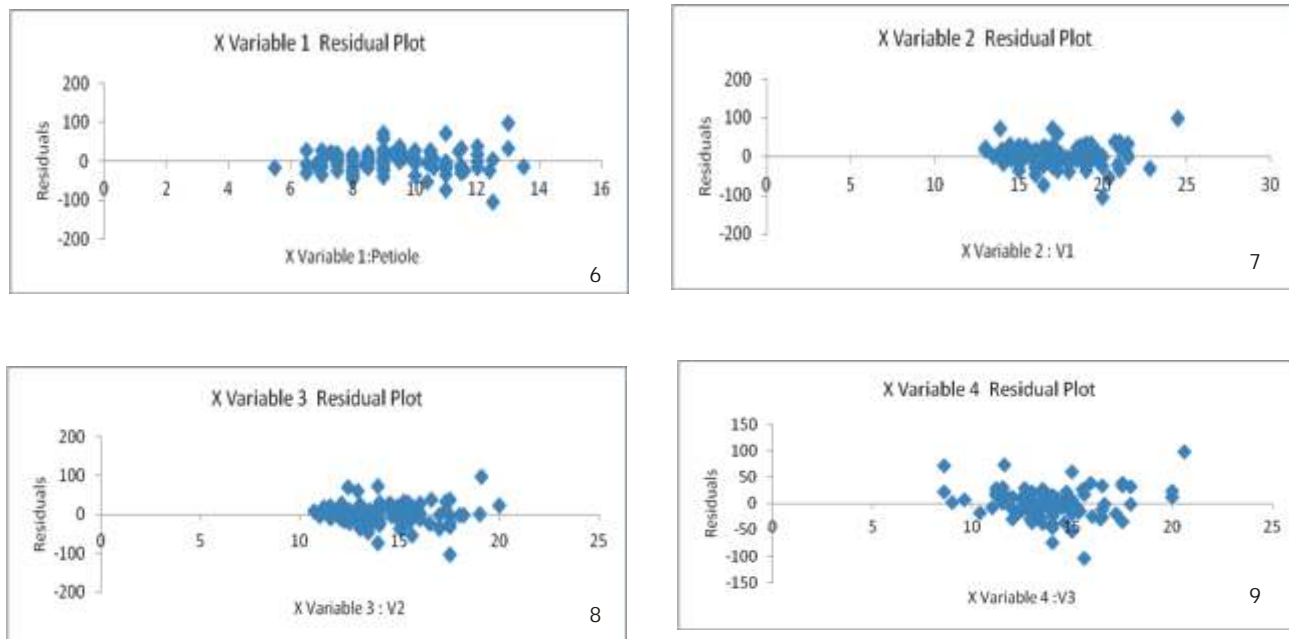


Figure 6 to 9 : Residual plots for Deanna parameters

Table 4. Correlation, fully optimized model with statistics and residual output for Deanna fig (V1 vs Leaf area) Correlation

	V1	L Area
V1	1	
L Area	0.875599586	1

Fully optimized modal  
 $y = -200.91 + 24.51 * V1$

R2 (%)  
 77

SE  
 31.27

Residual output

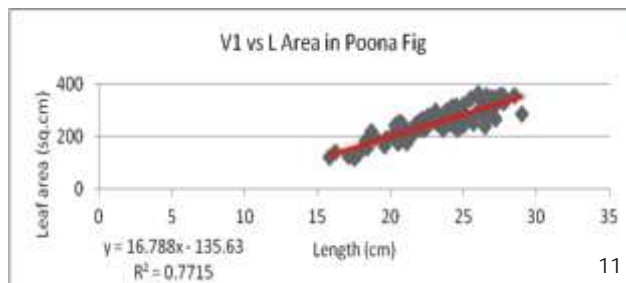
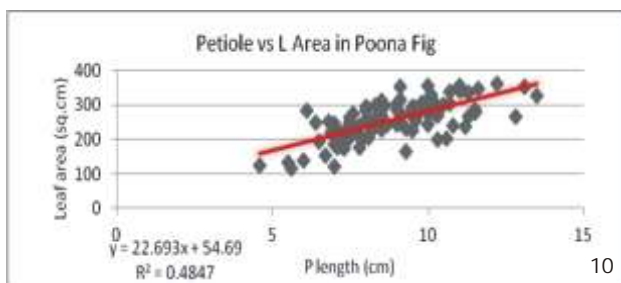
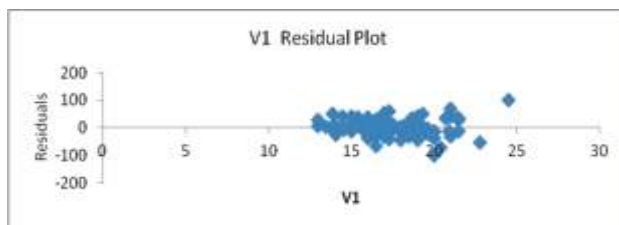


Figure 10 to 11 : Scatter plots of various parameters for leaf area in Poona fig

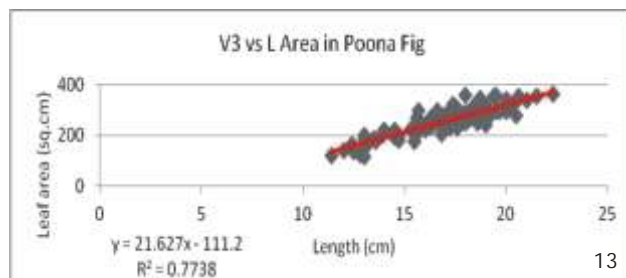
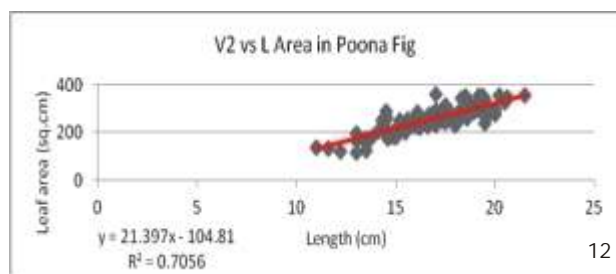


Figure 12 to 13 : Scatter plots of various parameters for leaf area in Poona fig

Table 5 : Correlation matrix, fully optimized model with statistics for Poona fig  
(Leaf area Vs P+V1+V2+V3)

Correlation matrix

	<i>Petiole</i>	<i>V1</i>	<i>V2</i>	<i>V3</i>	<i>L Area</i>
Petiole	1				
V1	0.663223564	1			
V2	0.589940453	0.868979583	1		
V3	0.64910328	0.872100967	0.786806847	1	
L Area	0.696187394	0.878335581	0.840011919	0.879636746	1

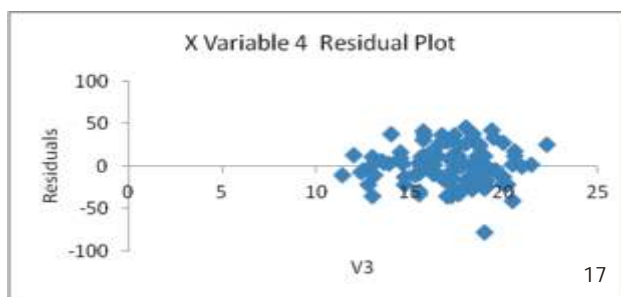
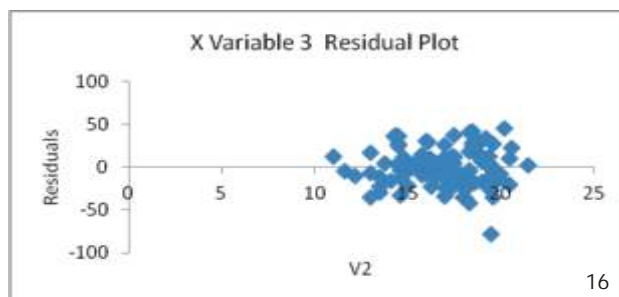
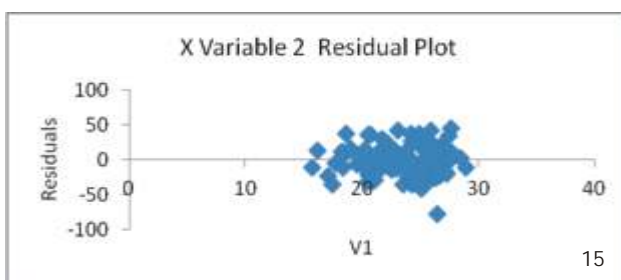
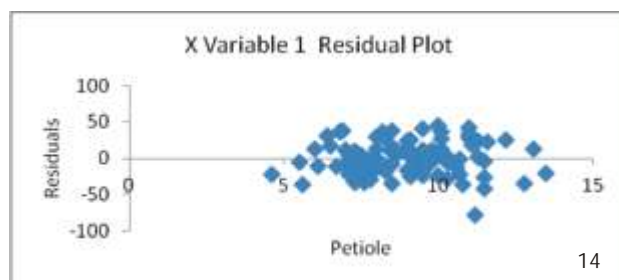
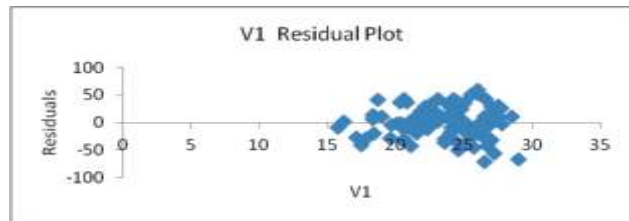


Figure 14 to 17 : Residual plots for Poona parameters

Table 6 : Correlation, fully optimized model with statistics and residual output for Poona fig (V1 vs Leaf area)

Correlation			
	V1	L Area	
V1	1		
L Area	0.878336	1	
Fully optimized modal		R2 (%)	SE
Y= -135.63+16.79*V1		77	27.42
Residual output			



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# Screening of watermelon genotypes for resistance to mosaic disease under hot arid conditions of Rajasthan

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## Abstract

Mosaic disease is one of the most important diseases in the production of watermelon under arid and semi-arid regions of India. Field trials were conducted to screen 13 watermelon/*mateera* genotypes viz., RW-177-3, RW-187-2, GP-20, GP-35, GP-42, Thar Manak, AHW-19, AHW-65, Asahi Yamato, Sugar Baby, Arka Manik, Bikaner Local-1 and Barmer Local-1 for resistance against mosaic disease with normal cultivation practices during summer 2011 and 2012 at Plant Pathology Block of Central Institute For Arid Horticulture, Bikaner under field conditions. Resistant genotypes were categorized on the basis of disease incidence. Among 13 watermelon/*mateera* genotypes, none was found immune against disease. One variety 'Asahi Yamato' showed resistance with less than 10.0% disease incidence, ten genotypes were categorized as moderately resistant ranging from 10.1 to 25.0% disease incidence and two genotypes such as RW-177-3 and GP-20 having more than 25.0% disease incidence proved susceptible against mosaic disease.

**Key words:** *Watermelon, genotypes, mosaic disease, resistance*

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## Introduction

Watermelon [*Citrullus lanatus* (Thunb) Mansf.] is one of the most widely cultivated crop in the world. China is the leading country in production of watermelon followed by Turkey, United States and Iran (Huh *et al.*, 2008). Watermelon is also known as *Tarbooj*, *Kalinda* and *Mateera* in some parts of India. This crop accounts for 6.8 per cent of the world area devoted to vegetable production (Goreta *et al.*, 2005). In Rajasthan, *mateera* is an important landrace of *Citrullus lanatus* crop grown by farmers using their own saved seeds. It has sufficient variation in productivity and quality and is able to withstand damage from biotic and abiotic factors (Wehner *et al.*, 2001). It is subjected to suffer various fungal and viral diseases, which inflict heavy damage on yield of the crop every year. Mosaic disease has become potential threat to the cultivation of watermelon in Western Rajasthan. This disease caused by *cucumber mosaic virus* (CMV). It is an important disease of Rajasthan as well as major watermelon growing states of India. Infected plants showed characteristic symptoms of dry, necrotic lesions along the veins of leaves, mottling, development of vein clearing and stunting of the plants. Field screening is one of the best method of integrated disease management against this disease. The cheapest and economical control of this disease can be achieved by resistant genetic stock (Jadhav & Sharma, 1983). Keeping in view, this important component of integrated disease management, efforts were

made to screen watermelon genotypes against mosaic disease and to identify resistant/tolerant genotypes under hot arid conditions of Western Rajasthan.

## Materials and Methods

Experimental trials were conducted during summer 2011 and 2012. Thirteen watermelon/*mateera* genotypes viz., RW-177-3, RW-187-2, GP-20, GP-35, GP-42, Thar Manak, AHW-19, AHW-65, Asahi Yamato, Sugar Baby, Arka Manik, Bikaner Local-1 and Barmer Local-1 were tested against mosaic disease of watermelon at Plant Pathology Block of Central Institute For Arid Horticulture, Bikaner with normal cultivation practices under field conditions. Thirteen genotypes seeds were sown in Randomized Block Design with a spacing 50 x 100 cm in three replications during both seasons (summer 2011 and 2012). No plant protection measures were sprayed in the present study. Susceptible genotype 'Bikaner Local-1' was sown after each five rows of the test genotypes as check. It was also grown around the border of the field to serve as infector rows. Data on disease incidence of mosaic symptoms were recorded during growth period of the crop. The reactions for resistance due to mosaic disease in watermelon/*mateera* were categorized by using 0-4 scale (Singh *et al.*, 2007): immune (0) = 0% symptoms, resistant (1) = 0.1 to 10.0% symptoms, moderately resistant (2) = 10.1 to 25.0% symptoms, susceptible (3) = 25.1 to 50.0% and highly susceptible (4) = >50.0% symptoms.

## Results and Discussion

Pooled data of both the years (2011 & 2012) presented in Table 1 indicated that variation in disease

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Table 1. In vivo screening of watermelon genotypes against mosaic disease (pooled data 2011 & 2012).

Genotypes	Disease incidence (%)
RW-177-3	27.86* (31.82)
RW-187-2	17.14 (24.33)
GP- 20	30.50 (33.50)
GP- 35	22.50 (28.26)
GP- 42	16.25 (23.75)
Thar Manak	19.82 (26.42)
AHW- 19	17.14 (24.43)
AHW- 65	12.99 (21.10)
Asahi Yamato	05.83 (13.93)
Sugar Baby	13.80 (21.75)
Arka Manik	10.82 (19.18)
Bikaner Local-1	18.33 (25.34)
Barmer Local-1	21.87 (27.87)
CD at 5%=	2.77

\*Figures in parenthesis are angular transformed

Table 2. Disease reaction of different watermelon/mateera genotypes to mosaic disease

Disease reaction	Cultivars/genotypes
Immune (I) (0.0%)	Nil
Resistant (R) (0.1 to 10%)	Asahi Yamato
Moderately resistant (MR) (10.1 to 25%)	Arka Manik, RW-187-2, GP- 35, GP- 42,
Susceptible (S) (25.1 to 50%)	Thar Manak, AHW- 19, AHW- 65, Sugar Baby, Bikaner Local-1 and Barmer Local-1 GP- 20 and RW-177-3
Highly susceptible (HS) (> 50%)	Nil

incidence of mosaic was found in all the genotypes of this crop. Among thirteen genotypes of watermelon/mateera, range of average disease incidence of mosaic was 5.83 to 30.50%. Minimum disease incidence (5.83%) was recorded in one variety 'Asahi Yamato', followed by variety 'Arka Manik' which were not statistically at par with each other. Maximum disease incidence (30.50%) was recorded in genotype 'GP-20', followed by RW-177-3 (27.86%) which were statistically at par with each other. These results are in consonance with the finding of earlier worker (Shah *et al.*, 2012) who reported that variation in disease incidence of different chilli germplasm against mosaic disease.

The results presented in Table 2 reveal that there was some variation in all the genotypes evaluated against mosaic disease. Out of thirteen watermelon/mateera genotypes, none was found immune (I) against mosaic disease. Among them, one variety 'Asahi Yamato' showed resistant (R) with minimum disease incidence (5.83%), ten genotypes/varieties were categorized as moderately resistant (MR, 10.82 to 22.50%) and two genotypes viz., GP- 20 and RW-177-3 were susceptible (S) having 27.86% and 30.50% disease incidence. The results supports the earlier findings of Singh *et al.* (2007) who reported that out of 146 genotypes of pigeon pea, 37 genotypes were categorized as resistant (incidence up to 10%), 45 genotypes showed moderately resistant and rest were noted as susceptible and highly susceptible against sterility mosaic. Shah *et al.* (2012) screened 28 germplasm of chilli against mosaic disease and found minimum disease incidence in Jawahar, BC-21-2, LCA- 305 and Pant C-2 germplasm.

### Conclusion

It is concluded that only one variety 'Asahi Yamato' of watermelon was found tolerance/resistant against mosaic disease with minimum disease incidence. The source of genotypes/varieties identified in present investigation under various categories could be utilized in breeding programme.

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# Production potential and economics of aonla based Agri-horti system under rainfed semi-arid ecosystem of western India

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## Abstract

A field trial was carried out to find out the practicalities and economics of suitable and profitable cucurbitaceous vegetables as intercrops (bottle guard, pumpkin, bitter guard, cucumber, sponge guard) on 7 to 10 years aonla orchard during the year of 2007-2011 at the Experimental Farm of Central Horticultural Experiment Station (CIAH), Vejalpur, Panchmahals (Godhra), Gujarat under rainfed semi arid ecosystem of western India. Among the different cucurbitaceous vegetable tried as intercrops, aonla + bottle gourd combination fetched the maximum net economic return of Rs. 147312.80/ ha with the B: C ratio 4.44 followed by aonla + pumpkin (Rs. 100525.00/ha with the B: C ratio 3.11) whereas the lowest economic return was recorded in control followed by aonla + sponge gourd purely under rainfed conditions of semi-arid ecosystem of western India. Based on the results, it has been confirmed that the aonla + bottle gourd combination is most effective to generate substantial additional income without affecting the aonla yield when compared to other treatment combinations. In order to its remunerativeness as additional income, it needs to be popularized among the farmers which not only will enhance the system productivity but also the space left the aonla orchards will be utilized efficiently.

**Keywords:** *Aonla, intercrops, cucurbits, productivity, economic return.*

## Introduction

Aonla (*Emblica officinalis* Gaertn) is an indigenous fruit of India. The fruit is richest source of vitamin C among all the fruits except Barbados cherry. It is very popular for its medicinal usage in different medicine system. The cultivation of crop is not very specific in its soil requirement and thrives well in fragile agro climatic conditions. It grows well in sandy loam to clay soils with pH range of 6 to 8.5. It is very remunerative to grow in varied agro-climatic conditions or wasteland of the dryland conditions without much care. The aonla variety NA-7 starts bearing on 3<sup>rd</sup> year after it's planting and reach their maximum capacity within 8 years of planting (Singh *et al*, 2010). Moreover, the aonla planted at distance of 10 m x 10 m. Due to less net return per unit area and time period to get economic yield from sole crop are not very encouraging to the farmers of arid and semi-arid region. To avoid such problems, an unoccupied space can be utilized efficiently by growing intercrops. An intercropping system is an age old practice which has attracted worldwide attention for yield advantages (Willey, 1979), where two or more crops share the same piece of land for part, or for all, of their growing

season. In aonla orchard, growing of ground storey intercrops of short duration which complete their life span during moisture availability period especially kharif season will be helpful to aonla growers to get more benefits (Singh *et al.*, 1996, Sarkar *et al.*, 2004), inhibit the soil erosion and improve the soil physico chemical properties (Bhatnagar *et al.*, 2007). The advantages of intercropping are commonly attributed to the complementarity of resources capture patterns by crops and better input management (Rodrigo *et al.*, 2001; Nedunchezhiyan *et al.*, 2010). To ensure the optimum productivity in intercropping system, one must ensure that the peak periods of growth of the two crops do not coincide with each other, so that one quick-maturing crop completes its life cycle before the main period of growth of the other crop starts (Saxena, 1972). Because of that short duration ephemeral cucurbits used as vegetable which is commonly used in such regions were selected as intercrops in aonla orchard. In western India, no systematic work has been conducted to determine the effect of different intercrops on productivity potential of NA-7 aonla orchard under rainfed conditions. Keeping these facts in background, the present study was carried out to find out the most suitable intercrops to maximize net profit under rainfed condition of semi- arid ecosystem of western India.

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## Materials and Methods

The field experiment was conducted during four consecutive years of 2007- 2011 at Central Horticultural Experiment Station (CIAH) Vejalpur, Panchmahals (Godhra), Gujarat under rainfed semi-arid ecosystem of western India. The location of the experiment is 113 m above msl on latitude 22° 41' 38" N and longitude 73° 33' 22" E and is characterized by hot semi-arid climate. The annual rainfall is mainly confined to three months (July-September) and mean precipitation is about 750 mm, and the total average number of rainy days are 33. The mean summer temperature is 32.9° C while the mean winter temperature is 21.3° C indicating that the area falls under hyperthermic soil regime. The mean annual maximum and minimum temperatures vary from 42 - 44° C in May and 6 - 9° C in January, respectively. The soil is clay to clay loam, soil depth ranges from 0.75 to 1.0 meter. The intercropping trial was conducted on 7 to 11 years old NA-7 aonla plants spaced apart from 10m x 10m. Experiment was consisted of 6 treatments including control; T<sub>1</sub>- bottle guard (*Lagenaria siceraria* (Mol.) Standl.), T<sub>2</sub>-pumpkin (*Cucurbita moschata* Poir.) T<sub>3</sub>- bitter guard (*Momordica charantia* L.), T<sub>4</sub>-cucumber (*Cucumis sativus* L.), T<sub>5</sub>- sponge guard (*Luffa cylindrica* Roem.) and T<sub>6</sub>- control. All treatments were replicated four times in randomized block design. The intercrops were sown during rainy season each year under rainfed condition. The manure and fertilizers, irrigation and plant protection measures were given as per package of practices uniformly to each treatment. The data on fruit yield were recorded at harvest during all the four years from all the treatments were statistically analyzed. The yield of different inter crops and sole crops was recorded to evaluate the productive potential of different combination and their economic produce were harvested and quantified per hectare and their cost of cultivation was worked out as per prevailing nearby market rate.

## Results and Discussion

### Productivity

The perusal of the data from the Table 1 showed that the mean fruit yield of sole crop (aonla) per was recorded 64.65, 60.53, 59.50, 58.35, 56.03 and 52.85 q/ha in control (T<sub>6</sub>), aonla + bottle guard (T<sub>1</sub>), aonla + sponge gourd (T<sub>5</sub>), aonla + pumpkin (T<sub>2</sub>), aonla + bitter guard (T<sub>3</sub>) and aonla+ cucumber (T<sub>4</sub>), respectively. It is quite obvious that the higher fruit yield was obtained in control where aonla was taken alone. An increase in yield in control might be due to fulfilment of the acquired resources whereas the other treatments had division of resources with intercrops which might have reduced the yield of aonla plants. Singh *et al.* (1996) also reported that the higher yield in control (without intercrops) mango orchard. The mean yield of the intercrops was recorded the highest 79.95, 74.40, 72.82 and 68.61 q/ha in T<sub>1</sub> (aonla + bottle guard) followed by T<sub>2</sub> (aonla + pumpkin) and T<sub>4</sub> (aonla + cucumber), whereas same was the minimum (47.25) in T<sub>3</sub> (aonla + bitter guard). During the experiment, it was observed that the intercrops yield was subsequently reduced with the increase of the age of the aonla plants. Such effect may be owing to increase in tree size and their resource requirements, and competition for nutrients between the crops. Similar results were also reported by Das *et. al* (2011) in aonla in eastern India and Pareek *et al.* (2007) in Kinnow based production system. The results indicated that treatment (T<sub>1</sub>) aonla + bottle guard had maximum yield of intercrop and slight reduction in fruit yield of sole crop. As far as the suitability with productivity of fruit yield and intercrop yield, treatments T<sub>1</sub> followed by T<sub>4</sub> and T<sub>2</sub> were performed better under rainfed condition of semi- arid ecosystem.

### Economics

The economic analysis of intercropping system

Table 1. Yield of intercrops under aonla based cropping system of western India.

Intercrops	Yield of intercrops (q/ha)					Yield of aonla crops (q/ha)				
	2007-08	2008-09	2009-10	2010-11	Mean	2007-08	2008-09	2009-10	2010-11	Mean
Bottle gourd	83.25	81.78	78.09	76.62	79.95	45.28	56.91	64.15	75.58	60.53
Pumpkin	75.99	75.12	73.68	72.82	74.40	42.17	52.19	67.00	72.09	58.35
Bitter gourd	51.13	50.64	47.74	47.25	49.19	40.00	50.23	63.47	70.45	56.03
Cucumber	69.58	69.15	68.07	67.64	68.61	35.14	46.00	60.32	69.95	52.85
Sponge gourd	46.13	45.09	42.37	41.33	43.73	44.17	56.75	62.25	74.50	59.50
Control	-----	-----	-----	-----	-----	50.18	61.27	68.03	79.12	64.65
CD at 5%	14.25	13.03	11.27	11.10	-----	4.13	6.32	5.07	4.35	-----

Table 2 . Net income (Rs ha<sup>-1</sup>) from aonla orchard with intercropping of cucurbitaceous vegetables.

Inter crops	Details of cost and benefits from inter crops					Details of cost benefits from sole crop aonla					B:C ratio		
	Produce of intercrop (q/ha)	Rate (Rs/kg)	Cost of cultivation (Rs ha <sup>-1</sup> )	Gross income (Rs ha <sup>-1</sup> )	Net income (Rs ha <sup>-1</sup> )	Produce of main crop (q/ha)	Rate (Rs/kg)	Cost of cultivation (Rs ha <sup>-1</sup> )	Gross income (Rs ha <sup>-1</sup> )	Net income (Rs ha <sup>-1</sup> )	Input costs (Rs ha <sup>-1</sup> )	Total net return (Rs ha <sup>-1</sup> )	B:C ratio
Bottle gourd	79.95	15.00	18142.20	119925.00	101782.80	60.53	10	15000	60530.00	45530.00	33142.20	147312.80	4.44
Pumpkin	74.40	10.00	17225.00	74400.00	57175.00	58.35	10	15000	58350.00	43350.00	32225.00	100525.00	3.11
Bitter gourd	49.14	15.00	18035.50	73521.00	55485.50	56.03	10	15000	56030.00	41030.00	33035.50	96515.00	2.92
Cucumber	68.61	10.00	16054.83	68610.00	52555.17	52.85	10	15000	52850.00	37850.00	31054.83	90405.17	2.91
Sponge gourd	43.73	10.00	15147.57	43730.00	28582.43	59.50	10	15000	59500.00	44500.00	30147.57	73082.43	2.42
Control	-----	-----	-----	-----	-----	64.65	10	15000	64650.00	49650.00	15000.00	49650.00	-----

presented in Table 2 shows that aonla + bottle gourd combination (T<sub>1</sub>) performed better in the terms of productivity thereby enhancing the net return rather than other combinations. The net economic return was obtained to the tune of Rs. 147312.80, 100525.00, 96704.50, 90405.17 and 73082.43 with aonla + bottle gourd (T<sub>1</sub>), aonla + pumpkin (T<sub>2</sub>), aonla + bitter gourd (T<sub>3</sub>), aonla + cucumber (T<sub>4</sub>) and aonla + sponge gourd combinations (T<sub>5</sub>), respectively. Considering the total cost and monetary benefits from sole and intercrops, the treatment T<sub>1</sub> (aonla + bottle gourd) had the maximum income (Rs.101782.80 /ha) followed by T<sub>2</sub> (Rs 57175.00 /ha) and T<sub>3</sub> (Rs 55485.50 /ha). The B : C ratio was calculated highest (4.44) in T<sub>1</sub> (aonla + bottle gourd) followed by T<sub>2</sub> and T<sub>3</sub>. The similar returns from intercrop and main crop combinations have also been reported by earlier workers in aonla-based cropping system (Kumar *et al.*, 2008 and Awasthi *et al.*, 2009). The minimum cost of cultivation (Rs.18142.20/ha) was recorded in aonla + bottle gourd (T<sub>1</sub>) followed by T<sub>3</sub>- aonla + bottle gourd (Rs.18035.50/ha) and the same was minimum with T<sub>5</sub>, aonla + sponge gourd (Rs.15147.57/ha) combinations. There was increase in the cultivation cost in T<sub>1</sub> aonla + bottle guard, but less labour intensive, pest free, and highest net returns per ha as compared to rest of the combinations.

Thus, based on above results from the four years intercropping with different cucurbits proved conducive and profitable under rainfed conditions, but the practice of intercropping with bottle gourd in aonla orchard was found to be more profitable and fetched more additional income (Rs.101782.80/ha) with highest benefit cost ratio (4.44) than other combinations under rainfed conditions which was found to be economically profitable and viable preposition under aberrant agro-climatic conditions. Based on the results, it can be concluded that the maximum additional income can be generated with aonla+ bottle guard combination under rainfed conditions.

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# Screening of ridge gourd varieties/ genotypes [*Luffa acutangula* (Roxb.) L.] for resistance against fruit fly (*Bactrocera cucurbitae* (Coquillett)) in hot arid region of Rajasthan

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## Abstract

Host plant resistance is an important component for management of the melon fruit fly, *Bactrocera cucurbitae* (Coquillett) owing to difficulties associated with its chemical and biological control. Ridge gourd varieties/ genotypes viz., AHRG-49, Arka Sujata, AHRG-29, AHRG-36, AHRG-47, AHRG-41, S. Manjari, AHRG-31, AHRG-33, AHRG-42, AHRG-30, AHRG-57, S. Uphal, Pusa Nasdar, AHRG-35, Jaipuri Long, AHRG- 23, AHRG-56, AHRG-53, AHRG-58, AHRG-50, AHRG-28, AHRG-43, AHRG-44, AHRG-46, AHRG-48, AHRG-52, AHRG-59 and AHRG-61 were evaluated to screen out the suitable resistant/susceptible varieties/ genotypes against the fruit fly in hot arid region of Rajasthan. The results imparted that the percentage of fruit infestation and larval population per fruit on tested varieties/ genotypes of ridge gourd varied significantly. Pooled data showed that the AHRG-49, AHRG-33, AHRG-42, AHRG-30, AHRG- 23, AHRG-58, AHRG-50, AHRG-28, AHRG-43, AHRG-52 and AHRG-59 were categorized as susceptible varieties/ genotypes with fruit infestation (70.85%, 68.13%, 57.97%, 55.93%, 70.17%, 55.00%, 53.25%, 65.75%, 57.82%, 69.68% and 65.83%, respectively) and larval population per fruit (22.27, 28.92, 25.93, 22.73, 22.63, 24.28, 22.27, 23.42, 24.12, 21.97, 24.93 and 24.13, respectively). Whereas, the varieties/ genotypes AHRG-29, AHRG-57 and Pusa Nasdar had fruit infestation (17.92%, 16.22% and 18.50%, respectively) and larval population per plant (16.60, 13.45 and 14.55, respectively) and declared as resistant varieties/ genotypes to fruit fly. The AHRG-47, AHRG-31, AHRG-48 and AHRG-61 with fruit infestation (78.02%, 80.13%, 80.10% and 79.42%, respectively) were highly susceptible varieties/ genotypes to fruit fly in pooled data of both the seasons viz., 2011 and 2012. Lower values of host plant susceptibility indices based on fruit infestation (HPSI) were recorded on resistant varieties/ genotypes, AHRG-29, AHRG-57 and Pusa Nasdar (36.12%, 32.69% and 37.29%, respectively) could be used as a source of resistance for developing ridge gourd varieties/ genotypes resistant to fruit fly.

**Key Words:** Screening, resistant, *Bactrocera cucurbitae*, *Luffa acutangula*

## Introduction

*Luffa acutangula* has essentially old world origin in subtropical Asia region particularly India (Kalloo, 1993). Plants are monoecious, andromonoecious, hermaphrodite and having gynoeious sex form (Richharia, 1948; Choudhury and Thakur, 1965). Fruits of ridge gourd are very nutritious and good source of vitamin A, calcium, phosphorus, ascorbic acid and iron (Aykroyd, 1963). Medicinally used as toothache, disinfectant, antihelmintic, anti-diarrhea, anti-syphilitic, purgative, cordio tonic, laxative and also potentially cure to diabetes and hypertension. Melon fruit fly, *Bactrocera cucurbitae* (Diptera: Tephritidae: Dacinae) are economically important pests of the cucurbits and are geographically distributed throughout the tropics and subtropics of the world

(Chinajariyawong *et al.*, 2003), especially in most of the countries of South East Asia (Allwood *et al.*, 1999). It has more than 81 plant species as its host (Dhillon *et al.*, 2005a), but plants of family Cucurbitaceae are considered to be its preferred hosts (Allwood *et al.*, 1999). The infested fruits and flowers do not develop properly and fall down or rot on the plant and result in a dramatic reduction of yield (Dhillon *et al.*, 2005a, Haldhar *et al.*, 2013). Depending on the cucurbit species, season and prevailing climatic conditions, a loss of 30 to 100% can be caused by the melon fruit fly (Dhillon *et al.*, 2005b). As the maggots damage the fruits internally, it is difficult to control this pest with insecticides. Hence, development of varieties resistant to melon fruit fly is an impotent component of integrated pest management (Panda and Khush 1995). Cultivation of varieties/ genotypes resistant to fruit fly is a crucial component of integrated pest management programmes for ridge gourd because of difficulties associated with chemical and

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biological control. Development of ridge gourd varieties/ genotypes resistant to fruit fly has been limited in India owing to inadequate information on the sources of plant traits associated with resistance to pest infestations. The present study was designed to screening of ridge gourd varieties/ genotypes associated with resistance against melon fruit fly in terms of fruit infestation and larval density under field conditions.

**Materials and Methods**

Twenty nine varieties/ genotypes of ridge gourd viz., AHRG-49, Arka Sujata, AHRG-29, AHRG-36, AHRG-47, AHRG-41, S. Manjari, AHRG-31, AHRG-33, AHRG-42, AHRG-30, AHRG-57, S. Uphal, Pusa Nasdar, AHRG-35, Jaipuri Long, AHRG- 23, AHRG-56, AHRG-53, AHRG-58, AHRG-50, AHRG-28, AHRG-43, AHRG-44, AHRG-46, AHRG-48, AHRG-52, AHRG-59 and AHRG-61 were sown at experimental farm of Central Institute for Arid Horticulture (CIAH), Bikaner (28°06'N, 73°21'E). The crop was sown in rainy, 2011 and summer, 2012 with three replicates (blocks) for each varieties/ genotypes following a randomized block design. The area of each bed was 5 m × 2 m and the plant to plant distance was maintained at 50 cm with drip irrigation system. All the recommended agronomic practices (e.g. weeding, fertilization, hoeing, etc.) were performed equally in each experimental bed. Six pickings were done for the entire growing season of ridge gourd fruits. Ten fruits were

randomly selected from each picking from each experimental bed; a total of 30 fruits were taken from each picking of each genotype and were brought to the laboratory for microscopic examination for fruit infestation. The infested fruits were sorted and the percent fruit infestation was calculated. Ten fruits from all infested fruits from each picking of each genotype were then randomly selected for further examination, and the numbers of larvae were counted in each infested fruit. The varieties/ genotypes were categorized by following the rating system given by Nath (1966) for fruit infestation as: immune (no damage), highly resistant (110%), resistant (1120%), moderately resistant (2150%), susceptible (5175%) and highly susceptible (76100%).

**Calculation of host plant susceptibility indices (HPSI)**

The objective of the present study was to determine the role of varieties/ genotypes towards susceptibility in percentage within the test materials. The HPSI was calculated by the following formula (Aziz and Hasan, 2010).

$$\text{Percent HPSI} = 100 (B-A)/B \times 100$$

Where, A is larval population per fruit/ percent fruit infestation in individual genotype of ridge gourd and B is larval population per fruit/ percent fruit infestation on all varieties/ genotypes of ridge gourd on average basis.

Table 1. Larval density and percent fruit infestation of fruit fly on different variety/ genotypes of ridge gourd in arid region

S. No.	Varieties/ genotypes	2011 year (Rainy season)		2012 year (Summer season)		Pooled data		Resistance category
		Larval density/ fruit	Fruit infestation (%)	Larval density/ fruit	Fruit infestation (%)	Larval density/ fruit	Fruit infestation (%)	
1	AHRG-49	22.50	71.33 (57.61)	22.03	70.37 (57.00)	22.27	70.85 (57.30)	S
2	Arka Sujata	17.77	30.63 (33.59)	17.27	29.93 (33.15)	17.52	30.28 (33.37)	MR
3	AHRG-29	16.90	18.13 (25.19)	16.30	17.70 (24.85)	16.60	17.92 (25.02)	R
4	AHRG-36	17.07	35.23 (36.39)	16.53	34.70 (36.07)	16.80	34.97 (36.23)	MR
5	AHRG-47	27.80	78.20 (62.46)	27.27	77.83 (62.21)	27.53	78.02 (62.33)	HS
6	AHRG-41	16.57	22.27 (28.14)	16.20	21.93 (27.91)	16.38	22.10 (28.03)	MR
7	S. Manjari	20.37	40.43 (39.47)	19.70	39.90 (39.15)	20.03	40.17 (39.31)	MR
8	AHRG-31	29.27	80.47 (64.10)	28.57	79.80 (63.55)	28.92	80.13 (63.82)	HS
9	AHRG-33	26.20	68.53 (55.86)	25.67	67.73 (55.37)	25.93	68.13 (55.62)	S
10	AHRG-42	23.00	58.30 (49.46)	22.47	57.63 (49.37)	22.73	57.97 (49.57)	S
11	AHRG-30	22.93	56.17 (48.52)	22.33	55.70 (48.26)	22.63	55.93 (48.39)	S
12	AHRG-57	13.60	16.47 (23.92)	13.30	15.97 (23.53)	13.45	16.22 (23.72)	R
13	S. Uphal	18.70	42.97 (40.94)	18.20	42.43 (40.63)	18.45	42.70 (40.78)	MR
14	Pusa Nasdar	14.77	18.70 (25.61)	14.33	18.30 (25.31)	14.55	18.50 (25.46)	R
15	AHRG-35	17.70	25.90 (30.58)	17.30	25.33 (30.20)	17.50	25.62 (30.39)	MR
16	Jaipuri Long	18.60	36.40 (37.09)	18.07	35.87 (36.77)	18.33	36.13 (36.93)	MR
17	AHRG- 23	24.50	70.47 (57.07)	24.07	69.87 (56.69)	24.28	70.17 (56.88)	S
18	AHRG-56	17.57	25.20 (30.12)	16.93	24.87 (29.90)	17.25	25.03 (30.01)	MR
19	AHRG-53	18.17	27.50 (31.62)	17.63	27.13 (31.38)	17.90	27.32 (31.50)	MR
20	AHRG-58	22.60	55.23 (47.99)	21.93	54.77 (47.72)	22.27	55.00 (47.85)	S
21	AHRG-50	23.70	53.63 (47.07)	23.13	52.87 (46.63)	23.42	53.25 (46.85)	S
22	AHRG-28	24.33	66.17 (54.42)	23.90	65.33 (53.91)	24.12	65.75 (54.16)	S
23	AHRG-43	22.20	58.27 (49.74)	21.73	57.37 (49.22)	21.97	57.82 (49.48)	S
24	AHRG-44	21.10	46.97 (43.24)	20.60	46.43 (42.94)	20.85	46.70 (43.09)	MR
25	AHRG-46	21.30	47.30 (43.43)	20.67	46.77 (43.13)	20.98	47.03 (43.28)	MR
26	AHRG-48	27.43	80.43 (64.09)	26.90	79.77 (63.60)	27.17	80.10 (63.84)	HS
27	AHRG-52	25.23	70.13 (56.85)	24.63	69.23 (56.29)	24.93	69.68 (56.57)	S
28	AHRG-59	24.73	66.13 (54.30)	23.53	65.53 (54.03)	24.13	65.83 (54.21)	S
29	AHRG-61	28.60	79.77 (63.56)	27.87	79.07 (63.10)	28.23	79.42 (63.33)	HS
SEm±		0.85	1.43	0.83	1.43	0.84	1.43	
CD (P = 0.05)		2.42	4.07	2.36	4.05	2.38	4.06	

Data presented are mean of three replications, Figures in parentheses are angular value

### Statistical analysis

Transformations (angular transformed value) were used to achieve normality in the data before analysis (Steel *et al.*, 1997), but untransformed means are presented in tables. The data on percentage fruit infestation and larval density per fruit and biochemical fruit traits were analyzed through one-way ANOVA using SPSS 16 software (O'Connor 2000). The means of significant parameters, among tested varieties/ genotypes, were compared using critical difference (CD) tests for paired comparisons at probability level of 5%.

### Results and discussion

The twenty nine ridge gourd varieties/ genotypes

were taken for screening against melon fruit fly. The significant differences were found in percentage fruit infestation and larval density per fruit among the tested varieties/ genotypes during screening. The larval density per fruit had a significant positive correlation with percentage fruit infestation. Pooled data showed that the AHRG-29, AHRG-57 and Pusa Nasdar were the most resistant; Arka Sujata, AHRG-36, AHRG-41, S. Manjari, S. Uphal, AHRG-35, Jaipuri Long, AHRG-56, AHRG-53, AHRG-46 and AHRG-48 were moderately resistant; AHRG-49, AHRG-33, AHRG-42, AHRG-30, AHRG- 23, AHRG-58, AHRG-50, AHRG-28, AHRG-43, AHRG-52 and AHRG-59 were susceptible whereas AHRG-47, AHRG-31, AHRG-48 and AHRG-61 were the highly susceptible varieties/ genotypes

Table 2. Host plant susceptibility indices (HPSI %) for fruit fly on different variety/ genotypes of ridge gourd in arid region

S. No.	Varieties/ genotypes	HPSI based on larval population (%)			HPSI based on fruit infestation (%)		
		2011	2012	Pooled 2011-12	2011	2012	Pooled 2011-12
1	AHRG-49	104.36	104.92	104.64	142.92	142.70	142.81
2	Arka Sujata	82.41	82.22	82.32	61.38	60.70	61.04
3	AHRG-29	78.39	77.62	78.01	36.33	35.90	36.12
4	AHRG-36	79.16	78.73	78.95	70.59	70.37	70.48
5	AHRG-47	128.94	129.84	129.38	156.68	157.84	157.26
6	AHRG-41	76.84	77.14	76.99	44.61	44.48	44.55
7	S. Manjari	94.47	93.81	94.14	81.01	80.92	80.96
8	AHRG-31	135.75	136.03	135.89	161.22	161.83	161.53
9	AHRG-33	121.52	122.22	121.87	137.31	137.36	137.34
10	AHRG-42	106.68	106.99	106.83	116.81	116.88	116.84
11	AHRG-30	106.37	106.35	106.36	112.54	112.96	112.75
12	AHRG-57	63.08	63.33	63.20	32.99	32.38	32.69
13	S. Uphal	86.73	86.67	86.70	86.09	86.05	86.07
14	Pusa Nasdar	68.49	68.25	68.37	37.47	37.11	37.29
15	AHRG-35	82.10	82.38	82.24	51.89	51.38	51.64
16	Jaipuri Long	86.27	86.03	86.15	72.93	72.74	72.83
17	AHRG- 23	113.64	114.60	114.11	141.19	141.69	141.44
18	AHRG-56	81.48	80.63	81.06	50.49	50.43	50.46
19	AHRG-53	84.26	83.97	84.12	55.10	55.03	55.06
20	AHRG-58	104.82	104.44	104.64	110.67	111.07	110.86
21	AHRG-50	109.93	110.16	110.04	107.46	107.21	107.34
22	AHRG-28	112.86	113.81	113.33	132.57	132.50	132.53
23	AHRG-43	102.97	103.49	103.23	116.74	116.34	116.54
24	AHRG-44	97.87	98.10	97.98	94.10	94.17	94.13
25	AHRG-46	98.79	98.41	98.60	94.77	94.84	94.81
26	AHRG-48	127.24	128.10	127.66	161.16	161.77	161.46
27	AHRG-52	117.04	117.30	117.17	140.52	140.40	140.46
28	AHRG-59	114.72	112.06	113.41	132.51	132.90	132.70
29	AHRG-61	132.65	132.70	132.67	159.82	160.35	160.08

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# Yield, economics and water use of fenugreek (*Trigonella foenum-graecum*) as influenced by drip irrigation and bio-regulators

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## Abstract

An experiment was conducted during winter season of 2009-10 and 2010-11 to assess the effect of drip irrigation levels and bioregulators thiourea and N-acetyl cysteine on fenugreek (*Trigonella foenum-graecum*) at S.K. Rajasthan Agricultural University Farm, Bikaner. Increasing levels of drip irrigation from 0.6 to 1.0 ETc enhanced yield attributes viz., branch/ plant, pods/ plant, pod length, seeds/ pod and test weight. Increased yield attributes thus, enhanced seed yield (1.61 t/ha) and B:C ratio (1.25) with 1.0 ETc. However, highest water use efficiency (5.06 kg/ ha-mm) was recorded with 0.6 ETc. Recommended surface irrigation treatment recorded 1.42 t/ha seed yield using 540 mm of water. Whereas, fenugreek under drip irrigation at 0.6, 0.8 and 1.0 ETc used 278.16, 370.88 and 463.60 mm of water, respectively. Seed treatment of fenugreek before sowing with bio-regulator thiourea (500 ppm solution) for 4 hours recorded higher seed yield of 1.59 t/ha against 1.47 t/ha where no seed treatment was done. Thus, thiourea seed treatment fetched higher water use efficiency (4.29 kg/ha-mm) and B:C ratio (1.25). Further, foliar spray with 20 ppm N-acetyl cysteine at vegetative and seed formation stages recorded highest seed yield of 1.59 t/ha over 10 ppm N-acetyl cysteine spray (1.53 t/ha) or no spray treatment (1.47 t/ha). Increased yield thus enhanced water use efficiency and B:C ratio.

**Key words:** Bioregulators, Thiourea, N-acetyl cysteine, Drip irrigation level, Fenugreek, Harvest index, Seed yield, Water

## Introduction

Arid region of Rajasthan is home to seed spice fenugreek (*Trigonella foenum-graecum*). The seeds of fenugreek are used as condiment and seasoning agent for garnishing and flavouring dishes. Water is an indispensable factor for every metabolic activity of plant and limited quantity of water available for irrigation calls for proper scheduling of irrigation to improve water productivity of fenugreek (Mehta *et al.*, 2010). Recent trend of scheduling irrigation on the basis of climatological approach has been considered as most scientific, particularly under drip system, since it integrate all weather parameters giving them natural weightage in a given climate-plant-continuum (Parihar *et al.*, 1976). In arid western Rajasthan, drip irrigation on the basis of climatological approach hold great promise for minimizing water loss and improving its utilization efficiency and yield. Not much attention so far has been focused on improving plant biology, more particularly plant molecular mechanisms, which inherently influence not only acquisition of water and nutrient from the soil but they also govern their transport inside the plants and thus these are efficient in improvement of plant performance and yield formation. Sulphydryl (-SH-) compounds improve phloem translocation of photosynthate and crop productivity. Thus, they act as bioregulators and play an important role in improving water use efficiency

through enhanced phloem translocation and yield formation in arid regions. Further, pre-conditioning of seeds by soaking in solution of growth regulators is known to improve seeding emergence and vigour (Garg *et al.*, 2006). The information on bioregulators, thiourea and N-acetyl cysteine and drip irrigation on fenugreek growth and yield are meager. Hence, there is a felt need to generate precise information on irrigation requirement of fenugreek through drip and effect of bio-regulators- thiourea and N-acetyl cysteine on fenugreek.

## Materials and methods

The field experiment was conducted during winter (*rabi*) seasons of 2009-10 and 2010-11 at Experimental Farm of Swami Keshwanand Rajasthan Agricultural University, Bikaner situated in arid North-Western plain zone of Rajasthan. The soil was sandy loam in nature, having field capacity 6.5%, permanent wilting point 1.8%, bulk density 1.52 g/cc, pH(1:2) 8.2, electrical conductivity (1:2) 0.2 dS/m. The soil is very low in organic carbon (0.11%) and medium in available P (12.4 kg/ha) and high in available K (340 kg/ha). The treatments consist of three irrigation levels (0.6, 0.8 and 1.0 ETc), two levels of bioregulator thiourea (no seed treatment and seed treatment with 500 ppm thiourea for 4 hours before sowing), foliar sprays of bioregulator N-acetyl cysteine (no spray, 10 ppm

Table 1. Monthwise irrigation events and irrigation water applied (mean of 2 years)

Month	Irrigation events	Pan evaporation (mm)	Drip irrigation (mm)		
			0.6 ETc	0.8 ETc	1.0 ETc
December (1/5-31)	14	79.16	22.97	30.63	38.29
January	16	59.94	27.34	36.45	45.56
February	14	135.79	70.68	94.24	117.80
March	15	214.86	88.37	117.83	147.29
April (1-20)*	10	373.85**	68.80	91.73	114.66
Total	69	863.60	278.16	370.88	463.60

\*upto last irrigation, \*\* upto harvesting

## Results and discussions

### Irrigation levels

Increase in irrigation levels from 0.6 to 1.0 ETc under drip increased height and yield attributes viz., branch/ plant, pods/ plant, pod length, seeds/ pod and finally test weight (Table-2). Increased height and yield attributes with increasing irrigation levels through drip thus, enhanced seed yield of fenugreek and highest seed yield of 1.61 t/ha was recorded at 1.0 ETc against 1.5, 1.40 and 1.42 t/ha with irrigation at 0.8, 0.6 ETc and surface irrigation respectively. Yadav *et al.* (2006) also reported higher seed cotton yield (2.11 t/ha) with drip irrigation at 1.0 ETc compared to 1.70 t/ha at surface irrigation. Drip irrigation levels from 0.6 to 1.0 ETc saved water by 261.84 to 76.4 mm over surface irrigation which used 540 mm water. Hence, increased yield under drip irrigation recorded higher water use efficiency (WUE) of 5.06, 4.25 and 3.46 at 0.6, 0.8 and 1.0 ETc, respectively. Higher water use efficiency with lower level of

drip irrigation might be due to greater increase in seed production as compare to increase in water use (Mehta *et al.* 2010). Whereas, lowest water use efficiency of 2.63 was recorded at surface irrigation. It may be due to loss of irrigation water from sandy loam soil through deep percolation resulted in higher irrigation requirement but lowered seed yield under surface irrigation. The benefit of drip irrigation at 0.8 and 1.0 ETc was further evident by higher B:C ratio of 1.23 and 1.25, respectively against 1.01 under surface irrigation. However higher irrigation levels under drip reduced harvest index and highest harvest index of 35.66% was recorded at 0.6 ETc compared to 35.56 and 33.09% with 0.8 and 1.0 ETc, respectively (Table-2). It may be ascribed to enhanced ease in absorbing water in higher levels of irrigation which attributed to luxuriant growth and development but that did not totally translated into seed production.

Table 2. Height and yield attributes of fenugreek as influenced by drip irrigation and bioregulators (mean of 2 years)

Treatment	Height (cm)	Branch/ plant	Pods/ plant	Pod length (cm)	Seeds/pod	Test weight (g)
<b>Irrigation level</b>						
0.6 ETc	46.5	5.5	38.4	9.7	14.2	9.68
0.8 ETc	60.8	8.0	48.5	12.3	15.8	12.98
1.0 ETc	63.4	8.6	50.2	12.3	15.9	13.01
Surface irrigation	46.6	5.6	39.8	9.7	14.2	8.72
CD at 5%	1.5	0.4	2.8	0.5	0.3	0.4
<b>Thiourea</b>						
No seed treatment	55.5	7.1	43.5	10.5	14.8	11.2
Seed treatment (500 ppm)	58.3	7.6	47.9	12.4	15.8	12.6
CD at 5%	1.1	0.3	2.4	0.4	0.2	0.3
<b>N-acetyl cysteine</b>						
No spray	53.4	6.9	44.2	10.5	14.8	10.6
10 ppm spray	57.8	7.5	45.7	11.6	15.4	12.5
20 ppm spray	59.5	7.6	47.2	12.2	15.7	12.6
CD at 5%	1.5	0.3	2.8	0.5	0.3	0.4

### Bioregulators

Seed treatment before sowing with 500 ppm thiourea enhanced plant height, branch/ plant, pods/plant, pod length, seed/ pod and seed index (Table 2). Seed treatment with thiourea enhanced seed yield and water use efficiency by 8.6% over crop grown with untreated seed (Table 3). Further, seed treatment with thiourea (500 ppm) enhanced harvest index by 6% over untreated seed. This may be due to thiourea induced improved photosynthetic efficiency (Hernandez *et al.*, 1983) and phloem

translocation of photosynthate from source to sink (Sahu and Singh, 1995). Burman *et al.*, (2007) also reported higher seed yield of clusterbean when treated with thiourea in arid region. The benefit of seed treatment with thiourea was further depicted by higher B:C ratio of 1.25 against 1.10 in no seed treatment.

Foliar spray of N-acetyl cysteine (NAC) at vegetative and seed formation stages recorded higher yield attributes than no spray treatment (Table 2). Higher yield attributes in turn improved seed yield and highest seed yield

(1.59 t/ha) of fenugreek was recorded with 20 ppm NAC followed by 10 ppm NAC (1.53 t/ha) and no spray treatment (1.47 t/ha). Increased seed yield thus improved water use efficiency with higher doses of NAC spray. Similarly, 20 ppm NAC foliar spray also recorded higher B:C ratio of 1.21 against 1.17 with 10 ppm NAC and 1.13 with no foliar spray (Table 3).

#### Irrigation-thiourea interaction

Irrigation-thiourea seed treatment interaction was found significant. Thiourea seed treatment along with drip irrigation at 0.6 ETc improved seed yield by 15.7% whereas, thiourea seed treatment gave 7.8 and 3.6% higher

seed yield at 0.8 and 1.0 ETc irrigation level, respectively. Thus, thiourea seed treatment increased water use efficiency at every level of irrigation. However magnitude of difference is higher at lower level of irrigation (Table 4). It might be due to alleviation of adverse effect of stress at 0.6 ETc, which improved photosynthetic efficiency and more efficient nitrogen metabolism even under water stress conditions (Garg *et al.*, 2006). Further, sulphhydryl compound thiourea played a crucial role in enhancing phloem translocation of photosynthate from source to sink, which is evident by higher harvest index at lower level of irrigation (0.6 ETc) in thiourea treated crop (Sahu and Singh, 1995).

Table 3. Effect of irrigation and bioregulators on seed yield, biological yield, water use and benefit : cost ratio of fenugreek (pooled of 2 years)

Treatment	Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest index (%)	Water use (mm)	Water use efficiency (kg/ha-mm)	B:C ratio
<b>Irrigation level</b>							
0.6 ETc	1.41	2.54	3.95	35.66	278.16	5.06	1.03
0.8 ETc	1.58	2.85	4.43	35.56	370.88	4.25	1.23
1.0 ETc	1.61	3.25	4.85	33.09	463.60	3.46	1.25
Surface irrigation	1.42	2.63	4.06	35.09	540.00	2.63	1.01
CD at 5%	0.01	0.02	0.02	-	-	-	-
<b>Thiourea</b>							
No seed treatment	1.47	2.79	4.31	34.01	370.88	3.95	1.10
Seed treatment (500 ppm)	1.59	2.96	4.36	36.51	370.88	4.29	1.25
CD at 5%	0.01	0.02	0.02	-	-	-	-
<b>N-acetyl cysteine</b>							
No spray	1.47	2.64	4.21	33.55	370.88	3.97	1.13
10 ppm spray	1.53	2.96	4.43	34.48	370.88	4.12	1.17
20 ppm spray	1.59	3.03	4.57	34.71	370.88	4.28	1.21
CD at 5%	0.01	0.02	0.02	-	-	-	-

Table 4. Interaction of bioregulator- thiourea and irrigation on fenugreek (pooled of 2 years)

Treatment	Seed yield (q/ha)	Biological yield (q/ha)	Harvest index (%)	Water use (mm)	Water use efficiency (kg/ha-mm)
<b>Irrigation and thiourea interaction</b>					
0.6 ETc + No thiourea	1.31	3.79	34.47	278.16	4.69
0.6 ETc + thiourea seed treatment	1.51	4.11	36.78	278.16	5.43
0.8 ETc + No thiourea	1.52	4.30	35.24	370.88	4.09
0.8 ETc + thiourea seed treatment	1.63	4.55	35.91	370.88	4.41
1.0 ETc + No thiourea	1.58	4.85	32.54	463.60	3.40
1.0 ETc + thiourea seed treatment	1.63	4.86	48.55	463.60	3.52
CD at 5%	0.01	0.04	-	-	-

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## Rejuvenation of Nagpur Mandarin (*Citrus reticulata* Blanco.) through top working

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### Abstract

The experiment was carried out at the farmers' field at Nimoda and Ummedpura villages, Jhalrapatan, Jhalawar during the year 2009-10. Declining plants of Nagpur Mandarin were subjected to different time of top working. It was observed that mid October time of budding as a part of top working on beheaded plants had significantly better effect on budding performance and growth. Maximum bud take per cent (75.80 %), minimum days required to first sprouting (18.27 days), minimum days required to 50 per cent sprouting (53.26 days) and the maximum budding success (70.23 %) were recorded in mid October budding time. Under this treatment maximum length of sprout shoot (14.19 cm), diameter of sprout shoot (4.97), number of nodes (11.04), length of internodes (1.29), plant height (31.01 cm) number of leaves on sprout shoots (15.23), leaf area (15.23 cm<sup>2</sup>), perimeter of leaves (20.25 cm) and chlorophyll content (3.704 mg/g) were noted.

**Key words :** *Rejuvenation, Nagpur Mandarin, top working*

### Introduction

Nagpur Mandarin (*Citrus reticulata* Blanco.) is the most valued member of citrus group. It belongs to the family Rutaceae. Maharashtra, Rajasthan, Karnataka, Madhya Pradesh, Nagaland, West Bengal, Assam, Meghalaya and Tripura are the major mandarin producing states in the country. It covers 2.85 lac hectares area in India and the production is 20.84 lac tonnes. In Rajasthan, the fruit occupies 8900 ha area producing 1.35 lac tonnes of fruits annually (Anon., 2011). Mandarin fruits are rich in calcium and potassium. They are mostly consumed as fresh. Fruits are processed into various products and by-products. Essential oil and pulp are major by-products. Essential oils are used in cosmetics, soaps, perfumes and aromatherapy and for pharmaceutical purposes. The essential oil possesses anti-fungal property against phytopathogens. There are many reasons for low productivity, but the malady of citrus decline is the major contributing factor. All citrus species and varieties are susceptible to decline, but the mandarins are the most susceptible, followed by sweet oranges. The causes of this problem are still unknown. It may be due to several reasons such as mismanagement of the orchard, improper soil type, poor drainage, nutritional deficiencies, insects and diseases etc. Rejuvenation is resorted as an alternative to bring back the plant in its normal capability

(Singh *et al.*, 2010). Besides pruning, it may also be attempted through top working. Top working being feasible, it may be made use in averting the declining situation in citrus orchard provided extent of decline, age of tree, soil and climatic conditions etc also do favours. Keeping all these considerations in notion the present investigation was planned so as to observe the efficacy of top working on rejuvenation of the declining mandarin.

### Materials and Methods

The experiment was carried out in declining orchard of mandarin during the year 2009-10 at the farmers' field at Nimoda and Ummedpura villages, Jhalrapatan, Jhalawar. Jhalawar falls at 23°45'20" to 24°52'17" N latitude and 75°27'35" to 76°56'46" E longitude in South Eastern Rajasthan. The district receives on an average 954.7 mm rainfall. Maximum temperature range in the summer is 43-48 °C and minimum 1 - 2.6 °C during winter. The pattern of weather parameters during investigation period are presented by Fig. 1. The treatments consisted of budding operation followed during the period of 15 September, 1 October, 15 October, 1 November and 15 November 2010. Declining plants of Nagpur Mandarin were subjected to different time of top working following beheading them at 15 cm height from ground level during the second week of

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May, 2009. With three plants as an experimental unit and five replications, considering 75 plants from among declining plants the experiment was carried out. Observations on budding performance, stem parameters and leaf parameters were recorded. Under budding performance, bud take was recorded on the basis of number of buds which manifested swelling on a particular rootstock. Total number of buds sprouted, whether survived further or not, constituted the observation on bud take. The number of sprouted buds in different treatments were recorded in order to calculate the percentage of bud take. The per cent bud take was calculated after a fortnight of budding operation. All the budded plants were visited regularly and date on which bud sprouted was recorded. The sprout which continued surviving till one month after sprouting were included to record budding success per cent.

As a part of stem parameters the length of sprouted scion shoot was measured with the help of a meter scale. The diameter of new shoot was measured with the help of Vernier caliper. It was measured at the very base of its sprouting near the bud union. The height of the plant was measured from the level of soil surface to the highest tip of the plant with the help of a meter scale. The number of nodes was recorded by counting the number of nodes on entire plant. The length of internodes was measured between length of two nodes with the help of a meter scale. Leaves emerging from the newly sprouted scion shoot were counted to make observation on number of leaves present on the scion shoot.

Leaf area was measured with the help of a leaf area meter. The same leaves as used for recording leaf area were used to measure perimeter. Chlorophyll content was measured as per the method suggested by Sadasivam and Manickam (1997). The RWC (relative water content) of leaves was also measured using the following formulae (Yadav, 2009):

$$\text{RWC (\%)} = \frac{\text{FW-DW}}{\text{TW-DW}} \times 100$$

Where: FW = Fresh weight; DW = Dry weight and TW = Turgid weight. As a part of the formulae (a) Fresh weight of leaves was measured selecting three fully grown leaves from the plants randomly at 15 days interval followed by weighing them with the help of an electronic balance (b) Turgid weight of the leaves was recorded selecting the same leaves as used for recording fresh weight followed by dipping them in distilled water for 24 hours and recording their weight with the help of an electronic balance (c) Dry weight of leaves was recorded by subjecting the turgid weight measured leaves to drying treatment in oven at 60°C for 24 hours and recording the weight thereof.

## Results and Discussion

### Budding performance

The maximum bud take percentage (75.80 %), minimum days required to first sprouting (18.27), 50 % sprouting (53.23) and budding success (70.23 %) were observed when budding was done on 15 October (Table 1, Fig. 2). It may be due to rapid and complete union of xylem and cambium tissues favouring closer matching of the scion to the rootstock tissues (Hartmann *et al.* 1997). The low bud-take percentage as observed in case of 15 September budding might be due to low callus formation (Hartmann *et al.*, 1997) under comparatively higher temperature prevailing during the period as compared to 15 October budding. Morton *et al.* (1972) observed the role of weather in bud union and sprouting in custard apple. Budding attributes being dependent upon climatic conditions especially temperature, humidity, rainfall, sunshine hours etc, the climatic condition prevailing during October might have favoured better response as observed under 15 October budding treatment. Hartmann *et al.* (1997) reported 24-28°C temperature was optimum for budding which coincides with the prevailing temperature prevailed during October. Less bud take and budding success with September budding might be due to comparatively higher prevailing temperature and also the occurrence of rain attributing rotting and thus failure of bud intake. Bruno (1962) reported poor bud break in rainy season (May-September) owing to *Fusarium* and *Phytophthora* infections. Decline in per cent bud sprouting during second week of September due to unfavorable weather conditions has also been recorded by Singh *et al.* (2003) in aonla. The findings of present investigation are in consonance with the results as observed by Mukherjee and Singh (1966) who reported best results by budding Sweet orange (cv. Pineapple) on *Citrus jambhiri* rootstock in October under Delhi condition.

### Growth parameters

The length and diameter of newly emerged shoot got influenced significantly by the time of budding (Table 2). As regard to the effect of time of budding on the length (14.19 cm) and diameter (4.97 mm) of newly emerged shoots, it was observed that plant when budded on 15 October had significantly higher length of scion shoot. Under this time of budding, the plant also had maximum plant height (31.01 cm) (Table, 2, 4 and Fig. 2, 3, 4). It may be due to quick and strong formation of union between the rootstock and bud and increased sap flow (Skene *et al.*, 1983) and subsequently due to greater utilization of nutrients by sprouted shoot. The prevalent climatic conditions during October might favour maximum length, diameter and the height of scion shoot, during growth phase of scion. The results are in conformity to the results as observed by Pandey and Prasad (1980) in case of aonla budding. The data on number of nodes and length of internodes were influenced significantly by different

periods of budding. With, 15 October budding, maximum number of nodes (11.04) and length of internodes (1.29 cm). The role of low temperature in restriction of growth has been highlighted by Singh (2002). Minimum plant height (23.27 cm), were recorded when budding was done on 15 November and observations were made on 15 March. It may be due to falling winter soon after budding which might restrict growth more to plants budded during 15 November as compared to those budded during 15 October. Further, the period of growth also got lessened with budding performed during November. The role of low temperature in restriction of growth has been highlighted by Singh (2002).

### Leaf parameters

The data as regard to leaf parameters are presented in Table 3 and 5 and Fig.4. Number of leaves, leaf area and other leaf parameters got influenced significantly by time of budding. The maximum number of leaves on sprouted scion (15.29), leaf area (15.23), perimeter of leaves (20.25 cm) and chlorophyll content (3.704 mg/g) was observed when budding was done on 15 October. It might be due to absorption and translocation of nutrients besides photosynthetic ability which might get promoted by more number of leaves on the scion shoot. The role of leaves in photosynthetic production and consequently growth has been highlighted by Sestak (1981). Significant variation in leaf parameters were noted with advancement of growing

periods. It may be due to on going development process accounting to cell division, expansion and differentiation governing size, shape and structure of plants (Taiz and Zeiger, 2002). The results obtained are in accordance with the earlier findings as quoted by Dubey and Singh (2003). The maximum chlorophyll content (4.263 mg/g) and relative water content of leaves (78.07 %) were found when budding was done on 15 October. It may be due to temperature dependent synthesis of chlorophyll in leaves on shoots appeared after budding and their better resumed growth budding afterwards. During 15 March, the plant had maximum relative water content (71.14 %) of leaves. All other period manifested significant effect on relative water content of leaves. The interaction reflects that the plant budded on 15 October had maximum relative water content in leaves (78.58 %) on 15 March which was significantly superior over all other interactions. The RWC in leaves showed progressive decline with advancement of period from March towards April. Such observation may be linked to stomatal conductance of leaves and prevailing temperature and relative humidity of atmosphere. Higher the temperature and lower the relative humidity, lower the RWC. The lower RWC of leaves during the September month may be ascribed owing to increased temperature and consequent loss of water through stomata. The loss of water from stomata of leaves has been highlighted by Malik and Srivastava (1980).

Table 1. Effect of time of budding on budding performance in top worked plants of Nagpur Mandarin

Budding time	Bud take percentage (%)	Days required to first sprouting	Days required to 50 % sprouting	Budding success (%)
15 Sept	62.43	23.09	59.72	43.47
1 Oct.	63.55	20.87	55.33	53.23
15 Oct.	75.80	18.27	53.26	70.23
1 Nov.	68.36	25.18	92.19	34.55
15 Nov.	66.29	27.46	95.09	25.19
SE(m) ±	0.103	0.083	0.133	0.115
CD at 5%	0.311	0.250	0.403	0.347

Table 2. Effect of time of budding on growth parameters in top worked plants of Nagpur Mandarin

Budding time	Length (cm) of sprouted scion	Diameter (mm) of sprouted scion	No. of nodes	Length of internodes (cm)
15 Sept	11.98	4.22	9.30	1.26
1 Oct.	12.82	4.55	10.18	1.27
15 Oct.	14.19	4.97	11.04	1.29
1 Nov.	11.42	4.10	8.98	1.25
15 Nov.	10.23	3.92	8.03	1.23
SE(m) ±	0.0484	0.011	0.0417	0.0036
CD at 5%	0.1372	0.0311	0.1181	0.0102

Table 3. Effect of time of budding on leaf parameters in top worked plants of Nagpur Mandarin.

Budding time	Number of leaves	Leaf area (cm)	Perimeter of leaves (cm)	Chlorophyll content (mg/g)
15 Sept	12.89	13.33	18.69	2.928
1 Oct.	14.62	13.93	18.93	3.340
15 Oct.	15.29	15.23	20.25	3.704
1 Nov.	11.84	12.71	17.47	2.438
15 Nov.	10.85	11.52	17.16	2.205
SE(m) ±	0.0565	0.0663	0.0606	0.0156
CD at 5%	0.1602	0.1901	0.1718	0.0442

Table 4. Effect of time of budding on plant height (cm) in top worked plants of Nagpur Mandarin during different period

Budding time	Plant height (cm)			
	15 March	1 April	15 April	Mean
15 Sept	24.95	28.27	30.89	28.04
1 Oct.	26.03	29.24	31.97	29.08
15 Oct.	27.19	30.81	33.71	30.57
1 Nov.	24.02	26.78	29.67	26.82
15 Nov.	23.27	25.85	28.79	25.97
Mean	25.09	28.19	31.01	
	SE(m) ±	CD at 5%		
Budding time (BT)	0.0517	0.1464		
Period (P)	0.04	0.1134		
BT x P	0.0895	0.254		

Table 5. Effect of time of budding on relative water content (%) of leaves in top worked plants of Nagpur Mandarin during different period

Budding time	Relative water content (%) of leaves			
	15 March	1 April	15 April	Mean
15 Sept	65.22 (53.84)	64.74 (53.55)	64.32 (53.30)	64.76 (53.56)
1 Oct.	67.41 (55.17)	66.93 (54.88)	66.49 (54.61)	66.94 (54.89)
15 Oct.	78.58 (62.41)	78.01 (62.01)	77.61 (61.74)	78.07 (62.05)
1 Nov.	74.58 (59.70)	74.08 (59.37)	73.62 (59.07)	74.09 (59.38)
15 Nov.	69.92 (58.72)	69.32 (58.34)	68.90 (56.08)	69.38 (57.71)
Mean	71.14 (57.97)	70.62 (57.63)	70.19 (56.96)	
	SE(m) ±	CD at 5%		
Budding time (BT)	0.0277	0.0785		
Period (P)	0.0215	0.0608		
BT x P	0.048	0.136		

Note: Figures in parentheses indicate angular transformed value.

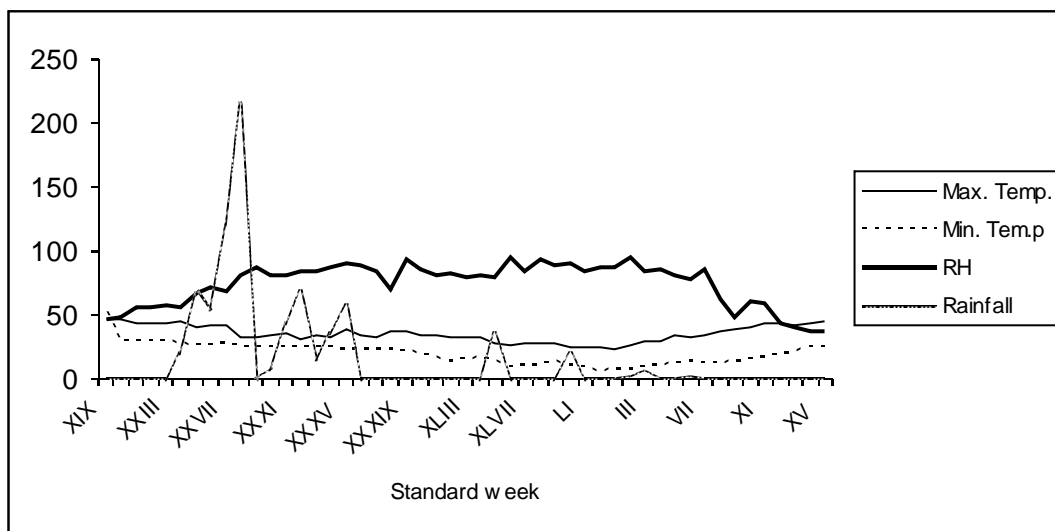


Fig 1. Pattern of weather parameters during 14 May, 2009 to 21 April, 2010.

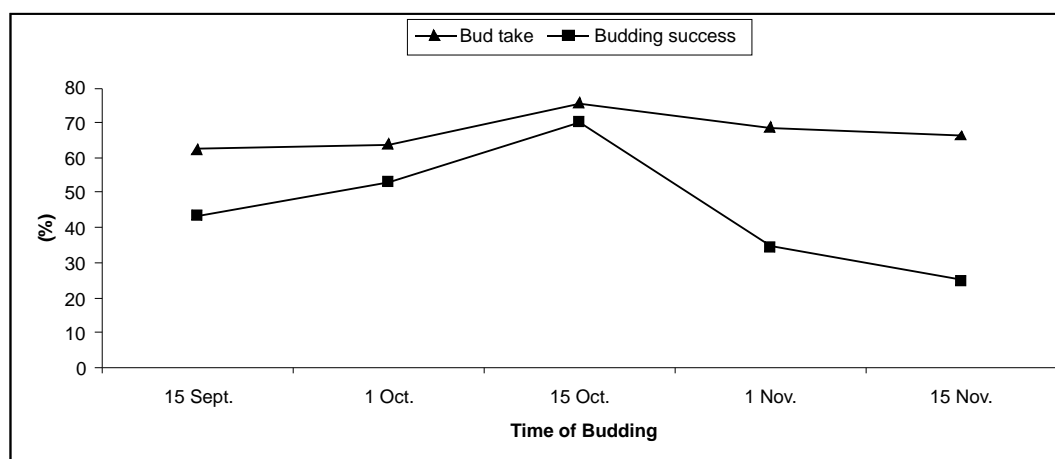


Fig.2. Effect of time of budding on bud take and budding success in top worked plants

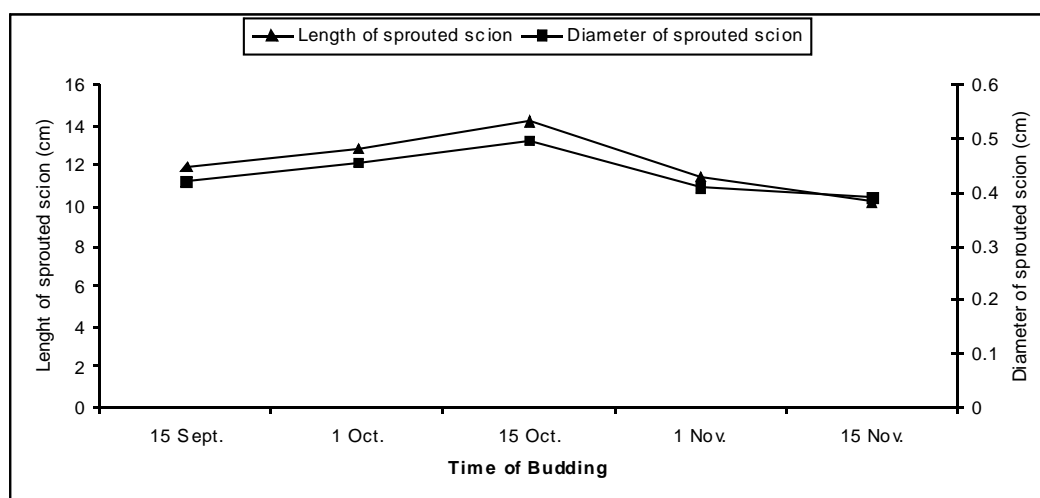


Fig. 3. Effect of time of budding on stem parameters in rejuvenation of Nagpur Mandarin

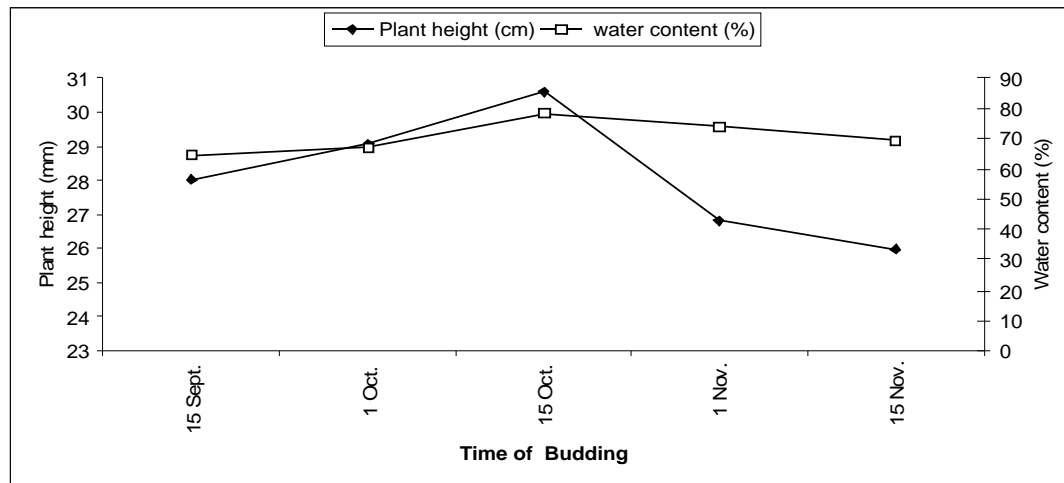


Fig. 4. Effect of time of budding on plant height (cm) and relative water content (%) of leaves in top worked plants of Nagpur Mandarin during different period

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# Ethnomedicinal Plants of Rajasthan Desert used in Herbal and Folk Remedies

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The Rajasthan desert is very rich in medicinal plant wealth. The medicinal plants of this region have great potential to be used in drug and pharmaceutical industries. These medicinal plants have been used by local people, tribal communities, vendors, native doctors such as Ojhas, Bhagats, Bhopas and experts of Ayurvedic fields since long time in herbal and folk remedies. Kalbelia, Nats, Bhils, Raika, Banjara, Gadolia-Lohar, Garasia, Kathodi, Dhanka, Saharia, Damor and Meena communities of this region have a rich knowledge of plants based traditional medicines. Ten ethnomedicinal plants like *Calotropis procera* (Ait.) R. Br., *Cleome gynandra* Linn., *Clerodendrum phlomidis* Linn., *Echinops echinatus* Roxb., *Leucas aspera* (Willd.) Spreng., *Mimosa hamata* Willd., *Moringa oleifera* Lamk., *Peganum harmala* Linn., *Sida cordifolia* Linn., *Solanum surattense* Burm. have been selected for this research work. The present investigation is aimed to create awareness about the ethnomedicinal value of the plants and their uses to draw the attention of pharmacologists, phytochemists and pharmaceuticals.

**Key words:** Ethno medicinal plants, Rajasthan Desert, Herbal and Folk Remedies

## Introduction

India is one of the richest floristic regions of the world and is well known for its ancient heritage regarding medicinal plants and plant drugs. Medicinal plants occupied an important position in the socio-culture, spiritual and medicinal arena of rural people of Rajasthan. The inhabitants of remote areas of arid zone of Rajasthan are totally dependent on indigenous system of medicine for their health care as it is difficult for them to get modern medical facilities for their day to day health problems. The traditional healers and inhabitants of this region have a rich knowledge of traditional plant based medicines. To preserve this valuable knowledge, there is a need to document it. This will not only provide recognition of this undocumented knowledge but will also help in conservation of such important medicinal plants. The Ethnomedicinal plants of Rajasthan have been studied for their medicinal uses in herbal and folk remedies by many workers like Singh and Pandey (1998), Katewa and Sharma (2001), Singh *et al.*, (2002), Kapoor and Ranga (2003), Kapoor and Ranga (2005), Sharma and Kumar (2006), Kapoor and Ranga (2008), Kapoor and Prajapat, 2010, Kapoor *et al.*, 2010, Kapoor (2010), Kapoor (2011), Sharma and Kumar (2011), Kapoor (2012), Kapoor and Kumar (2013), Kapoor and Sharma (2013).

The present chapter highlights the importance of ethnomedicinal plants of Rajasthan Desert. Rajasthan

Desert covers most of the north-western part of Rajasthan state. This region exhibits a great variety of geology, physiography, climatic, edaphic and biotic conditions and represents diversity of medicinal plants, which occur on a wide range of habitat. Kalbelia, Nats, Bhils, Raika, Banjara, Gadolia-Lohar, Garasia, Kathodi, Dhanka, Saharia, Damor and Meena communities of this region have a rich knowledge of plants based traditional medicines used in herbal and folk remedies.

## Materials and Method

To collect and document this valuable information, several field trips were made in all the twelve districts of this region. Interviews were conducted with experienced people of various tribal communities, vendors, experts of Ayurveda, and native doctors such as Ojhas, Bhopas, Bhagats and Vaidyas as they possess inherited knowledge regarding the plants of ethnomedicinal importance. Repeated enquiries and group discussion on the use of same plant were made to ascertain the authenticity of information.

## Results and Discussion

Ten important ethnomedicinal plants are described here in brief with their botanical name, family, local name and ethnomedicinal uses.

### 1. *Calotropis procera* (Ait.) R. Br.

**Family:** Asclepiadaceae

**Local Name:** Aak, Aakra, Madar

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#### **Ethnomedicinal Uses:**

- The tribals use the plant to cure liver disorders.
- The milky latex and its flowers are cooked in earthen utensils to dry ashes. The ashes are to be taken with honey regularly one teaspoonful twice daily to cure asthma.
- Dried leaves are smoked in a pipe to cure asthma and cough.
- Dried roots (1kg) and *Achyranthes aspera* (250 gm) are mixed with dried rhizome of *Curcuma longa* (250 gm) and *Gingiber officinalis* (250 gm) and placed in earthen pot. This mixture is burned slowly to make ash. Half teaspoonful of this ash is taken by tribals with honey twice a day for 15 days to cure asthma.
- One gynostegium is given to the patient of asthma for 1<sup>st</sup> day, two for 2<sup>nd</sup> day, three for 3<sup>rd</sup> day and so on up to seven days and again it is given in decreasing order like seven for 8<sup>th</sup> day, six for 9<sup>th</sup> day and so on to cure asthma.
- Latex mixed with jiggery to consume as such to cure asthma.
- 5-6 flowers soaked in buttermilk for 2-3 hours are cooked as vegetables and eaten as such to cure asthma.
- A hollow is made into stem of this plant. Mixture is prepared by adding 50 gm coriander seeds, 50 gm sugar candy and some dry chestnuts. The mixture is kept in the hollow and closed for 8 days. On ninth day this mixture is taken out and consumed orally in the morning for 8 days to cure asthma.
- The Bhil tribals boil the dry stem bark with mustard oil and 3-4 pieces of garlic and apply this paste against rheumatic pain.

#### **2. *Cleome gynandra* Linn.**

**Family** - Cleomaceae

**Local name** - Safed bagro, Karalia, Hulhul

#### **Ethnomedicinal Uses**

- The decoction of seeds is given orally in cough, cold and fever.
- Bhils believe that leaf-juice when dropped in the ears, it is very effective to cure intermittent fever-locally called 'Tihalia or Otagia'.
- They also rub the leaves in rheumatic pains and headache.
- Garasia tribe eat fresh leaves to cure intestinal ulcer and take orally 5-10 gm seed powder with cold water daily after dinner for three days to cure painful piles and for removing intestinal worms.

- The tribals eat the vegetable of leaves to cure night-blindness and apply the seed powder on the eyes to improve eye-sights.
- Leaf extract is poured in the ear to cure earache.
- The paste of fresh leaves is applied locally to cure skin diseases.
- Seed powder is used to improve eye sight.
- Patient suffering from scorpion bite is made to smell the pieces of hulhul root seven times.

#### **3. *Clerodendrum phlomidis* Linn.**

**Family** - Verbenaceae

**Local name** - Arni, Yerna, Anni

#### **Ethnomedicinal Uses**

- Bhils apply leaf-juice on the male sex organs to cure syphilis.
- The decoction of fresh roots is also given by them orally to cure gonorrhoea and to the children to cure measles.
- The Garasia tribals mix the twigs of this plant with the fodder of their cattle suffering from diarrhoea and worms.
- They also apply non-edible seed oil to their hairs as a hair tonic.
- The Saharia and Damor tribals take about 50 gm leaves and boil them in 250 ml water till it is reduced to one-fourth. Now the decoction is filtered and little sugar is added to it before taking orally thrice a day for two days to cure pain of joints.
- However, the Bhils prepare a sweet called 'Laddoo' with seed powder, ghee and flour of *Sorghum bicolor* (Jowar) and give to the patients of rheumatism.
- They also apply leaf-juice on the pimples and wounds.
- Two tea spoon mixture of powder of dried roots and leaves is taken twice a day for 15-20 days to cure body swelling and bodyache.
- Paste of leaves is bandaged on swollen part of the body whereas in eczema and other diseases it is applied locally and 1/4<sup>th</sup> cup of juice of leaves is also taken orally.
- The fresh leaves are tied over the eyes in ophthalmia.
- The paste of root is applied locally in snake-bite as antidote whereas the decoction of roots is taken orally by the tribals as demulcent in gonorrhoea and obesity.
- Dried shoot powder of *Clerodendrum phlomidis* and leaf powder of *Azadirachta indica* are fried in purified butter and paste is prepared. This paste is applied locally by the tribals once a day for seven

days to cure eczema.

#### 4. *Echinops echinatus* Roxb.

**Family** - Asteraceae

**Local name** - Oont-kanti, Oont-katalo

##### **Ethnomedicinal Uses**

- The Garasia and Bhil tribals apply root powder mixed with gum of *Acacia senegal* (Kumatio) to destroy lice, ticks and to heal up the wounds of cattle.
- Decoction of roots is placed in the navel of women for easy and quick delivery by the Garasia tribe in Jodhpur district.
- Saharia tribals take orally the infusion of plant with Jaggery (Gur) to cure cough, hysteria, dyspepsia and seminal debility.
- Kathodi and Dhanka tribals, however, boil the pieces of roots in milk and drink the latter for sexual vigour.
- Bhils take orally the extract of roots to cure cough and cold.
- The tribals apply the root paste on the body in fever.
- The Kathodi tribes give infusion of leaves and inflorescence in the morning for seven days to the barren ladies to induce fertility.
- They also put inflorescence on fire and inhale fumes through mouth to cure teeth infection.

#### 5. *Leucas aspera* (Willd.) Spreng.

**Family** - Lamiaceae

**Local name** - Goma

##### **Ethnomedicinal Uses**

- The plant is used traditionally as an antipyretic. Medicinally it has been proven to possess various pharmacological activities like antifungal, antioxidant, antimicrobial, antinociceptive and cytotoxic activity
- Warmed leaves are applied locally on painful swelling, whereas leaf paste is applied locally on various skin diseases like eczema, warts etc.
- The inflorescence is massaged by the tribals on forehead to cure headache and migraine.
- Poultice of warmed leaves is applied locally in abdominal pain and gastric complaints.
- Leaf paste is applied locally in leprosy while root paste is used in hemicrania.
- The smoke of whole plant is inhaled by the tribals to cure chickenpox.
- Leaves are considered useful in chronic rheumatism, psoriasis and other chronic skin eruptions.

- Bruised leaves are applied locally in snake bites.

#### 6. *Mimosa hamata* Willd.

**Family** - Mimosaceae

**Local name** - Jinjani, Jinjania, Liptti, Bander-Ki-Rakhi

##### **Ethno medicinal Uses**

- The Garasia and Bhils tribes take about 5 gm of seed powder with buffalo milk during night for seven days to cure sexual weakness in males.
- Saharia tribes apply fresh juice of leaves to check bleeding from the wound and ulcer.
- Kathodi tribals, however, take orally the leaf juice in diarrhoea and dysentery.
- The criminal tribes especially Kanjar, give the leaf juice with goat milk to the children to cure bronchitis.
- Mixture of flower powder of *Mimosa hamata* and powder of bunch of sterile flowers of *Mangifera indica* is given to women in leucorrhoea and menorrhagia.

#### 7. *Moringa oleifera* Lamk.

**Family** - Moringaceae

**Local name** - Sanjna, Hargua, Sargua, Segu, Sahjan, Sainjna

##### **Ethnomedicinal Uses**

- The fresh roots and stem bark are crushed with little water and the paste is applied to the joints for relief in swellings, tumour and in rheumatic pain by Bhils.
- Bruised fresh leaves are mixed with lime and applied to the wounds caused by snake-bite and dog-bite by the nomadic tribe Kalbelia.
- In this region however, the bark powder mixed with the bark powder of *Azadirachta indica* is given orally for 2-3 days and their paste is applied on the spot of bite.
- Garasias give the extract of fresh leaves with goat milk and sugar in acute dyspepsia and without milk in acute diarrhoea.
- The leaves of plants are used to treat scurvy and catarrhal affection, paste of the leaves is applied externally on wounds.
- Flowers are tonic, diuretic, and cholagogue.
- The seeds are antipyretic. The oil extracted from seed is used to treat gout and rheumatism.
- The roots of the young tree and root bark are vesicant and rubefacient.
- The folks found that pods are made into vegetable and is useful in care of spleen disorders, diabetes and constipation.

- The Garasia tribe has found this plant quite beneficial in curing fever, stomachache in children and pain during menstruation. Mainly leaves, roots and bark of stem are used.
- In Siddha system of medicine, leaves are used to cure boils and abscess.

### 8. *Peganum harmala* Linn.

**Family** Zygophyllaceae

**Local name** - Harmal, Gandhiyo, Syrian Race

**Ethnomedicinal Uses**

- Garasia tribes inhale the smoke of the dry plant for relief in toothache.
- The decoction of leaves is given orally to cure rheumatism and seed powder is given orally to the children with water as a vermifuge against tape worm.
- The Garasias and Bhils make a paste of root and seed powder in mustard oil and apply on hair to kill the lice.
- Meena tribes boil the seeds in *Sesamum* oil (Til) and drop the latter in the ears to cure earache.
- The decoction of entire plant is considered as a strong abortifacient by Bhils and Garasia tribals and they use it only when the *Plumbago zeylanica* (Chitrak) and *Rhynchosia minima* (Kalta) are not available to them, since latter are rather soft and safe for causing abortion.
- Seeds contain harmaline, yageine and harmine alkaloids, so the plant and dried seeds are used as drug.
- It has narcotic, emetic and anthelmintic properties. It is used in the treatment of jaundice, fever and painful menstruation, colic pains gallstones, asthma, hysteria and rheumatism.
- Higher doses are toxic and cause nervous depressions. The alkaloids act as hallucinogen. It stimulates motor tracts of cerebrum and central nervous system. Experiments have confirmed bactericidal action of the drug.

### 9. *Sida cordifolia* Linn.

**Family** Malvaceae

**Local name** - Bal, Kungyi, Sahaderi, Bala

**Ethnomedicinal Uses**

- Bhil and Saharia tribes apply pounded leaves on cuts and take internally to cure diarrhoea of pregnant woman.
- Kathodi tribals prepare a paste of flowers and unripe fruits and take orally with water against

painful urination.

- Kathodi tribals also take the roots orally with sugar to cure the effect of sun-stroke.
- The seeds make general tonic for improving sexual strength.
- Decoction of roots is administered in fever.
- The powder of root bark (with milk and sugar, or singly) is given in certain disease of woman, such as leucorrhoea and in nervous diseases.
- Root juice is used for promoting healing of wounds.
- The bark of the root, with sesamum oil and milk is efficacious in curing certain types of facial paralysis.
- Seeds of the plant are considered useful in gonorrhoea and colic pains.
- The parts of its leaves are applied in ophthalmic diseases.

### 10. *Solanum surattense* Burm.

**Family:** Solanaceae

**Local Name:** Ringani, Bhurhingani

**Ethnomedicinal Uses:**

- Bhils smoke the dry fruits to cure cough.
- The extract of roots is taken orally to cure cough.
- Decoction of whole plant with *Ocimum sanctum* (Tulsi) juice is taken orally to cure cough and asthma.
- The Damor tribes smash 9-10 anthers or 2-3 flowers and take orally twice daily for 2-3 days to cure cough.
- The Roots are thoroughly washed in water and a paste of root-bark is prepared and applied on swollen part of testicles.
- Local tribals use the root powder with honey to eat for about a month after meal to the women to increase fertility and chances for early pregnancy.
- The plant if dipped in water overnight and decoction is given to the patients cures Syphilis.
- Leaves are applied as such to relieve muscular pain.
- The juice of leaves with black pepper is given to cure rheumatism.

### Conclusion

This arid region of Rajasthan is a rich repository of genetic material of important ethnomedicinal plant wealth. Tribal communities have been using these medicinal plants as traditional medicines in herbal and folk remedies since long. There is an urgent need to create greater awareness amongst the population for protection and conservation of

these ethnomedicinal plants. These studies of ethnomedicinal aspects will be useful for further researches in the field of pharmacology, phytochemistry and pharmaceutical chemistry.

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# Long-term effect of Raw Sewage Application on Chemical Composition of Vegetables Grown on Sandy Soils of Western Rajasthan.

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## Abstract

Sewage water from Nathusar drain irrigating the vegetable crops in Shriramsar and Sujandesar area was collected and analysed for the various chemical constituents. Five vegetables of winter season Spinach, Fenugreek, Cauliflower, Cabbage, and Radish and five vegetables of summer season Bottle gourd, Ridge gourd, Amaranth, Cucumber and Brinjal from the fields irrigated with sewage were collected at the stage to be picked up for marketing. The sewage water of Nathusar drain of Bikaner city contain higher values of EC, adjusted SAR, TSS and BOD, however, the metallic cations content were below the recommended maximum permissible concentrations. A higher inorganic and organic loading of sewage water and metallic cations buildup particularly Zn, Cu and Fe in vegetables under study call for passing of the sewage water through an effluent treatment plant before being diverted for irrigation in this area also as it is being passed through treatment plant in the Jorbeer area of the city.

**Key words:** *Sewage water, sandy soils, vegetables*

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## Introduction

Demographic growth, increasing urbanization, industrialization and change in life style triggering greater use of detergents, domestic sprays, medical wastes, etc. are expected to produce larger quantities of anthropogenic wastewaters with different composition. It is estimated that the present population of India of more than one billion is expected to cross 1.5 billion marks by 2050. More than 50% of the total population will be in urban sector and number as well as size of settlements will multiply. Presently about 15% of India's water resources are consumed in domestic and industrial requirements and share of these two sectors will grow to about 30% by 2050.

The disposal of domestic waste water through crop irrigation is an age-old practice in India, which is an excellent and a convenient means of sewage disposal through land application. Irrigation with sewage water not only meets the water requirement but also fulfill partial nutrient need of the crop. Besides this, under arid and semi arid conditions, where irrigation is a pre-requisite for successful agriculture, sewage water as a source of irrigation is equally important as the need for its disposal.

Use of sewage water in agriculture can contribute to a reduction in stress on the utilizable water resources. It will not only reduce disposal problems of sewage but also contribute towards the up-gradation of soil fertility as it

contains appreciable amounts of macro and several micronutrients (Mitra and Gupta 1999). In general, sewage effluents from municipal origin contain appreciable amounts of plant nutrients and therefore, its use as a source of irrigation in agriculture is worth. The raw sewage water contain beneficial (Zn, Cu, Fe, Mn) as well as toxic-metals such as Cd, Pb, Ni, Cr, etc in addition to various bacteria and viruses. These contaminants behave differently after entering a particular medium or following a particular path depending upon the stability of the contaminant, interaction of the contaminant with the medium and the interaction of contaminant with other contaminants (Lundgren, 1986). A long-term and indiscriminate use of raw sewage water may prove hazardous to human health since it contains variable amounts of metallic cations. Thus, keeping in view the importance and risks of using raw sewage water to irrigate different vegetable crops in the arid area, this study was conducted to achieve the objectives.

## Material and Methods

The sewage water being used in the Shriramsar and Sujandesar area of Bikaner city is raw (untreated) mainly for growing vegetables and berseem and sorghum for fodder. The major portion of sewage water in Bikaner city is contributed from the domestic waste water and a very small portion contributed from the wool industries and cottage tying and dyeing industries. Most of the soils of the area are sandy in texture having very low to low soil fertility. Organic

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carbon content of most of the soils rarely exceeds  $1 \text{ gm kg}^{-1}$ . Phosphorus and potassium status of soil varies from low to medium and medium to high, respectively. So far as micro nutrients are concerned zinc and copper are low but iron and manganese are sufficient to support the crop plants. However, the calcareous nature of the soils imparts hindrance in micro nutrient availability to plants. Soils of the region were slightly alkaline in reaction having pH ranging between 7.66 to 8.67 and non saline, EC ranging between  $0.30$  to  $1.24 \text{ dS m}^{-1}$ .

Raw sewage water from Nathusar area drain irrigating the vegetable crops in Shriramsar and Sujandesar area was collected to analyse the chemical constituents. A part of sample so collected was acidified by adding Nitric acid at the rate of  $5 \text{ ml/l}$  and kept for analysis of metallic cations. The metallic cations Zn, Cu, Fe, Mn, Ni, Pb and Cd were analysed with the help of Atomic Absorption Spectrophotometer. The un-acidified part of the sample was analysed for pH, EC, BOD, TSS, Cations, Anions, Phosphates and Nitrates employing the methods suggested by Trivedi and Goel (1984) and APHA-AWWA-WPCF (1975).

Five vegetables of winter season Spinach (*Spinacea oleracea*), Fenugreek (*Trigonella foenum-graecum*), Cauliflower (*Brassica oleracea var. Botrytis*), Cabbage (*Brassica oleracea var. capitata*), and Radish (*Raphanus sativus*) and five vegetables of summer season Bottle gourd (*Lagenaria siceroria*), Ridge gourd (*Luffa acutangula*), Amaranth (*Amaranth spp*), Cucumber (*Cucumis sativus*) and Brinjal (*Solanum melongena*) from the fields irrigated with sewage were collected at the stage to be picked up for marketing. From locations under study five samples of each vegetable were collected and chopped to make a composite sample for analysis. The vegetable samples so collected were dried at  $65^\circ\text{C}$  in hot air circulating oven to a constant weight. After processing, the vegetable samples were digested with  $\text{HClO}_4\text{-HNO}_3$  acid mixture and analysed for N, P, K and metallic cations (Zn, Cu, Fe, Mn, Ni, Pb and Cd) using standard methods of analysis.

## Results and Discussion

Chemical composition of sewage water (Table 1) indicated that pH and EC of water sample were 8.3 and  $2.1 \text{ dSm}^{-1}$ , respectively. The sewage water was slightly alkaline in reaction having a higher electrical conductivity and could be categorized into category of causing slight to moderate degree of restriction when used for irrigation (Ayers and Westcot, 1985). Further, the sewage water contains considerable amounts of basic cations.  $\text{Na}^+$  was the dominant cation followed by  $\text{Mg}^{+2}$ ,  $\text{Ca}^{+2}$  and  $\text{K}^+$  and  $\text{Cl}^-$  was the dominant anion followed by  $\text{SO}_4^{-2}$ ,  $\text{HCO}_3^-$  and  $\text{CO}_3^{-2}$ . The  $\text{Na}^+$  and  $\text{Cl}^-$  was  $14.1$  and  $12.1 \text{ meL}^{-1}$ . Adj. SAR of the water sample was 18.19. It was observed that adj SAR and Cl content of the sewage water was so high that it may cause severe problems for the sensitive crops (Ayers and Westcot,

1985).  $\text{NO}_3\text{-N}$  and phosphate contents were 12.5 and  $2.8 \text{ mgL}^{-1}$ , respectively. BOD and TSS of water samples were 388.0 and  $347.2 \text{ mgL}^{-1}$  were higher than the values prescribed for their tolerance limit ( $200 \text{ mgL}^{-1}$  and  $100 \text{ mgL}^{-1}$ , respectively) to be used for irrigation (ISI-standards, 1982).

As regards micronutrients composition, Zinc, Copper, Iron and Manganese contents of the water sample were 259.3, 231.6, 485.4 and  $311.0 \mu\text{gL}^{-1}$ , respectively. The Nickel, Lead and Cadmium contents were 119.7, 68.2 and  $57.7 \mu\text{gL}^{-1}$ , respectively. The metallic cations content of sewage water were below the recommended maximum permissible concentrations of these trace elements in irrigation water for continuous use on all types of soils (Pratt, 1972).

The nutrient contents in the vegetable samples presented in Table 2 showed that the nitrogen content was of higher magnitude in the leafy vegetables spinach, fenugreek, amaranth and cabbage (3.80, 3.51, 3.69, and 3.65 %, respectively) and was of lower magnitude in radish (1.89 %). However, the phosphorous content recorded ranged to a narrow range, ranging between 0.37 to 0.51 per cent for all the vegetables under study. The potash content was of higher magnitude in the radish and cucumber (6.08 and 5.21%) and was of lower order in the ridge gourd and cauliflower (3.33 and 3.67%).

The metallic cations content i.e. zinc, copper, iron and manganese (Table 3) in different vegetables under study ranged from  $82.3$  to  $131.2 \text{ mg kg}^{-1}$ ,  $19.9$  to  $48.3 \text{ mg kg}^{-1}$ ,  $239.9$  to  $850.7 \text{ mg kg}^{-1}$  and  $45.9$  to  $73.4 \text{ mg kg}^{-1}$ , respectively. The nickel and lead content in the vegetables under study ranged between  $14.9$  to  $20.5 \text{ mg kg}^{-1}$  and  $0.84$  to  $2.69 \text{ mg kg}^{-1}$ , respectively. However, the Cadmium content was in the order not detectable on AAS. The Zn, Cu and Fe in different vegetables under study were below the phytotoxicity limits ( $150\text{-}200$ ,  $20\text{-}100$  and  $>500 \text{ mg kg}^{-1}$ , respectively) as reported by Mortvedt *et al.*, 1991. However, when compared with the critical levels of Zn, Cu and Fe ( $30$ ,  $6$  and  $60 \text{ mg kg}^{-1}$  for leafy vegetables and  $25$ ,  $5$  and  $75 \text{ mg kg}^{-1}$  for tuber/root crops, respectively) reported by Ankerman and Range (1988) the concentration of these cations observed for the vegetables under study were much above the critical levels suggested. The Mn and Ni contents were much below the phytotoxicity level of  $>500 \text{ mg kg}^{-1}$  and  $50 \text{ mg kg}^{-1}$ , respectively, in the dry matter of plant tissue (Mortvedt *et al.*, 1991). The Pb and Cd content in different vegetable samples were also below the phytotoxicity limits of  $>20 \text{ mg kg}^{-1}$  (Mortvedt *et al.*, 1991) and  $0.8 \text{ mg kg}^{-1}$  (Alloway, 1968), respectively.

The sewage water of Nathusar drain of Bikaner city contain higher values of EC, adjusted SAR, TSS and BOD, however, the metallic cations content were below the recommended maximum permissible concentrations. A higher inorganic and organic loading of sewage water and metallic cations buildup particularly Zn, Cu and Fe in

vegetables under study call for passing of the sewage water through an effluent treatment plant before being diverted for irrigation in this area also as it is being passed through treatment plant in the Jorbeer area of the city. Further, quality of sewage plays an important role for its use as a source of nutrients. Therefore, regular monitoring of the

quality of sewage should be done and threshold limit of sewage application should be estimated based on its quality. However, a gap of at least 1-2 seasons may be given after every 3-4 years of sewage application to allow the soil to come back to the equilibrium.

Table 1. Chemical composition of sewage water of Nathusar drain of Bikaner city.

Chemical characteristics	Range	Chemical characteristics	Range
pH	8.3	Phosphates (mgL <sup>-1</sup> )	2.8
EC (dSm <sup>-1</sup> )	2.1	Adj. SAR	18.19
Ca <sup>+2</sup> (meL <sup>-1</sup> )	3.4	T S S (mgL <sup>-1</sup> )	347.2
Mg <sup>+2</sup> (meL <sup>-1</sup> )	3.7	B O D (mgL <sup>-1</sup> )	388.0
Na <sup>+2</sup> (meL <sup>-1</sup> )	14.1	Zinc (µgL <sup>-1</sup> )	259.3
K <sup>+</sup> (meL <sup>-1</sup> )	0.8	Copper (µgL <sup>-1</sup> )	231.6
Cl <sup>-</sup> (meL <sup>-1</sup> )	12.1	Iron (µgL <sup>-1</sup> )	485.4
CO <sub>3</sub> <sup>-2</sup> (meL <sup>-1</sup> )	0.9	Manganese (µgL <sup>-1</sup> )	311.0
HCO <sub>3</sub> <sup>-</sup> (meL <sup>-1</sup> )	3.8	Nickel (µgL <sup>-1</sup> )	119.7
SO <sub>4</sub> <sup>-2</sup> (meL <sup>-1</sup> )	5.2	Lead (µgL <sup>-1</sup> )	68.2
No <sub>3</sub> <sup>-</sup> (meL <sup>-1</sup> )	12.5	Cadmium (µgL <sup>-1</sup> )	57.7

Table 2. N, P and K content (%) of vegetables from sewage water irrigated areas

Vegetables	Nitrogen	Phosphorus	Potash
Winter season			
Spinach ( <i>Spinacea oleracea</i> )	3.80	0.41	3.79
Fenugreek ( <i>Trigonella foenum -graecum</i> )	3.51	0.47	4.53
Cauliflower ( <i>Brassica oleracea</i> var. <i>Botrytis</i> )	3.49	0.51	3.67
Cabbage ( <i>Brassica oleracea</i> var. <i>capitata</i> )	3.65	0.51	3.75
Radish ( <i>Raphanus sativus</i> )	1.89	0.37	6.08
Summer season			
Bottle gourd ( <i>Lagenaria siceroria</i> )	2.79	0.44	3.64
Ridge gourd ( <i>Luffa acutangula</i> )	2.57	0.40	3.33
Amaranth ( <i>Amaranth spp</i> )	3.69	0.48	3.83
Cucumber ( <i>Cucumis sativus</i> )	3.29	0.49	5.21
Brinjal ( <i>Solanum melongena</i> )	2.92	0.43	3.98

Table 3. Metallic cation content (mg Kg<sup>-1</sup>) of vegetables from sewage water irrigated areas

Vegetables	Zn	Cu	Fe	Mn	Ni	Pb	Cd
Spinach	131.7	40.1	525.6	65.5	14.9	1.88	ND
Fenugreek	130.1	48.3	850.7	45.9	14.9	2.04	ND
Cauliflower	120.2	19.9	303.7	54.4	20.5	2.69	ND
Cabbage	113.2	27.0	263.6	63.9	19.6	2.30	ND
Radish	82.3	23.1	239.9	73.4	13.5	1.84	ND
Bottle gourd	101.2	30.5	607.0	66.2	15.2	2.31	ND
Ridge gourd	117.4	39.5	695.3	66.3	16.5	2.53	ND
Amaranth	106.1	42.5	699.9	62.1	13.3	1.81	ND
Cucumber	120.6	37.5	421.8	61.4	16.2	1.77	ND
Brinjal	97.4	44.7	438.0	65.0	19.6	2.12	ND

ND = Not detectable

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# A study on preparation and storage of low calorie RTS beverage of Indian gooseberry and *Kinnow* mandarin

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## Abstract

Low calorie blended RTS beverages of Indian gooseberry and *Kinnow* were prepared by replacing sucrose with artificial sweeteners Acesulfame -K and Sucralose. The treatments were analyzed for sensory quality and physico-chemical attributes, at monthly interval during storage for three months at refrigerated temperature. Treatments significantly affected the taste and overall sensory quality of the beverages. Sensory quality of the beverages decreased with the storage intervals. Use of acesulfame-K and sucralose in 25:75 proportions had an overall sensory score of 5.86/9.00 at the end of the storage period of 90 days, which was at par with that in RTS beverage sweetened by cane sugar (6.06/9.00). TSS, acidity and total sugar increased, while ascorbic acid and total phenol decreased with the advancement of storage period. The sugars content in the freshly prepared *aonla*- *Kinnow* RTS beverages having cane sugar was 9.58 per cent but in the same RTS having acesulfame- K and sucralose (25:75 ratio) was 1.03 per cent only. It was observed from this research that the low calorie beverages sweetened with 25% Acesulfame- K and 75% sucralose were found optimum regarding sensory characteristics.

**Key words:** Artificial sweeteners; *aonla*; *Kinnow* orange; beverages.

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## Introduction

Fruit based beverages continue to receive wide acceptability reflected by augmented awareness of the potentiality of these products as compared to synthetic drinks in the food market. Fruit based beverages are not only refreshing, provide energy but also boast high nutritional appeal. These could be quite handy in elevating problems concerning nutritional deficiency in developing countries like India.

Indian gooseberry (*Emblica officinalis* Gaertn.), popularly known as '*aonla*' belongs to family Euphorbeaceae has come up with tremendous potential for its economic utilization in beverage industry during the past few years. *Aonla* is a quite hardy, prolific bearer and highly remunerative even without much care. Being adapted to dry region and salt affected soils (Singh and Pathak, 1987) *aonla* is worth cultivating in wastelands. The tree bearing capsular fruit with fleshy pericarp is well known for its nutritional and pharmacological properties.

The fruits are particularly rich in ascorbic acid and tannins. The ascorbic acid content of fresh *aonla* fruit varies from 200-900 mg/ 100 g pulp as reported by several workers (Barthakur and Arnold, 1991; Jain and Khurdiya, 2002; Kalra, 1988 and Mehta and Bajaj, 1983). Various types of tannins are responsible for the peculiar taste of astringency in the fruit and thus responsible for the flavour (Kalra, 1988) owing to which *aonla* possess strong antioxidant properties. The most limiting amino acid in plant protein is lysine and methionine (Zemen and Ney,

1988). *Aonla* contains considerable amount of lysine which increases the biological value of its protein (Barthakur and Arnold, 1991). Its fruits also contains fair amount of minerals such as phosphorus, calcium, iron etc (Chauhan *et al.*, 1991) It also possesses astringent, de-obstruent, diuretic and antiseptic properties and is said to be used against wide range of diseases such as tuberculosis of lungs, asthma, bronchitis, scurvy, diabetes, anaemia, cancer, leprocy, dysentery, constipation etc. *Aonla* is strong antioxidant and is effective in preventing haemolysis of red blood cells (Vani *et al.* 1997). *Aonla* has been used as an important ingredient in several *ayurvedic* drugs e.g. *Chyavanprasha*, *Triphala*, *Arogyavardhini*, *Ashokarishtha* etc.

Owing to nutritional and pharmaceutical properties, the possibilities of using *aonla* fruits for development of beverages are explored on. Attempts have been made in recent years to commercialize the nutraceutical drinks of pure *aonla* juice or blended with other fruit juices such as lime, ginger, Aloe vera etc.

*Kinnow* (*Citrus reticulata* Blanco) is a hybrid between 'King' and 'Willow leaf' mandarin. Among the new exotic citrus cultivars grown in India, *Kinnow* is undoubtedly the most priced one. The fruit is quite important as it has a great variety of beverage, nutritious, juicy, industrial and medicinal uses due to its nutritious, juicy attractive colour, distinctive flavor and being rich source of vitamin 'C', vitamin 'B', calcium and phosphours (Sogi and Singh, 2001). Its juice has strong flavour and could well be utilized for blending with *aonla* juice for

preparation of RTS beverages.

Further it is presumed that if table sugar (sucrose) is replaced by artificial sweetener while preparation of *aonla*: *Kinnow* nutraceutical beverage can avoid problems of dental decay and would prove more useful for diet conscious population and diabetic patients. There are a number of artificial sweeteners available in the market such as Aspartame, cyclamate, sucralose, Acesulfame- K etc. (ADA, 2004). These are non- nutritive sweeteners; not metabolized by the body and do not contribute energy or calorie to the diet.

**Material and Method**

**Extraction of juice:** Fresh, fully ripe, sound *aonla* and *Kinnow* were used for extraction of juice. *Aonla* fruits were cleaned, thoroughly washed, blanched and juice was extracted by crushing in fruit mill and pressing in basket press followed by filtering through muslin cloth. *Kinnow* fruits were peeled and juice was extracted by screw type juice extractor. Juice from *aonla* and *Kinnow* was separately heated to 90° C for 1 minute to inactivate enzyme, cooled immediately to be used for preparation of RTS beverages.

**Preparation of RTS beverage:**The *aonla* and *Kinnow* beverages were prepared by blending of *aonla* and *Kinnow*

juice in 40: 60 proportions. The RTS beverages with sucrose to be treated as control was prepared by following standard procedure and specifications (Blended Juice: 10%, TSS: 12 % (adjusted by sucrose), Acidity: 0.3%, Sodium benzoate: 0.1 % and water). While RTS beverages with artificial sweeteners were prepared by using the same formulation except sugar was replaced by combinations of artificial sweeteners equal to the sweetness of same amount of sugar. The various treatment combinations and recipe of the various treatments are presented in Table 1 and 2, respectively, while flow sheet for the preparation of beverages is presented in Fig 1.

Table 1: Details of the treatments

Notation	Sweeteners combinations		
	Sucrose (%)	Acesulfame K (%)	sucralose (%)
T1	100	0	0
T2	0	100	0
T3	0	75	25
T4	0	50	50
T5	0	25	75
T6	0	0	100

Fig 1: Flow chart for the preparation of *aonla* based blended ready-to-serve (RTS) beverages

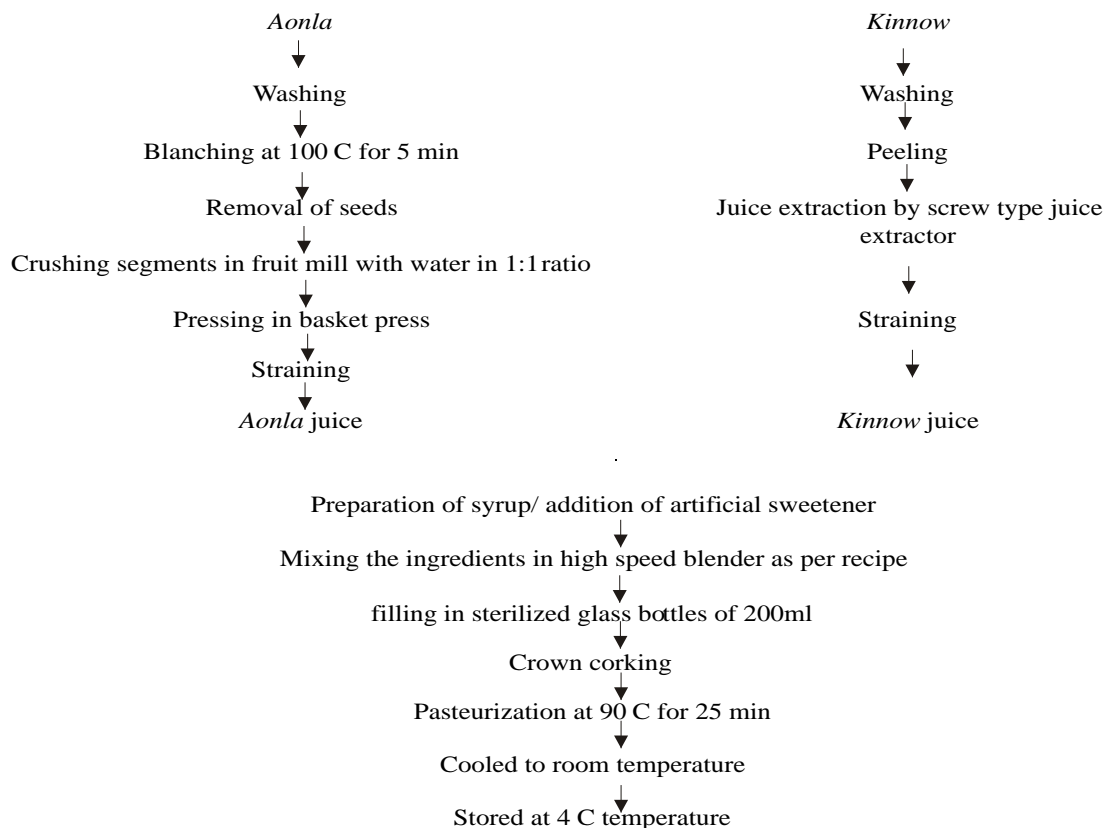


Table 2. Recipe for preparation of beverages (2400 ml each).

Treatment	Juice (ml)		Sweetener(g)			Citric Acid (g)	Sodium Benzoate	Water (mg)
	Aonla	Kinnow	Sucrose	Acesulfam-k	Sucralose			
T <sub>1</sub>	96	144	279	0	0	6.32	2.4	1872.3
T <sub>2</sub>	96	144	0	1.39	0	6.32	2.4	2149.9
T <sub>3</sub>	96	144	0	1.05	0.12	6.32	2.4	2150.1
T <sub>4</sub>	96	144	0	0.69	0.23	6.32	2.4	2150.3
T <sub>5</sub>	96	144	0	0.35	0.35	6.32	2.4	2150.6
T <sub>6</sub>	96	144	0	0	0.47	6.32	2.4	2150.8

Thus, prepared beverages was filtered and filled in previously sterilized glass bottles (200 ml) leaving 2.5 cm head space and sealed airtight by crown corking. Then the bottles were pasteurized at 90°C for 25 minutes and cooled to room temperature and stored at 4 ± 1°C for storage studies. Samples were drawn at a regular interval of 30 days and evaluated for various quality attributes.

**Sensory evaluation:** For sensory evaluation of the beverages, the product was judged for colour, taste and aroma on a 9-point hedonic scale (Ranganna, 1978) by a panel of 6 trained judges which comprised of scientists and students. The marks given by them were averaged to get Overall rating.

**Proximate analysis:** The TSS content (°Brix) of *aonla* and *Kinnow* blended RTS beverage was directly measured by the “Erma” Hand Refractometer (0-30) and value obtained was corrected at 20°C (AOAC, 1995). The acidity (%) of *aonla* and *Kinnow* blended RTS beverage was determined by diluting the known volume of RTS beverage with distilled water and titrating the same against standard N/10 sodium hydroxide solution, using phenolphthalein as an indicator. The ascorbic acid content of *aonla* based blended RTS beverage was determined by diluting known volume of RTS beverage with 3 per cent metaphosphoric acid as buffer and titrating against 2, 6-dichlorophenol indophenol dye solution until the stable faint pink colour was obtained (AOAC, 1995). The results were expressed as mg ascorbic acid per 100ml of RTS beverage. Total sugar content (%) was determined by using Anthrone's reagents method (Dubois *et al.*, 1951). Phenols content (%) of RTS beverage was determined by Folin-ciocalteau phenol reagent (Sadasivam and Manickam, 1991).

## Results and Discussion

**Sensory qualities:** The colour, aroma and taste were important consideration for overall acceptance of *aonla* and *Kinnow* blended RTS beverage (Table 3). The perusal of the data indicates that the treatments had non-significant effect on the colour and aroma but had significant effect on the taste of the RTS during entire storage period. Similar

findings were reported by Porto-Cadoso and Andre-Bolini (2007).

Initially, the beverage had high sensory values pertaining to colour, aroma and taste but with the advancement of storage period, a decrease in their values and hence, in the overall acceptance was noticed upto 90<sup>th</sup> day. These results are in conformity to the results of Jain and Khurdiya (2004); Gomez and Khurdiya (2005) in *aonla* beverages, and Gaikwad *et al* (2013) in *aonla*: ginger RTS beverages sweetened by artificial sweeteners. Among the various treatment combinations the highest overall acceptance was observed for RTS beverages sweetened by sucrose alone, which remained highest during entire period of storage as compared to use of Acesulfame- K and Sucralose. While among RTS beverages sweetened by artificial sweeteners, the highest overall acceptance was observed in those sweetened by Acesulfame-K and Sucralose (in 25:75 ratio) with an overall rating of 5.86 at the end of the storage period. These findings are in conformity to that of Ahmed *et al.* (2008). At the end of the storage period minimum taste value (4.86) was observed in RTS sweetened by Acesulfame K alone, while using acesulfame K and sucralose in 25:75 ratio gave better taste value (5.86) which was comparable with the best taste value (6.06) of RTS beverage sweetened by sucrose. This phenomenon has been explained by Ahmed *et al.* (2008) who reported that sensation of sweetness caused by artificial sweeteners (the sweetness profile) is sometimes notably different from sucrose, so they are often used in combination to achieve the most natural sweet taste.

**TSS:** Analysis of variance revealed significant effect (P = 0.05) of variations in sweeteners proportions. It is evident from Table 4 that TSS of all treatments showed an increasing trend during the storage period of 90 days, which is possibly due to hydrolysis of polysaccharide (starch) into monosaccharide (sugars) and concentration of *aonla* and *Kinnow* blended RTS beverage due to dehydration. A similar increase in TSS content with the increase in storage period was observed in juice of mandarin, sweet orange and lemon (Mehta and Bajaj, 1983) and in lime: *aonla* and mango: pineapple spiced RTS beverage (Deka, 2000). Further, it was observed that the TSS content of *aonla* and

*Kinnow* blended RTS beverages was significantly higher throughout the storage period in samples sweetened by sucrose (T<sub>1</sub>) as compared to those by artificial sweeteners. Similar findings have been reported by Porto-Cadoso and Andre-Bolini (2007) in peach nectar.

**Acidity:** The results presented in Fig. 2 indicate a gradual increase in acidity content during storage of *aonla* and *Kinnow* blended RTS beverage irrespective of the treatments. This could be attributed to the chemical interaction between the organic constituents of *aonla* and *Kinnow* blended RTS beverage affected by the temperature and action of enzymes. A gradual increase in acidity has also been reported by Gaikwad *et al.* (2013) and Butt *et al.* (2000) in mango drinks sweetened by aspartame and cyclamate. However, the acidity content of *aonla* and *Kinnow* blended RTS beverages did not differ significantly among samples sweetened by sucrose or those by artificial sweeteners. This is probably due to adjustment of the acidity to 0.3 per cent in all the samples initially by using citric acid.

**Ascorbic acid (Vitamin C):** The results presented in Fig. 3 reveals a steady decline in the ascorbic acid content with the advancement of storage period in all the treatments. Smoot and Nagy (1980) reported that the decrease in ascorbic acid in hermetically sealed juice is primarily via anaerobic pathway and it highly depends on storage time and temperature. The loss of ascorbic acid during storage at room temperature might be due to degradation of ascorbic acid in dehydro- ascorbic acid. Similar findings have been reported by Butt *et al.* (2000) in mango drinks sweetened by aspartame and cyclamate, Jain (2001) in *aonla* drinks and Deka *et al.* (2005) in mixed fruit beverages.

The results also indicates that the treatments involving use of sweeteners viz. sucrose or Acesulfame- K and Sucralose in different combinations were found to have non-significant effect on the ascorbic acid content of the RTS beverage during entire storage period, since the composition of *aonla* and *Kinnow* juice was constant i.e. 40:60 in all the treatments.

**Total sugars:** A progressive and marked increase in total sugar content of the RTS beverages was observed irrespective of the treatments, throughout the storage period (Table 4). The increase in total sugar might be due to the

hydrolysis of polysaccharides like pectin, cellulose, starch, etc. and its conversion into simple sugars. Similar findings have already been reported by Deka and Sethi (2001) in mango juice blends and Bharadwaj and Mukherjee (2011) in *Kinnow* juice blends.

The results showed the treatments involving use of artificial sweeteners viz. Acesulfame- K, Sucralose and their combinations were found to have significant effect on the total sugar content of the RTS beverages during entire period of storage. The total sugar content (calorific value) remain higher (in the range of 9.58-11.38 per cent in RTS beverages sweetened by cane sugar (sucrose) as compared to RTS beverages sweetened by acesulfame-k, sucralose or their combinations, throughout the storage. Similar findings have been reported by Ahmed *et al.* (2008); Gaikwad *et al.* (2013) and Pastor *et al.* (1996).

**Total phenols:** Phenolic compounds are naturally occurring antioxidants, usually found in fruits and vegetables. *Aonla* is a rich source of phenolic compounds; the main phenolic compound found in *aonla* being gallotannic acid (Kalra, 1988).

The results presented in Table 4 indicate that the total phenol content of the RTS beverages decreased with the increase in storage period at ambient temperature. At the end of the storage period the total phenol content varied between 0.63-0.75 per cent. Similarly, Verma and Gehlot (2007) observed decrease in total phenols of *bael* ready-to-serve beverage during storage and Reddy and Chikkasubbanna (2008) reported decreasing trend in tannins of lime-*aonla* blended squash during storage of 90 days. The total phenol content among RTS beverages did not differ significantly due to various treatments of sweeteners.

From the finding of the present study, it can be concluded that the despite the acidic and astringent taste the nutritive benefits of *aonla* can be utilized by blending its juice with *Kinnow* juice in 40: 60 ratio for the development of RTS beverages without significant loss of sensory attributes. Further, the cane sugar used in the preparation of RTS beverages can be substituted by artificial sweeteners viz. acesulfame-K and sucralose in 25:75 proportions for the development of low calorie (diet) drink having other chemical components and sensory attributes same as that of RTS prepared by adding cane sugar for calorie conscious

Table 3. Sensory evaluation of *aonla* and *Kinnow* blended RTS beverages during storage

Treat code	Colour (score out of 9)				Aroma (score out of 9)				Taste (score out of 9)				Overall rating (score out of 9)			
	Storage periods (days)				Storage periods (days)				Storage periods (days)				Storage periods (days)			
	0	30	60	90	0	30	60	90	0	30	60	90	0	30	60	90
T <sub>1</sub>	6.83	6.60	6.40	5.40	7.58	7.00	6.24	5.00	7.33	6.90	6.50	6.20	7.23	6.83	6.26	6.06
T <sub>2</sub>	6.80	6.66	6.46	5.39	7.56	6.98	6.22	4.93	6.10	5.63	5.10	4.86	6.00	5.53	6.16	4.80
T <sub>3</sub>	6.90	6.70	6.33	5.43	7.53	6.95	6.20	5.00	6.83	6.33	5.93	5.63	6.70	6.23	6.16	5.53
T <sub>4</sub>	6.80	6.66	6.10	5.43	7.58	7.06	6.30	5.00	7.06	6.56	6.06	5.73	6.86	6.46	6.43	5.66
T <sub>5</sub>	6.86	6.63	6.16	5.44	7.51	7.00	6.21	5.30	7.10	6.53	6.13	5.86	7.00	6.58	6.20	5.86
T <sub>6</sub>	6.83	6.53	6.43	5.40	7.54	6.83	6.12	5.13	6.26	5.70	5.30	5.00	6.16	5.70	6.23	5.00
SEm ±	0.053	0.073	0.064	0.247	0.405	0.569	0.667	0.123	0.047	0.050	0.042	0.060	0.0461	0.060	0.051	0.051
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	0.138	0.146	0.122	0.175	0.135	0.175	0.149	0.149

Table 4. Total soluble solids (%), total sugars (%) and total phenol (%) content of *aonla* and *Kinnow* blended RTS beverages during storage

code	TSS ( Brix )				Total sugars (%)				Total Phenol (%)			
	Storage periods (days)				Storage periods (days)				Storage periods (days)			
	0	30	60	90	0	30	60	90	0	30	60	90
T <sub>1</sub>	12.00	12.14	12.71	13.30	9.58	10.19	10.62	11.38	1.13	0.96	0.63	0.75
T <sub>2</sub>	1.38	1.50	2.11	2.50	1.04	1.58	2.03	2.74	1.13	0.87	0.52	0.66
T <sub>3</sub>	1.39	1.48	2.08	2.49	1.03	1.53	2.08	2.68	1.14	0.84	0.57	0.70
T <sub>4</sub>	1.38	1.48	2.08	2.49	1.05	1.57	2.10	2.73	1.11	0.89	0.59	0.68
T <sub>5</sub>	1.39	1.48	2.08	2.49	1.05	1.58	2.06	2.73	1.13	0.83	0.56	0.69
T <sub>6</sub>	1.38	1.48	2.08	2.49	1.03	1.55	2.09	2.79	1.13	0.85	0.55	0.64
SEm ±	0.003	0.006	0.009	0.006	0.012	0.015	0.029	0.027	0.031	0.028	0.030	0.023
CD at 5%	0.010	0.017	0.028	0.018	0.035	0.043	0.086	0.780	NS	NS	NS	NS

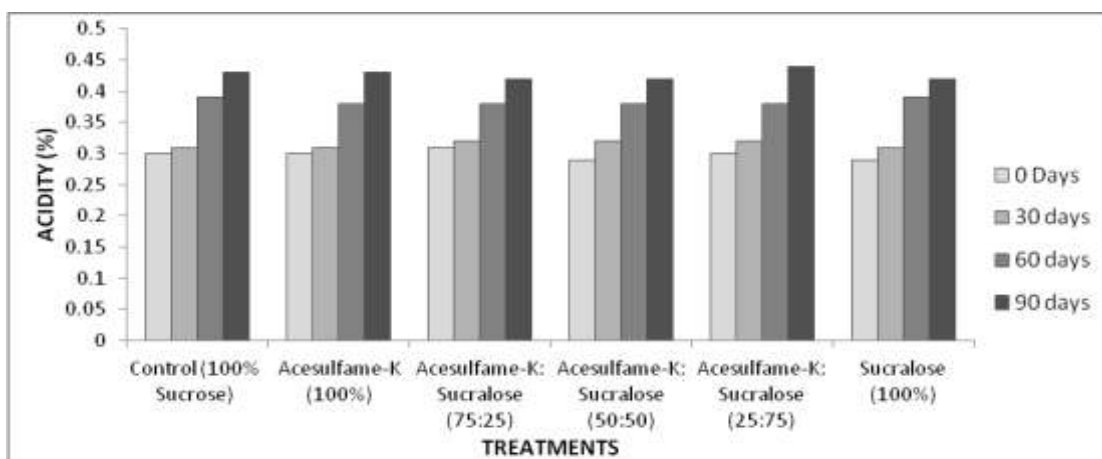


Fig. 2. Acidity (%) of *aonla* and *Kinnow* blended RTS beverages during storage

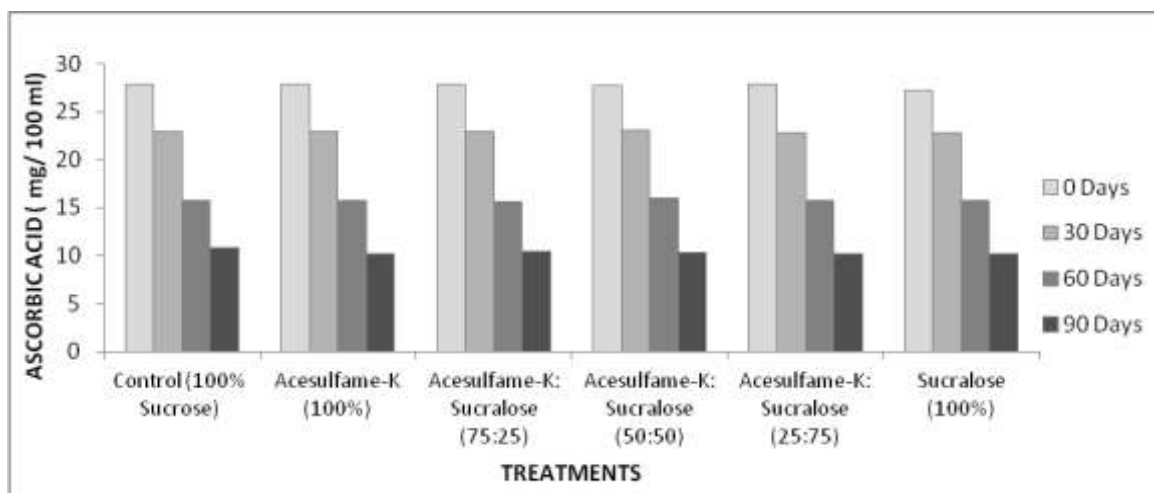


Figure 3. Ascorbic acid content (mg/ 100 ml) of *aonla* and *Kinnow* blended RTS beverages during storage

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# Targeted Yield Based Integrated Nutrient Management of Egg plant in Torripsammet

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## Abstract

Soil test crop response correlation studies were conducted to formulate the fertilizer adjustment equations for egg plant (Var. Kanhaya F<sub>1</sub> hybrid) under integrated plant nutrition system in Torripsammet during kharif 2010 following Ramamoorthy's inductive-cum-targeted yield approach. The nutrient requirement for producing one quintal fruit yield of egg plant was 0.31, 0.05 and 1.31 kg of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O, respectively. The per cent contribution from soil and fertilizer nutrients were found to be 44.98 and 13.57 for nitrogen, 23.75 and 3.06 for phosphorus and 21.97 and 26.68 for potassium, respectively. The per cent organic nutrient contribution of FYM was 29.14 for nitrogen, 10.06 for phosphorus and 30.28 for potassium. As per the IPNS based fertilizer prescription equation, for obtaining 250 q ha<sup>-1</sup> fruit yield of egg plant on a Torripsammet considering the average soil test values of 110, 40 and 25 kg ha<sup>-1</sup> of available N, P and K, respectively the requirement of fertilizer nutrients will be 98.4, 31.6 and 59.1 kg ha<sup>-1</sup> of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O, respectively along with 15 t FYM ha<sup>-1</sup>.

**Key words:** *Egg plant, STCR-IPNS, fertilizer adjustment equation, Torripsammet*

## Introduction

Integrated nutrient management strategies that include site-specific knowledge of crop nutrient requirements, soil nutrient supply and recovery efficient of applied fertilizer are required to sustain high yields and maintain or build-up of soil fertility at a level that ensures maximum efficiency from nutrient inputs. Several approaches have been used for fertilizer recommendation based on chemical soil test so as to attain maximum yield per unit of fertilizer use. Among the various approaches, the targeted yield approach (Trough 1960; Ramamoorthy *et al.* 1967) has gaining popularity in India. Targeted yield concept is based on quantitative idea of the fertilizer needs based on yield and nutritional requirement of the crop, per cent contribution of the soil available nutrient and that of the applied fertilizer. This method not only estimates soil test based fertilizer dose but also the level of yield the farmer can achieve with that particular dose. Application of fertilizers by the farmers in the field without information on crop requirement may cause adverse effects on soils and crops owing to either over use or inadequate use of fertilizers. Further, exorbitant cost of fertilizers also demands a more comprehensive approach for fertilizer utilization incorporating soil tests, field research and economic evaluation of result. Egg plant is important vegetable crop grown worldwide for culinary and medicinal

purpose. India is a major egg plant producing country with 13444 thousand tones production from 722 thousand hectare area having 18.6 t ha<sup>-1</sup> productivity followed by China. Among the major egg plant growing states, West Bengal ranks first in area (161 thousand hectare) and production (2965.60 thousand tones) with productivity of 18.42 t ha<sup>-1</sup>. In Rajasthan egg plant is cultivated on an area of 5.55 thousand hectare with 28.38 thousand tons of production with productivity of 5.11 t ha<sup>-1</sup> (Anonymous, 2013).

The fertilizer application practices based on targeted yield approach indicated the possibility of enhancing production potential of egg plant. Hence, the present study was undertaken to develop balanced fertilizer schedule with or without FYM application for desired yield targets of egg plant on Torripsammet of Western Rajasthan.

## Material and Methods

Soil test crop response correlation studies on egg plant (Var. Kanhaya F<sub>1</sub> hybrid) was conducted during kharif-2010 on a sandy soil, Agricultural Research Station, Beechwal, S.K.R.A.U., Bikaner, Rajasthan. The soil was non-calcareous well-drained and slightly alkaline (P<sup>H</sup> 8.4) in reaction. The alkaline KMnO<sub>4</sub>-N, Olsen-P and NH<sub>4</sub>OAc-K of the experimental field were of the order of 97.70, 19.30 and 167.57 kg ha<sup>-1</sup>, respectively. The inductive-cum fertility gradient approach of Ramamoorthy *et al.* (1967)

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was followed for conduction of the experiment. Three fertility gradients were created by dividing the experimental with  $N_0P_0K_0$ ,  $N_1P_1K_1$ , and  $N_2P_2K_2$  levels. These fertility gradients were fertilized as 0x: no N,  $P_2O_5$  and  $K_2O$ , 1x: 150:62:80 kg ha<sup>-1</sup> and 2x: 300:124:160 kg ha<sup>-1</sup>, N,  $P_2O_5$  and  $K_2O$ , respectively. Barley var.(RD-2508) was grown as on gradient crop so that the fertilizers could undergo transformations in the soil with plant and microbial agencies. By growing the exhaustive gradient crop the operational range of soil fertility was created in the fertility strips which was evaluated in terms of variations in yield, nutrient uptake and soil test values. After the harvest of exhaust crop, the main experiment on egg plant was conducted. Each strip was divided into 24 equal size plots. Twenty one selected fertilizer treatments comprising different combinations of N (60, 120 and 180 kg ha<sup>-1</sup>),  $P_2O_5$  (40, 80 and 120 kg ha<sup>-1</sup>) and  $k_2O$  (30, 60 and 90 kg ha<sup>-1</sup>) were randomly distributed in each strip along with three control ( $N_0P_0K_0$ ) plots. The FYM levels (0, 15 and 30 t ha<sup>-1</sup>) were imposed across each fertility gradient strips. The initial soil samples before transplantation of egg plant were collected and analyzed for  $KMnO_4-N$  (Subbiah and Asija 1956), Olsen-P (Olsen *et al.*, 1954) and neutral normal  $NH_4OAc-K$  (Hanway and Heidal, 1952). The FYM used in the experiment was analyzed for total nitrogen by  $H_2SO_4$  digestion using macro-Kjeldhal method (A.O.A.C., 1990) while phosphorus and potassium were estimated by digesting 1 g dry FYM sample with 10 ml di-acid mixture ( $HNO_3:HC_1O_4$ ). The test crop egg plant (Var. Kanhaya  $F_1$  hybrid) was transplanted during September 2010. The plot-wise fruit yield and biomass yield of egg plant were recorded. Plant samples (fruit and biomass) from each plot were analyzed for total N, P and K content (Piper, 1966) and the total uptake was computed using fruit and biomass yield data. Using the data on fruit yield, nutrient uptake, initial soil available nutrients and fertilizer doses applied, the basic parameters viz., nutrient requirement (kg q<sup>-1</sup>), contribution of nutrients from soil ( $C_s$ ), contribution of fertilizers ( $C_f$ ) and contribution of nutrients from FYM were estimated as described by Ramamoorthy *et al.* (1967). These parameters were used for the formulation of fertilizer adjustment equation for deriving fertilizer doses and the soil test based fertilizer recommendations were prescribed in the form of a ready reckoner for desired fruit yield targets of egg plant under NPK as well as with FYM.

## Result and Discussion

### Soil Available Nutrients and fruit yield of Egg plant:

The initial  $KMnO_4-N$  ranged from 97.70 to 135.20 kg ha<sup>-1</sup> with mean of 119.83 kg ha<sup>-1</sup>, Olsen-P from 19.30 to 35.08 kg ha<sup>-1</sup> with a mean of 27.95 kg ha<sup>-1</sup> and  $NH_4OAc-K$  from 167.57 to 245.58 kg ha<sup>-1</sup> with a mean of 207.3 kg ha<sup>-1</sup>. The range and mean values of fruit yield, and total nutrient uptake of treated and control plots are furnished in table 1.

The fruit yield of egg plant in treated plots ranged from 6.26 to 40.51 q ha<sup>-1</sup> with a mean of 21.73 q ha<sup>-1</sup> whereas in control plots it ranged from 5.68 to 12.90 q ha<sup>-1</sup> with a mean of 8.51 q ha<sup>-1</sup>. Total N, P and K uptake in treated plots were ranged from 15.60 to 103.30 kg ha<sup>-1</sup>, 4.30 to 29.57 kg ha<sup>-1</sup> and 15.90 to 108.16 kg ha<sup>-1</sup> with mean of 55.16, 15.64 and 55.97 kg ha<sup>-1</sup>, respectively. However, in control plots, N, P and K uptake ranged from 14.09 to 32.38 kg ha<sup>-1</sup>, 3.86 to 9.03 kg ha<sup>-1</sup>, and 14.20 to 32.76 kg ha<sup>-1</sup> with a mean of 21.27, 5.92 and 21.51 kg ha<sup>-1</sup>, respectively.

The above data clearly indicated that a wide variability existed in the soil test values, egg plant fruit yield and total nutrient uptake in treated and control plots, which is a prerequisite for calculating the basic parameters and fertilizer adjustment equations for calibrating the fertilizer doses for specific yield targets.

### Basic Parameters

The basic parameters viz., the nutrient requirement for producing one quintal of fruit yield of egg plant (kg q<sup>-1</sup>), the per cent contribution of nutrients from soil ( $C_s$ ), per cent contribution of fertilizer ( $C_f$ ) and per cent contribution of nutrient from FYM ( $C_{fym}$ ) have been calculated as described by Reddy *et al.* (1964) and Subba Rao and Shrivastava (1999) and furnished in table 2. These basic parameters were used for formulating the fertilizer prescription equation under NPK alone and along with FYM.

The nutrient requirements per quintal of fruit yield were computed as 0.31, 0.05 and 1.31 kg N,  $P_2O_5$  and  $K_2O$ , respectively. The per cent contributions of soil were 44.98, 23.75 and 21.97 for N,  $P_2O_5$  and  $K_2O$ , respectively. The per cent contribution of fertilizer nutrients were 13.57 for nitrogen, 3.06 for phosphorus and 26.68 for potassium, respectively. Similarly, the per cent contribution of N,  $P_2O_5$  and  $K_2O$  from FYM were 29.14, 10.06 and 30.98, respectively.

### Fertilizer Prescription Equations for Desired Yield Targets of egg plant

Soil test based fertilizer prescription equations for target yield of egg plant on Torripsamment were formulated using the basic parameters (Table3). On the basis of these equations a ready reckoner was prepared for an average range of soil test values and egg plant fruit yield targets of 250 q ha<sup>-1</sup> (Table 4).

Fertilizer N,  $P_2O_5$  and  $K_2O$  requirements decreased with an increase in soil test values. For producing 250 q ha<sup>-1</sup> fruit yield of egg plant on Torripsamment, the fertilizer doses required for the average soil test values of 100, 35 and 300 kg ha<sup>-1</sup> of N and K, respectively were 131.5, 70.3 and 79.6 kg ha<sup>-1</sup> of N,  $P_2O_5$  and  $K_2O$ , respectively. However, in order to produce 250 q ha<sup>-1</sup> fruit yield of egg plant with the above soil test values with 15t FYM ha<sup>-1</sup>, the fertilizer requirement would be 76.7, 37.4 and 56.4 kg ha<sup>-1</sup> of N,  $P_2O_5$

and K<sub>2</sub>O, respectively.

The application of fertilizer nutrient based on targeted yield approach may not be highly economical during first season of crop. But consistent fertilizer application based on targeted yield approach for every year will be highly economical and viable technology considering soil health and desired yield targets. Similar results were also reported by Santhi *et al.* (2002) for onion

on Inceptisols and Singh *et al.* (2005) for maize and chickpea in the alluvial soil of Indo-Gangetic plains.

The foregoing results revealed that targeted yield concept could effectively be adopted to bring in site specificity in fertilizer use and achieve high yields of egg plant on the Torripsamments of Rajasthan. Also, the fertilizer application rates will be subsequently curtailed with conjoint use of fertilizers and organic manure.

Table 1. Range and mean values of available nutrients in the pre-sowing surface soil and yield of Egg plant (var. F<sub>1</sub> Hybrid Kanhaya)

Parameters	Range	Mean
Soil test values		
KMnO <sub>4</sub> -N	97.70-135.20	119.83
Olsen-P	19.30-35.08	27.95
NH <sub>4</sub> OAc-K	167.57-245.58	207.3
Egg Plant Yield (q ha <sup>-1</sup> )		
Treated Plots	6.26-40.51	21.73
Control Plots	5.68-12.90	8.51
Nutrient Uptake (kg ha <sup>-1</sup> )		
Treated Plots		
N uptake	15.60-103.30	55.16
P uptake	4.30-29.57	15.64
K uptake	15.90-108.16	55.79
Control Plots		
N uptake	14.09-32.38	21.27
P uptake	3.86-9.03	5.92
K uptake	14.20-32.76	21.51

Table 2. Nutrient requirement, per cent contribution from soil, fertilizer and FYM for Egg plant (var. F<sub>1</sub> Hybrid Kanhaya)

Parameters	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Nutrient requirement (kg q <sup>-1</sup> )	0.31	0.05	0.31
Soil Nutrient utilization Efficiency (%)	44.98	23.75	21.97
Fertilizer nutrient utilization Efficiency (%)	13.57	3.06	26.68
Nutrient contribution (%) from organic source	29.14	10.06	30.98

Table 3. Soil test based fertilizer prescription for targeted yields of egg plant

FN = 2.28 T 3.31 SN 2.15 ON
F P <sub>2</sub> O <sub>5</sub> = 1.63 T- 7.76 SP <sub>2</sub> O <sub>5</sub> 3.29 OP
F K <sub>2</sub> O = 1.16 T 0.82 SK <sub>2</sub> O 1.16 OK

Note: FN, F P<sub>2</sub>O<sub>5</sub> and F K<sub>2</sub>O: Fertilizer N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O in kg ha<sup>-1</sup>, respectively: T- Yield target in q ha<sup>-1</sup>; SN, S P<sub>2</sub>O<sub>5</sub> and SK<sub>2</sub>O KmnO<sub>4</sub>-N, Olsen-P and NH<sub>2</sub>OAc-K in kg ha<sup>-1</sup> respectively; ON, OP and OK denote N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O content in Organic Manure

Table 4. Ready Reckoner of fertilizer doses at varying soil test values for specific yield target

Soil Available Nutrients (kg ha <sup>-1</sup> )			Fertilizer nutrient required (kg ha <sup>-1</sup> ) with 15 & 30 t ha <sup>-1</sup> FYM for yield target of 250 q ha <sup>-1</sup>					
			15 t ha <sup>-1</sup>			30 t ha <sup>-1</sup>		
N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
90	25	150	164.7	147.8	126.5	57.7	82.2	85.9
100	30	175	131.6	109	105.9	24.2	43.4	65.4
110	35	200	98.5	70.3	85.5	40	27	44.9
120	40	225	65.4	31.6	64.9	40	27	24.4
130	45	250	40	27	44.5	40	27	20
140	50	275	40	27	20	40	27	20

FYM composition: N 0.333, P<sub>2</sub>O<sub>5</sub> 0.133, K<sub>2</sub>O 0.233

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## Effect of vermicompost and sulphur on quality of garlic (*Allium sativum* L.) under semi arid conditions.

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### Abstract

An experiment was carried out to study the suitable dose of vermicompost and sulphur for obtaining good quality bulbs of garlic (*Allium sativum* L.) cv. G-41. The experiment comprised of 16 treatment combinations with four levels of each vermicompost (0, 2.5, 5.0 and 7.5 t ha<sup>-1</sup>) and sulphur (0, 30, 60 and 90 kg ha<sup>-1</sup>). The application of 5.0 t vermicompost ha<sup>-1</sup> and 60 kg sulphur ha<sup>-1</sup> was found suitable in terms of quality and resulted in saving of 2.5 t/ha of vermicompost and 30 kg of S ha<sup>-1</sup>. Thus, application of 5.0 t vermicompost and 60 kg S ha<sup>-1</sup> to garlic crop was found significantly better for quality production of bulbs in respect to nitrogen, phosphorus, potassium, sulphur, TSS, ascorbic acid, crude protein and volatile oil content.

**Key words:** *Bulb, volatile oil, nutrients, TSS, ascorbic acid*

### Introduction

Garlic (*Allium sativum*) is the second important bulb crop after onion which belongs to the family amaryllidaceae. It is also included in Indian system of medicines (Ayurvedic, Unani and Siddha) as carminative and gastric stimulant to help in digestion and absorption of food. It is rich in protein, carbohydrate and ascorbic acid and about 142 calories of energy can be obtained from 100 g of garlic. The present experiment was conducted to produce better quality garlic bulb with regard to nutritive, pharmaceutical and flavouring properties. Garlic responds very well to organic manures as well as inorganic fertilizers. The low quality production of garlic bulb might be due to imbalanced fertilization and Poor management practices. Keeping the fact in mind a field experiment was conducted at Horticulture farm, S K N College of Agriculture, Jobner.

### Materials and methods

A field experiment was conducted in rabi season during 2010-11 to study the suitable dose of vermicompost and sulphur for obtaining good quality bulbs of garlic (*Allium sativum* L.) cv. G-41. Sixteen treatment combinations with four levels of vermicompost (control, 2.5, 5.0 and 7.5 t ha<sup>-1</sup>) and four levels of sulphur (control, 30, 60 and 90 kg ha<sup>-1</sup>) were undertaken in sandy loam soil at horticulture research farm, S.K.N. College of Agriculture, Jobner (Rajasthan). The experiment was laid out in randomized block design with three replications. The soil of experimental plot had 8.2 pH, 0.92dSm<sup>-1</sup> electrical

conductivity, 133.80 kg ha<sup>-1</sup> available nitrogen, 8.14 kg ha<sup>-1</sup> phosphorus, 148.15 kg ha<sup>-1</sup> potash and 8.40 mg kg<sup>-1</sup> sulphur. Vermicompost and sulphur were applied as basal doses. Sulphur was applied in its elemental form. Besides the treatments, the recommended dose of NPK for garlic (120: 40: 100 kg ha<sup>-1</sup>) was also applied through urea, single super phosphate and muriate of potash. Full dose of phosphorus and potassium and half dose of nitrogen were applied as basal dose just before sowing and rest half dose of nitrogen was applied 30 days after planting as top dressing. Garlic cloves were sown manually on 15<sup>th</sup> November having a seed rate of 500 kg ha<sup>-1</sup> with a spacing of 15 cm X 10 cm.

Five plants were selected randomly from each plot for recording observations on TSS, ascorbic acid content, crude protein, volatile oil and NPKS content in bulbs. The TSS, ascorbic acid, crude protein and volatile oil content in garlic bulb were determined as per methodology suggested by A.O.A.C. (1990). Nitrogen, phosphorus, potassium and sulphur content were estimated as per methods described by Snell and Snell (1949), Jackson (1973), Bhargava and Raghupathi (1993) and Tabatabai and Bremner (1970), respectively.

### Results and Discussion

#### Effect of vermicompost

The findings of present experiment showed that nitrogen, phosphorus, potassium, total soluble solids, sulphur and crude protein content of bulb increased significantly with increasing levels of vermicompost up to 5.0 t ha<sup>-1</sup> (Table 1 & 2) but the ascorbic acid content in bulbs increased significantly up to application of highest dose (7.5 t ha<sup>-1</sup>) of vermicompost. However, the volatile oil content increased significantly higher up to 2.5 t ha<sup>-1</sup>

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vermicompost over control. Application of vermicompost might have the ability to increase the availability of nutrients like nitrogen, phosphorus, potassium and sulphur, probably due to higher rate of mineralization and favourable conditions for microbial and chemical activity, which in turn increased the N, P, K and S content in garlic bulbs. Application of vermicompost also helped in vigorous vegetative growth and imparted deep green colour to the foliage which favoured photosynthesis activity of the plants & greater accumulation of food material *i.e.* carbohydrates & more synthesis of TSS content. The increase in protein content might be due to application of vermicompost & increasing availability of N. They also increased the proportion of proteinous substances in the sink. Another reason might be the increased activity of nitrate reductase which helped in synthesis of certain amino acid and protein in bulb (Chinaswamy and Mariakulandi, 1966). The ascorbic acid and volatile content in bulb increased significantly with increasing levels of vermicompost might be due to improved nutritional environment in the rhizosphere as well as its utilization in the plant system. This leads to enhance translocation of nutrients, vitamins and proteins in the bulb, which are required for the synthesis of ascorbic acid and volatile oils. These results are in close agreement with those of Shreeniwas *et al.* (2000) and Yadav and Vijyakumari (2004).

#### Effect of sulphur

Nitrogen, phosphorus, potassium, sulphur, TSS, ascorbic acid and crude protein content & other quality attributes were increased the in garlic bulbs with increasing

levels of sulphur up to 60 kg/ha under the study (Table 1 & 2). However, volatile oil content increased significantly up to 30 kg S ha<sup>-1</sup>. It is observed that sulphur deficiency prevents utilization of nitrogen and brought about accumulation of soluble nitrogen in the plant leaves. Further, sulphur being an integral constituent of certain amino acids, of which nitrogen is also an essential constituent, might have helped in increasing net assimilation rate of nitrogen. Thus, the application of sulphur significantly increased the nitrogen, crude protein, TSS and ascorbic acid content in garlic bulbs. These results are in close conformity with those of Kumar and Singh (1992). However, the increase in levels of sulphur fertilization might be resulted in higher rate of mineralization and favourable conditions for microbial and chemical activity which ultimately resulted in higher concentration of phosphorus, potassium and sulphur in soil & increased P, K and S content in garlic bulbs. Similar results were also reported by Singh and Srivastava (1993) on potato. As sulphur is directly involved in the metabolism of volatile oil content, there was an increase in volatile oil content with increasing level of sulphur application. These results are in accordance with the findings of Khalaf and Taha (1988), and Srinidhi (2000).

On the basis of experiment results, it could be concluded that the combined application of 5.0 t vermicompost ha<sup>-1</sup> and 60 kg sulphur ha<sup>-1</sup> was found suitable in terms of quality and resulted in saving of 2.5 t of vermicompost and 30 kg of S ha<sup>-1</sup>. Thus, application of 5.0 t vermicompost and 60 kg S ha<sup>-1</sup> to garlic crop was found overall best treatment from quality point of view.

Table 1. Effect of vermicompost and sulphur on nitrogen, phosphorus, potassium and sulphur content of bulb

Treatments	Nitrogen content (%)	Phosphorus content (%)	Potassium content (%)	Sulphur content (%)
VC levels (t/ha)				
Control (V <sub>0</sub> )	2.310	0.275	0.041	1.26
2.5 (V <sub>2.5</sub> )	2.600	0.320	0.047	1.37
5.0 (V <sub>5.0</sub> )	3.070	0.342	0.052	1.43
7.5 (V <sub>7.5</sub> )	3.120	0.357	0.056	1.44
SEm±	0.043	0.005	0.002	0.02
CD at 5%	0.124	0.016	0.004	0.05
S levels (kg/ha)				
Control (S <sub>0</sub> )	2.230	0.286	0.039	1.22
30 (S <sub>30</sub> )	2.570	0.316	0.048	1.37
60 (S <sub>60</sub> )	3.100	0.340	0.053	1.44
90 (S <sub>90</sub> )	3.200	0.352	0.056	1.47
SEm±	0.043	0.005	0.002	0.02
CD at 5%	0.124	0.016	0.004	0.05

Table 2. Effect of vermicompost and sulphur on total soluble solids, crude protein, ascorbic acid and volatile oil content of bulb

Treatments	Total soluble solids (%)	Crude protein (%)	Ascorbic acid (mg/100 g)	Volatile oil content (%)
VC levels (t/ha)				
Control (V <sub>0</sub> )	37.20	14.44	9.87	0.533
2.5 (V <sub>2.5</sub> )	37.30	16.25	10.02	0.560
5.0 (V <sub>5.0</sub> )	38.20	19.19	10.30	0.572
7.5 (V <sub>7.5</sub> )	38.70	19.50	10.88	0.574
SEm <sub>±</sub>	0.48	0.23	0.13	0.009
CD at 5%	1.37	0.66	0.37	0.027
S levels (kg/ha)				
Control (S <sub>0</sub> )	36.90	13.94	9.70	0.522
30 (S <sub>30</sub> )	37.10	16.06	10.20	0.562
60 (S <sub>60</sub> )	38.50	19.38	10.50	0.576
90 (S <sub>90</sub> )	38.90	20.00	10.67	0.579
SEm <sub>±</sub>	0.48	0.23	0.13	0.009
CD at 5%	1.37	0.66	0.37	0.027

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# Impact of micro-irrigation system on growth and yield of Kinnow mandarin under aridisols of Sri Ganganagar district

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## Abstract:

Proper irrigation scheduling will help to assure efficient use of water and energy in crop production. To avoid wastage of water for crop irrigation it is necessary to develop methods that estimate plant water demands based on the needs to obtain good qualitative crop results. The quantity of irrigation water needed for fruit crops is greatly optimized under micro irrigation systems of different efficiencies. When using micro-sprinkler irrigation, 20% of irrigation water quantity can be conserved compared to surface irrigation, when using drip irrigation 33.3% and 16.6% of irrigation water quantity can be saved when compared to surface irrigation and sprinkler irrigation respectively. Studies were conducted on newly established Kinnow orchard under the arid conditions of Western Rajasthan in 2001. Both drip and micro-sprinkler systems with differential water requirement dosages per irrigation scheduling were evaluated. The harvesting studies up to 5<sup>th</sup> year of production (2008) revealed that maximum average fruit weight, maximum fruit yield/tree and total yield was observed under 70% Crop evaporation as compared to 40% and 100% Crop evaporation treatments under both drip and micro-sprinkler system. The crop geometry studies on Kinnow plants under two planting densities (6x3m) and (6x6m) with respect to three differential irrigation treatments (40%, 70% and 100% crop evapotranspiration) up to 8<sup>th</sup> year of bearing reveals that highest number of fruits/tree, maximum average fruit weight, maximum fruit yield/tree and total yield was observed under 100% Crop evaporation treatment under 6 x 3 m crop geometry of drip system whereas under traditional system (6 x 6 m) of Kinnow tree plantation, maximum average fruit weight, maximum fruit yield/tree and total yield was observed under 70% Crop evaporation treatments.

**Key words:** Drip system, micro-sprinkler system, crop evapotranspiration, irrigation treatments.

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## Introduction

Citrus is one of the main crops of agricultural production systems in the arid regions of North Western Rajasthan and covers more than 20,000 ha. However, water in this region is scarce. Widening water crisis across the globe has been a matter of concern throughout the agricultural sector. Agricultural sector being the largest consumer of water (Yadav *et al.*, 2007) promises great scope for managing water effectively. Micro-irrigation system has proven its use in this regard. This system, besides economizing on water economy to the extent of 70% (Chundawat, 1990) offers the best performance of crops in terms of maximal water use efficiency. These features have added headway to installation of micro-irrigation system installation especially in orchard installation and the fruit growers in Western Rajasthan support micro-irrigation to grow the orchards. In North Western parts of Rajasthan state particularly in SriGanganagar district in canal irrigated

areas of aridisols, the Kinnow cultivation has gained immense popularity owing to its precocity, prolific bearing, relative freeness from granulation and other biotic stresses. The vagaries of weather particularly water scarcity, erratic rainfall, drought and declining water table are the major impediments in Kinnow cultivation usually encountered by fruit growers of Western Rajasthan. Method of irrigation that can continuously sustain regular moisture in the root zone and can maintain continuous moisture throughout growth and development phases in continuum can help a lot in sustained productivity in general and kinnow in particular. In the light of this gratis utility, the adoption of micro-irrigation systems in citrus has increased manifold from 500 to 10000 hectares during the last decade in SriGanganagar district. In Kinnow orchards particularly during summer months (May-June), severe physiological fruit drop occurs which causes substantial losses to fruit growers. In many citrus growing countries, orchardists follow micro-irrigation systems for citrus growing (Zekri and Parson, 1989). With a view to standardize irrigation use and to optimize resource use, it was intended to integrate cropping in time and space dimension under new vistas of

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micro-irrigation. The objective of this study was to evaluate suitable mode of micro-irrigation; To compare the effect of drip and micro-sprinkler on young citrus tree growth, yield potential and crop geometry studies (6x6m) and (6x3m) under differential irrigation treatments based on crop evapotranspiration as well as to standardize the irrigation scheduling of Kinnow.

### Materials and Methods

A field experiment on micro-irrigation system was conducted on newly established orchard for 8 consecutive years commencing from the year 2001 to 2008 at the experimental farm of Agriculture Research Station, SriGanganagar (Rajasthan) India. As mixed planting, the Kinnow plants were planted at spacing of 6 x 6m<sup>2</sup> and also under combination of Kinnow at 6 x 3m<sup>2</sup> (Kinnow x Kinnow) under both drip and micro-sprinkler system. The plants were subjected to differential irrigation treatments viz., 40, 70 and 100 per cent crop evaporation levels (ETc). Three factors- the first being drip and micro-sprinkler, second being crop geometry of Kinnow and third being levels (three) of irrigation (40, 70 and 100% ETc) of irrigation were studied in split plot design with four replications to quantify statistically the effect of different irrigation levels on growth of Kinnow mandarin. Six plants were taken as a unit to record various observations. The volume of irrigation water provided to each plant on alternate day basis under drip and micro-sprinkler system for three irrigation scheduling viz. 40, 70 and 100% ETc were calculated using 20 years data of mean pan evaporation, reference evapotranspiration and crop coefficient. Data pertaining to Kinnow on increase in vegetative growth parameters viz. cumulative plant height, no. of fruits/tree, average fruit weight, fruit yield/tree and yield/ha was recorded.

### Results and Discussion

#### Crop geometry studies in Kinnow

The results in table 1 show the irrigation scheduling monthwise vis a vis treatment wise (40, 70 and 100% ETc) to each experimental plant on alternate day basis. The results presented in table 2 indicates that under drip system there was lesser number of average fruits/tree (343.2) in 6 x 3m spacing against 6 x 6m traditional system of planting (409.9) fruits. However, average fruit (195.6g), fruit yield/tree (63.8kg) and cumulative yield (326.6 q/ha) were significantly higher as compared to 6 x 6m spacing. The better yield under 6 x 3m spacing might be due to better utilization of spatial and temporal variation by the wetted root zone of the Kinnow plants under high density plantation. Trickle-irrigated trees under 6 x 3m had better access to water stored in the deep soil layers and capillary water from the water table. Thus, the substantial water savings with trickle irrigation compared to sprinkler system may be attributed to not only the improved irrigation

efficiency but also changes in vertical root distribution. Likewise in sprinkler system, better average fruit weight (184.3g), fruit yield/tree (59.3kg) and total yield/ha (303.6q) was observed under 6 x 3m crop geometry as compared to conventional planting system (6x6m). No published reports could be found on effects of irrigation method on early production of citrus. Tree vegetative growth was almost similar under both sprinkler and drip system at 6 X 3 m and 6 X 6 m spacing except at 6 X 3 m spacing under drip irrigation system which supports the early findings that trickle irrigation does not improve tree establishment in fine textured soils of Texas (Leyden, R.F. 1975).

#### Effect of different water allowances studies in Kinnow Drip system

The results elucidated in table 3 indicates that the application of differential water allowances in Kinnow had a significant impact on overall tree growth being maximum under 100% Evapotranspiration treatment which was considerably higher than 40% Evapotranspiration treatment under drip system of irrigation. The yield attributes such as average no. of fruits/tree (386.2) was maximal under drip system of 100% Crop Evapotranspiration treatment followed by (374.7) in 70% Etc and (368.8) in 40% ETc, respectively which clearly indicates the response of better availability of moisture under root zone with increasing water allowances in the sandy soils of Western Rajasthan. However, average fruit weight of (192.3g) and (183.3g), respectively fewer than 70% ETc and 100% ETc treatments were at par and statistically significant over 40% ETc treatment under drip system of irrigation. Likewise fruit yield/tree (71.9kg) and overall yield/ha (368.1q) was also higher under 70% ETc treatment under drip system with respect to other treatments. This may be due to more frequent irrigation and maintenance of constant soil moisture under the tree. The losses like conveyance, evaporation and percolation were also simultaneously supposed to be get lessened in sandy loam soil thereby creating optimum moisture in the root zone. Similar findings have been obtained in acid lime by Shirgure *et al.*, (2001).

#### Sprinkler system

The results presented in table 3 clearly indicate a rising trend in the growth of Kinnow trees with application of differential water allowances under Sprinkler system. Tree growth was maximal (245.8cm) under 100% Crop Evapotranspiration treatment and minimal (223.3cm) in 40% Crop Evapotranspiration treatment. The delay in growth flush was a more pronounced response to irrigation frequency than individual shoot and leaf growth. The phenomenal better yield attributes such as average fruit weight (183.2g), fruit yield/tree (59.8kg) and overall yield/ha (153.1q) were recorded under 70% Crop

Evapotranspiration treatment followed by 100% and 40% ETc treatments. These results demonstrate that yields increased with increasing areas of coverage of the tree root zone. These findings are in consonance with the findings of Bhatnagar *et al.*, (2011) who reported better assimilation rates of photosynthate in Kinnow under 70% ETc irrigation treatment. Fig.1 clearly depicts the effect of drip and micro-sprinkler system on high density planting in Kinnow mandarin.

**Effect of different water allowances and different crop geometry of Kinnow on growth and yield attributes of Kinnow under Drip System**

The data presented in table 4 showed an incremental growth of different crop geometry studies in Kinnow trees under drip system with maximal growth in 100% ETc under both 6x3m and 6x6m spacings. The fruit yielding attributes under 6x3m spacing revealed that average fruits/tree (362.5), average fruit weight (206.0), fruit yield/tree (70.3) and total yield/ha (359.9 q) was found maximal under 100% ETc treatment. This may be due to the fact that yields increased with increasing areas of the coverage of tree zone. Similar findings have been

demonstrated by Smajstrla and Koo (1984) who reported that that yields of Valencia orange increased as the coverage area of the tree root zone is increased. However, yield attributes under 6x6 m spacing revealed an interesting trend as average fruit wt. of Kinnow was found maximum and at par under both 70% ETc (169.5g) and 100% ETc (170.7g), respectively whereas fruit yield/tree (61.4kg) and total yield/ha (157.2q) was found statistically significantly higher under 70% ETc treatment over other treatments. This might be due to better osmolality of cell sap of Kinnow mandarin under 70% ETc treatment.

Proper irrigation scheduling will help to assure efficient use of water and energy in crop production. Irrigation scheduling methods that are currently applicable are 1) a water budget method requiring estimation of daily ET and soil water content, and 2) the use of soil moisture measurement instrumentation. Techniques for estimating ET, determining soil water storage, determining allowable water depletions, and water budgeting when properly used and combined with efficient methods of water application, these techniques should also result in increased production and profits.

Table1. Allowances of water provided to each plant on alternate day basis through micro-irrigation systems (2004-2008)

Micro-sprinkler System												
ETc (%)	Mar	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
40	26	68	85	89	81	78	64	47	28	18	6.0	9
70	44	119	148	155	142	136	112	83	49	32	8.0	12
100	62	170	209	221	204	194	159	118	70	45	15.0	23
Drip System												
40	4.3	6.2	7.5	7.8	7.2	7.0	5.8	4.6	3.2	1.6	1.6	3.2
70	6.7	10.1	12.3	12.8	11.9	11.4	8.5	7.3	4.8	2.6	2.5	4.8
100	9.2	14.0	16.2	17.0	16.5	15.9	12.1	10.0	6.4	3.6	3.7	6.4

Table 2. Effect of Drip and micro-sprinkler irrigation on High density planting of Kinnow on Tree height, Fruits /Tree, Fruit weight, yield/tree and Yield/ha (2004-2008)

Treatment		Tree height (cm)	Fruits/tree	Average fruit weight (g)	Fruit yield/tree (kg)	Yield/ha (q)
Drip	6 x3m	228.0	343.2	195.6	63.8	326.6
	6 x 6m	243.6	409.9	153.8	61.1	156.4
Sprinkler	6 x3m	244.5	301.2	184.3	59.3	303.6
	6 x 6m	243.6	325.1	141.3	45.4	116.2
CD 5%		7.58	26.9	8.36	2.79	

Table 3. Effect of Drip and micro -sprinkler system along with different water allowances for Kinnow on cumulative Tree height, Fruits /Tree, Fruit weight, yield/tree and Yield/ha (2004-2008)

Treatment/ETc	Tree height (cm)	Fruits/tree	Av. Fruit weight (g.)	Fruit yield/tree (kg.)	Yield/ha. (q)	
Drip	40%	223.4	368.8	131.5	44.7	228.9
	70%	240.6	374.7	192.3	71.9	368.1
	100%	243.4	386.2	183.3	70.7	362.0
Sprinkler	40%	223.3	319.0	142.7	43.4	111.1
	70%	243.1	327.3	183.2	59.8	153.1
	100%	245.8	293.2	179.5	53.9	138.0
C.D at 5%	3.49	43.2	15.3	2.57		

Table 4. Effect of different water allowances and different crop geometry of Kinnow on cumulative Tree height, Fruits /Tree, Fruit weight, yield/tree and Yield/ha under Drip System (2004-08)

Treatment/ETc		Tree height (cm)	Fruits/tree	Av. Fruit weight (g.)	Fruit yield/tree (kg.)	Yield/ha. (q)
6 x 3m	40	220.5	261.7	171.7	44.9	229.9
	70	241.3	342.5	192.7	69.4	355.3
	100	247.0	362.5	206.0	70.3	359.9
6 x 6m	40	226.2	426.1	102.5	43.1	110.3
	70	242.4	359.5	169.5	61.4	157.2
	100	242.3	316.8	170.7	55.2	141.3
C.D. at 5%		9.26	10.7	10.5	3.41	

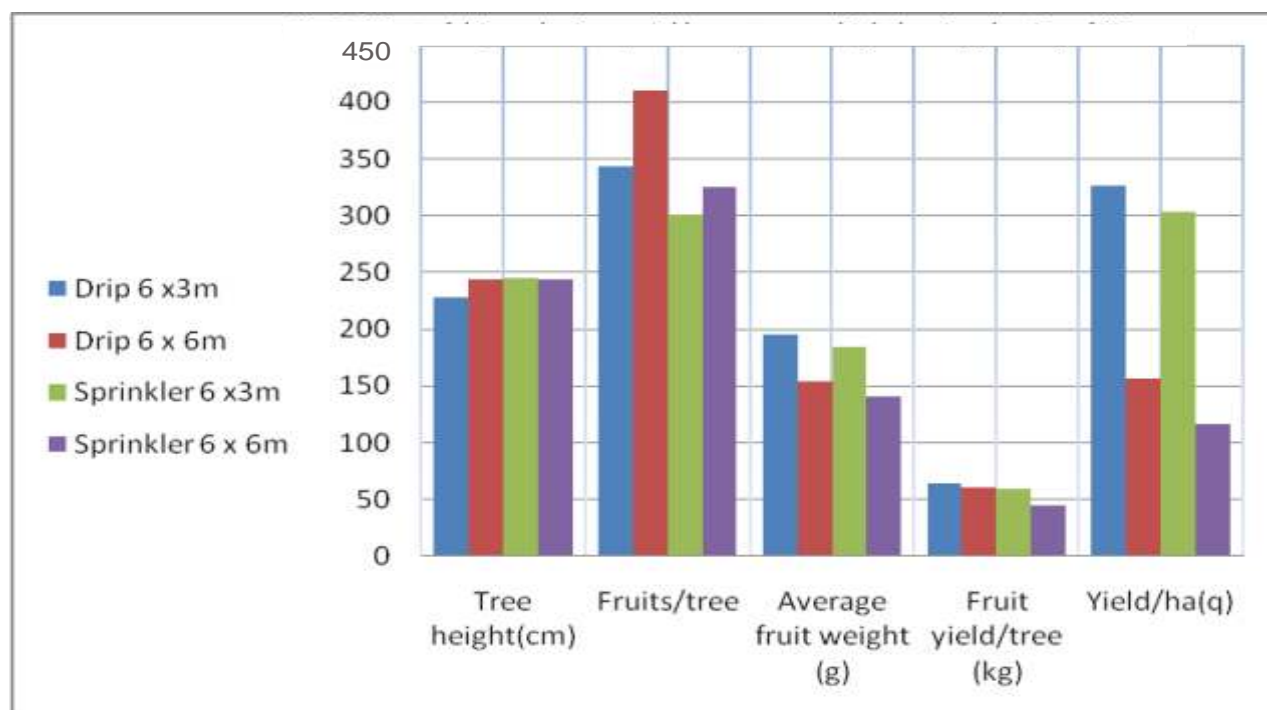


Figure 1. Effect of drip and micro sprinkler system on high density planting of kinnow.

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## Organoleptic rating of RTS prepared from pulp of Bael cultivars

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### Abstract

Bael (*Aegle marmelos* Correa.) is a nutritive and medicinally important fruit and also known as bilvpatra, beel, shripthal and Bengal quince. Fruit is eaten as fresh and also used for making several value added products. All the parts of the bael tree viz. stem, bark, root, leaf, flowers, seed oil or fruits of any stage of maturity and ripen are used for preparation of *Ayurvedic* medicines and it is major constituent of *Dashmool*. The fruit is generally available from March to May month. Important aspect of fruit is therapeutic and nutraceutical value, which could safeguard stomach ailments and improve health of rural populations. The bael pulp is used as a base of various products like squash, jam, toffee, slab, powder, nectar, beverage, RTS, etc. Bael fruit pulp of cultivar NB-5, CISH Bael-2 and Goma Yashi was used to make ready to serve drink by adding sugar @ 700g/l of pulp or juice. This RTS was further diluted with water in 30:70 for sensory evaluation to assess the quality of products. Organoleptic score indicated that ready to serve drink varied among pulp of bael varieties and RTS prepared from pulp of Goma Yashi was found better by getting highest score than other varieties. The utilization of bael fruits pulp for preparation of delicious drink has been discussed in this paper.

**Key words:** Bael, *Aegle marmelos*, RTS, fruit pulp, value addition

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### Introduction

Bael (*Aegle marmelos* Correa.) is an important fruit tree for semi arid and hot arid regions of the country. Bael fruit is a highly nutritious and favorite fruit throughout the country because of its medicinal and nutraceutical value. Besides eaten as fresh, many products like jam, squash, candy, nectar, jam, slab, beverages, powder, RTS, etc. are prepared from fruits (Singh and Roy, 1984; Singh *et al.*, 2011). This fruit can supplement the dietary needs of the rural people, where very less nutritious fruit is available. Sometimes the pulp diluted with water and added with requisite amount of sugar and tamarind, forms a delicious drink. Analysis of the fruit gave the following values: 61.5g moisture, 1.8 g protein, 0.39 g fat, 31.8 g carbohydrates, 1.7 g minerals, 55 mg carotene, 0.13 mg thiamine, 1.19 mg riboflavin, 1.1mg niacin and 8.0 mg vitamin C per 100 g of edible portion (Gopalan *et.al.*, 1985). In India, bael fruits are matured after 10-11 month of flowering and harvested during mid March to May. If fruits are left on the trees beyond ripening, these may get spoiled due to high temperature, monsoon rains and humidity. Normally the storage life of bael fruit is less hence, fresh fruit have to be processed in to value added products or pulp should be preserved. The fruit weight vary from 200g to 4000g and bigger size fruits can be successfully utilized for drying of

pulp for preparation of ready to serve drink. It can also be stored for long period by adding preservatives. Bael fruit has been in use from time immemorial in traditional medicine for relieving constipation, diarrhea, dysentery, peptic ulcer, and respiratory infections. In recent times, to make better use of fruits there has been a renewed interest in the bael as a main component in ayurvedic preparations, health food, beverages and delicious drink, etc (Singh *et al.*, 2012). In India, limited work has been carried out on post harvest management for proper utilization of bael fruits. Keeping in view, an attempt was made to utilize bael varieties fruits pulp for preparation of delicious drink to assess the quality parameters.

### Materials and Methods

The experiment was carried out in Plant Physiology Laboratory, CIAH, Bikaner during the year 2013 using fruits of bael cultivars Goma Yashi, NB-5 and CISH Bael -2 . The fruits were procured from Central Horticultural Experiment Station, CIAH, Godhra, Gujarat during April, 2013. Before extraction of pulp; data on morphological characters of fruits were recorded. Fruits were cleaned with water and then shell was broken in to pieces. Seeds were removed manually from pulp. Pulp was properly meshed with small quantity of water and fibre was removed from pulp. The ready to serve drink was prepared in the last week of May, 2013. Sugar was added @ 700g per litre of pulp to make ready to serve drink and to maintain

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TSS (14.0- 14.5 °Brix). Further, ready to serve drink was diluted with water in the ratio of 30:70 for organoleptic test.

Organoleptic testing was carried out on the day of preparation with a panel of ten judges on score basis (maximum 10 marks). TSS of the drink was monitor by Digital hand refractometer before sensory evaluation. Hedonic scale method was used for the organoleptic evaluation of drink prepared for colour, flavour, acceptability and taste characters. The mean data of score was assessed for sensory evaluation of ready to serve drink of bael varieties fruits.

### Results and Discussion

The mean data on physical characters of bael varieties fruit is given in Table-1. At maturity stage, the colour of fruit was yellow in both NB-5 and CISH B-2

varieties while it was yellowish green in Goma Yashi. It is early maturing variety producing sweet fruits in taste. The weight of fruit was higher in Goma Yashi than other varieties. The fruit weight vary from 1.0 to 1.6kg(Singh *et al*, 2012). The skull thickness was higher in NB-5 and CISH Bael -2 followed by Goma Yashi cultivar. However; there were no remarkable differences in TSS and number of seed locules/fruit. It was noticed that number of seed was more in NB-5 followed by Goma Yashi . The less number of seed was observed in CISH Bael -2. Variation in fruit size, skull thickness, number of seeds, mucilage content has been observed in other varieties (Ram and Singh, 2003), it may possibly be due to genetic features of the varieties and growing environment. In wild bael fruits, more number of seeds is found in comparison to improved ones. Moreover, mucilage content was more in CISH Bael -2 than other varieties which may due to genetic make up.

Table 1. Physico-chemical characteristics of bael varieties fruits.

Characters	Goma Yashi	N.B.-5	CISH Bael -2
Colour	Yellowish green	Yellow	Yellow
Fruit weight (kg.)	1.30	0.610	0.835
Length x width (cm.)	15.6 x 12.6	9.84 x 10.6	16.7 x 10.2
Specific gravity	0.95	0.86	0.86
Skull thickness(mm)	1.51	1.86	1.84
No of seed locules	14	16	13
No. of seed /fruit	71	85	41
Weight of seed (g.)	26		
Fibre weight/fruit(g)	40-50		
TSS (°brix)	37.7	36.8	38.7
Titrateable acidity (%)	0.28	0.34	0.41

Data presented in table -2 showed that ready-to-serve drink prepared from pulp of Goma Yashi was highly acceptable by the panel of judges on score basis. The appearance of product was attractive in packed glass bottle at fresh stage of testing. The appearance of RTS of Goma Yashi was yellowish getting maximum score (6.90) followed by NB-5 (6.50). The minimum score (5.80) was recorded with RTS prepared from cv. CISH Bael -2. The appearance was light yellow in colour.

The colour of product is an important character of any value added product. The initial colour of product was yellowish and attractive. There was no artificial colour mixed in the drink as pulp retains the natural yellow-reddish colour. The maximum scores (7.10) for colour was observed in Goma Yashi followed by others ( Table 2). The colour of product was good in case of NB-5 than CISH Bael-2. The minimum score was obtained in CISH Bael -2 which showed the poor pulp colour than other varieties.

Table 2. Sensory evaluation of RTS prepared from bael varieties fruits.

Characters	Goma Yashi	N.B.-5	CISH Bael- 2
Appearance	6.9	6.5	5.8
Taste	7.0	6.2	5.1
Flavour	7.8	5.6	5.2
Sweetness	8.5	7.0	5.3
Colour	7.1	6.7	5.3
Acceptability	7.3	6.3	5.1
TSS (°brix)	14.6	14.5	14.8

The maximum score of ready to serve drink was obtained for sweetness (8.5) followed by flavour (7.8) and acceptability characters (7.3). In sensory evaluation, taste is very important factor after colour and flavour. The highest score (7.30) was ranked for acceptability character followed by (6.30) in NB-5 (Table -2). The minimum score (5.10) was given by tasters for CISH Bael -2 variety which may possibly be due to poor taste sensation because of high titratable acid content in fruits (0.41%). The study is similar with the earlier findings on sensory evaluation of ready to serve drink prepared from date juice (Godara and Pareek, 1985).

The maximum mean score (7.0) of taste character was in Goma Yashi than NB-5 and CISH Bael-2 and this trend was similar for other characters. This may possibly be due to variation in the quality characters of fruits. The finding is similar with the characters reported by Singh *et al.*, (2011). However, poor score was obtained for maximum character in CISH bael -2 because of poor taste sensation among the tasters.

The sensory evaluation of RTS was indicative of high acceptance of Goma Yashi varieties. By this way, ripe bael fruits particularly big size can be utilized for making pulp for preparation of delicious drink. The score of acceptability and taste characters indicated that the ready to serve drink can be a better value added product of bael fruits because of its curative properties. However, this technique

provides the growers an ample scope to utilize their produce profitably in arid and semi arid regions.

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# Yield optimization in isabgol through improved seed and fertilizer management practices in Transitional Plain of Luni Basin of Rajasthan

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## Abstract

Field studies were conducted to evaluate the significant varieties/ genotypes and fertilizer management practices for harvesting the higher seed yield of isabgol in Transitional Plain of Luni Basin of Rajasthan. The maximum seed yield of 14.31 q/ha was provided by variety RI 89 followed by RI 3025 and GI 2 with 14.10 and 13.67 q/ha, respectively. The application of FYM @ 10 t/ha and biofertilizers (PSB & Azotobactor) along with chemical fertilizers @ 30kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha provided 32.92% increase in seed yield of isabgol over farmer's practice. The use of improved seed with recommended seed rate of 5 kg/ha along with foliar spray of 1% soluble NPK at flowering stage also provided 27.35% increase in seed yield over farmer's practice.

**Key words:** Foliar nutrition, improved seed, integrated nutrient management, isabgol, seed yield.

## Introduction

Isabgol (*Plantago ovata* Forsk; family Plantaginaceae) is a small herbaceous crop cultivated during rabi season. It is nearly a stem less soft hairy plant with large narrow linear leaves attains a height of 30-45 cm. The flowers are bisexual, tetramerous, anemophilous and protogynous and as such favouring out crossing (Barfa *et al.*, 2011). The seed epidermis is made of polyhedral cells whose walls are thickened by a secondary deposit which is the source of mucilage (Chopra, 1930). The coating of seed provides husk on mechanical milling. Husk is widely used in traditional and industrial pharmacology (Patel *et al.*, 1996) particularly in stomach disorder such as constipation, intestine irritation and dysentery (Mandal *et al.*, 2007; Viqar *et al.*, 2002). Isabgol husk forms gel and increases in volume many folds after absorption of water and stimulates normal bowel elimination. It is a dietary fibre which is effective in reducing cholesterol (Gupta *et al.*, 1994; Sagawa *et al.*, 1998). Looking to the importance and medicinal properties, isabgol has become a significant crop in international market with high export potential.

Isabgol requires moderately cool, dry and frost free clean weather conditions for proper growth and development. It is an excellent crop for input deficit situation because of its ability to grow on poor soils with

minimum irrigation and fertilization. In India, isabgol is predominantly cultivated in Rajasthan and Gujarat states. In Rajasthan, the major area under isabgol cultivation has been covered by district Barmer, Jalore, Nagaur, Jodhpur and Jaisalmer. Presently, its cultivation is becoming more popular in western Rajasthan because of poor soil fertility, undulated topography and meagre availability of irrigation water. The method of irrigation mainly applied in isabgol particularly on undulated topography is sprinkler. In Rajasthan, isabgol has occupied average area of 123746 ha with annual production of 45813 tones and average productivity of 370 kg/ha (Anonymous, 2009-10).

Cultivation of suitable variety and fertilizer management are important aspects to harness higher crop yield. The farmer participatory action research is a very effective means for validation and dissemination of technology among farmers. Hence, keeping in view, a farmer participatory action research under RKVY programme was undertaken with the objective to validate the integrated nutrient management technology and foliar nutrition at farmer's fields with farmer participation.

## Materials and Methods

The present study was conducted in Transitional Plain of Luni Basin of Rajasthan (zone IIb), which covers whole area of district Jalore and Pali, and part of district Jodhpur and Sirohi. In first experiment, seven varieties and improved genotypes of isabgol were evaluated for two years (2008-09 and 2009-10) in a randomised block design with 3

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replications at Agricultural Research Station, Keshwana, Jalore. The site is situated at latitude of 25°22'N and longitude of 72° 58'E, elevation 162 msl and has a tropical arid climate with mean annual rainfall of 421 mm. Soil at the site was clay loam slightly saline in reaction (pH 8.7).

Sowing was done on 07.11.2008 and 27.11.2009, respectively with standard seed rate. A fertilizer dose of 30 kg N and 25 kg P ha<sup>-1</sup> was applied to the crop as per zonal recommendation. A half dose of N and full dose of P were applied at the time of sowing, in the form of urea and DAP. The remaining half dose of the N was top dressed in the form of urea in two splits at the time of first and second irrigation. During 2009-10, a foliar spray of 1% soluble NPK (19:19:19) at flowering stage was also applied to the crop for harvesting the higher yield. Total 5 flood irrigations, each of about 6 cm depth were applied as per requirement of the crop. Two hand weeding were also carried out at 30 and 45 days after sowing to have the crop free from weeds. Data recorded on seed yield for 2 years was analysed using standard analysis of variance (ANOVA) technique through Excel software of Microsoft Office.

During 2008-09, an experiment on integrated nutrient management was also carried out at 4 farmer's fields for validation and dissemination of improved nutrient management technology. The experiment was laid out uniformly in strips of 0.40 ha accommodating each treatment in 0.10 ha land at each location. Improved seed and fertilizers were provided to farmers as experimental input.

During 2011-12, a technology demonstration of improved seed (var. RI-1) and foliar spray of 1% soluble NPK (19:19:19) at flowering stage was also laid out at 50 farmer's fields (Jalore 24, Pali 13, Sirohi 3 and Jodhpur 10 farmers). The technology demonstration was laid out in strips of 0.40 ha at each location. Improved seed and soluble NPK were provided to farmers under technology demonstration.

Field day programmes were also organised at demonstration sites to witness the performance of technology package vs. farmer's practice.

## Results and Discussion

### Varietal performance

Differences among varieties for seed yield were found statistically significant during both years. First year, seed yield ranged between 9.13 to 11.73 q/ha with the mean of 10.52 q/ha; however, in second year, it ranged between 12.75 to 18.05 q/ha with the mean of 15.16 q/ha. On the basis of two years performance, maximum yield of 14.31 q/ha was recorded in variety RI 89 followed by RI 3025 and GI 2 with 14.10 and 13.67 q/ha, respectively (Table 1). Therefore, varieties RI-89 and GI-2 may be promoted for cultivation in Transitional Plain of Luni Basin of Rajasthan for enhancing the production and productivity of isabgol. Improved genotype of isabgol RI-3025 may be further evaluated under multi location trials of crop improvement.

Table 1. Seed yield of different varieties of isabgol

S. No.	Varieties	Seed yield (q/ha)		Mean
		2007-08	2008-09	
1.	RI-3025*	10.15	18.05	14.10
2.	RI-3026*	10.97	13.25	12.11
3.	RI-3004*	9.13	12.75	10.94
4.	RI-1	10.33	13.88	12.11
5.	GI-2	10.60	16.73	13.67
6.	HI-2	10.33	14.63	12.48
7.	RI-89	11.73	16.88	14.31
	Mean	10.52	15.16	12.84
	SEm±	0.41	0.83	-
	CD (p=0.05)	1.28	2.56	-
	CV (%)	6.82	10.95	-

\*Improved genotypes

### Effect of integrated nutrient management practices on seed yield of isabgol

Results revealed that the use of FYM @ 10 t/ha along with recommended dose of fertilizers (30kg N + 25 kg P<sub>2</sub>O<sub>5</sub>) provided 28.75% increase in seed yield of isabgol over farmer's practice. The application of biofertilizers (PSB &

Azotobactor) has further accelerated the productivity level (Table 2). Therefore, the use of FYM @ 10 t/ha and biofertilizers (PSB & Azotobactor) should be encouraged along with chemical fertilizers @ 30kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha for harvesting the higher seed yield of isabgol

**Effect of improved seed and foliar nutrition of soluble NPK on seed yield of isabgol**

Results of technology demonstrations revealed that improved treated seed (var. RI 1) and foliar spray of 1% soluble NPK at flowering stage provided 27.35% increase in seed yield of isabgol over farmer's practice (Table 3). The

foliar nutrition of soluble NPK might have played an important role in photosynthesis, growth regulation along with tolerance against environmental stresses. The foliar nutrition of 1% soluble NPK needs to be promoted at farmer's field for enhancing the production and productivity of isabgol.

Table 3. Seed yield of isabgol as affected by improved seed and foliar nutrition at farmers fields

S. No	Particulars	Average seed yield (q/ha)	Yield increase over farmers practice
1.	Technology package ☞ Improved treated seed @ 5 kg/ha ☞ Foliar spray of 1% soluble NPK at flowering stage	7.45	27.35%
2.	Farmers own seed & management practice	5.85	-

Isabgol variety RI 89 has been found most suitable for cultivation in Transitional Plain of Luni Basin of Rajasthan. It was followed by improved genotype RI 3025 and variety GI 2. The application of FYM @ 10 t/ha and biofertilizers (PSB & Azotobactor) along with chemical fertilizers @ 30kg N + 25 kg P<sub>2</sub>O<sub>5</sub>/ha is beneficial in harvesting the higher seed yield. The use of improved seed with recommended seed rate of 5 kg/ha along with foliar spray of 1% soluble NPK at flowering stage should also be promoted at farmer's field for enhancing the production and productivity of isabgol.

**Acknowledgements**

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# Impact of front line demonstrations on productivity of Okra cv. Gujarat Okra-2 in Panchmahals district of middle Gujarat

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## Abstract

The present study was carried out at Panchmahals district of middle Gujarat during 2011-12. Okra is one of the most important vegetable crop of the country and India is the largest producer in the World. The development of the Agriculture is primarily depends on the application of the scientific technologies by making the best use of available resources. One of the major constraints of traditional okra farming is low productivity because of non-adoption of advanced technologies. To increase the production, productivity and quality of agricultural produce, Front Line Demonstrations is conducting at various farmers' field. All the recommended practices were provided to the selected farmers. The data related to cost of cultivation, production, productivity, gross return and net return were collected as per schedule and analyzed. Results of the present study revealed that the improved variety of Okra Gujarat Okra-2 recorded the higher yield (105.90 q/ ha) as compared to local check (87.60 q/ ha) traditionally grown by the farmers. The percentage increase in the yield over local check 20.89 was recorded. The technology gap in terms of productivity (9.1 q/ha) were computed. The technology index values 7.91 % was recorded. The results of study indicated the gap existed in the potential yield and demonstration yield is due to soil fertility and weather conditions. By conducting Front Line Demonstrations (FLDs) of proven technologies, yield potential of Okra can be increased upto great extent. This will substantially increase the income as well as the livelihood of the farming community.

**Keywords:** - *Front Line Demonstrations, local check, Okra, Technology, Yield*

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## Introduction

Okra (*Abelmoschus esculentus* L. Moench) is one of the most important annual vegetable in tropical and subtropical region of the World. It is a semi-woody, fibrous, herbaceous annual plant with an indeterminate growth habit (Balock, 1994). In India, okra is one of the most important vegetables in terms of consumption and area covered under cultivation (Iremiren and Okiy, 1986). India is the largest producer and exporter of okra in the World. It is used by people in different ways, the immature pods are consumed as boiled vegetables and they are also dried and used as soup thickeners or in stews (Yadev and Dhankhar, 2002). The green fruits are rich sources of vitamins, calcium, potassium and other minerals (Lee *et al.*, 1990). The area, production and productivity of Okra is 5.30 lakh ha, 62.88 lakh M.T and 11.8 M.T., respectively. In Gujarat, it is grown in area of 0.66 lakha ha with production of 7.23 lakh M.T and productivity 11.84 (Anonymous, 2012). In Panchmahals district of Gujarat, Okra is one of the most important vegetable crops. The area, production and productivity of

okra of the district are 600 ha, 3000 M.T and 5 M.T (Anonymous, 2010) per ha, respectively.

The okra variety Gujarat Okra-2 suits to this region. A field trial was carried out at the ten farmer's field at Panchmahals district of Gujarat. The Panchmahals district of Gujarat is characterized as hot semi-arid climate. It can be grown throughout the year under assured irrigation facility, whereas, the large numbers of farmers are growing okra during kharif season.

The main objective of Front Line Demonstrations (FLD) to introduce suitable Agriculture practices like high yielding varieties, seed treatment, spacing, nutrient management, pest and disease management etc among the farmers accompanied with organizing extension programmes (field day) for horizontal dissemination of the technologies. FLD is playing a very important role for transfer of technologies and changing scientific temperament of the farmers by seeing and believing principle.

In order to have better impact of the demonstrated technologies for farmers and field level extension functionaries, Front Line Demonstrations was conducted in a cluster of one or two hectares land.

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Generally, the agricultural technology is not accepted by the farmers as such in all respects. There is always gap between the recommended technology by the scientist and its modified form at the farmer's level which is major absentee in the efforts of increasing agricultural production in the country. It is need of the hour to reduce this technological gap between the agricultural technology recommended by the scientists or researchers and its acceptance by the farmers on their field. In view of the above facts, frontline demonstrations were undertaken in a systematic manner on farmers' field to show the worth of a new technology and convince the farmers to adopt in their farming system.

**Materials and Methods**

The present study was conducted in Panchmahals district of middle Gujarat during 2011-12. The genuine seed of Okra cv. Gujarat Okra-2 was procured and distributed to ten selected farmers. All the participating farmers were trained on various aspects of Okra production technologies. The field was prepared by deep ploughing during May and harrowing before sowing. The seeds were sown in well prepared field during monsoon season. A one fifth area was also devoted to grow local check. All the recommended practices *i.e.* seed treatment, spacing, recommended dose of manure and fertilizers, weed management, insect pest management were provided to the farmers in both treatments (local check and Gujarat Okra-2.) The data related to cost of cultivation, production, productivity, total return and net return were collected in both treatments as per schedule from all selected farmers. An average of cost of cultivation yield, net returns of different farmers was analyzed by the formula.

$$\text{Average} = [F1+F2+F3.....Fn]/N$$

F1 = Farmer  
N=No. of farmers (10)

In the present study, technology index was operationally defined as the technical feasibility obtained due to implementation of Front Line Demonstrations in Okra. To estimate the technology gap, extension gap and technology index following formula used by Samui *et al.* (2000) have been used:

$$\text{Technology gap} = P_i (\text{Potential yield}) - D_i (\text{Demonstration yield})$$

$$\text{Extension gap} = D_i (\text{Demonstration Yield}) - F_i (\text{Farmers yield})$$

$$\text{Technology Index} = [( \text{Potential yield} - \text{Demonstration yield} ) \times 100] / \text{Potential yield}$$

**Result and Discussion**  
**Performance of FLD**

A comparison of productivity levels between demonstrated variety and local check is shown in table-1. During the period of study, it was recorded that in front line demonstrations, the improved okra variety Gujarat Okra-2 recorded the higher pod yield (105.90 q/ ha) than local check (87.60 q/ ha). The percentage increase in the yield (20.89) over local check was recorded. Similarly, yield enhancement in different crops in front line demonstration had apply been documented by Hiremath *et al.* (2007), Mishra *et al.* (2009), Kumar *et al.* (2010), Suryawanshi and Prakash (1993) and Dhaka (2010). From these results it is evident that the performance of improved variety was found to be better than the local check under same environment conditions. The farmers were motivated by seeing the results in term of productivity and they are adopting the technologies. The yield of the front line demonstrations and potential yield of the crop was compared to estimate the yield gaps which were further categorized into technology index.

**Technology gap**

The technology gap shows the difference between potential yields over demonstration yield of the technology. The potential yield of the technology (variety Gujarat Okra-2) is 115 q. ha. The technology gap 9.10 q/ ha was recorded. The Front Line Demonstration was laid down under the supervision of KVK Specialist at the farmer's field; there exist a gap between the potential yield and demonstration yield. This may be due to the soil fertility and weather conditions. Hence location specific recommendations are necessary to bridge the gap. These findings are similar to the findings of Sharma and Sharma (2004) in oilseeds at Baran district of Rajasthan.

**Technology index**

Technology index shows the feasibility of the variety at the farmer's field. The lower the value of technology index more is the feasibility of the particular technology. The result of study depicted in Table- 1 revealed that the technology index value was 7.91. It means the technology okra cv. Gujarat okra-2 is suitable for the Panchmahals district of middle Gujarat. The results of the present study are in consonance with the findings of Singh *et*

Table 1. Yield, technology gap and technology index of demonstration

Variables	Yield (q/ h)	Increase (%) over Local check	Technology gap- (q/ h)	Technology index (%)
Local check	87.60	-	-	-
Demonstration (Gujarat Okra.-2)	105.90	20.89	9.1	7.91

al. (2007) and Hiremath and Nagaraju (2009) in onion.

### Economics of frontline demonstrations

The economics of okra production under front line demonstration was recorded and the results of the study have been presented in Table- 2. The Results of economic analysis of okra production revealed that front line demonstration recorded higher gross returns (Rs. 90015 / ha) and net return (Rs. 74460 /ha) with higher benefit ratio

(2.89) as compared to local check. These results are in accordance with the findings of Hiremath *et al.* (2007) and Hiremath and Nagaraju (2009). Further, additional cost of Rs.1400 per hectare in demonstration has increased additional net returns Rs. 15555 per hectare with incremental benefit cost ratio 10.11 suggesting its higher profitability and economic viability of the demonstration. More and less similar results were also reported by Hiremath and Nagaraju (2009), and Dhaka *et al.* (2010).

Table 2. Economics of frontline demonstrations

Variables	Cost of cultivation (Rs/ ha)	Gross return (Rs/ ha)	Net return (Rs ha)	Benefit: cost ratio
Local check	30800	74460	43660	2.41
Demonstration	32200	90015	57815	2.89
Additional in demonstration	1400	15555	14155	10.11*

\* Incremental benefit cost ratio

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SHORT COMMUNICATION

## Evaluation of *Morinda tomentosa* accession under zero irrigation conditions of semi-arid ecosystem

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*Morinda sp.* belongs to family Rubiaceae and the plant is believed to have originated in India and South East Asia and to be precise in Andaman and Nicobar Islands (Singh, 2009). It is also known by different vernacular names in different parts of world like *nuna*, *ach*, Indian mulberry, *awl*, great *Morinda*, cheese fruit, mouse's pineapple, jumbie breadfruit, hog apple, pain killer, *mengkudu*, *aledi* and *bilimbi*. It is grown wildly in many places throughout India viz. Madhya Pradesh, Gujarat, Rajasthan, Andhra Pradesh etc. It is hardy green small tree bearing flowers and fruits throughout the year under different agro-climatic conditions, but more prominently during rainy season (April to August). Plants of different species of *Morinda* spp. are found to be growing in fragile edaphoclimatic conditions and adapted to acidic, alkaline and saline conditions (Cambie and Ash, 1994). *M. tomentosa* is known to various usages by native folklore. Its decoction is used to cure chronic skin infections like boils. Ash of its leaves is also made into paste in oil base and applied on boils. Its fruits after discarding seeds are used as poultice. Its bark and wood are used to make yellow pigment and wood is used as timber for making stakes, pillars and handles of farm implements. Its fragrant flowers are offered to Lord Ganesh. The seeds are triangular reddish to brown in colour have prominent air sac attached to one end which makes the seeds buoyant. The noni is one of the most important botanical, medicinal remedies & food supplements traded on national as well as international market. Looking into the need of it elite cultivar, which are having desirable characters for above said reasons. An attempt was made to study variability in *Morinda* genotypes from Madhya Pradesh for the development of the suitable cultivar.

An extensive survey was made during the year 2010-11 to diversity rich areas of Madhya Pradesh (Berzer, Kathiwada, Dhar, Mandav, Ujjan, Mandasaur, Ratlam, Amarkantak, Jobat, Bhabhara, Jhabua etc.) to identify, earmark and collect the genotypes in the form of shoots, leaves, flowers and fruit for further evaluation. Efforts were made to select regular, prolific bearer genotype with good fruit quality. The method of random sampling from a population and biased sampling after gathering information

about particular genotype was selected. A total of sixteen fruits were randomly collected from all the direction of each genotype to record the qualitative and quantitative morphological characters. The extent of variation in physico-chemical traits of fruits from different location was recorded. A total of 20 genotypes were collected which had fairly wide spectrum of variability with respect to growth, flowering, fruiting behaviour and quality attributes. The samples of leaf, bud, flower and fruit were brought to the laboratory for morphological study and fruit quality attributes. The observations on qualitative characteristics like tree habit, and leaf morphology were recorded visually. Observation on the leaf morphology was in terms of leaf shape, leaf apex, leaf margin and leaf colour was taken as illustrated by Wilde et al., 1972 and Simpson, 2006.

The mature fruits of various genotypes differing in shape, size and appearance were collected from disease free plant to study the variability in physico-chemical attributes. Fresh samples in form of leaf, flower, fruit and seeds of selected genotypes of *Morinda* were collected for further study. Total soluble solids and pH of fruits were measured with the help of hand refractometer and pH meter, respectively and for estimation of acidity and vitamin C, the methods as advocated by A.O.A.C. (1990). The data were statistically analyzed for measurable characters as per method given by Gomez and Gomez (1984).

### Leaf

There was significant variability among all the genotypes studied for morphological characters of leaf. There were mainly 2 types of leaf shape observed i.e., elliptical and oval elliptical. Majority (60 %) of the genotypes were elliptical and remaining (40%) were oval elliptical in shape. The color of the leaves observed green in all the genotypes excluding CHESNM-1, CHESNM-7, CHESNM-9, CHESNM-13, CHESNM-15 and CHESNM-17. The leaf apex observed acute in CHESNM-1, CHESNM-5, CHESNM-8, CHESNM-10, CHESNM-11, CHESNM-13, CHESNM-14, CHESNM-16, CHESNM-17, CHESNM-19, CHESNM-20. Acuminate type of leaf apex was observed in CHESNM-2, CHESNM-3, CHESNM-6, CHESNM-9, CHESNM-12, whereas the

genotypes; CHESNM-4, CHESNM-7, CHESNM-18 had acute to acuminate type of leaf apex. The leaf length ranged between 20.40 -25.22 cm. The larger leaves measured in CHESNM-18 (25.22 cm) followed by CHESNM-7 (25.00cm) and smaller leaves in CHESNM-17(20.40 cm) followed by CHESNM-9(20.42 cm) among all the genotypes studied in M.P. The leaf width ranged between 8.00 -16.19 cm. The leaves were observed broader in CHESNM-2 (16.19 cm) and CHESNM-18(16.00 cm) and narrowly broader in CHESNM-12 (8.00cm) and CHESNM-15 (8.70 cm). Value petiole length ranged between 1.20 -

2.10 cm being maximum in CHESNM- 7 (2.10 cm) and CHESNM-16 (2.08 cm) and the same was the minimum in CHESNM-12 (1.20 cm) and CHESNM-6 (1.22 cm).The vain pairs per leaf was varied significantly among all the genotypes which was measured between 7.43- 12.33cm. It was counted maximum in CHESNM-16 (12.33) followed by CHESNM-5(10.95) and CHESNM-2 (10.12), whereas same was calculated minimum in CHESNM-6 (7.43) followed by CHESNM-12(7.70) among all the genotypes (Table 1).

Table 1. Leaf morphomatrix of different *M. tomentosa* genotypes.

Genotypes	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)	Vain pairs/ leaf	Leaf adexial surface	Leaf abexial surface	Leaf apex	Leaf shape	Leaf colour
CHESNM-1	22.41	13.22	2.05	09.95	Smooth	rough with hairs	Acute	elliptical	dark green
CHESNM-2	24.53	16.19	2.10	10.12	smooth shining	rough with hairs	Acuminate	oval elliptical	green
CHESNM-3	22.17	13.00	1.73	08.75	smooth	rough with hairs	Acuminate	elliptical	Green
CHESNM-4	21.71	12.50	1.50	09.41	smooth shining	rough with hairs	acute to acuminate	elliptical	green
CHESNM-5	23.20	13.27	2.07	10.95	Smooth shining	rough with hairs	acute	elliptical	green
CHESNM-6	21.48	12.74	1.22	07.43	smooth	rough with hairs	Acuminate	elliptical	Green
CHESNM-7	25.00	10.18	2.10	10.00	smooth	rough with hairs	acute to acuminate	elliptical	dark green
CHESNM-8	19.20	09.95	1.38	08.15	smooth	rough with hairs	acute	oval elliptical	green
CHESNM-9	20.42	13.30	1.90	08.70	smooth shining	rough with hairs	acuminate	elliptical	dark green
CHESNM-10	24.40	14.50	1.75	10.00	Smooth shining	rough with less hairs	acute	elliptical	green
CHESNM-11	22.17	14.00	1.80	09.15	smooth	rough with less hairs	acute	elliptical	green
CHESNM-12	15.54	08.00	1.20	07.70	smooth	rough with less hairs	acuminate	elliptical	green
CHESNM-13	22.10	14.20	1.73	09.00	smooth	rough	acute	elliptical	dark green
CHESNM-14	22.38	12.74	1.90	08.12	smooth	rough with hairs	acute	oval elliptical	green
CHESNM-15	16.17	08.70	1.45	09.64	smooth	rough with hairs	acute to acuminate	elliptical	dark green
CHESNM-16	22.43	11.75	2.08	12.33	Smooth shining	rough with hairs	acute	elliptical oval	green
CHESNM-17	20.40	13.05	1.97	08.40	smooth	rough less hairs	acute	elliptical	dark green
CHESNM-18	25.22	16.00	1.62	08.50	smooth	rough with less hairs	e to acuminate	elliptical	green
CHESNM-19	21.19	14.03	1.45	8.79	Smooth shining	rough with hairs	acute	elliptical	green
CHESNM-20	17.19	09.67	2.00	8.32	smooth	rough with hairs	acute	oval elliptical	green
C. D. at 5%	1.91	1.35	0.16	0.95	--	--	--	--	--

### Floral traits

Perusal of data from the Table 2 revealed that the colour of flower observed mainly white and greenish white amongst the genotypes studied. The larger number of flowers per head was recorded in CHESNM-4 (29.04) followed by CHESNM-16 (23.13) and CHESNM-11(22.83) whereas it was observed minimum in CHESNM-6 (12.25) followed by CHESNM- 8 (13.21) and CHESNM-20 (13.45).The maximum panicle length (12.00 cm) and diameter (1.20 mm) observed in CHESNM-2 and CHESNM-3, respectively. The bud length ranged between 11.00-13.50 cm and it was observed maximum in both the genotypes CHESNM-1 and CHESNM-11 (13.50 cm) followed by CHESNM-16 (13.24 cm) and CHESNM-9 (13.05 cm). The sepal length ranged between 3.30 -6.53 cm. It was measured maximum in CHESNM-5 (6.53 cm) followed by CHESNM-15 and CHESNM-7 and similar trait was minimum in CHESNM-3 (3.30 mm) followed by CHESNM-19 (3.50 mm).The petal length observed the maximum in CHESNM-19 (9.47 mm) followed by CHESNM-6 (9.34 mm) and same was the minimum in CHESNM-7 (7.12 mm) followed by CHESNM-4 (7.50 mm) and CHESNM-2 (7.54 mm). The number of stamen ranged between 5-6.50 and it was highest in number in CHESNM-1 and CHESNM-7 (6.50) and lowest in

CHESNM-5, CHESNM-9, CHESNM-14 and CHESNM-18.The stamen length ranged between 5.12 -7.00 cm, it was maximum in CHESNM-4 (7.00 mm) followed by CHESNM-13 (6.85 mm) and CHESNM-7 (6.80 mm) whereas similar trait was the minimum in CHESNM-3(5.12 mm) followed by CHESNM-17(5.13 mm) and CHESNM-1 (5.15 mm).Style length varied from 14.00-17.15 mm, the maximum style length measured in CHESNM-9(17.15 mm) followed by CHES -12 (17.12 mm) and CHESNM-14 (17.10mm) whereas same was the minimum in CHESNM-5 (14.00 mm) followed by CHESNM-10 (14.12 mm) and CHESNM-15 (14.15 mm). The observation was supported with the finding of cooke (1908).

### Fruit quality attributes

Results of study on the physico-chemical characters of different genotypes of *Morinda* spp. revealed that the wide genetic diversity collected from different parts of Madhya Pradesh. Perusal of the data on the genetic diversity of *Morinda* spp. revealed that the different genotypes varied widely in their fruit quality attributes. The physico-chemical attributes of fruits varied significantly among the different genotypes of *Morinda* spp. (Table-3). The fruit weight was recorded the maximum in CHESNM-

Table.2.Variability for flower characters of different *M. tomentosa* genotypes

Genotypes	No of flowers /head	Panicle length (mm)	Panicle diameter (mm)	Bud length (mm)	Sepal length ( mm)	Petal length (mm)	Stamen number	Stamen length (mm)	Style length (mm)	Flower colour
CHESNM-1	22.00	21.23	2.00	13.50	4.05	8.50	6.50	5.15	16.00	White
CHESNM-2	14.24	12.00	2.50	12.12	4.50	07.54	6.00	6.24	15.50	White
CHESNM-3	16.47	18.20	1.25	12.23	3.30	09.20	6.00	5.12	14.43	White
CHESNM-4	29.04	17.15	2.57	11.12	4.00	07.50	6.00	7.00	15.80	Greenish white
CHESNM-5	20.25	24.05	2.30	12.00	6.53	08.65	5.00	5.50	14.00	White
CHESNM-6	12.25	25.54	1.50	12.65	5.50	09.34	6.00	6.50	15.00	Greenish white
CHESNM-7	15.17	27.20	2.75	11.46	6.20	07.12	6.50	6.80	18.13	white
CHESNM-8	13.21	30.12	3.00	12.45	5.20	08.00	6.00	6.67	15.17	Greenish white
CHESNM-9	19.84	21.23	2.05	11.00	5.27	08.08	5.00	5.87	17.15	White
CHESNM-10	21.25	24.55	2.40	12.23	5.25	07.53	6.45	5.42	14.12	white
CHESNM-11	22.83	25.00	2.95	13.50	5.22	10.00	6.00	5.50	15.00	Greenish white
CHESNM-12	14.15	25.15	2.65	12.05	5.24	09.27	6.00	6.54	17.12	white
CHESNM-13	15.12	14.82	2.55	13.00	4.83	06.75	6.00	6.85	15.17	white
CHESNM-14	15.15	12.15	1.95	11.15	4.15	08.50	5.00	6.67	17.10	Greenish white
CHESNM-15	16.85	16.65	1.62	12.57	6.42	09.30	6.00	5.87	14.15	White
CHESNM-16	23.13	18.13	1.94	13.24	5.23	07.98	6.00	5.42	16.00	Greenish white
CHESNM-17	18.05	15.12	1.57	10.65	5.47	08.15	6.00	5.13	14.64	white
CHESNM-18	22.21	16.69	2.00	11.95	4.28	09.24	5.00	6.24	15.57	Greenish white
CHESNM-19	20.14	18.07	2.55	13.05	3.50	09.47	6.00	5.18	14.15	white
CHESNM-20	13.45	12.21	2.23	12.22	5.00	08.50	6.00	7.05	15.12	white
C. D. at 5%	1.98	2.32	0.24	1.25	0.48	0.83	0.51	0.67	1.49	--

12 (34.24g) followed by CHESNM-20 (30.50g), CHESNM-14 (30.24g) while the same was recorded the minimum in CHESNM-2 followed by (15.38g), CHESNM-6 (16.76g) and CHESNM-16 (17.38g). The maximum length and breadth of the fruit was recorded 4.00 cm and 4.05 cm in CHESNM-12 while it was recorded the minimum in CHESNM-1 (length- 2.30cm and breadth- 2.20cm) among the evaluated genotypes. These findings are in consonance with results as reported by Singh *et al.* (2010) and Gupta *et al.* (2011). The number of pyrites and seed weight varied from 14.00 - 23.14 and from 23.00 to 44 per fruit. Per seed weight was recorded the maximum in CHESNM-12(0.11g) and the lowest in CHESNM-2 (0.07g), while TSS was recorded the maximum in CHESNM-12 (10.50) followed by CHESNM-6 (10.15) and it was minimum in CHESNM-1 (7.00). The P<sup>H</sup> of fruit juice

was recorded the maximum in CHESNM-14 (6.25) followed CHESNM- 12 (5.50). The acidity of fruit juice and vitamin C varied between 0.49 to 0.72% and 30.00-40.00 mg/100g, respectively among the genotypes collected from Madhya Pradesh. These findings are in agreement with the results as reported by Singh *et al.*, (2010) and Singh *et al.*, (2011).

However, based on the overall performance the genotypes with respect to physico-chemical attributes CHESNM-12 and CHESNM-14 were found to be promising with respect to quality attributes. Though only the genotypes of Madhya Pradesh are reported here, but the general morphology of various genotypes are in accordance with that of reported by earlier workers (Singh *et al.* 2009, Singh *et al.* 2010 and Singh *et al.*, 2008).

Table.3. Variability for fruit characters of different *M. tomentosa* genotypes.

Genotypes	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Pyrites / fruit	Number of seed / fruit	Seed weight (g)	TSS (%)	p <sup>H</sup> of fruit juice	Acidity (%)	Vitamin C mg/100 g
CHESNM-1	16.72	2.30	2.20	14.00	23.00	0.08	07.00	4.25	0.70	32.12
CHESNM-2	15.38	2.42	2.25	16.12	28.28	0.07	10.00	4.70	0.65	38.00
CHESNM-3	20.76	3.40	3.35	17.17	30.23	0.10	08.00	5.00	0.54	39.15
CHESNM-4	18.12	3.38	3.30	17.19	35.17	0.08	08.00	4.60	0.53	38.45
CHESNM-5	19.43	3.60	3.62	16.34	36.48	0.09	08.00	4.25	0.57	38.00
CHESNM-6	16.76	2.45	2.45	18.27	36.27	0.08	10.15	4.50	0.52	32.15
CHESNM-7	19.97	3.58	3.47	19.10	34.00	0.09	09.00	5.00	0.63	31.65
CHESNM-8	25.73	3.90	3.80	19.00	27.00	0.10	10.20	4.25	0.52	34.00
CHESNM-9	20.65	3.47	3.56	16.00	30.00	0.08	09.21	4.62	0.62	37.13
CHESNM-10	23.92	3.52	3.81	17.75	26.13	0.08	08.50	4.25	0.67	34.20
CHESNM-11	23.77	3.68	3.60	18.80	38.00	0.07	10.00	4.70	0.55	36.00
CHESNM-12	34.24	4.00	4.05	23.14	44.00	0.11	10.50	5.50	0.49	45.00
CHESNM-13	18.76	3.32	3.45	23.00	26.00	0.08	10.0	4.60	0.60	39.00
CHESNM-14	30.24	3.98	3.84	13.00	42.25	0.09	08.50	6.25	0.55	33.00
CHESNM-15	27.68	3.68	3.67	19.25	39.00	0.08	09.00	4.50	0.72	32.00
CHESNM-16	17.38	2.65	2.70	18.11	26.15	0.09	10.00	4.00	0.66	35.00
CHESNM-17	19.08	3.12	3.00	15.17	32.00	0.10	10.00	4.25	0.50	34.12
CHESNM-18	22.77	3.50	3.40	16.13	34.58	0.08	09.50	4.62	0.61	30.00
CHESNM-19	26.70	3.98	3.80	19.00	41.18	0.08	08.00	4.25	0.65	31.00
CHESNM-20	30.50	3.95	3.90	21.00	40.00	0.07	09.50	5.00	0.52	32.15
C. D at 5%	3.21	0.31	0.29	3.10	5.42	NS	2.11	0.30	0.08	1.42

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SHORT COMMUNICATION

## Response of ber (*Ziziphus mauritiana* Lamk.) cultivars against black leaf spot (*Isariopsis indica* var. *zizyphi*) disease and its correlation with weather parameters

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Ber [*Ziziphus mauritiana* Lamk. (Syn. *Z. jujuba* L.)] Indian jujube also known as Narkelikul, Boroi, Bor, Beri, Indian plum is a tropical fruit tree species belonging to the family *Rhamnaceae*. Indian jujube is one of the two *Zizyphus* species that have considerable horticultural importance. The other one is Chinese jujube. It is commonly found in the tropical and subtropical regions. Originally native to India, it is now widely naturalized in tropical region from Africa, Afghanistan and China and in some Pacific regions. *Ziziphus* spp. can be grown even on marginal land in the hot arid regions of Rajasthan. Its cultivation has received a great impetus in recent years in the northern part of India; especially in the states of Punjab, Haryana, Rajasthan, Uttar Pradesh and Gujarat from 1984 to 1995 with improved cultivars.

The fruits are eaten raw or as pickles or used in beverages. It is quite nutritious and rich in vitamin C. In India, the ripe fruits are mostly consumed raw, but are some times stewed. Ripe fruits are preserved by sun drying and a powder is prepared for out-of-season purposes. Production of ber is affected by a large number of biotic stresses. A number of fungi belonging to different taxonomic families attack the crop. Among the fungal diseases, rust (*Phakospora zizyphus vulgaris*), powdery mildew (*Oidium erysiphoides* f. sp. *zizyphi*), leaf spot (*Tandonella zizyphi*, *Alternaria* sp.) *Cercospora zizyphi*, *Cladosporium zizyphi* and *Phoma* sp.) and mouldy leaf spot (*Isariopsis indica* var. *zizyphi*) are very important. This disease was first reported from Haryana by Gupta and Madan, 1977. However, mouldy (black) leaf spot of ber caused by *I. indica* causes the maximum yield less and appears in severe form on various cultivars of ber (Verma and Kumar, 1992).

The experiment was carried out at Main Experiment Station, Department of Horticulture, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad (Uttar Pradesh) during 2008-09. Three cvs viz., Tikadi (with maximum resistance) cv. Gola (with moderately resistance) and Chhuhara (with minimum resistance) were selected for the experiment. Three plants for each cvs. were selected for the same. Four branches in 4 diagonally opposite directions of each of the three plants were selected and 5 healthy leaves from each of the branch were selected for observations. Thus, total 60 leaves for each of the three groups of the cvs. were selected for the observations.

Date of first appearance of the spot on each leaf were recorded as well as area covered in each leaf at weekly intervals till the maximum/ whole leaf covered were also observed.

### The temperature and relative humidity under the tree canopy and sunshine hrs/day

The temperature and relative humidity of the canopy were recorded with hygro-thermometer while sunshine hrs/day at weekly intervals recorded from meteorological department of this university from the start of the experiment till the end.

### Disease intensity

Natural incidence of the black leaf spot disease of ber was recorded at weekly intervals and average disease incidence was calculated. The disease severity were observed on all three cvs. Disease severity was calculated by using 0-5 scale as given below:

Table 1. Scale for varietal screening

Disease intensity	Rating	Reaction
0	0	Immune
0.1-5	1	Resistant
5.1-20	2	Moderately susceptible
20.1-50	3	Susceptible
50.1 and above	4	Highly susceptible

A comparative observations regarding symptoms were noted at three stages viz. initial stage, middle stage and peak stage of disease development of all the three cvs. Gola, Chhuhara and Tikadi described as under:

1. Initial stage- Black spot disease symptoms are on lower side of leaves in the cvs. Gola (0.10 per cent) and Chhuhara (1.10 per cent). While in cv. Tikadi, there is no any symptoms appeared.
2. Middle stage- Sooty black spots observed on lower side of leaves in cvs. Gola (16-17 per cent) and Chhuhara (22-23 per cent) leaf area covered. While in cv. Tikadi, tiny globose, corky, brown coloured spots covering 1.0 per cent area.
3. Peak stage- Sooty black spots observed on lower side of leaves in both the cvs. in Gola (40-41 per cent) and Chhuhara (52-53 per cent) of leaf area covered, whereas in cv. Tikadi tiny, globose, corky, brown colour spots seen on lower side of leaves up to 2.9-3.0 per cent area covered. Bakshi and Singh (1974) recorded sooty black spots on the leaves

resulting into yellowing of leaves and premature defoliation.

First appearance of disease was recorded during 3<sup>rd</sup> week of September (38<sup>th</sup> meteorological week) on cvs. Gola and Chhuhara when weather factor viz. temperature maximum (30.88) and minimum (25.00), relative humidity morning (87.00) and evening (80.75), sunshine hrs/day (2.4). Disease appeared on Tikadi during 3<sup>rd</sup> week of October (19.10.2008) 42<sup>nd</sup> meteorological week. It was also observed that, disease increases fast during last November to last December (47<sup>th</sup> - 52<sup>th</sup> meteorological week). During 52<sup>nd</sup> meteorological week temperature maximum (19.88) and minimum (7.5). Relative humidity (morning), 90.50 and evening (62.25), sunshine hrs (4.7) The PDI of all the three cvs. Gola (37.90), Chhuhara (47.00) and Tikadi (2.26).

Maximum PDI of cvs. Gola (40.18%), Chhuhara (52.95%) and Tikadi (2.92%) was found during 3<sup>rd</sup> week of January, 2009 at maximum temperature 23.75 C and minimum temperature of 6C, RH (morning 90.50%) and evening (38%), sunshine hours (5.8).

Table 1. Response of ber cultivars against black leaf spot disease and its correlation with weather parameters.

Date of observation	Met. Week	PDI of Tikadi	PDI of Gola	PDI of Chhuhara	Temperature		R.H.		Sunshine (hrs/day)
					Max.	Min.	Morning	Evening	
15.9.08	37	0.00	0.00	0.00	33.5	27.00	87.00	64.00	7.7
21.9.08	38	0.00	0.81	4.65	30.88	25.00	87.00	80.75	2.4
28.9.08	39	0.00	3.19	6.32	31.00	23.00	90.67	71.00	6.3
5.10.08	40	0.00	6.59	9.33	31.00	23.25	89.00	70.50	5.6
12.10.08	41	0.00	8.26	11.66	32.00	21.83	90.67	66.33	7.7
19.10.08	42	0.11	10.37	14.18	31.13	19.50	89.00	59.75	7.5
26.10.08	43	0.28	11.94	16.97	30.67	16.17	83.33	48.00	7.0
2.11.08	44	0.50	14.07	18.46	30.00	15.38	86.00	44.75	6.6
9.11.08	45	0.66	15.41	22.09	30.67	13.83	86.33	52.33	5.9
16.11.08	46	0.89	18.15	24.97	16.75	12.13	86.75	43.50	6.1
23.11.08	47	1.15	20.39	26.43	21.50	10.67	79.67	45.67	5.5
30.11.08	48	1.33	23.44	30.00	25.63	9.63	88.25	42.25	4.1
7.12.08	49	1.51	27.49	35.00	25.17	9.23	91.00	45.00	2.4
14.12.08	50	1.78	32.33	39.50	25.38	9.38	90.75	60.75	2.1
21.12.08	51	1.97	35.40	44.95	19.00	10.23	93.67	69.33	1.6
28.12.08	52	2.26	37.90	47.00	19.88	7.50	90.50	62.25	4.7
4.1.09	1	2.47	38.75	49.25	21.60	6.02	85.67	66.00	2.4
11.1.09	2	2.77	39.95	51.00	21.88	6.88	79.75	66.50	3.9
18.1.09	3	2.92	40.18	52.95	23.75	6.00	90.50	38.00	5.8

**Correlation matrix studies**

Correlation matrix studies indicated that, temperature (maximum and minimum) showed highly significant negative correlation with PDI of all three ber cvs. Gola, Chhuhara and Tikadi. Sunshine hrs/day showed significant negative correlation while relative humidity

(evening) showed negative correlation against PDI of all three cvs. Relative humidity (morning) showed negative correlation against PDI of Tikadi whereas positive correlation against cvs. Gola and Chhuhara as shown in Table-2. Similar results were also recorded by Singh *et al* (1996).

Table 2. Correlation coefficient of PDI of black leaf spot of ber cvs. with weather parameters.

Cultivars	Weather parameters				
	Temperature		Relative humidity		Sunshine (hrs/day)
	Max.	Min.	Morning	Evening	
Tikadi	-0.768**	-0.911**	-0.024	-0.233	-0.565*
Gola	-0.786**	-0.946**	0.031	-0.258	-0.569*
Chhuhara	-0.789*	-0.948**	0.021	-0.264	-0.568*

\* Significant

\*\* Highly significant

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SHORT COMMUNICATION

## Influence of organic enrichment and foliar feeding of nitrogen on productivity, nitrogen uptake of winter drilled fennel (*Foeniculum vulgare*)

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Fennel one of the most important seed spices crop in India grown mainly as transplanted crop, although it can also be raised profitably as a winter direct-seeded crop (Mehta *et al.*, 1990). Direct seeded fennel is very popular due to short duration than transplanted crop. Thus, direct-seeded fennel is profitable than other winter crops like mustard chickpea and wheat (Mehta *et al.*, 1990). Fennel being a wide rowed crop can be grown successfully under drip in water scarce state like Rajasthan and various experiments conducted at Swami Keshwanand Rajasthan Agricultural University, Bikaner concluded that 80% ETc is optimum level for drip irrigated fennel. Indian agriculture is facing a serious problem of declining total factor productivity and low crop response to inputs chiefly fertilizers. Declining crop response to water and fertilizer particularly nitrogen is due to deteriorating soil health and productivity. Organic matter enrichment can rejuvenate the soil health in a dramatic manner. This will lead to increased efficiency of water and fertilizers particularly nitrogen. Light soils are prone to increased losses of nitrogen in process of deep percolation loss. Split application through fertigation is therefore recommended. A less attended practice of fertilizing crop is that of foliar feeding particularly of fertilizer nitrogen. It ensures ample availability of nitrogen to crops for obtaining higher growth and yield (Arif *et al.*, 2006). Foliar nitrogen nutrition plays a crucial role in maintaining leaf nitrogen to an optimum level during reproductive growth when yield formation is often limited by low crop photosynthetic efficiency. Therefore, efforts have been made to enhance seed yield of fennel through organic enrichment and foliar feeding of nitrogen.

The field experiment was conducted during the winter seasons of 2010-11 and 2011-12 at Swami Keshwanand Rajasthan Agricultural University Farm, Bikaner in randomized block design with 3 replications. The treatments comprised of 3 organic enrichment [Recommended fertilizers (90:20:0 - RD), RD + 10 t FYM/ha and RD + 5 t vermicompost/ha] and 3 methods of nitrogen application (90 kg nitrogen/ha through drip system, 60 kg nitrogen through drip system + foliar spray of 30 kg nitrogen upto flowering stage and 60 kg nitrogen through drip system + foliar spray of 30 kg nitrogen from flowering to physiological maturity). Organic matter as per

treatment was applied at the time of land preparation and soil application of nitrogen was done as fertigation in 6 splits at 15 days interval starting from sowing. Foliar spray of nitrogen was done through urea in 3 splits during reproductive stage at 10 days interval as per treatment. The fennel variety RF 101 was sown on 11<sup>th</sup> November using 10 kg seed/ha and harvesting in 4<sup>th</sup> week of April in both the years. The crop was sown in paired row spacing of 30 cm x 60 cm i.e. 30 cm between rows in a pair and 60 cm between two pairs in 120 cm drip line spacing to reduce cost of drip system. The crop was raised at drip irrigation level of 80% ETc through out the growing period, which is recommended as optimum for the zone. The details of irrigation events and monthwise irrigation water applied are presented in table 1. The soil was sandy loam having field capacity 7.2%, permanent wilting point 1.8%, bulk density 1.51 g/cc, pH (1:2) 8.2, electrical conductivity (1:2) 0.2 dS/m, organic carbon 0.11% and available P and K 15 and 320 kg/ha, respectively.

### Organic enrichment

Organic enrichment with 10 t farmyard manure/ha in addition to recommended fertilizers dose (RD) recorded the highest plant height (120.4 cm), branch/plant (17.1), umble/plant (20.3), seed/ umble (311) and test weight (7.7g) followed by RD + 5 t vermicompost/ha, where the corresponding values are 118.3 cm, 16.3, 19.4, 298 and 7.4 g, respectively and significantly superior to recommended fertilizer dose. Increased yield attributes with RD + 10 t FYM thus gave the highest seed yield (23.07 q/ha), stover yield (48.93 q/ha) and biological yield (71.5 q/ha). Vermicompost (5 t/ha) along with recommended dose of fertilizer (RD) also gave superior seed yield (22.23 q/ha), stover yield (48.72 q/ha) and straw yield (71 q/ha). The improvement of yield and yield attributes might be due to FYM / vermicompost which had supplied available plant nutrients and brought about a favourable soil environment, which ultimately increased the nutrient and water-holding capacity of soil (Khiriya and Singh, 2003 and Gupta *et al.*, 2006). Further, FYM/vermicompost improved activities of heterophilic bacteria and fungi in soil, which in turn increased the activity of soil enzymes responsible for the conversion of nutrients from unavailable to available form (Sarma *et*

al., 2007). Addition of 10 t FYM/ha along with recommended level of fertilizers recorded highest nitrogen uptake (68.3 kg/ha) followed by vermicompost (5 t/ha) + RD (65.6 kg N/ha) and RD recorded the lowest nitrogen uptake of 60.5 kg/ha. It might be due to better physical conditions of soil with organic matter which not only supplied nutrients also improved soil physical condition congenial for better root-growth and nutrient uptake (Khiriya and Singh, 2003). Organic enrichment with FYM and vermicompost also improved harvest index compared to crop grown with only recommended fertilizer dose.

#### Fertigation and foliar nutrition of nitrogen

Application of 60 kg N/ha through fertigation (drip) + 30 kg N/ha as foliar spray from flowering to physiological maturity recorded highest plant height (121.5 cm), branch/plant (17.5), umble/plant (21.0), umblest/umblem (23.5), seed/umblem (303) and test weight

(7.8 g) followed by 60 kg N/ha as fertigation + 30 N/ha foliar spray upto flowering stage where the corresponding values are 119.5 cm, 16.8, 20.8, 296 and 7.3 g, respectively. Higher yield attributes with fertigation (60 kg N/ha) + foliar nutrition (30 kg N/ha) from flowering to physiological maturity in turn contributed to highest fennel seed (2.38 t/ha) and biological yield (7.18 t/ha). This may be attributed to maintaining higher leaf nitrogen at reproductive stage which enhanced photosynthesis rate and transportation of photosynthate from source to sink. This is in conformity with Arif *et al.* (2006). Further, higher seed and biological yield taken up more nitrogen (67.5 kg/ha) which in turn gave highest nitrogen use efficiency of 35.21 kg seed/kg N. Water use efficiency was also highest (5.99 kg/ha-mm) with 60 kg N/ha (fertigation) + 30 kg N/ha as foliar feeding in reproductive stage.

Table 1. Monthwise irrigation events and irrigation water applied to fennel (mean of 2 years)

Month	Irrigation events	Irrigation water (mm) applied at 80% ETC with drip system
November (11-30)	10	51.39
December	15	74.77
January	16	76.47
February	14	67.32
March (1-31)	16	87.80
April (1-10)	5	39.02
Total	76	396.77

Table 2. Effect of organic enrichment and foliar application of nitrogen on height and yield attributes of fennel (pooled of 2 years)

Treatment	Height (cm)	Branch/plant	Umbles/plant	Umblets/umblem	Seed/umblem	Test Weight (g)
Organic enrichment						
Recommended fertilizer (RD)	112.3	14.4	18.5	20.5	280	7.2
RD + 10 t FYM/ha	120.4	17.1	20.3	23.3	311	7.7
RD +5 t vermicompost /ha	118.3	16.3	19.4	22.4	298	7.4
CD at 5%	1.5	1.2	1.1	0.8	5	0.2
Methods of nitrogen application						
90 kg N/ha in split through drip	110.0	13.5	17.1	20.0	290	7.2
60 kg N(drip) + foliar spray (30 kg N/ha) up to flowering stage	119.5	16.8	20.8	22.8	296	7.3
60 kg N (drip) + foliar spray (30 kg N/ha) from flowering to physiological maturity	121.5	17.5	21.0	23.5	303	7.8
CD at 5%	1.5	1.2	1.1	0.8	5	0.2

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SHORT COMMUNICATION

## Impact of intercropping in disease management in mandarin

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Nagpur mandarin (*Citrus reticulata* Blanco) is the most valued member of Rutaceae family and enjoy predominant position among fruit crops grown in the country. Brazil, USA, Mexico, India, China, Spain, Italy, Iran, Egypt and Pakistan are the major producing countries of mandarin in the world. Nagpur, Akola, Amrawati and Wardha in Maharashtra; Jhalawar and Kota in Rajasthan; Chikmagalur, Kodagu and Hassan in Karnataka; Chhindwara, Mandsaur, Betul, Ujjain and Shajapur in Madhya Pradesh; Wokha and Tuensang in Nagaland; Darjeeling in West Bengal; Tinsukia, NC Hills, Karbi and Anglong in Assam; East and West Khasis, Ribhoi, Garo Hills and Jaintia Hills in Meghalaya and Tripura are the major mandarin belts in the country.

Mandarin fruits are mostly consumed as fresh. It is processed into various products and by-products. The essential oil possesses anti-fungal property against phytopathogens. Hesperidins, the most abundant bioflavonoid in juice of oranges has been found to inhibit metabolization of precarcinogens into carcinogens reducing the chance of cancer in human being.

Multifold nutritional and medicinal values of fruits have made them especially important in the nutritionally aware consumer world. The fruits of mandarin command demand in the market. There is need to augment production and productivity of the crop. However, the productivity of the mandarin orchard in India is 7-8 tonnes/ha only as against 25-30 tonnes/ha in major citrus growing countries of the world (Sharma, 2006). In Jhalawar district 8492.26 hectare area is under mandarin production and the total production as per the statistics for the year 2009-10 is 160509.79 tonnes (Anon., 2009-10). It has been established that disease alone account for 20 % loss in yield in agriculture in general (Panda, 2005). Managing them properly has its worth in hastening production and productivity. With such a view, a survey of different area of the Jhalawar district was conducted and attempt has been made to draw impact of intercropping on the incidence of diseases in mandarin.

The district falls under sub humid South Eastern plain under Zone V. Jhalawar extends over 6.32 lac hectare area among 23°40' to 24°52' N- latitude and 75°29' to 76°56' E- longitudes in south Eastern Rajasthan. Average rainfall in

the region is 1000 mm. Maximum temperature range in summer is 43° to 47°C and thus the minimum temperature during winter is 4° to 6°C.

The long-term mean annual rainfall of the district is 910 mm with a standard deviation of 218 mm and a coefficient of variation of 24 %. On long term basis the district experiences 38 mean number of rainy days with a standard deviation of 6 days and a coefficient of variation of 15.49 %. The annual mean, maximum and minimum monthly relative humidity of the region are 69 %, 91 % (August) and 31 % (July) respectively. Temperature varies according to altitude. The annual mean, maximum and minimum monthly mean daily temperatures in the district are 27.48°C, 48.8°C (May) and 5.5°C (February), respectively.

However, during study period (October, 2008 till May, 2009), the maximum temperature varied from 44.58°C during May to 24.5°C during January and the minimum from 9.9°C December to 27.5°C during May. The relative humidity was observed 95 % during December and the minimum 7 % during April. Rainfall of 35.5 mm magnitude was observed during November and those of 10 mm was observed during May in three span (Fig. 2).

In an attempt to study the influence of intercropping on the incidence of diseases in mandarin orchard, a survey of orchards located in Asnawar, Jhalrapatan, Junakhera, Aktasa, Manpura, Kherla, Guradia, Salotia, Pirawa and Pachpahar localities of the Jhalawar district were made during 2008-09. The detailed information of intercrops grown in the orchard during different season of the year in the aforesaid locality and incidence of diseases was collected on the basis of personal interview of the landlord and are presented here under Table 1.

Going through the information furnished under Table-1, it appears that out of phytophthora rot, sooty mould, vein yellowing and soft rot, the first two diseases were more pervasive in the area. In the orchards wheat, mustard, barley, lucern, soyabean, cauliflower, cowpea, clusterbean, coriander, etc were found as the major intercrops in the locality. Further, the orchard where garlic was intercropped the incidence of the diseases was minimum. It may be due to presence of sulphur containing aroma compounds; allyl-

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propyl-disulphide in garlic plants. The aroma emancipated in the nearby environment from the plant might serve as a sheath in safeguarding mandarin from the attack of diseases. It was also noted that garlic was an intercrop in the orchard which was having proper penetration of solar radiation on

the ground surface. It becomes possible during early stage of orchard. In general, early stage plants are strong and vigorous enough to ward themselves from the incidence of diseases by virtue of presence of range of metabolites inside plant system.

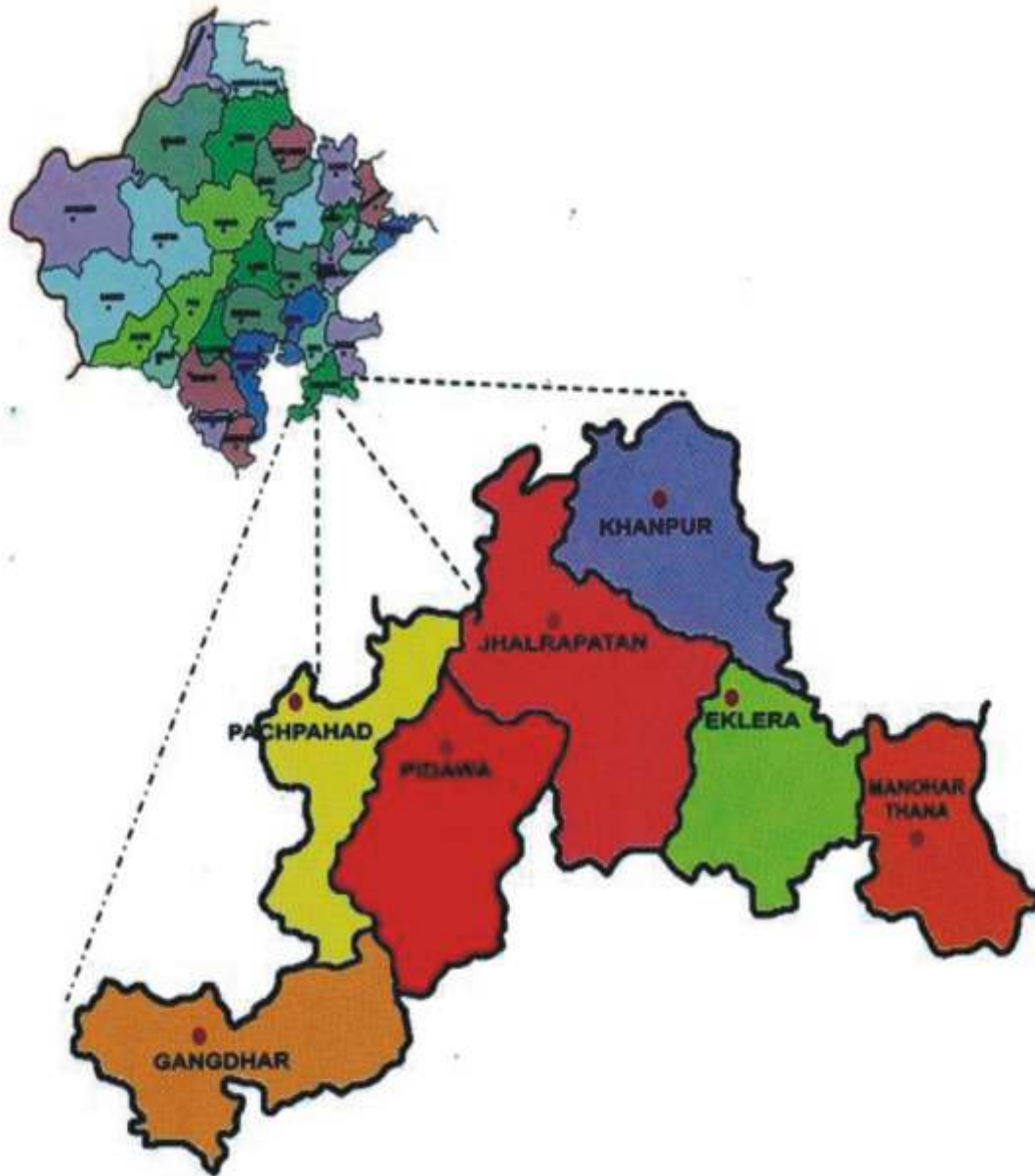


Fig. 1 Map of Jhalawar district, Rajasthan

In an attempt to study the influence of intercropping on the incidence of diseases in mandarin orchard, a survey of orchards located in Asnawar, Jhalarapatan, Junakhera, Aktasa, Manpura, Kherla,

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presence of sulphur containing aroma compounds; allyl-propyl-disulphide in garlic plants. The aroma emancipated in the nearby environment from the plant might serve as a sheath in safeguarding mandarin from the attack of diseases. It was also noted that garlic was an intercrop in the orchard which was having proper penetration of solar radiation on the ground surface. It becomes possible during early stage of orchard. In general, early stage plants are strong and vigorous enough to ward themselves from the incidence of diseases by virtue of presence of range of metabolites inside plant system.

Table 1. Commonly grown intercrops and incidence of diseases in mandarin orchard

S. No.	Name of orchardist	Locality	No. of tree in orchard	Intercropping followed	Incidence of disease
1.	AS-01	Asnawar	680	Lucern, Barley	Phytophthora rot, Sooty mould
2.	JH-02	Jhalarapatan	750	Coriander, Soybean	Sooty mould
3.	JK-03	Junakhera	397	Wheat, Soybean	Phytophthora rot
4.	JK-04	Junakhera	400	Garlic	Nil
5.	AK-05	Aktasa	720	Fenugreek, Soybean	Phytophthora rot, vein yellowing
6.	AK-06	Aktasa	200	Garlic, marigold, clusterbean	Nil
7.	AK-07	Aktasa	400	Garlic, cauliflower, brinjal, spinach	Nil
8.	DT-08	Dityakher	300	Garlic, soyabean, mustard	Nil
9.	MP-09	Manpura	330	Fenugreek, Gram	Phytophthora rot
10.	KH-10	Kherla	600	Coriander, Soyabean	Sooty mould
11.	GR-11	Guradiya	450	Mustard, Wheat, Moong, Cowpea	Phytophthora rot
12.	SA-11	Salotia	493	Coriander, Maize	Phytophthora rot
13.	PR-12	Pirawa	200	Wheat, Urd	Phytophthora rot
14.	PR-13	Pirawa	330	Wheat, Soyabean	Sooty mould
15.	PR-14	Pirawa	250	Fenugreek, Urd	Phytophthora rot
16.	PR-15	Pirawa	170	Wheat, Soyabean	Phytophthora rot, vein yellowing
17.	PC-16	Pachhpahar	400	Coriander, Soyabean	Phytophthora rot
18.	PC-17	Pachhpahar	600	Mustard, Soyabean	Sooty mould
19.	PC-18	Pachhpahar	300	Wheat, Soyabean	Phytophthora rot
20.	PC-19	Pachhpahar	80	Soyabean	Sooty mould, Soft rot
21.	PC-20	Pachhpahar	330	Nil	Sooty mould
22.	PC-21	Pachhpahar	300	Nil	Sooty mould

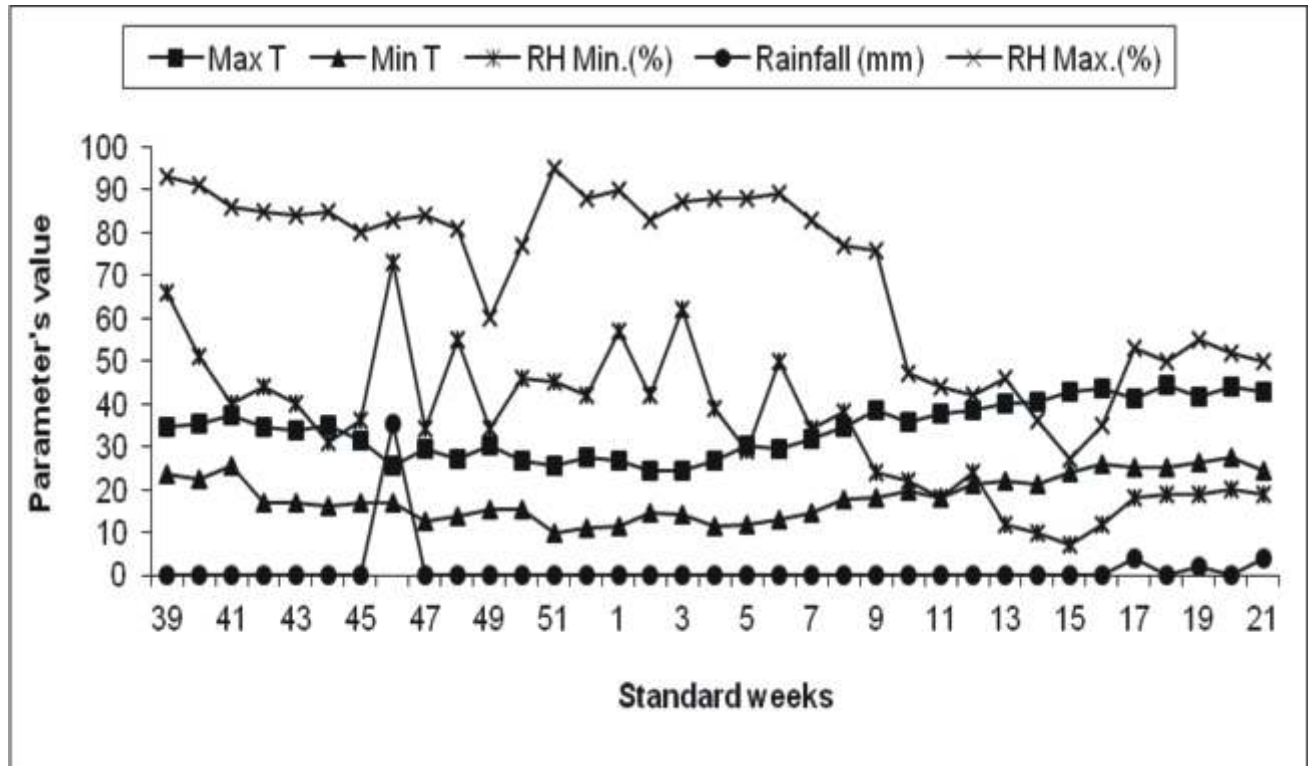


Fig.2. Climatic parameters during study period of Oct, 2008 to May, 2009.

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SHORT COMMUNICATION

## Antimicrobial activities of some arid medicinal plants of Rajasthan

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Arid region of Rajasthan is a potential source of medicinal plants, covers most of the north-western part of Rajasthan state. Most of the medicinal plants of Rajasthan Desert belong to the families such as Apiaceae, Asclepiadaceae, Asteraceae, Cactaceae, Casalpiniaceae, Cappariaceae, Chenopodiaceae, Convolvulaceae, Cucurbitaceae, Cyperaceae, Euphorbiaceae, Fabaceae, Mimosaceae, Molluginaceae, Solanaceae and Zygophyllaceae etc.

These medicinal plants are a good source of phytochemicals of pharmaceutical interest such as flavonoids, sterols, alkaloids, phenolic compounds, sulphides, isothiocyanates, anthocyanins, terpenoids etc. These are the active principles which act as antioxidants, anticarcinogenic, antimicrobials and immunity stimulants. A number of herbal plants have been screened for antimicrobial activities and their principles by several workers like Ahmed and Beg-Arina, 2001, Ahmed-El-Sawi

*et al.*,1999, Akhtar *et al.*,1997, Khan *et al.*,1996, Kapoor and Kumar,2005, Kapoor *et al.*,2007, Kapoor and Mishra,2013, Kapoor *et al.*,2011, Kapoor *et al.*,2012, Kapoor and Lakhera, 2013, Kapoor and Pandita, 2013.

From the arid region of Rajasthan five medicinal plants like *Crotalaria burhia*, *Euphorbia caducifolia*, *Leptadenia pyrotechnica*, *Clitoria ternatea* and *Tephrosia purpurea* were screened for their antimicrobial activities.

Fresh leaves of all the selected medicinal plant species were collected from Bikaner and Jaisalmer districts and pulverized into a paste. Cold extraction was done by blending the paste with ethyl ether and 50% ethanol in the ratio of 1:2, in a Waring Blender at 2500 rpm for 10 minutes. The mixture was centrifuged at 3000 rpm. The supernatant was evaporated to dryness and the residue was suspended in double distilled water. The micro-organisms used for screening were *Staphylococcus aureus* (Gram positive),

Table 1. Antimicrobial activity of leaf extracts of selected medicinal plant species and standard reference antibiotics.

Plants	Leaf Extract	Test Organisms				
		<i>S.aureus</i>		<i>E. Coli</i>		<i>C. albicans</i>
		I/C <sup>a</sup>	I/P <sup>a</sup>	I/C <sup>a</sup>	I/S <sup>a</sup>	I/M <sup>a</sup>
<i>Crotalaria burhia</i>	Ether	1.04	1.60	0.60	0.60	0.50
	Alcoholic	0.43	0.66	0.64	0.64	0.68
<i>Euphorbia caducifolia</i>	Ether	0.50	0.93	1.50	1.14	0.65
	Alcoholic	1.00	1.86	0.75	0.57	0.60
<i>Leptadenia pyrotechnica</i>	Ether	1.10	0.88	0.95	0.86	0.75
	Alcoholic	0.80	0.64	0.85	0.78	0.90
<i>Clitoria ternatea</i>	Ether	0.38	0.36	0.92	0.88	0.54
	Alcoholic	0.64	0.51	0.82	0.80	0.66
<i>Tephrosia purpurea</i>	Ether	0.86	0.80	0.64	0.68	0.61
	Alcoholic	0.75	0.72	0.58	0.61	0.80

a = Ratio of diameters of the inhibition zone to leaf extracts (10 g) under observation (I) and diameter of inhibition zone due to standard reference antibiotics.

C = Chloramphenicol (30 g) against *S. aureus* 30 mm and *E. coli* 32 mm.

P = Penicillin (10 units) against *S. aureus* 32 mm.

S = Streptomycin (10 g) against *E. coli* 20 mm.

M = Mycostatin (100 units) against *C. albicans* 32 mm.

*Escherichia coli* (Gram negative) (Bacterial pathogens) and *Candida albicans* (Fungal pathogen). The growth medium used for *Staphylococcus aureus* and *Escherichia coli* was Nutrient broth (10% peptone, 0.5% labanco and 0.5% NaCl, pH adjusted to 7.5) and for *Candida albicans* was Sabourands liquid medium (1% peptone, 4% glucose, pH adjusted to 5.8). Paper discs of known concentration of standard antibiotics namely chloramphenicol, penicillin and mycostatin were used for comparison. Blank papers discs were used as control. Control discs dipped in ethyl ether and 50% ethanol, plates (5 each for *Staphylococcus aureus*, *Escherichia coli* and *Candida albicans*) were employed for each extract. The ratio of inhibition zone of the various test samples was compared with the inhibition zone from the high concentration antibiotic reference discs by method as given by Khanna *et al.*, 1971. Antimicrobial screening of all the five selected medicinal plant species is given in Table 1.

The present investigation indicates that ethyl ether and alcoholic leaf extracts of all the selected medicinal plants showed positive reactions against all the three test organisms i.e. *Staphylococcus aureus* & *Escherichia coli* (Bacterial pathogens) and *Candida albicans* (Fungal pathogen).

The medicinal plants of the arid region of the Rajasthan are a potential source of antimicrobial principles. These medicinal plants are more resistant to bacterial and fungal attacks due to presence of biologically active substances like flavonoids. Due to presence of some secondary products which are responsible for antimicrobial activities, these medicinal plant species can be used in drug and pharmaceutical industries.

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SHORT COMMUNICATION

## Influence of IAA, IBA and GA<sub>3</sub> on growth and yield of onion (*Allium cepa* L.)

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Onion (*Allium cepa* L.) is among the most important vegetable / medicinal crop grown in India. This crop introduced in India from Central Asia, the primary centre of origin. Onion must have been grown in India from very ancient times as their utility as medicinal herbs has been mentioned in the medicinal treatises like “*Charka Samhita*” dated to be around 600 B.C. (Swarup, 2006). About 47.63 million tonnes of onion is produced in the world from about 2.71 million hectares of land (Anonymous, 2009). India ranks second in area (0.81 million ha), production (12.16 million tonnes) and productivity 15.1 mt/ha (Anonymous, 2008).

Onion is an indispensable item in every kitchen as condiment and vegetable. Hence, this crop has gained the importance of a cash crop, rather than a vegetable crop, because of its high marketable value. The bulbs of onion are rich in calories, vitamins and minerals and endowed with medicinal properties. It is a unique vegetable, which is consumed by almost all the sections of the society throughout the year, not only at the maturity, but also at different stages of growth.

Plant growth regulators modify the plant characters by influencing the physiological processes within the plant body, which ultimately affect the growth and yield of the crop. The present investigation was, therefore, carried out to study the effect of IAA, IBA and GA<sub>3</sub> on growth and yield of onion cv. RO-59 a newly released variety of Agriculture Research Station, Durgapura, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India.

The experiment was conducted during *rabi* season of the year 2006-2007 at the farm area of Landscape and Nursery Unit, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India. The city of Bikaner is situated 28.01° N and 73.22° E at an elevation of 234.70 meter above sea level. The soil was sandy loam with pH 8.4, organic carbon 0.15, available P 21 kg ha<sup>-1</sup> and available K 124 kg ha<sup>-1</sup>. Forty tonnes of FYM was mixed in soil before one month of transplanting of the seedlings. 100 Kg nitrogen (N), 50 Kg phosphorous (P) and 100 Kg potash (K) as recommended for Bikaner zone (Anonymous 1996) was applied. Full amount of P and K and half of N was added just

before transplanting. Rest of the N was given as a single dose 25 days after transplanting. All other recommended cultural practices were adopted to raise a good crop. Each plot consisted of five rows of 3 m length with 15 cm spacing between rows and 10 cm between plants. Furrow method of irrigation was followed.

The experiment comprising of 16 treatments viz. IAA 30 ppm D, IAA 30 ppm DS, IAA 50 ppm D, IAA 50 ppm DS, IAA 50 ppm S, IBA 30 ppm D, IBA 30 ppm DS, IBA 50 ppm D, IBA 50 ppm DS, IBA 50 ppm S, GA<sub>3</sub> 30 ppm D, GA<sub>3</sub> 30 ppm DS, GA<sub>3</sub> 50 ppm D, GA<sub>3</sub> 50 ppm DS, GA<sub>3</sub> 50 ppm S and untreated control, with three replications planted in a randomized block design. Six weeks old healthy seedlings of onion (cv. RO-59) were uprooted from nursery bed. Roots of the plants were dipped in solution of respective treatments for 14 hours and then transplanting was done in the field. Spray treatments were followed after 45 days of transplanting. Observations on growth and yield contributing characters viz. height (cm), number of leaves, fresh weight of plants (g), diameter of bulbs (cm), weight of bulbs (g) and yield of bulbs (Kg ha<sup>-1</sup>), were recorded.

The maximum mean plant height (Table 1) as recorded on 45, 90 and 120 days after transplanting was 43.85 cm, 55.12 cm and 61.65 cm, respectively for treatment IAA 50 ppm DS. This was followed by GA<sub>3</sub> 50 ppm DS, and IAA 30 ppm DS. Whereas the least mean plant height values in the untreated control. Such growth behavior might be due to enhancement of growth and apical dominance under the influence of IAA. These results are in confirmation with the findings of Shakhda and Gajipara (1998) and Poonam *et al.* (2002) in onion crop.

The number of leaves per plant counted at 45 days after transplanting (Table 1) was non-significant. However, the number of leaves as on 90 and 120 days after transplanting were significantly maximum (8.72 and 10.52, respectively) in GA<sub>3</sub> 50 ppm DS. The minimum number of leaves per plant at 90 and 120 days after transplanting (5.78 and 6.72, respectively) was obtained in the untreated control. A similar trend was observed by Deore and Bharad (1991) and Poonam *et al.* (2002).

Maximum fresh weight of plant (162.14 g) was found under concentration of GA<sub>3</sub> 50 ppm DS, where as the

minimum fresh weight (106.66 g) was found under untreated control (Table 2). Highest bulb diameter and bulb weight was found at 200 ppm each of GA<sub>3</sub> and IAA and the highest bulb yield (15.57 t ha<sup>-1</sup>) was observed at 200 ppm GA<sub>3</sub> followed by 200 ppm of IAA (15.53 t ha<sup>-1</sup>) in onion which complements the findings of Abdul *et al.* (2002).

Significantly the maximum diameter of bulb (7.26 cm) and bulb weight (41.25 g) were found in the treatment

GA<sub>3</sub> 50 ppm DS and the minimum bulb diameter (4.75 cm) and weight (25.0g) were observed in untreated control (Table 2.). These results corroborate the findings of Deore and Bharad (1991), Nandekar and Sawarkar (1992) and Abdul *et al.* (2002) in onion. Pogroszewska *et al.* (2007) reported that GA<sub>3</sub> (500 mg dm<sup>-3</sup>) applied in the form of bulb soaking had a positive effect on the total yield expressed in the number of bulbs, while applied in bulb soaking and

Table 1. Effect of treatments on plant height and number of leaves per plant at 45, 90 and 120 days after transplanting

Treatment	Height (cm)			Number of leaves		
	45 days	90days	120 days	45days	90 days	120 days
IAA 30 ppm D	40.18	44.05	53.32	5.98	7.45	8.38
IAA 30 ppm DS	39.95	50.62	57.05	6.05	7.78	8.72
IAA 50 ppm D	43.65	45.18	55.18	6.25	7.52	8.45
IAA 50 ppm DS	43.85	55.12	61.65	6.38	8.25	9.12
IAA 50 ppm S	33.65	44.38	56.05	4.95	7.58	8.52
IBA 30 ppm D	38.05	44.32	52.98	5.72	7.32	8.32
IBA 30 ppm DS	39.52	45.25	54.98	5.85	7.18	8.58
IBA 50 ppm D	37.65	44.18	52.12	5.65	7.05	8.25
IBA 50 ppm DS	37.72	43.98	52.45	5.52	7.32	8.32
IBA 50 ppm S	33.48	43.85	52.38	4.98	6.78	8.12
GA <sub>3</sub> 30 ppm D	39.32	44.32	53.05	6.12	7.72	8.65
GA <sub>3</sub> 30 ppm DS	39.42	48.25	54.98	6.52	8.38	8.95
GA <sub>3</sub> 50 ppm D	41.72	45.05	53.52	6.32	7.85	8.85
GA <sub>3</sub> 50 ppm DS	42.52	53.92	58.05	6.72	8.72	10.52
GA <sub>3</sub> 50 ppm S	33.05	44.85	54.78	5.05	8.05	8.98
Untreated control	32.95	39.37	43.85	4.98	5.78	6.72
CD at 5%	3.915	4.318	7.422	NS	1.352	1.400
CV %	6.049	5.613	8.178	14.71	10.35	9.450

Table 2. Effect of treatments on fresh weight, diameter of bulb, weight of bulb and yield of bulbs

Treatment	Fresh weight of plant (g)	Diameter of bulb (cm)	Weight of bulb (g)	Yield of bulb (kg/ha)
IAA 30 ppm D	131.56	5.70	29.96	29960
IAA 30 ppm DS	143.80	5.75	31.17	31170
IAA 50 ppm D	135.23	5.72	30.13	30131
IAA 50 ppm DS	154.76	6.65	38.64	38640
IAA 50 ppm S	132.70	5.77	30.48	30481
IBA 30 ppm D	134.56	5.72	29.79	29790
IBA 30 ppm DS	138.70	5.73	30.83	30830
IBA 50 ppm D	126.80	5.70	29.44	29440
IBA 50 ppm DS	129.03	5.71	30.44	30441
IBA 50 ppm S	127.23	5.69	29.61	29611
GA <sub>3</sub> 30 ppm D	137.73	5.73	30.31	30310
GA <sub>3</sub> 30 ppm DS	152.83	6.75	38.46	38461
GA <sub>3</sub> 50 ppm D	141.43	5.76	31.87	31870
GA <sub>3</sub> 50 ppm DS	162.14	7.26	41.25	41250
GA <sub>3</sub> 50 ppm S	144.43	5.73	31.53	31530
Untreated control	106.66	4.75	25.00	25000
CD at 5%	16.67	0.86	6.96	6968.7
CV %	7.14	8.45	13.34	12.22

spraying (both forms), it increases the bulb weight of the total yield of *Allium karataviense*.

Maximum yield of 41,250 kg per hectare was found under the treatment of GA<sub>3</sub> 50 ppm DS, and the minimum yield of 25,000 kg per hectare was observed under the treatment, untreated control. It revealed from the Table 2 that when IAA or GA<sub>3</sub> was applied twice *i.e.* dip and spray, then yield increased significantly 38,640 (kg ha<sup>-1</sup>) and 41,250 (kg ha<sup>-1</sup>) higher than only single dip application 30,161 (kg ha<sup>-1</sup>) and 31,870 (kg ha<sup>-1</sup>), respectively. This suggests that both growth regulators helped in root growth as well as vegetative growth because dip application alone v/s dip + spray application showed significant difference. An increase in onion bulb yield after the application of GA<sub>3</sub> was observed by Shakhda and Gajipara (1998), Anant and Maurya (2001), Abdul *et al.* (2002), Poonam *et al.* (2002), Subimal *et al.* (2003), although Kurtar and Ayan (2005) noted a decrease in the tulip bulb yield after the application of GA<sub>3</sub>.

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SHORT COMMUNICATION

## Influence of weather parameters on the seasonal incidence of sucking pests of pomegranate, *Punica granatum* L. during *ambia bahar*

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The pomegranate, *Punica granatum* L. (Family: Punicaceae) is a favourite table fruit in the tropical and subtropical region of the world. The successful cultivation and effective utilization of this fruit crop depends upon the proper pest management practices. Pomegranate crop is mainly attacked aphids (*Aphis punicae* Passerini), thrips (*Scirtothrips dorsalis* Hood), whitefly (*Siphoninus phillyreae* Haliday) and fruit borer (*Deudorix isocrates* Fabricius). Sucking pests cause severe damage by desapping the plants. These secrete wax and excrete honey dew like substances on which black sooty mould develops, which hinders the photosynthetic activities which devalizes the plant ultimately deteriorate the quality of the fruits. Keeping in view, the present study was undertaken deals with the population build-up of major sucking pests (aphids and whiteflies) on pomegranate in relation to weather parameters.

The field trial using cv. Arakta was carried out on 5 years-old orchard of pomegranate at Research Farm of AICRP on Arid Zone Fruits MPKV, Rahuri in *Ambia bahar* 2012 (January to June). The incidence of aphids and whiteflies were recorded on randomly selected 10 plants. On each tree, aphids and whiteflies populations was recorded on newly emerged from 5 twigs of 5 and 30 cm apical portion of each twig, respectively were tagged and observations were recorded at each meteorological week on every Monday for the period of six months. The data on weekly population of aphids and whiteflies were correlated with abiotic factors viz., maximum and minimum temperature, morning and evening relative humidity, sunshine hours and rainfall and subjected to simple correlation studies.

### Aphid

It could be seen from the results presented in Table 1, the incidence of aphids was noticed throughout the season of *Ambia bahar* except the months of May and June. The incidence of aphids was recorded from 1<sup>st</sup> meteorological week with peak of 63.4 aphids/5 cm apical twig on 4<sup>th</sup>

meteorological week with corresponding weather parameters viz., maximum and minimum temperature, morning and evening relative humidity, sunshine period and rainfall were 29.57 and 13.54°C, 65.29 and 30.86 per cent, 8.53 hrs. and 0.00 mm, respectively. The aphid population was increasing trend (38.5 to 63.4 aphids) during 1<sup>st</sup> to 4<sup>th</sup> week of January and thereafter it showed decreased up to 4<sup>th</sup> week of April (51.3 to 3.1 aphids). The maximum and minimum temperature had significant negative correlation ( $r = -0.88^{**}$  and  $r = -0.79^{**}$ ) with build-up aphids population, while high relative humidity of morning and evening had positive correlation ( $r=0.37$  and  $r= 0.11$ ) and sunshine hours ( $r=0.077$ ).

The results of present study are in accordance with Kulkarni (2007) reported that the incidence of aphids was noticed throughout the year except the month of May, June and July and its peak from October to March, i.e. during *Hasta bahar* (39.58 aphids/5 cm tender shoot tip) and low incidence in *Ambia bahar* (4.41) and *Mrig bahar* (3.67). Sreedevi and Verghese (2007) also reported that the *A. punicae* infestation was found during December to March, peaking in January and February and infestation declined after March. Karruppuchamy *et al.* (1998) recorded the maximum incidence of aphid, *Aphis punicae* on pomegranate during the third week of February and March in hill area at Yercaud and plains at Namakkal in Tamil Nadu, respectively. These results lend support to the present findings.

### Whitefly

During the present study, there no incidence of whiteflies was recorded from 1 to 7 and 20 to 26 meteorological weeks. The whiteflies populations were first recorded on 8<sup>th</sup> meteorological week (3.8 nymphs and adults /30 cm length of twig) with peak 8.9 on 4<sup>th</sup> week of April and afterwards there was a steady decline. Weather parameters viz., maximum and minimum temperature, morning and evening relative humidity, sunshine period and rainfall were 37.57 and 19.76°C, 40.14 and 16.29 per cent, 10.14 hrs. and

0.00 mm, respectively was recorded during peak activity of whitefly incidence. However, meteorological week 8 to 17 showed increasing trend of whitefly infestation (3.8 to 8.9 whiteflies population).

The present findings are in agreement with Kulkarni (2007) who reported that the maximum build up of whiteflies (9.05% infested leaves) was found in the month of April, which declined steadily afterwards with minor fluctuations till October. Balikat *et al.* (1999) reported that severe incidence of whitefly (*S. phillyreae*) was observed in February-April, 1999 to the extent of 60 to 65 per cent

infested leaves/plant. Ash whitefly population was very high (40.4 to 70.3 per leaf) during February to May and very low (0.00 to 18.7 per leaf) from June to December when field studies were conducted in peninsular India from April 1997 to 1999 reported by Mani and Krishnamoorthy (2002).

There was a significant positive correlation between whiteflies population with maximum temperature ( $r = 0.498^{**}$ ) and positive correlation with minimum temperature ( $r = 0.110$ ) and sunshine hrs ( $r = 0.155$ ) while morning and evening relative humidity had significant negative correlation ( $r = -0.635^{**}$  and  $r = -0.564^{**}$ ).

Table 1. Seasonal incidence of aphids and whiteflies on pomegranate in relation to weather parameters  
Average

Month (2012)	Meteorological Week	No. of aphids per 5 cm twig	No. of whiteflies per 30 cm twig	Weather parameters					
				Temperature ( $^{\circ}\text{C}$ )		Relative humidity (%)		Sunshine (Hours)	Rainfall (mm)
				Maximum	Minimum	Morning	Evening		
January	1	38.5	0	31.59	13.10	64.00	25.88	8.59	0
	2	42.5	0	26.06	6.54	54.57	24.71	9.97	0
	3	52.2	0	28.60	9.00	60.00	27.43	9.86	0
	4	63.4	0	29.57	13.54	65.29	30.86	8.53	0
	Mean	49.15	0	28.96	10.55	60.97	27.22	9.24	0
February	5	51.3	0	29.51	13.41	65.71	33.00	8.97	0
	6	53.1	0	29.51	8.97	51.86	19.71	9.56	0
	7	34.2	0	32.29	12.01	57.57	19.47	9.43	0
	8	25.6	3.8	34.23	13.53	43.86	18.14	9.67	0
	Mean	41.05	0.95	31.39	11.98	54.75	22.58	9.41	0
March	9	19.5	4.2	33.74	11.76	53.57	14.14	9.77	0
	10	12.4	3.9	33.09	11.06	47.43	15.43	9.60	0
	11	10.2	4.1	34.91	13.93	36.86	15.43	9.37	0
	12	11.8	3.6	37.63	15.01	39.71	11.43	8.76	0
	13	11.2	4.3	38.11	16.70	35.57	13.14	8.57	0
	Mean	11.4	3.98	35.94	14.18	39.89	13.86	9.08	0
April	14	8.3	5.2	38.46	19.51	44.86	15.57	8.79	0
	15	6.3	6.8	38.63	20.74	44.14	17.29	9.00	0
	16	5.3	7.6	37.14	22.00	51.14	23.57	7.99	0
	17	3.1	8.9	37.57	19.76	40.14	16.29	10.14	0
	Mean	5.75	7.13	37.95	20.50	45.07	18.18	8.98	0
May	18	0	6.5	38.90	19.38	40.17	14.33	10.68	0
	19	0	5.1	38.26	21.60	59.29	24.57	9.91	0
	20	0	0	38.51	20.51	49.00	17.00	10.80	0
	21	0	0	39.88	21.50	45.50	16.50	10.98	0
	22	0	0	38.34	22.17	49.29	22.57	10.70	0
	Mean	0.0	1.28	38.75	21.45	50.77	20.16	10.60	0
June	23	0	0	35.71	24.20	55.43	34.29	6.27	0
	24	0	0	36.37	24.23	65.29	38.71	9.17	27.2
	25	0	0	34.89	26.29	62.86	38.00	6.44	0
	26	0	0	34.83	27.26	67.43	39.57	6.16	2.2
	Mean	0	0	35.45	25.49	62.75	37.64	7.01	7.35

Table 2. Correlation coefficient (r) between incidence of aphids and whiteflies on pomegranate and weather parameters

Pest	Weather parameters					
	Temperature ( <sup>0</sup> C)		Relative humidity (%)		Sunshine (Hrs.)	Rainfall (mm)
	Maximum	Minimum	Morning	Evening		
Aphids	-0.878**	-0.796**	0.372*	0.111	0.077	-0.185
Whiteflies	0.498**	0.110	-0.635**	-0.564**	0.155	-0.184

Significance levels: \* 0.05, \*\*0.01

The results of the present finding are in agreement with Shevale and Kaulgud (1998) revealed that the mealy bug, scale insect and whitefly were more abundant during *ambia bahar* having significant positive correlation with temperature and negative correlation with relative humidity.

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SHORT COMMUNICATION

## Protein and amylase profile- an aid in cultivar identification in some date palm (*Phoenix dactylifera* L.) cultivars

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Morphological and anatomical characteristics of plants have been extensively exploited in plant systematics. However, at infra-specific level, these parameters become limiting since varieties/ cultivars are distinguished from each other on the basis of one or two floral or fruit characters. These at times are so overlapping that it becomes difficult to identify the cultivars. In a situation such as this, when traditional methods of taxonomy becomes limiting for variety/ cultivar identification, recourse to more sophisticated methods such as phyto-chemical markers are adopted. For this, secondary metabolites have gained reputation to be used as taxonomic markers, since, their constitution in plants are specific and are not affected by environmental factors. Among these, protein and amylase profiles of a cultivar have gained reputation to be an ideal markers for delimitation of taxonomic entity at intra specific level (Wang-Xiao *et al.*, 2007; Emari *et al.*, 2006; Mohamed, 2006; Sharma, *et al.* 2006; Abel *et al.*, 2005; and Kende *et al.*, 2004).

Date palm is represented by a large number of cultivars which have been identified/ developed for specific purpose. In this species too, the morphological and anatomical parameters are insufficient to clearly distinguish the cultivars. Moreover, majority of cultivars have come up either due to natural selection or through deliberate breeding. The genetic variability once generated has been fixed on account of vegetative propagation which is commonly practiced in this taxon. Hence, the phylogenetic kinship among the cultivars is not certain which is utmost required under pre-breeding programme.

Accordingly, the present investigation was undertaken using five date palm cultivars to develop phyto-chemical markers for them using foliar protein and amylase profiles and the data thus generated was used to assess the phylogenetic relationships among them.

Five genotypes of date palm (*Phoenix dactylifera* L.) viz. Halawy, Khalas, Sewi, Khuneizi and Dayari constituted the material for present investigation. The foliar protein and amylase profiles of these cultivars were studied as described below:

### **Extraction of foliar protein and amylase**

Extraction of proteins as well as isozymes was

performed in cold. 10 gm of leaf base material was crushed in ice chilled all glass pestle and mortar containing 5 ml of 0.05 M phosphate buffer, (pH 7.3). The mixture was left undisturbed for two hours at low temperature and then centrifuged at 8000 rpm for 10 minutes. The supernatant was collected in a separate tube and supplemented with dry sucrose (about 10% by volume). The extract thus obtained, was utilized subsequently for analysis.

### **Separation of protein and isozyme through electrophoresis**

The gel-electrophoresis technique of Ornstein and Davis (1964) was employed for separating anodic proteins and isozymes. All separations were achieved on 7.5% polyacrylamide gel columns in electrophoresis apparatus. The steps involved in electrophoresis are:

### **Polymerization of gel**

For preparing gels three solutions viz. A, B and C were mixed in a proportion of 1:1:2, by volume. This mixture was poured, with the help of glass dropper, into 10 cm long corning glass gel tubes, closed at one end by rubber bungs. The tubes were left undisturbed at room temperature for two hours to allow for polymerization.

For separation of amylases, gels were polymerized in the same way as described above, except for addition of starch (0.07%) to the final volume of the polymerizing solutions. This was done to facilitate detection of amylases on gel columns.

### **Loading the extract**

Once polymerization was achieved, for separating proteins, each tube was loaded with 200 $\mu$ l of the extract. The same volume of the extract was utilized for purpose of amylases separation. Loading was completed, by adding a drop of 0.01% bromophenole blue to each gel tube. The remaining space therein, was filled with Tris-glycine electrode buffer of pH 8.3

### **Running the apparatus**

The reservoirs of the electrophoresis apparatus containing loaded gel tubes were filled with Tris-glycine electrode buffer maintained at pH 8.3. Current at the rate of

5 mA per gel tube was applied to the apparatus. The whole operation was performed inside a refrigerator at 8 °C. Once the tracking dye reached the anodic end, the current was switched off and gel columns were removed from the containers by forcing water along the inner wall of the tubes with the help of hypodermic syringe. The gels were transferred into bigger glass vials for further processing.

**Detection of protein bands**

For detection of proteins, gels were strained at room temperature, in coomassie brilliant blue solution for 15 hours and differentiated in a mixture of methanol, acetic acid and water. The differentiating medium was changed daily till such time the inter-band region got destained and band become distinct. These gels were stored at low temperature in 7.5% acetic acid and scrutinized for band pattern and characteristics.

**Detection of amylase bands**

Starch impregnated gels were used to facilitate detection of amylases. These were incubated for two hours at room temperature in 0.02 M-phosphate buffer at pH 6.9 and then transferred to 0.004 M iodine solution for about 10 minutes. After a while, transparent bands and dark inter-bands differentiated on the gels. The gel columns were subsequently scrutinized for band number and characteristics.

**Proteins**

Anodic protein profiles of the five cultivars of date palm contained a total of 13 protein bands. The individual bands in each cultivar are summarized in table 1. Perusal of table revealed that the number of protein bands varied from 6 to 9 in different genotypes; maximum in cv. Halawy and minimum in cv. Khuneizi. A wide variation was observed for their distribution among the genotypes investigated. For instance, band numbers 5 and 13 had the highest representation as it is present in 100% of genotypes. Band number 2 illustrated a representation of 80% of genotypes. Similarly, band numbers 1, 4 and 11 were represented in 60 of the genotypes. On the contrary few bands have restricted distribution as illustrated by band numbers 3, 6, 7, 8, 10 and 12 were found only in 40% of genotypes and used as phyto-chemical markers.

The distribution of the protein bands also indicated qualitative variation among the genotypes. Single band or band combinations were typical for individual cultivar which is found in particular genotype. For instance band combination 7, 9 and 12 were specific bands for cv. Halawy, bands 7, 8, 10 and 12 were typical for cv. Khalas, bands 3, 6 and 8 were found special for cv. Sewi, bands 3, 6 and 10 were typical for cv. Khuneizi and band number 9 was typical for cv. Dayari.

A role of protein in cultivar identification at species or sub species level has been demonstrated earlier

Table 1. Banding pattern for Proteins in different date palm cultivars

Cultivars	Bands												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Halawy	+	+		+	+		+		+		+	+	+
Khalas	+				+		+	+		+		+	+
Sewi		+	+	+	+	+		+			+		+
Khuneizi		+	+		+	+				+			+
Dayari	+	+		+	+				+		+		+

Table 2. Banding pattern for amylase in different date palm cultivars

Cultivars	Bands				
	1	2	3	4	5
Halawy	+	+			
Khalas	+		+		+
Sewi	+	+		+	
Khuneizi	+		+		
Dayari	+		+		

too (El-Akkad *et al.*, (2002), Kende *et al.* (2004), Abou-El-Enain, (2004), Yan-Xue Bing *et al.* (2005), Signor, *et al.* (2005), Jalilion, *et al.* (2005), Abel *et al.* (2005), Sharma *et al.* (2006), Mohamed (2006), Emre *et al.* (2006) and Wang-Xiaofei *et al.* (2007)

**Amylase**

Like other secondary metabolites, isozyme plays

an important role to assess phylogenetic relationship between species, sub-species, genera and cultivars. A total of 5 bands were depicted for amylase during the study. The banding pattern is illustrated in Table 3. Perusal of data revealed that the number of bands varied from 2 to 3 in different genotypes, maximum in cv. Khalas and Sewi and minimum in Halawy, Khunezi and Dayari. Band number 1 was universally distributed (100 per cent) in all the

cultivars. Similarly band number 3 had 60 per cent representation and band number 2 has 40 percent distribution. Contrary to this, band numbers 4 and 5 had least distribution as these were found in only one of the cultivars and represented 20 percent distribution.

Like other secondary metabolites, isozyme plays an important role to assess phylogenetic relationship between species, sub-species, genera and cultivars. This has been demonstrated by many researchers viz. Staub and Frederick, (1985), Ramirez and Pisabarro, (1985), Jarret and Litz, (1986), Kesseli and Michelmore, (1986), Tao and Sugiura, (1987), Yang and Xi (1989), Oliva-Tejera *et al.*, (2004), Bessage, *et al.* (2005), Karam, *et al.*, (2006).

Thus from the foregoing account, it can be concluded that proteins and amylase profile can be used for cultivar identification in date palm.

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