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Effect of mechanical treatments on rooting in cuttings of guava, lemon and pomegranate

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Abstract

An attempt was made to determine the most effective mechanical treatments i.e. ringing and girdling in relation to upper & lower portion of shoot of guava, lemon and pomegranate. The results revealed that cuttings obtained from lower end portion of ringed branch (M2) promoted significantly better growth parameters, particularly number of sprout shoots (4.0), shoot length 120 days after planting (28.00 cm), number of leaves (45.66), length and width of leaves (8.03 cm and 3.24 cm), leaf area index (41.24 cm2) as well as better success of rooting percentage (80 %) in lemon followed by pomegranate (78 %). In case of crop response, lemon significantly responsed to cuttings made from lower end portion of ringed branch followed by pomegranate subjected to shoot and root characteristics.

Key words: *Mechanical, Cuttings, Ringing, Guava, Lemon, Pomegranate, Girdling*

Introduction

Cutting is the cheapest, rapid and simplest method of propagation and the new plants develop from cutting are true to type and uniform in growth. Such plants come into bearing, earlier than the seedlings and do not require any special techniques necessary in grafting, budding and layering. The success in stem cutting multiplication of fruits crops depend upon some factors such as condition of the mother plant, age of the tree, part of the tree from where the condition of the mother plant, age of the tree, part of the tree from where the cuttings are made, time of planting, rainfall, humidity, temperature, rooting media, care while planting and after care Frey *et al.* (2006). Besides these factors, mechanical treatment like ringing and girdling play an important role in rooting Biswas (1995). Ringing and girdling interrupt the downward translocation of carbohydrates, hormones and other possible root promoting substances which helps in shoot initiation and formation Evert and Smittle (1990). Using these techniques on shoots prior to their removal for use as cuttings improve the rooting.

Materials and methods

The present investigation was conducted at Fruit Research Station, Imalia Farm, Department of Horticulture, JNKVV, Jabalpur (M.P.) during September 2007 to January 2008. Five treatments viz. control (M_0), cuttings of upper portion of ringed branch (M_1), cuttings of lower portion of ringed branch (M_2), cuttings of upper portion of girdled branch (M_3), cuttings of upper portion of girdled branch (M_4) as main treatments and three crops i.e. guava (C_1), lemon (C_2) and pomegranate (C_3) as sub treatments were taken in Factorial Complete Randomized Design with three replication. Five semi hard wood cuttings of 15 cm length with 4-5 buds and 0.75-1.0 cm thickness were taken for each treatment in each replication. A straight cut was made at the base end just below the bud and slanting cut was made at the apical end just above the bud. The cuttings were planted as per treatments in the pre-watered poly bags containing rooting media in partial shade condition with the help of dibbler to avoid any injury to the cuttings.

Two third part of the treated cuttings were inserted in the rooting media at a slight angle (45°) to the vertical. The observation on days taken for sprouting and days taken for 50% sprouting was recorded at every week interval. The success of rooting percentage, number of roots per cutting, number of shoots per cutting, total number of leaves/cutting, length & width of leaf (cm), leaf area index (cm^2), fresh & dry weight of leaves (g), fresh & dry weight of roots (g), length & diameter of longest root (mm) were recorded after 120 days. The length of shoots (cm) was recorded with the help of centimeter scale at 80, 100 and 120 days interval after planting of cuttings. Fresh and dry weight of five leaves from planted cuttings was taken with the help of electronic balance and oven dry method.

Results and discussion

The success of rooting percentage (57.77%), length of shoot at 80 and l00 days (14.55 cm & 17.11 cm.), total number of leaves per cutting (26.00), number of shoot per cutting (2.77), leaf area index(18.72), fresh weight of five leaves (3.94 gm), dry matter percentage of leaves (30.05%), diameter of longest root(0.49 mm), fresh weight of roots (1.24 gm) and dry matter percentage of roots (28.46) were found significantly surpassed under ringed lower portion of branch (M2) as compared to other mechanical treatments and control. Shoot length at 120 days(18.79 cm), length and width of leaf (6.05 & 2.61 cm), length of longest root (16.12 mm)and number of roots per cutting (25.11) were also found maximum under ringed lower portion of branch (M2) but, it did not differ significantly from girdled lower portion of branch . The increase in root and shoot characters in lower portion of ringed branch might be due to optimum increase in the endogenous auxin level, phenols, carbohydrates and other bio compounds which stimulate cell division and growth. These findings are in close agreement with.the findings of Biricolti *et al.* (1994) in chestnut, Fachinello *et al.* (1988) in apple and Gruddutt *et al* (2004) in guava. Although different mechanical treatments did not influenced earliest sprouting (days taken for sprouting and 50% sprouting) significantly, but the minimum (19.33) and maximum (23.00) days taken for sprouting was noted under ringed lower portion of branch (M_2) and control (Mo) respectively. Earliest sprouting of cuttings may be due to prevention of downward translocation of carbohydrates and accumulation of higher level of endogenous auxin in the ringed, lower portion of cuttings during the period of root initiation which might have resulted earliest completion of physiological process involved in rooting and sprouting. Similar results were also reported by Baghel *et al.* (1993) in lemon cuttings.

As regards the response of different crops percentage of success (68%), number of shoot per cutting (3.13), shoot length at 80 and 100 and 120 days after planting(20.39,21.98 and 23.90 cm), number of leaves per cutting (9.80), leaf length (6.43 cm), leaf width (2.74 cm), fresh weight of leaves (6.02 g), leaf area index (22.77 cm^2), dry matter percentage of leaves (31.71%), length of longest root (23.09 mm), diameter of longest root (1.01 mm), number of roots per cutting (40.13), fresh weight of roots (2.13 g) and dry matter percentage of roots (26.67 %) were significantly influenced and recorded maximum in lemon crop (C_2). Whereas, earliest sprouting (days taken for sprouting (14.20) and 50% sprouting (14.73) and maximum number of leaves per cutting (11.00) were observed in cuttings of pomegranate (C_3). The maximum rooting as well as vegetative growth characters except maximum number of leaves per shoot (9.80) in lemon crop (C_2) might be due to the fact that lemon crop uptake maximum nutrients as compare to other crop and use these nutrients for their vegetative growth and survival. Similar findings are also supported by Subramanyam and Dinesh (1993), Urban and Leachaudel (2005) in mango and Sharda (2008). The earliest sprouting in pomegranate may be due to higher level of nitrogen in the cuttings of pomegranate which stimulated the faster sprouting.

In case of different combination of mechanical treatments and fruit crops the percentage of success (80%), number of leaves per cutting (13.33%), leaf area index (41.24), fresh weight of leaves (7.89 g), dry matter percentage of leaves (35.82%), total number of leaves per cutting (45.66), fresh weight of roots (2.30) and dry matter percentage of roots (30.08 %) were found significantly superior under treatment combination of lower portion cutting of ringed branch of lemon (M_2C_2). Similarly shoot length after 120 days (28.00 cm), width of leaves (3.24 cm) and length of longest root (50.00 mm) were also found maximum under the same treatment (M_2C_2) which did not differ significantly from M_4C_2 and M_1C_2. The maximum number of leaves per shoot was recorded under treatment combination of lower portion cutting of ringed branch of lemon which did not differ significantly from M_2C_3 and M_4C_2. The maximum diameter of longest root was noted under treatment combination of upper portion of cutting of ringed branch with lemon which did not differ significantly. Although different combinations could not affect the sprouting of cuttings, number of shoot per cutting, shoot length at 80 and l00 days and length of leaf significantly, but the maximum (34.66 days) and minimum (12.00 days) days taken for bud sprouting was found under treatment combination of M_0C_2 and M_2C_3 respectively. The earliest (12.33 days) and latest 50% (47.00 days) sprouting was observed under M_4C_3 and M_0C_2 respectively. The maximum (4.00) and minimum (1.00) number of shoots per cutting were founding the treatment combination of M_2C_2 and M_2C_1 respectively. The maximum (24.13 and 26.08 cm) shoot length at 80 and l00 days and maximum length of leaf (8.03 cm) were recorded in treatment combination of M_2C_2 respectively.

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Table 1: Effect of mechanical treatments on rooting in cuttings of guava, lemon and pomegranate

Treatments	Days taken for sprouting	Days taken for 50% sprouting	Success of rooting percentage (%)	No. of shoots per cutting	Shoot length (cm) Days after planting 80	100	120	Total No.of leaves/ cutting	Length of Leaf (cm)	Width of leaf (cm)	Leaf Area Index (cm^2)	Fresh WL of leaves (g)	Dry matter of leaves (%)	No. of roots/ cutting	Length of longest root (mm)	Fresh WL of roots (%)	Diameter of longest root (mm)	Dry matter of roots (%)
(A) MECHANICAL TREATMENTS																		
Mo	23.00	27.77	35.55	1.33	7.81	9.10	10.18	11.33	3.49	1.27	4.32	2,15	15.53	13.11	8.88	0.75	0.33	14.76
M_1	21.33	25.00	42.22	1.66	9.47	10.99	12.78	15.22	3.88	1.65	8.38	3.18	17.30	14.44	10.24	0.82	0.37	17.54
M_2	19.33	22.88	57.77	2.77	14.55	17.11	18.79	26.00	6.05	2.61	18.72	3.94	30.05	25.11	16.12	1.24	0.49	28.46
M_3	21.22	24.77	37.77	1.77	8.85	10.22	11.87	14.55	3.55	1.58	6.95	2.23	16.22	13.88	9.81	0.78	0.34	16.65
M_4	20.11	23.22	49.11	2.55	13.81	16.51	18.62	22.00	5.42	2.45	13.63	3.18	28.50	20.88	15.75	1.15	0.49	27.54
S Em±	1.26	1.46	1.01	0.27	0.81	0.81	0.18	1.28	0.41	0.15	0.10	0.22	0.29	1.77	0.55	0.01	0.02	0.29
CD(5%)	NS	NS	2.93	0.79	2.34	2.34	2.35	3.71	1.18	0.45	0.30	0.64	0.86	5.13	1.60	0.04	0.06	0.86
(B) CROPS																		
C_1	17.33	19.26	4.00	0.53	2.97	3.53	4.47	3.80	1.36	0.98	2.02	0.56	11.48	7.13	4.60	0.37	0.15	10.78
C_2	31.06	40.26	68.00	3.13	20.39	21.98	23.90	29.66	6.43	2.74	22.77	6.02	31.71	40.13	23.09	2.13	1.01	26.67
C_3	14.20	14.73	61.46	2.40	9.33	12.85	14.98	20.00	5.64	2.02	6.40	2.23	21.38	5.20	8.79	0.34	0.05	25.53
S Em ±	0.97	1.13	0.78	0.21	0.62	0.62	0.63	0.99	0.31	0.12	0.08	0.17	0.23	1.37	0.42	0.01	0.01	0.23
CD (5%)	2.81	3.27	2.27	0.61	NS	1.81	1.82	2.87	0.91	0.35	0.23	0.50	0.66	3.97	1.24	0.03	0.04	0.66
(C) INTERACTION (MECHANICAL TREATMENTS X CROPS)																		
M_0C_1	18.33	19.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M_0C_2	34.66	47.00	60.00	2.33	16.00	17.16	18.16	18.00	5.75	2.22	9.33	4.66	28.66	35.33	19.66	1.97	0.95	22.08
M_0C_3	16.00	16.66	46.66	1.66	7.45	10.15	12.38	16.00	4.73	1.32	3.36	1.78	18.00	4.00	7.00	0.27	0.04	22.22
M_1C_1	17.66	19.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M_1C_2	30.66	39.33	66.66	3.00	19.65	21.41	24.00	28.00	6.38	2.88	19.91	7.58	31.08	38.66	23.36	2.16	1.06	26.85
M_1C_3	15.66	16.00	6.00	2.00	8.76	11.58	14.35	17.66	5.26	2.06	5.24	1.97	20.82	4.66	7.36	0.31	0.05	25.78
M_2C_1	17.00	18.66	13.33	1.00	7.78	9.06	11.43	8.33	3.53	2.36	5.05	1.26	29.33	18.66	11.63	0.98	0.39	27.03
M_2C_2	29.00	36.00	80.00	4.00	24.13	26.08	28.00	45.66	8.03	3.24	41.24	7.89	35.82	50.00	25.46	2.30	1.03	30.08
M_2C_3	12.00	14.00	78.00	3.33	11.74	16.20	16.95	24.00	6.60	2.23	9.89	2.68	25.00	6.66	11.26	0.43	0.06	28.28
M_3C_1	18.33	19.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M_3C_2	31.33	40.33	60.00	3.00	18.24	19.43	21.33	25.00	5.56	2.71	16.27	4.62	29.33	37.33	22.26	2.05	0.97	25.52
M_3C_3	14.00	14.66	53.33	2.33	8.31	11.23	14.30	18.66	5.10	2.03	4.59	2.08	19.33	4.33	7.16	0.30	0.05	24.45
M_4C_1	17.33	19.00	6.66	1.66	7.10	8.61	10.93	10.66	3.30	2.53	5.09	1.54	28.09	17.00	11.40	0.87	0.38	26.88
M_4C_1	29.66	38.33	73.33	3.33	23.95	25.85	28.00	31.66	6.43	2.67	27.13	5.37	33.66	39.33	24.70	2.19	1.05	28.82
M_4C_3	13.33	12.33	67.33	2.66	10.38	15.08	16.94	23.66	6.53	2.16	8.69	2.64	23.77	6.33	11.16	0.39	0.05	26.92
S Em+	2.18	2.53	1.75	0.47	1.40	1.04	1.41	2.22	0.71	0.27	0.18	0.38	0.51	3.07	0.96	0.02	0.03	0.51
CD(5%)	NS	NS	5.08	NS	NS	NS	4.07	6.43	NS	0.79	0.53	1.12	1.49	8.88	2.77	0.06	0.10	1.49

Abbreviations: M_0: Control M_1: Upper portion of the ringed branch M2: Lower portion of the ringed branch M3: Upper portion of the girdled branch
M_4: Lower portion of the girdled branch C_1: Guava C_2: Lemon C_3: Pomegranate

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Characterization of underutilized fruit crops: bael and karonda by RAPD marker

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Abstract

Twenty four accession of Bael, representing four cultivars (Pant Shivani, Pant Urvashi, Pant Sujata and Pant Aparna) and seven accessions of Karonda, representing three cultivars (Pant Manohar, Pant Sudarsan, and Pant Suvarna) have been characterized with RAPD markers. In case of Bael out of the 19 primers screened, 5 were amplified reproducible bands and only three primers were selected for polymorphic study. Out of 10 DNA fragments amplified with three random primers, 8 showed polymorphism. These genotypes were classified into two major groups with each containing three sub-groups. While, in Karonda out of the 19 primers screened, 4 primers amplified reproducible bands and only two primers were selected for the polymorphic study. Out 10 DNA fragments amplified with two random primers, 7 were polymorphic. These genotypes were grouped into two major clusters and one cluster containing two sub- clusters while other consists only one cluster. RAPD data were analyzed by cluster analysis and UPGMA Our analysis revealed that in Bael, some genotypes are identical at DNA level but given different name whereas, Karonda genotypes showed the existence of considerable variation among the test accessions.

Key words: *Bael Germplasm, Karonda, RAPD, DNA, Dendogram*

Introduction

Horticultural crops have also received attention during the last few years related to molecular markers. However, there have been only few attempts in fruit crops. To, date, no information is available on characterization of Bael (*Aegle marmelos* Correa) and Karonda (*Carissa carandus*) germplasm at the molecular level. However, Morphological and phonological traits were used to identified Bael and Karonda genotypes (Misra *et al.* 2003) resulting into the discrimination of different genotypes. But, disease and environmental factors can affect these traits, leading to a wrong identification. Arduous efforts to improve the agronomic traits of wild Bael and Karonda germplasm by traditional selection based on the visible phenotypes started in 1987 and some elite genotypes have been obtained, but genetic improvement has been greatly limited by the limited information on the genetic background of this germplasm. Accurate identification of genotypes is a requisite for efficient conservation, maintenance and utilization of the existing germplasm of Bael and Karonda. In view of there nutritional, medicinal and commercial value, it is desirable to study RAPD markers used to estimate the diversity and relationship among 24 Bael accessions and 7 Karonda accession from different parts of India, maintained at Horticulture Research Centre of Govind Ballabh Pant University and Technology and to identify a 'core collection' from the same.

Materials and methods

Plant materials

Twenty four Bael and seven Karonda accessions (Table1) collected from different states, namely Bihar, Jharkhand, Uttar Pradesh, Uttarakhand and West Bengal and conserved at Horticulture Research Centre, Patharchatta, Pantnagar were utilized in the study. The accessions include diverse types such as four released varieties and twenty genetic stocks of Bael and three released varieties and four genetic stocks of Karonda.

DNA extraction

Total genomic DNA was extracted from recently matured leaves using the CTAB method (Murray and Thompson 1980) with a few modifications. Approximately 2.0 grams of fully expanded fresh leaves were crushed with the help of liquid nitrogen into very fine powdered and was mixed **with 8 ml of extraction buffer (2 % CTAB, 100 mM Tris HCl-pH 8.0, 20 mM EDTA pH 8.0, 1.4 M NaCl), 1 % PVP and 0.2 % β-mercaptoethanol which was pre-heated to 65°C.** The contents were then incubated in a

Table 1. Similarity matrix for Jaccard's coefficient for twenty four genotyeps of Bael.

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24
B1																								
B2	0.667																							
B3	0.713	0.667																						
B4	0.833	0.8	0.833																					
B5	0.667		0.667	0.8																				
B6	0.833	0.5	0.833	0.667	0.5																			
B7	0.667	0.6	0.667	0.8	0.6	0.5																		
B8	0.667	0.333	0.6667	0.5	0.333	0.5	0.6																	
B9	0.667	0.33	0.667	0.5	0.333	0.5	0.6	0.725																
B10	0.667	0.6	0.667	0.8	0.6	0.8	0.6	0.333	0.333															
B11	0.647	0.667		0.833	0.667	0.833	0.667	0.667	0.667	0.667														
B12	0.667	0.333	0.667	0.5	0.333	0.5	0.6	0.80	0.725	0.333	0.667													
B13	0.647	0.667		0.833	0.667	0.833	0.677	0.667	0.667	0.667	0.8	0.667												
B14	0.833	0.8	0.833	0.750	0.8	0.667	0.8	0.5	0.5	0.8	0.833	0.5	0.833											
B15	0.833	0.5	0.833	0.667	0.5	0.667	0.5	0.8	0.8	0.5	0.833	0.8	0.833	0.667										
B16	0.667	0.6	0.667	0.8	0.6	0.8	0.6	0.333	0.333	0.8	0.667	0.333	0.667	0.8	0.5									
B17	0.667	0.333	0.667	0.5	0.333	0.5	0.6	0.785	0.725	0.333	0.667	0.725	0.667	0.5	0.8	0.333								
B18	0.833	0.8	0.833	0.750	0.8	0.667	0.8	0.5	0.5	0.8	0.833	0.5	0.833		0.667	0.8	0.5							
B19	0.833	0.5	0.833	0.667	0.5	0.647	0.5	0.5	0.5	0.8	0.833	0.5	0.833	0.667	0.667	0.8	0.5	0.667						
B20	0.647	0.667	0.647	0.833	0.667	0.833	0.667	0.667	0.667	0.667	0.783	0.667	0.783	0.833	0.833	0.667	0.667	0.833	0.833					
B21	0.833	0.5	0.833	0.667	0.5	0.667	0.5	0.8	0.8	0.5	0.833	0.833	0.833	0.667	0.8	0.5	0.8	0.667	0.667	0.833				
B22	0.674	0.667	0.647	0.833	0.667	0.833	0.667	0.667	0.667	0.667	0783	0.667	0.783	0.833	0.833	0.667	0.667	0.833	0.833	0.833	0.833			
B23	0.647	0.667		0.833	0.667	0.833	0.667	0.667	0.667	0.667	0.8	0.667	0.8	0.833	0.833	0.667	0.667	0.833	0.833	0.783	0.833	0.7 83		
B24	0.0667	0.333	0.667	0.5	0.33	0.5	0.6	0.725	0.725	0.333	0.667	0.725	0.667	0.5	0.8	0.333		0.5	0.5	0.667	0.8	0.667	0.667	

water bath at 65°C for one hour with intermittent shaking. The homogenate was cooled to room temperature and add 10 ml of chloroform : isoamyl alcohol (24 : 1 v/v) was added and shaken well. The tubes were spun in a centrifuge at 8000 rpm for 20 minutes at 27°C and the supernatant transferred to a clean tube. This was repeated three times until a clear solution was obtained and transferred the aqueous phase to a fresh centrifuge tube. To this 0.6 v/v of chilled isopropanol was added, mixed thoroughly and the mixture kept overnight at 4°C to allow DNA to **precipitate. DNA was pelleted the next day by spinning the tubes at 10000 rpm for ten minutes at 4°C and the pellet was washed with 70 % ethanol, dried and dissolved in 500 µl TE buffer (Tris HCl 10 mM and EDTA 1 mM pH 8.0). Five µl of RNase (10 mg/ml) was** added to each sample and incubated overnight at 37°C. The histones were removed by mixing with phenol and centrifuging at 10000 rpm for 5 minutes at 20°C and collecting the supernatant. This step was repeated with phenol, chloroform and isoamyl alcohol (25 **: 24 : 1) and only chloroform : isoamyl alcohol (24 : 1), then the DNA was precipated with 0.6 volume of propanol. The DNA was then dissolved in 500 µl 1x TE and quantified using a 'UV-VIS Spectronic 1210'.**

PCR amplification, gel electrophoresis and statistical analysis

Amplification was achieved by the protocol described by William *et al.* (1990) with some modification. The DNA was amplified with four random 10 mer primers which produced the maximum number of amplified product after screening 19 primers. Ingredients for each reaction include template DNA 35-40 ng, 100 **µM dNTPs each, Taq DNA polymerase 0.5 unit, 1 X magnesium chloride buffer and 5 pmoles primers (Genie, Bangalore, Pvt. Ltd.). The reaction mixtures were** overlaid with mineral oil and amplification was performed in a thermal cycler (Eppendorf). Total reaction consisted of 40 cycles, each cycle consisting three steps, denaturation at 94°C for 30 sec, annealing at 36°C for 1 min and primer extension at 72°C for 5 min. Amplification fragment were separated on 1.6 % agarose (HIMEDIA) gels containing ethidium

Table 1. List of accessions under study and their place of collection

List of Bael Genotypes					
S. N.	Genotypes	Place of collection	S. N.	Genotypes	Place of collection
1.	PB 1	Deoria, U.P.	13.	PB 13	Pantnagar,Uttarakhand
2.	PB 2	Deoria, U.P.	14.	PB 14	Pantnagar,Uttarakhand
3.	PB 3	Deoria, U.P.	15.	PB 15	Sultanpur, U.P.
4.	PB 4	Deoria, U.P.	16.	PB 16	Sultanpur, U.P.
5.	Pant Shivani	Jaunpur, U.P.	17.	PB 17	Pantnagar,Uttarakhand
6.	Pant Urvashi	Samastipur, Bihar	18.	PB 18	Pantnagar,Uttarakhand
7.	PB 7	Gonda, U.P.	19.	PB 19	24-Parganas, W.B.
8.	PB 8 (NB I)	Faizabad	20.	PB 20	24-Parganas, W.B.
9.	Pant Aparna	Faridpur	21.	PB 21	24-Parganas, W.B.
10.	PB 10	Pantnagar,Uttarakhand	22.	PB 22	24-Parganas, W.B.
11.	PB 11	Pantnagar,Uttarakhand	23.	PB 23	24-Parganas, W.B.
12.	Pant Sujata	Pantnagar,Uttarakhand	24.	PB24	24-Parganas, W.B.
List of Karonda Genotypes					
1.	PK 1	U.P.	5.	Pant Suvarna	Pantnagar,Uttarakhand
2.	Pant Manohar	Pantnagar,Uttarakhand	6.	PK 6	U.P.
3.	PK 3	U.P.	7.	PK 7	U.P.
4.	Pant Sudharsan	Pantnagar,Uttarakhand			

Table 2. The amplification profile of three RAPD primers

Primer No.	Sequence 5'? 3'	Amplified Range	RAPD loci	Polymorphic %
23SS10AT7	AGCCAGCGAA	600 - 1000 bp	3	100
26SS10C10	TTCCGAACC	500 – 1000 bp	3	66.67
28SS10C12	GGACCCTTAC	550 – 890 bp	4	75

Table 3. The amplification profile of three RAPD primers

Primer No.	Sequence 5'? 3'	Amplified Range	RAPD loci	Polymorphic %
25SS10T9	GTCCCGTGGT	170 - 790 bp	4	50
OPBF 06	TCCACGGGCA	230 – 650 bp	6	83.33

Table 5. Similarity matrix for Jacard's coefficient of seven genotypes of Karonda

	PK 1	Pant Manohar	PK 3	Pant Sudarshan	Pant Suvarna	PK 6	PK 7
PK 1	1						
Pant Manohar	0.747	1					
PK 3	0.572	0.572	1				
Pant Sudarshan	0.680	0.733	0.572	1			
Pant Suvarna	0.647	0.572	0.940	0.572	1		
PK 6	0.940	0.747	0.572	0.680	0.572	1	
PK 7	0.747	0.813	0.572	0.680	0.647	0.747	1

bromide (0.5 µg per 10 µl) solution for 20 min and photographed under Gel Documentation System (Alpha Innotech Corporation, USA). Each PCR was conducted as an experiment with controls to test purity and viability of reagents. Two controls namely 'no template' (distilled water instead of template DNA) and 'positive control' (with template DNA) were included in all the PCR reactions. Bands were manually scored 1 for presence and 0 for absence and the binary data were used for statistical analysis. The matrix of different RAPD phenotypes of all the primers was assembled. The sizes of the fragments (molecular weight in base pairs) were estimated by using 100-bp ladder marker, which was run along with the amplified products. Genetic similarities (GS) for the RAPD data were calculated using the Jaccard algorithm, and phenograms were constructed using the clustering method of the unweighted pair group method of arithmetic averages (UPGMA). All the above analysis was performed using the NTSYS-PC version.2.11. (Rohlf, 2000).

Results and Discussion

Diversity of the Bael accessions

The 24 accessions of Bael were characterized and a total of ten RAPD loci were detected. Out of nineteen tested primer, purchased from Genie, Bangalore, Pvt. Ltd. only five gave results and from five, only three primers (Table 2) produced polymorphic products. The average number of bands per primer was 3.33 and these amplified products ranging from 550 to 1000 bp by three primers. About 50 % of the samples were repeated to test for reproducibility and only the reproducible and unambiguous bands were for the analysis. Out of 10 loci, 8 were polymorphic and only two bands were found to monomorphic. The average of polymorphic bands per primer was 2.67. The scored from 24 accessions of Bael with three RAPD (10 mer) primers were used to generate similarity coefficient. Jaccard's similarity matrix presented in Table 4, showed the pair wise similarities among Bael genotypes with similarity coefficient ranged from 0.333 to 1.00.

UPGMA cluster analysis categorizes twenty four germplasm of Bael into two main clusters. In cluster I, there are 16 accessions of Bael which again sub-divided into two Subgroups. Subgroup I^1 contains 8 accessions viz., PB 16, PB 10, PB 4, Pant Shivani, PB 2, PB 18, PB 14 and PB 1 with coefficient of 0.71. The PB 1 shows 83.3 % similarity with PB 14 and PB 18 while PB 2 and PB 5 are related to PB 1, PB 14 and PB 18 with 78 % similarity. The other subgroup I^2 comprised PB 3, PB 11, PB 13, PB 23, PB 19, PB 20, PB 22 and Pant Urvashi. The genotypes in this group showed highest similarity of 1. In cluster II consists of eight Bael genotypes which again sub-divided into Subgroup II^1 and Subgroup II^2. In Subgroup II^1 only one genotype i.e., PB 7 exist with coefficient of 0.667. Subgroup

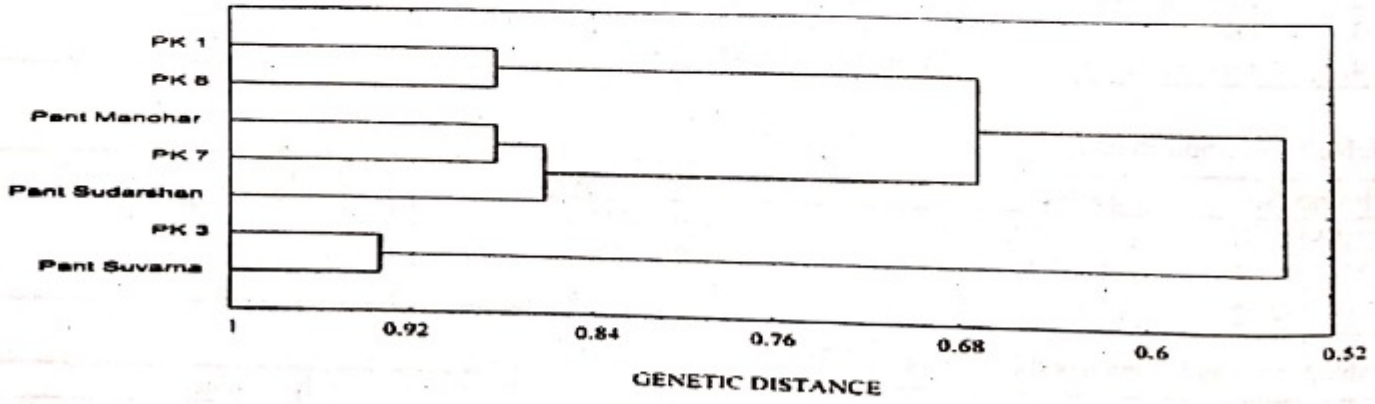

Fig. 1. Dendogram of 24 varieties of Bael genotypes constructed by using UPGMA based on Jaccards similarity Coefficient

II[2] contains seven genotypes i.e., NB 1, Pant Sujata, Pant Aparna, PB 17, PB 24, PB 15 and PB 21 with coefficient 0.8. PB 17 is related to PB 24 and shows coefficient of 1 and are similar to each other. However, PB 15 and PB 21 are related to other genotypes of cluster II with 0.74 genetic similarity. It was clear that some accessions from the same geographical regions clustered together along with other accessions from other places. Our findings agree with those of Prakash *et al.* (2002) who also observed that gropus of cultivars were clustered according to their origin in Indian guava. Similarly Cortes *et al.* (2001) reported for olive cultivars that provinces are not geographically isolated, because of the movement and exchange of germplasm among countries is very improbable that unique cultivars evolved in a specific country. Similar findings were reported by Misra *et al.* (2003) in Bael genotypes using seed protein electrophoresis, Deng *et al.* (1995) in lemons, Hancock *et al.* (1994) in strawberry and Matsumota *et al.* (1996) in rose cultivars. From above study it is concluded that there was a great variability between different accessions of same origin as well as similarity was also observed in between accessions of same origins which clearly indicating a low to moderately high genetic diversity among the accessions of Bael. Pant Shivani, Pant Urvashi, NB 1, and PB 7 were found great variability from other genotypes of Bael. So these genotypes could be used as 'core collection' for the improvement and new release of cultivars in Bael.

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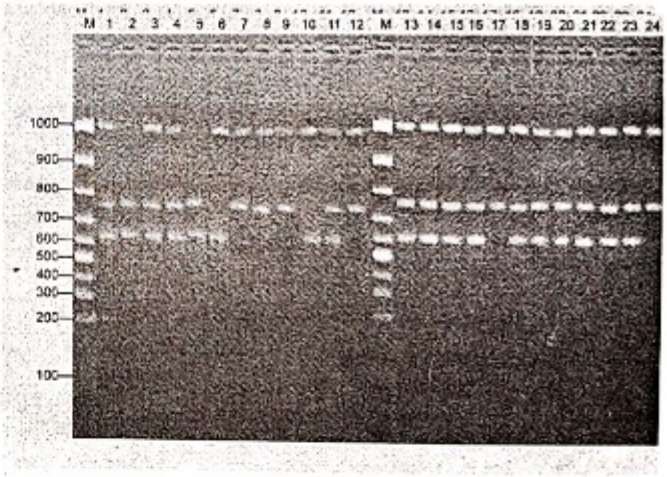

Fig. 2. The RAPD profile of 24 Bael genotypes generated by the primer 23SS10AT7 on 1.6 per cent agarose gel

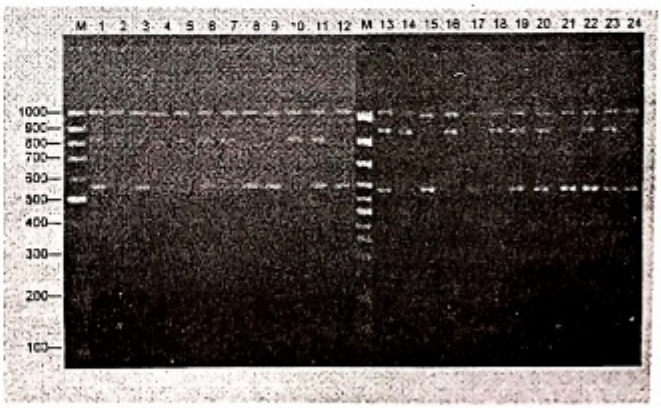

Fig. 3. The RAPD profile of 24 Bael genotypes generated by the primer 26SS10C10 on 1.6 per cent agarose gel

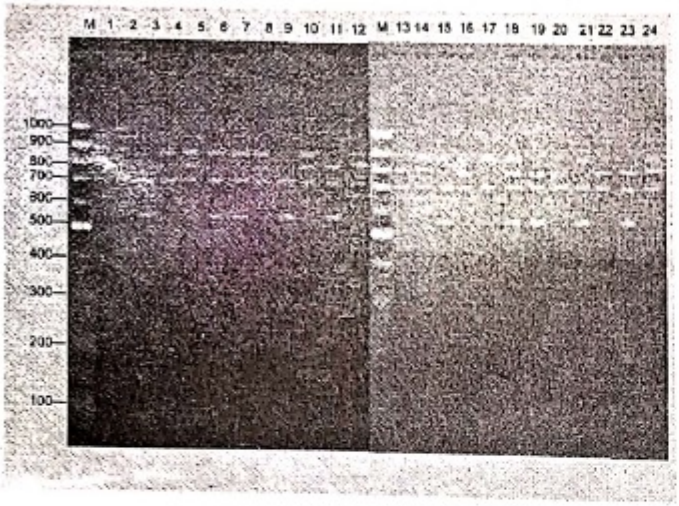

Fig. 4. The RAPD profile of 24 Bael genotypes generated by the primer 28SS10C12 on 1.6 per cent agarose gel

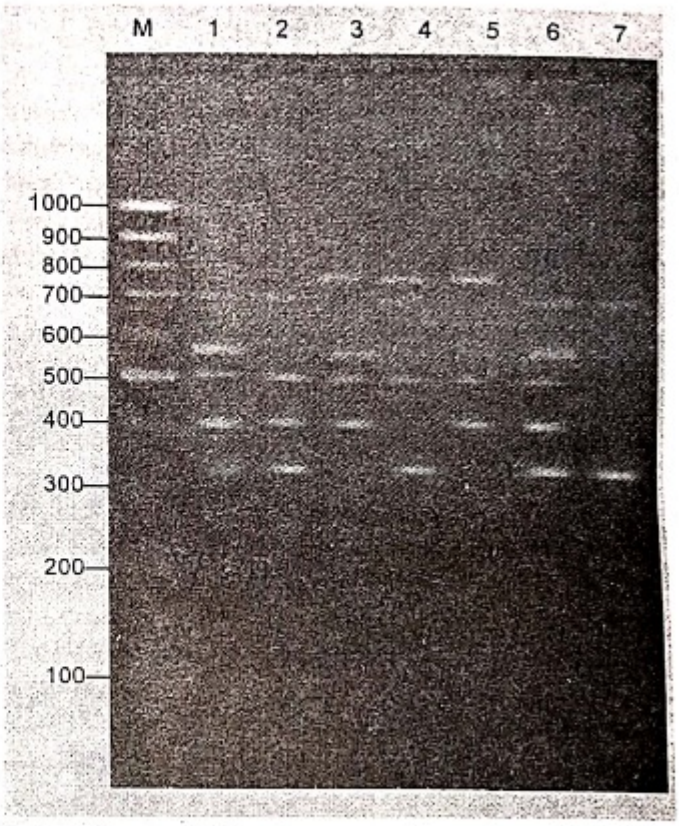

Fig 6. Polymorphic bands generated by primer OPBF06

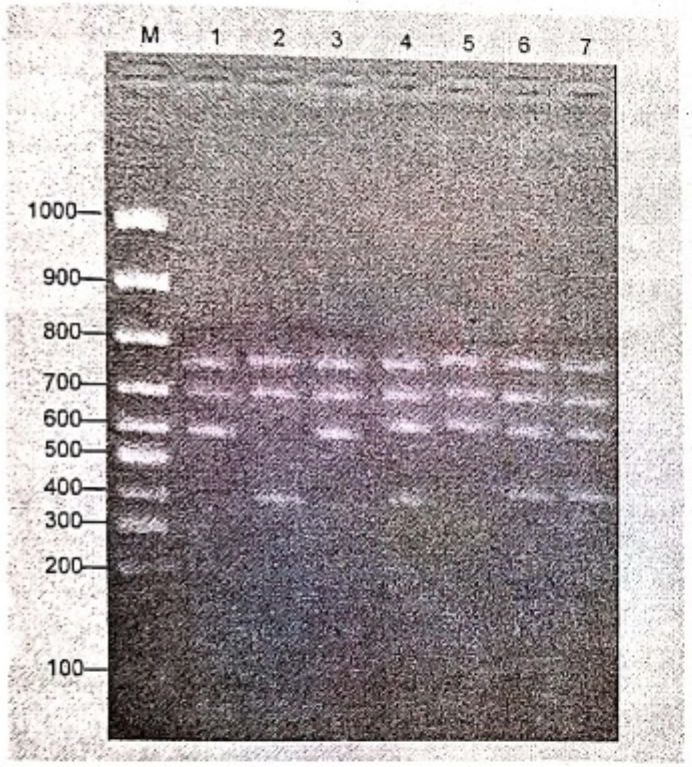

Fig 5. Polymorphic bands generated by primer

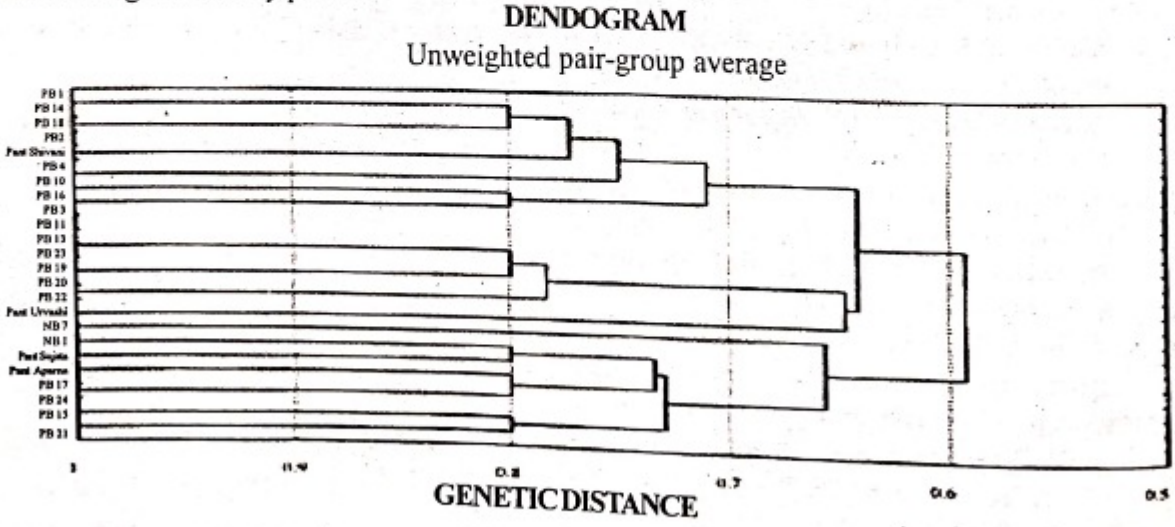

Fig 7. Dendogram of 7 varieties of Karonda genotypes constructed by using UPGMA based on Jaccard's similarity

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Effect of zinc and iron application on vegetative growth and quality of brinjal cv. Pusa Kranti

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Abstract

A field experiment to study the effect of zinc and iron application on vegetative growth and quality of brinjal cultivar Pusa Kranti was conducted during Dec., 2006 to July, 2008 as main crop and ratoon crop of brinjal at the Department of Horticulture, College of Agriculture, Bikaner. The results revealed that soil application of 40 kg $FeSO_4$ before transplanting followed by 40 kg $ZnSO_4$ ha^{-1} as soil application showed increased plantheight, stem girth, number of fruits per plant, fruit weight, fruit width, fruit length and ascorbic acid content in the fruits considerably.

Key words : *Brinjal, micronutrient, nutrition, zinc and iron.*

Introduction

Brinjal (*Solanum melongena* L.) is a major vegetable crop of India after potato. It is highly nutritive and contains fairly high amounts of iron and ascorbic acid. It has medicinal value and reported to lower down blood cholesterol level and is also said to be good remedy for those suffering from liver complications. Under arid areas of Rajasthan, its cultivations is being done successfully. However, productivity is low i.e. about 2.82 MT ha^{-1}, mainly because of poor fertility status. Soils of Bikaner are high in pH (8.20), low in organic carbon (0.09%), low in zinc (0.24 mg kg^{-1}) and medium in iron (3.93 mg kg^{-1}). Zinc and iron are important micronutrients for vegetative growth, yield attributing characters and quality of fruits in brinjal crops (Ravichandran *et al.*, 1995 and Raj *et al.*, 2001). Such studies were also under taken by Yadav *et al.* (2001) at Hisar in Haryana. There was need to initiate the study on the response of these micronutrients under extreme arid irrigated conditions of Bikaner in Rajasthan. Therefore, keeping in view the above consideration, an experiment was carried out to find out effect of zinc and iron on vegetative growth and quality of brinjal cv. Pusa Kranti.

Materials and methods

The experiment was laid out at experimental farm of College of Agriculture, Rajasthan Agricultural university, Bikaner during the year 2006-07 with brinjal cultivar Pusa Kranti. The seedlings of brinjal were transplanted in the field on 21 Dec., 2006. Prior to transplanting, well rotten FYM @ 150 q ha^{-1} was incorporated in the soil and also nitrogen was applied through urea half as basal dose of total 120 kg N ha^{-1} + full quantity of phosphorus (40 kg ha^{-1}) through single super phosphate and potassium 60 kg ha^{-1} through murate of potash. Remaining half quantity of nitrogen was applied in two equal doses at 30 and 45 days after transplanting. Basal dose of $FeSO_4$ and $ZnSO_4$ (20, 30, 40 kg ha^{-1}, respectively) were applied at the time of transplanting. The treatments consisted of three levels of each zinc and iron as soil application *viz.* 20, 30 and 40 kg $ZnSO_4$ ha^{-1} i.e. T_3, T_4, T_5, respectively and 20, 30 and 40 kg $FeSO_4$ ha^{-1} i.e. T_8, T_9, T_{10}, respectively and foliar spray of 0.1 per cent citric acid (T_1), 1 per cent urea (T_2), 0.25% $ZnSO_4$ + 1% urea (T_6), 0.50% $ZnSO_4$ + 1% urea (T_7), 0.5% $FeSO_4$ + 0.1% citric acid (T_{11}), 1.0% $FeSO_4$ + 0.1% citric acid (T_{12}), 1.5% $FeSO_4$ + 0.1% citric acid (T_{13}) and absolute control (T_0). Total 14 treatment combinations were replicated thrice in the randomized block design having plot size of 3 x 2.4 sqm with 60 cm x 45 cm plant to plant and row to row distance.

In main crop, foliar application of micronutrients, urea and citric acid as per treatments was done 105 and 120 days after transplanting. Thereafter on 14.09.2007 pruning was done and uniform application of vermicompost @ 25 kg/ plot was done on 22nd October, 2007. Subsequent flowering and fruiting was damaged by severe cold and frost conditions experienced during December, 2007 to February, 2008. It was maximum

between 2 February, 2008 to 4th February, 2008. The entire crop was burnt due to severe frost occurrence. Foliar sprays of micronutrients were again done on 25 February, 2008, 18.03.2008 and 07.04.2008 after pruning.

The observations on plant height and stem girth were recorded 115, 130 and 145 days after transplanting. No. of fruits per plant, fruit weight, fruit length and fruit width were recorded at the time of each picking. There were 11 pickings in main crop and 14 pickings in ratoon crop. First picking in main crop started from 24 April, 2007 and lasted on 2 July. 2007. whereas, in ratoon crop first picking started on 19 April, 2008 and continued upto 15 July, 2008. Ascorbic acid content was estimated in the fruits of first picking of both main crop as well as ratoon crop.

Results and discussion

Plant height

The present investigation revealed that application of 40 kg $FeSO_4$ ha^{-1} soil application had maximum plant height at 115 days after transplanting (31.34 cm) followed by 40 kg $ZnSO_4$ ha^{-1} soil application (30.99 cm). Similarly at 130 days after transplanting, 40 kg $FeSO_4$ ha^{-1} soil application had maximum plant height (32.90 cm) followed by (32.48 cm) in T_5 i.e. 40 kg $ZnSO_4$ ha^{-1} soil application and also it was minimum in control. At 145 days after transplanting, the same trends was observed (Table 1). It is because of the fact that soil application of zinc and iron might have improved their status in soil as the experimental field was low in available zinc (0.24 mg kg^{-1}) as well as in available iron (3.93 mg kg^{-1}). The application of these micronutrients through zinc sulphate and ferrous sulphate in the soil increased their availability in the soil for uptake by the plants. Similar findings have been reported by Singh and Maurya (1979) and Mallick and Muthukrishan (1979) who observed enhancement of plant height due to application of zinc in case of okra and tomato, respectively. Hatwar *et al.* (2003) also reported increase in the plant height due to foliar application of zinc, iron and boron in chilli.

Stem girth

Similar to results of plant height, maximum stem girth was recorded at 40 kg $FeSO_4$ ha^{-1} soil application at 115, 130 and 145 DAT which was 2.45 cm, 2.85 cm and 3.06 cm, respectively under this treatment. It was followed by 30 kg soil application of $FeSO_4$ ha^{-1} and soil application of 40 kg $ZnSO_4$ ha^{-1}. It is because of beneficial effect of zinc and iron in plant metabolism. Similar results have been reported by Seelliger and Moss (1976) and Sharma (1994) in pea and radish, respectively.

Number of fruits per plant

Number of fruits per plant were maximum in both main crop and ratoon crop in the treatments 40 kg $FeSO_4$ ha^{-1} as soil application which were recorded 7.11 and 6.97, respectively and was followed by 40 kg $ZnSO_4$ ha^{-1} soil application. The present findings is in agreement to the finding of Dube *et al.* (2003) in tomato and also by Ravichandran *et al.* (1995) in brinjal and Hatwar *et al.* (2003) in chilli.

Fruit weight

Fruit weight was recorded maximum (38.50 g) in 20 kg $ZnSO_4$ as soil application in main crop whereas at ratoon crop, maximum fruit weight (39.42 g) was recorded in the treatment of 20 kg $FeSO_4$ ha^{-1} as soil application (Table 1). The present finding is in agreement with the finding of Chaudhary and Mukherjee (1994) in cauliflower and also of Bhatt *et al.* (2004) and Seediger and Moss (1976) in pea. The increase in fruit weight by application of zinc and iron might be because of increased photosynthetic activity resulting more production of metabolities and thus help in increasing fruit weight in brinjal.

Fruit yield

Fruit yield was obtained maximum under soil application of 40 kg $FeSO_4$ ha^{-1} (442.80 q ha^{-1}) closely followed by 40 kg $ZnSO_4$ soil application ha^{-1} (437.68 q ha^{-1}) as compared to 264.54 q ha^{-1} obtained in absolute control in main crop whereas in ratoon crop it was also maximum in soil application of 40 kg $FeSO_4$ ha^{-1} (592.01 q ha^{-1}) followed by 30 kg soil application of $FeSO_4$ (540.47 q ha^{-1}) and 40 kg $ZnSO_4$ ha^{-1} (511.44 q ha^{-1}) as compared to 279.60 q ha^{-1}. Similarly soil application of zinc sulphate and different treatment combinations of zinc and iron along with citric acid and urea as foliar application also significantly increased fruit yield in main as well as in ratioon crop. These results are in agreement with the findings of Reddy *et al.* (1995) who reported application of zinc through $ZnSO_4$ either to soil or as foliar spray and iron as foliar spray through $FeSO_4$ resulted in significantly increased fruit yield of tomato accompanied by increased concentration of zinc and iron. Similarly, Bid *et al.* (1994), Ravichandran *et al.* (1995) and Raj *et al.* (2001).

Fruit width and fruit length

Fruit width was maximum in both main crop and in ratoon crop in the treatment of 40 kg $FeSO_4$ ha^{-1} soil application which was recorded 3.14 cm and 3.09 cm, respectively followed by 40 kg $ZnSO_4$ ha^{-1} as soil application. Similarly, fruit length was also recorded maximum under the above treatment (Table 2). It is in conformity to the findings of Pal *et al.* (2004) who also observed maximum fruit length and width in chilli cultivar Yolol wonder.

Table 1. Effect of different doses of zinc sulphate and ferrous sulphate as soil application and foliar application on plant height, stem girth, number of fruits per plant and yield of brinjal cv. Pusa Kranti

	Treatment	Plant height (cm)			Stem girth (cm)			Number of fruits per plant		Yield (q ha^{-1})	
		115 DAT	130 DAT	145 DAT	115 DAT	130 DAT	145 DAT	Main crop	Ratoon crop	Main crop	Ratoon crop
T_0	Absolute control	26.77	28.88	31.14	2.00	2.38	2.64	4.80	5.27	264.54	279.60
T_1	0.1% citric acid foliar spray	26.92	29.88	31.53	2.15	2.42	2.74	5.80	6.53	282.63	293.33
T_2	1.0% urea foliar spray	28.28	30.47	33.08	2.16	2.46	2.80	5.92	6.55	271.33	315.39
T_3	20 kg $ZnSO_4$ ha^{-1} soil application	30.04	31.02	33.19	2.23	2.60	2.89	6.37	6.75	414.23	325.11
T_4	30 kg $ZnSO_4$ ha^{-1} soil application	30.64	31.91	33.70	2.29	2.63	2.90	6.95	6.86	382.86	511.44
T_5	40 kg $ZnSO_4$ ha^{-1} soil application	30.99	32.48	35.12	2.35	2.72	2.94	7.03	6.89	437.68	493.72
T_6	0.25% $ZnSO_4$ + 1% urea foliar application	28.37	30.68	34.13	2.29	2.53	2.79	6.12	6.70	399.74	462.38
T_7	0.50% $ZnSO_4$ + 1% urea foliar application	28.34	30.69	34.18	2.32	2.59	2.85	6.62	6.75	411.80	459.01
T_8	20 kg $FeSO_4ha^{-1}$ soil application	29.89	32.02	34.20	2.24	2.57	2.85	6.50	6.78	410.11	535.33
T_9	30 kg $FeSO_4ha^{-1}$ soil application	30.15	32.81	34.25	2.40	2.75	3.05	6.63	6.95	424.02	540.97
T_{10}	40 kg $FeSO_4ha^{-1}$ soil application	31.34	32.90	35.22	2.45	2.85	3.06	7.11	6.97	442.80	592.01
T_{11}	0.5% $FeSO_4$ + 0.1% citric acid foliar spray	29.17	31.25	33.83	2.17	2.45	2.83	6.28	6.78	390.99	505.91
T_{12}	1.0% $FeSO_4$ + 0.1% citric acid foliar spray	29.84	31.34	34.24	2.21	2.55	2.79	6.39	6.83	346.57	460.16
T_{13}	1.5% $FeSO_4$ + 0.1% citric acid foliar spray	30.00	32.89	34.94	2.21	2.56	2.88	6.93	6.83	368.03	426.39
	S.Em±	0.77	0.74	0.68	0.06	0.07	0.07	0.39	0.13	19.38	35.05
	CD at 5%	2.25	2.15	1.99	0.17	0.21	0.20	1.10	0.38	56.34	101.89
	C.V. (%)	4.57	4.10	3.50	4.46	4.79	4.11	19.46	7.53	8.96	13.71

Table 2 . Effect of different doses of zinc sulphate and ferrous sulphate as soil application and foliar application on fruit weight, fruit length, fruit width and ascorbic acid of brinjal cv. Pusa Kranti

	Treatment	Fruit weight (g)		Fruit length (cm)		Fruit width (cm)		Ascorbic acid content (mg/100 g pulp)	
		Main crop	Ratoon crop	Main crop	Ratoon crop	Main crop	Ratoon crop	Main crop	Ratoon crop
T_0	Absolute control	34.80	35.18	7.72	7.08	1.99	1.98	9.00	9.28
T_1	0.1% citric acid foliar spray	35.27	37.26	7.86	7.27	2.00	2.02	10.00	10.25
T_2	1.0% urea foliar spray	37.13	37.60	7.90	7.49	2.15	2.13	10.40	10.25
T_3	20 kg $ZnSO_4$ ha^{-1} soil application	38.50	38.22	11.60	10.98	2.71	2.83	11.60	11.75
T_4	30 kg $ZnSO_4$ ha^{-1} soil application	35.67	38.31	11.61	11.04	2.81	2.85	12.50	12.25
T_5	40 kg $ZnSO_4$ ha^{-1} soil application	36.50	37.53	11.77	11.64	3.06	3.00	13.00	12.75
T_6	0.25% $ZnSO_4$ + 1% urea foliar application	37.17	36.83	10.87	10.77	2.73	2.80	12.30	12.10
T_7	0.50% $ZnSO_4$ + 1% urea foliar application	36.43	38.18	11.27	10.97	2.74	2.84	13.00	13.30
T_8	20 kg $FeSO_4ha^{-1}$ soil application	34.77	39.92	11.39	10.72	2.91	2.90	12.20	12.20
T_9	30 kg $FeSO_4ha^{-1}$ soil application	32.73	38.47	11.61	11.43	2.99	2.96	13.00	14.24
T_{10}	40 kg $FeSO_4ha^{-1}$ soil application	36.40	38.47	11.94	12.03	3.14	3.09	14.52	13.63
T_{11}	0.5% $FeSO_4$ + 0.1% citric acid foliar spray	38.37	39.64	11.20	10.70	2.90	2.71	12.00	13.50
T_{12}	1.0% $FeSO_4$ + 0.1% citric acid foliar spray	37.60	38.23	11.32	11.11	2.96	2.92	12.50	12.40
T_{13}	1.5% $FeSO_4$ + 0.1% citric acid foliar spray	34.33	37.11	11.51	11.15	3.06	2.85	13.50	12.50
	S.Em±	1.94	0.75	0.32	0.29	0.13	0.09	0.58	0.30
	CD at 5%	NS	2.09	0.92	0.81	0.37	0.24	1.68	0.92
	C.V. (%)	16.99	7.40	9.48	10.48	15.20	11.91	8.25	3.50

Ascorbic acid

Ascorbic acid content was also recorded maximum in soil application treatment of 40 kg $FeSO_4$ in main crop (14.52 mg/100g) and ratoon crop (13.63 mg/ 100 g), respectively which is similar to fruit size parameters. Other treatments of zinc and iron both in soil application and foliar application also resulted in increased ascorbic acid content in brinjal fruits in main crop as well as in ratoon crop significantly (Table 2). It might be because of better vegetative growth, more availability of metabolites for ascorbic acid synthesis and accelerated activity of ascorbic acid oxidase enzyme due to improved in zinc and iron. The positive response of increased ascorbic acid content in fruits by application of zinc and iron has also been reported by Singh and Tewari (1993) in onion, Ravichandran *et al.* (1995) in brinjal and Dube *et al.* (2003) in tomato.

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To study the effect of plant growth regulators and urea on flowering, fruiting and yield of custard apple (*Annona squamosa* L.) cv. Sindhan

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Abstract

The experiment was laid out in Randomized Block Design (RBD) with three replications at Horticulture Instructional Farm, Department of Horticulture, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Dist. Banaskantha, Gujarat during the year 2005 and 2006. The experiment involved fourteen treatments comprising of three levels each of NAA and GA_3 (50 ppm, 100 ppm and 150 ppm) alone and their combinations with 2 % Urea, 2 % Urea alone and Control. Seventeen years old custard apple plants of uniform growth and size were selected. Plants were planted at distance of 6 m x 6 m. The experimental findings revealed the effectiveness of plant growth regulators and urea on flowering, fruiting and yield of custard apple as compared to control. The result indicated that the significantly minimum number of days was taken for flowering and fruit ripening were recorded with combined application of NAA 150 ppm + Urea 2 % during both the years and in pooled data. The combined application of GA_3 50 ppm + Urea 2 % treatment recorded significantly maximum hermaphrodite flower, more rate of fruit development, fruit size (7.31 cm and 7.75 cm), number of pickings of fruit (6.42), average number of fruits per tree (194.38), average fruit weight (216.93 g), fruit yield per tree (40.26 Kg), fruit yield per hectare (11182.49 Kg) and less number of rudimentary flowers during both the years and in pooled data.

Key words: *Custard apple, Plant Growth Regulators, flowering, fruiting.*

Introduction

Custard apple have greenish yellow flowers arise at an extra axillary position, usually in clusters and rarely solitary. Six petals are in two whorls, the outer petals are thick, linear and rounded at the apex while inner ones are minute, ovate or obovate and keeled on the outside. The flower has numerous stamens and carpels. The fruit is composed of loosely cohering carpels forming a squamose or tuberculated surface. It bear hermaphrodite flowers either singly or in cluster on current season's growth and rarely on old wood (Nakasone and Paull, 1998). Flowers have thick sepals and petals, numerous ovaries, short styles, sessile stigmas, one or more ovules in each cell, small embryo and carpels united into a large fleshy fruit. The flowering period of custard apple is very long commencing from March – April continue up to July – August. Flower beings to appear in spring, yet no fruit set occurs during the entire spring and summer. It commences only in the rainy season, leaving little period for the on set of winter season. The setting of fruits early in the season is important because, immature fruit instead of developing become inedible in winter season and turn into stone (Hayes, 1957). Enough flowers are born but the poor fruit set causes low yield. Only one to eight per cent fruit set has been reported under natural conditions. Custard apple fruits usually mature in about four months from the time of anthesis. Fruits reached half their final size after the end of the initial rapid growth phase thereafter intermediate resting phase of four weeks and attain the full size and mature during the final growth phase. The skin colour turns to light green which was due to gradual decline in chlorophyll *a* and chlorophyll *b* concentrations during the last seven weeks of development. The harvesting of custard apple continues up to December, the peak period being October and November. The light green fruit colour, yellowish white colour between carpels and initiatin of cracking of the skin between the carpels are three maturity indices adopted in custard apple.

Auxin promotes elongation and growth of stem and roots and enlargement of many fruits by stimulating cell wall to stretch in more than one direction. Auxin promotes cell division in vascular combination in the growing season through movement of IAA from the developing shoot buds. GA_3 is most thoroughly studied gibberellin. The major sites of gibberellin production in plants are embryos, roots and young leaves near the shoot tip, immature fruits, seeds and tissues are good source. Nitrogen is chief promoter of plant growth. It imparts green colour to leaves and stem and enable them for efficient photosynthesis. Nitrogen is constituent of amino acids and it is important for the synthesis of several proteins.

Materials and methods

The experiment involved three levels each of higher concentration of NAA and GA_3 (50, 100 and 150 ppm) with urea and without urea 2 % were taken to find out their influence on flowering of custard apple at Horticulture Instructional Farm, Department of Horticulture, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Dist: Banaskantha, Gujarat during crop season of the year 2005 and 2006. Seventeen year old custard apple orchard uniform in growth and size which were planted at the distance of 6 x 6 meters. All the plants were subjected to uniform application of cultural practices like irrigation, weeding and fertilizer etc. Sindhan variety of custard apple was taken under investigation as this variety is promising one and most of cultivators of North Gujarat regions are growing extensively. The experimental field was loamy sand in texture and good drainage property. Randomized Block Design (RBD) was adopted with three replication and two plant in each replication. Farm Yard Manure was applied at the rate of 50 Kg to each plants uniformly, while chemical fertilizers were applied at the rate of 250 g : 125 g : 125 g NPK/plant/year. Three irrigation were given during experimentation.

Three level of NAA and GA_3 were sprayed singly and combined with urea and thus fourteen number of treatment combinations were T_1 – NAA 50 ppm, T_2 – NAA 100 ppm, T_3 – NAA 150 ppm, T_4 – GA_3 50 ppm, T_5 – GA_3 100 ppm, T_6 – GA_3 150 ppm, T_7 – Urea 2 %, T_8 – NAA 50 ppm + Urea 2 %, T_9 – NAA 100 ppm + Urea 2 %, T_{10} – NAA 150 ppm + Urea 2 %, T_{11} – GA_3 50 ppm + Urea 2 %, T_{12} – GA_3 100 ppm + Urea 2 %, T_{13} – GA_3 150 ppm + Urea 2 %, T_{14} – Control.

Result and discuss

Effect of NAA and NAA with urea

The foliar application of NAA with 2 % Urea and NAA alone with all its concentration gave most promising results by decreasing the number of days taken to flowering after spray in custard apple during both the year of experimentation. The number of days taken for flowering significantly decreased by NAA 150 ppm with 2 % urea followed by NAA 150 ppm during the years of experimentation. The application of NAA can be accelerate to synthesis and promote to auxins which preventing the formation of abscission layer possibly through the inhibition of enzymatic activity such as pectinase, cellulose and polygalactauronase. This findings are in conformity with the results of Singh A. R. (1971) in Mango and Khan *et al.* (1974) in Litchi.

The higher concentration of NAA with 2 % urea and NAA alone were found beneficial for reduction in time taken to fruit ripening. The significantly minimum time for fruit ripening was recorded under the treatment NAA 150 ppm + Urea 2 % (T_{10}) and the maximum under GA_3 150 ppm during both the years and pooled data of two years. The results of present study are in accordance with the finding of Maurya *et al.* (1973) in Mango and Khan *et al.* (1974) in Litchi.

The higher concentration of NAA 150 ppm with 2 % urea and NAA alone recorded more percentage of hermaphrodite flowers during both the years and in pooled of two years. It might be due to the fact that auxin prevents abscission and facilitates the ovary to remain attached with the shoot. The flower drop was thus reduced due to NAA application as compared to other application. The increased fruit set due to NAA could be attributed to the fact that auxin is involved in the growth of a ovary into fruit and its adequate quantity is necessary for fruit to set. Similar results due to application of NAA were reported by Singh *et al.* (1991) in Mango and Bhati and Yadav (2003) in Ber.

The per cent rudimentary flowers decreased with all the levels of NAA and NAA with 2 % urea in custard apple. The minimum rudimentary flower were recorded under NAA 150 ppm + Urea 2 % (T_{10}). It might be due to the reason that NAA spray was probably might have forced profuse flowering. It seems to have helped to increase the fruit set either by improving pollen germination or by helping the growth of pollen tubes and thus, facilitates timely fertilization before the stigma looses its receptivity or the style becomes non-functional.

The maximum fruit diameter was recorded under higher concentration of NAA with 2 % urea and NAA alone. The maximum fruit diameter was obtained under NAA 150 ppm + Urea 2 % (T_{10}). NAA is a synthetic auxin and auxins are known for their growth promoting activity in plant tissue through RNA and protein synthesis. The results are in agreement with those of Sharma *et al.* (1987), Banker and Prashad (1990) and Singh *et al.* (2001) in Ber.

The mature fruit size and weight was increased with concentration of NAA, amongst them NAA 150 ppm with 2 % urea and NAA alone were found to be the superior. An increase in fruit size (length and width) is caused mainly by cell division and cell elongation. Hence,

probably auxins positively help in fruit growth and increased fruit size as well as weight. Ultimately, increased fruit yield which is due to increase in yield contributing factors such as fruit set, weight and size. The findings are supported by Bankar and Prashad (1990), Singh *et al.* (2001) and Bhati and Yadav (2003) in Ber.

Effect of GA_3 and GA_3 with urea

Among the various treatments, the data on number of days taken for flowering after first spray were significantly influenced by all the concentrations of GA_3 and the combination of GA_3 with 2 % urea. It was found that the application of GA_3 50 ppm + 2 % urea (T_{11}) took significantly more number of days for flowering during both the years. The more days of flowering duration increased the more number of fruit set due to stimulation of endogenous NAA. So, the hermaphrodite flowers forced to set as fruit which ultimately increases the number of fruit per tree. Similar results were obtained by Khan *et al.* (1974) in Litchi, Kumar *et al.* (1975) in Lime and Ahmad and Zargar (2005) in Grape.

The lower concentration of GA_3 with 2 % Urea and GA_3 alone were found beneficial for percent hermaphrodite flowers forced to set as fruit which ultimately increases the number of fruit per tree and reduction in percent rudimentary flowers during both the years. GA_3 50 ppm + Urea 2 % (T_{11}) treatment give significantly maximum percent hermaphrodite flowers and minimum percent rudimentary flowers during both the years and in pooled data.

The rate of fruit development was significantly increased over control with the application of GA_3 alone with all concentrations during experimental year. The significantly highest fruit development was observed under GA_3 50 ppm + Urea 2 % (T_{11}) during both the years of experimentation. It might be due to the growth of fruit is largely a result of cell division and cell elongation. Gibberellin's is known for its important role in cell elongation and cell division therefore, is responsible for an increase in fruit development. The findings are supported by results of Banker and Prashad (1990) in Ber, Sharma *et al.* (2005) in Litchi and Kaur *et al.* (2000) in Kinnow Mandarin.

The data indicated that the significantly maximum fruit length and width were obtained under treatment GA_3 50 ppm + Urea 2 %. The superiority of GA_3 over NAA treatments might be due to the fact the increase in fruit size (length and width) is chiefly because of increase in the volume of cells in the mesocarp and only partially due to cell division. The exogenous application of gibberellins might have stimulated cell division and cell elongation. Consequently, rate of growth and development of fruit was enhanced resulting in larger size of fruits. The findings are in agreement with Ray *et al.* (1991) in Litchi and Rani and Brahmachari (2004) in Kinnow mandarin.

All the treatments significantly increased number of pickings of custard apple cv. Sindhan. However, the significant increase in number of pickings was recorded with all the levels of GA_3. The treatment of GA_3 50 ppm + Urea 2 % recorded significantly more pickings during both the year of experimentation. It might be due to the fact that gibberellins has an effect on cell elongation which ultimately results in bigger size of fruit and increasing flowering period and more number of fruit set and required more days of maturity. The findings are in conformity with results of Chundawat and Singh (1980) in Phalsa and Parmar and Chundawat (1984) in Banana.

The application of GA_3 with 2 % urea and GA_3 alone with all concentrations significantly increased number of fruits carried up to maturity which were also statistically superior over the control. The exogenous application of gibberellins in the present experiment might have kept the protein synthesis in an active state and allowed the fruit to continue growth for longer period and thus delayed the maturity. This prolonged growth in gibberellin's treatment has also resulted in bigger sized fruits. These results are in consonance with those already reported on the effect of NAA by earlier workers such as Chundawat and Singh (1980) in Phalsa, Parmar and Chundawat (1984) in Banana and Ahmad and Zargar (2005) in Grape.

The data also showed general superiority of GA_3 over NAA as revealed by significantly higher fruit weight under GA_3 50 ppm + Urea 2 % as compared to the respective NAA treatments. It is well established that gibberellins bring about certain metabolic changes which are reflected through increased weight of fruit. The fruit weight was major yield attributing parameters which was significantly increased with the application of GA_3 with 2 % urea and treatment of GA_3 alone in the present studies. GA_3 50 ppm + 2 % Urea gave significantly maximum fruit weight as compared to control and all the other treatments during both the year of experimentation and in pooled of two years. The similar results were recorded by Ahmad and Zargar (2005) in Grape and Sharma *et al.* (2005) in Litchi.

In this investigation, GA_3 with 2 % urea as well as alone produced significantly the highest fruit yield per tree of custard apple than other treatments during both the year of experimentation. The highest yield of custard apple was obtained from GA_3 50 ppm + Urea 2 % in comparison to other treatments and also in control. Gibberellins play a important role in cell elongation and cell division. Therefore, it is responsible for increase in fruit size (length and width) as well as fruit weight. An increase in yield would be attributable to the reduction in flower drop and also better fruit growth, which was contributed to an overall increase in yield. The results are in conformity with the findings of Parmar and Chundawat (1984) in Banana.

Table 1. Effect of plant growth regulators and urea on number of days taken for flowering after first spray and days taken to fruit ripening of custard apple cv. Sindhan

Treatment	Number of days taken for flowering after first spray			Days taken to fruit ripening		
	Year-2005	Year-2006	Pooled	Year-2005	Year-2006	Pooled
T_1	75.45	73.78	74.61	78.81	80.21	79.51
T_2	71.55	67.50	69.53	77.45	78.06	77.76
T_3	68.15	65.15	66.65	75.63	76.14	75.89
T_4	80.06	77.75	78.91	85.81	86.68	86.25
T_5	83.77	81.08	82.43	89.43	90.32	89.87
T_6	84.59	81.40	82.99	90.68	91.03	90.85
T_7	77.01	75.72	76.37	84.12	84.98	84.55
T_8	74.25	70.95	72.60	79.30	79.42	79.36
T_9	72.87	68.53	70.70	76.58	77.14	76.86
T_{10}	66.48	63.50	64.99	73.32	74.05	73.69
T_{11}	78.79	77.30	78.05	85.18	85.79	85.49
T_{12}	81.44	78.99	80.22	86.45	87.30	86.88
T_{13}	82.47	80.92	81.69	87.66	88.59	88.13
T_{14}	77.76	76.28	77.02	84.34	85.01	84.68
S. Em ±	3.64	4.12	2.47	3.67	3.72	2.34
C. D. at 5 %	10.58	11.98	6.98	10.67	10.81	6.63
Year x Treatment (Y x T) Interaction:						
S. Em. +	-	-	3.89	-	-	3.69
C. D. at 5 %	-	-	NS	-	-	NS
C. V. %	8.21	9.62	8.92	7.71	7.74	7.72

Table 2. Effect of plant growth regulators and urea on percent hermaphrodite flowers and rudimentary flowers of custard apple cv. Sindhan

Treatment	Percent hermaphrodite flowers			Percent rudimentary flowers		
	Year-2005	Year-2006	Pooled	Year-2005	Year-2006	Pooled
T_1	14.54	16.69	15.61	85.46	83.31	84.39
T_2	15.26	17.89	16.58	84.74	82.11	83.42
T_3	16.51	19.07	17.79	83.49	80.93	82.21
T_4	27.79	31.10	29.44	72.21	68.90	70.56
T_5	25.46	27.92	26.69	74.54	72.08	73.31
T_6	19.38	22.22	20.80	80.62	77.78	79.20
T_7	12.25	14.93	13.59	87.75	85.07	86.41
T_8	13.68	16.07	14.88	86.32	83.93	85.13
T_9	16.86	19.99	18.43	83.14	80.01	81.57
T_{10}	17.59	21.02	19.30	82.41	78.98	80.70
T_{11}	29.27	33.79	31.53	70.73	66.21	68.47
T_{12}	23.85	25.84	24.84	76.15	74.61	75.16
T_{13}	20.48	23.92	22.20	79.52	76.08	77.80
T_{14}	11.56	12.97	12.26	88.44	87.03	87.74
S. Em +	3.77	4.21	2.54	3.77	4.21	2.54
C. D. at 5 %	10.98	12.25	7.17	10.97	12.25	7.20
Year x Treatment (Y x T) Interaction:						
S. Em. ±	-	-	4.00	-	-	4.00
C. D. at 5 %	-	-	NS	-	-	NS
C. V. %	34.61	33.68	34.16	8.06	9.32	8.69

Table 3 . Effect of plant growth regulators and urea on rate of fruit development (diameter) of custard apple cv. Sindhan

Treatment	Rate of fruit development (diameter) (cm)								
	30 days			60 days			At time of harvesting		
	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled
T_1	4.83	4.79	4.81	5.56	5.52	5.54	6.76	6.73	6.75
T_2	4.93	4.89	4.91	5.62	5.60	5.61	6.88	6.87	6.87
T_3	5.08	5.05	5.07	5.77	5.73	5.75	6.99	6.99	6.99
T_4	5.72	5.71	5.71	6.71	6.68	6.70	7.71	7.61	7.66
T_5	5.60	5.56	5.58	6.61	6.56	6.58	7.38	7.34	7.36
T_6	5.32	5.30	5.31	6.26	6.20	6.23	7.30	7.26	7.28
T_7	4.61	4.57	4.59	5.45	5.42	5.43	6.57	6.55	6.56
T_8	4.71	4.67	4.69	5.51	5.48	5.49	6.69	6.66	6.68
T_9	5.17	5.13	5.15	5.89	5.88	5.89	7.17	7.14	7.15
T_{10}	5.24	5.22	5.23	6.11	6.08	6.10	7.23	7.20	7.21
T_{11}	5.91	5.89	5.90	6.78	6.74	6.76	7.77	7.73	7.75
T_{12}	5.58	5.54	5.56	6.51	6.46	6.48	7.58	7.55	7.57
T_{13}	5.34	5.32	5.33	6.37	6.32	6.35	7.49	7.37	7.43
T_{14}	4.51	4.47	4.49	5.39	5.31	5.35	6.55	6.53	6.54
S. Em ±	0.22	0.22	0.14	0.22	0.22	0.14	0.27	0.26	0.17
C. D. at 5 %	0.65	0.64	0.40	0.64	0.64	0.39	0.78	0.76	0.48
Year x Treatment (Y x T) Interaction:									
S. Em. +	-	-	0.22	-	-	0.22	-	-	0.27
C. D. at 5 %	-	-	NS	-	-	NS	-	-	NS
C. V. %	7.45	7.40	7.43	6.28	6.35	6.31	6.54	6.35	6.45

Table 4 . Effect of plat growth regulators and urea on fruit size and number of pickings of custard apple cv. Sindhan

Treatment	Fruit length (cm)			Fruit width (cm)			Number of pickings		
	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled
T_1	6.39	6.36	6.37	6.76	6.73	6.75	5.17	4.83	5.00
T_2	6.48	6.45	6.47	6.88	6.87	6.87	5.33	5.00	5.17
T_3	6.57	6.54	6.56	6.99	6.99	6.99	5.33	5.00	5.17
T_4	7.16	7.13	7.14	7.71	7.61	7.66	6.33	6.17	6.25
T_5	7.07	7.02	7.04	7.38	7.34	7.36	6.17	5.83	6.00
T_6	6.80	6.76	6.78	7.30	7.26	7.28	5.67	5.67	5.67
T_7	6.26	6.22	6.24	6.57	6.55	6.56	5.00	4.67	4.83
T_8	6.30	6.27	6.29	6.69	6.66	6.68	5.17	4.83	5.00
T_9	6.65	6.62	6.64	7.17	7.14	7.15	5.50	5.33	5.42
T_{10}	6.72	6.71	6.72	7.23	7.20	7.21	5.50	5.50	5.50
T_{11}	7.33	7.29	7.31	7.77	7.73	7.75	6.50	6.33	6.42
T_{12}	6.97	6.94	6.96	7.58	7.55	7.57	6.00	5.83	5.92
T_{13}	6.86	6.81	6.84	7.49	7.37	7.43	5.83	5.50	5.67
T_{14}	6.16	6.14	6.15	6.55	6.53	6.54	4.83	4.50	4.67
S. Em +	0.24	0.24	0.15	0.27	0.26	0.17	0.35	0.39	0.24
C.D. at 5 %	0.71	0.69	0.43	0.78	0.76	0.48	1.02	1.13	0.67
Y x T Interaction									
S. Em. ±	-	-	0.24	-	-	0.27	-	-	0.37
C.D. at 5 %	-	-	NS	-	-	NS	-	-	NS
C. V. %	6.32	6.14	6.23	6.54	6.35	6.45	10.82	12.59	11.70

Table 5. Effect of plat growth regulators and urea on number of fruits per tree and average fruit weight (g) of custard apple cv. Sindhan

Treatment	Number of fruits per tree			Average fruit weight (g)		
	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled
T_1	147.77	144.10	145.94	189.48	182.58	186.03
T_2	150.29	146.73	148.51	193.24	186.48	189.86
T_3	155.87	152.50	154.19	194.44	188.94	191.69
T_4	191.91	187.11	189.51	214.59	210.11	212.35
T_5	186.41	180.04	183.23	213.38	210.03	211.71
T_6	167.46	163.08	165.27	199.65	195.16	197.41
T_7	142.27	138.99	140.63	183.81	178.99	181.40
T_8	145.21	142.60	143.90	187.08	180.33	183.71
T_9	158.52	154.07	156.30	195.59	180.14	192.36
T_{10}	162.10	157.70	159.90	198.52	190.79	194.65
T_{11}	196.73	192.02	194.38	218.82	215.03	216.93
T_{12}	182.41	177.43	179.92	208.97	204.83	206.90
T_{13}	174.79	170.28	172.54	201.47	196.56	199.02
T_{14}	140.15	136.59	138.37	182.63	178.83	180.73
S. Em +	6.26	5.82	3.83	6.75	7.79	4.62
C.D. at 5 %	18.19	16.93	10.86	19.63	22.63	13.11
Y x T Interaction						
S. Em. ±	-	-	6.04	-	-	7.29
C.D. at 5 %	-	-	NS	-	-	NS
C. V. %	6.59	6.29	6.45	5.89	6.97	6.44

Table 6. Effect of plat growth regulators and urea on fruit yield per tree (kg) and fruit yield per hectare (kg) of custard apple cv. Sindhan

Treatment	Fruit yield per tree (kg)			Fruit yield per hectare (kg)		
	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled
T_1	30.34	30.11	30.22	8427.82	8363.60	8395.71
T_2	30.86	30.66	30.76	8571.54	8515.85	8543.70
T_3	32.00	31.86	31.93	8889.79	8851.12	8870.45
T_4	39.40	39.10	39.25	10945.27	10859.85	10902.56
T_5	38.27	37.62	37.95	10631.58	10449.52	10540.55
T_6	34.38	34.07	34.23	9550.61	9464.98	9507.80
T_7	29.21	29.04	29.13	8114.32	8067.02	8090.67
T_8	29.81	29.79	29.80	8281.62	8276.15	8278.89
T_9	32.55	32.19	32.37	9041.11	8942.25	8991.68
T_{10}	33.28	32.95	33.12	9245.29	9152.73	9199.01
T_{11}	40.39	40.12	40.26	11220.36	11144.63	11182.49
T_{12}	37.45	37.07	37.26	10403.45	10297.65	10350.55
T_{13}	35.89	35.58	35.73	9968.86	9882.86	9925.86
T_{14}	28.78	28.54	28.66	7993.22	7927.34	7960.28
S. Em +	1.28	1.22	0.79	356.79	337.98	219.97
C.D. at 5%	3.73	3.54	2.25	1037.18	982.50	624.24
Y x T Interaction						
S. Em. ±	-	-	1.25	-	-	347.52
C.D. at 5%	-	-	NS	-	-	NS
C. V. %	6.59	6.29	6.45	6.59	6.29	6.45

Effect of urea

The treatment of 2 % urea gave superior results in respect of number of days taken to flowering after first spray, percent hermaphrodite and rudimentary flower during both the years of experimentation and in pooled of two years data. It might be due to the nitrogen application may increase the supply of some hormones to the fruit that tend to reduce abscission, probably auxins. The effect of C : N ratio on growth and fruitfulness are paralleled by its effect on abscission. The foliage is also thought to be seat of auxin production needed for many physiological activities. The findings are in conformity with findings of

Chundawat and Singh (1980) in Phalsa and Parmar and Chundawat (1984) in Banana.

The rate of fruit development increased with 2 % urea during both the years of experimentation but it failed to reach the level of significance. The foliar application of urea attributes proper supplementation of nutrients thereby it increases the efficiency of metabolic processes of the various parts of tree including fruit and provides proper development (Singh, A. R., 1977). The findings are in agreement with results of Singh *et al.* (1991) in Mango.

The treatment of 2 % urea gave superior results in respect of days taken to fruit ripening during both the years of experimentation and in pooled of two years data. The fruit carried up to the maturity in urea were higher than control during both the years but failed to reach the level of significance. The urea 2 % gave more mature fruit over control. The findings are supported by Malik *et al.* (2000) in Kinnow.

The fruit size and weight was not statistically significant with treatment of urea. The increase in fruit size and weight might be due to foliar feeding of nutrients and consequently rapid fruit development caused easy availability of nutrients to the plants. The findings are in conformity with results of Singh *et al.* (1991) in Mango.

The increasing yield with 2 % urea was recorded under present investigation during both the years and yield attributing parameters like more number of pickings, number of fruits per tree, average weight of fruit, fruit length and fruit width. An increase in the yield might be due to the fact that nitrogen is an important constituent of protoplasm and it is helpful in chlorophyll synthesis which increased photosynthetic activity of leaves and consequently the yield. Yield is also affected by reduction of flower drop and also better fruit growth. The findings are in accordance with results of Singh *et al.* (1991) in Mango and Malik *et al.* (2000) in Kinnow.

The effect of urea on number of pickings was non- significant during both the years and in pooled of two year data. It might be due to the reason that urea is a nitrogenous fertilizer and is known for its growth promoting activity in plant tissues.

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Evaluation of Indian bean genotypes under hot arid environment

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Abstract

Horticultural and morphological studies among twelve genotypes of Indian bean were made for growth, pod quality and yield contributing characters under arid environment to select desirable types for commercial exploitation. Significant variation in all the important characters was observed in the genotypes especially for days to first picking, pods per plant, pod yield per plant, fresh weight, length and width of pod and these characters are of great significance in redesigning the plant architecture of the genotype having higher early yield with better quality pods. The genotypes AHDB-16 (818.0 g), AHDB-15 (707.1 g), AHDB- 3 (698.3 g) and AHDB-7 (147.7 g) were found to be promising on the basis of important traits like plant type, fruiting, quality of pod and yield under arid conditions.

Key word: *Indian bean, Lablab purpureus, arid environment.*

Introduction

Indian bean or sem (*Lablab purpureus*) is adapted to a wide range of climatic conditions and also has ability to tolerate the extremes of temperature and drought conditions. It is growth for tender pods and immature and mature seeds. In western parts of India particularly in tribal areas of Rajasthan and Gujarat it is being cultivated as a rescue vegetable crop under rainfed situations. In these areas, farmers generally grow perennial and vine type landraces having low harvest index. In spite of the potentials for crop diversification under drought conditions, suitable cultivars have not yet been developed for arid and semi-arid areas. Its current status as a minor legume vegetable is due to its underexploitation (Samadia *et al.*, 2002). The present need is to develop early maturing and high yielding genotypes with better pod quality attributes. Preliminary identification of desirable genotypes can be done based on characters like days to first picking, number of pods per plant, pod yield per plant and pod quality (Singh *et al.*, 1985; Chattopadhyay *et al.*, 1996 and pan *et al.*, 2001). Therefore, diverse genotypes collected indigenously were evaluated for horticultural and morphological traits and tested for yield potential to identify suitable types in Indian bean for the cultivation under arid and semi-arid environment.

Materials and methods

The experimental material for the study comprised of twelve indigenous Indian bean genotypes collected from tribal areas of Rajasthan and Gujarat. These genotypes were evaluated during 2000-2001 and 2001-2002 as a rainy-winter season crop at Central Institute for Arid Horticulture, Bikaner. The agro-climate of Bikaner is characterized by extremes of temperature (as low as 1°C in winter and as high as 48°C in summer), low rainfall (250-350 mm) in few spells from July to September, high vapour pressure deficit, intense solar radiation and high wind velocity besides poor soil fertility and water holding capacity. For the experiment, a spacing of 1.5 m was kept between the rows and 3.0 m long channels were made for six plants per genotype which were replicated three times. Thorny twigs support in between wires on iron poles were provided for supporting vining plants. The crop was grown with proper care during both the years (July to February) for recording the observations. Morphological characters were recorded on five plants in a genotype whereas 10 pods at tender stage were harvested/plant from the marked plants of the genotype in each replication. Pooled data were statistically analyzed (Panse and Sukhatme, 1985).

Results and discussion

Data pertaining to various horticultural and morphological characters of twelve genotypes are presented in Table 1 and 2. The plant structure in Indian

bean is one of the important parameters for the feasibility of its economical cultivation. In the present study, there were three types of plant structure *i. e.* viny, inter-mediate and erect. However, most of the genotypes were viny types having moderate to vigorous growth habit except AHDB-7 (erect) and AHDB-12 (semi-erect). The plant height ranged from 0.95 m to 4.12 m. The least inter-nodal length was measured 5.23 cm in the genotype AHDB-7 and maximum for AHDB-15 (15.33 cm). The genotype AHDB-2 and AHDB-9 showed recordable variation in plant pigmentation on leaf stalk base, base of primary branches, inter-nodal region, base of mid rib of leaflet and tender pods.

The period of appearance of flowering in the genotypes ranged from 81.33 to 141.0 days after sowing (DAS). Among the genotypes tested, the appearance of the flowers was earliest in AHDB-16 (81.33) followed by AHDB-15 (83.33) and AHDB-7 (85.33). However, one of the potential genotype AHDB-3 (125.67) was amongst the late flowering types. Days taken for first picking is one of the most important parameters for higher and early yields especially in beans where pods have to be harvested at tender stage for vegetable purpose. Under arid and semi arid conditions of western India short duration genotypes with early flowering and fruit setting (October to February) are desirable. This results in higher productivity because the crop is able to give maximum fruit pickings under moderate range of climatic conditions during period of cultivation. In the present study the range of days to first harvesting varied from 96.33 to 167.67 days. As far as earliness for first picking is concern, the genotype AHDB-16 (96.33 days) gave significantly earliest harvest compared to general mean (105.94 days). The potential genotypes AHDB-15 and AHDB-7 were amongst the early group whereas AHDB-3 (150.6 days) showed late harvesting.

The number of flower per floret, pods per floret, pods per plant and pod weight are the major characters to asses the yield potential of Indian bean genotype. The genotype with more number of pods per floret and per plant along with early setting and picking should result in higher and early production. In the present study, number of flower/floret, pods/floret and pods/plant ranged from 3.4-14.53, 1.16-7.73 and 12.67-116.0, respectively. The significantly highest flowers/floret was recorded for AHDB-16 (14.53). The number of pods per floret was found to maximum in AHDB-7 (7.73) followed by AHDB-16 (6.66) and AHDB-15 (5.50). The genotype AHDB-16 (116.0) followed by AHDB-15 (107.0), AHDB-12 (82.32) and AHDB-3 (85.0) produced significantly higher number of pods per plant than the mean (67.11). Marketable tender pod yield per plant ranged from 58.0 to 818.0 g in the tested genotypes under arid conditions. The genotype AHDB-16 (818 g) recorded significantly higher tender pod yield per plant, which was followed by AHDB-15 (707.6 g) and AHDB-3 (698.3). However, the genotype AHDB-7 produces only 147.7 g tender pod per plant have also better scope for its utilization owing to erect plant growth habit which does not required any support for the cultivation in open fields. Although, the pods of this early fruit setting genotype are smaller but the number of seeds/ pod (4.13) and tender seed weight per pod (1.25 g) are equally better and comparable with other genotypes.

The physical characteristics of tender pods/seeds are very important deciding parameters of a genotype for its palatable acceptability, quality and yield. In the present study wide variations were observed for fresh pod colour (dark green, green, light green to whitish green), pod shape (sickle and slightly sickle or curved and straight) and texture at marketable stage (smooth and rough or glossy and dull). Among the high yielding genotypes, in order of physical characters and acceptable quality of pods are AHDB-3, AHDB-16, AHDB-15, AHDB-17 and AHDB-18. Weight of tender fresh pod varied from 1.84 to 8.47 with a mean 5.77 g/pod. The range for length and width of pod were from 4.15 to 13.55 cm and 0.72 to 2.50 cm, respectively. The genotypes possessing better pod quality traits, *i. e.* AHDB-3, AHDB-16, AHDB-15 and AHDB-18 have desirable pod characters (which require for higher yields and acceptability)) like weight, length and width of the pods at tender stage. The weight, length and width of pod and number of seeds per pod in high yielding genotypes were in AHDB-16 (7.09, 9.67, 1.70 and 5.11), AHDB-15 (6.54, 9.24, 1.74 and 5.03) and AHDB-3 (8.47, 13.55, 0.98 and 5.03), respectively. The genotype AHDB-7 (erect type) possessing desirable character for the cultivation without support produces smaller sized pods of 1.84 g in weight, 4.15 cm in length, 0.75 cm in width and 4.13 seeds per pod.

In the present study, the genotypes emerging out superior on the basis of mean values for pod yield and quality contributing traits and also potentialities for successful cultivation under extremes of arid environmental conditions are AHDB-16, AHDB-15, AHDB-3 and AHDB-7 respectively, 1 to 4 in order of merit. Among viny types AHDB-16 and AHDB-15 are early whereas AHDB-3 is late bearer and produces excellent quality pods. The erect and early maturing genotype AHDB-7 is equally potential even with smaller sized pods, since in this genotype the total pod yield could be compensated by more number of plants per unit area in the field resulting in to higher early yields.

Table-1 : Morphological characteristics of Indian bean germplasm under hot arid environment

Genotype	Plant growth habit	Leaf colour	Plant pigmen -tation	Flower bud colour	Open flower colour	Fresh pod colour	Pod shape	Pod texture	Pod angle	Seed shape	Seed testa colour	Seed coat colour
AHDB-2	Climbing	Light green	L, P, I, M	Dark purple	Purple	Light green*	Sickle	Smooth, glossy	Pendent	Kidney, long	Whitish green	Dark brown - yellowish
AHDB-3	Climbing	Green	--	Dark purple	Purple	Green	Slightly sickle	Smooth, glossy	Pendent	Kidney, long	Greenish white	Dark brown-greenish
AHDB-6	Climbing	Dark green	I	Dark purple	Purple	Dark green	Sickle curved	Smooth, glossy	Pendent	Kidney, long	White	Dark brown-black
AHDB-7	Erect	Light green	--	Whitish green	White	Whitish green	Sickle curved	Smooth, dull	Horizontal	Round	Whitish brown	Greenish
AHDB-9	Climbing	Dark green	L, P, I, M	Dark purple	Purple	Whitish green*	Straight	Rough, glossy	Pendent	Reniform, kidney	Whitish green	Dark black-brown
AHDB-12	Semi-erect	Green	--	Whitish green	White	Whitish green	Sickle curved	Smooth, dull	Horizontal	Kidney	White	Greenish
AHDB-13	Climbing	Dark green	--	Greenish white	White	Light green	Slightly sickle	Smooth, dull	Horizontal	Kidney	Whitish green	Yellowish
AHDB-15	Climbing	Green	--	Greenish white	White	Light green	Slightly sickle	Smooth, glossy	Pendent	Kidney	Whitish yellow	Creamy white
AHDB-16	Climbing	Dark green	--	Greenish white	White	Light green	Slightly sickle	Smooth, glossy	Pendent	Kidney	Whitish green	Yellowish-white
AHDB-17	Climbing	Green	--	Whitish green	White	Light green	Sickle	Smooth, glossy	Pendent	Kidney	White	Creamy white
AHDB-18	Climbing	Dark green	--	Whitish green	White	Light green	Sickle	Smooth, dull	Pendent	Kidney	Whitish yellow	Yellowish-white
AHDB-19	Climbing	Green	L, P, I	Dark purple	Purple	Green	Sickle	Rough, dull	Pendent	Kidney	Whitish yellow	Creamy white

Pigmentation at leaf stalk base(L), base of primary branches(P), inter-nodal region(I), base of middle rib of leaflets(M) and fresh pod(*).

Table-2: Growth, pod quality and yield contributing characters of Indian bean genotypes.

Genotype	Flowers /floret	Pods /floret	Fresh pod weight (g)	Pod length (cm)	Pod width (cm)	Seeds /pod	Fresh seed weight/ pod (g)	Seed length (cm)	Days to flower (DAS)	Days to harvest (DAS)	Pods/ plant	Pod yield/ plant (g)	Plant height (m)	Inter-nodal length (cm)
AHDB-2	8.46	3.10	3.15	8.46	0.83	4.10	1.62	1.33	130.00	152.33	60.66	185.5	2.13	10.26
AHDB-3	8.93	4.33	8.47	13.55	0.98	5.03	1.81	1.55	125.67	150.60	85.00	698.3	2.82	15.67
AHDB-6	5.66	3.20	8.12	13.17	0.81	4.16	1.76	1.42	110.66	134.25	35.00	104.6	3.24	16.53
AHDB-7	12.43	7.73	1.84	4.15	0.75	4.13	1.25	0.75	85.33	98.33	78.00	147.7	0.95	5.23
AHDB-9	4.56	2.13	8.08	11.85	2.50	4.66	1.84	1.35	111.66	136.30	18.12	144.1	2.52	11.50
AHDB-12	7.60	4.06	2.19	4.52	0.72	3.10	1.19	0.96	120.33	139.66	87.33	191.6	1.51	8.13
AHDB-13	10.86	4.43	7.07	9.03	1.62	4.20	1.78	1.25	89.66	125.00	70.66	489.7	3.46	11.30
AHDB-15	9.33	5.50	6.54	9.24	1.74	5.03	1.72	1.14	83.33	98.67	107.05	707.6	3.13	15.33
AHDB-16	14.53	6.66	7.09	9.67	1.70	5.11	1.76	1.32	81.33	96.33	116.00	818.0	3.24	8.83
AHDB-17	14.43	4.10	5.60	8.25	1.84	4.91	2.35	1.45	94.25	130.65	70.66	404.2	3.56	10.96
AHDB-18	13.73	4.0	6.45	9.06	1.61	5.20	2.13	1.23	98.00	125.00	65.00	419.1	3.56	10.23
AHDB-19	3.40	1.16	4.69	10.12	1.64	5.40	2.06	1.32	141.00	167.67	12.67	58.0	4.12	13.53
CD(5%)	0.57	0.28	0.22	0.26	0.05	0.27	0.13	0.06	4.27	5.27	6.48	16.64	0.18	0.68
CV(%)	3.6	4.1	2.3	1.7	2.0	2.5	4.5	3.1	2.4	2.4	5.7	2.7	3.7	3.5

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Influence of inorganic fertilizers, organic manures and bio-fertilizers on quality of winter season guava (*Psidium guajava* L.) cultivar "L-49" grown under system of HDP.

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Abstract

Eighteen-year-old plants of guava cv. 'L-49' were subjected to various treatments comprising organic manures, inorganic fertilizers and *PSB* i.e., 100, 50 and 25 per cent of recommended dose of NPK, FYM @ 75 kg per plant, vermicompost @ 10 kg per plant, *neemcake* @ 5 kg per plant, *PSB* @ 20 g per plant. In this way, total 14 treatments were used in the present study. The results revealed that all the treatments had significantly increased the quality of fruits over absolute control. Further, the application of organic manures was found significantly superior over 100 per cent recommended dose of NPK. Among the different organic manures used in the present study, the application of vermicompost @ 10 kg per plant significantly improved fruit quality in terms of TSS (14.75 %) , acidity (0.434%), ascorbic acid (207.4 mg/100 g pulp) and TSS : acid ratio (34.71) as compared to FYM @ 75 kg per plant and *neemcake* @ 5 kg per plant treatment. Among the different levels of recommended dose of NPK, the application of 50 per cent recommended dose of NPK treatment also improve the quality of fruits as compared to 25 per cent recommended dose of NPK. Similarly, the application of *PSB* @ 20 g per plant was found to be superior with respect to quality of fruits in level of significance.

Key words: *Guava, organic and inorganic nutrition, chemical characteristics*

Introduction

Guava is the most important, highly productive, delicious and nutritive fruit of tropical and sub tropical regions. It is a good source of calcium and iron, fair source of phosphorus and a rich source of vitamin C and pectin. It is enjoyed both as fresh as well as in processed form. In north Indian agro-climatic conditions, guava flowers twice in a year i.e., April-May for rainy season crop and then, in August-September for winter season crop. Generally, fruit yield is more in rainy season crop as compared to winter season crop, but are poor in quality. During the last 50 years, considerable research has been done in the country on various aspects of guava cultivation such as varieties, propagation, irrigation, training and pruning etc. to increase the yield and quality of guava fruits. The production of poor quality fruits is a matter of common experience. It would therefore be worthwhile to improve the productivity of guava by nutrient management. Guava is reported to develop characteristic deficiency symptoms with reduced yield in the absence of macro nutrients N, P, K, Ca, Mg, S and the micronutrients Zn, Bo, Mn, Fe, Cu, Mo. Many of these nutrients are made available by the soil depending upon physical and chemical properties. However, in production system management, which aims to achieve targeted yield, required quantity of above mineral nutrients are desirable to be supplied. It is essential that optimum quantity of nutrients is applied with best sources, at appropriate time, to achieve targeted production. Of late, the use of organic manure along with biofertilizers and inorganic fertilizers, as a cheap source of available nutrients to plants, has resulted in beneficial effects on growth, yield and quality of various fruit crops. Wagh and Mahajan (1985) reported better growth and higher yield in 'Sardar' guava receiving N, P_2O_5 and K_2O at 600, 300 and 300 g per plant, respectively, along with 25 kg FYM in Maharashtra conditions. Ram and Rajput (2000) recorded the maximum TSS and acidity in guava cv. 'Allahbad Safeda' by application of FYM along with *Azotobacter*. It can, therefore, conclusively be said that guava plants responds to integrated nutrient management under different agro-climatic and soil conditions in respect to yield and quality.

Materials and methods

The studies were carried at Instructional Farm, Department of Horticulture, Rajasthan College of Agriculture, M.P.U.A.T., Udaipur during two successive years i.e. 2005-06 and 2006-07 in which 18 years old guava plants of uniform size and growth were selected. In all 56 uniform plants were selected from the guava block (6x3 m spacing) for this study. The selected plants were moderately pruned. The experiment comprised of fourteen treatment combinations consisting of inorganic fertilizers (NPK), organic manures (FYM, *neemcake* and vermicompost) and bio-fertilizer (*PSB*). The experiments were laid out in a completely randomized design with fourteen replications.

Result and discussion

The results obtained in present investigation reveal that the application of inorganic fertilizers, organic manures and PSB had significantly improved nutritional quality of guava fruits in terms of TSS, acidity, TSS/acid ratio ascorbic acid and sugar content as compared to control (Table 1). It is further evident from the data that application of organic manure found significantly superior over inorganic fertilizers treatment. However, among various organic manure treatments, the application of vermicompost @ 10 kg per plant was found to be best treatment as compared to others with respect to nutritional quality parameters of the fruit. The maximum TSS content of 14.75 percent and minimum acidity of 0.434 percent (Table 1) were recorded due to application of vermicompost @10 kg per plant treatment. Similarly, this treatment also exhibited highest TSS /acid ratio of 34.71 (Table 1). The present results on TSS, acidity and TSS/acid ratio close accordance with those of Rathore and Dhyani (2005) in guava, who reported that application of poultry manure + vermicompost + FYM resulted in enhancement of fruit quality but has less effect on productivity. Similarly, Athani et al. (2005) recorded maximum TSS content of fruit with the application of 75 percent RDF +10 kg vermicompost followed by the treatment in situ vermiculturing @50 worms per plant and 100 percent RDF.

The application of inorganic fertilizer at different levels also significantly influenced the TSS, acidity and TSS/acid ratio. The higher TSS content of 15.11 percent (Table 1) lowest acidity of 0.396 percent (Table 1) and maximum TSS /acid ratio 38.38 (Table 1) were recorded due to application of 50 percent recommended dose of NPK treatment. As compared to lowest TSS (13.80 percent) (Table 1), highest acidity and minimum TSS/acid ratio (27.97) (Table 1) at 25 percent recommended dose of NPK treatment. The improvement in fruit quality by an increase in TSS content of fruits might have been due to beneficial role of nutrients on the process of photosynthesis which ultimately led to the accumulation of large amount of carbohydrates and there by increase TSS content of fruits. The acidity of guava fruit significantly decreased with the application of nutrients might be due to increase in sugar content with the application of nutrients. Wahid et al. (1991) reported that nitrogen treatments improved fruit quality by increasing the TSS, sugar, ascorbic acid and decreasing acidity of fruits. The upsurges in TSS, TSS/ acid and decrease in acidity of guava fruits due to application of NPK have also been reported by Rathore and Dhyani (2005) in guava. The results obtained by Mitra and Bose (1985) in guava are also in accordance with present findings.

Similarly, the application of PSB had significantly increased TSS and TSS/acid ratio and decreased acidity of fruit The maximum TSS of 14.72 percent (Table 1), minimum acidity of 0.429 percent (Table 1) and highest TSS /acid ratio of 35.10 (Table 1) were recorded at the application of *PSB* @ 20 g per plant which were significantly higher than without *PSB* treatment. The beneficial effect of *PSB* on fruit quality with respect to TSS and acidity might be due to phosphate solubilising bacteria that solubilise the insoluble forms of phosphorus and make them available to the plants. The mechanism of

Details of the treatments are as follow:

S. No.	Treatments	Notation
1.	Absolute control	T_0
2.	Recommended dose of NPK (500:200:500 g/plant)	T_1
3.	FYM 75 kg + 50% recommended NPK (250:100:250 g/plant)	T_2
4.	FYM 75 kg + 50% recommended NPK (250:100:250 g/plant) + *PSB* (20 g/plant)	T_3
5.	FYM 75 kg + 25% recommended NPK (125:50:125 g/plant)	T_4
6.	FYM 75 kg + 25% recommended NPK (125:50:125 g/plant) + *PSB* (20 g/plant)	T_5
7.	*Neemcake* 5 kg + 50% recommended NPK (250:100:250 g /plant)	T_6
8.	*Neemcake* 5 kg + 50% recommended NPK(250:100:250 g /plant) + *PSB* (20 g/plant)	T_7
9.	*Neemcake* 5 kg + 25% recommended NPK (125:50:125 g/plant)	T_8
10.	*Neemcake* 5 kg + 25% recommended NPK (125:50:125 g/plant) + *PSB* (20 g/plant)	T_9
11.	Vermicompost 10 kg + 50% recommended NPK(250:100:250 g /plant)	T_{10}
12.	Vermicompost 10kg+50% recommended NPK(250:100:250 g/plant)+*PSB*(20 g/plant)	T_{11}
13.	Vermicompost 10 kg + 25% recommended NPK (125:50:125 g/plant)	T_{12}
14.	Vermicompost 10 kg + 25% recommended NPK (125:50:125 g/plant) + *PSB* (20 g/plant)	T_{13}

stabilization appears to be acid metal reaction and thus dissolution and chelation of metal and release of phosphorus. These are also known to produce acids, vitamins growth promoting substances like IAA, GA3 etc. which might have improved the quality of fruits (Kashyap et al., 2004)

The application of organic manure had significantly increased the ascorbic acid content of the guava fruit (Table 1). Among the various organic manure treatments the maximum ascorbic acid (207.4mg/100g pulp) (Table 1) was recorded for vermicompost @ 10 kg per plant treatment followed by FYM @ 75 kg per plant (200.8mg/100g pulp) (Table 1). Where as, the minimum ascorbic acid content of 196.5 mg per 100g pulp (Table 1) was recorded for *neemcake* @ 5 kg per plant treatment. Similar beneficial effect of organic manure on vitamin 'C' content of fruit was recorded by Pereira and Mitra (1999), who reported higher vitamin 'C' content (130.0mg/100g pulp) in fruits harvested from the plants receiving only FYM of 30 kg per plant. The present results were in accordance with the findings of Naik and Babu (2005), Athani et al. (2005) and Madhavi et al. (2005) in guava cv. 'Sardar'. The highest amount of ascorbic acid (2.61mg/100ml juice) was also recorded for vermicompost treated fruits in grape by Venkatesh et al. (1998).]

However, among the different treatments of inorganic fertilizer attempted in the present study, the application of higher dose of NPK (50% recommended dose of NPK) resulted higher ascorbic acid content (206.3mg/100g pulp) (Table 1) as compared to 25 per cent recommended dose of NPK treatment (196.9mg/100g pulp) (Table 1). Uma Shankar et al. (2002) was recorded higher ascorbic acid content of guava fruit with the application of NPK at 225g,150g and 150g and 225g, 150g and 225g per plant respectively. Similar results were recorded by Sen and Chauhan (1983) in guava. Similarly, the maximum ascorbic acid content of 204.5 mg per 100g pulp (Table 1) was recorded at with *PSB* treatment (20g/plant) as compared to minimum (198.8mg/100g pulp) at without *PSB* treatment in the present study (Table 1).

The sugar content (reducing, non- reducing and total sugar) of guava was significantly influenced with the use of different organic manure treatments. The maximum quantity of reducing sugar of 4.39 per cent (Table 2), non reducing sugar of 2.95 per cent (Table 2) and total sugar of 7.50 per cent (Table 2) were recorded at vermicompost @ 10 kg per plant treatment. Where as, the application of

Table1. Effect of inorganic fertilizers, organic manures and *PSB* on TSS, Acidity, TSS /acid ratio and Ascorbic acid content of guava fruits cv. "L-49".

	Treatments	Total soluble solids (%)	Acidity (%)	TSS /acid ratio	Ascorbic acid (mg/100 g pulp)
(A)	Absolute control v/s treatment				
	Absolute control	11.27	0.664	17.01	166.0
	Treatments	14.30	0.455	32.35	200.2
	F cal	Sig.	Sig.	Sig.	Sig.
(B)	Inorganic fertilizers v/s organic manures				
	100 % Recommended dose of NPK	12.50	0.559	22.41	183.3
	Organic manures (OM)	14.45	0.446	33.18	201.6
	F cal	Sig.	Sig.	Sig.	Sig.
(C)	Organic manures				
	FYM @ 75 kg/plant	14.40	0.457	32.39	200.8
	Neemcake @ 5 kg/plant (NC)	14.21	0.448	32.43	196.5
	Vermicompost @ 10 kg/plant (VC)	14.75	0.434	34.71	207.4
	SEm ±	0.11	0.004	0.39	1.9
	CD at 5%	0.30	0.011	1.09	5.4
(D)	Inorganic fertilizers				
	50% Recommended dose of NPK	15.11	0.396	38.38	206.3
	25% Recommended dose of NPK	13.80	0.496	27.97	196.9
	SEm ±	0.09	0.003	0.32	1.6
	CD at 5%	0.24	0.009	0.89	4.4
(E)	*PSB*				
	Without *PSB*	14.19	0.464	31.26	198.8
	With *PSB* @ 20 g/plant	14.72	0.429	35.10	204.5
	SEm ±	0.09	0.003	0.32	1.6
	CD at 5%	0.24	0.009	0.89	4.4

Sig. = Significant

neemcake resulted minimum sugar content of fruit. Venkatesh et al. (1983) also recorded the highest quantity of total sugar wit the application of vermicompost +25 per cent recommended fertilizer rates in grape. Similar beneficial effect on sugar content due to vermicompost was recorded by Rathore and Dhyani (2005) and Madhavi et al. (2005) in guava. Similarly, the application of different levels of recommended dose of fertilizer significantly influenced the sugar content of guava fruits. The application of 50 per cent recommended dose of NPK increased reducing sugar (4.41%) (Table 2), non-reducing sugar (3.01%) (Table 2) and total sugar (7.57 %) (Table 2) content as compared to 25 per cent recommended dose of NPK treatment. The present results are in accordance with the findings of Uma Shankar et al. (2002), Kumar et al. (2005) in guava. The data further reveal that the application of *PSB* had significantly affected on reducing, non-reducing and total sugar content of guava fruit. Where highest reducing sugar (4.39 %) (Table 2), non-reducing sugar (2.91 %) (Table 2) and total sugar content (7.45 %) (Table 2) was recorded at with *PSB* @ 20g per plant treatment as compared to lowest at without *PSB* treatment.

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Table 2. Effect of inorganic fertilizers, organic manures and *PSB* on reducing sugar content of guava fruits cv. "L-49".

	Treatment	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
(A)	Absolute control v/s treatment			
	Absolute control	3.70	2.52	6.35
	Treatments	4.26	2.82	7.22
	F cal	Sig.	Sig.	Sig.
(B)	Inorganic fertilizers v/s organic manures			
	100 % Recommended dose of NPK	3.99	2.65	6.79
	Organic manures (OM)	4.28	2.83	7.26
	F cal	Sig.	Sig.	Sig.
(C)	Organic manures			
	FYM @ 75 kg/plant	4.28	2.87	7.30
	Neemcake @ 5 kg/plant (NC)	4.17	2.68	6.99
	Vermicompost @ 10 kg/plant (VC)	4.39	2.95	7.50
	SEm ±	0.03	0.02	0.04
	CD at 5%	0.09	0.06	0.12
(D)	Inorganic fertilizers			
	50% Recommended dose of NPK	4.41	3.01	7.57
	25% Recommended dose of NPK	4.15	2.66	6.95
	SEm ±	0.03	0.02	0.03
	CD at 5%	0.07	0.05	0.09
(E)	*PSB*			
	Without *PSB*	4.17	2.76	7.07
	With *PSB* @ 20 g/plant	4.39	2.91	7.45
	SEm ±	0.03	0.02	0.03
	CD at 5%	0.07	0.05	0.09

Sig. = Significant

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Studies on propagation of aonla under Paschimanchal condition of West Bengal.

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Abstract

A study was carried out in a private orchard in Paschim Midnapore district of West Bengal during the period 2006-2008 to find out the best time for propagation of aonla in nursery and field. Another investigation was also made to find out the compatibility of seven cultivars of aonla to wedge grafting in nursery, using rootstock of 'local' cultivar. Results indicated that wedge grafting to be the best in nursery propagation as it gave higher success (60 to 70 per cent) for a longer period (45th August to 25th September) as compare to budding. The growth of the plant was better when operation was performed in early part of monsoon (*i.e.*, June) in both the cases of budding and grafting. *In-situ* propagation of aonla considered to be the best way for raising orchard as compare to nursery propagation as it resulted highest success (80%) with better plant growth and suitable time was the last week of June and first week of August. Regarding compatibility of the cultivars to wedge grafting with local cultivar, NA-10 found to show best result by giving 70% success followed by BSR-1, Chakaiya and Neelum (50% success). Growth of the grafted plants was good in most of the cultivars.

Key words: Aonla, budding, wedge grafting, nursery, field, Paschimanchal.

Introduction

For versatile use with nutritive and high medicinal values, cultivation of aonla has been gaining popularity mainly in marginal and waste lands where other crops even many fruit crops are difficult to grow. It is well known that varietal specification is the foremost task for commercialization of any crop for a locality. In aonla a number of varieties have been recommended for various agro-climatic zones of India (Ghosh *et al.*, 2003; Chezhiyan and Shanmugasundaram, 2003; Singh *et al.*, 2003). It is experienced that availability of sufficient number of good planting materials of recommended cultivars is one of the major problem in fruit cultivation and it is quite true for West Bengal. For production of sufficient planting materials or raising of aonla orchard in degraded soil, best time and method of propagation should be known for commercial multiplication of the crop as it is varied from region to region (Patil, 2004; Tewari *et al.*, 2005; Panchbhai *et al.*, 2006). Incompatibility in grafting is now considered to be one of the common problems for poor success in many fruit crops (Ghosh and Tarai, 2005; Shirol *et al.*, 2005) and very less report on graft-compatibility of various aonla cultivars is available. With the view to above discussed problem, an propagation investigation was undertaken to standardize the propagation package of aonla for Paschimanchal of West Bengal. The Paschimanchal of West Bengal include the districts of Paschim Midnapore, Bankura, Purulia, Birbhum and part of Burdwan where the soil is red and laterite and receive low precipitation.

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Materials and methods

The experiment was conducted in a nursery of private farm at Jhargram in Paschim Midnapore district of West Bengal during the monsoon period of 2006 and 2008. The soil in the area of study was laterite and climate is dry, sub-tropical in nature. Meteorological data during the course of study has been presented in Table 1. To standardize the season for commercial multiplication of aonla in nursery, the seedlings of local rootstock were raised in perforated black polythene packets (25 cm x 15 cm). Budding and grafting operation was carried out on one year old rootstock seedlings, using 'NA-10' scion. The operation was carried out on 10 and 25th dates of each

month of June to October of 2006 and 2007. In each time 50 seedlings were used in each case which were replicated three time in a randomized block design. The budding was done under open sunlight condition as it was found to be the best as compare to full or partial shed condition. In case of grafting, the grafted plants were kept under full shade for 21 days after operation and then shifted to open sunlight. The ploy-cap (pepsi cap) was used to cover the grafted scion for increasing humidity around the graft-union. The poly-cap was removed, when scion sprouted well, which generally took 8-15 days. Success and plant growth in budding and grafting were recorded 3 months after operation.

To know the best time of *in-situ* propagation in field, budding was done on one year old rootstock seedlings of local cultivar, grown in open field condition at a spacing of 60 cm x 60 cm. The operation was carried out on 10th and 25th dates of each month of June to October of 2006 and 2007. Fifty seedlings of *in-situ* grown was patch budded with scions of NA-10 cultivar of aonla which were replicated three time in a randomized block design. Budding success and budling growth was recorded, three month after operation.

To know the varietal response to wedge grafting, scions of seven cultivars *viz.*, Anand-1, BSR-1, Chakaiya, Kanchan, Krishna, NA-10 and Neelum were grafted on rootstocks of local cultivar of 12 month old on 25th August of 2007 and 2008 under nursery condition. The data on grafting success and plant growth was taken in both the years and average data has been presented in the paper.

Results and discussion

To get maximum success with better plant growth, information on exact time and method of propagation of aonla grown in poly packets is paramount importance for successful nursery business in a locality. The results presented in Table 2, clearly indicated that grafting gave higher success as compare to budding irrespective of time of operation except on 10th June and 10th August. Patil (2004) from Maharashtra also found wedge grafting was better as compared to budding in aonla and the operation time, mid August was the best followed by July. However, Tewari *et al.* (2005) from Jhansi (Uttar Pradesh) reported that bench grafting with softwood cleft grafting during February would be the best as it gave 85% success in seedlings, grown in poly packets in nursery. It was noted that 25th August was the best time for nursery propagation in aonla under present situation as highest success was noted both in budding (60%) and grafting (70%) at that time. Higher propagation success during the period of 25th August to 10th September was due to better physiological condition of scion and rootstock and congenial atmospheric condition. Singh *et al.* (2003) also observed highest success in patch budding when performed during last week of August under Hisar (Haryana) condition. But under Faizabad (Uttar Pradesh) condition last week of June reported to be the best (Srivastava *et al.*, 2002). It is cleared from the discussion that method and time of operation for getting maximum success is varied from place to place. It was further noted that success was low during the period 10th July to 10th August both in budding and grafting.

The growth of successful plants in respect of height and leaf number was more in grafted plants as compared to budding irrespective of time of operation (Table 2). The growth of the plant was maximum when operation was made in June (10th and 25th) followed by 25th August in both the cases of budding and grafting and this may be due to higher atmospheric temperature, that caused more cell division and enlargement at faster rate.

In West Bengal, aonla has been cultivated mainly in red and laterite zone (Paschimanchal) where the soil is porus, low water holding capacity and the zone receives low precipitation. Raising of orchard in such adverse situation, with poly packet grown seedlings, may result poor field establishment due to damage of tap root system. *In-situ* raising of orchard in such peculiar situation is to be real solution. The data of two years of investigation showed an encouraging result (Table 2). Highest success (80%)

Table 1. Meteorological data at the experimental site during the period of investigation (Average of 2006 and 2007).

Time	Rainfall (mm)	No. of rainy days	Temperature (°C)		Humidity (%)	
			Maximum	Minimum	7.00 am	2.00 pm
1st June to 15th June	126.0	9	40.5	24.6	92.0	67.0
16th June to 30th June	498.0	12	34.9	24.7	89.0	79.7
1st July to 15th July	76.6	9	34.8	25.8	88.7	74.7
16th July to 31st July	55.0	8	34.8	25.8	89.0	76.0
1st August to 15th August	157.1	11	36.1	26.1	93.0	80.3
16th August to 31st August	129.9	10	35.8	25.3	93.7	79.3
1st Sept. to 15th September	84.1	8	35.7	25.2	90.0	75.3
16th Sept. to 30th September	167.0	8	35.7	24.6	89.4	75.3
1st October to 15th October	50.8	4	35.9	23.6	89.3	60.0
16th October to 31st October	0.0	0	35.8	20.8	86.0	53.3

Table 2. Effect of season on success of budding and grafting of aonla cv. NA-10 in nursery and field.

Time of operation	Propagation in nursery seedlings, raised in polybags*						Propagation in field (*In-situ*) by budding*		
	Budding			Grafting					
	Success (%)	Height (cm)	Leaf number	Success (%)	Height (cm)	Leaf number	Success (%)	Height (cm)	Leaf number
10th June	40 (39.23)	20	30	30 (33.21)	24	40	40 (39.23)	27	33
25th June	20 (26.57)	15	20	45 (42.13)	30	60	80 (63.43)	32	38
10th July	10 (18.43)	1	5	20 (26.57)	20	30	40 (39.23)	17	18
25th July	0 (0.0)	-	-	10 (18.43)	10	12	60 (50.77)	15	20
10th Aug.	25 (30.00)	2	6	10 (18.43)	12	14	80 (63.43)	33	35
25th Aug.	60 (50.77)	11	18	70 (56.79)	22	22	20 (26.57)	4	13
10th Sept.	40 (39.23)	4	8	65 (53.73)	20	22	0 (0.00)	-	-
25th Sept.	20 (26.57)	1	3	60 (50.77)	10	16	0 (0.00)	-	-
10th Oct.	0 (0.00)	-	-	40 (39.20)	2	8	0 (0.00)	-	-
C.D. at 5%	6.60	3.5	3.1	4.30	4.8	8.0	7.80	3.2	5.1

* Average of two years. Figures in the brackets are angular transformed values.

Table 3. Response of different cultivars of aonla to wedge grafting.

Cultivars	Success (%)	Plant growth – 3 months after grafting	
		Height (cm)	Leaf number
Anand-1	10 (18.43	20.0	21.5
BSR-1	50 (45.00)	35.2	26.2
Chakaiya	50 (45.00)	19.0	15.2
Kanchan	15 (22.79)	23.0	11.3
Krishna	35 (36.27)	15.2	11.8
NA-10	70 (56.79)	24.2	23.2
Neelum	50 (45.00)	18.3	17.2
C.D. at 5%	4.8	0.8	2.6

Figures in the brackets are angular transformed values.

with maximum plant growth was achieved in *in-situ* when budding was done on 25th June and 10th August followed by 25th July (60%). It was very interesting to note that budding during 25th June to 10th August, which resulted low success in poly packet grown seedlings, gave higher percentage of success in *in-situ* grown seedlings in field. This reason may be explained from the fact that *in-situ* grown seedlings have good tap root system that help to supply better nutrients and moisture to the stock plant and thereby improve physiological condition of the plants. Better physiological status of stock plant of *in-situ* grown seedlings, would result better cambium activity and help to show good success after budding. Dixit *et al.* (1996) from Gujarat also observe higher success with better plant growth in *in-situ* patch budded plants as compared to pot-grown seedlings at the same time of operation. *In-situ* raising of aonla orchard through patch method of budding in second week of September has also been advocated by Kumari *et al.* (2004) for area extension in Haryana.

The results of response of aonla cultivars to wedge grafting on rootstocks of local cultivar have been presented in Table 3. Maximum budding success of 70% was noted in NA-10 followed by 50 per cent in BSR-1, Chakaiya and Neelum. Lowest success (10%) was observed in Anand-1 followed by Kanchan (15%). Good budding success in cultivars like NA-10, BSR-1, Chakaiya and Neelum may be due to cambium continuity which is always observed in compatible graft unions (Ermel *et al.*, 1995). Shete *et al.* (1999) also noted differential budding success of aonla cultivars on local rootstock under Rahuri (Maharashtra) condition. Highest plant height (35.2 cm) and maximum leaf number (26.2) was recorded from cultivar BSR-1 followed by NA-10 having height of 24 cm and leaf number of 23.2, recorded three months after budding. Highest plant growth in BSR-1 may be due to higher activity of meristematic tissues which is seemed to be inherent nature of the cultivar concerned.

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Effect of pruning intensity on fruit yield and quality of guava (*Psidium guajava* L.) cv. Sardar

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Abstract

An experiment was conducted on fifteen-year-old guava (*Psidium guajava* L) plants of cultivar '*Sardar*' planted at 6.5 m x 6.5m at Punjab Agricultural University, Regional Station, Bathinda (Punjab), India. The pruning of plants was done in the first week of March, 2004 with three pruning intensities/levels viz. 15 cm, 30 cm and 45 cm from the shoot tips leaving the unpruned trees as a control. The fruit yield and quality characters were recorded for both rainy season (RS) and winter season (WS) crops. It was observed that the fruit set was significantly higher in pruned trees at 30cm and 45 cm levels as compared to unpruned and lightly pruned trees in WS crop. The maximum number of fruits (430 and 496) and yield (72.2 and 82.3 kg) per tree were recorded in the plants pruned at 15cm level followed by unpruned trees in both WS and RS crops respectively. In both crops, the size of fruits was maximum in trees pruned at 45 cm level followed by 15 cm level and minimum in unpruned trees. An ascending trend of fruit weight with increase in pruning intensity was observed i.e. the weight of fruits was recorded approximately 30 percent more (168.0, 168.1, 170.2g and 168.4, 169.8, 172.3g at 15, 30, 45cm pruning intensities for both RS and WS crops respectively as compared to unpruned {130.4 (RS) and 127.2g (WS)} guava trees. Total Soluble Solids (TSS) percentage was comparatively more (ranging between 10.4 to 11.1 and 10.8 to 11.5 in RS and WS crop, respectively) in the fruits of pruned trees and was least (9.7 and 10.2 in RS and WS crop, respectively) in unpruned trees. Although, acidity in fruits taken from all the pruned trees was at par but higher than the fruits from unpruned trees. The number of seeds in fruits of pruned trees at 15 cm level was significantly higher than fruits obtained from other pruned trees. On the basis of the present study it may be concluded that guava plants respond positively to lighter pruning intensities.

Key words: Guava pruning, quality, yield

Introduction

Pruning helps in maintaining the root to shoot ratio and improves fruit yield and quality. When the shoots are not pruned judiciously, the limited root system is not able to meet the nutrient requirements of the top. Extensive vegetative growth leads to unfruitfulness thereby decreasing the yield considerably with sub-optimal fruit quality. In India, studies have been conducted to standardize pruning in guava (Dalal et al., 2004, Dhaliwal and Kaur, 2003 and Gopi Krishan, 1981). However, pruning of guava is not yet been undertaken commercially due to the fact of being an evergreen fruit plant guava does not extend much growth annually. Judicious pruning can be useful to make guava trees bear profitable crops year after year. Guava is one of the major fruit crops of the arid irrigated region of North West India. In this region, till now no study has been conducted to standardize the pruning intensity for guava. Hence, the present studies were undertaken to study the effect of pruning intensity on fruit yield and quality of guava cv. *Sardar.*

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Material and methods

The present investigations were conducted during the year 2004-05 under the arid –irrigated region of Punjab state of India. Three pruning intensities viz. 15, 30 and 45cm from the shoot tips were compared with no pruning in fifteen-year-old grafted plants of guava cv. *Sardar.* There were three replications, with three trees per replication in a randomized block design. The percent fruit set was recorded one month after anthesis from four tagged shoots by dividing the number of flowers counted on the same branch and multiplied by 100, gave the percent fruit set. Average fruit weight was calculated by taking the mean of ten randomly selected fully mature fruits. Fruit yield per tree was calculated by multiplying the number of fruits with average fruit weight. Observations on the total soluble solids and acidity were recorded as per the standard methods (A.O.A.C.,1980)

Results and discussion

Fruit set

Data in Table 1 shows an increasing trend in per cent fruit set with an increase in the pruning intensity. Similar trend was observed in both the seasons. The unpruned trees have shown minimum fruit set of 62.5 per cent and 59.8 percent in rainy season (RS) crop and winter season (WS) crop, respectively. The increase in fruit set with the pruning intensity as compared to the unpruned trees indicates that pruning resulted in the production of new growing points on the pruned trees. Further, it also reduced flower drop, thus directly increasing the number of fruits per tree and resulting in higher fruit set. These results are in line with the findings of Awasthi and Mishra (1969) in jujube and Arora and Yamdagini (1985) in sweet lime. In guava, Dalal *et al.* (2004) have also reported highest fruit set with heavy pruning. However, the results are contrary to the findings of Lotter and Lotter (1990) who found a reduction in fruit set following summer pruning in guava.

Number of fruits

Present investigation reveals that the number of fruits was maximum (430 and 496 in both rainy as well as winter season, respectively) in the trees pruned at 15 cm (Table 1). The number of fruits was reduced significantly with an increase in pruning intensity (30 cm and 45 cm). Minimum number of fruits (270 and 403 in RS and WS, respectively) was found with the highest pruning level of 45 cm. The numbers of fruits in unpruned trees was at par with 15 cm pruning level in WS but 20 per cent higher in RS crop. The increase in number of fruits at light pruning intensity (15 cm) might be due to the optimum balance between the vegetative and reproductive growth of trees. The lesser number of fruits per tree with the increase in pruning intensity may be due to loss of bearing area on the trees. The present findings regarding the lesser number of fruits per tree at higher pruning intensities and maximum numbers of fruit in unpruned tree are in conformity to the findings of Bajpai *et al.* (1973). Similarily, Dalal *et al.* (2004) observed that with an increase in pruning intensity numbers of fruits per tree were reduced and the yield was maximum with medium pruning level.

Fruit yield

Substantial increment in yield per tree was obtained with 15 cm level of pruning (72.24 and 82.31 kg per tree) followed by 49.60 and 74.14 Kg at 30 cm level in RS and WS, respectively (Table 1). Minimum yield (45.2 kg) in rainy season was obtained with 45 cm pruning level. In winter season, minimum yield (62.2 kg) was obtained with unpruned trees. The decline in yield at higher pruning intensities may be due to the loss of bearing area on the trees. However, increase in yield at light pruning (15 cm) can be attributed to higher fruit size and weight. The present findings are in accordance with the findings of Dalal *et al.* (2004) who obtained maximum yield with medium pruning treatment in guava. Similarly, Bajpai *et al.* (1981) observed an increase in yield following light pruning in guava. Mishra and Pathak (1998) have reported 3.5 times increase in yield with 50 per cent pruning in L-49 guava. Gopi Krishana (1981) and Manica *et al.* (1982) have found that the fruit yield per tree decreased with an increase in the severity of pruning in Guava.

Fruit size

A progressive increment in fruit size was observed with an increase in the pruning intensity (Table 2). The length and the breadth of the fruits obtained from pruned trees were significantly higher than the fruits from unpruned trees. Maximum fruit length (7.05 cm both in RS and WS) was recorded in trees pruned at 45 cm level followed by 15 cm level (6.92 and 7.02 cm in RS and WS, respectively). Similarly, the highest fruit breadth was obtained with 45 cm pruning intensity (6.70 and 6.55 cm, for RS and WS, respectively) followed by 7.02 and 6.65 cm at 15 cm level of pruning in RS and WS crops, respectively. In both the seasons, minimum fruit size was recorded in unpruned trees. These results may attributed to the reduction in crop load on pruned trees which resulted in the diversion of more translocates to the remaining fruits thereby increasing the fruit size. These results are in line with the findings of Bajpai *et al.* (1973) and Lotter and Lotter (1990), who also observed an increase in fruit size with increasing pruning intensities in guava. In a similar study, Dalal *et al.* (2004) reported an increase in individual fruit size with pruning intensity in guava.

Fruit weight

The fruit weight increased significantly with all the pruning intensities over control (Table 2). However, the pruning levels do not show any edge over each other as far as fruit weight is concerned. The highest fruit weight was recorded (170.2 and 172.3 g in RS and WS, respectively) from the trees pruned at 45 cm level. Fruits obtained from unpruned tress exhibit minimum fruit weight of 130.4 and 127.2 g in RS and WS, respectively. The production of heavier fruits on pruned trees can attributed to the lesser crop load, higher nutrient supply to the lesser number of fruits and proper partitioning of translocates to the vegetative and fruit growth. Sundarajan and Muthuswamy (1966) and Bajpai *et al.* (1973) also obtained increment in fruit weight with increase in severity of pruning intensity in guava. Dalal *et al.* (2004) obtained maximum fruit weight under medium pruning intensity of 3.0 cm thick shoot from the tip. Dhaliwal and Kaur (2003) obtained highest average fruit weight with pruning intensity of 30 cm.

Table 1. Effect of Pruning intensity on fruit yield and quality of guava (*Psidium guajava* L) cv. Sardar

Pruning intensity (cm)	Fruit set (%)		No. of Fruits / Tree		Yield / Tree (kg)	
	RS	WS	RS	WS	RS	WS
0	62.5	59.8	360	495	46.4	62.2
15	64.0	61.2	430	496	72.2	82.3
30	64.9	70.1	296	430	49.6	74.1
45	65.6	71.6	270	403	45.2	69.0
C.D. (p=0.05)	NS	3.88	14.68	11.31	5.53	4.72

Table 2. Effect of Pruning intensity on quality characters of guava(*Psidium guajava*.L) cv. Sardar

Pruning intensity (cm)	Fruit Size				Fruit weight (g)		Seed Number		TSS (%)		Acidity (%)	
	Length (cm)		Breadth (cm)									
	RS	WS	RS	WS	RS	WS	RS	WS	RS	WS	RS	WS
0	5.70	5.60	5.47	5.20	130.4	127.2	261	290	9.7	10.2	.25	.26
15	6.92											
30	6.75	7.02	6.65	6.51	168.0	168.4	272	307	11.1	11.5	.29	.30
45	7.05											
		6.45	6.32	6.21	168.1	169.8	268	270	10.4	10.8	.28	.28
		7.05	6.70	6.55	170.2	172.3	259	275	11.0	11.3	.28	.28
C.D. (p=0.05)	0.45	0.23	0.18	0.10	6.3	5.48	9.16	7.20	NS	0.8	.026	0.017

RS-Rainy Season WS-Winter Season

Seed number

During both the cropping seasons, 15 cm pruning level has shown a significant increase in seed number over the other treatments (Table 2). In this treatment, maximum number of seeds (272 and 307 in RS and WS crops, respectively) was observed in both rainy as well as the winter season crops. This may be due to the fact that the microclimate of tree canopy with light pruning was more favourable for pollen germination on the stigma or pollen tube penetration through the style. Deep penetration of dry winds in the tree canopy, which is a common feature of this arid irrigated zone, may have created an unfavorable condition for pollen germination and resulted in fruits with lesser seed number with pruning of higher intensities. Teaotia and Singh (1971) observed reduction in seed number in guava fruits with an increase in the severity of pruning.

Total soluble solids (TSS)

Increase in TSS content was observed with all the pruning treatments (Table 2). Fruits from the trees pruned at 15 cm level showed maximum TSS (11.1 and 11.5 per cent in RS and WS, respectively). The trees pruned at 45 cm followed it. The minimum TSS content (9.7 and 10.2 per cent for RS and WS, respectively) was observed in unpruned trees. Although, 30 cm level could not exhibit significant increase in TSS over 15 cm and 45 cm level yet, the TSS with this treatment was higher than that of fruits obtained from unpruned trees. The increase in TSS content in all the pruning treatments may be ascribed to the higher leaf to fruit ratio in pruned trees as compared to the unpruned trees. The increase in fruit TSS following pruning has been earlier reported by Awasthi and Mishra (1969) in jujube and Bajpai *et al.* (1973) in guava. In guava, Dhaliwal and Kaur (2003) have also reported highest average TSS content of fruits obtained from the trees pruned to 30 cm level.

Acidity

Data related to the fruit acidity have shown that under the entire pruning treatments acidity was at par with each other yet, significantly higher than control (Table 2). Maximum acidity was recorded from fruits obtained from 15 cm level of pruning in both RS and WS crops. Similar results have been reported by Patil *et al.* (1996) in Jujube.

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Pollen grain studies of guava genotypes in winter and rainy season crops

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Abstract

The pollen morphology and germination percentage of guava cultivars during two flowering seasons viz., spring (April-May) and autumn (August- September) were observed. Pollen grain germination was recorded best in two hours after pollination in 12 per cent sucrose solution. Pollen size as well as pollen tube length was recorded larger in cultivar Lucknow-49 as compared to other cultivars.

Key words: Guava, flowering seasons, pollen morphology and germination

Introduction

Guava (*Psidium guajava* L.) is an important fruit crop of tropical and subtropical region. It is aptly known as "Poor man's Apple" and "Apple of the Tropics". In India, it ranks 4th in total cultivated area under fruits after mango, banana and citrus, occupying an area of 0.19 millions hectares. However, guava is 5th most important fruit crop in production with a total production of 1.68 million tonnes (Anonymous, 2002). It occupies a premier position by virtue of its high food value (Kahlon *et al.*, 1987). Three flowering seasons for guava have been observed in the Indian peninsula, viz. ambe bahar, mrig bahar and hastha bahar.

The peak anthesis is found to occur between 5.00 and 6:30 AM in most of the varieties under south Indian conditions. In northern India, guava flowers twice in a year (in April–May and August-September). However, under north Indian conditions, anthesis occurs between 6.00 and 7:30 AM (Singh, 2002).

Only a few attempts to improve its varietal wealth have been made for north Indian conditions. The need for improvement of this fruit crop is therefore, imperative and requires active consideration. Hybridization is one of the most important methods for bringing improvement in the fruit crops. It requires proper study of flower biology (pollen morphology, germination) so crossing can do as per requirement.

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Materials and methods

Morphology of the pollens was measured with the help of an Ocular micrometer. Fertility of pollen grains was tested in sucrose solutions of different concentrations at three different time intervals. The pollen grains were cultured in sucrose concentration of 10, 12 and 14 per cent at three different time intervals viz. Pollen collected immediately, two hours and four hours after opening of flowers.

Pollen tube length

Pollen tube length was recorded from the Petri dishes prepared for pollen germination record. Pollen tube length was measured with the help of Ocular micrometer. Average of thirty germination pollens was calculated and expressed as tube length in microns (μ).

Pollen germination assay:

At the flowering stage, flowering buds were collected randomly a day before anthesis from three different plants of each cultivar. The pollen grains from these flowers were mixed thoroughly on a glazed paper and sprinkled with the help of a camel hairbrush on the surface of semisolid germination medium contained in Petri Plates. The composition of the medium was as given below:

Sucrose	=	35 %
Boric acid	=	100 ppm
Calcium nitrate	=	100 ppm
Agar	=	0.8 %

The medium was supplemented with different concentrations of sucrose (10, 12, and 14, per cent). After pollen inoculation, Petri plates were incubated at 25 ± 2 °C for 24 hour in dark in a BOD incubator with four replicates per treatment. After incubation, the pollen activity was terminated by flooding the surfaces of media with killing and fixing solution of the following composition (Sass, 1951):

Formaldehyde	=	5ml
Glacial acetic acid	=	3 ml
Water	=	72 ml
Glycerine	=	20 ml

Pollen producing a tube length of a size greater than its diameter was designated as germinated. Ten readings for pollen and thirty for tube length from different microscopic fields of each Petri plate were made from area with uniform distribution pollen and fairly good population.

Result and discussion

There was a significant difference in pollen grain length with regard to the cultivars and season of flowering as given in Table-1. Amongst different cultivars, Lucknow-49 produced pollen grains of maximum pollen length (22.65 µ) that was significantly longer than other cultivars. The minimum pollen grain length was recorded in Hisar Safeda (20.48 µ) that was significantly lower than Allahabad Safeda (21.79 µ) and Hisar Surkha (21.66 µ). Lucknow-49 produced significantly longer pollen grains in spring flowering (23.00 µ) and autumn flowering season (22.30 µ) as compared to other cultivars. It was further observed that average pollen grain length was more in autumn flowering season (21.84 µ) as compared to spring flowering season (21.46 µ), however, the difference was non significant. Considerable variations were recorded in pollen grain breadth of different cultivars in spring as well autumn flowering seasons (Table-1). The seasonal effect on average pollen grain breadth in all the cultivars was non significant. Among the different cultivars, pollen grains

Table 1. Pollen grain size, germination percentage and Pollen tube length in guava cultivars during spring and autumn flowering season

Cultivars	Pollen grain size (µ)						Germination percentage			Pollen tube length (µ)		
	Pollen length (µ)			Breadth (µ)								
	Spring	Autumn	Mean	Spring	Autumn	Mean						
Hisar Safeda	20.52	20.45	20.48	19.3	18.82	19.06	36.17	39.44	35.06	40.50	41.00	40.75
Hisar Surkha	21.90	21.42	21.66	20.53	19.95	20.25	34.92	35.47	35.18	39.00	38.25	38.62
Lucknow-49	23.00	22.30	22.65	20.90	21.00	21.02	43.17	43.14	43.16	41.50	43.00	42.25
Allahabad Safeda	21.92	21.65	21.79	20.25	19.92	20.09	39.50	40.58	40.04	37.25	38.50	37.87
Mean	21.84	21.46	21.79	20.25	19.96	20.11	38.44	38.28	38.36	39.56	40.31	39.94
CD at 5%	Cultivar =0.67				1.06			1.27			3.59	
	Season =0.48				N.S.			1.80			N.S.	
	Season X Cultivar = 0.95				1.50			2.55			5.08	

Table 2. Germination percentage of pollen grains under different concentrations of sucrose

Concentration of sucrose	Time			Mean
	Immediately after anthesis	2 hrs. after anthesis	4 hrs. after anthesis	
10%	39.16	43.34	21.91	34.80
12%	49.56	51.94	30.84	44.11
14%	38.78	43.78	25.91	36.16
Mean	42.58	46.78	26.21	
CD at 5%	Time	= 1.56		
	Conc.	= 1.56		
	Time X Conc.	= 2.70		

of Lucknow-49 have maximum pollen breadth (21.02 μ), which was significantly at par with Allahabad Safeda (20.09 μ) and Hisar Surkha (20.25 μ). The minimum pollen grain breadth was observed in Hisar Safeda (19.06 μ), which was significantly lower than other cultivars except, Allahabad Safeda (20.09 μ). Interaction of season with cultivar showed that pollen grains breadth was found non significant in all the cultivars during both the seasons. Kahlon *et al.*, (1987) also favored pollen grain size of various cultivars of guava.

The percentage of pollen grains germination in different guava cultivars was found significant. Seasonal effect on pollen grain germination was found non significant in all the cultivars except Hisar Safeda. Amongst the cultivars, maximum percentage of pollen grain germination was observed in Lucknow-49 (43.16 per cent), which was significantly higher as compared to other cultivars, whereas, minimum pollen germination was observed in cultivar Hisar Safeda (35.06 per cent) that was at par with Hisar Surkha (35.18 μ). Interaction of season and cultivar was found significant. Significantly higher pollen germination was recorded in Lucknow-49 during spring flowering (43.17 per cent) and autumn flowering season (43.14 per cent) as compared to other cultivars.

Data regarding pollen tube length present in the Table-1 indicated that pollen tube length varied from 37.25 μ to 41.50 μ in spring flowering season and 38.25 μ to 43.0 μ in autumn flowering season of flowering in different cultivars of guava. It was also recorded that longer pollen tube was obtained in autumn flowering season as compared to spring flowering season in all the cultivars except Hisar Surkha where it was other way round. The results of the present study are similar to that of Nalawadi *et al*, (1973) who also reported maximum pollen tube length of 52 μ in Lucknow-49 variety of guava.

An appreciable difference was observed in pollen grain germination at three different sucrose concentrations with regard to three time intervals from the Table-2 respectively. Maximum percentage of pollen grain germination was recorded two hours after opening of flowers (46.78 per cent), which was significantly higher as compared to other times of germination. Among the different concentrations of sucrose solution pollen grain germination was found maximum at 12% concentration (44.11 per cent) in all the cultivars. It was further observed that percentage of pollen grain germination increased with the increase in sucrose concentration up to 12 % in all the cultivars and later it declined at 14 % concentration of sucrose solution. The findings of Rattanpal and Dhaliwal (1995), Dhaliwal and Singla (2002) and Kahlon *et.al.*, (1987) corroborated the results of present investigation who also obtained maximum pollen germination of guava in 10 and 15 per cent sucrose solution. It was further observed that cultivar Lucknow-49 showed statistically better pollen germination than other cultivars and rainy season established its significant superiority over winter season.

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Performance of F_4 progenies developed through bud and mixed pollination in late cauliflower (B*rassica oleracea* var. *botrytis* L.): Variability study

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Abstract

The five plants in each progeny of F_3 from a cross PSB-1 x KT-9 were selected. These plants were bud and mix pollinated (BP & MP) to produce bud and mix pollinated seeds of F_3 i.e. F_4. The materials thus, developed were evaluated in compact family block design with three replications for eight horticultural and three quality traits. F_4 11-119-BP, F_4 11-111-BP, F_4 11-113-BP, F_4 5-109-BP and F_4 2-77-BP and F_4 4-92-MP, F_4 4-94-MP, F_4 11-120-MP, F_4 3-84-MP and F_4 11-112-MP possessed good yield and quality traits. PCV & GCV was high for the gross curd weight, net curd weight and harvest index. These three characters also exhibited high heritability and genetic advance as percentage of mean indicating the additive gene effects for these traits. The high heritability with low to moderate genetic advance was found for stalk length and days to harvesting.

Key words: Cauliflower, F_4, bud pollination, mixed pollination

Introduction

Cauliflower (*Brassica oleracea* var. *botrytis* L.) has got an important place among cole crops due to its taste, flavour and nutritive value. It has been rightly described as the "Aristocrat of Cole crops" (Boswell, 1949). The crop is native of Southern Europe (Chatterjee and Swarup, 1972). Cauliflower was introduced in India from England by Britishers in 1822 (Chatterjee, 1986) and in such a short period of its introduction, it has gained a lot of importance among the breeders, farmers and consumers. It is grown for its white tender curds which are used as vegetable, soups and pickles. Cauliflower is good source of proteins, carbohydrates, minerals and vitamins (Choudhury, 1996).

The leading cauliflower growing states in the country are West Bengal, Bihar, Uttar Pradesh, Punjab, Rajasthan and Karnataka. In Himachal Pradesh, Snowball group of cauliflower contributes both in terms of off-season crop as well as seed crop. The seed production of late cauliflower is also highly remunerative and is being done on commercial scale in mid hills of Himachal Pradesh. In mid and high hills of the state, it is grown as off- season crop during summer months, which fetches a premium in the plains and brings lucrative returns to the farmers. A large number of cultivars are available in early and mid season group due to the presence of greater variability in both the groups. However, there are limited cultivars in Snowball/ late group as much variability is not available in this type.

Though snowball group provides ideal genotypes both to the farmers and consumers, yet these cultivars are very sensitive to fluctuating environmental conditions resulting sometimes in the development of undesirable traits which make the curds unfit for marketing. Thus an attempt was made in a heterotic cross PSB-1 × KT-9 of

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cauliflower and the identified/ selected F_3 were bud and mixed pollinated and the progenies developed (F_4) were evaluated for the performance of different horticultural and quality traits.

Materials and methods

The present studies were conducted at experimental farm of Department of Vegetable Crops, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P. The experimental materials comprised different F_3 progenies selected from heterotic cross (PSB-1 x KT-9) of cauliflower. These F_3 progenies were identified on the basis of their performance and five plants from each progeny of F_3 were selected. These plants were bud and mix pollinated (BP and MP) to produce bud and mix pollinated seeds of F_3's i.e., F_4. The materials thus, developed were evaluated in compact family block design, whereby whole populations generated in F_4 under bud pollination and mix pollination were treated as main plot or family and randomized. The progenies developed from the selected plants were also randomly planted along with the checks in each family / main plot and considered as sub plots. These entries were replicated thrice and spaced at 60 x 45 cm. The plot size per entry comprised three rows per replication and each row had four plants. All the recommended package of practices was followed during growth period of the crop. The observations were recorded for plant frame (cm), No. of leaves per plant, No. of leaves per whorl, stalk length (cm), days to harvesting, gross curd weight (g), net curd weight (g) and harvest index (%) and quality traits viz. color, compactness and riceyness. Statistical analysis was done for all the traits except quality parameters. Coefficients of variability (phenotypic and genotypic) were calculated as per Burton and DeVane (1953), Heritability and Genetic advance as per Allard (1960) and Genetic gain was calculated as per the method suggested by Johnson et al. (1955b).

Results and Discussion

Perusal of data in Table 1 indicated that twelve progenies showed less plant frame than the mean value, of which F_4 2-71-BP, F_4 4-93-BP, F_4 1-63-BP, F_4 3-81-BP and F_4 1-67-BP were promising. Thirteen F_4's (BP) had less number of leaves per plant as well as number of leaves per whorl of which F_4 1-63-BP, F_4 2-71-BP, F_4 4-93-BP, F_4 3-81-BP, F_4 4-91-BP and F_4 4-99-BP were promising. Significantly minimum stalk length was found in F_4 11-111-BP followed by F_4 3-81-BP, F_4 1-69-BP, F_4 4-99-BP, F_4 3-87-BP and F_4 5-105-BP. Twenty F_4's (BP) gave the stalk shorter than the mean. Minimum and maximum days to harvesting were exhibited by $F_4$1-67-BP and $F_4$11-115-BP, respectively. F_4 1-67-BP, F_4 1-63-BP, F_4 1-61-BP, F_4 1-69-BP, $F_4$2-71-BP, F_4 2-79-BP and F_4 3-83-BP showed significantly early maturity whereas F_4 11-115-BP, F_4 11-117-BP, F_4 11-113-BP. F_4 11-119-BP, F_4 2-77-BP, F_4 5-103-BP and $F_4$11-111-BP were found significantly late in maturity. F_4 11-119-BP recorded highest gross curd weight followed by F_4 5-109-BP, F_4 11-113-BP, F_4 11-111-BP and F_4 1-65-BP. F_4 11-119-BP recorded highest net curd weight followed by F_4 5-107-BP, F_4 11-113-BP, F_4 2-77-BP and F_4 11-111-BP. Harvest index was maximum in F_4 2-71-BP and F_4 4-91-BP, F_4 2-79-BP, F_4 2-77-BP and F_4 3-85-BP were also promising. White colour of the curd was exhibited by majority of the characters except F_4 11-115-BP, F_4 1-67-BP. $F_4$3-83-BP, $F_4$4-95-BP and $F_4$5-103-BP. Compact curds were found in F_4 11-111-BP while the progenies viz., F_4 2-79-BP, F_4 1-65-BP, $F_4$5-101-BP, $F_4$5-107-BP and F_4 2-77-BP gave compact to semi-compact curds. Majority of the F_4's showed non ricey curds however $F_4$1-69-BP, $F_4$1-65-BP, $F_4$1-67-BP and F_4 3-87-BP gave considerable percentage of ricey curds. From the above results it may be concluded that F_4 11-119-BP, F_4 11-111-BP, F_4 11-113-BP, F_4 5-109-BP and F_4 2-77-BP which possessed good yield and quality traits were found best.

Mean performance of F_4's (MP) with respect to different traits has been given in Table 2. It is evident from the table that sixteen progenies showed less plant frame than the mean value of which F_4 1-62-MP, F_4 3-90-MP, F_4 4-100-MP, F_4 2-72-MP and F_4 5-104-MP were promising. Eighteen F_4's (MP) had less number of leaves per plant and fifteen had less number of leaves per whorl of which F_4 2-72-MP , F_4 1-62-MP, F_4 2-74-MP, and F_4 3-82-MP were promising. Minimum stalk length was found in F_4-1-62-MP and nine F_4's (MP) gave the stalk shorter than the mean. Minimum and maximum days to harvesting were exhibited by F_4 1-62-MP and F_4 11-118-MP, respectively. F_4 1-62-MP, F_4 2-80-MP, F_4 2-76-MP, F_4 5-102-MP and F_4 5-106-MP were early while F_4 11-118-MP, F_4 4-96-MP, F_4 11-116-MP, F_4 11-120-MP and F_4 4-92-MP were significantly late in maturity. F_4 4-92-MP recorded highest gross curd weight followed by F_4 11-120-MP, F_4 4-94-MP, F_4 4-96-MP and F_4 3-84-MP. F_4 4-92-MP recorded highest net curd weight followed by $F_4$11-120-MP, F_4 3-90-MP, F_4 4-94-MP and F_4 3-84-MP. Harvest index was maximum in F_4 1-70-MP followed by F_4 5-110-MP, $F_4$2-78-MP, F_4 11-112-MP and $F_4$11-120-MP, F_4 3-90-MP and F_4 1-68-MP were also promising. Nine progenies gave more than 80.00 per cent white curds where F_4 1-66-MP, F_4 3-86-MP and F_4 3-84-MP gave some per cent of creamish yellow curds. None of the progeny had completely compact curds. F_4 11-120-MP showed more number of compact curds (80.00%) followed by $F_4$4-100-MP (73.33%) and $F_4$11-116-MP (73.33%), Majority of the progenies gave semi-compact curds. Majority of the progenies showed non-ricey curds and ranged from 66.67-100.00 per cent. The curds were completely non-ricey in 10 progenies viz., F_4 2-72-MP, F_4 2-74-MP, F_4 2-76-MP, F_4 2-78-MP, F_4 2-80-MP, F_4 3-82-MP, F_4 3-86-MP, $F_4$4 - 94-MP, F_4 4-96-MP, $F_4$5-110-MP. From the above results it may be concluded that F_4 4-92-MP, F_4 4-94-MP, F_4 11-

Table 1. Mean performance of F_4 (BP) Progenies with respect to different traits

BIP (BP)	Plant frame (cm)	No. of leaves per plant	No. of leaves per whorl	Stalk length (cm)	Days to harvesting	Gross curd weight (g)	Net curd weight (g)	Harvest index (%)	Curd colour			Compactness?			Riceyness	
									Snow White	White	Creamish Yellow	Compact	Semi compact	Loose	Ricey	Non-Ricey
F_4 1-61-BP	54.94	20.64	5.16	2.95	124.45	1854.18	834.93	44.85	13.33	86.67	-	13.33	40.00	46.67	66.67	33.33
F_4 1-63-BP	52.30	18.25	4.56	2.94	123.50	1813.33	824.33	45.23	6.67	80.00	13.33	26.67	53.33	20.00	73.33	26.67
F_4 1-65-BP	54.63	20.75	5.19	3.03	128.67	2193.00	1028.67	46.71	26.67	73.33	-	6.67	66.66	26.67	53.33	46.67
F_4 1-67-BP	53.17	20.58	5.15	3.07	121.17	1695.28	847.67	49.69	6.67	46.66	46.67	-	33.33	66.67	60.00	40.00
F_4 1-69-BP	56.00	20.42	5.10	2.89	124.67	1809.33	765.67	42.36	6.67	53.33	40.00	6.67	20.00	73.33	46.67	53.33
F_4 2-71-BP	51.44	18.83	4.71	3.50	124.67	1592.22	825.00	52.74	13.33	66.67	20.00	40.00	26.67	33.33	100.00	-
F_4 2-73-BP	54.22	21.66	5.42	2.94	125.83	1969.44	902.33	45.67	-	100.00	-	26.67	33.33	40.00	93.33	6.67
F_4 2-75-BP	55.07	21.16	5.29	3.17	126.42	1920.94	871.67	45.50	20.00	53.33	26.67	46.66	26.67	26.67	100.00	-
F_4 2-77-BP	55.07	20.33	5.08	3.00	130.50	2089.47	1056.33	51.13	-	93.33	6.67	26.67	60.00	13.33	93.33	6.67
F_4 2-79-BP	54.26	20.33	5.08	3.03	124.67	1923.61	970.33	51.57	6.67	80.00	13.33	-	80.00	20.00	100.00	-
F_4 3-81-BP	52.82	19.78	4.96	2.87	125.66	1708.11	845.64	49.97	-	66.67	33.33	13.33	40.00	46.67	80.00	20.00
F_4 3-83-BP	54.37	20.56	5.17	3.00	124.67	1858.11	862.33	46.68	-	53.33	46.67	13.33	33.33	53.34	86.67	13.33
F_4 3-85-BP	56.54	20.91	5.23	2.97	125.83	1891.89	958.33	50.28	-	73.33	26.67	13.33	53.34	33.33	66.67	33.33
F_4 3-87-BP	55.72	21.08	5.27	2.97	128.08	1844.78	858.333	46.40	-	86.67	13.33	46.66	26.67	26.67	60.00	40.00
F_4 3-89-BP	54.47	20.75	5.19	2.93	126.83	2042.00	875.00	43.00	-	46.67	53.33	20.00	40.00	40.00	100.00	-
F_4 4-91-BP	55.26	20.17	5.04	3.04	127.33	1749.33	902.33	51.85	-	60.00	40.00	46.67	53.33	-	80.00	20.00
F_4 4-93-BP	51.84	19.67	4.92	3.03	129.78	1975.85	855.00	44.95	-	80.00	20.00	53.34	33.33	13.33	86.67	13.33
F_4 4-95-BP	56.17	21.35	5.34	2.97	129.18	2159.00	927.32	42.99	-	53.33	46.67	66.67	20.00	13.33	93.33	6.67
F_4 4-97-BP	55.32	20.75	5.19	3.00	127.67	1808.83	858.33	47.15	-	66.67	33.33	40.00	33.33	26.67	93.33	6.67
F_4 4-99-BP	57.70	20.08	5.52	2.90	129.83	2104.06	979.33	46.12	-	86.67	13.33	53.33	26.67	20.00	93.33	6.67
F_4 5-101-BP	54.34	20.33	5.08	3.02	130.17	2112.17	959.00	45.68	-	66.67	33.33	20.00	66.67	13.33	80.00	20.00
F_4 5-103-BP	56.32	21.08	5.27	3.09	130.50	2107.67	983.33	46.67	-	53.33	46.67	26.67	46.66	26.67	86.67	13.33
F_4 5-105-BP	54.31	20.17	5.04	2.93	129.83	2021.33	995.33	48.80	-	93.33	6.67	40.00	20.00	40.00	73.33	26.67
F_4 5-107-BP	56.53	21.39	5.38	2.98	126.77	2023.78	1093.33	46.92	-	80.00	20.00	33.33	60.00	6.67	100.00	-
F_4 5-109-BP	57.22	21.50	5.38	3.10	129.25	2329.17	990.67	42.73	-	80.00	20.00	26.67	73.33	-	100.00	-
F_4 11-111-BP	55.62	21.00	5.25	2.85	130.50	2208.11	1031.33	46.51	13.33	66.67	20.00	80.00	6.67	13.33	66.67	33.33
F_4 11-113-BP	55.57	20.68	5.17	3.29	133.42	2269.44	1066.67	47.31	13.33	53.34	33.33	60.00	20.00	20.00	80.00	20.00
F_4 11-115-BP	54.98	20.25	5.06	3.21	137.50	2073.11	918.33	44.02	-	46.67	53.33	53.34	13.33	33.33	93.33	6.67
F_4 11-117-BP	56.16	20.25	5.06	3.32	137.00	1945.33	877.33	45.45	-	60.00	40.00	66.67	33.33	-	100.00	-
F_4 11-119-BP	55.05	21.27	5.32	3.27	131.73	2440.67	1209.33	49.59	6.67	93.33	-	53.33	20.00	26.67	73.33	26.67
Mean	54.74	20.53	5.15	3.04	128.28	1695.28	925.34	46.87								
CD 0.05	NS	NS	0.15	0.095	1.38	144.96	80.24	2.07								

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Table 2. Mean performance of F_4 (MP) Progenies with respect to different traits

BIP (BP)	Plant frame (cm)	No. of leaves per plant	No. of leaves per whorl	Stalk length (cm)	Days to harvesting	Gross curd weight (g)	Net curd weight (g)	Harvest index (%)	Curd colour			Compactness?			Riceyness	
									Snow White	White	Creamish Yellow	Compact	Semi compact	Loose	Ricey	Non-Ricey
F_4 1-62-MP	51.30	20.00	5.00	2.74	127.67	1700.00	745.33	44.08	6.67	80.00	13.33	13.33	46.67	40.00	66.67	33.33
F_4 1-64-MP	53.91	21.53	5.35	3.00	130.92	2085.67	981.29	46.64	26.67	53.33	20.00	20.00	53.33	26.67	80.00	20.00
F_4 1-66-MP	54.63	21.43	5.45	3.01	136.40	1830.00	830.00	44.94	6.67	60.00	33.33	6.67	40.00	53.33	53.33	46.67
F_4 1-68-MP	55.49	21.13	5.35	3.24	133.81	2120.00	1050.00	48.78	6.67	86.66	6.67	13.33	26.67	60.00	60.00	40.00
F_4 1-70-MP	55.60	23.69	5.10	3.11	130.80	1930.00	1010.00	52.04	26.67	53.33	20.00	20.00	53.33	26.67	86.67	13.33
F_4 2-72-MP	53.25	19.91	5.02	3.09	131.72	2031.27	961.12	47.04	-	100.00	-	26.67	53.33	20.00	100.00	-
F_4 2-74-MP	54.03	20.42	5.10	3.42	133.00	2087.33	995.28	47.41	20.00	73.33	6.67	33.33	40.00	26.67	100.00	-
F_4 2-76-MP	54.78	20.59	5.23	3.18	128.42	2071.00	983.11	47.41	13.33	66.67	20.00	20.00	66.67	13.33	100.00	-
F_4 2-78-MP	55.57	20.50	5.13	3.31	134.83	2062.33	1033.11	50.07	6.67	86.66	6.67	40.00	46.67	13.33	100.00	-
F_4 2-80-MP	57.76	22.14	5.54	3.20	127.67	1867.00	891.22	48.53	13.33	73.34	13.33	13.33	46.67	40.00	100.00	-
F_4 3-82-MP	56.30	20.42	5.10	3.36	135.25	2175.00	1007.39	45.75	13.33	66.67	20.00	20.00	53.33	26.67	100.00	-
F_4 3-84-MP	54.26	21.25	5.31	3.26	132.33	2520.28	1200.00	47.51	-	73.33	26.67	26.67	40.00	33.33	93.33	6.67
F_4 3-86-MP	58.21	23.18	5.79	3.13	129.58	2110.14	987.33	47.02	6.67	60.00	33.33	20.00	60.00	20.00	100.00	-
F_4 3-88-MP	54.23	21.42	5.35	3.37	134.75	2200.00	1025.00	46.44	-	80.00	20.00	13.33	46.67	40.00	66.67	33.33
F_4 3-90-MP	53.05	20.64	5.16	3.47	132.18	2526.12	1223.76	48.44	-	93.33	6.67	53.33	13.33	33.34	80.00	20.00
F_4 4-92-MP	55.49	21.67	5.42	3.39	136.65	2633.22	1258.11	48.19	-	93.33	6.67	60.00	26.67	13.33	93.33	6.67
F_4 4-94-MP	53.96	21.08	5.27	3.63	134.25	2559.67	1206.08	46.42	-	86.67	13.33	46.67	46.66	6.67	100.00	-
F_4 4-96-MP	55.16	21.00	5.25	3.56	137.33	2554.11	1164.19	45.13	13.33	73.34	13.33	53.33	40.00	6.67	100.00	-
F_4 4-98-MP	56.44	21.73	5.43	3.23	134.82	2150.00	1012.24	47.14	6.67	80.00	13.33	40.00	60.00	-	86.67	13.33
F_4 4-100-MP	53.14	20.92	5.23	3.29	132.25	2125.00	1008.69	47.09	20.00	66.67	13.33	73.34	13.33	13.33	86.67	13.33
F_4 5-102-MP	58.99	22.95	5.75	3.08	130.33	2475.00	1095.28	44.75	-	100.00	-	26.67	66.66	6.67	80.00	20.00
F_4 5-104-MP	53.26	20.92	5.23	3.32	133.00	2146.00	1016.22	47.64	13.33	66.67	20.00	26.67	60.00	13.33	86.67	13.33
F_4 5-106-MP	56.44	21.17	5.29	3.24	130.50	2348.00	1125.00	47.73	-	80.00	20.00	40.00	53.33	6.67	93.33	6.67
F_4 5-108-MP	54.12	20.50	5.13	3.41	135.08	2137.33	1002.03	47.30	20.00	73.33	6.67	46.67	46.66	6.67	93.33	6.67
F_4 5-110-MP	55.72	20.67	5.17	3.38	136.50	1975.00	1019.56	51.84	-	93.33	6.67	26.67	73.33	-	100.00	-
F_4 11-112-MP	54.07	20.67	5.17	3.38	136.08	2157.00	1080.06	49.44	20.00	66.67	13.33	60.00	33.33	6.67	86.67	13.33
F_4 11-114-MP	53.32	21.17	5.29	3.29	136.08	2333.33	1074.19	45.85	20.00	53.33	26.67	53.33	20.00	26.67	80.00	20.00
F_4 11-116-MP	57.25	21.08	5.27	3.42	137.50	2263.00	1025.00	45.70	20.00	60.00	20.00	73.33	26.67	-	86.67	13.33
F_4 11-118-MP	56.08	20.50	5.13	2.89	137.92	2333.11	1025.00	44.57	6.67	86.66	6.67	66.66	26.67	6.67	93.33	6.67
F_4 11-120-MP	54.73	21.42	5.35	3.36	136.58	2604.06	1241.22	47.69	-	80.00	20.00	80.00	13.33	6.67	93.33	6.67
Mean	54.84	21.14	5.27	3.22	133.22	2178.59	1028.60	47.22								
$CD_{0.05}$	1.25	NS	0.15	0.12	1.28	179.69	97.70	1.90								

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Table 3. Comparison of means of F_4 (BP) and F_4 (MP) progenies

Traits	Mean		
	F_4 (BP)	F_4 (MP)	t-ratio
Plant frame (cm)	54.74	54.84	-0.165
No of leaves/plant	20.53	21.14	-1.52
No of leaves/whorl	5.15	5.27	-1.93
Stalk length (cm)	3.04	3.25	-2.1*
Days to harvesting	128.28	133.22	-5.80*
Gross curd weight (g)	1973.08	2178.59	-3.61*
Net curd weight (g)	925.34	1028.60	-3.68*
Harvest index (%)	46.87	47.22	-0.595

Table 4. Coefficients of variability (phenotypic and genotypic), heritability and genetic gain for different characters in different progenies of cauliflower

Characters		PCV (%)	GCV (%)	H (%)	Genetic advance	Genetic gain
Plant frame (cm)	1	-	-	-	-	-
	2	4.16	2.74	43.40	2.04	3.72
Number of leaves per whorl	1	4.92	2.97	36.50	0.19	3.69
	2	4.71	2.71	33.20	0.17	3.22
Stalk length (cm)	1	5.07	4.78	88.80	0.28	9.21
	2	6.31	6.13	94.50	0.40	12.34
Days to harvesting	1	3.02	2.77	83.60	6.68	5.21
	2	2.39	2.37	97.60	6.42	4.82
Gross curd weight (g)	1	10.12	9.95	96.70	397.54	20.15
	2	11.72	11.66	99.00	520.71	23.90
Net curd weight (g)	1	10.73	10.72	99.90	204.16	22.06
	2	12.18	11.99	96.80	249.88	24.29
Harvest index (%)	1	5.88	5.79	96.80	5.50	11.73
	2	4.05	3.90	93.00	3.66	7.75

1 = F_4's (BP) 2 = F_4's (MP)

120-MP, F_4 3-84-MP and F_4 11-112-MP which possessed good yield were found best.

The means of F_4 bud pollinated and F_4 mix pollinated progenies were compared with the help of t-ratio with respect to traits under study (Table 3). Significant differences in the means were noticed for days to harvesting, net curd weight, gross curd weight and stalk length. The differences were non significant for all other characters.

Estimates of the phenotypic and genotypic coefficients of variability (Table 4) were comparatively low for all the traits in (F_4) progenies. However, net curd weight (10.73, 12.18 and 10.72, 11.99%) and gross curd weight (10.12, 12.18 and 9.95, 11.99%) show maximum variability in both the progenies, respectively. The phenotypic coefficients of variability were larger in magnitude than genotypic coefficients of variability for all the traits in different families. The difference in the values of these estimates were also less in most of the characters indicating that genetic factors had played major role in the expression of these characters. Overall net curd weight followed by gross curd weight and harvest index had high coefficients of genotypic and phenotypic variability. Earlier workers like Jamwal et al. (1992) and Khar et al. (1997) had also reported high values for these characters.

Heritability and genetic advance are two complimentary parameters, the former may be used to estimate expected genetic advance through selection. The success of any selection programme depends upon the extent of heritability as well as genetic advance which usually changes for population to population and

environment to environment. Burton (1952) was of the opinion that the genetic coefficient of variation along with heritability give the best picture of the genetic advance to be expected from selection whereas, Johnson *et al.* (1955b) advocated that heritability together with genetic advance is more useful than the heritability alone in predicting the resultant effects in selecting best individuals in soyabean.

Heritability in broad sense (Table 4) was found to be high for net curd weight (99.90, 96.80%), harvest index (96.80, 93.00%), gross curd weight (96.70, 99.00%) and days to harvesting (83.60, 97.60%) in both the progenies i.e. F_4's (BP & MP), respectively. These were low for other characters indicating that these characters are controlled largely by genetic factors. Genetic advance as percentage of mean was found maximum in net curd weight (22.06, 24.29%) and gross curd weight (20.15, 23.90%) in both the progenies i.e. F_4 (BP) and F_4 (MP) respectively. It was found to be moderate for stalk length and harvest index in F_4 (BP) and low for remaining characters viz. plant frame number of leaves per whorl and days to harvesting. Similar results were also reported by Lal *et al.*, 1990, Jamwal *et al.*, 1992, Radhakrishna and Korla, 1994 and Sanjeev, 1998). In the present studies the characters like gross curd weight and net curd weight exhibited high genotypic coefficients of variability, heritability and genetic advance as percentage of mean indicating thereby that selection would be effective for the improvement of these characters as these are controlled by additive gene action (Panse, 1957, Lal *et al.*, 1990, and Radhakrishna and Korla, 1994). Whereas, high heritability with low to moderate genetic advance was found for stalk length and days to harvesting (Kanwar and Korla, 2002a & 2002b). The other characters exhibited low values of either of these estimates indicating that these are controlled by non-additive gene and selection would not be effective for bringing the improvement.

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Effect of cultural and chemical treatments on fruit set and fruit yield of custard apple (*annona sqamosa* Lin.) cv. Sindhan

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Abstract

A trial was conducted to study the influence of wheat straw mulch and different plant growth regulators on fruit set, yield and quality of custard apple. Maximum flowering duration and fruit retention was observed with wheat straw mulch + GA_3 (5 t/ha + 50 ppm) treatments. Highest number of fruits, fruit yield , fruit diameter and fruit pulp were also recorded under same treatments. Wheat straw mulch gave 21% higher fruit yield of custard apple. However application of 20 ppm NAA was at par with GA_3 (50 ppm). On economic basis , 50 ppm GA_3 + wheat straw mulch followed by 20 ppm NAA + wheat straw mulch gave highest net income.

Key wards: *Custard apple ,fruit retention, fruit yield, GA, mulch, NAA*

Introduction

Custard apple (*Anona squamosa* L.) is an arid fruit crop and hardy in nature requires dry climate with mild winter . It can grow successfully from sea level up to 100 m above the mean sea level elevation and also drought (Singh, 1992). Custard apple flowered during the period of April to August. Due to high temperature , low atmospheric humidity , lack of irrigation water and natural stress resulted less number of flower , poor fruit setting and low yield and degraded quality of fruit too. To control these problems only one solution is that , with mulch to procure the moisture within the periphery of the plant of custard apple . Several scientists have also reviewed this type of the cultural practices in Maharashtra and also in Gujarat. Studies have shown that mulching of even an evergreen tree like mango could ensure regular bearing. The techniques have been successfully tried in many orchards in Maharashtra. Among the various uses of growth regulators which have received wide spread acceptance and application in the field of Horticulture in recent years, the use of plant growth regulating chemicals in grape,mango,mandrin have become a standard practice for increasing flowering , fruit setting , fruit size and control of post harvest losses. This paper describes the interference of mulch and plant growth regulators on yield attributing characters and fruit yield of custard apple.

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Materials and methods

Present investigation on the Effect of mulch and plant growth regulators on custard apple cv. Sindhan were carried out on the nine year old trees having uniform growth with spaced at 6 m x 5 m at Fruit Research Station, Dehgam, Di: Gandhinagar (Gujarat) during the year 2002 and 2003. The experiment was conducted in Randomized Block Design with four replications with total sixteen treatment combinations. Mulch with wheat straw and no mulch were tested. Custard apple trees were sprayed with different plant growth regulators viz., GA3 at 50 and 100 ppm , NAA at 20 and 30 ppm , 2,4-D at 15 and 30 ppm and water spray. The plant growth regulators were sprayed four times at twenty-one days interval. The first spray was done on 1st week of May in both the years. Irrigation was given one day before spray. All the cultural operations like weeding, interculturing and irrigation were adapted uniformly to all experimental plants. Observations of various yields attributing characters and fruit yield were recorded. Results thus obtained were subjected to statistical analysis.

Results and discussion

Wheat straw mulch and spraying of plant growth regulators like GA_3 50 ppm and NAA 20 ppm had

significant effect on flowering duration , fruit retention , number of fruits , fruit yield , fruit pulp and fruit diameter during both the years of study as well as in pooled results also (Table 1,2,3). Only flowering duaration and fruit retention were not affected significantly in pooled years. Mandal and Chattopadhyay (1994) observed the effect of mulches like black plastic , saw dust, straw or coarse sand increase the flowering duration , fruit set and yield of *Annona squamosa* at Mondouri during 1990-91. Among the various treatments, flowering duration was longest with the spraying of 50 ppm GA_3 and it was followed by 20 ppm NAA and 100 ppm GA_3. In this study, it was observed that four spraying of plant growth regulators increased flowering duration over control and other sprays. The more day of flowering duration increased the more number of fruit set due to the application of 50 ppm GA_3 and mulch with wheat straw . Khan et al (1974) also found same results with 75 ppm GA_3 in litchi fruits. Chaudhary *et al* (1992) proved that application of GA_3 was the best for fruit retention percentage in Loquat. The results obtained by Raghuramulu *et. al* (1990) in Robusta coffee , Oasthuyse (1995) in Tommy Atkins and Heldi mango, Sandhu and Thind (7) in Umran ber are collaborated with these results. This might be due to well known effect of NAA for its flower and fruit retention property.

Fruit diameter and fruit pulp were also affected significantly due to wheat straw mulch, 50 ppm GA_3 and 20 ppm NAA. The research work done by Chaudhary *et al* (1992) and reported that GA3 at 40 ppm proved to be the most effective for the retention of fruits, increased diameter and weight of fruits. The increase in total yield of fruits by GA treatments can be attributed to better vegetative growth and more leaf area for photosynthetic activity. With the spraying of GA , number of seeds and seed weight are reduced and higher pulp produced. Chaudhary *et al* (1992) noticed reduction in seed size in ber by spraying of 40 ppm NAA. Wheat straw mulch also significant affect on fruit diameter and fruit pulp . This might be due to mulching reduced the need for weed control and substituted control the soil temperature and accumulation of more moisture resulted more absorption of water and plant nutrients from the soil and ultimately attain big size of fruit, higher fruit pulp and resulted more yield per tree. Aulakh and Sir (1999) also observed the effect of different mulches on soil temperature, soil moisture, weed population, growth and yield in pomegranate.

The combined effect of GA_3 50 ppm and wheat straw mulch was significantly influenced in pooled results in respect of fruit yield , number of fruits and fruit pulp (Table 2.1, 2.2, 3.1). Application of GA_3 identically prolonged the maturity of fruit and increased the number of fruits as well as fruit yield (Fig. 1 and Fig. 2). By using different cultural practices and spraying of GA_3 (50 ppm) and NAA (20 ppm), the benefits to farmers can be increased.(Table 4)

Table 1. Effect of various plant growth regulators and mulching treatments on flowering duration and fruit retention of custard apple

	Flowering duration (Days)			Fruit retention (%)		
	2002	2003	pooled	2002	2003	pooled
Cultural (Mulching) :						
With mulch	93	97	96	81.74	85.60	83.67
Without mulch	91	93	92	75.33	82.51	78.92
S.Em.±	0.16	0.53	0.72	0.87	0.46	1.17
C.D. at 5%	0.47	1.51	N.S.	2.50	1.33	N.S.
Chemicals (PGRs) :						
GA_3 50 ppm	94	97	96	89.31	91.56	90.44
GA_3 100 ppm	93	96	94	85.10	87.51	86.31
NAA 20 ppm	93	97	95	85.78	89.70	87.74
NAA 30 ppm	93	96	95	80.61	86.70	83.65
2,4 -D 15 ppm	93	95	94	77.35	82.90	80.13
2,4-D 30 ppm	93	93	93	75.20	81.20	78.20
Water spray	92	93	93	72.32	78.06	75.19
Control	90	93	92	62.61	74.84	68.73
S.Em.±	0.32	1.06	0.55	1.75	0.93	1.56
C.D. at 5%	0.92	N.S.	1.56	5.01	2.67	5.23
C.V.%	0.99	3.17	2.37	6.33	3.15	4.90
Interaction :						
C.D. at 5%	NS	NS	NS	NS	NS	NS

Table 2. Effect of various plant growth regulators and mulching treatments on number of fruits and fruit yield of custard apple

	Number of fruits			Fruit yield (kg ha^{-1})		
	2002	2003	pooled	2002	2003	pooled
Cultural (Mulching) :						
With mulch	65.50	126.71	96.10	2640	4640	3640
Without mulch	53.71	108.37	81.04	2197	3840	3020
S.Em.±	1.30	2.38	1.35	73.33	113.3	66.67
C.D. at 5%	3.71	6.80	3.82	206.7	323.3	190
Chemicals (PGRs) :						
GA_3 50 ppm	84.12	166.37	125.25	3363	5790	4577
GA_3 100 ppm	63.75	122.25	93.00	2600	4437	3517
NAA 20 ppm	66.37	139.50	102.93	2963	5280	4120
NAA 30 ppm	60.50	123.12	91.81	2337	3667	3003
2,4 -D 15 ppm	52.50	105.12	78.81	2583	4453	3520
2,4-D 30 ppm	56.62	104.87	80.75	2083	3543	2813
Water spray	53.37	95.37	74.37	1720	3777	2750
Control	39.62	83.75	61.68	1703	2977	2340
S.Em.±	2.60	4.77	7.09	143.3	226.7	220
C.D. at 5%	7.43	13.60	23.74	410	650	733.3
C.V.%	12.38	11.48	12.28	16.83	15.17	16.16
Interaction :						
C.D. at 5%	N.S.	N.S.	CUCH	N.S.	N.S.	CUCH

Table 2.1. Interaction for number of fruits/tree (pooled) Mulching x Plant growth regulators

Mulching / Plant growth regulators	CH_1	CH_2	CH_3	CH_4	CH_5	CH_6	CH_7	CH_8
With mulch (CU_1)	142.87	100.00	109.87	100.87	80.37	88.50	81.87	64.50
Without mulch (CU_2)	107.62	86.00	96.00	82.75	77.25	73.00	66.87	58.87
S.Em.±	3.84							
C.D. at 5%	10.82							

Table 2.2. Interaction for total fruit yield (kg ha^{-1}) (pooled) Mulching x Plant growth regulators

Mulching / Plant growth regulators	CH_1	CH_2	CH_3	CH_4	CH_5	CH_6	CH_7	CH_8
With mulch (CU_1)	5187	4093	4420	3320	3900	2897	2920	2373
Without mulch (CU_2)	3960	2940	3820	2683	3137	2727	2573	2303
S.Em.±	190							
C.D. at 5%	533							

From the foregoing discussion, it can be concluded that application of either GA_3 (50 ppm) or NAA (20 ppm) with wheat straw mulch enhanced fruit set, fruit retention and fruit yield of custard apple as well as higher economic return in North Gujarat conditions.

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Table 3. Effect of various plant growth regulators and mulching treatments on fruit diameter and fruit pulp weight of custard apple

	Fruit diameter (cm)			Fruit pulp (g)		
	2002	2003	pooled	2002	2003	pooled
Cultural (Mulching) :						
With mulch	6.89	7.00	6.95	71.09	81.96	76.53
Without mulch	6.60	6.66	6.63	65.00	70.87	67.93
S.Em.±	0.07	0.05	0.04	1.19	1.41	0.92
C.D. at 5 %	0.21	0.15	0.13	3.40	4.03	2.59
Chemicals (PGRs) :						
GA_3 50 ppm	7.22	7.40	7.31	88.50	97.12	92.81
GA_3 100 ppm	6.71	6.95	6.83	75.00	84.75	79.87
NAA 20 ppm	6.95	7.10	7.02	84.00	92.37	88.18
NAA 30 ppm	6.75	6.82	6.78	67.75	76.50	72.12
2,4 -D 15 ppm	6.76	6.81	6.78	61.12	71.50	66.31
2,4-D 30 ppm	6.53	6.68	6.61	59.50	65.50	62.50
Water spray	6.62	6.53	6.58	54.37	60.50	57.43
Control	6.42	6.36	6.39	54.13	63.12	58.62
S.Em.±	0.15	0.10	0.09	1.19	2.82	1.85
C.D. at 5 %	0.43	0.31	0.26	3.40	8.06	5.19
C.V.%	6.38	4.50	5.51	9.94	10.46	10.26
Interaction :						
C.D. at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	CUCH

Table 3.1. Interaction for fruit pulp weight of fruit (g) (pooled) Mulching x Plant growth regulators

Mulching / Plant growth regulators	CH_1	CH_2	CH_3	CH_4	CH_5	CH_6	CH_7	CH_8
With mulch (CU_1)	95.75	82.62	89.00	82.12	73.75	67.87	61.25	59.87
Without mulch (CU_2)	89.00	77.12	87.00	62.12	58.87	51.12	53.62	56.12
S.Em.±	2.61							
C.D. at 5 %	7.35							

Table 4. Economics of custard apple as influenced by various plant growth substances and mulching treatments

Treatments	Net income (Rs./ha)	B:C Ratio
With mulch + GA3 50 ppm	42087	5.38
With mulch + GA3 100 ppm	29137	3.50
With mulch + NAA 10 ppm	36315	5.60
With mulch + NAA 20 ppm	25287	4.20
With mulch + 2,4-D 15 ppm	31147	5.00
With mulch + 2,4-D 30 ppm	21097	3.70
With mulch + Water spray	21397	3.70
With mulch + Control	16437	3.20
Without mulch + GA3 50 ppm	31150	4.70
Without mulch + GA3 100 ppm	18970	2.80
Without mulch + NAA 10 ppm	31648	5.80
Without mulch + NAA 20 ppm	20250	4.10
Without mulch + 2,4-D 15 ppm	24850	4.80
Without mulch + 2,4-D 30 ppm	20730	4.20
Without mulch + Water spray	19270	3.90
Without mulch + Control	17030	3.80

Selling price of custard apple fruit Rs. 10/- / kg

Oosthuyse, S.A. (1995). Effect of spray application of GA_3, NAA and CPPU on fruit retention, fruit size and yield in Tommy Atkins and Heldi mango. South African Mango Growers Association. **15** : 31-33.

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Efficacy of plant growth regulator and food preservative against *Penicillium* rots of Kinnow (*Citrus deliciosa* Ten.) fruits

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Abstract

Kinnow (*Citrus deliciosa*) fruits are prone to attack with various post-harvest fungal rots. Among these, *Penicillium* rots viz., green mould rot (*P. digitatum*) and blue mould rot (*P. italicum*) are most destructive, sharing around 40 to 50 per cent of the total post-harvest fruit decay occurred in Sriganganagar belt of Rajasthan. Studies were conducted to evaluate the efficacy of Naphthalene acetic acid (NAA) and potassium metabisulfite (KMS) against these two post-harvest rots during 2004-05 and 2005-06. The results revealed that the dipping treatment of KMS solution proved significantly superior to NAA in respect of retarding the incidence of these rots. The reduction of 57.53 and 60.58 per cent incidence was recorded in green mould rot and blue mould rot respectively in pre-inoculation treatment of KMS while 50.70 and 54.53 per cent reduction in incidence of these rots was noted in post-inoculation treatment of the same chemical in comparison to control. The disease incidence was found to increase with increasing period of incubation.

Key words: Kinnow, post-harvest, *Penicillium*, rots, PGR, food preservative.

Introduction

Kinnow (*Citrus deliciosa* Ten.) is a hybrid variety of mandarin group of citrus. It is exceedingly popular due to its adaptability to varied agro-climatic conditions, heavy bearing and excellent juice quality. It is mostly grown in Northern states of India, covering area of 45101 ha and producing 324208 million tonnes with productivity of 7.18 million tonnes ha^{-1} (Singh and Thakur, 2006). Rajasthan occupies a pivotal role in Kinnow cultivation with 10382 ha area and annual production of 85700 million tonnes with productivity of 250-300 qtl ha^{-1} (Anonymous, 2008). Kinnow fruits are prone to attack with various post-harvest fungal rots during storage. Among these, green mould rot and blue mould rot caused by *Penicillium digitatum* and *P. italicum* respectively are most destructive causes around 40 to 50 per cent of the total post-harvest fruit loss in Sriganganagar belt of Rajasthan (Sharma, 2007). It is not essential to kill a pathogen present in a injury in order to prevent disease development but rather only to maintain a fungistatic concentration of the chemical at the injury site for as long as the injury is receptive to infection. Fruits that have an active metabolism show considerable resistance to microbial infection and decay, whereas stressed or senescent fruits are prone to disease. Plant growth regulators control physiological processes at extremely low concentrations, are known to delay the senescence and onset of fruit rotting (Sommer, 1982). Present investigation was therefore undertaken to find out efficacy of plant growth regulator (PGR) viz., naphthalene acetic acid (NAA) and food preservative viz., potassium metabisulfite (KMS) against two major post-harvest *Penicillium* rots in Kinnow fruits.

Material and methods

Healthy and mature fruits of uniform size were harvested, surface sterilized and pricked through 'pin-prick method' (Tomkins and Trout, 1931) upto the depth of 2 mm, making 5 wounds/fruit. These fruits were separately inoculated by dipping them in spore suspension (10^6 spores ml^{-1}) of each pathogen i.e. *P. digitatum* and *P. italicum* separately for 2 minutes. The plant growth regulator (NAA) and food preservative (KMS) were dissolved separately in sterile distilled water so as to get 100 and 600 ppm concentration of these chemicals respectively and used for pre- and post-inoculation dip treatments (Thompson, 1996. In case of pre-inoculation treatment, the fruits were first dipped in the test chemical for 5 minutes, air dried for 15 minutes and then inoculated with the respective pathogen. While in the post-inoculation treatment, the fruits were first inoculated and then treated with chemicals. Parallel controls with fruits dipped in

sterile distilled water were run simultaneously. The interval between inoculation and treatment with chemicals or vice-versa was of 12 hr. Each treatment was replicated thrice, having seven fruits in each replication. The experimental design was a factorial completely randomized design.

The inoculated fruits were enclosed separately in pre-sterilized perforated polythene bags partially sealed with paper pins and incubated at 25 ± 1°C temperature and 90-100 per cent relative humidity. The number of wounds showing rotting were recorded on 3rd and 6th day of inoculation and analysed statistically after angular transformation. The rot reduction index (RRI) was calculated on the basis of aggregate mean of rotting (Gutter, 1969) is given below:

$$RRI = \frac{\text{\% rot in control} - \text{\% rot in treatment}}{\text{\% rot in control}} \times 100$$

Results and discussion

In general, fruits treated with plant growth regulator (NAA) and food preservative (KMS) exhibited significantly less incidence of rotting in both pre- and post-inoculation treatments as compared to untreated control fruits. Between these chemicals, KMS given significantly better results to NAA in reducing the incidence of rots. The rot incidence was found to increase with increasing period of incubation. At 6th day of inoculation the rot incidence was significantly higher to the incidence of rot

Table 1. Efficacy of plant growth regulator and food preservative against green mould rot incidence in post-harvest treated Kinnow fruits

Treatments	Conc. (ppm)	% Rot incidence in pre-inoculation treatment at (days)				% Rot incidence in post-inoculation treatment at (days)			
		3	6	Mean	RRI	3	6	Mean	RRI
Naphthalene acetic acid	100	30.4 (33.4)	46.1 (42.8)	38.2 (38.1)	48.1	38.6 (38.4)	53.9 (47.3)	46.3 (42.8)	39.2
Potassium metabisulfite	600	25.0 (30.0)	37.5 (37.8)	31.3 (33.9)	57.5	30.7 (33.7)	44.3 (41.7)	37.5 (37.7)	50.7
Control	-	60.0 (50.8)	87.1 (69.6)	73.6 (60.2)	0.0	62.2 (52.0)	90.0 (72.1)	76.1 (62.1)	0.0
Mean		38.5 (38.1)	56.9 (50.0)			43.8 (41.4)	62.7 (53.7)		
CD (*P=0.05*)									
Treatments			2.3					2.1	
Days			1.9					1.7	
Treatments x Days			3.3					2.9	
CV (%)			5.0					4.1	

Figures in parentheses are arc sine transformed values

Table 2: Efficacy of plant growth regulator and food preservative against blue mould rot incidence in post-harvest treated Kinnow fruits

Treatments	Conc. (ppm)	% Rot incidence in pre-inoculation treatment at (days)				% Rot incidence in post-inoculation treatment at (days)			
		3	6	Mean	RRI	3	6	Mean	RRI
Naphthalene acetic acid	100	28.6 (32.3)	41.8 (40.3)	35.2 (36.3)	52.6	35.4 (36.5)	50.0 (45.0)	42.7 (40.7)	44.5
Potassium metabisulfite	600	24.3 (29.5)	34.3 (35.8)	29.3 (32.7)	60.6	28.9 (32.5)	41.1 (39.9)	35.0 (36.2)	54.5
Control	-	60.0 (50.8)	88.6 (70.8)	74.3 (60.8)	0.00	61.8 (51.8)	92.2 (74.2)	77.0 (63.0)	0.0
Mean		37.6 (37.5)	54.9 (49.0)			42.0 (40.3)	61.1 (53.0)		
CD (*P=0.05*)									
Treatments		2.4						1.5	
Days		1,9						1.2	
Treatments x Days		3.4						2.1	
CV (%)		5.2						3.0	

Figures in parentheses are arc sine transformed values

occurred at 3rd day of inoculation in both pre- as well as post-inoculation treatments.

Green mould rot

Dipping treatment of KMS proved significantly superior in checking the rot where only 31.3 and 37.5 per cent incidence was noted in pre- and post-inoculation treatments respectively (Table 1) as compared to NAA treatment. The rot incidence in untreated control fruits was 73.6 and 76.1 per cent in pre- and post-inoculation treatments respectively. The rot incidence of 38.5 and 56.9 per cent recorded at 3rd and 6th day of inoculation in pre-inoculation treatment while these were 43.8 and 62.7 per cent rot respectively in post-inoculation treatment.

Blue mould rot

In KMS treatment, the blue mould rot was 29.3 and 35.0 per cent rot in pre- and post-inoculation treatments respectively while, these were 35.2 and 42.7 per cent in NAA treatment as compared to 74.3 and 77.0 per cent in untreated control fruits (Table 2). At 3rd and 6th day of inoculation, the rot incidence of 37.6 and 54.9 per cent recorded in pre-inoculation treatment while 42.0 and 61.1 per cent rot incidence was observed in post-inoculation treatment at same days of inoculation respectively.

These findings are corroborated with that of Dhatt *et al.* (1995) who reported that plant growth regulators reduced the incidence of post-harvest diseases and consequently increased shelf life of citrus fruits. The efficacy of plant growth regulators against *Penicillium* rot of sweet orange fruits has also been reported earlier by Godara (1994). Gupta and Pathak (1990) reported that NAA was most effective against post-harvest rotting of fruits when applied at 0.01 per cent concentration. According to Adaskaveg *et al.* (2002) plant growth regulators delayed the senescence of citrus fruits and consequently delay their susceptibility to rotting. Therefore, the incidence of rottings reduced in NAA treated fruits might be due to its antisenescent properties that maintained better fruits, avoiding congenial conditions for attack of pathogenic fungi. Most of these compounds occur naturally and hence their use in post-harvest citrus treatments is expected to receive consumer acceptance (Singh *et al.*, 2004).

Sharma *et al.*, (1994) and Jakhar (2003) have also reported the efficacy of potassium metabisulfite in checking post-harvest spoilage in mango and tomato fruits. Potassium bisulfite checks the post-harvest fruit decay by releasing sulphur dioxide (SO_2) which had inhibitory effect on pathogenic moulds (Luvisi, 1992). In general, fruit rot incidence increased over duration of storage might be due to weakening of the defence system in fruits against the fungal attack because of decrease in pectin substances and multiplication of already existing pathogens during storage (Dennis, 1977).

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Distribution of solar radiations in guva (Psidium guajava L.) plants at different spacing : influence on fruit quality

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Abstract

The study was conducted to examine the solar radiation distribution in different parts of 7- year's old guava plants and its subsequent effect on fruit quality. The interception of solar radiation was decreased markedly with the depth of plant canopy from top to bottom as well as with increase plant density. More than 3/4th of incoming radiations were intercepted by upper one meter periphery of guava plants irrespective of plant spacing. The fruit quality in terms of size, weight, TSS, vitamin C and overall palatability was significantly reduced with the depth of plant canopy and decrease in plant spacing. The upper canopy fruits particularly of widely spaced plants were better than others. Winter season fruits were double in weight and more palatable as compared to rainy season fruits.

Key words: *Guava, fruit size, solar radiations, quality.*

Introduction

Guava (*Psidium guajava* L.) is an important fruit crop grown in India. Although, the area and production of guava increased significantly in last decade, but there is no significant increase in productivity. Therefore, to increase the productivity level to its maximum productive potential, certain important strategies have been identified. One such strategy is the high density plantation (HDP). However, in high density planting system, interception of solar radiations and other microclimatic conditions such as canopy temperature and relative humidity are important aspects which directly or indirectly affect the vegetative growth, yield and quality of guava fruits. Guava has a higher proportion of 'shade' to 'sun' leaves and their leaves are found photosynthetically inactive under deeper shade and act as unproductive sink (Singh et al, 2005).Therefore, vegetative growth, fruit yield and quality are functions of light interception and translocation of light energy into chemical energy. Production of good quality fruit is function of absorption of light and light is directly proportional to the yield and quality of fruit trees (Jackson, 1980, Palmer, 1989, 1992). Brar *et al* (2009) investigated that light interception was more in guava trees planted at wider spacing and decrease significantly with the depth of the canopies irrespective of the planting densities. Similarly Singh and Dhaliwal (2007) reported that fruit yield and quality of guava fruits decreased with poor light interception at higher planting densities. Therefore, the present investigations were made to study the radiation penetration in guava plants at different spacing and its effect on physical and chemical characteristics of fruits.

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Materials and Methods

The present investigation on seven year old guava plants cv. 'Allahabad Safeda' at different spacing viz. 6x2m, 6x3m, 6x4m and 6x5m were carried out at the New Orchard, Department of Horticulture, PAU, Ludhiana in the year 2007-08 to 2008-09 for both rainy (March-August) and winter (September-February) crop seasons. The solar radiation measurements were recorded in clear days thrice a day viz. 8.00-10 am, 12.00-2.00 pm and 4.00-6.00 pm by recording the sensor output from Pyranometer using a Digital Multi-Volt Meter. The Pyranometer measures the total direct and diffuse solar radiation. Incoming solar radiation measurements (Cal/cm^2/min) were recorded at one foot above the canopy and at the centre of the upper, middle and lower parts of the tree by facing Pyranometer upward. The Pyranometer was inverted at a height of one foot above the canopy to see the tree canopy below and thus the amount of reflected short wave radiations [Albedo (A)] was recorded. The radiation/light interception was calculated as the difference between incoming radiations received in each of the three different parts of the tree canopy and was expressed as intercepted radiation at a particular time of observation.

Radiation intercepted in the upper part = $\frac{I-(I1+A)}{I} \times 100 = X\%$

Radiation intercepted in the middle part = $\frac{I-(I2+A)}{I} \times 100 - X\% = Y\%$

Radiation intercepted in the lower part = $\frac{I-(I3+A)}{I} \times 100 - (X\%+Y\%) = Z\%$

Total light intercepted by the tree canopy = X+Y+Z

Where,

I = Incoming solar radiation received one feet above top of the tree canopy.

I_1= Incoming solar radiation received in the upper part of the tree canopy.

I_2= Incoming solar radiation received in the middle part of the tree canopy.

I_3= Incoming solar radiation received in the lower part of the tree canopy

The physico-chemical characteristics of both rainy and winter season crops were recorded in July-August and November-December respectively. The observations on physical characters of fruits of all canopy parts of plants at different spacing were noted in terms of fruit size, fruit weight and seed number per fruit. Similarly, the quality characters of both rainy and winter season fruits were recorded in July-August and November-December, respectively during the year of 2007 and 2008. The data on quality characters of fruits were determined in terms of palatability rating, total soluble solids, acidity and vitamin C content according to the method of AOAC (2000).

Results and Discussion

The total radiation intercepted by Allahabad Safeda guava plants was maximum i.e. 72.76 % and 67.93% of 6x4m followed by 70.94% and 66.49% in 6x5m spaced plants during rainy and winter season, respectively (Table 1). Decrease in radiation interception with the increasing plant density and depth of canopy was observed during both seasons. Minimum total radiations i.e. 61.13% and 57.64% were intercepted in 6x2m spaced plants during rainy and winter crop seasons, respectively.

The upper part of plants at 6x4m spacing intercepted highest solar radiations during rainy (56.10%) as well as winter (51.25%) season and least in 6x2m spaced plants with 48.7% (rainy) and 45.2% (winter) radiation interception. Similar trend of radiation interception with plant density and depth of plant canopy was recorded during both seasons. During winter crop season (September-February), radiation interception in the upper part of plants in all spacing levels as well as total radiation intercepted was recorded lesser as compared to the rainy crop season i.e. March – August due to the difference in inclination of solar radiations during winter and summer seasons. Moreover the old leaves turning yellow as well as the new leaves have relatively high transmissibility (Mavi,1986), thus less radiations were intercepted during this period in the upper part of the plant canopies and slightly more of radiations were reached in the middle and lower parts of the canopies.

Somewhat vertical orientation of auxiliary shoot and leaves causing less absorption and more reflection of incoming solar radiations results reduction in radiation interception in plants at closer spacing of 6x2m and 6x3m. The plants at 6x4m spacing were found to intercepted highest radiations owing to higher foliage and more horizontal orientation of shoots and leaves. The results obtained in the present study are in line with that of Heinicke (1963) and Loony (1968) who also found rapid decrease in light intensity with increasing depth of plant canopy. The present findings are in accordance with Singh *et al* (2005) and Singh and Dhaliwal (2007) who also found that, in guava radiation interception by the guava tree increased with increasing planting distance. The other related finding are also in accordance with the present investigation e.g. light intensity of full sun light (100 per cent) available at periphery of the round headed apple tree canopy fell to 34 per cent at the depth of 1m (Jackson, 1976) and 42 per cent at the depth of 2m (Heinicke, 1966). In citrus 90 per cent of solar radiation is absorbed by the first 3 feet (0.9m) of tree canopy (Green and Gerber, 1967).

Quality characteristics of guava fruits

Fruit size: Reduction in fruit size was recorded with the increase in plant density as well as with the depth of plant canopy (Table 2). Size of fruits obtained from the upper parts of plants at 6x4m spacing during rainy season was found maximum (length 5.10cm and breadth 5.25cm). During winter season fruit length was recorded maximum i.e. 6.70cm in 6x4m and fruit breadth 6.67cm in 6x5m spaced plants. Smallest fruits were obtained from the lower parts of plant canopy i.e length (4.48 and 5.75cm) and breadth (4.62 and 5.82cm) during rainy and winter season, respectively. Higher fruit size during winter season might be due to quite less number of fruit bearing during winter season and also due to more accumulation of carbohydrates at low temperature in winter season. Higher availability of photosynthates and less competition for nutrients and microclimatic parameters in plants at wider

spacing and upper parts of canopy contributed increment in fruit size. The reduction in fruit size due to poor light penetration subsequently affecting carbohydrate supply in apple supports the results of present investigations (Tustin et al, 1989). The present results are also in agreement with the findings of Lal *et al* (2000) and Singh and Bal (2002) in a similar study on guava.

Fruit weight: The mean fruit weight was found to be increased with increase in plant spacing particularly during winter season. Maximum mean fruit weight of 94 and 95g per fruit during rainy season (Table 2) and 162 and 160 g per fruit during winter season was recorded in upper parts of plants at 6x5m and 6x4 m spacing, respectively. Size of fruits obtained from the lower parts of plants reduced significantly in all spacing levels during both seasons. The winter season fruits were much heavier than rainy season fruits (Table 3). The results are in agreement with the findings of Rathore (1976) in guava that cessation of vegetative growth during cool climate results divertion of food reserves to fruit development causing higher fruit size and weight. The fruits were weighted less in plants at closer spacing and lower parts of plant canopy; this may be ascribed to the reduced availability of photosynthates to the developing fruits due to smaller canopies of the trees and less light penetration. The similar results were obtained by Lal *et al* (2000) and (Kundu, 2007) in guava.

Seed number: Seed numbers in fruit of both season exhibited positive relationship with increase in spacing. However, middle canopy fruits contained higher seed content as compared to lower and upper canopy fruits during rainy (Table 2) and winter (Table 3) seasons. Maximum mean number of seeds were counted in fruits obtained from middle parts of the plants during rainy (239) and winter (326) season. Fruits taken of lower canopy of plants at closest spacing of 6x2m exhibited least seed numbers during rainy (185) as well as winter (267) season. Reduction in seed proportion in fruits of lower parts of plant at closer spacing may be attributed to uncongenial microclimatic conditions resulting poor germination of pollens on the stigma or poor pollen tube growth *in vivo* under such conditions. Since the seed number of guava is due to pollen germination on stigma/pollen tube penetration through style dependent, therefore, stigma desiccation due to high velocity winds might have created unfavorable conditions for pollen germination thereby fertilizing less number of ovules per fruit of upper parts of canopy of plants at wider spacing (Singh, 2003).

Palatability rating (PLR): The palatability rating of fruits was increased with increase in plant spacing as well as height of plant canopy in both rainy (Table 4) as well as winter (Table 5) season crops. The upper canopy fruits of plants at 6x5m spacing were maximum palatable with rating of 8.38 during winter and 6.70 during rainy season. The fruit PLR of both seasons decreased significantly with the depth of plant canopy and increase in plant density. The least PLR during rainy (6.10) and winter (8.0) was recorded in lower canopy of plants at highest density plants. Decrease in palatability rating with decrease in plant spacing and depth of plant canopy may be due to reduced interception of solar radiations and uncongenial microclimatic conditions leading to reduced TSS, reducing sugars, higher acidity, poor fruit size and lesser colour development as compared to fruits obtained from plants at wider spacing and upper parts of canopy. These results are in the same line with the results recorded by Singh (2005) who obtained significantly higher PLR in widely spaced and upper parts of plants of guava.

Total soluble solids (TSS): The upper canopy fruits of plants exhibited maximum mean TSS i.e. 9.77 and 11.26% and minimum of 9.49 and 10.36% in lower canopy fruits during rainy (Table 4) and winter (Table 5) season crop, respectively. Highest TSS content in rainy (9.90%) and winter (11.80%) season was recorded in upper canopy fruits of 6x5m spaced plant and least 9.13% (rainy) and 10.20% (winter) in lower canopy fruits of 6x2m spaced plants. Decrease in TSS in fruit of closely spaced plants particularly at lower canopy areas may be ascribed to the upright and compact canopies which interfere in radiation penetration during the critical period of fruit development and also lesser source to sink ratio at smaller canopies of plants at high density. Amiable microclimatic conditions results higher TSS in upper parts of plants. Lal *et al* (2000) Singh and Bal (2002) and Singh *et al* (2007) also recorded increase in brix degree with increase in plant spacing. Singh and Dhaliwal (2004) also reported higher TSS in fruits of upper parts of plant canopy in guava.

Acidity: Decreasing trend of acidity in guava fruits with increasing plant spacing and height of plant canopy was observed during both seasons. Lower canopy fruits of both seasons contained average maximum acidity of 0.213% (Table 4 &5) followed by middle and upper canopy fruits. Least ascorbic acid content was analyzed in fruits of upper canopy of plant at wider spacing of 6x5m during rainy (0.185%) seasons. The reduction in acid content in fruits of upper parts of plants and plants at wider spacing may be accredited to the possible conversion of organic acids into total sugar content or increased fruit volume may also be the another reason to reduce the acidity level in larger fruits. These findings are in agreement with that of Singh and Dhaliwal (2004) that the acidity was increased with the increase in planting density in guava.

Vitamin C: In rainy season, average vitamin C content of upper canopy fruits was significantly higher i.e. 152.3 mg /100g fruit in rainy and 178.4 mg/100 g fruit in winter season. Highest vitamin C content was recorded in upper canopy fruits of plants in rainy (158.1 and 160.5 mg) and winter (190.0 and 185.5 mg) season at 6x5 m and 6x4m spaced plants, respectively. Increment in vitamin C content of fruits of widely spaced and upper canopy fruits may be owing to higher radiation interception and assimilation of

better nutrition and photosynthates as compared to the plants at closer spacing. Similar results were obtained by Singh and Dhaliwal (2004) and Singh and Bal (2002) also reported that ascorbic acid content was increased with increase in plant spacing in different cultivars of guava.

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Table 1. Distribution of solar radiations in different parts of plants at different spacing.

Spacing (m)	Solar radiation interception (%)							
	Rainy Season				Winter Season			
	U	M	L	T	U	M	L	T
6x5m	54.25	10.73	5.96	70.94	49.80	10.78	5.91	66.49
6x4m	56.10	10.71	5.95	72.76	51.25	10.79	5.89	67.93
6x3m	53.12	8.32	4.29 6	5.73	49.50	8.56	4.36	62.42
6x2	48.70	8.25	4.18	61.13	45.20	8.25	4.19	57.64
CD (P=0.05)	Spacing (A): 1.31 Part of plant (B): 2.26 AxB: NS				Spacing (A): 2.07 Part of plant (B). 0.75 AxB : NS			

Table 2. Physical characters of rainy season fruits obtained from upper (U), middle (M) and lower (L) parts of plants at different spacing.

Spacing (m)	Solar radiation interception (%)											
	Fruit length (cm)			Fruit breadth (cm)			Fruit weight (g)			Seed number		
	U	M	L	U	M	L	U	M	L	U	M	L
6x5m	5.10	4.72	4.65	5.23	5.13	4.82	94	76	64	243	252	245
6x4m	5.10	4.70	4.63	5.25	5.09	4.85	95	74	65	250	255	248
6x3m	4.95	4.62	4.52	5.10	5.03	4.70	82	67	58	221	235	210
6x2m	4.87	4.55	4.48	4.90	4.75	4.62	68	62	52	209	213	185
Mean	5.01	4.65	4.57	5.12	5.00	4.75	84.8	69.8	59.8	231	239	222
CD (P=0.05)	A: 0.09 B: 0.11 AxB: NS			A: 0.08 B: 0.09 AxB: NS			A: .9.4 B:5.8 AxB: 6.5			A: 21.2 B : 18.5 AxB: 16.3		

Table 3. Physical characters of winter season fruits obtained from upper (U), middle (M) and lower (L) parts of plants at different spacing.

Spacing (m)	Fruit length (cm)			Fruit breadth (cm)			Fruit weight (g)			Seed number		
	U	M	L	U	M	L	U	M	L	U	M	L
6x5m	6.60	6.35	6.10 6.35	6.24	6.10	162	151	136	310	327	357	
6x4m	6.70	6.32	6.10 6.33	6.20	6.05	160	155	135	302	342	322	
6x3m	6.40	6.20	5.85 6.25	6.13	5.90	150	133	128	284	317	308	
6x2m	6.25	6.08	5.75 5.80	6.05	5.82	132	125	119	285	319	267	
	6.49	6.24	5.95 6.18	6.16	5.97	151.0	141.0		129.5 295	326	314	
CD (P=0.05)	A: 0.12 B: 0.10 AxB: NS		A: 0.07 B: 0.06 AxB: NS	A: 6.7 B: 7.2 AxB: 3.8			A: 10.5 B : 13.3 AxB: 12.2					

Table 4. Quality of rainy season fruits obtained from upper (U), middle (M) and lower (L) parts of plants at different spacing.

Spacing (m)	PLR (out of 9)			TSS (%)			Acidity (%)			Vitamin C(mg/100 g pulp)		
	U	M	L	U	M	L	U	M	L	U	M	L
6x5m	6.65	6.45	6.35	9.88	9.75	9.83	0.185	0.190	0.203	158.1	152.5	147.1
6x4m	6.70	6.45	6.29	9.90	9.72	9.66	0.192	0.191	0.210	160.5	150.5	148.5
6x3m	6.25	6.18	6.20	10.00	9.66	9.35	0.190	0.200	0.225	145.5	148.2	140.5
6x2m	6.15	6.10	6.05	9.55	9.33	9.13	0.210	0.215	0.215	145.0	140.5	138.6
Mean	6.44	6.30	6.22	9.77	9.62	9.49	0.194	0.199	0.213	152.3	147.9	143.7
CD (P=0.05)		A: 0.09		A: 0.04	A: 0.04		A: 10.1					
		B: 0.12		B: 0.05	B: 0.07		B: 9.5					
		AxB: NS		AxB: NS	AxB: NS		AxB: 8.6					

[A: Plant spacing, B: Parts of plant canopy AxB: Interaction of spacing and parts of plant canopy, U: Upper, M: Middle, L: Lower parts of plant canopy, T: Total light interception in whole plant, PLR: Palatability rating; NS: Non-significant]

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SHORT COMMUNICATION

Effect of peeling and thickness of slices on shelf-life of dehydrated kachari (*Cucumis callosus* L.)

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Kachari (*Cucumis callosus* L.) is one of the minor vegetables of family cucurbitaceae. The post-harvest losses in Kachari vary from 30-40 per cent due to its perishable nature and glut during harvesting time, which also reduces the market value of the fruit. Hence, dehydration is the only solution to overcome the problem of post-harvest losses as well as to provide high returns to the growers alongwith the availability of the fruit during off-season. Appropriate size of slices and peeling of fruits are good for drying and dehydration and improve the appearance, colour, quality of dehydrated product. Sulphuring treatment also improve the quality of the product. Sanitation was maintained in solar dryer as the dehydrated produce should be free from dust, flies, bees, etc. The solar dryers are simple to fabricate and well suited to rural conditions and small scale food processing industries. Keeping these points in view the present investigation has been carried out to study the effect of peeling, thickness of slice, sulphuring treatments and drying and dehydration techniques on the physico-chemical quality of the product.

Fully matured unripened uniform sized fruits with no injury on skin were procured from the Kachari growing area of Jaipur district of Rajasthan. Fruits were washed in the laboratory with running tape water followed by distilled water to remove dirt, dust particles, pesticide residues, etc and air dried. The fruits were subjected to three drying methods viz. sun drying (D_1), solar drying (D_2) and oven drying (D_3). Fruits were sliced in two thickness viz., 0.3 cm thick slices (T_1) and 0.6 cm thick slices (T_2). There were two treatments of peeling viz., with peeling (P_1) and without peeling (P_2). The slices prepared were subjected to two sulphuring treatments viz., with sulphuring (S_1) and without sulphuring (S_2). In all there were 24 treatment combinations. Required quantity of Kachari fruits were taken and removed the peels by peeling knife. Slices of 0.3 cm and 0.6 cm thickness were prepared from both peeled and unpeeled fruits with the help of peeling knife. Slices were exposed to sulphur fumes in a sulphuring cell. The tray load was 500 g fruits per square ft area. Burning sulphur dust on the charcoal fire produced fumes. The slices were confined to the fumes for 30 minutes. The quantity of sulphur burnt was 2 g per charge. After application of treatments the slices were subjected to drying. For sun drying, the slices were spreaded in open sun light until completely dried. The average maximum and minimum, temperature was 35.1° and 11.6°C, respectively. The slices were completely dries in 8 days. The slices were loaded uniformly in a multitray cabinet solar dryer which was placed in open sun for solar drying. The top of the solar dryer was covered with a transparent glass and the sides were coated with black colour. The trays were changed in rotation from lower shelf to the upper one in order to ensure uniform drying of the entire mass. The temperature of the solar dryer was 5-7°C higher than sun drying. The slices were completely dried in 6 days. For dehydration in oven, the slices were spreaded on trays with a load of 500 g per sq. ft area. The temperature of the oven was ranged from 50-55°C. The slices were completely dried in 10-12 hrs. The drying ratio was calculated after weighing the fresh and dried slices. 10g of dried slices from lot were taken and subjected to boiling water for 15 minutes and then weighed after cooling and rehydration ratio was calculated (Ranganna,1991). The ascorbic acid, carbohydrates and protein content of slices were analyzed with the help of methods suggested by (AOAC,1990). The colour and organoleptic evaluation was done by a panel of 5 judges, as per the Hedonic Rating Test Amerine et al.(1965). To test the significance of variation in the date obtained, the analysis of variance technique was adopted as suggested by Fisher (1950) for completely randomized design. Significance of the difference in the treatment effect was tested through 'F' test.

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It is obvious from the results that the drying and rehydration ratio was significantly affected by different treatments (Table 1). The maximum (10.10) drying ratio was obtained in 0.3 cm thick peeled sulphured slices dried in solar dryer ($D_2T_1P_1S_1$ treatment combination). The slices dried under sun resulted in **maximum moisture loss as** compared to other methods. It was observed that 0.3 cm thick unpeeled sulphured slices of Kachari dried in solar dryer ($D_2T_1P_2S_1$ treatment combination) absorbed more water and resulted highest rehydration ratio (4.0) as compared to 0.6 cm thick peeled non-sulphured slices dried in sun or oven. It might be due to uniform drying in solar dryer as compared to sun and oven drying, favourable effect of sulphuring treatment, presence of more pulp and seeds in peeled slices increased the drying ratio while the presence of peels on the slices favoured the absorption of water and consequently increased the rehydration ratio. Roy and Singh (1979) in bael have also reported similar findings.

The results revealed (Table 1) that the solar dried slices of 0.6 cm thickness with peeling and sulphuring treatment retained greater amount of ascorbic acid as compared to sun and oven drying of 0.3 cm thick unpeeled slices without sulphuring treatment. Sulphur treatment reduced the destruction of carotene and ascorbic acid, which are important nutrients for fruits Raghupathy and Thangavel (2003).

The carbohydrates and protein content of the slices affected significantly with the application of different treatments. The solar dried peeled sulphured slices of 0.3 cm thickness retained maximum carbohydrates and protein as compared to all other treatment combinations. More availability of pulp in peeled slices and favourable effect of sulphuring treatment retained more carbohydrates. Khurdia and Roy (1986) found that fruits dried in solar dryer retained high SO_2 content with fewer changes in reducing and total sugars as compared to those dried in

Table 1. Effect of different treatments on the physico-chemical characteristics of dried Kachari slices.

Treatments	Drying ratio	Rehy-dration ratio	Ascorbic acid (mg/ 100g pulp)	Carbo hydrates (%)	Protein (%)	Colour score (Out of 10 marks)	Organo leptic rating (out of 10 marks)
$D_1T_1P_1S_1$	10.05	2.28	19.35	49.39	9.97	6.70	6.41
$D_1T_1P_1S_2$	10.01	2.20	18.50	49.15	9.46	6.52	6.00
$D_1T_2P_1S_1$	10.05	2.25	19.45	49.24	9.85	6.62	6.38
$D_1T_2P_1S_2$	10.03	2.18	18.61	48.99	9.40	6.43	5.90
$D_1T_1P_2S_1$	9.85	3.28	17.50	42.76	6.95	5.55	6.40
$D_1T_1P_2S_2$	9.80	3.20	16.70	42.10	6.25	5.30	5.97
$D_1T_2P_2S_1$	9.82	3.26	17.40	42.61	6.90	5.47	6.35
$D_1T_2P_2S_2$	9.78	3.19	16.65	42.20	6.39	5.25	5.87
$D2T_1P_1S_1$	10.10	2.90	23.29	42.39	12.20	8.20	8.51
$D2T_1P_1S_2$	10.06	2.70	22.89	52.00	11.90	8.00	7.90
$D_2T_2P_1S_1$	10.09	2.89	23.40	52.23	12.10	8.15	8.45
$D_2T_2P_1S_2$	10.05	2.65	22.75	51.89	11.70	7.90	7.70
$D_2T_1P_2S_1$	9.95	4.00	17.90	46.50	7.69	7.50	8.25
$D_2T_1P_2S_2$	9.90	3.50	16.85	46.20	7.20	7.31	7.65
$D_2T_2P_2S_1$	9.94	3.95	17.95	46.37	7.67	7.40	8.18
$D_2T_2P_2S_2$	9.90	3.45	16.90	46.15	7.19	7.20	7.60
$D_2T_2P_1S_1$	10.07	2.83	21.09	50.62	10.92	7.93	7.37
$D_3T_1P_1S_2$	10.00	2.61	20.65	49.84	10.49	7.70	7.13
$D_3T_2P_1S_1$	10.04	2.80	21.00	50.48	10.75	7.89	7.35
$D_3T_2P_1S_2$	10.00	2.56	20.52	49.75	10.45	7.60	7.10
$D_3T_1P_2S_1$	9.89	3.80	17.69	44.79	7.56	7.32	7.00
$D_3T_1P_2S_2$	9.84	3.40	16.95	44.25	7.30	7.14	6.69
$D_3T_2P_2S_1$	9.87	3.75	17.74	44.67	7.45	7.10	6.95
$D_3T_2P_2S_2$	9.83	3.39	16.90	44.11	7.35	6.90	6.67
SEm -+	0.01	0.02	0.051	0.060	0.075	0.058	0.075
CD (P=0.05)	0.03	0.06	0.15	0.18	0.22	0.17	0.22

D_1 - Sundrying
D_2-Solar drying

T_1 – 0.3 cm thick slice
T_2 – 0.6cm thick slice

P_1-With peeling
P_2- Without peeling

S_1-Sulphuring
S_2- Non-sulphuring

open sun. Similar results were also reported by Tripathi *et al.* (1988) in aonla.

Slices dried under solar dryer resulted in minimum loss of colour as compared to slices dried under sun and oven. Sun dried slices had maximum loss of colour due to the effect of direct sunlight. Lee *et al.*, (1994) also obtained desirable colour when persimmon fruits were either dried with hot air + sun or artificial ventilation. The desirable bright attractive white yellowish colour with maximum score was observed by colour judging panel peeled slices of 0.3 cm thickness as compared to unpeeled and 0.6 cm thick unsulphured slices. It might due to the fact that colour of smaller peeled slices was attractive and desirable and sulphur fumes prevent oxidative browning. These results are close agreement with those of Cai and Corke (2001). The peeled slices of 0.3 cm thickness dried in solar dryer were highly acceptable with maximum organoleptic score over unpeeled slices of 0.6 cm thickness dried in sun or oven. The maximum benefit cost ratio of 1.21 was obtained with 0.3 cm peeled and sulphured slices dried under solar dryer.

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SHORT COMMUNICATION

Performance of garlic (*Allium sativum*) var. Agrifound Parvati under different planting system in cold arid condition of Ladakh (J&K)

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Ladakh, the northern part of India located in the Trans Himalayas at an altitude of 11,500 ft. above MSL. The climate of cold arid region is a blunt of arctic and desert climates characterized by long severe winter where mercury drops down to -40°C while summer is short hot with cooler nights and dries with scanty rainfall. Garlic (*Allium sativum*) is the second most widely used cultivated vegetable *Allium sativum* after onion it is being used in several food preparations. This is an essential part of the fresh vegetable provided to the troops of Ladakh due to its high medicinal value. According to the ration scale of the Army, it is provided at a scale of 20gm/person/day (Sharma et al., 2009). If the same scale used, there is an average requirement of 1800 MT fresh Garlic annually in Ladakh region for local population as well as army deployed in this sector (FRL Report, 2003). As on date, the complete requirement is met by airlifting Garlic from others part of the country, so in order to achieve this targets, there is need to develop the production technology and to enhance the production of Garlic. Therefore, an attempt was made on the production and performance of Garlic under different planting methods in Leh conditions.

A field experiment was conducted at RARS, SKUAST-K, Leh, Ladakh (J&K) during 2006 and 2007. The soil are sandy loam in texture, slightly alkaline in reaction (pH - 8.2), medium in organic carbon (0.62%), low in available phosphorus (8.2 kg ha^{-1}) and medium in available potassium (225 kg ha^{-1}). The experiment was laid out in Randomized Block Design under two planting methods (Raised bed system and flat bed system). The test variety of Garlic was Agrifound parvati. The nitrogen was applied @ 80 kg ha^{-1}, half dose of nitrogen was applied at field preparation and remaining half 15-20 days after emergence: Phosphorus (60 kg ha^{-1}) was applied through DAP and potassium 40 kg ha^{-1} through MOP as a basal dose at field preparation. Sowing was done on 15th and 17th October during 2006 and 2007, respectively, at a spacing of 15 cm between rows and 9 cm between plants. The field was covered by the leaf litter of popular and willow trees during winter season (November to April) of the year. After removing the leaf litter from Garlic field need based agricultural practices were performed in the Garlic field in the month of April.

The survival per cent of Garlic var. Agrifound parvati was similar in both the raised bed system and flat bed system. The yield of Garlic under raised bed system was higher during both the years (2006 and 2007) as compared to flat bed system or conventional system. On an average yield of Garlic was 104.09 qha^{-1} and 86.38 q ha^{-1} under raised bed and flat bed system respectively (Table 1) the variety of Garlic (Agrifound parvati) raised bed system shown 20.14 % higher in yield over flat bed system. The highest yield (106.67 qha^{-1}) was obtained in the year 2006 under raised bed system and lowest (85.76 q ha^{-1}) in flat bed system during 2007. During the year 2006 and 2007, the yield of Garlic was significantly differ among the planting systems. It may be due to more values of yield attributes characters of Garlic under raised bed system and irrigation water creates the compaction of the soil within 4-5 days after irrigation, which causes average relative humidity <45% and high wind speed under the flat bed system. The trend of variation in yield components

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Table 1. Yield and yield attributes of Garlic (var. Agrifound parvati) under cold arid condition among the different planting system

Characters	Raised bed system			Flat bed system		
	2006	2007	Mean	2006	2007	Mean
Number of bulbs /m^2 at harvest	60	56	58	57	59	58
Survival per cent	77.92	77.2	75.32	74.02	76.62	75.32
Bulb size in length (cm)	3.94	3.79	3.87	3.11	3.13	3.12
Bulb weight (gm)	17.80	18.13	17.97	15.40	14.92	15.16
Cloves / bulb	7.75	7.51	7.63	6.91	6.82	6.87
Cloves weight (gm)	2.97	2.91	2.94	2.34	2.23	2.29
Yield (q ha-1)	106.67	101.50	104.09	87.00	85.76	86.38
Per cent increase over FBS	22.61	18.35	20.48	-	-	-
CD at 1% for yield	4.073	4.062				

viz. bulb size, bulb weight and cloves weight was similar to that of yield of Garlic between raised bed system and flat bed system. On the basis of this study, for Ladakh condition, where the pan evaporation is high and dry environment (average RH <45%), the propagation of cultivation of Garlic on raised bed system can be suggested to achieve the demand targets and get maximum earn from cultivation of Garlic under raised bed system by farmers of Ladakh region.

It is concluded that the survival percentage of Garlic var. agrifound parvati was similar in both the planting system viz. raised bed and flat bed system. The variety of Garlic under raised bed system showed superiority w.r.t. bulb size, bulb weight, cloves bulb, cloves weight and yield (104.09 qha^{-1}) over flat bed system. The variety under raised bed system showed 20.14 per cent higher in yield over flat bed system.

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SHORT COMMUNICATION

Effect of surface sterilizing agents on establishment of axenic culture in kinnow mandarin (*Citrus deliciosa*)

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The surface sterilization is the most important step prior to initiate tissue culture and can become a critical point in establishment of certain species particularly when the explants was derived from field grown woody perennial plants. Kinnow mandarin (*Citrus deliciosa*) is a cross, between the king sweet orange (*Citrus nobilis*) and Willow leaf mandarin (*C. deliciosa*) developed in California by H.B. Frost. Kinnow fruits have a great therapeutic value due to favourable ratio of K and Na. Kinnow fruits are not only delicious and refreshing but also possess great nutritive value. It contains 10-12% carbohydrate, 0.6-0.8% protein, 0.9-1.1% vitamin A, 0.45–0.55% vitamin C, 0.01-0.02% thiamine, 0.002 – 0.003% riboflavin, 0.25-0.35% calcium, 0.18-0.25% magnesium and 0.028-0.034% iron.

Tissue culture technology offers an advantage over conventional methods of propagation ('T'-budding) in producing large number of true to type plants from healthy plant with in a short period of time. In this perspective studies were taken out to standardize the safest concentration and duration of treatment for maximum aseptic culture establishment in kinnow from field grown adult plants.

Young, fresh growing branch from mature (4-5 years) plant of kinnow were harvested and cut in to segments, each segment having at least one bud. These nodal segment were washed under running tap water for two hours followed by 10 minutes in 0.5per cent Bavistin. These explants were treated with quickly once in 70 per cent ethanol followed by surface sterilized with 0.1per cent $HgCl_2$ for 4,6,8,10,12 and 14 minutes and 0.5 per cent sodium hypochlorite solution for 5,10,15,20,25 and 30 minutes and washed thoroughly with autoclaved double distilled water for 3-4 times. These surface sterilized segments were inoculated in screw cap Jam bottles of 200 ml. The bottles contained 30-40 ml of Murashige and Skoog (1962) medium containing 3 per cent sucrose and 0.8 per cent agar. All the surface sterilized explants were inoculated. The medium autoclaved at 121 °C (1.06kg cm-2) for 20 minutes. All the process was carried out under aseptic condition in laminar air flow cabinet.

The each treatment was replicated ten times. All the cultures were incubated in culture room at 27°C ± 0.5°C with 13/11 hrs photoperiod at photo lux intensity of 50-70 μE^2S^1 provided from cool white fluorescent tubes. The data were analyzed in CRD design.

The response of explants to various sterilizing agents in culture medium is presented in Table-1. The efficacy of sterilizing agents $HgCl_2$ and NaOCl with different exposure time was adjudged in terms of maximum aseptic explants produced, which responded to sprouting. In case of Mercuric chloride @ 0.1 per cent, the highest contamination free explants, 95.00 per cent were recorded when quick diped in Ethanol (70 per cent) followed by 12 minutes whereas with NaOCl @ 0.5 per cent at 30 minutes gave 85 per cent. The increase in the exposure period with mercuric chloride (0.1 per cent) upto 14 minutes resulted in death of explants whereas no such effect was observed with NaOCl. The decrease in exposure period with both the chemicals, the contamination of explants increased significantly. These results are in agreement with the results of Kour *et al.* (2007) who reported in rough lemon.

At the end of 30 days of inoculation, the maximum (80 per cent) survival of explants was recorded with mercuric chloride @ 0.1 per cent at 10 minutes with 80 per cent survival, whereas under NaOCl 0.5 per cent with 25 minutes exposure recorded 65 per cent survival of explants. Syamal *et al.* (2007) also reported that $HgCl_2$ was better surface sterilizing agents over other chemicals. The number of shoots (3.09) as well as shoot length (0.93 cm) per explants was maximum under sodium hypochlorite @ 0.5 per cent with 10 minutes exposure whereas in case of mercuric chloride @ 0.1 per cent maximum number of shoots(2.50) and shoot length (0.82 cm). It may be due to tissue injury by the chemical. These results are in concurrence with (Karwa, 2003, Meghwal *et al.*, 2001). The number of shoot and length of shoot decreased with increasing time exposure of treatment of both chemicals, may be due to presence of mercury in mercuric chloride and chlorite in sodium hypochlorite. Similar results have been reported by Amin and Jaiswal (1987)

Table 1. Effect of Surface sterilizing agents on sterilization on nodal segments of kinnow mandarin after 30 days of incubation.

	Mercuric chloride (HgCl@ 0.1%)					Sodium hypochlorite (NaOCl@0.5%)			
Duration (Min.)	Contamination free explant (%)	Final establishment of explants (%)	Number of shoots per explants	Length of shoot (cm)	Duration (Min.)	Contamination free explant (%)	Final establishment of explants (%)	Number of shoots per explants	Length of shoot (cm)
4	0.0 (0.0)	0.00 (0.00)	0.0	0.00	5	0.0 (0.0)	0.00 (0.00)	0.0	0.00
6	40.0 (39.23)	25.0 (30.00)	2.50	0.82	10	15.0 (22.79)	10.0 (18.43)	3.09	0.93
8	70.0 (56.79)	65.0 (53.73)	2.26	0.63	15	30.0 (33.21)	25.0 (30.00)	2.73	0.62
10	85.0 (67.21)	80.0 (63.43)	1.93	0.54	20	65.0 (53.73)	55.0 (47.87)	2.10	0.56
12	95.0 (77.08)	20.0 (26.57)	0.97	0.51	25	80.0 (63.43)	65.0 (53.73)	1.76	0.50
14	0.00 (0.00)	0.00 (0.00)	0.00	0.00	30	85.0 (67.21)	15.0 (22.79)	1.06	0.35
Mean	63.41 (52.77)	31.66 (34.20)	1.27	0.42	Mean	51.13 (45.63)	16.0 (22.92)	1.79	0.50
	0.33	0.037	0.035	0.08	SEm±	0.711	0.033	0.065	0.87
	0.95	0.158	0.157	0.22	CD at 5%	2.09	0.172	0.184	0.25

*Figures given in parentheses are angular transformed value

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SHORT COMMUNICATION

Performance of new introduction of date palm under hot arid conditions

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Date palm (*Phoenix dactylifera* L.) is a nutritious fruit and provides high calories of energy. It is rich source of carbohydrates, minerals, vitamin A, B, and B_2 Date palm is mostly suitable for cultivation in arid regions of the country where irrigation facilities are available. It is drought hardy plant and tolerates salinity and aridity. It requires rainless period during fruiting season particularly at the time of ripening. In order to exploit the potential of the north -western dry regions of India for date palm cultivation, a number of varieties have been introduced from Middle East countries, USA, which is performing better in different parts of country (Chandra *et. al.* 1990). Introduction of new varieties having better traits is a continuous process to enrich genetic resource and productivity of crops. In India, date palm is mainly cultivated in western parts of Rajasthan, Kachchh region of Gujarat, Punjab and Haryana. The districts of Rajasthan such as Jaisalmer, Barmer, Bikaner, Jodhour are extremely dry and suitable for date palm cultivation. In addition to this, parts of Sri Ganganagar, Churu, Nagour, Hanumangarh, Sirsa, Sikar are also suitable for date production (Mertia and Vashishtha, 1985). In Kachchh region of Gujarat, date palm is growing in about 12,493 ha area with production of 85,352 tonne doka stage fruits . At present, India imports about 253,341 MT dates from Gulf countries every year of worth 7.2 million $ in the form of pind (soft dates) and dry dates (Chhuhara). In our country, date production is very less due to lack of early maturing varieties, rain tolerant genotypes and sufficient planting materials as well as improved production technology for different agro-climatic conditions. By introducing new cultivars and increasing in area of production will certainly help to save foreign exchange and provide nutritious fruit to rural inhabitants (Singh *et al*, 2003). Looking to its vast potential in arid and semi arid regions, three date palm cultivars were introduced from Iraq to India. In this paper, the performance of new introductions of date palm under hot arid conditions of Bikaner has been discussed.

The Central Institute for Arid Horticulture, Bikaner is located in the north western part of the country. The soil of arid region is sandy, very poor in fertility and water holding capacity, having pH 8.3 to 8.5, ECe 0.1 to 0.15 dSm^{-1} and 0.08 to 0.09 per cent organic carbon. The recurrent drought and extreme aridity is common. The average rainfall is about 240 mm/ annum. May-June is the hottest (mean max. temp. 42.9 °C and mean min. temp. 29.6 °C) and December-January (mean max. temp. 23.7 °C and mean min. temp 8.9 °C) are coldest months of the year. Being sandy desertic, the soil gets heated up and cools soon when exposed to high or low temperatures. Accordingly, occasional frost during December and January is also experienced in this region. The ground water source is deep and saline in quality. The source of irrigation is open well and canal in the region.

Three date palm cultivars namely Shakkar (EC 402388), Braim (EC 402389)and Chip chap (EC 402390) were introduced from Iraq to India through NBPGR, New Delhi during the year 1997 (Annonymous, 1998). One sucker of each cultivar was procured in April, 1997.The sucker of cultivar Shakkar was small in size and rootless while other two were appropriate in size/weight and 3-4 roots were present. The imported plant material was kept under nursery conditions for six months for hardening and rooting before planting in the field. At planting, suckers were treated with Carbendazim (0.1%) and IBA 1000 ppm. The pits of 1x1x1 m size were prepared and filled with soil mixtures of sand + clay + FYM (1:1:1 ratio) and Methyl parathion dust (50g/ pit). The offshoots were transplanted in field during the month of October. Plants were monitored regularly till establishment and irrigation was given as and when required.

Observations on height of palm, size of leaves, pinnae, emergence of spathe, opening of spathe, fruiting, maturity of berry and quality of berry were recorded.

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The performance of date palm varieties with respect to survival, growth, suckering, spathe emergence, opening of spathe, fruiting, yield (kg/palm) number of bunch/ palm, size of bunch and berry characters have been presented in Table –1.

and Chip chap offshoots survived and sprouted under field conditions of Bikaner, Rajasthan. However, the offshoot of Shakkar could not survive in the field and dried after two months of transplanting, which may possibly be due to small size and under weight of sucker and lack of roots.

Table 1. Performance of exotic date palm germplasm under Indian arid conditions.

Characters	Braim (EC 402389)	Chip chap (EC 402390)
Palm height (cm)	300	250
Number of suckers/plant	08	06
Spread (cm)		
N-S	250	240
E-W	270	250
Length of leaf cm.	210	170
Pinnae size ,		
Length x width (cm)	26.3x2.57	31.5x2.70
Spathe		
Emergence	2March	7March
Opening	19March	21March
Fruiting		
Fruit set (%)	70	80
Doka stage maturity	20July	14July
Colour of berry	Yellow	Wellow
Size of berry cm.	3.34x2.10	3.56x2.26
(Length x width)		
Weight of berry g.	7.74	8.32
Pulp:stone ratio	7.00	6.60
No. of bunch/plant	4.0	1.0
Length of bunch	48	35
Bunch weight kg	1.5	1.0
No of strand per bunch	21	16
Length of strand cm.	29	21
No. of berries /strand	14	14
Yield kg/palm (5th year)	6.000	1.000
Stone weight (g.)	1.08	1.25
Stone length x width cm.	2.00x0.80	2.52x0.85
Taste of doka fruit	Sweet and juicy	sweeet
Acidity (%)	0.17	0.22
Ascorbic acid (mg/100g pulp)	200	170
Sugars (mg. /100g fresh pulp)	620	630

Survival of plant

One offshoot of three cultivar was introduced from Iraq through a delegation which visited to India. The plants were brought without any packaging. The plant material was transported from NBPGR, New Delhi to C.I.A.H., Bikaner by train. The offshoots were initially planted in perforated gunny bags, which were filled with garden soils. The plants were maintained under normal cultural practices. All offshoots were survived under nursery conditions. Sprouting was started in Chip chap and Braim suckers. During the month of October, the suckers were transplanted in the field. Out of these, Braim

Sucker size/weight play an important role in survival and establishment of plant under field conditions (Pareek, 1984). Though, Date palm is a hardy but rooting in offshoot is very difficult which is the main cause of mortality of suckers besides attack of diseases especially crown rot and environmental conditions of the growing sites.

Plant growth

The vigorous plant growth was observed in cultivars Chip chap in comparison to Braim plant in respect of palm height, spread, leaf size, pinnae, and suckering also (Table 1). Plant growth pattern in both the cultivars

were at par to other germplasm planted in the same year at same site. It seems that the growth performance of both the cultivars is satisfactory under hot arid environment. However, plant growth depends upon genetic character of the genotype besides environmental conditions of growing sites. Similar view has been expressed by Zaid (1999) while working on production technology of date palm.

Spathe emergence and flowering

In general, emergence of spathe in date palm starts after 3-4 years of planting. However, it depends on the age and size of suckers in addition to cultural practices employed. Spathe emergence period also depends both on climatic conditions and genotypes. Variation in emergence of spathe has also been reported by Zaid (1999). Under Indian conditions, emergence of spathe has been reported during February to March (Chandra et *al*, 1990). In both the introductions, spathe emergence was recorded in the first week of March during 2003. It is also similar to earlier introductions and shows medium to late maturing type. Besides, spathe opening pattern was also similar in both the cultivar.

Yield and berry characters

In the first year of fruiting, 6.000 kg/plant berry (doka) was harvested from Braim plant after five years of planting. However, Chip chap cultivar started flowering and fruiting in the year 2002 after four years of planting but the yield was very less. Only one bunch of 500g weight was produced in the year 2002. During the year 2003, fruit yield (1.000 kg) was obtained from the plant of Chip chap which increase subsequently with the age of plant. In both the cultivar, berry colour was yellow and sweet in taste (table 1) with average berry weight 7.74g and 8.32g for Braim and Chip chap, respectively. Bigger berry size was recorded in Chip chap than that of Braim cultivar, which possibly be due to genetic feature of the genotype in addition to environmental conditions. Doka stage was early in Chip chap cultivar. Bunch size was also bigger in Braim in respect of number of strands per bunch, number of berries per strands. Fruit set also depends on the time of spathe opening, pollination, viability of pollens and receptivity of stigma besides climatic features. However, better percentage of fruit set (70-80 %) was also recorded in both the cultivars under arid conditions. The percent acidity was 0.17 and 0.22 in Braim and Chip chap, respectively. There was no much more difference in both the cultivars with respect to acidity (%), ascorbic acid and sugars content. The stone size and pulp stone ratio was higher in case of Chip chap which might be due to genetic features of the variety.

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SHORT COMMUNICATION

Screening of bael (*Aegle marmelos* Correa) cultivars for preparation of candy

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Bael (*Aegle marmelos* Correa) is an importance indigenous fruit of rutaceae family. The tree is very hardy in nature and can withstand against various biotic and abiotic stresses. The importance of bael is enumerated in ancient Indian and Buddhist literature. The fruits of bael is known for its curative properties and nutritive value. The fruit pulp contains fair amount of vitamin A, C and high amount of riboflavin (Gopalan *et al.*, 1985 and Saroj *et.al.*, 2006). The fruit pulp contains marmelosin, which is laxative, diuretic, astringent, digestive, stomachic and also posses anti-amoebic and hypoglycemic properties.

Bael fruits are mostly utilized in form of beverages so far. Moreover, candy is another product of dry in nature and becoming popular among consumers. However, the quality of candy not only depends upon the recipe but the also the cultivar by which it has been prepared. In the last decade, several varieties of bael has been released for commercial cultivation under tropical, subtropical and arid conditions. The information on suitability of cultivar for preparation of candy is essentially required for processing industries. Therefore, present study was panned to screen the suitable cultivar for preparation of candy.

The investigation on "Screening of bael (*Aegle marmelos* Correa) cultivars for preparation of candy" was carried out in the Post Harvest Laboratory, Department of Horticulture, N.D. University of Agriculture and Technology, Kumarganj, Faizabad (UP) during 2004-05. The fruits of five cultivars of bael viz., NB-4, NB-5, NB-7, NB-9 and NB-17 were taken in the month of April from the main Experimental Station, which were grown under uniform management conditions. Before preparation of candy, physico-chemical parameters of all cultivars including fruit length, fruit diameter, fruit weight, skull thickness, pulp, seed, fibre and mucilage content, TSS, acidity, reducing and non-reducing sugars, Vitamin-C, carotene and protein content were recorded. The chemical estimation was done as per AOAC (1970). The experiment was laid out in the complete randomized block design with five treatments having five replications.

For preparation of candy, 2 Kg of mature fruit of each cultivar was taken. The fruits were washed and sliced into pieces of 2.0-2.50 cm with the help of saw. Thereafter, the hard skull and seeds with mucilage were removed with the help of knife. The pieces were pricked from both sides by hand operated pricking machine. The pricked slices of different cultivars were dipped separately in 2 per cent lime solution for 24 hours. Thereafter, the slices were washed thoroughly with water and blanched in boiling water for 5 minutes. The blanched pieces were steeped in syrup solution of 55 per cent TSS for 24 hours followed by 70 per cent for 4 days. The drying was done at 50 0C for 12 hours. The quality of candy was evaluated by the organoleptic test by the panel of 10 judges on a 9 point hedonic scale.

Physical parameters

The appearance of fruit in form of shape, size, skin colour etc. also play important role in marketing and processing of fruits for various purposes. However, the pulp colour can only be seen after cutting of the fruits and natural pulp colour gives direct impact on processed product. In the present investigation (Table 1), the fruit shape of NB-4 and NB-5 was round while NB-9 and NB-17 was ovate. The flattened round shape was observed in case of NB-7 only. The skin and pulp colour were varied from green to yellowish green and yellow to deep yellow respectively.

The weight of fruits varied significantly and maximum fruit weight was recorded in NB-7 (3.55 Kg) followed by NB-9 (2.09 Kg) and minimum in NB-4(0.75 Kg). Regarding skull thickness, except NB-5, all the cultivars having thick skin with maximum in NB-17 (3.00 mm) and minimum in NB-5 (1.44 mm). The per cent fibre content was also minimum in NB-7 (4.45 %) and maximum in NB-9 (7.07%). The mucilage content varied from 9.05

Table 1. Physical characteristics of bael fruits.

Parameters	Cultivars					CD (p=0.05)
	NB-4	NB-5	NB-7	NB-9	NB-17	
Shape	Round	Round	Flattened round	Ovate	Ovate	-
Skull colour	Yellowish green	Greenish yellow	Green	Greenish yellow	Slight green	-
Pulp colour	Yellow	Deep yellow	Pale yellow	Yellow	Deep yellow	-
Fruit weight (kg)	0.75	1.05	3.55	2.09	1.45	1.12
Skull thickness (mm)	2.40	1.44	2.60	2.20	3.00	0.94
Fibre content (%)	5.03	4.96	4.45	7.07	4.85	1.80
Mucilage content (%)	10.05	13.05	9.05	11.00	9.67	1.20
Pulp content (%)	69.05	68.13	70.05	71.40	68.90	NS
Seed content (%)	2.70	2.33	2.40	2.67	2.20	NS

Table 2. Chemical characteristics of bael fruits.

Parameters	Cultivars					CD (p=0.05)
	NB-4	NB-5	NB-7	NB-9	NB-17	
TSS (0B)	28.00	30.00	26.00	33.00	30.00	3.60
Acidity (%)	0.29	0.20	0.32	0.23	0.20	NS
Reducing sugar (%)	3.75	3.90	2.90	3.85	3.96	NS
Non-reducing sugar (%)	14.25	12.25	8.14	14.25	12.54	2.30
Total sugar (%)	14.00	16.50	11.00	18.10	16.50	2.40
Vitamin-C / 100g pulp	14.40	24.60	16.49	19.06	26.00	2.80
Carotene (IU)/ 100g pulp	15.00	16.00	17.00	18.00	16.00	NS
Protein(mg)/ 100g pulp	1.40	1.50	1.80	1.90	1.60	NS

Table 3. Organoleptic quality of different cultivars of bael candy.

Cultivars	Organoleptic quality	
	Average Score	Rating
NB-4	5.9	Like slightly
NB-5	6.8	Like moderately
NB-7	7.8	Like very much
NB-9	8.8	Like extremely
NB-17	6.7	Like moderately
CD (p=0.05)	0.08	-

per cent (NB-7) to 13.05 per cent (NB-5). Moreover, the per cent pulp and seed content were non-significant among different cultivars. In fact, these variations are inherited characteristics of an individual cultivar. Similar observations were made by Roy and Singh (1978) about physico-chemical parameters of different bael cultivars.

Chemical parameters

The data on chemical compositions of different bael cultivars are given in table 2 indicate that the TSS varied significantly among different cultivars. The highest TSS was recorded in NB-9 (33.0 %) while minimum in NB-7(26.0 %). The NB-5 and NB-17 having same level of TSS (30.0%). The acidity and reducing sugar did not vary significantly, however non-reducing sugar varied significantly. The total sugar was highest in NB-9 (18.10 %) followed by NB-5 and NB-17 (16.50%) while minimum in NB-4 (14.0%). The Vitamin-C content was extremely high in NB-17 (26.0 mg/100 g) and lowest in NB-4 (14.40 mg/ 100g). Whereas, non-significant variations were observed in case of carotene and protein content among different cultivars but highest value was observed in NB-9. Such quality variations were also reported by Singh *et al.* (2003). These quality attributes ultimately reflect the quality and acceptability of processed products.

Organoleptic rating

The simplest method for judging acceptability of any new products is organoleptic evaluation by the panel of experts. The data given in table 3 indicate that the candy prepared by NB-9 was judged as best by scoring 8.8 value on 9 point scale followed by NB-7 (7.8). Whereas, the candy prepared by NB-5 and NB-17 were liked moderately but the candy prepared by NB-4 scored lowest value (5.9). The relative organoleptic rating indicate that the cultivar NB-9 is most suitable for candy preparation. The fruits of this variety are big in size, attractive pulp colour, high TSS and acid blend as well as fairly good amount of carotene and protein; probably responsible for quality candy prepared by cultivar NB-9. Thu, any bael cultivar with these parameters may be selected for preparation of quality candy. Ram and Singh (2003) had already advocated that NB-9 is a good variety for processing.

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SHORT COMMUNICATION

Plant extract as antimicrobial agent

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Several plants have been evaluated for possible Antimicrobial activity and to get remedy from a variety of ailment of microbial origin. Certain plants contain products such as alkaloids, tannins, quinons, essential oil phenol compound and mercuric compound in their extracts. These compounds are known for their antimicrobial activity. In the present study plant extract of various wild species were used as antimicrobial agent. Impregnated discs of the above wild species were prepared using concentrated leaf extract. These discs were used as antibiotic agent against different bacterial species.

For testing the antimicrobial activity of plant extract against different bacterial isolates, the aqueous extract was prepared. Plants in use were mostly herbs and trees. These plants include- *Azadiracta indica*, *Chenopodium album*, *Phyllanthus* sp., *Ocimum sanctum*, *Lantana camara*, *Aloe vera*, *Parthenium hysterrophorus*, *Catharanthus roseus*, *Eucalyptus* sp.

Impregnated discs of these plant extracts were used for testing the antimicrobial activity. Prepared antimicrobial discs were aseptically placed on nutrient dextrose agar seeded with the test organisms. Plates were incubated at ± 27°C temperature for 24-48 hours. A zone of inhibition around the discs was recorded as positive test for sensitivity (Schaad, 1988).Mean colony diameter in mm. was recorded after 24 and 48 hours of incubation.

The zone of inhibition (in mm.) were recorded after 24 and 48 hours and sensitivity of various plant extract on different bacterial isolates are presented in Table 1and 2. The result indicated that leaf extract of plant species differed significantly in their effectiveness. Bacterial isolates were more sensitive to plant extract of *Azadiracta indica*, *chenopodium album* and *Phyllanthus* sp. than other plant leaf extracts. *Azadirecta indica* was most effective against *Bacillus* sp.4 and *Bacillus* sp.5. The zone of inhibition produced by these isolates was 10mm.The zone of inhibition of other bacterial species varied from 5 mm. to 9 mm. *Chenopodium album* was more effective against *Erwinia* sp. The zone of inhibition produced by these isolates was 9.5 mm. The zone of inhibition of other bacterial isolates varied from 4 mm. to 9 mm. *Phyllanthus* sp. was very effective against *Erwinia* sp.3. The zone of inhibition produced by this isolate was 10 mm. The zone of inhibition produced by other bacterial isolates varied. from 4 mm. to 9 mm. In camparison to *Azadiracta indica*, *Chenopodium album* and *Phyllanthus* sp. all bacterial isolates were less sensitive to *Ocimum sanctum*, *Parthenium hysterrophorus*, *Lantana camara* and *Catharanthus roseus*. However *Xanthomonas* sp.1 and *Xanthomonas* sp.2 were very sensitive to plant extract of *Ocimum sanctum*. The zone of inhibition produced by these isolates was 9 mm.

Singh and Dwivedi(1990) reported fungicidal properties of Neem (*Azadiracta indica*) against Sclerotium *rolfsii*. Khilare *et al* (2002) reported that the plant extract of *Azadirecta indica*, *Adhathoda vasica*, *ocimum sanctum* and *Phyllanthus emblica* were highly effective against *Alternaria tenius* causing fruit rot of grapes. Kadam (1997) reported that extract of *Ocimum sanctum*, *Azadiracta indica*, *Terminalia chebula* and *Catharanthus roseus* were highly effective against fruit rot caused by *Alternaria alternate*. The extract of *Ocimum sanctum*, *Azadiracta indica*, *Vitex negundo*, *Eucalyptus globules*, *Vinca rosea* and *Aloe vera* were effective against microbes *Gliocladium roseum* and *Bacillus* sp. (Devkate 1998).

Parthenium hysterrophorus was more effective against *Planococcus* sp.1. The zone of inhibition was 9 mm. The zone of inhibition produced by other isolates varied from 3 mm. to 8 mm. All bacterial isolates were less sensitive to leaf extracts of *Lantana camara* and *Catharanthus roseus* but these plant extracts were effective against *Planococcus* sp.3 *Planococcus* sp.4. Their zone of inhibition was 8 mm. and 7.5 mm. in both case. All bacterial species were completely resistant for leaf extract of *Aloe vera* and *Eucalyptus* sp. No zone of inhibition was formed in them.

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Table 1. Effect of plant extract on different bacterial species

S. No.	Bacterial Species	*Azadirachta indica*		*Chenopodium album*		*Phyllanthus Sp.*		*Ocimum sanctum*		*Parthenium hysterrophorus*		*Lantana camara*		*Catharanthus roseus*	
		Zone of Inhibition (in mm.) after													
		24 h.	48 h.	24 h.	48 h.	24 h.	48 h.	24 h.	48 h.	24 h.	48 h.	24 h.	48 h.	24 h.	48 h.
1.	*Bacillus* sp. 1.	7	7.5	8	8	7	7	6	6.5	5	5.5	5	5	4.5	4.5
2.	*Bacillus* sp. 2.	7	7.5	8	8	7	7	6	6.5	5	5.5	5	5	4.5	4.5
3.	Bacillus sp. 3.	7	8	8	9	7	7.5	6	6	5	5	4	4.5	4	4
4.	*Bacillus* sp. 4.	10	10	8	8	7	7	6.5	6.5	3	3	6	6	5	5
5.	*Bacillus* sp. 5.	10	10	8	8	7	7	6.5	6.5	3	3	6	6	5	5
6.	*Erwinia* sp. 1.	6	6	7	7	6.5	6.5	4	4.5	4	4	5.5	5.5	5	5
7.	*Erwinia* sp.-2.	7	7.5	9	9.5	5	6	5	5	3.5	3.5	4.5	4.5	4	4
8.	*Erwinia* sp. 3.	7	7	8.5	8.5	10	10	5	5	4	4	4	4.5	6	6.5
9.	*Micrococcus* sp.1.	8	8.5	8	8.5	8	8.5	4.5	5	5.5	5.5	6	6	3.5	4
10	*Micrococcus* sp.2.	8	8.5	8	8.5	8	8.5	4.5	5	5.5	5.5	6	6	3.5	4
11.	*Planococcus* sp. 1.	6	6	5	5	5	5.5	6	6	8	9	7	7	6	6
12.	*Planococcus* sp. 2.	6	6	5	5	5	5.5	6	6	8	8	7	7	6	6
13.	*Planococcus* sp. 3.	7	7	5	6	4	4	3	3	8	8	8	8	8	8
14.	*Planococcus* sp. 4.	7	7	5	6	4	4	3	3	7.5	7.5	7.5	7.5	7.5	7.5
15.	*Planococcus* sp. 5.	5	5	5	5	5	5	4	4	6	6	5	5	7	7
16.	*Planococcus* sp. 6.	5	5	5	5	5	5	3	4	6	6	5	5	6	7
17.	*Pseudomonas* sp.1.	6	6.5	6	6	4	5	3	4	2	3	6	6.5	6	6.5
18.	*Pseudomonas* sp.2.	5	5.5	4	4	4.5	5	4	4.5	3	3	5	6	5.5	6
19.	*Xanthomonas* sp.1.	9	9	9	9	9	9	9	9	5	6	4	5	4	4
20.	*Xanthomonas* sp.2.	9	9	9	9	9	9	9	9	5	6	4	4	5	5.5

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Table 2. Sensitivity of various plant extract on different bacterial species

S. No.	Bacterial Species	Sensitivity to plant extract
1.	*Bacillus* sp. 1.	Ch > Az > Ph > Oc > Pa > La > Ca
2	*Bacillus* sp. 2.	Ch > Az > Ph > Oc > Pa > La > Ca
3	*Bacillus* sp. 3.	Ch > Az > Ph > Oc > Pa > La > Ca
4	*Bacillus* sp. 4.	Az > Ch > Ph > Oc > La > Ca > Pa
5	*Bacillus* sp. 5.	Az > Ch > Ph > Oc > La > Ca > Pa
6	*Erwinia* sp. 1.	Ch > Ph > Az > La > Ca > Oc > Pa
7	*Erwinia* sp. 2.	Ch > Az > Ph > Oc > La > Ca > Pa
8	*Erwinia* sp. 3.	Ph > Ch > Az > Ca > Oc > La > Pa
9	*Micrococcus* sp.1.	Az = Ch = Ph > La > Pa > Oc > Ca
10	*Micrococcus* sp.2.	Az = Ch = Ph > La > Pa > Oc > Ca
11	*Planococcus* sp. 1.	Pa > La > Oc = Ca = Az > Ph > Ch
12	*Planococcus* sp. 2.	Pa > La > Oc = Ca = Az > Ph > Ch
13	*Planococcus* sp. 3.	La = Ca = Pa > Az > Ch > Ph > Oc
14	*Planococcus* sp. 4.	La = Ca = Pa > Az > Ch > Ph > Oc
15	*Planococcus* sp. 5.	Ca > Pa > La = Ph = Ch = Az > Oc
16	*Planococcus* sp. 6.	Ca > Pa > La = Ph = Ch = Az > Oc
17	*Pseudomonas* sp.1.	Az = Ca = La > Ch > Ph > Oc > Pa
18	*Pseudomonas* sp.2.	Ca = La > Az > Ph > Oc >Ch > Pa
19	*Xanthomonas* sp.1.	Az = Ch =Ph =Oc > Pa > La > Ca
20	*Xanthomonas* sp.2.	Az = Ch =Ph =Oc > Pa > Ca > La

Az = *Azadiracta indica*
Ch= *Chenopodium album*
Ph= *Phyllanthus* sp.
Oc *Ocimum sanctum*
La = *Lantana camara*
Pa =*Parthenium hysterrophorus*
Ca =*Catharanthus roseus*

Dhaliwa *et al* (2002) found that essential oils viz. *Eucalyptus camaldulesis*, *Parthenium hysterrophorus*, *Mentha piperita*, *Cleodendron inerme* prepared from different plants by steam distillation process were effective against Mandarin fruit rot caused by *Penicillium digitatum*. Pawar, 2005 reported that *Aloe vera* leaf extract was highly effective against *Staphylococcus aureus*. Similar analysis of antimycobacterial activity of *Aloe vera* L. and *Adhathoda vasica* Nees were conducted by Gupta *et al* (2006). Allelopethic effect of *Lantana camara* extracts on spore germination of *Riccia billardieri* Mont et Nees tested by Chaudhary *et al* (2007).

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SHORT COMMUNICATION

Evaluation of fungicides against blight of cumin caused by *Alternaria burnsii*

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In India cumin is an important seed spice crop grown in the states of Rajasthan, Gujarat, Uttar Pradesh and Tamil Nadu. Rajasthan stands first in acreage (149 thousand ha) and production (27 thousand metric tonnes) (Anonymous, 2008). The crop suffers severely from blight disease which generally appears at the time of flowering or seed formation causing heavy losses in grain yield (Gemawat and Prasad, 1969; Bhatnagar *et al.*, 1995). The present investigation are undertaken to evaluate the efficacy of different fungicides and one neem pesticide against severity of blight and yield of cumin.

With a view to determine the efficacy of different fungicides and a neem pesticide on blight intensity and yield of cumin, an experiment in Randomized Block Design was laid out with three replications during *rabi*,2003-04 with RZ-19 variety. There was 12 treatments including control with a plot size of 4m × 3m for each treatment. The following fungicides were used-

The crop was first sprayed with different fungicides at the flowering stage followed by second spray one month after the first spray. The disease intensity was recorded by using a rating scale (Gemawat and Prasad, 1969).

Table 1:Per cent doses of test fungicides used against blight of cumin

S. No.	Test fungicides	Doses
	Current M-45 (mancozeb 75 WP)	0.2%
	Dithane M-45 (mancozeb flowable 35 SC)	0.3%
	Blue copper (copper oxychloride 50 WP)	0.2%
	Kavach (chlorothalonil 75 WP)	0.2%
	Companion (carbendazim 2% + mancozeb 63% WP)	0.2%
	Dithane Z-78 (zineb 75 WP)	0.2%
	Tilt (propiconazole 25 EC)	0.1%
	Topas (penconazole 10 EC)	0.05%
	Controll (hexaconazole 5 EC)	0.1%
	Score (difenoconazole 25 EC)	0.1%
	Nimbicidine (azadirachtin 0.03 EC)	0.3%
	Control (no fungicide was applied)	

The data presented in Table 1 revealed that severity of *Alternaria* blight was significantly affected by fungicidal sprays. The minimum disease severity was recorded with Score (16.66%) followed by Kavach (19.45%), Companion (20.66%), Topas (20.66%), Tilt (20.00%) and Controll (21.78%) against control (50.77%). However, Score was highly effective followed by Kavach which were statistically at par with each other. The maximum disease severity was recorded with Nimbicidine (38.44%) followed by Blue Copper (32.89%) and Current M-45 (28.44%). Similarly fungicidal sprays had significant effect on grain yield of cumin. Maximum grain yield (683.3 kg/ha) was recorded in Score (0.1%) which was significantly superior over other fungicidal treatments. The lowest grain yield (306.0 kg/ha) was recorded in Nimbicidine (0.3%) treatment. Further, it can be concluded that minimum disease severity (16.66%) of *Alternaria* blight and maximum grain yield (683.3 kg/ha) of cumin was recorded in Score followed by Kavach treatment. Some what similar findings are reported by Akbari and Dhruj (1995) and Akbari *et al.*,(1996).

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The disease intensity was rated by preparing an arbitrary scale-

Grade		Disease description
Low	: 1 = A	Symptoms on leaf tips and leaves only
Medium	: 2 = B	Symptoms on leaf tips, leaves, stem
Severe	: 3 = C	Symptoms on leaves, stem, inflorescence, seeds etc.
Healthy	: 4 = D	No symptoms: plants being healthy

Disease intensity was observed on 100 plants at random in each plot and calculated as under.

$$DI = \frac{NA + NB + NC + ND}{\text{Total number of plants} \times 3} \times 100$$

(N = Number of plants)

Table 2. Efficacy of various fungicides on *Alternaria* blight and yield of cumin

Treatments	Disease intensity (%)	Yield (kg/ha)
Current M-45	28.44(32.22)*	478.0
Dithane M-45 (Flowable)	26.66(31.09)*	462.0
Blue Copper	32.89(34.98)*	389.0
Kavach	19.45(26.12)*	612.1
Companion	20.66(27.04)*	596.0
Dithane Z-78	27.33(31.48)*	470.0
Tilt	21.00(27.24)*	536.0
Topas	20.66(27.04)*	571.0
Controll	21.78(27.78)*	544.5
Score	16.66(24.07)*	683.3
Nimbicidine	38.44(38.29)*	306.0
Control	50.77(45.44)*	183.3
S.Em±	1.119	19.189
CD (P=0.05)	3.282	56.280

* ( ) percentage transformed to angels : values outside parenthesis are back transformation to percentage

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