Crop Regulation in Guava (*Psidium guajava* L.) cv. 'Sardar' as Influenced by Chemicals and Cultural Practices

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Thesis

Submitted to the

Maharana Pratap University of Agriculture & Technology, Udaipur

in partial fulfillment of the requirements for

the degree of

Master of Science in Agriculture

(Horticulture)

BY

MANISH KUMAR AGNIHOTRI

2008

Maharana Pratap University of Agriculture and Technology, Udaipur

Rajasthan College of Agriculture, Udaipur

CERTIFICATE-I

Dated: / /2008

This is to certify that **Mr. Manish Kumar Agnihotri** has successfully completed the Comprehensive Examination held on 21-06-2008 as required under the regulation for the degree of **Master's degree in Agriculture** (Horticulture).

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CERTIFICATE-II

Dated: / /2008

This is to certify that the thesis entitled **"Crop Regulation in Guava (*Psidium guajava* L.) cv. 'Sardar' as Influenced by Chemicals and Cultural Practices"** submitted for the degree of **Master of Science in Agriculture** in the subject of **Horticulture**, embodies bonafide research work carried out by **Mr. Manish Kumar Agnihotri** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of this thesis was also approved by the advisory committee on ----------.

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Dated: / /2008

This is to certify that the thesis entitled **"Crop Regulation in Guava (*Psidium guajava* L.) cv. 'Sardar' as Influenced by Chemicals and Cultural Practices"** submitted by **Mr. Manish Kumar Agnihotri** to the Maharana Pratap University of Agriculture and Technology, Udaipur in partial fulfillment of the requirements for the degree of **Master of Science in Agriculture** in the subject of **Horticulture** after recommendation by the external examiner was defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination on his thesis has been found satisfactory, we therefore, recommend that the thesis be approved.

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Dated: / /2008

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Crop regulation in guava (*Psidium guajava* L.) cv.'Sardar' as influenced by chemicals and cultural practices.

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ABSTRACT

A field experiment was conducted at Instrumental Farm, Department of Horticulture, Rajasthan College of Agriculture, Udaipur during the year 2007-08. The soil of experimental field was low in nitrogen, phosphorus and medium in potassium. The experiment consisted of 8 treatments comprising chemicals (Urea @ 10% and 15% foliar spray, NAA @ 1000 ppm) and cultural practices (pruning at 75 % and 50 5 intensity, bending of shoots, withholding of irrigation water) were applied during the course of investigation. These treatments were evaluated under randomized block design with 4 replications by adopting uniform cultural schedule during the experimentation.

The results revealed that all treatments had significant increase in vegetative growth characteristics (number of newly emerged shoots, per cent increase in shoot growth after 30 days interval, canopy volume, PAR above and below canopy and leaf area index) physico-chemical characteristics(Fruit weight, fruit volume, pulp weight, pulp thickness, pulp: seed ratio, TSS, acidity, ascorbic acid content, total sugars and reducing sugar) and yield characteristics(number of flower per shoot, per cent fruit retension, per cent fruit set, number of fruits per plant, yield per tree and yield per hectare), leaf nutrient content (N, P and K) and available N, P, K status of soil at harvest over the *Ambe bahar* and control. Among the treatments foliar spray of NAA @ 1000 ppm in the month of April (T_7) significantly increase the canopy volume (371.55 m^3), fruit weight (152.60 g), fruit volume (139.25 cc), pulp weight (147.25 g), pulp thickness (1.13 cm), pulp seed ratio (58:90), TSS (13.80%), ascorbic acid (193.75 mg/100 gm pulp), total sugars (7.29%), reducing sugar (4.21%) and per cent fruit set (60%) followed by application of single foliar spray of 15 per cent urea at 50 per cent bloom stage (T_2). Number of fruit per plant (389.50), yield per tree (56.38 kg) estimated fruit yield (156.39 q ha^{-1}) with higher net return (Rs.109394.88 ha^{-1}) and B:C ratio (2.81:1) were recorded maximum in T_2.

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1. INTRODUCTION

Guava (*Psidium guajava* L.) is one of the most exquisite and valuable fruit of the tropics belongs to family "Myrtaceae". It has been under cultivation in India since 17^{th} century. It is forth important fruit crop after mango, banana and citrus, with covering an area 0.16 million hectares with total production of 1.29 million tonnes and productivity 10.40 t/ha in India (Anon. 2007). Guava contributes 4 percent share of total fruit production of the country. It is predominantly cultivated in the states of Uttar Pradesh, Bihar, Maharastra, Gujarat, Madhya Pradesh, Karnataka, Andra Pradesh, Assam, Orissa, Punjab, Tamil Nadu, West Bengal and Rajasthan.

In Rajasthan, it is third important fruit crop after citrus and mango, occupies an area of 2003 hectares with an annual production of 20555 metric tones (Anon. 2006). The major guava growing pockets in Rajasthan are Swaimadhopur, Kota, Bundi, Ajmer, Udaipur and Chittorgarh district.

Guava is considered to be an "apple of tropics" because of its nutritive value with respect to vitamin C (75.260 mg/100 gm pulp), thiamin (0.03-0.07 mg), riboflavin (0.02-0.04 mg/100gm pulp) (Singh *et al.* 2003). Fruit can be eaten fresh and in form of other, edible and delicious preserved like jam, jelly, nectar, RTS, flacks etc.

Guava does equally well under tropics and sub tropical climatic conditions. Under tropical climate due to availability of sufficient heat and moisture, it produces fruits almost continuously. However, in sub tropical climate there are three distinct periods of growth and fruiting. It can therefore, be said that guava plant have great adaptability to different agro climatic conditions would bring variation in productivity and quality (Shukla *et al*. 2008).

Flowering and fruiting in guava may continue all the year round. There are three distinct periods i.e. *Ambe bahar* - February to March flowering and fruit ripens in July – August, *Mrig bahar* – June to July flowering and fruit ripens October to December and *Hast bahar* – October to November flowering and fruit ripens in February to April (Shukla *et al*. 2008).

Further, flowering and fruiting through out the year may cause poor fruit quality and yield, particularly during rainy season crop (*Ambe bahar*). At that time maximum fruits get infected with fruit fly. Therefore, it is essential to take on commercial crop instead of all. *Mrig bahar* is considered as best fruiting season because of lower infestation of fruit fly and good quality fruits. In order to avoid heavy crop load during rainy season, chemicals and cultural means are important tools for crop regulation to get quantum and quality yield (Singh, 2001).

During last 3-4 decades sufficient research work in guava has been done on various aspects like crop improvement, use of organic and inorganic fertilizers etc. However, impact of plant growth regulators, chemicals and other cultural practices in regulation of flowering and fruiting of guava has not been fully exploited for growth yield and quality.

Guava gives good response to spray of growth regulators (NAA), chemicals (urea) and other cultural practices like pruning, bending, with holding of irrigation etc. for crop regulation in guava. Since performance of different chemicals and cultural practices for crop regulation may vary with agro climatic conditions and same recommendations may not be useful for other climatic zones.

Keeping in view the above, present experiment on "Crop regulation in guava (*Psidium guajava* L.) cv. 'Sardar' as influenced by chemicals and cultural practices" was carried out at Horticultural Farm, Rajasthan College of Agriculture with following objectives:

1- To study the response of chemicals and cultural practices on growth, yield and quality of guava cv. 'Sardar' in *Mrig bahar* as compare to. *Ambe bahar*

2- To find out appropriate treatment for crop regulation.

3- To workout economic feasibility of the treatments.

2. REVIEW OF LITERATURE

Crop regulation in fruit crops such as guava, pomegranate, citrus, fig etc. is the most important aspect of fruit production as yield and fruit quality are directly influenced by the regulation of flowering and fruiting. In general good quality guava fruits are produced during winter season (*Mrig bahar*). The literature pertaining to effect of chemicals, plant growth regulators and cultural practices on crop regulation of guava and other fruit crops has been reviewed in this chapter.

2.1 EFFECT OF UREA SPRAY:

Chapman *et al.* (1979) reported that application of 25 per cent urea plus a wetting agent (Shirwet) to 15 month old seedling of guava in rainy season resulted in 3 fold increase in winter season yield (27.98 t/ha) as compare to control (8.73 t/ha).

Chapman and Paxton (1983) observed that delay in harvesting period in guava by 17 days for cultivar 'Beaumont' and for 'Kahua' by 16 days in winter season with 25 percent urea spray in April- May, marketable fruit yield per tree was 94.0 and 86.4 kg for 'Beaumont' and for 'Kahua' respectively.

Rajput *et al.* (1986) reported that, with aqueous solution of urea (12, 15 and 20 %) spray in guava crop urea resulted in no flowering and fruiting in summer season. Further, it resulted maximization in fruit number, fruit yield, However, fruit size was reduced in winter season crop with an increase in urea concentration.

Singh *et al.* (1989) reported that all the treatments of urea (10, 15 or 20 %) and NAA (200, 400, 600 ppm) in guava cultivar 'Allahabad Safeda' were good for leaf and flower abscission (84.4-100 %) in rainy season but the best combination with regard to yield in winter season (155.6 kg/tree) was 15 percent urea + 400 ppm NAA, as compared with control (28 kg/tree).

Dwivedi *et al.* (1993) reported that fruit set and yield was deceased and terminal and lateral growth increased in guava with increasing urea concentration (up to 15 %) in rainy season whereas, high concentration of urea (20 %) reduced the yield in rainy

season. Fruit yield, TSS, total sugars and vitamin C content was increased in winter season guava with increasing urea concentration up to 15 percent and higher concentration did not enhance the yield.

Singh *et al.* (1994) investigated that a double spray of 10-20 percent urea to 4 year old guava cv 'Sardar' at flowering removed nearly all flowers and foliage in rainy season and gave highest subsequent winter crop yield (33.13 kg/plant) than single spray of 10 percent urea (31.10 kg/plant) and control (5.05 kg).

Narayana *et al.* (1999) advocated that for guava, urea can be used as an alternative defoliant to potassium iodite and within urea treatments, 'Sardar' responded best to 20 percent urea spray at 25 April, while 'Allahbad Safeda' responded best to urea at 15 percent at 5 May.

Singh *et al.* (2000) reported that spraying of 10 percent urea gave significantly higher yield (100 kg tree^{-1}) in 'Allahabad Safeda' during winter season. However, 2 spray of 10 percent urea and 15 percent urea at 10 days intervals during in summer season was economically feasible for crop regulation of 'Allahabad Safeda' and 'Sardar' guava, respectively.

Sahay *et al.* (2001) recorded that a double spray of (15 %) urea spray caused marginal burning of leaves, which started 2-3 days after spraying in guava. The highest fruit set, maximum fruit weight (257 g) and maximum fruit yield (42.12 kg plant $^{-1}$) and significantly increased total soluble solids, sugars and pectin content of fruits in following winters was found with spray of 15 percent urea compared with control.

Singh *et al.* (2002) observed that crop yield decreased with increasing urea concentration (10, 20, 25 and 30 %) during rainy season in cultivar 'Sardar' and 'Allahabad Safeda'. Fruit yield, TSS, ascorbic acid and reducing sugar content were highest with foliar spray of 25 percent urea on cv. 'Allahabad Safeda' and decreased with increasing urea concentration in cv 'Sardar'.

2.2 EFFECT OF NAA SPRAY:

Rathore (1975) reported that young guava trees cv 'Allahabad Safeda' sprayed with an aqueous solution of NAA at 0, 80 or 100 ppm in April, when about 10 percent

of flower had opened, fruit set was greatly reduced by both the concentrations and number of new shoots increased correspondingly. A high proportion of the new shoots subsequently flowered.

Chundawat *et al.* (1975) recorded deblossoming in guava cv. 'Banarasi Surkha', 24, 51 and 82 percent by using NAA at 100, 200 and 400 ppm respectively. It is recommended as a preferred alternative to the conventional method of with holding irrigation water before the bloom period in rainy season.

Singh and Singh (1975) reported 100 percent abscission of flower buds and opened flowers by using NAA, applied at 1000 or 2000 ppm as compared with 80 percent abscission with MH at 2000 ppm in rainy season guava crop.

Agnihotri and Bhullar (1979) observed that in guava cv ' Allahabad Safeda' deblossoming during rainy season done with NAA (100-150 ppm), MH (150-250 ppm) or ethophone (250-400 ppm) in the month of May gave significant fruit set reduction (74.86 %) compared with control.

Josan and Sharma (1987) reported that best results with regard to fruit size and quality in winter season were obtained with NAA at 600 ppm applied in May just before the June drop in 'Wilking Mandarin'.

Singh *et al.* (1987) observed that complete flower abscission but no leaf abscission or damage to bud with NAA 400 ppm occurred in crop regulation of ber (*Zizyphus mauritiana*) cv. 'Umran'.

Sharma and Avasthi (1988) reported best results with regard to thinning and regulation of cropping with 350 ppm NAA in 'Kinnow' (*Citrus nobilis* x *Citrus deliciosa*) and next best in hand thinning as compared to 2,4-D (350 ppm), NAA (100 ppm), 2,4,5-T (20 ppm) and ethrel (200 ppm).

Sharma and Avasthi (1990) reported that best crop regulation was obtained with NAA at 350 ppm which gave 48.8 percent and 44.03 percent fruit set in 1980 and 1981, respectively and with manual thinning which gave 42.2 and 42.01 percent fruit set, respectively in crop regulation of 'Kinnow mandarin'.

Singh *et al.* (1992) studied the efficacy of chemicals to deblossoming the rainy season guava crop cv. 'Allahabad Safeda' and found that all treatments of urea (10, 15 or 20 %) and NAA (400, 600, 800 or 1000 ppm) at full bloom stage resulted in

complete deblossoming and highest yield for winter crop (33.2 kg plant $^{-1}$) and highest fruit weight and TSS were recorded with 800 ppm NAA closely followed by 10 percent urea spray.

Desai *et al.* (1993) reported that highest number of fruits, highest yield of marketable fruits (18.7 kg tree $^{-1}$), highest number of large fruits (>200 g in weight) and highest net return were recorded with NAA 250 ppm spray followed by GA (20 ppm) and carbaryl (0.70 %) compared with control and manual removal of flowers was the most effective in reducing fruit set and fruit drop in pomegranate.

Singh *et al.* (1996) recorded maximum yield during the winter season from trees treated with 600 ppm NAA followed by 1800 ppm ethophone and 20 percent urea and higher yellowness index, better appearance, firmness and organoleptic quality and reducing minimum weight loss during storage and better quality in terms of acidity, TSS, ascorbic acid and sugars content with this treatment.

Gaur (1996) observed that reduction in rainy season guava crop and effective increased winter season production was achieved by spray with either 600 ppm NAA or 16 percent urea or pruning top half of current season's growth (93.33, 96.25 and 83.54 kg tree $^{-1}$, respectively) All these treatments also improved the fruit quality (fruit size, TSS, sugars, acidity content etc.) and net income per tree.

Choudhary *et al.* (1997) observed reduced fruit set in rainy season guava crop but increased crop yield in winter season (42.39 kg/plant) with NAA 250 ppm compared to lowest yield (20.7 kg / plant) in control.

Dubey *et al.* (2002) reported highest deblossoming in guava cv. 'Allahbad Safeda' during rainy season and the highest yield and fruiting quality during the winter season with spray of 250 ppm NAA comparison to other concentration of NAA (125 and 750 ppm).

2.3 EFFECT OF SHOOT PRUNING:

Moss (1973) observed that no flowers were found on regrowth after one year of pruning, Only 75 percent of regrowth produced flowers 2 year after pruning and only

50 percent flowers produced fruits in sweet orange cv. ‘Late Valencia’. However, light pruning of less vigorous plants did not inhibit subsequent flowering.

Bajpai *et al*. (1973) reported that maximum flower number, fruit set, fruit retention and yield (109.68 kg/ tree) were obtained with 30 cm pruning in winter crop of guava. Severely pruned tree produced the fewest but largest fruits with the highest TSS and total sugars content, while unpruned tree produced the smallest fruits and lowest TSS and sugars level.

Lotter (1990) reported that shoot growth, number of inflorescence and fruit set were significantly less in rainy season for all spring pruning treatments compared with the intact shoots and these parameters also decreased with severity of pruning. Although severe pruning (3 nodes or less) produced a significantly increase in fruit size guava cv. ‘Fan Retief’.

Sheikh and Hulmani (1993) observed that pruning adversely affected the flower production in rainy season and reduced fruit yield per branch. However, individual fruit weight increased from light pruning (82.34 g) to severe pruning (96.45 g) in guava cv. ‘Navalur’.

Pawar *et al.* (1994) reported that shoot length, number of leaves per shoot, number of fruits and percentage of better grade fruits, fruits size, juice content and TSS increased in *Mrig bahar* with increasing severity of pruning in pomegranate. However rind and aril colour, percentage aril content and seed hardiness were not influenced by pruning treatments. Pruning also delayed sprouting, flower appearance and harvesting.

Sheikh and Hulmani (1994) reported that severe pruning had beneficial effect on fruit volume and weight in guava. Genotype ‘CIW-2’ responded well to pruning with fruit weight increasing from 103.4 g with mild pruning to 116.5 g with severe pruning. TSS content increased with severe pruning but total sugars content showed no difference.

Chandra and Govind (1995) found that an increase in plant height and a reduction in plant width were observed as pruning intensity increased up to 75 percent. Pruning at intensities above 25 percent reduced the fruit weight significantly and highest fruit yield (9.18 kg /tree) was obtained in 1992 with 75 percent pruning and advocated that

25 percent pruning in February could regulate fruit yield in guava without affecting fruit quality under high density planting.

Singh *et al.* (1996) reported that highest yield (16.18 kg/plant) was obtained from 50 percent pruned plants in guava and no yield from 100 percent pruned plants and with urea 20 percent spray. These treatments have a significant effect on total sugar content and yield per plant in winter crop.

Lal *et al.* (1996) reported that spacing did not effect fruit set and flower / fruit drop. However, trees at 2 X 2 meter had a lower yield per tree than these at 9 X 8 meter but 10 fold higher yield per hectare. Pruning significantly influenced cropping pattern, as pruning intensity decreased rainy season fruit yield as there was no fruiting with full shoot pruning in rainy season crop of guava.

Anez (1998) recorded highest shoot growth between May and July 1994, with monthly increment in shoot length varying between 4 cm and 24 cm and light pruning resulted in the greater number of the lateral shoots. Peaks in increment in shoot length and number of internodes occurred during the periods of highest rainfall in guava.

Jadhao *et al.* (1998) observed that pruning 60 cm from tip on 25 April in the most vigorous growth and highest fruit yield in winter season compared to other dates of pruning (25 March, 25 May, 25 June) and pruning intensities (30cm of the shoot tip or no pruning) in guava cv. 'Sardar'.

Mishra and Pathak (1998) reported that 50 percent pruning in May produced highest yield (25.8 kg/tree) than unpruned (7.6 kg / tree) in winter crop of guava cv. 'Sardar'.

Dhaliwal *et al.* (2000) studied on 5 intensities levels of pruning (control, 25, 50, 75 and 100 %) on 6 dates (From 20 February to 30 May at 20 days intervals) in guava cv. 'Sardar' and found that percent fruit set, fruit weight fruit retentions, TSS, ascorbic acid increased in winter crop with increasing pruning intensities and maximum fruit number was at 50 percent intensity while minimum was at 100 percent.

Dalal *et al.* (2000) found that severe pruning increased fruit set and individual fruit size but decreased fruit yield per tree in 25 year old guava cv. 'Sardar'.

Santosh *et al.* (2000) observed that fruit yield in general was not affected by pruning date and intensities in fig. However, plants with 36 branches yield were not best with pruning in March or July.

Singh *et al.* (2001) observed that pruning in February and March compared with pruning from April to June enhanced the number of shoots and flower percentage. Shoot growth was reduced in May and June pruned trees where as total yield during winter season increased significantly in May and June pruned trees in both the cultivars of guava ('Allahabad Safeda' and 'Sardar').

Sahay and Kumar (2002) reported that pruning of half of the current shoots resulted in highest crop yield during the winter crop (36.20 kg/plant), total cost (Rs. 13 plant $^{-1}$) and net profit (Rs. 340.62 plant $^{-1}$) in guava.

Jadav *et al.* (2002) studied the effect of pruning dates and pruning intensities (30 and 60 cm from tip) on vegetative growth and fruit yield of 16 year old guava cv. 'Sardar' and found that number of days before sprouting increased while the average length of shoots, number of flowers and fruits per shoot, average fruit weight and crop yield decreased with delay in pruning in rainy season.

Sheikh and Rao (2002) observed that severe pruning and retaining 30 fruits load per plant in two year old pomegranate cv. 'Ganesh' tree resulted in highest fruit weight of 424.28 g, which corresponds to over 67 percent increase but reduced overall yield of the tree by 20 percent. However, produced fruits were superior in terms of 100 aril weight, TSS and total sugar content.

Puebla *et al.* (2003) reported in fig cv. 'San Pedro' that earliest pruning date (20 June) resulted in highest fruit yield (1.73 kg/tree), trunk cross area (107 cm^2), productivity (10.016 kg /cm^2) and shoot length (5.6 cm) in winter season. The lowest pruning intensity removal of terminal bud) gave highest fruit yield (1.46 kg/tree), productivity (0.012 kg /cm^2) and mean fruit weight (36 g).

2.4 EFFECT OF BENDING OF SHOOTS:

Kiper (1972) observed that fruit yield was highest with all the main branches and shoots which were bent down to 50-60 deg from the vertical in pear.

Jaumien *et al.* (1973) reported that shoots were bent horizontally in early spring and this method retarded growth only in the year of treatment and total yield was almost double from trees those with bent shoots in succeeding season as compared to CCC treated trees in 'McIntosh'.

Purohit (1982) observed that girdling at base, horizontal bending or girdling plus horizontal bending did not induce flowering, even after 10 months and the branches were defoliated in the following June in pomegranate.

Wang (1987) reported that increasing fruit weight (kg/plant) and encouraging fruit set in lower part of tree and controlling vegetative shoot growth effectively done by bending of branches. Further, total yield and average fruit weight also increased with shoot bending in guava cv. 'Sardar'.

Rameshwar (1989) reported that mango flowering was induced by stress factor such as shoot bending ringing, shoot and root pruning and these treatment resulted in early flowering shortness of flower duration in mango.

Praagh and Hauschildt (1991) observed that shoot bending gave better flower initiation but fruit set was lower than on pruned trees in apple.

Sarkar *et al.* (2005) observed that yield (kg plant $^{-1}$), TSS, total sugars, TSS: acid ratio and vitamin C content were increased while acidity and core weight was reduced with bending of shoots in guava cv. 'Sardar'.

2.5 WITH HOLDING OF IRRIGATION WATER:

To regulate the crop in guava, the guava tree should not be given irrigation from February to middle of May (Singh, 1995) and followed by manuring and irrigation in month of June (Mitra and Bose, 2002).

Similarly agronomic practices like with holding irrigation, manual thinning of flowers and fruits gave good fruit yield and quality produce (Singh, 1993).

Lihshang *et al.* (1997) observed that fruit yield on per tree basis (12.8 kg/month) and total soluble solid content, firmness, ascorbic acid and juice pH of the fruits were highest in winter season fruits where as core : flesh ratio and acidity were highest without withhold irrigation water in summers in guava.

Patil and Patil (1998) observed that decreasing the IW/CPE ratio by 0.2 during April-May (bahar treatment) increased fruit quality and yield in guava cv. 'Sardar'.

3. MATERIALS AND METHODS

Investigation on "Crop regulation of guava (*Psidium guajava* L.) cv. 'Sardar' as influenced by chemicals and cultural practices" was conducted during the year 2007-08 at Horticulture Farm, Rajasthan College of Agriculture, Udaipur.

'The details of the material used and techniques followed during the course of investigation are described in this chapter.

3.1 EXPERIMENTAL SITE AND CLIMATIC CONDITIONS:

Udaipur (Rajasthan) is situated at 24^0 34'N latitude and 73^0 42' E longitude at the elevation of 582.17 meter above mean sea level. This region has a typical sub tropical climate, characterized by mild winters and summers. The average rainfall of this tract ranges from 76 to 90 cm per year more than 90 per cent of rainfall is received during mid June to September with scanty showers during winter months. Data recorded from mean weekly weather parameters during the field experimentation have been presented in Table 3.1 and Fig 3.1.

3.2 SOIL OF THE EXPERIMENTAL FIELD:

In order to determine the physical and chemical properties and fertility of soil, the soil samples were collected with the help of screw auger up to the depth of 45 cm. The soil samples were taken from each treatment randomly. The collected soil samples were mixed thoroughly on a clean piece of cloth and the bulk reduced by quartering so that a composite sample about 500 g of was obtained.

Collected samples were brought to laboratory and spreaded on a thick brown paper, stones, piece of roots, leaves and other decomposed organic residues were removed. Large lumps of moist soil were broken by hand. It was air dried at 20-25^0 C and 20 to 60 per cent relative humidity (Jackson, 1973). After air drying soil samples were crushed gently in pastel and Mortar and sieved through 92 mm sieve. Grounded samples were stored in a glass container. The grounded samples were mixed well and then weighted for analysis. Soil was analyzed according to the method given in table and initial N, P and K obtained in the experimental sample perior to the start of experiment are given in table 3.2. The results of the analysis showed that the soil of

the experimental field was clay loam in texture, poor in organic carbon, low in available nitrogen, phosphorus and potassium.

Table 3.2: Physico-chemical properties of experimental soils.

	Characteristics of soil	Content	Method of analysis	Reference
(A) Mechanical				
1	Coarse sand (%)	16.5	Hydrometer method	Bouyoucos (1962)
2	Fine sand (%)	21.5	Hydrometer method	Bouyoucos (1962)
3	Silt (%)	28.3	Hydrometer method	Bouyoucos (1962)
4	Clay (%)	34.05	Hydrometer method	Bouyoucos (1962)
5	Textured class	Clay loam	Triangular diagram	Brady (1983)
(B) Physical				
(i)	Bulk density (g cm^{-3})	1.48	Core sample	Piper (1950)
(ii)	Particle density (g cm^{-3})	2.61	Core sample	Piper (1950)
(iii)	Porosity (%)	43.29	Core sample	Piper (1950)
(C) Chemical				
(i)	Organic carbon	0.73	Rapid titration method	Walkley and Black (1947)
(ii)	Available nitrogen (kg ha^{-1})	189.7	Olesen (slkaline Kmnoy)	Subbiah and Asija (1956)
(iii)	Available phosphorus	25.6	Olesen's method	Olesen *et al.*(1954)
(iv)	Available potassium	150.8	Flame photo meter method	Richards (1968)

3.3 PLANT MATERIAL:

Eighteen years old trees of uniform vigour guava cv. 'Sardar' were selected for experiment at Instructional Farm, Department of Horticulture, Rajasthan College of Agriculture, Udaipur. All 32 plants were selected for experimentation from the guava block planted at spacing of 6X6 meter.

3.4 EXPERIMENTAL DETAILS:

The experiment comprised of 8 treatments consisting of foliar spray of urea, NAA, with holding of irrigation, bending of shoots and pruning. The following treatments were used.

Details of treatments are as follow:

S No	Treatments	Notation
1	Absolute control.	T_0
2	Foliar spray of 10 per cent urea at time of 50 per cent bloom stage. Second foliar spray of same dose after 10 days of first spray.	T_1
3	Single foliar spray of 15 percent urea at 50 percent bloom stage.	T_2
4	Pruning (removal of ¾ of current shoots) with 75 per cent intensity at 50 per cent bloom stage in month of April.	T_3
5	Pruning of branch lets i.e., removal of terminal branches with 50 per cent intensity at 50 per cent bloom stage.	T_4
6	Bending of shoots in month of July-August.	T_5
7	With holding of irrigation during February to May.	T_6
8	Foliar spray of NAA @ 1000 ppm in month of April.	T_7

3.5 EXPERIMENTAL DESIGN AND LAYOUT:

The experiment was laid out in a Randomize Block Design with 4 replications.

The detail of the layout was under:

Total Number of treatments	:	8
Number of replications	:	4
Number of plants in each treatment	:	1
Total number of plants	:	32
Cultivar	:	Sardar (Luknow-49)
Age of plant	:	18 years
Plant spacing	:	6 X 6 m

3.6 CULTURAL OPERATIONS:

3.6.1 Nutrients management:

After the application of treatments ploughing of orchard was done with the help of Mitsubishi power tiller. There after, the recommended dose of nutrients were applied at the rate of 50 kg FYM 1kg N, 500 g P_2O_5 and 500 g K_2O per plant. After application of organic and inorganic fertilizers a light irrigation was given.

3.6.2 Time and mode of treatment:

The plants of absolute control, no treatment was applied. Pruning with 50 per cent and 75 per cent intensities was done at 50 per cent bloom stage with the help of tree pruner and irrigation was stopped from February to May by chocking the drippers. Foliar spray of 10 per cent and 15 per cent urea was done at 50 per cent bloom stage followed by repeated spray of 10 per cent urea after 10 days of first spray with the help of Knapsack sprayer. Foliar spray of 1000ppm NAA was done in the month of April. The bending of shoots was done in the month of July-August. Manure and fertilizers were applied just after application of treatment.

Table 3.3: Time and mode of treatment application.

S.No.	Particular	Date
1	Preparation of basin	10 Feb, 2007
2	With holding irrigation	15 Feb, 2007
3	Pruning	14 April, 2007
4	NAA spray	15 April, 2007
5	Urea spray	15 April, 2007
6	Manure and fertilizer application	20 April, 2007
7	Weeding and hoeing	(i) 4 July, 2007 (ii) 11 August, 2007 (iii) 10 September, 2007
8	Bending of shoots	20 July, 2007
9	Application of monocrotophos (0.03% to control fruit fly)	(i) October, 2007 (ii) November, 2007
10	Pasting of copper oxy chloride + lime	20 June, 2007
11	Irrigation (due to no rainfall)	(i) 7 June, 2007 (ii) 14 October, 2007 (iii) 11 November, 2007 (iv) 10 December, 2007
12	Initiation of harvesting of fruit	10 October, 2007

3.7 METHODOLOGY:

3.7.1 Vegetative growth characteristics:

(i) Number of newly emerged shoots:

Total number of newly emerged shoots were counted on five randomly selected branches from all the direction of the tree and average number of newly emerged shoots per branch were calculated.

(ii) Percent increase in shoot growth after 30 days interval:

Five newly emerged uniform sized shoots were randomly selected and tagged in each treatment. The initial length of tagged shoots was measured with the help of meter scale at the time of application of the treatments. Later the length of shoots was measured periodically at 30 days interval for a total period of 90 days. The percent increase in length of shoot was calculated on the basis of initial length of shoot on each day of observation.

(iii) Canopy volume (m^3):

Canopy volume was calculated with the help of following formula and expressed in cubic meter.

$$\text{Canopy volume} = r^2 \times \left[\frac{2}{3} - x + \frac{x^3}{3}\right]$$

Where

r = Radius of crown (m)

x = Crown height (m)

(iv) Photo active radiation (PAR) above and below the canopy:

PAR was taken with the help of IRGA (Infrared Gas Analyzer), model Ciras-2 and expressed in μ Mol / m^2 S.

(v) Leaf area index:

Leaf area index was also calculated with the help of IRGA (Infrared gas analyzer), model Ciras-2.

3.7.2 Physico-chemical characteristics of fruits:

3.7.2.1 Physical characteristics:

(i) Fruit weight (g)

At the time of harvesting all fruits were weighted with the help of an electronic balance and the number of fruits were counted and mean fruit weight was calculated from dividing the total fruits weight by total numbers of fruits.

(ii) Fruit volume (cc):

The volume of ten randomly selected fruits in each treatment was measured by water displacement method. For this purpose, the fruits were dipped in a full filled jar of water and the water displaced by the fruits was collected and measured by graduated glass jar and the recorded reading was averaged.

(iii) Pulp weight:

Ten above selected fruits skin was peeled out with the help of peeling knife and weighted on electronic balance and weight was recorded in gram. Then seeds were extracted from fruits and weighted on electronic balance and recorded, then pulp weight was worked by the substrating peeled fruit weight from seed weighted average, was worked out.

(iv) Pulp thickness:

Thickness of the pulp was measured by ordinary scale by cutting the fruits in two halves and expressed in centimeter.

(v) Seed weight:

Seed cavity was taken out from the above selected fruits and seeds were subjected to wash with tap water and dried in shade thereafter, weight was taken by electronic balance and expressed in gram.

(vi) Pulp: Seed ratio:

The ratio was obtained by dividing the weight of pulp with weight of seed of each replication.

3.8.2.2 Bio chemical characteristics:

(i) Total soluble solids (TSS %):

Total soluble solids of the fruit was determined by using a hand refractometer of 0-30 percent range where in one drop of fruit juice was put on the prism of the refractometer and the percent TSS was recorded directly. The value were corrected at 20^0C and expressed as percent total soluble solids of the fruits (A.O.A.C., 1990).

(ii) Acidity:

The acidity was determined by diluting the known volume of clean juice, filtrate through muslin cloth with distilled water and titrating the same against standard N/10 sodium hydroxide solution (NaOH) using phenolphthalein as an indicator. The appearance of light pink colour was marked as the end point. The result was expressed in terms of percent acidity of the fruit juice (A.O.A.C., 1990).

(iii) Ascorbic acid (Mg/100g pulp)

Ascorbic acid content of juice was determined by diluting the known volume of clean juice filtered through muslin cloth with 3 percent metaphosphoric acid to appropriate volume. A 10 ml of aliquot was titrated against 2, 6- dichlorophenol indophenol dye solution till a stable light pink colour appeared. The result was expressed as Mg ascorbic acid/100g pulp of fruit (A.O.A.C., 1990).

Standardization:

Standardization of 2, 6- dichlorophenol indophenol dye was done by titrating against standard ascorbic acid solution. The standard ascorbic acid solution was prepared by dissolving 100 mg of L- ascorbic acid in 3 percent metaphosphoric acid and 1 ml was used for titration.

The ascorbic acid content of fruit was calculated using following formula:

$$\text{Ascorbic acid} = \frac{\text{Titrate (ml) X Dye factor X Volume made up (ml)}}{\text{Aliquot (ml) X Weight of pulp (g)}} \text{ X } 100$$

(vi) Reducing sugar:

Reducing sugar content was measured by following Nelson's modification of Somogyi's method (Somogyi, 1952) using arsenomolybdate colour forming reagent

and two copper reagents ‘A’ and ‘B’. One ml of juice (100 times diluted) was added with a mixture of 1 ml copper reagent (24 parts of copper ‘A’ and 1 part of copper ‘B’ solution). The mixture was heated in boiling water bath in test tube and cooled, to which added the colour forming reagent and the resulting absorbance was measured at 620 nm in spectronic-20. The value was plated against a standard curve prepared from glucose. The figures expressed on percentage basis.

(v) Total sugars:

Total sugar content was determined by using Anthrone reagent method (Dubois *et al*., 1951). Take 1 ml of diluted fruit juice (100 times), 4 ml of Anthrone reagent was added, then heated for 10 to 15 minutes in water bath, later cooled to room temperature and the absorbance was measured at 630 nm in spectronic-20. The amount of sugar present in the juice was plotted against a standard curve prepared from glucose and was expressed on a percentage basis.

3.7.3 YIELD CHARACTERISTICS:

(i) Number of flowers per shoot:

The total number of flowers was counted on the five randomly selected shoot and average number of flower per shoot was calculated.

(ii) Percent fruit set:

Total number of flowers which set into fruits was counted and percent fruit set was calculated on the basis of number of flowers that emerged.

(iii) Fruit retention:

Total number of fruits set on the tagged shoots were counted. Then the total number of fruits were again counted at the time of fruit maturity. The percent fruit retention was calculated on the basis of initial number of fruit set.

(iv) Number of fruits per plant:

Total number of fruits was counted during harvesting at different times for various treatments periodically.

(v) Yield per tree:

Mature fruits were harvested periodically in each treatment separately and the weight was recorded with the help of electronic balance. Then the total yield (kg/plant) was calculated.

(vi) Estimated yield of fruits per hectare:

The yield of fruits per hectare was calculated by multiplying the yield of fruit per plant with number of plants per hectare i.e. 278 plants per hectare at the spacing of 6 X 6 M.

3.8.4 Leaf analysis:

To determine the nutrient status of plant before and after the application of treatment, the third pair of leaves recently matured were collected in March (before treatment) and February (after harvesting). The sample size was kept 25 leaves. After sample collection, the fresh leaves were decontaminated from dust and other foreign material by washing with the following solutions.

1. 0.2 percent liquid detergent
2. N/10 HCl solution (8 ml concentrated HCl / liter water)
3. Deionized water

Leaf analysis: Leaf nutrient guide for guava

Nutrient	Range (%)
Nitrogen (%)	1.63 - 1.96
Phosphorus (%)	0.18 - 0.24
Potassium (%)	1.31 – 1.71

Source: The guava extension bulletin -17, CISH, Lukhnow

Table 3.4: Analysis of plant leaves before application of treatment.

Nutrient	Value obtained (%)	Method	Reference

Nitrogen	1.200	Nesseler's reagent colorimetric method	Linder (1944)
Phosphorus	0.305	Ammonium vanadomolybdo phosphoric acid yellow colour method	Richards (1968)
Potassium	1.022	Flame photometer method	Richards (1968)

3.9 Economics of the treatments used:

The relative economics of different chemical (urea), PGRs, (NAA) and cultural practices (Bending, pruning, withholding irrigation) were determined on the basis of cost of treatment and yield of per plant as well as per hectare. The net income was deducted by substrating the treatment cost from gross income. It was expressed on net excess income over control.

Gross return (Rs ha^{-1}) = Return from fruit yield (Rs.)

Net return = Gross return – Total cost of cultivation (Rs ha^{-1})

$$B : C = \frac{\text{Net return (Rs ha}^{-1}\text{)}}{\text{Total cost of cultivation (Rs ha}^{-1}\text{)}}$$

Statistical analysis:

The data of 2007-08 were obtained on various characters were subjected to RBD analysis and interpretation of the data was carried out in accordance to Panse and Sukhatme (1985). The values calculated in percent were subjected to angular trans formation according to the table given by Snedecor and Cochran (1967). The coefficient of correlation was also calculated between dependent and independent variable using formula given below.

$$R = \frac{S.P.(X.Y.)}{\sqrt{SS(x)\,X\,SS(y)}}$$

4. EXPERIMENTAL RESULTS

In the succeeding pages, the experimental results of present investigation have been illustrated diagrammatically, wherever necessary. Analysis of variance of various characteristics has been presented in the appendices at the end.

Data interpreted in the results are important for namely number of newly shoot emerged, per cent increase in shoot growth after 30 days interval, canopy volume, PAR above and below canopy, leaf area index, fruit weight, fruit volume, pulp weight, pulp thickness, seed weight, pulp : seed ratio, total soluble solids, per cent acidity, ascorbic acid, per cent reducing sugar and total sugars, number of flowers per shoot, per cent fruit set, per cent fruit retention, number of fruits per plant, yield per plant and yield per hectare.

4.1 VEGETATIVE GROWTH CHARACTERISTICS

4.1.1 Number of newly emerged shoots:

The data pertaining number of newly emerged shoots are presented in Table 4.1 reveal that chemicals and cultural practices significantly influence the number of newly shoot emerged. The maximum number of newly emerged shoots (4.60) was recorded under treatment T_3 (Pruning with 75 intensity at 50 per cent bloom stage in the month of April) followed by treatment T_4 (heading back of terminal branches with 50 per cent intensity at 50 per cent bloom in the month of April) (4.05) and minimum number of newly emerged shoots were recorded under control (2.55).

However, T_3 and T_4 found statistically at par with treatment T_1 (3.80) (Foliar spray of 10 per cent urea at 50 per cent bloom stage. Second spray of same dose after 10 days of first spray).

4.1.2 Per cent increase in shoot growth after 30 days interval:

The data regarding the per cent increase in shoot growth after 30 days interval presented in table 4.1 and Fig.4.1, revealed that highest per cent increase in shoot growth after 30 days (13.91 %) was noticed under the treatment T_4 (heading back terminal branches with 50 per cent intensity at 50 per cent bloom stage in the month of April) followed by T_3 (Pruning with 75 per cent intensity at 50 per cent bloom stage in the month of April) (13.31). Further, per cent increase in shoot growth after 60 days was highest in T_3 (8.30) followed by T_4 (7.94) per cent increase in shoot growth after 90 days was recorded highest in T_4 (3.87) followed by T_3 (3.28). Where

as minimum per cent increase in shoot growth after 60 and 90 days was recorded lowest in control (4.57 and 1.30 respectively).

4.1.3 Canopy volume:

Data pertaining to canopy volume presented in table 4.2 and fig. 4.2 indicate that different treatments significantly influence the canopy volume of the tree. Significant maximum value for canopy volume 371.55 m^3 was recorded under T_7 (foliar spray of NAA @ 1000 ppm in the month of April) which was at par with T_1 (348.48) (foliar spray of 10 per cent urea at the time of 50 per cent bloom stage and second foliar spray of same dose after 10 days of first spray) and T_2 (349.30) (single foliar spray of 15 per cent urea at 50 per cent bloom stage) while the lowest canopy volume (193.10 m^3) was recorded at T_0 (control).

4.1.4 PAR above and below canopy (μ Mol / m^2 S):

The data regarding the PAR above and below canopy are presented in Table 4.2 revealed that effect of different treatments on PAR above and below canopy was non significant. However, the maximum value recorded (870.75 μ Mol / m^2 S above the canopy and 306.00 μ Mol / m^2 S below the canopy) under treatment T_3 (Pruning with 75 per cent intensity at 50 per cent bloom stage in the month of April) as compare to control and *Ambe bahar*. Further, canopy volume was 182.64 (m^3) in the *Ambe bahar* which was minimum than the any treatment used for crop regulation and control.

4.1.5 Leaf area index:

Data presented in Table 4.2 revealed that there was non significant effect of the treatment on leaf area index. Further, maximum value of leaf area index was recorded under T_7 (foliar spray of NAA @ 1000 ppm in the month of April) and minimum in *Ambe bahar* (1.69).

4.2 PHYSICAL CHARACTERISTICS OF FRUITS:

4.2.1 Fruit weight:

The data on fruit weight as influenced by different treatments have been presented in Table 4.3 and Fig.4.3. A critical examination of data revealed that among

the various treatments, significantly higher fruit weight 152.60 g was recorded in treatment T_7 (foliar spray of NAA @ 1000 ppm in the month of April) over rest of the treatments with minimum at control (98.25 g). After comparison of *Ambe bahar* (101.25 g) with T_7 treatment, 50.71 per cent higher fruit weight was recorded in *Mrig bahar*.

4.2.1.2 Fruit volume:

The perusal of data presented in Table 4.3 revealed that the different treatments significantly influenced the fruit volume. Maximum fruit volume 139.25 cc was recorded at treatment T_7 (foliar spray of NAA @ 1000 ppm in the month of April) over rest of the treatments with minimum in *Ambe bahar* (87.40 cc) and control (85.75 cc).

4.2.1.3 Pulp weight:

A critical examination of data presented in Table 4.3 revealed that among various treatments significantly higher pulp weight 147.25 g was recorded in treatments T_7 (foliar spray of NAA @ 1000 PPM in the month of April) followed by treatment T_2 (137.65 g) (single foliar spray of 15 per cent urea at 50 per cent bloom stage).pulp weight of *Mrig bahar* was increased 52.57 per cent as compare to *Ambe bahar*.

4.2.1.4 Pulp thickness:

The data regarding the pulp thickness are presented in Table 4.3 reveal that different chemicals and cultural practices significantly influenced the pulp thickness. The maximum pulp thickness 1.13 cm recorded in T_7 (foliar spray of NAA @ 1000 PPM in the month of April) over rest of treatment with minimum (0.53 cm) in control and *Ambe bahar* (0.55 cm).

4.2.1.5 Seed weight:

The perusal of data presented in Table 4.3 reveal that seed weight was found to be non significant character influenced by the application of chemicals and cultural practices, However, minimum seed weight of 2.28 g was recorded in T_5

(bending of shoots in the month of July-August) and T_6 (with holding of irrigation water during the month of February to May). The maximum seed weight was noticed in *Ambe bahar* as compare to *mrig bahar*.

4.2.1.6 Pulp : Seed ratio:

A perusal of data presented in table 4.3 reveled that the maximum pulp : seed ratio (58.90) was recorded under T_7 (foliar spray of NAA @ 1000 ppm in the month of April) and minimum in control (35.17) and *Ambe bahar* (33.27).

4.3 BIOCHEMICAL CHARACTERISTICS:

4.3.1 Total Soluble Solids:

The data related to TSS content of guava fruit have been presented in Table 4.4 and fig. 4.4. The total soluble solids were significantly influenced by different treatments. This clearly indicate that the maximum TSS (13.80 ^{o}B) was obtained in T_7 (foliar spray of NAA @ 1000 ppm in the month of April) as compare to minimum in control (10.60 ^{o}B) and (10.40 ^{o}B) in *Ambe bahar*.

4.3.2 Acidity:

A perusal of data presented Table 4.4 reveal that per cent acidity was significantly influenced by the cultural practices and chemicals application. Highest acidity was observed in *Ambe bahar i.e.* 1.05 per cent and minimum acidity observed under T_3 treatment (Pruning with 75 per cent intensity at 50 per cent bloom stage in the month of April) *i.e.* 0.75 per cent.

4.3.3 Ascorbic acid content:

A critical look at data reveal that effect of different treatments on ascorbic acid content of guava fruits was found to be statistically significant (Table 4.4, fig. 4.5). The maximum ascorbic acid (193.75 mg / 100 g) was recorded in T_7 (foliar spray of NAA @ 1000 PPM in the month of April) and T_4 (heading back of terminal branches with 50 per cent intensity at 50 per cent bloom stage in the month of April) (178.13 mg / 100 g) as compared to *Ambe bahar* (132.50 mg / 100 g) and control (134.25 mg

/100 g). Further, 46.22 per cent more ascorbic acid was noticed in T_7 during the *Mrig bahar* as compared to *Ambe bahar*.

4.3.4 Total sugars:

The data regarding effect of various treatments on total sugar content of guava fruits are presented in Table 4.4, Fig.4.6 The results reveal that the use of chemicals and cultural practices significantly affected the total sugars content. The maximum total sugar content 7.29 per cent was recorded in T_7 (foliar spray of NAA @ 1000 ppm in the month of April) as compared to *Ambe bahar* (5.92 per cent) and control (6.04 %). On comparison noticed that 23.14 per cent total sugars content was increased in T_7 during *Mrig bahar* as compare to *Ambe bahar*.

4.3.5 Reducing sugar:

The data presented in Table 4.4 reveal that reducing sugar content was significantly affected by various treatments. The maximum reducing sugar 4.21 per cent was reported under T_7 (foliar spray of NAA @ 1000 ppm in the month of April) while the minimum value of 3.40 per cent observed under *Ambe bahar* and control (3.44 %).

4.4 YIELD CHRACTERISTICS:

4.4.1 Number of flowers per shoot:

A reference of data presented in Table 4.5 reveal that application of different treatments of chemicals and cultural practices significantly influenced the number of flowers per shoot. The maximum number of flowers per shoot (10.85) was recorded in T_2 (single foliar spray of 15 per cent urea at 50 per cent bloom stage) followed by T_7 (foliar spray of NAA @ 1000 ppm in the month of April) (9.70) and minimum under control (4.45) and *Ambe bahar* (4.65).

4.4.2 Per cent fruit set:

The perusal of data presented in Table 4.5 and Fig. 4.7 reveal that different treatments significantly influenced the per cent fruit set. The maximum fruit set 60 per cent was recorded in T_2 (single foliar spray of 15 per cent urea at 50 per cent bloom stage) as compared to *Ambe bahar* (39.85 %) and control (36.90 %). However, treatment T_2, T_4, T_6 and T_7 were found statistically at par.

4.4.3 Per cent fruit retention:

The data regarding the fruit retention as influenced by the application of different treatments of chemical and cultural practices are presented in Table 4.5 and depicted in Fig. 8. It was evident from the data that T_3 (Pruning with 75 per cent intensity at 50 per cent bloom stage in the month of April) registered maximum per cent fruit retention (69.60 %) as compared to *Ambe bahar* (45.74 %) and control (49.30 %). However, T_4 (heading back of terminal branches with 50 per cent intensity at 50 per cent bloom stage in the month of April) and T_3 found statistically at par. The tree receiving T_3 treatment showed 52.16 per cent higher retention in *Mrig bahar* as compare to *Ambe Bahar*.

4.4.4 Number of fruits per plant:

The perusal of data presented in Table 4.5 reveal that number of fruits per plant significantly influenced with the application of chemicals and cultural practices. The maximum number of fruits per plant recorded in T_3 (Pruning with 75 per cent intensity at 50 per cent bloom stage in the month of April) *i.e.* 389.50 and minimum was in control (165.00). T_3 had more number of fruits per plant during *Mrig bahar* as compare to *Ambe Bahar* (212.5).

4.4.5 Yield per tree (kg):

The data related to yield per tree (kg) of guava significantly influenced by the application of different treatments have been summarized in Table 4.5, Fig. 4.9.

An appraisal of data revealed that yield per plant was significantly affected by the application by the application of chemicals and cultural practices. The maximum yield (56.38 kg tree^{-1}) was obtained in T_2 (single foliar spray of 15 per cent urea at 50 per cent bloom stage) whereas minimum yield of fruits (16.63 kg tree^{-1}) was recorded under control. Further, treatment T_7 and T_4 were found statistically at par.

4.4.6 Yield (q ha^{-1}):

The data on yield (q ha^{-1}) as affected by different treatments are presented in Table 4.5. It was evident from the data that the yield (q ha^{-1}) was significantly affected by the application chemicals and cultural practices. The maximum yield (156.73 q ha^{-1}) was obtained in T_2 (single foliar spray of 15 per cent urea at 50 per cent bloom stage) followed by T_7 (foliar spray of NAA @ 1000 ppm in the month of April) (54.38) and T_1 (foliar spray of 10 per cent urea at the time of 50 per cent bloom stage and second foliar spray of same dose after 10 days of first spray) (50.00) and minimum yield (46.09 q ha^{-1}) was recorded under control and *Ambe bahar* (76.45 q ha^{-1}).

4.5 LEAF NUTRIENT STATUS:

4.5.1 Nitrogen content:

The results regarding the N content in leaves of guava as influenced by different treatments of chemicals and cultural practices in Table 4.6 and Fig.4.10. Among the various treatments T_1 (foliar spray of 10 per cent urea at the time of 50 per cent bloom stage and second foliar spray of same dose after 10 days of first spray) registered maximum value of 1.407 per cent followed by T_2 (single foliar spray of 15 per cent urea at 50 per cent bloom stage) (1.396 %). The minimum nitrogen content was recorded under control (1.200 %). The N content of leaves of T_1 treatment was 17.25 per cent higher over control.

4.5.2 Phosphorus content:

The data with respect to P content of leaves as affected by the chemicals and cultural practices have been summarized in Table 4.6 and Fig. 4.10 It is obvious from the data that P content of leaves was significantly influenced by various treatments. The maximum P content was observed 0.465 per cent under T_1 (foliar spray of 10 per cent urea at the time of 50 per cent bloom stage and second foliar spray of same dose after 10 days of first spray) followed by 0.425 per cent in T_7 (foliar spray of NAA @ 1000 ppm in the month of April) and minimum P content was reported in T_0 (0.305 %).

Considering the increase in P content in leaves under T_1 was 52.45 per cent higher then control.

4.5.3 Potassium content:

A reference data (Table 4.6 and Fig. 4.10) reveal that the maximum K content (1.172 %) in guava leaves was recorded under T_1 (foliar spray of 10 per cent urea at the time of 50 per cent bloom stage and second foliar spray of same dose after 10 days of first spray) and minimum K content 1.022 per cent was recorded under the control.

4.6 Available NPK status (kg ha^{-1}) of soil at harvest:

The data regarding the effect of chemicals and cultural practices on leaf nutrient status are given in Table 4.7.

The data reveal that the application of chemicals and cultural practices had non significant effect on available NPK content of soil. However, the highest nitrogen content (225.14 kg ha^{-1}) in T_2 (single foliar spray of 15 per cent urea at 50 per cent bloom stage), highest phosphorus content (25.57 kg ha^{-1}) in T_1 (foliar spray of 10 per cent urea at the time of 50 per cent bloom stage and second foliar spray of same dose after 10 days of first spray) and highest K content (290.12 kg ha^{-1}) in treatment T_2.

4.7 Economics:

Data presented in Appendix VIII indicated that the general cost of guava cultivation was Rs. 37181 per hectare including labour cost, cost of various material inputs and overhead costs.

Treatment wise addition cost included cost of chemicals (urea, NAA), cultural practices (labour cost and material required) are given in Appendix-IX.

The economics of various treatments with benefit: cost ratio is given in Table 4.8 and Fig. 4.11. The gross return from the sale of guava was calculated at an average price of Rs. 600 per quintal for *Ambe bahar* yield and Rs. 900 per quintal for *Mrig bahar* yield. The net profit from cultivation under different were worked out after substrating the cost of cultivation from gross return. The data reveal that the maximum net return of Rs. 109394.88 ha^{-1} and **B : C** ratio 2.81 : 1 were obtained in T_2 (single foliar spray of 15 per cent urea at 50 per cent bloom stage) whereas the minimum net return (Rs. 50170) and **B : C** ratio (1.31 : 1) obtained under control. Table (4.8) also reveals that after T_2 closely followed treatment were T_5 and T_1.

Therefore it may inferred from the above finding that treatment T_2 was most economic followed T_5 (Bending of shoots in the month of July-August).

5. DISCUSSION

The results of experiment entitled "Crop regulation in guava (*Psidium guajava* L.) cv. Sardar as influenced by chemicals and cultural practices" has been discussed in the light of acceptable principals and available literature as under:

5.1 VEGETATIVE GROWTH CHARACTERISTICS:

It is evident from the data presented in the preceding chapter that different treatments had significant effect on vegetative characteristics *viz.* number of newly emerged shoots, per cent increase in shoot growth after 30 days interval and canopy volume.

A perusal data presented in table 4.1 and 4.2 clearly indicated that the treated plants exhibited significantly higher number of newly emerged shoots, per cent increase in shoot growth after 30 days interval and canopy volume over control. Treatment T_3 (pruning with 75% intensity at 50% bloom stage in the month of April) showed significantly superior with respect to number of newly emerged shoots, per cent increase in shoot growth after 60 days of pruning, whereas, T_4 (heading back of terminal branches with 50% intensity at 50% bloom stage in the month of April) found superior with per cent increase in shoot growth after 30 and 90 days. Treatment T_7 (foliar spray of NAA @ 1000 ppm in the month of April) showed significant superior with respect to canopy volume over control and *Ambe Bahar*. Further, T_1 (foliar spray of 10 % urea at the time of 50 per cent bloom stage. Second foliar spray of same dose after 10 days of fruit spray) and T_7 was statistically at par.

It might be due to well response of vegetative growth to pruning and narrow C: N ratio of plant that induce vegetative flush in tree (Anez, 1998) that resulted in vigorous growth of plant (Jadhav *et al.* 1998). The increase in plant canopy, number of shoots and percent increase in growth may be due to positive response of treatment. Which reduce the crop load of the *Ambe bahar* and whole energy was diverted towards the vegetative growth of plant. Highest canopy volume with foliar spray of NAA @ 1000 ppm may due to its immediate absorption which increased the

endogenous auxin level that resulted in cell elongation and enhanced vegetative growth (Singh *et al.* 1987 and Singh *et al.* 1992).

5.2 PHYSICAL CHARACTERISTICS OF FRUITS:

The results obtained in present investigation reveal that the application of chemicals and cultural practices significantly improved the physical attributes of fruits (fruit weight, fruit volume, pulp weight, pulp thickness, pulp: seed ratio) as compare to absolute control and *Ambe Bahar*.

The perusal of data presented in table 4.3 clearly indicate that the treated plants exhibited higher fruit weight, pulp weight, pulp thickness and pulp: seed ratio. The fruit was significantly increased due to various treatments to control and *Ambe Bahar* (Table 4.3). Moreover, the foliar application of NAA @ 1000 ppm in the month of April (T_7) was significantly superior in terms of physical characteristics rest of treatments. Maximum fruit weight was recorded in T_7 (152.60 g) as compared to control (98.25 g). Further, highest fruit volume (139.25 cc), pulp weight (147.25 g), pulp thickness (1.13 cm) and pulp: seed ratio (58.90) was highest in treatment T_7. It might be due to adverse influence of foliar spray of 1000 ppm NAA on guava which cause burning and defoliation in rainy season. High vegetative growth due to residual effect of NAA on plants that resulted in high leaf to fruit ratio and high fruit weight, fruit volume, pulp thickness, pulp weight and pulp: seed ratio. In the literature regarding the influence of chemical treatments on fruit weight, fruit volume and pulp: seed ratio indirectly supported by the findings of Dubey *et al.* (2002), who observed that highest deblossoming of guava during rainy season and the highest yield and fruiting quality during the winter season with spray of 250 ppm NAA (Gaur, 1996; Josan and Sharma 1987 and Singh *et al.* 1992).

5.3 BIOCHEMICAL CHARACTERISTICS OF FRUITS:

The results obtained in present investigation reveal that the application of chemicals and cultural practices significantly improve the fruit quality of guava in term of TSS, acidity, ascorbic acid and sugars content as compare to control and *Ambe Bahar.*

A perusal of data presented in table 4.4 indicated that the guava plant received foliar spray of NAA @ 1000 ppm in the month of April exhibited maximum value of TSS (13.80 %), ascorbic acid (193.75 mg/100 g pulp), total sugars and reducing sugars (7.29% and 4.21% respectively).

The maximum TSS, sugars and ascorbic acid might be probably due to high leaf to fruit ratio because of restricted number of fruits harvested and high photosynthesis activity. The results are cognizance with the findings of Dubey *et al.* (2002), Singh *et al.* (1996) and Gaur (1996).

Acidity of guava shows decreasing trend with the rising concentration of NAA (Dubey *et al.*, 2002 and Singh *et al.*, 1992).

5.4 YIELD CHARACTERISTICS:

The data presented in table 4.5 clearly showed that application of different treatments of chemicals and cultural practices had significantly influenced the yield per plant and yield per hectare as compare to absolute control and *Ambe Bahar.*

The number of flower per shoots and per cent fruit retention (60.00), number of fruits per plant (389.50), yield per plant (56.38 kg) and estimated yield per hectare was superior in treatment T_2 (Single foliar spray of 15 % urea at 50% bloom stage) over rest of the treatments. Whereas highest fruit retention (67.85 %) in T_3 (pruning at 75 % intensity at 50 % bloom stage in the month of April) while, all the characters had least value under T_0 (control). On comparison of T_2 (*Mrig Bahar*) with *Ambe Bahar*, T_2 show significantly higher number of fruits, per cent fruit set, per cent fruit retention, number of fruits per plant, yield per plant and estimated yield per hectare.

It might be due to owing to the improved nutritional status of plant. Due to foliar spray of urea at 15 per cent, tree tends to produce more flowers and that can be supported by photosynthesis and remobilization (Rajput *et al.*, 1986). It might also be due to residual effect of higher concentration of urea on flowers abscission in rainy season and further increase in higher number of fruits per plant (Singh *et al.*, 2002 and Dwivedi *et al.*, 1993). Increase in yield also may be due to higher fruit weight, more number of fruits per plant because of better leaf nutrient status in the leaves, which directly or indirectly helps in improve photosynthesis and translocation from source to sink.

5.5 LEAF NUTRIENT STATUS:

The result of present experiment reveal that leaf nutrient status with respect to N,P and K content were increased after the terminal of trial due to various treatments over control. The leaf nutrient status from the table 4.6 reveals that the decreasing trends of NPK content in leaves with treatments were found as under:

N : $T_1 > T_2 > T_7$

P : $T_1 > T_7 > T_2$

K : $T_1 > T_7 > T_2$

Application of foliar spray of 10 per cent urea at 50 per cent bloom stage. Second spray of the same dose at 10 days after first spray registered maximum value for N (1.407 %), P (0.465 %) and K (1.172 %) content in leaf. The results are closely conformatory with those of Singh *et al.* (1994).

5.6 ECONOMICS:

Data reported in table 4.9 that application of single spray of 15 per cent urea at 50 per cent bloom stage (T_2) significantly increased the net return (Rs. 109394.88) and B : C ratio (2.81 : 1) over the control (Rs. 50170 and 1.34 : 1 respectively) This might be due to the increase in the per plant and per hectare yield of guava.

6. SUMMARY

The experiment entitled "Crop regulation in guava (*Psidium guajava* L.) cv. 'Sardar' as influenced by chemical and cultural practices" was conducted during 2007-08, at Instructional Farm, Department of Horticulture, Rajasthan College of Agriculture, Udaipur. The results obtained and discussed in the preceding chapter have been summarized below:

Significant improvement was registered in the vegetative growth characteristics (number of newly emerged shoots, per cent increase in shoot growth after 30 days interval and canopy volume), physical characteristics of fruits (fruit weight, fruit volume, pulp weight, pulp thickness and pulp: seed ratio), bio-chemical characteristics (TSS, acidity, ascorbic acid content, reducing sugar and total sugars), yield characteristics (number of flowers per shoot, per cent fruit set, per cent fruit retention, number of fruit per plant, yield per tree and yield per hectare), leaf nutrient status at harvest due to applied treatment over control.

6.1 VEGETATIVE GROWTH CHARACTERISTICS:

- The number of newly emerged shoots significantly influenced by chemical and cultural practices pruning with 75 per cent intensity 50 at per cent bloom stage in the month of April gave maximum number newly emerged shoots (4.60) and minimum in control (2.55).
- The various treatments had significantly influenced the per cent increase in shoot growth. The maximum per cent increase in shoot growth after 30 and 90 days (13.91 and 3.87 %) recorded in T_4 (heading back of terminal branches with 50 per cent intensity at 50 per cent bloom stage in the month of April) whereas, maximum per cent increase in shoot growth after 60 days (8.30 %) was recorded in T_3 treatment (Pruning with 75 per cent intensity at 50 per cent bloom stage in the month of April) over rest of the treatments.
- The foliar spray of NAA @ 1000 ppm in the month of April gave maximum canopy volume *i.e.* 371.55 m^3 while the minimum canopy volume (102.62 m^3) was observed in *Ambe bahar* and control.

6.2 PHYSICAL CHARACTERISTICS OF FRUITS:

- The different treatments had significantly influenced the fruit weight. Foliar spray of NAA @ 1000 ppm in the month of April recorded higher fruit weight (152.60 g) and the minimum (98.25 g) was observed in T_0 (control).
- The foliar spray of NAA @ 1000 ppm in the month of April gave maximum fruit volume (139.25 cc), pulp weight (147.25 g), pulp thickness (1.13 cm) and pulp seed ratio (58.90) as compared to *Ambe bahar* and absolute control.

6.3 BIO-CHEMICAL CHARACTERISTICS OF FRUITS:

- The different treatments of chemicals and cultural practices had significantly influenced the total soluble solids. Where the maximum TSS of 13.80^{o} B was recorded due to foliar spray of NAA @ 1000 ppm in the month of April and maximum in *Ambe bahar* (10.40^{o} B) and control (10.60^{o} B).
- The acidity was significantly influenced by different treatments of chemicals and cultural practices. Pruning with 75 per cent intensity at 50 per cent bloom stage in the month of April gave minimum (0.75 %) and minimum recorded under *Ambe bahar* (1.05 %) and control (1.01 %).
- The ascorbic acid significantly influenced by different treatments of chemicals and cultural practices. Foliar spray of NAA @ 1000 ppm in the month of April gave maximum ascorbic acid (193.75 mg /100 g pulp) and minimum (132.50 mg /100 g pulp) was recorded in *Ambe bahar*.
- The various treatments of chemical and cultural practices had significantly influenced the total sugars and reducing sugar. The maximum total sugars and reducing sugar of 7.29 and 4.21 per cent, respectively were recorded with the foliar spray of NAA @ 1000 ppm in the month of April and minimum total sugar and reducing sugar of (5.92 %) and (3.40 %), respectively recorded in *Ambe bahar*.

6.4 Yield characteristics

- Number of flower per shoot and per cent fruit set were significantly influenced by different treatments of chemical and cultural practices. The single foliar spray of 15 per cent urea at 50 per cent bloom stage gave higher

number of flower per shoot (10.85) and per cent fruit set (60 %) as compare to minimum (4.45 %) and (36.17 %), respectively in control.

- The different treatments of chemicals and cultural practices significantly influenced the per cent fruit retention. The highest fruit retention (69.60 %) recorded under pruning with 75 per cent intensity at 50 per cent bloom stage as compare to least in *Ambe bahar* (45.75 %).
- Single foliar spray of 15 per cent urea at 15 per cent bloom stage gave maximum fruit yield per plant (56.38 kg) and per ha. (156.73 q) which was significantly influenced by treatment. Whereas minimum fruit yield per plant (16.63 kg) and per hectare (46.09 q) was recorded in T_0 (control).

6.5 Leaf nutrient status

- The nitrogen, phosphorus and potassium content in leaf were significantly influenced by application of different treatments. Leaf N content (1.407 %), P content (0.465 %) and K content (1.172 %) were recorded in plants received foliar spray of 10 per cent urea at the time of 50 per cent bloom stage and second foliar spray of same dose after 10 days of first spray. Whereas the minimum leaf N content (1.20 %), P content (0.305 %) and K content (1.022 %) were recorded in T_0 (control).

6.6 Economics:

- The net return and **B : C** ratio significantly influenced by different treatments of chemical and cultural practices. The application of single foliar spray of 15 per cent urea at 50 per cent bloom stage gave maximum net returns Rs. 109394.88 ha^{-1} with **B : C** ratio 2.81 : 1. The minimum net returns (Rs. 50170 ha^{-1}) with **B : C** ratio (1.34 :1) were recorded at T_0 (control).
- **Table 4.1. Response of chemicals and cultural practices on vegetative growth characteristics.**
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Treatments	No. of newly emerged shoots	Percent increase in shoot growth		
		30 days	60 days	90 days
T_0	2.55	10.60	4.57	1.30

		(18.96)	(12.07)	(6.67)
T_1	3.80	10.62	7.08	2.68
		(19.01)	(15.33)	(9.44)
T_2	3.50	10.62	7.10	2.16
		(19.01)	(15.45)	(8.47)
T_3	4.60	13.31	8.30	3.28
		(21.36)	(16.62)	(10.43)
T_4	4.05	13.91	7.90	3.87
		(21.85)	(16.30)	(11.36)
T_5	3.00	11.53	6.89	2.14
		(19.81)	(15.19)	(8.42)
T_6	3.02	7.70	6.73	1.10
		(16.10)	(14.99)	(5.91)
T_7	3.35	11.70	7.13	2.94
		(20.02)	(15.47)	(9.62)
SEm ±	0.33	0.43	0.35	0.39
CD at 5%	0.98	1.27	1.05	1.15

- **Table 4.2. Response of chemicals and cultural practices on canopy volume, PAR and leaf area index**

Treatment	**Canopy volume (m^3)**	**PAR above canopy (µ Mol $m^{-2}S$)**	**PAR below canopy (µ Mol $m^{-2}S$)**	**Leaf area index**
Ambe bahar	182.64	712.00	244.00	1.69

T_0	193.10	726.50	252.25	1.71
T_1	348.68	845.00	272.25	1.96
T_2	349.30	812.25	250.00	1.93
T_3	197.83	870.75	306.00	1.87
T_4	294.20	865.50	283.00	1.94
T_5	238.90	793.75	217.50	1.82
T_6	295.78	823.25	245.75	1.90
T_7	371.55	837.75	255.00	2.07
SEm ±	11.90	37.53	17.53	0.23
CD at 5%	34.99	NS	NS	NS

- **Table 4.3. Response of chemicals and cultural practices on physical characteristics of fruits**

Treatment	Fruit weight (g)	Fruit volume (cc)	Pulp weight (g)	Pulp thickness (cm)	Seed weight (g)	Pulp:seed ratio
Ambe bahar	101.25	87.40	96.50	0.55	2.90	33.27

T_0	98.25	85.75	92.5	0.53	2.63	35.17
T_1	134.08	118.25	129.72	0.90	2.95	43.97
T_2	143.85	130.75	137.65	0.95	2.50	55.06
T_3	141.53	126.00	135.38	0.88	3.15	42.97
T_4	131.33	122.25	126.10	0.80	2.45	51.46
T_5	98.03	86.50	92.25	0.85	2.28	40.46
T_6	101.13	87.50	95.57	0.95	2.28	41.91
T_7	152.60	139.25	147.25	1.13	2.50	58.90
SEm ±	2.24	3.38	2.09	0.05	0.18	1.93
CD at 5%	7.17	9.95	6.17	0.16	NS	5.69

- **Table 4.4. Response of chemicals and cultural practices on biochemical characteristics of fruits**

Treatment	**TSS (%)**	**Acidity (%)**	**Ascorbic acid content (mg/ 100 g pulp)**	**Total sugars (%)**	**Reducing sugar (%)**
Ambe bahar	10.40	1.05	132.50	5.92	3.40

T_0	10.60	1.01	134.25	6.04	3.44
T_1	12.50	0.77	175.63	7.27	3.83
T_2	13.20	0.80	177.50	7.02	4.08
T_3	13.00	0.75	170.63	7.05	3.95
T_4	13.30	0.77	178.13	6.81	4.01
T_5	12.70	0.85	176.25	6.38	3.92
T_6	12.70	0.84	171.88	6.49	3.90
T_7	13.80	0.82	193.75	7.29	4.21
SEm ±	0.40	0.03	6.06	0.23	0.10
CD at 5%	1.19	0.11	17.82	0.67	0.29

- **Table 4.5. Response of chemicals and cultural practices on yield characteristics**

Treatment	Number of flower per shoot	Per cent fruit set	Per cent fruit retention	No. of fruits per plant	Yield per tree (kg)	Yield (q ha^{-1})
Ambe bahar	4.65	39.85 (39.11)	45.74 (42.53)	212.5	27.5	75.06

T_0	4.45	36.17 (36.90)	49.30 (44.61)	165.00	16.63	46.09
T_1	9.15	52.20 (46.25)	62.30 (52.14)	380.50	50.00	139.00
T_2	10.85	60.00 (50.78)	58.70 (50.01)	389.50	56.38	156.73
T_3	6.88	52.27 (46.28)	69.60 (56.57)	383.25	40.25	111.89
T_4	6.63	57.15 (49.06)	67.85 (55.42)	313.50	42.50	118.15
T_5	5.55	52.40 (46.36)	59.90 (50.70)	360.50	36.88	102.52
T_6	5.80	54.80 (47.73)	51.64 (45.90)	235.62	34.08	94.72
T_7	9.70	59.42 (50.43)	59.86 (50.67)	351.75	54.38	151.16
SEm ±	0.52	2.20	2.06	7.54	1.60	4.21
CD at 5%	1.54	6.48	6.06	22.20	4.73	12.39

- **Table 4.6. Effect of chemicals and cultural practices on leaf nutrient status**

Treatment	**Nitrogen (%)**	**Phosphorus (%)**	**Potassium (%)**

T_0	1.200	0.305	1.022
T_1	1.407	0.465	1.172
T_2	1.396	0.400	1.096
T_3	1.310	0.375	1.066
T_4	1.314	0.330	1.068
T_5	1.320	0.345	1.072
T_6	1.305	0.315	1.065
T_7	1.357	0.425	1.103
SEm ±	0.031	0.010	0.024
CD at 5%	0.092	0.029	0.072

- **Table 4.7. Effect of chemicals and cultural practices on available N, P and K (kg ha^{-1}) in soil at harvest**

Treatment	**Available N (kg ha^{-1})**	**Available P_2O_5 (kg ha^{-1})**	**Available K_2O (kg ha^{-1})**

T_0	211.10	22.00	289.75
T_1	223.37	26.57	288.25
T_2	225.15	25.02	290.12
T_3	221.95	24.70	291.12
T_4	219.80	23.00	286.05
T_5	217.50	22.50	285.52
T_6	219.15	21.70	287.90
T_7	222.40	24.02	290.12
SEm ±	3.251	1.28	4.07
CD at 5%	NS	NS	NS

- **Table 4.8. Response of chemicals and cultural practices on net returns and B : C ratio of guava**

Treatment	**Net returns (Rs. ha^{-1})**	**B:C ratio**

T_0	50170.00	1.34
T_1	101332.76	2.49
T_2	109394.88	2.81
T_3	63520.00	1.65
T_4	80569.00	2.10
T_5	98842.00	2.52
T_6	68101.00	1.83
T_7	95119	1.45
SEm ±	593.68	0.132
CD at 5%	1781.12	0.398

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