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Effect of Different Crop Regulation Methods and Chemicals on Yield and Physico-Chemical Characteristics of Guava cv Arka Mridula

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ABSTRACT

A field experiment was conducted during 2016-17 and 2017-18. Jharsuguda in guava (*Psidium guajava* L.) with an objective to evaluate the effect of plant growth regulation practices (both cultural and chemical methods) on yield and physico-chemical parameters. The experiment consisted of 8 treatments viz., T_1: Control, T_2: Shoot bending ; T_3: 10 cm pruning with complete removal of old leaves, in April-May ; T_4: 50% fruit thinning randomly by hand at an average fruit weight 15 –20 g in April-May ; T_5: Foliar spray of Naphthalene Acetamide (NAD) @ 50 ppm twice at 15 days interval during April-May ; T_6 : Foliar spray of (2, 4-D) @ 60 ppm, twice at 15 days interval in the during April-May ; T_7 : Foliar spray of urea @ 15%, twice at 15 days interval during April-May and T_8 : Foliar spray of Dinitro Ortho Cresol (DNOC) @ 10 ppm, twice at 10 days during April-May. These 8 treatments were evaluated in Randomized Block Design with three replications. Shoot bending (T_2) recorded highest number of fruits per plant during both the years (64.90 and 71.91 during 1st and 2nd year respectively) and were significantly different from other treatments. The heaviest fruit (132.23 g) was obtained in T_5 (50 ppm NAD) followed by 126.67 g in T_3 (10 cm pruning) and 123.54 g in T_6 (60 ppm 2, 4-D). The treatment T_5 (50 ppm NAD) gave highest fruit yield (8.80 kg) followed by 7.88 kg in T_3 (10 cm pruning), 7.76 kg in T_6 (60 ppm 2, 4-D) and 7.34 kg in T_2 (Bending) whereas it was recorded lowest in control (5.43 kg/plant). The fruit quality which is determined by TSS : Acid ratio was found highest (48.18) in T_5 (50 ppm NAD) closely followed by (43.75 each) in T_2 (Shoot bending) and T_6 (60 ppm 2, 4-D) and minimum (28.71) in control plants (T_1). In general, all the crop regulation practices and application of chemicals were found superior over the untreated control with respect to yield and physico-chemical characteristics of guava.

Keywords Guava, Bending, Pruning, Thinning, Chemicals.

INTRODUCTION

Guava is a popular fruit tree of tropical and sub-tropical climate and is native to the tropical America. It is the third richest source of vitamin C (299 mg/100

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g) after Barbados cherry (1000–4000 mg/100 g pulp) and aonla (600 mg/100 g of pulp), contains 2 to 5 times more vitamin C than oranges and 10 times more than tomato Gupta (2014). Crop regulation in guava can be adopted successfully by various cultural and chemical methods. In general, guava flowers twice in a year, i.e., in April–May and August–September, of which fruits ripen in rainy and winter season, respectively. The fruits produced in rainy season are insipid and watery and do not keep well. Fruits of winter season crop are superior in all respect as compared to rainy season fruits (Sahoo and Tarai 2018). Therefore there is need to regulate guava crop in such a way that only quality fruits are harvested in winter season (Gorakh and Reddy 1997). In order to have a winter harvest, fruit thinning is advisable. According to Singh (1986), flower thinning from guava plants during summer, improved fruit quality and increase yield during next winter. The percentage of flowering and fruiting, poor yield and quality fruits are of major concern of the fruit growers. The natural flowering and fruiting behavior of guava are needed to be regulated, towards the production of heavy crop load during winter season to make guava cultivation highly profitable and market oriented. However, no such work has been reported under the hot and moist sub-humid conditions of Western Central Table Land Zone of Odisha in Eastern part of India. Keeping this in view, an investigation was carried out to evaluate the effect of different crop regulation methods and chemicals on yield and physico-chemical characteristics of guava cv Arka Mridula.

MATERIALS AND METHODS

The study was conducted at Instructional Farm, Krishi Vigyan Kendra, Jharsuguda in Guava (*Psidium guajava* L.) cv Arka Mridula during 2016-17 and 2017-18. The soil of the experimental orchard is red laterite and the climatic condition of the region is hot and moist sub-humid conditions of Western Central Table Land Zone of Odisha. The guava plants were procured from Central Horticultural Experiment Station, Bhubaneswar. The experiment consisted of 8 treatments (T_1 : Control, T_2: Shoot bending during April-May at 90° angle with the help of piece of rope, keeping 10-12 inch of terminal of growth and rest leaves are to be removed; T_3 : 10 cm pruning with complete removal of old leaves, in April-May ; T_4: 50% fruit thinning randomly by hand at an average fruit weight 15–20 g in April-May ; T_5 : Foliar spray of Naphthalene Acetamide (NAD) @ 50 ppm twice at 15 days interval during April-May ; T_6 : Foliar spray of (2, 4-D) @ 60 ppm, twice at 15 days interval in the during April-May, T_7 : Foliar spray of urea @ 15%, twice at 15 days interval during April-May and T_8 : Foliar spray of Dinitro Ortho Cresol (DNOC) @ 10 ppm, twice at 10 days during April-May. Healthy and disease free lateral shoots were selected for shoot bending with utmost care. Shoot bending was done in such a way that the bent branch did not broken down after bending. Shoots were bent at 90° angle with the help of a piece of rope. Before shoot bending 3-5 leaves were kept at the upper portion of the branch to continue its photosynthesis and respiration process and rest leaves were removed off.

The experiment was conducted in Randomized Block Design (RBD) with 8 treatments (cultivars) and 3 replications. Datas were taken on various parameters like number of fruits per plant, fruit weight (g) and fruit yield per plant (kg). After harvesting of the fruits, it were brought to the laboratory of College of Horticulture, Chiplima for recording observation on various physico-chemical characteristics of the fruits under different treatments. Ten fruits were taken from each plant randomly at mature stage replication wise from each treatments by using electronic balance and average weight was expressed in gram (g). Fruit size in terms of fruit length and fruit diameter was calculated by vernier calliper. The volume of fruit was measured by the conventional water displacement method and expressed in ml. Specific gravity was calculated by the formula ; Specific gravity = Weight of fruit (g) / Volume of fruit (ml). The skin of freshly harvested fruits was peeled and pulp was separated and weighed by using electronic balance and the mean weight was recorded and expressed in grams. The pulp of the fruit was made into pieces and boiled in hot water for 15 minutes. Later the seeds were separated by using ordinary sieve (< 20 mm) and were weighed and expressed in grams. Pulp percentage was calculated by using the following; Pulp percentage = (Total weight of pulp/total weight of the fruit) × 100. Similarly, the percentage of seed

Table 1. Effect of different crop regulation methods and chemicals on number of fruits per tree and yield of guava cv Arka Mridula.

Treatments	No. of fruits per tree			Yield per tree (kg)			Yield per hectare (q/ha)		
	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean
T_1-Control	56.16	60.21	58.19	5.89	4.96	5.43	23.56	19.84	21.72
T_2-Shoot bending	64.50	71.91	68.20	7.43	7.24	7.34	29.72	28.96	29.36
T_3-10 cm pruning	58.00	66.00	62.00	7.00	8.75	7.88	28.00	35.00	31.52
T_4-50% fruit thinning	56.33	58.35	57.34	6.69	7.41	7.05	26.76	29.64	28.20
T_5-50 ppm NAD	63.19	69.36	66.28	7.70	9.90	8.80	30.80	39.60	35.20
T_6-60 ppm 2, 4-D	59.58	65.87	62.73	7.16	8.36	7.76	28.64	33.44	31.04
T_7-15% urea	58.00	59.75	58.87	6.65	6.54	6.60	26.60	26.16	26.40
T_8-10 ppm DNOC	56.17	58.14	57.16	6.35	4.98	5.66	25.40	19.92	22.64
SE (m) +	2.25	1.18	1.23	0.25	0.19	0.14	1.00	0.83	2.08
CD at (5%)	4.55	2.38	2.48	0.50	0.39	0.27	2.02	1.68	4.20

weight was calculated by the following formula : Seed percentage = (Average of seed weight /average weight of fruit) × 100.

Total soluble solids of fruit were estimated with the help of a hand refractometer based on the principle of total refraction. Acidity of the fruit juice was estimated by titrating against standard alkali (0.1 N NaOH) solution (AOAC 1984) using phenopthalein as an indicator and was expressed as percentage in terms of citric acid. The total sugars content was estimated by following Shaffer Shomogi method as described by Ranganna (1977). Ascorbic acid content of the fruit was estimated by using 2, 6-dichlorophenol indophenol dye which is reduced by ascorbic acid to a colorless form (Ranganna 1977). TSS/acid ratio was calculated by dividing TSS with their corresponding acidity. The data on the above parameters were subjected to analysis of variance (Panse and Sukhatme 1989).

RESULTS AND DISCUSSION

Number of fruits per plant

From the mean data, presented in Table 1, it was found that the number of harvested fruits per plant varied significantly and it ranged between 58.19 in control (T_1) to 68.20 (T_2). The highest number of fruits (68.20) per plant were obtained by the treatment T_2 (Shoots bending) followed by T_5 (66.28) i.e. with 50 ppm NAD. The control plant (T_1) recorded the lowest number of fruits (56.16). Shoot bending (T_2) recorded highest number of fruits per plant followed by 50 ppm NAD (T_5) during 1st and 2nd year respectively and were significantly different from other treatments. Both the treatments were also found significantly superior over the control. The results are in line with the findings of Singh (1986) who reported NAD (50 ppm) application was very effective in reducing rainy season crop with subsequent increased fruit set and fruit number during winter and Kumar and Hoda (1977) who suggested for application of NAD (50 ppm) and 2, 4-D (30 ppm) in thinning rainy season crop. Pruning also reduces tree crown area and improves number of fruits per plant in guava (Dalal *et al.* 2000, Brar *et al.* 2007).

Fruit weight (g)

The data presented in Table 1, showed that all the treatments varied significantly. All the treatment resulted higher fruit weight over the control (T_1). From the mean data it was confirmed that the heaviest fruit (132.23 g) was obtained in T_5 (50 ppm NAD) followed by 126.67 g in T_3 (10 cm pruning) and 123.54 g in T_6 (60 ppm 2, 4-D). From the treatments pertaining to cultural methods (pruning, thining and bending), the T_3 treatment (10 cm pruning) recorded maximum fruit weight (126.67 g). However, with respect to treatment with chemicals (Urea, NAD, 2, 4-D and DNOC), the treatment T_5 (50 ppm NAD) recorded highest fruit weight (132.23 g). Lowest fruit weight was obtained in T_1 i.e. control (93.64 g). This result is in close proximity with the findings of Mitra *et al.* (1982), who reported that application of growth substances like NAD (30 and 50 ppm) increased weight of fruit. The increased fruit weight could be

Table 2. Effect of different crop regulation methods and chemicals on fruit weight, fruit size and fruit volume of guava cv Arka Mridula.

	Average fruit weight (g)			Fruit volume (ml)			Specific gravity		
Treatments	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean
T_1-Control	104.91	82.36	93.64	76.27	85.29	80.78	1.38	0.97	1.16
T_2-Shoot bending	115.24	100.69	107.96	92.35	101.37	96.86	1.25	0.99	1.11
T_3-10 cm pruning	120.67	132.65	126.67	109.36	127.58	118.47	1.10	1.04	1.07
T_4 -50% fruit thinning	118.96	127.01	122.98	113.52	122.54	118.03	1.05	1.04	1.04
T_5-50 ppm NAD	121.67	142.79	132.23	121.67	118.38	120.03	1.00	1.21	1.10
T_6-60 ppm 2, 4-D	120.20	126.88	123.54	120.20	130.89	125.55	1.00	0.97	0.98
T_7-15% urea	114.78	109.45	112.16	106.31	115.33	110.82	1.08	0.95	1.01
T_8-10 ppm DNOC	113.02	85.58	99.30	69.49	78.51	74.00	1.63	1.09	1.34
SE (m) ±	2.36	2.01	1.35	1.73	3.22	3.21	0.07	0.04	0.05
CD at (5 %)	4.77	4.07	2.74	3.50	6.51	6.48	0.15	0.09	0.10

Table 2. Continued.

	Fruit length (cm)			Fruit diameter (cm)		
	1st year	2nd year	Mean	1st year	2nd year	Mean
T_1-Control	6.39	6.69	6.54	5.30	5.55	5.42
T_2-Shoot bending	6.70	7.00	6.85	6.25	6.50	6.37
T_3-10 cm pruning	7.06	7.36	7.21	6.47	6.72	6.59
T_4-50% fruit thinning	6.52	6.82	6.67	6.49	6.74	6.61
T_5-50 ppm NAD	7.52	7.82	7.67	6.72	6.97	6.84
T_6-60 ppm 2, 4-D	7.00	7.30	7.15	6.17	6.42	6.29
T_7-15% urea	6.30	6.60	6.45	5.61	5.86	5.73
T_8-10 ppm DNOC	5.90	6.20	6.05	6.14	6.39	6.26
SE (m) ±	0.36	0.35	0.14	0.17	0.17	0.07
CD at (5 %)	0.72	0.71	0.43	0.34	0.34	0.21

attributed to an increase in the size of the cells and accumulation of food substances in the intercellular spaces in fruit. Fruit weight at harvest was negatively correlated with crop load and fruit weight was greatest when there was minimum competition between fruit. These results are nearly in agreement with finding of Haropinder *et al.* (2006) according to whom the fruit weight was improved at 20 cm level of pruning in guava fruits.

Yield per plant (kg)

The fruit yield is an ultimate factor that decides the success and failure of any technology to the fruit growers. It was inferred from the average data presented in the Table 1, that the yield (kg / plant) varied significantly due to different treatments. From the mean data, the treatment T_5 (50 ppm NAD) gave highest fruit yield (8.80 kg) followed by 7.88 kg in T_3 (10 cm pruning), 7.76 kg in T_6 (60 ppm 2, 4-D) and 7.34 kg in T_2 (Bending) whereas it was recorded lowest in control (5.43 kg/plant). So it was clear that with respect to the yield per plant the all treatments were found superior to the check. With respect to cultural treatments like pruning, fruit thining and shoot bending, the yield per plant was recorded maximum (7.88 kg) in T_3 (10 cm pruning) while it was found maximum (8.80 kg) in T_5 (50 ppm NAD) with respect to the plants treated with chemicals. However, according to Bagchi *et al.* (2008), bending of shoots gave the highest yield per plant (48.6 kg/plant), followed by 20 cm pruning (23 kg /plant). The result is in close proximity with the findings of Sahar and Abdel-Hameed (2014) who obtained maximum fruit yield in guava with pruning at 10 cm. Similarly, Mamun *et al.* (2012) obtained highest fruit yield (13.50 kg/plant) in shoot bending treatment and the lowest fruit yield (7.19 kg/plant) was recorded in 100% fruit thinning treatment.

Fruiting characters

Different fruiting characters under the study were found statistically significant.

The fruit size in terms of fruit length and fruit diameter varied significantly during the period of investigation.

Fruit length

From the data depicted in the Table 2, it was found that the fruit length varied significantly due to different treatments. From the data presented in the Table 2, the fruit length varied between 5.90 cm to 7.52 cm due to different treatments and variations were found to be significant during first year. The longest fruit (7.52 cm) was observed in T_5 (50 ppm NAD) followed by (7.06 cm) in treatment T_3 (10 cm pruning), while shortest (5.90 cm) fruit length was noted in the 10 ppm DNOC (T_8). The treatments 50 ppm NAD (T_5) and 10 cm pruning (T_3) were observed to be statistically significant over the other treatments and these were also found superior over control in terms of length of the fruit. Similarly during 2nd year the maximum fruit length (7.82 cm) was recorded in 50 ppm NAD (T_5) followed by (7.36 cm) in (T_3–10 cm pruning), 7.30 cm in T_5 i.e. with 60 ppm 2, 4-D and 7.00 cm in shoot bending treatment (T_2) and the treatments were T_5, T_3, T_6 and T_2 found statistically at par. The minimum fruit length was recorded in 10 ppm DNOC (T_8) 6.20 cm followed by 15 % urea (T_7) 6.60 cm. The treatments T_5, T_3, T_6 and T_2 were found significantly different and superior to the treatments like T_8, T_7, T_1 and T_4. From the mean data, similar trend is obtained with longest fruit (7.67 cm) in T_5 and shortest fruit in T_8 (6.05 cm).

Fruit diameter

From the data depicted in the Table 2, it is clear that the fruit diameter ranged from 5.30 cm in control (T_1) to 6.72 cm (T_5) during first year and 5.55 cm in control (T_1) to 6.97 cm in 50 ppm (T_5) during 2nd year. During 1st year the maximum fruit diameter (6.72 cm) was recorded in (T_5) i.e. with 50 ppm NAD followed by 6.49 cm with 50% fruit thinning (T_4), 6.47 cm with 10 cm pruning (T_3), 6.25 cm in shoot bending (T_2) and 6.14 cm in (T_8) i.e. with application of 10 ppm DNOC while it was found minimum (5.30 cm) in control (T_1). During 2nd year the fruit diameter was observed highest (6.97 cm) in 50 ppm NAD (T_5) followed by 6.74 cm in 50% fruit thinning (T_4), 6.72 cm in 10 cm pruning (T_3) and 6.50 cm in treatment T_2 i.e. with shoot bending (T_2), while it was found lowest (5.55 cm) in control (T_1). Similarly, from the average data, it was recorded highest (6.84 cm) in T_5 and lowest (5.42 cm) in control (T_1). Jain and Dashora (2011) observed maximum fruit diameter of 7.30 cm due to pre-harvest application of 200 ppm NAA in guava.

The improvement in size of guava fruits due to application of various chemicals and practicing of cultural practice, might be due to enhanced internal physiology during fruit development which induced efficient utilization of resources like water, nutrients and other vital compounds due to the above treatments. This might be also due to the reduction in crop load on treated tree which resulted in the diversion of more translocates to the fruits thereby increased fruit size and weight and similar results also reported by Brar *et al*. (2007).

Fruit volume

The data presented in the Table 2, showed significant difference among the treatments with respect to fruit volume during both the years of study. During first year, the maximum fruit volume (121.6 ml) was recorded in (T_5) 50 ppm NAD closely followed by (120.20 ml) in T_6–60 ppm 2, 4-D where as the minimum volume of the fruit (69.49 ml) was observed in T_8 (10 ppm DNOC). During second year, the fruit volume was found highest (130.89 ml) in T_6–60 ppm 2, 4-D followed by T_3 (127.58 ml), T_4 (122.54 ml), T_5 (118.38 ml) while lowest fruit volume (78.51 ml) was

Table 3. Effect of different crop regulation methods and chemicals on specific gravity, pulp percentage and seed percentage of guava cv Arka Mridula.

Treatments	Pulp weight (g)			Seed weight (g)			Pulp (%)			Seed (%)		
	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean
T_1-Control	96.34	72.37	84.35	6.94	7.34	7.14	91.83	87.87	90.08	6.62	8.91	7.62
T_2-Shoot bending	107.51	85.55	96.53	6.87	7.27	7.07	93.29	84.96	89.41	5.96	7.22	6.55
T_3-10 cm pruning	114.11	115.15	114.63	6.28	6.68	6.48	94.56	86.81	90.49	5.20	5.04	5.12
T_4-50% fruit thinning	112.28	109.78	111.03	6.45	6.85	6.65	94.38	86.43	90.28	5.42	5.39	5.41
T_5-50 ppm NAD	115.45	126.61	121.03	6.18	6.58	6.38	94.89	88.67	91.53	5.08	4.61	4.82
T_6-60 ppm 2, 4-D	113.34	109.38	111.36	6.24	6.64	6.44	94.29	86.21	90.14	5.19	5.23	5.21
T_7-15% urea	107.28	94.62	100.95	6.29	6.69	6.49	93.47	86.45	90.01	5.48	6.11	5.79
T_8-10 ppm DNOC	106.21	65.49	85.85	6.03	6.43	6.23	93.97	76.52	86.46	5.34	7.51	6.27
SE (m) ±	0.79	1.42	0.61	0.10	0.10	0.49	2.19	0.83	1.06	0.13	0.16	0.10
CD at (5 %)	1.60	2.86	1.23	0.21	0.21	0.98	4.43	1.67	2.14	0.26	0.33	0.20

noticed in T_8 (10 ppm DNOC). Similarly from the average data, it was found highest (125.55 ml) in T_5 closely followed by T_5 (120.03 ml), T_3 (118.47 ml), T_4 (118.03 ml) while it was recorded lowest (74.00 ml) in T_8. However, Agnihotri *et al.* (2013) reported fruit volume of 185.38 ml with the foliar spray of 60 ppm 2, 4-D under Mandsaur, Madhya Pradesh condition.

Specific gravity

It is inferred from data depicted in the Table 2, that during 1st year the specific gravity of the fruit ranged from a minimum of 1.00 in T_5 (50 ppm NAD) and T_6 (60 ppm 2, 4-D) to a maximum of 1.63 in 10 ppm DNOC (T_8). During 2nd year, it ranged from a minimum of 0.95 in 15% urea (T_7) to a maximum of 1.21 in 50 ppm NAD (T_5). Similarly, from the mean data, the specific gravity was found maximum (1.34 cm) in T_8 and minimum (0.98) in T_5.

Pulp percentage

Significant differences in the percentage of pulp were found among the treatments during both years of study. From the data presented in the Table 3, all treatments were found statistically significant and it was recorded highest (94.89%) in T_5 followed by 94.56% in T_3 (10 cm pruning), 94.38% in T_4 (50 % fruit thinning) and 94.29% in T_6 (60 ppm 2, 4-D) while it was recorded lowest (91.83%) in control (T_1). During 2nd year the pulp content (88.67%) was found highest in 50 ppm NAD (T_5) and lowest in 10 ppm DNOC (T_8) 76.52%. From the mean data, it was found highest (91.53%) in T_5 (50 ppm NAD) and lowest (86.46) in (T_8) i.e. with application of 10 ppm DNOC.

Seed percentage

There were significant differences within the different treatments with respect to the percentage of seed content inside the fruit during both 1st and 2nd year as revealed from the data presented in the Table 3. During 1st year the maximum seed content (6.62 %) was obtained in control (T_1) followed by 5.96% in shoot bending (T_2) and 5.48%, in 15% urea (T_7) while minimum seed content (5.08%) was observed in 50 ppm NAD (T_5) followed by 5.19% in (T_6) i. e. with 60 ppm 2, 4-D. During 2nd year maximum seed (8.91%) was obtained in the fruits of control T_1 followed by 7.51% in 10 ppm DNOC (T_8) and 7.22% in shoot bending (T_2) while it was lowest (4.61 %) in 50 ppm NAD (T_5) followed by 5.04% in 10 cm pruning (T_3). From the average data, it was recorded highest (7.62%) in T_1 in and lowest (4.82 %) in 50 ppm NAD (T_5).

The results pertaining to the above physical pa-

Table 4. Effect of different crop regulation methods and chemicals on chemical parameters of guava cv Arka Mridula.

Treatments	Total soluble solid (°Brix)			Acidity (%)			Total sugar (%)		
	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean
T_1-Control	8.50	9.31	8.90	0.31	0.30	0.31	4.60	4.73	4.67
T_2-Shoot bending	10.30	10.70	10.50	0.22	0.25	0.24	6.70	6.83	6.77
T_3-10 cm pruning	8.90	10.20	9.50	0.27	0.28	0.28	6.90	7.03	6.97
T_4-50% fruit thinning	10.10	10.37	10.20	0.25	0.28	0.27	8.20	8.33	8.27
T_5-50 ppm NAD	10.40	10.79	10.60	0.21	0.23	0.22	8.20	8.32	8.26
T_6-60 ppm 2, 4-D	10.30	10.75	10.50	0.23	0.25	0.24	8.10	8.23	8.17
T_7-15% urea	9.60	10.50	10.10	0.27	0.29	0.28	7.60	7.73	7.67
T_8-10 ppm DNOC	8.50	9.49	9.00	0.27	0.30	0.29	5.90	6.03	5.97
SE (m) ±	0.39	0.33	0.27	0.01	0.01	0.01	0.11	0.11	0.06
CD at (5 %)	0.78	0.66	0.54	0.02	0.03	0.02	0.34	0.34	0.19

Table 4. Continued.

Treatments	Ascorbic acid (mg/100 g edible portion)			TSS : Acid ratio		
	1st year	2nd year	Mean	1st year	2nd year	Mean
T_1-Control	129.0	128.73	128.9	27.42	31.03	28.71
T_2-Shoot bending	203.7	206.29	205.0	46.82	42.80	43.75
T_3-10 cm pruning	183.8	176.39	180.1	32.96	36.43	33.93
T_4-50% fruit thinning	186.0	188.79	187.4	40.40	37.04	37.78
T_5-50 ppm NAD	209.8	210.49	210.1	49.52	46.91	48.18
T_6-60 ppm 2, 4-D	207.0	206.40	206.7	44.78	43.00	43.75
T_7-15% urea	153.9	157.20	155.6	35.56	36.21	36.07
T_8-10 ppm DNOC	149.3	150.43	149.9	31.48	31.63	31.03
SE (m) ±	3.73	4.04	2.82	2.84	1.68	1.68
CD at (5%)	7.55	8.17	5.70	5.73	3.39	3.40

rameters of fruits corroborates the findings of Maji *et al.* (2015) who also reported that NAD @ 60 ppm showed maximum increase in fruit morphological characters viz., length, diameter, volume, weight, specific gravity, pulp weight, core weight, pulp percentage and pulp thickness over the control in winter crop.

Bio-chemical quality parameters

Total soluble solids

The total soluble solids are the index of sweetness of fruit. It is quite evident from the data presented in the Table 4, that TSS of the fruit during 1st year was maximum (10.40 °Brix) in (T_5) i.e. 50 ppm NAD followed by (10.30 °Brix each) in (T_6) i.e. 60 ppm 2, 4-D and (T_2) i.e. shoot bending and 10.11 °Brix in T_4 i.e. 50% fruit thinning while, the minimum TSS (8.46 °Brix each) was obtained in (T_1) control and (T_8) i.e. with 10 ppm DNOC. During 2nd year, the treatments studied with respect to the TSS content of the fruits varied significantly. It was recorded maximum (10.79 °Brix) in 50 ppm NAD (T_5) followed by (10.75 °Brix) in 60 ppm 2, 4-D (T_6), 10.70 °Brix in T_2 (Shoot bending) and minimum (9.31 °Brix) was recorded in control (T_1). During both the years, the treatments were significantly different from each other. The treatments viz. T_2 to T_8 was found significantly superior over the check with respect to the TSS content of the fruits. Similarly, from the mean data, the treatment T_5 (10.60 °Brix) was found superior followed by T_6 and T_2 (10.5 °Brix each) while it was found minimum (8.90 °Brix). The significant improvement in total soluble solids (TSS), due to the application of chemicals and other treatments might be due to the quick metabolic transformation of starch into sugars and rapid mobilization of photosynthetic metabolites and minerals from other parts of the plant to the developing fruits (Maji *et al*. 2015).

Acidity (%)

It was noted from data presented in the Table 4, that during 1st year the acidity of the fruit varied significantly with highest acidity (0.31%) obtained in control (T_1) plants followed by (0.27% each) in (T_3) i.e. 10 cm pruning, (T_8–10 ppm DNOC) and (T_7–15% urea) while the lowest acidity (0.21%) was recorded in (T_5) i.e. 50 ppm NAD followed by 0.22% in shoot bending (T_1). During 2nd year, the maximum acidity (0.30%) was observed in control (T_1) and 10 ppm DNOC (T_8) while it was found minimum (0.23%) in 50 ppm NAD (T_5) followed by (0.25% each) in 60 ppm 2, 4-D (T_6) and shoot bending (T_2) treatment. With regards to acidity fruits produced from control (T_1) were found most acidic and significantly different from other treatments. Similarly, from the average data, it was found maximum (0.31%) in control (T_1) and minimum (0.22%) in T_5 (50 ppm NAD). The decrease in acidity with the application of chemicals might be due to their effect on faster degradation of organic acid and might have either been quickly converted into sugars or their derivatives by the reaction involving reversal of glycolytic pathway or consumed in respiration or both. The reason for reduction in acidity with the application of NAD @ 50 ppm might be due to the rapid utilization of organic acid as the respiratory substrate in respiration process at maturity. Similar results were obtained by Dubey *et al.* (2002).

Ascorbic acid (mg/100 g pulp)

There were significant differences within the different treatments with respect to the ascorbic acid content of the fruit during both 1st and 2nd year as revealed from the data presented in the Table 4. The highest ascorbic acid (209.8 mg/100 g during 1st year and 210.49 during 2nd year) was recorded in 50 ppm NAD (T_5) followed by (207.0 mg/100 g during 1st year and 206.40 mg/100 g) in T_6 i.e. with 60 ppm 2, 4-D and (203.7 mg/100 g during 1st year and 206.29 mg/100 g during 2nd year) in T_2 (Shoot bending) whereas it was recorded minimum (129 mg/100 g during 1st year and 128.73 mg/100 g during 2nd year) in control (T_1). From the mean data, it was found highest in T_5 (210.1 mg/100 g) closely followed by T_6 (210.1 mg/100 g) and T_2 (205.0 mg/100 g). So with respect to ascorbic acid content, 50 ppm NAD (T_5), T_6 (60 PPM 2, 4-D) and T_2 (Shoot bending) were found statistically significant and superior over the rest treatment and control. The improvement in ascorbic acid content under the above treatments was probably due to the catalytic influence of growth regulation on biosynthesis of ascorbic acid and/or chemical substances might inhibit the activities of oxidative enzymes. The increase in ascorbic acid also might be due to catalytic activity of chemicals on its biosynthesis from its precursor glucose-6-phosphate or inhibition of its conversion into dehydro ascorbic acid by enzyme ascorbic acid oxidase or both (Saikia and Kotoky 2019). Similarly, Samant *et al.* (2016) obtained a vitamin C content (204.6 mg 100 g pulp) by the branch bending in guava under Bhubaneswar condition of Odisha.

Total sugar (%)

It was implied from data presented in the Table 4, that during 1st year highest total sugars content (8.2% each) was recorded in 50 ppm NAD (T_5) followed by (8.1%) in (T_6) i.e. with 60 ppm 2, 4-D and (7.60 %) in T_7 i.e. with 15% urea while it was recorded lowest (4.60 %) in control (T_1) followed by 5.9% in 10 ppm DNOC (T_8) and 6.7% in shoot bending. During 2nd year highest total sugar (8.33%) was recorded in plants treated with 50% fruit thinning (T_4) followed by 8.32% in 50 ppm NAD (T_5) and 8.23 % in 60 ppm 2, 4-D (T_6), while it was recorded lowest (4.73%) in control (T_1) followed by (6.03 %) in 10 ppm DNOC (T_8) and (6.83%) in shoot bending (T_2) treatment. During both the years all the treatments were found statistically significant and superior over the control. Similarly, from the average data, the treatment T_4 (8.27%) recorded highest total sugar content closely followed by T_5 (8.26%) and T_6 (8.17%) while the control plants gave lowest total sugar content (4.67%). The above result supports the findings of Maji *et al.* (2015) who reported that the plants when treated with NAD @ 60 ppm with superior quality in respect of higher total sugars content (6.71% to 8.85% total sugars). This increase in content of total sugars in fruits was due to the degradation of polysaccharides into simple sugars by metabolic activities, conversion of organic acids into sugars and loss of moisture (Kumar 2012).

TSS : Acid ratio

From the data depicted in the Table 4, it was clear that the TSS : Acid ratio varied significantly. It was recorded highest in T_5 (49.52 during 1st year and 46.91 during 2nd year) closely followed by T_2 (46.82 during 1st year and 42.80 during 2nd year) and T_6 (44.78 during 1st year and 43.00 during 2nd year) while the control plants gave the lowest TSS : Acid ratio (27.42 during 1st year and 31.03 during 2nd year). These treatments were found statistically significant with rest of the treatments. Similarly from the average data, it was found maximum (48.18) in T_5 (50 ppm NAD) closely followed by (43.75 each) in T_2 (Shoot bending) and T_6 (60 ppm 2, 4-D) while minimum TSS : Acid ratio (28.71) was obtained in control plants (T_1). The increase in TSS : Acid ratio with application of chemicals and following cultural practices might be attributed to increase TSS content and reduced level of titrable acidity in the current study. The similar improvement in fruit quality in guava with NAD, NAA, Urea and manual means had also been reported by Dubey *et al.* (2002), Tiwari and Lal (2007), Singh (2007).

CONCLUSION

In general, all the crop regulation practices were found superior over the untreated control with respect to yield and physico-chemical characteristics of guava. If the guava tree is left unpruned, they tend to prolong the vegetative growth, reduce the bearing area, thus leading to decreased fruit size, yield and quality. Among the cultural treatments, the treatment T_2 (bending) was found superior to T_3 (10 cm pruning) and T_1 (control). The shoot bending might improves the light penetration inside the canopy and increases the rate of photosynthesis which might have improved the fruit quality. Among chemical treatments, the treatment T_5 (50 ppm NAD) was found superior to T_6 (60 ppm 2, 4-D) and others with respect to yield and other fruit quality parameters studied.

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