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EFFECTS OF PRUNING INTENSITY AND PLANT GROWTH REGULATORS ON GROWTH, YIELD AND QUALITY OF GUAVA (*PSIDIUM GUAJAVA* L.) CV. SARDAR

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Abstract

Effects of pruning intensity and spray of plant growth regulators (PGR) on dfferent parameters of Guava (*Psidium Guajava* L.) Sardar were investigated. Growth, quality and yield attributing characters were improved at 30 cm pruning intensity. With respect to effect of plant growth regulators, application of 600 ppm NAA improved all the characters except minimum number of days taken to flower initiation (39.47), acidity (0.33 %), TSS (12.11 ^{o}Brix) and total sugars (6.79 %) which were recorded in 600 ppm ethephon. The interaction studied showed that P_3G_2 (30 cm pruning + 600 ppm NAA) had recorded the highest value with growth, yield and quality, while the combination of P_3G_3 (30 cm pruning + 600 ppm ethephon) was good for qualitative parameters.

Introduction

Guava (*Psidium guajava* L.) is one of the most popular fruit grown in tropical and subtropical regions of India. It is the fourth most important fruit crop in area and production after mango, banana and citrus. Guava bears on current season's growth and flowers appear in the axils of new leaves and so it responds well to pruning. Pruning is usually practiced in the summer (April – May) before flower initiation. Whenever pruning has been attempted in guava, there has been a vast improvement in yield and fruit quality, especially with light pruning (Bajpai *et al*. 1973). Use of plant growth regulators has assumed an integral part of modern crop husbandry for increasing production of quality fruits. They are readily absorbed and move rapidly through the tissues, when applied to different plant parts. Thus, the plant growth regulators like NAA, NAD, 2,4-D carbaryl and ethrel were found successful in reducing the rainy season and increasing the winter season crop under different agro-climatic conditions (Chundawat *et al*. 1975). Whereas, ethephon acts as a ripening hormone and enhances the ripening process and thus helps in improving the fruit quality. In view of the above facts, it becomes quite clear that shoot pruning and applications of plant growth regulators are very useful not only for increasing the yield, but also to improve the quality of fruits. Hence in the present study attempts were taken to study the effects of pruning intensity and plant growth regulators on growth, yield and quality of guava (*Psidium Guajava* L.) Cv. Sardar

Materials and Methods

The present investigations were carried out on ten years old tree of uniform size at the *Instructional Cum Fruit Research Orchard*, Department of Fruit Science, RVSKVV, College of Horticulture, Mandsaur Madhya Pradesh India during the year 2016-2017. There were four levels of pruning intensity, namely P_0 (control unpruned plants), P_1 (10 cm pruning), P_2 (20 cm pruning) and P_3 (30 cm pruning). Regarding plant growth regulator treatments different concentrations, i.e.

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G_0 (control-water spray), G_1 (30 ppm 2,4-D), G_2 (600 ppm NAA) and G_3 (600 ppm Ethephon) were applied alone and in combinations. The experiment was laid out in 4 × 4 factorial randomized block design. A tree was taken as a unit for each treatment in a replication and over all forty eight trees were applied. The plants were planted at spacing of 6 × 6 m. Mandsaur is situated at 23.45^0 to 24.13^0 N latitude and 74.44^0 to 75.18^0 E longitudes at an altitude of 435 m MSL. The soil type is sandy loam with a pH of 6.5-7 and represents a typical subtropical zone with a hot summer and cool winter. The temperature rises up to 46^0C during summer and falls to 3.6^0C during winter with an occasional occurrence of frost. The average rainfall is 579.2 mm, most of which occurred during July to September, winter and summer rain are uncommon. The meteorological data such as maximum and minimum temperature (35.20^0C to 8.70^0C), relative humidity (85.7 %) and rainfall (276 mm) were recorded during the experimental period. The total numbers of flowers were counted on the five randomly selected shoots of whole plants and average numbers of flowers/shoot were calculated. Total number of flowers which set into fruits was counted and per cent fruit set was also calculated. The per cent fruit retention was calculated on the basis of initial fruit set and fruit reached to maturity. Fruit diameter, polar and equatorial was taken with the help of vernier caliper. Acidity was estimated by simple acid–alkali titration method as described in AOAC (1970). Hand refractometer was used for determination of TSS in ^{0}Brix. Total, reducing and non-reducing sugar contents were determined with the adapted method described by Nelson (1944). Briefly, sample (100 µl) was diluted in distillated water (1 ml) and neutralized to pH 7 (glacial acetic acid). An aliquot (500 µl) of neutralized extract was mixed with $Ba(OH)_2$ (0.2 µl), $ZnSO_4$ (0.2 µl) and distillated water (4.0 ml), vortexed and allowed to stand (10 min) to precipitate proteins. Samples were filtered with paper filter (Whatman 1) and 1.0 ml was mixed with distillated water (1.0 ml) plus cupric reagent (1.0 ml) and heated (100°C, 20 min). Next they were cool down in ice water bath and arsenomolibdic reagent (1.0 ml) plus 5.0 ml of distillated water were added. Reducing sugar was estimated spectrophotometrically at 510 nm, using a standard curve constructed from a glucose solution (0–180.0 mg/ml). For total sugar content samples were first heated (100°C, 15 min) with concentrated HCl (1.0 ml of sample to 25 µlof HCl), neutralized with Na_2CO_3 and followed the protein removing step and analysis of reducing sugars. Non-reducing sugars were calculated by difference of total sugars minus reducing sugars. Analysis were carried out in triplicate and expressed as mg/100 g of sample. Ascorbic acid was estimated by Assay method given by Ranganna (1977). Chlorophyll content in leaves was estimated by using instrument SPAD-505. Average fruit weight was recorded with the help of electronic balance. Mature fruits were harvested periodically in each treatment separately and the weight was recorded with the help of single pan balance and expressed in kg. Further, estimated fruit yield ha^{-1} was calculated by multiplying the fruit yield $plant^{-1}$ to the number of plants ha^{-1}.

Results and Discussion

Maximum number of new emerged shoots (8.22) per meter branch was counted with P_3 (30 cm pruning) followed by P_2 (20 cm pruning) (7.77) and maximum length of new emerged shoots (35.97 cm) was recorded with P_3 (30 cm pruning) as compare to P_2 (20 cm pruning) (34.56 cm). Further, G_2 (600 ppm NAA) resulted maximum number of new emerged shoots per meter branch (9.39) and length of new emerged shoots (37.72 cm) as compared to G_1 (30 ppm 2,4-D) (7.97 and 35.92 cm). However, interaction effect of P_3G_2 (30 cm pruning and NAA 600 ppm) showed maximum number of new emerged shoots per meter branch (10.73). The interaction treatments revealed non-significant differences for length of new emerged shoots (Table 1). It might be due to well response of vegetative growth to pruning and narrow C: N ratio of plant that induces vegetative flush in tree in vigorous growth of plant (Jadhav *et al.* 1998). Pruning caused better movement of air and light into the inner part and thereby resulted in greater photosynthesis. This

increased photosynthesis activity of the plants leads to higher accumulation of the photosynthates, which were utilized by developing shoots, leading to increase in plant vigour. Pruning also encouraged dormant bud to put forth new shoots owing to absence of apical dominance. This Increase in number of shoot may be attributed to the reserve food material in the main scaffolds or branches due to which new growth was put forth just after the pruning. Similar views were reported by Mohammed *et al.* (2006) and Shabban and Haseeb (2009) in guava.

Among different intensity of pruning treatment, P_1 (10 cm pruning) gave minimum number of days (37.36) for flower initiation. Minimum number of days (32.83) taken to flower initiation was recorded in G_3 (600 ppm ethephon). Among the interactions treatments significant variation was found with the respect to the number of days taken to flower initiation, the minimum number of days (31.33) was recorded in P_1G_3 (10 cm pruning and 600 ppm ethephon). The maximum days (39.47) required for flower initiation was found in P_3 (30 cm) pruned plants when compared to unpruned plants, this may be because light pruned trees stored more reserved food compared to un pruned trees (Table 1). Moreover, in severe pruned trees, a part of energy is always lost in healing the pruning setback in plants. Pruned trees started new vegetative growth immediately after pruning and almost the entire amount of carbohydrates, which otherwise would form flower buds, might have been utilized in the vegetative growth of trees resulting in a late start of flowering in pruned trees. A perusal of Table 1 indicated that maximum number of flowers (1134.70) plant^{-1}, maximum fruit set (72.23%), minimum fruit drop (30.83%) and maximum fruit retention (68.28%) were recorded in P_3 (30 cm pruning), compared with the control (no pruning). However, under plant growth regulators the maximum number of flowers (1179.70) plant^{-1}, maximum fruit set (77.24%), minimum fruit drop (27.99%) and maximum fruit retention (70.13%) were recorded in G_2 (600 ppm NAA) as compared to untreated plants. Interactions study showed that pruning intensity and plant growth regulators had significant variation with respect to all reproductive parameters. The maximum number of flowers (1218.70) plant^{-1}, maximum fruit set (80.17%), minimum fruit drop (25.91%) and maximum fruit retention (71.07%) were recorded in P_3G_2 (30 cm pruning with NAA 600 ppm).These findings are in agreement with the results reported by Mehta *et al.* (2012), Rajput *et al.* (2015) and Raval *et al.* (2016) in guava.

Data presented in Table 2 showed that physical characteristics of guava had increased significantly with the increasing intensity of pruning. Among various pruning levels, 30 cm pruning (P_3) registered the maximum fruit volume (179.31 ml), fruit length (6.52 cm), fruit diameter (7.01 cm), pulp thickness (1.44 cm), pulp weight (127.91 g) at harvest, as compared to the control (P_0). However, the different physical characteristics of guava as influenced by plant growth regulators also indicated significant differences. The maximum fruit volume (191.63 ml), fruit length (6.86 cm), fruit diameter (7.51 cm), pulp thickness (1.50 cm), pulp weight (139.55 g) were recorded in G_2 (600 ppm NAA), as compare to the control (P_0). Further, in interaction maximum fruit volume (220.20 ml), fruit length (7.13 cm), fruit diameter (8.04 cm), pulp thickness (1.64 cm), pulp weight (149.53 g) were observed in P_3G_2 (30 cm pruning with NAA 600 ppm). An increase in physical parameters in terms of fruit length, fruit diameter and fruit volume may be attributed due to the reduction in rainy season crop load, which in turn diverted more nutrients to the remaining fruits, thereby improving fruit length, diameter, and volume of fruits. Results of the present study are found in consonance with those of Kumar and Rattanpal (2010) in guava. An increase in fruit diameter and fruit volume might be due to the NAA activity of cell enlargement and division. These results are in conformity with the findings of Dubey *et al*. (2002), Jain and Dashora (2010) and Raval *et al.* (2016) in guava.

Tables 2 and 3 showed the quality parameters of guava as influenced by pruning, spray of plant growth regulators and their interaction treatment. Among different intensity of pruning treatments, P_3 (30 cm pruning) gave minimum acidity (0.34 %), maximum TSS (11.46 ^{0}Brix),

Table 1. Effect of pruning intensity and spray of plant growth regulators on growth and reproductive parameters of guava (*Psidium guajava* L. cv. Sardar).

Treatment	Number of new emerged shoots per meter branch	Length of new emerged shoots (cm)	No. of days taken to flower initiation	Number of flowers per plant	Fruit setting (%)	Fruit drop (%)	Fruit retention (%)
Pruning Intensity							
P_0	6.00	31.89	38.50	1058.10	65.06	37.73	63.19
P_1	7.32	33.88	37.36	1112.00	69.31	33.35	67.60
P_2	7.77	34.56	38.28	1134.10	71.51	31.67	67.63
P_3	8.22	35.97	39.47	1134.70	72.23	30.83	68.28
S.Em±	0.11	0.46	0.38	8.65	0.45	0.64	0.22
CD at 5%	0.32	1.33	1.11	24.99	1.31	1.85	0.64
Plant growth regulators							
G_0	6.35	32.49	47.88	1064.60	61.29	39.52	62.30
G_1	7.97	35.92	37.61	1115.30	74.69	30.03	67.73
G_2	9.39	37.72	35.29	1179.70	77.24	27.99	70.13
G_3	5.60	30.16	32.83	1079.50	64.88	36.04	66.53
S.Em±	0.11	0.46	0.38	8.65	0.45	0.64	0.22
CD at 5%	0.32	1.33	1.11	24.99	1.31	1.85	0.64
Interactions							
P_0G_0	5.20	29.24	44.57	964.0	58.16	46.09	50.26
P_0G_1	6.80	34.41	39.23	1106.5	70.93	31.73	65.23
P_0G_2	7.40	34.71	35.87	1107.4	71.86	31.50	69.17
P_0G_3	4.60	29.20	34.33	1054.5	59.30	41.60	68.10
P_1G_0	6.33	32.80	47.23	1091.2	65.20	34.37	66.73
P_1G_1	7.93	35.50	36.03	1110.3	74.98	30.88	66.70
P_1G_2	9.35	37.93	34.83	1179.3	77.19	27.70	69.60
P_1G_3	5.67	29.27	31.33	1067.3	59.86	40.43	67.37
P_2G_0	6.80	33.92	48.70	1101.3	65.38	33.57	65.91
P_2G_1	8.27	35.97	37.10	1117.6	76.77	29.04	69.40
P_2G_2	10.07	38.83	35.00	1213.3	79.75	26.86	70.70
P_2G_3	5.93	29.50	32.33	1104.2	64.14	37.23	64.50
P_3G_0	7.07	33.99	51.00	1101.7	68.43	32.06	66.28
P_3G_1	8.87	37.82	38.07	1126.9	76.09	28.46	69.60
P_3G_2	10.73	39.40	35.47	1218.7	80.17	25.91	71.07
P_3G_3	6.20	32.67	33.33	1091.7	64.21	36.89	66.17
S.Em±	0.22	0.92	0.77	17.30	0.91	1.28	0.44
CD at 5%	0.64	NS	2.22	49.98	2.63	3.71	1.28

Table 2. Effect of pruning intensity and spray of plant growth regulators on physical and quality parameters of guava (*Psidium guajava* L. cv. Sardar).

Treatment	Fruit volume (ml)	Fruit length (cm)	Fruit diameter (cm)	Pulp thickness (cm)	Pulp weight (g)	Acidity (%)	TSS (°Brix)
Pruning Intensity							
P_0	150.59	5.86	5.99	1.08	114.63	0.44	10.44
P_1	165.25	6.28	6.62	1.30	122.07	0.37	11.11
P_2	171.13	6.42	6.78	1.33	125.72	0.36	11.30
P_3	179.31	6.52	7.01	1.44	127.91	0.34	11.46
S.Em±	2.79	0.07	0.08	0.03	1.45	0.01	0.10
CD at 5%	8.06	0.20	0.22	0.09	4.19	0.03	0.29
Plant growth regulators							
G_0	150.98	5.83	5.90	1.10	110.27	0.46	10.23
G_1	170.86	6.53	6.95	1.35	129.74	0.34	11.36
G_2	191.63	6.86	7.51	1.50	139.55	0.40	10.61
G_3	152.80	5.86	5.96	1.15	110.77	0.33	12.11
S.Em±	2.79	0.07	0.08	0.03	1.45	0.01	0.10
CD at 5%	8.06	0.20	0.22	0.09	4.19	0.03	0.29
Interactions							
P_0G_0	116.53	5.00	5.16	0.65	96.87	0.59	9.67
P_0G_1	167.50	6.30	6.46	1.32	125.00	0.37	11.00
P_0G_2	167.70	6.37	6.63	1.33	127.73	0.46	9.93
P_0G_3	150.63	5.78	5.73	1.03	108.93	0.35	11.17
P_1G_0	161.03	5.93	6.19	1.31	112.67	0.43	10.30
P_1G_1	168.70	6.43	6.82	1.33	129.20	0.34	11.20
P_1G_2	179.30	6.96	7.58	1.47	135.60	0.40	10.70
P_1G_3	151.97	5.81	5.90	1.08	110.80	0.33	12.23
P_2G_0	162.00	6.10	6.30	1.31	115.07	0.41	10.30
P_2G_1	170.00	6.69	6.99	1.36	130.87	0.34	11.60
P_2G_2	199.33	6.97	7.80	1.56	145.33	0.39	10.87
P_2G_3	153.17	5.90	6.01	1.10	111.60	0.32	12.43
P_3G_0	164.37	6.30	6.30	1.33	116.47	0.41	10.67
P_3G_1	177.23	6.70	7.54	1.39	133.90	0.33	11.63
P_3G_2	220.20	7.13	8.04	1.64	149.53	0.37	10.93
P_3G_3	155.43	5.94	6.17	1.40	111.73	0.31	12.60
S.Em±	5.58	0.14	0.15	0.06	2.90	0.02	0.20
CD at 5%	16.12	0.40	0.43	0.18	8.39	0.07	NS

Table 3. Effect of pruning intensity and spray of plant growth regulators on quality and yield parameters of guava (*Psidium guajava* L. cv. Sardar).

Treatment	Total sugars (%)	Ascorbic acid (mg/100 g)	Chlorophyll content (SPAD value)	Number of fruits harvested per plant	Fruit weight (g)	Fruit yield/ (kg/plant)	Fruit yield (q per ha)
Pruning Intensity							
P_0	6.31	161.54	38.63	407.67	141.32	57.61	160.03
P_1	6.56	171.40	38.66	453.83	156.41	70.98	197.18
P_2	6.60	176.60	38.38	469.17	159.14	74.66	207.40
P_3	6.68	178.66	38.40	479.58	163.06	78.20	217.22
S.Em±	0.02	0.67	0.17	6.95	1.19	1.20	3.34
CD at 5%	0.06	1.93	NS	20.07	3.43	3.48	9.65
Plant growth regulators							
G_0	6.17	163.07	37.25	402.17	142.58	57.61	159.28
G_1	6.65	182.26	38.43	477.00	164.22	78.33	217.59
G_2	6.44	187.62	39.29	521.92	170.33	88.90	246.94
G_3	6.79	155.25	39.09	409.17	142.79	58.43	162.29
S.Em±	0.02	0.67	0.17	6.95	1.19	1.20	3.34
CD at 5%	0.06	1.93	0.48	20.07	3.43	3.48	9.65
Interactions							
P_0G_0	5.73	139.29	38.57	303.33	105.53	32.01	88.92
P_0G_1	6.57	178.43	36.67	456.67	159.77	72.96	202.67
P_0G_2	6.22	178.74	39.30	470.67	161.37	75.95	210.98
P_0G_3	6.60	149.70	39.97	400.00	138.60	55.44	154.00
P_1G_0	6.36	160.60	36.97	412.00	151.13	62.27	172.96
P_1G_1	6.63	180.33	40.00	474.67	163.13	77.43	215.09
P_1G_2	6.50	189.30	40.83	525.33	170.47	89.55	248.76
P_1G_3	6.73	155.35	36.83	403.33	140.90	56.83	157.86
P_2G_0	6.43	175.93	37.13	443.33	155.00	68.72	190.88
P_2G_1	6.67	183.77	38.97	486.67	166.17	80.87	224.64
P_2G_2	6.51	189.66	39.97	536.67	173.53	93.13	258.69
P_2G_3	6.80	157.04	37.47	410.00	141.87	58.13	161.57
P_3G_0	6.44	176.47	36.33	450.00	158.67	71.40	198.34
P_3G_1	6.72	186.51	38.10	490.00	167.80	82.22	228.39
P_3G_2	6.53	192.76	37.07	555.00	175.97	97.66	271.29
P_3G_3	7.07	158.91	42.10	423.33	149.80	63.41	176.15
S.Em±	0.04	1.34	0.33	13.90	2.37	2.41	6.69
CD at 5%	0.13	3.86	0.96	40.14	6.85	6.95	19.31

total sugars (6.68 %) and ascorbic acid (178.66 mg/100g). Data regarding on chlorophyll contents revealed that non-significant variation were observed. However, the different quality characteristics of guava as influenced by plant growth regulators also indicated significant differences. The minimum acidity (0.33), maximum TSS (12.11 ^{0}Brix) and maximum total sugars (6.79 %) were recorded with G_3 (600 ppm ethephon), while the maximum ascorbic acid (187.62 mg/100g) and chlorophyll content in leaves (39.29 SPAD value) was observed in G_2 (600 ppm NAA), as compared to control (P_0-unpruned). Further, among the various interaction treatments minimum acidity (0.31), maximum TSS (12.60 ^{0}Brix), maximum total sugars (7.07 %) and chlorophyll content in leaves (42.10 SPAD value) were observed in P_3G_3 (30 cm pruning with 600 ppm ethephon), while the maximum ascorbic acid (192.76 mg/100 g) was observed in P_3G_2 (30 cm pruning with NAA 600 ppm). The plants treated with ethrel had higher quantity of soluble carbohydrate in the sap and glucose concentration was strikingly high due to marked increase in carbon assimilation (Yadav *et al.* 2001). These findings are also in agreement with the results reported by Singh and Bal (2006) Jain and Dashora (2010) in guava.

Table 3 revealed that various treatments resulted in significant increase in the number of fruits harvested plant^{-1}, fruit weight (g), fruit yield plant^{-1} (kg) and fruit yield ha^{-1} (q) as compared to the control. Among the various level of pruning intensity, the maximum number of fruits harvested (479.58) plant^{-1}, fruit weight (163.06 g), fruit yield plant^{-1} (78.20 kg) and fruit yield ha^{-1} (217.22 q) were recorded in P_3 (30 cm pruning). However under plant growth regulators, maximum number of fruits (521.92) plant^{-1}, fruit weight (170.33 g), fruit yield plant^{-1} (88.90 kg) and fruit yield ha^{-1} (246.94 q) were recorded in G_2 (600 ppm NAA), as compared to the control (P_0- unpruned). Further, in interaction study, the maximum number of fruits (555) plant^{-1}, fruit weight (175.97 g), fruit yield plant^{-1} (97.66 kg) and fruit yield ha^{-1} (271.29 q) were recorded in P_3G_2 (30 cm pruning with NAA 600 ppm). Prakash *et al.* (2012) also found that pruning in guava induced fruit production in winter season. Maximum numbers of fruits were produced by 30 cm pruning level. The similar results were also reported by Mohammed *et al.* (2006), Kumar and Rattanpal (2010) and Abbas *et al.* (2014) in guava.

Therefore, it may be suggested that pruning intensity of 30 cm and plant sprayed with 600 ppm NAA can be utilized for commercial fruit production with better quality of guava cv. Sardar. It is also higher cost economics of winter season guava in Madhya Pradesh, India.

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