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RESEARCH PAPER

Quantitative and qualitative enhancement in guava (*Psidium guajava* L.) cv. CHITTIDAR through foliar feeding

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Abstract : The present experiment was conducted at the Department of Fruit Science, K.N.K. College of Horticulture, Mandsaur (M.P.) on six years old guava tree cv. Chittidar during 2011-2012. On the basis of results obtained in present investigation it is concluded that foliar spray of $ZnSO_4$ 0.8% + borax 0.4% + NAA 50 ppm + GA_3 100 ppm was found best to increase fruit set, fruit retention, volume of fruit, pulp thickness, pulp weight, pulp per cent, length and diameter of fruit at harvest, average fruit weight, and reduced the seed per cent and seed pulp ratio which ultimately increased the yield per tree. Various quality parameters total sugars, reducing sugars, non reducing sugars, TSS, zinc and iron content in fruit pulp were also improved with application of $ZnSO_4$ 0.8% + borax 0.4% + NAA 50 ppm + GA_3 100 ppm. Same treatment also recorded reduced fruit drop, minimum number of seeds per fruit, maximum TSS/acid ratio and minimum acidity per cent of fruit.

Key Words : Guava, Foliar feeding, Growth regulators, Micro-nutrients

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INTRODUCTION

Guava (*Psidium guajava* L.) is one of the most popular fruit grown in tropical and sub-tropical regions of India, which belongs to the family Myrtaceae. This fruit is a native of tropical America and extensively grown in South Asian countries. Zinc is the important constitute of several enzymes systems which regulate various metabolic reactions in the plant. Zinc is essential for auxin and protein synthesis, seed production and proper maturity. Boron is a constituent of cell membrane and essential for cell division. It acts as a regulator of potassium /calcium ratio in the plant, helps in nitrogen absorption and translocation of sugar in plant. The application of GA_3 improves the size, shape and weight of the fruits. GA_3 increases fruit set and fruit retention of the tree. By the application of NAA, T.S.S. and ascorbic- acid content of fruits are increased and acidity is reduced.

NAA reduces the number of seed of the fruits. It also induces heavier fruiting and promotes flowering. In subtropical climate, three distinct periods of flowering and fruiting in the guava. These three distinct periods are, 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 Hasta bahar- October to November flowering and fruit ripens in February to April (Shukla e*t al.*, 2008).

The quality of guava fruit is greatly affected by temperature and humidity, because of these facts the fruit quality of winter season is far better than rainy season. High temperature during summer coupled with low humidity has been reported to reduce fruit set and increase fruit drop. The foliar application of nutrients and growth regulators play vital role in improving the quality and comparatively more effective for rapid recovery of plants. The foliar feeding of fruit tree has gained much importance in recent years, as nutrients applied through soil are needed in higher quantity because some amount leaches down and some become unavailable to the plant due to complex soil reactions. The yield parameter like average fruit weight, number of fruits per tree and yield per tree are increased by the spray with micronutrients. Through the application of plant growth regulators the physical (size, diameter and shape), chemical

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(T.S.S. and ascorbic acid) and the reproductive (fruit set and fruit retention) parameters are improved.

MATERIALS AND METHODS

The experiment was conducted at the Department of Fruit Science, K.N.K. College of Horticulture, Mandsaur (M.P.) on six years old guava tree cv. Chittidar during 2011-2012. The experiment was conducted in randomized block design. The experiment comprised of 13 treatments consisting of foliar spray of zinc sulphate, borax, NAA, GA_3 and control. First foliar spray of micronutrient and growth regulator on crop was done on 5 August 2011 and same spray was repeated after 30 days. The following treatments T_0 - Control , T_1- zinc sulphate 0.4%, T_2- zinc sulphate 0.8%,T_3- borax 0.2%,T_4- borax 0.4%, T_5- NAA 25 ppm, T_6- NAA 50 ppm ,T_8- GA_3 100 ppm, T_9- zinc sulphate 0.8% + borax 0.4%, T_{10}- NAA 50 ppm + $GA_3$100 ppm,T_{11}- $ZnSO_4$ 0.4% + borax 0.2% + NAA 25 ppm + GA_3 50 ppm, T_{12}- $ZnSO_4$ 0.8% + borax 0.4% + NAA 50 ppm + GA_3 100 ppm were used:

For recording reproductive parameters of guava *viz.*, fruit setting, fruit retention and fruit drop per cent, four branches were randomly selected and tagged on the plant and the number of flowers was counted at full bloom separately on each branch after that number of fruits were counted. The fruit setting per cent was calculated with following formula:

Fruit setting (%) = (Number of set fruits/ Number of flowers) x100

The fruit drop per cent was calculated by the following equation:

$$\text{Fruit drop\%} = \frac{(\text{Total number of fruit set} - \text{Total number of fruits at harvest time})}{\text{Total number of fruit set}} \times 100$$

The fruit retention per cent (at maturity) was calculated with following formula:

Fruit retention (%) = Number of fruits at harvest/ initial number of fruit set x100

For determination of chemical parameters of fruit *viz.*, acidity, total soluble solids (TSS), sugars (total, reducing and non-reducing sugars), ascorbic acid, pectin content, zinc and iron content four healthy fruits were selected randomly from each tree at full maturity stage. Hand refractometer was used for determination of T.S.S. in ^{0}Brix. Acidity was estimated by simple acid–alkali titration method as described in A.O.A.C. (1970). Sugars in fruit juice were estimated by the method as suggested by Nelson (1944). Assay method of ascorbic acid was followed given by Ranganna (1977). The estimation of pectin was according to the methods of Kertesz (1951).

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

Physical parameters:

The various physical parameters (fruit volume, pulp thickness, pulp weight, pulp per cent, fruit diameter, fruit length, number of seeds per fruit and seed pulp ratio of fruit were significantly affected by application of different micronutrient and growth regulators (Table 1). Maximum fruit volume, length and diameter of fruit at harvest, pulp thickness, pulp weight, pulp per cent, and minimum seed pulp ratio were recorded with foliar spray of $ZnSO_4$ 0.8% + borax 0.4% + NAA 50 ppm + GA_3 100 ppm. The increase in fruit size was due to accelerated

Table 1: Effect of micronutrients and growth regulators on physical parameters of guava

Treatments	Fruit volume (ml)	Pulp Percen Tage (%)	Fruit length	Fruit dia-meter	No. of Seeds/ fruit	Seed weight (g)
T_0 (Control)	147.33	98.39	5.78	5.13	310.97	3.65
T_1 (Zinc Sulphate 0.4%)	186.67	98.88	6.00	5.28	239.39	2.22
T_2 (Zinc Sulphate 0.8%)	205.33	99.02	6.03	5.30	234.32	1.94
T_3 (Borax 0.2%)	196.00	99.01	6.02	5.29	291.68	1.95
T_4 (Borax 0.4%)	206.00	99.04	6.04	5.32	295.43	1.76
T_5 (NAA 25 ppm)	157.67	98.41	5.84	5.15	221.36	2.44
T_6 (NAA 50 ppm)	179.33	98.83	5.91	5.16	225.45	2.33
T_7 (GA_3 50 ppm)	181.00	98.84	5.92	5.22	284.50	3.34
T_8 (GA_3 100 ppm)	184.67	98.91	5.99	5.24	289.63	3.32
T_9 (Zinc Sulphate 0.8% + Borax 0.4%)	208.67	99.05	6.08	5.38	245.40	1.38
T_{10} (NAA 50 ppm + $GA_3$100 ppm)	207.33	99.03	6.07	5.33	219.24	1.67
T_{11} ($ZnSO_4$ 0.4% + Borax 0.2% + NAA 25 ppm + GA_3 50 ppm)	215.00	99.17	6.24	5.46	214.98	1.37
T_{12} ($ZnSO_4$ 0.8% + Borax 0.4% + NAA 50 ppm + GA_3 100 ppm)	225.00	99.32	6.46	5.90	209.90	1.29
S.E. ±	2.52	0.03	0.12	0.13	3.33	0.03
C.D. at 5%	7.35	0.09	0.34	0.37	9.72	0.09

rate of cell division and cell enlargement and more intercellular space with the application of higher concentration of growth substances. Endogenous auxin is responsible for increasing fruit size in guava. The rapid growth of the fruit synchronized with the maximum amount of auxin present therein. The increase in length and diameter of guava fruit may be that higher concentration of mineral nutrients (Boron and zinc) appears to have indirect role in hastening the process of cell division and cell elongation due to which size and weight of fruits would have improved. The results are in conformity with those reported by Prasad *et al.* (2005). Volume of the fruit was increased due to augmentation of the native supply of hormones. The results are in conformity with the findings of Dutta and Banik (2007).

Increased vegetative growth due to residual effects of higher concentration of auxins on plant which resulted in high leaf to fruit ratio ultimately resulted in higher amount of photosynthates finally increased pulp weight, pulp thickness and seed: pulp ratio. The results are in accordance with the findings reported by Yadav *et al.* (2011). Minimum number of seed was recorded with higher concentration of micronutrient and plant growth regulator combinations due to their dominating role to the accumulation of flesh in the fruits.

Reproductive and yield parameters :

The reproductive characters of tree were significantly affected by different micronutrient and growth regulators (fruit setting, fruit retention and fruit drop per cent) (Table 2). Maximum fruit set, fruit retention and minimum fruit drop were with foliar application of $ZnSO_4$ 0.8% + borax 0.4% + NAA 50 ppm + GA_3 100 ppm. The higher fruit set in response to higher concentration of growth substances application is probably due to translocation of hormones, food substances and other factors stimulating fruit formation to the tissue of ovary in greater amount. These results are similar to the findings of Iqbal *et al*. (2009), Yadav *et al.* (2011) and Prasad *et al.* (2005) in guava. There is correlation between fruit drop and endogenous hormonal status and existence of high level of internal auxin that prevent fruit drop. Since high level of endogenous hormones might help in building up endogenous hormone at appropriate level potent to enough reduce the fruit drop. Zinc spray increased the fruit retention and auxin balance may lead to the prevention of fruit drop. By the foliar application of boron the fruit drop was reduced because boron plays an important role in translocation of carbohydrate and auxin synthesis to sink and increased pollen viability and fertilization. These results are in accordance with the finding of Yadav *et al.* (2011) in guava.

The data obtained from present experiment revealed that the different treatments had significant effect on yield parameters of tree (fruit weight, number of fruits per tree and yield per tree) (Table 2). Fruit weight was significantly increased with different micronutrients and plant growth regulators. The maximum fruit weight was obtained with foliar spray of $ZnSO_4$ 0.8% + borax 0.4% + NAA 50 ppm + GA_3 100 ppm. Increase in fruit weight may be attributed to the strengthening of middle lamella and consequently cell wall, which later may have increase the free passage of solutes to the fruits. By the application of GA_3 size and certain changes of fruit are improved which reflected in more accumulation of water and enhanced deposition of soluble solids. The higher fruit weight due to combined application of higher

Table 2. Effect of micronutrients and growth regulators on reproductive and yield parameters of guava.

Treatments	Fruit Setting (%)	Fruit Drop (%)	Fruit Retention (%)	Average fruit weight (g)	No. of fruits / tree	Yield / tree (kg)
T_0 (Control)	68.05	28.86	44.86	143.33	181.33	32.00
T_1 (Zinc Sulphate 0.4%)	76.43	23.11	51.41	193.67	209.50	37.36
T_2 (Zinc Sulphate 0.8%)	77.78	22.64	55.26	204.33	214.83	39.74
T_3 (Borax 0.2%)	77.43	22.78	52.09	206.00	214.17	39.54
T_4 (Borax 0.4%)	78.37	22.52	56.93	217.33	217.33	43.05
T_5 (NAA 25 ppm)	72.54	24.59	49.77	153.33	191.17	33.89
T_6 (NAA 50 ppm)	75.15	24.65	49.87	175.33	193.50	34.53
T_7 (GA_3 50 ppm)	75.71	24.93	51.10	180.67	195.67	34.58
T_8 (GA_3 100 ppm)	75.89	25.19	51.18	183.33	206.83	35.83
T_9 (Zinc Sulphate 0.8% + Borax 0.4%)	79.83	21.44	57.19	207.00	225.33	46.82
T_{10} (NAA 50 ppm + $GA_3$100 ppm)	78.67	21.65	57.02	180.67	223.33	44.44
T_{11}($ZnSO_4$ 0.4% + Borax 0.2% + NAA 25 ppm + GA_3 50 ppm)	80.84	20.78	57.37	210.33	229.83	48.91
T_{12} ($ZnSO_4$ 0.8% + Borax 0.4% + NAA 50 ppm + GA_3 100 ppm)	80.98	18.89	62.10	230.00	235.83	49.88
S.E. ±	1.92	1.63	2.68	4.37	5.74	0.76
C.D. at 5%	5.63	4.75	7.82	12.76	16.76	2.26

concentration of zinc and boron may be attributed to their stimulatory effect on plant metabolism. These findings are in conformity with the results reported by Kumar *et al.* (2010) and Katiyar *et al*. (2009). The results further revealed that the combination of plant regulators with nutrients produced an additive effect on the yield. The beneficial effect of higher concentration of plant regulators in increasing the size of the fruit may be due to cell elongation or increase in number of cell. *i.e.* cell volume as viewed by Leopold (1958). The fruit yield was increased due to combined application of higher concentration of both the nutrients (Zn and B). It might be due to significant increase in the fruit length, fruit diameter and diameter of the seed cavity which might be attributed to their stimulatory effect on plant metabolism and production of auxins. These results are more or less in conformity with the findings reported by Yadav *et al.* (2011) and Singh *et al.* (2004).

Chemical parameters :

The data obtained from present investigation indicate that application of micronutrients and plant growth regulators significantly improved the fruit quality of guava in terms of total sugars, reducing sugars, non-reducing sugars, TSS, ascorbic acid content of fruit, pectin per cent, TSS/acid ratio, acidity per cent, zinc and iron content of fruit (Table 3). Maximum increase in these parameters was noticed with foliar spray of $ZnSO_4$ 0.8% + borax 0.4% + NAA 50 ppm + GA_3 100 ppm. All the plant growth substances at different concentration augmented TSS content of the fruit. These have been reported to divert more solids towards developing fruits and might also enhance the conversion of complex polysaccharide into simple sugars. These results are in conformity with the results reported by Pal *et al.* (2008), Iqbal *et al.* (2009) and Yadav *et al.* (2011). Increase in TSS might be due to spray of boron which helps in sugar transport ultimate accumulation of more sugars and organic acids in fruits. The higher percentage of total sugar, reducing and non-reducing sugar might have been due to efficient translocation of photosynthates to the fruits by regulation of boric acid. These results are in conformity with the findings of Dutta and Banik (2007) and Iqbal *et al*. (2009). Acidity of fruits was reduced by application of all the treatments, however maximum reduction was noted with foliar spray of $ZnSO_4$ 0.8% + borax 0.4% + NAA 50 ppm + GA_3 100 ppm. It appears that acid under the influence of higher concentration of growth regulators might has either fastly been converted into sugar and their derivatives by reactions involving reverse glycolytic pathways or might have been used in respiration or both. These results are in accordance with the findings of Pal *et al*. (2008) and Yadav *et al.* (2011). Acidity was also reduced by the foliar application of boron because it helps in preventing excessive polymerization of sugar and accumulation of more sugar in the cells of plant. Same treatment was also reported to increase the TSS/ acid

Table 3: Effect of micronutrients and growth regulators on chemical parameters of guava

Treatment	Acidity (%)	TSS/ acid ratio	TSS (°Brix)	Pectin (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	Ascorbic acid (mg/ 100g pulp)	Zn (ppm)	Fe (ppm)
T_0(Control)	0.39	47.33	08.67	0.61	9.00	5.47	3.51	138.26	4.63	89.60
T_1(Zinc Sulphate 0.4%)	0.31	54.48	12.00	0.88	9.34	5.67	3.72	153.42	8.53	168.47
T_2(Zinc Sulphate 0.8%)	0.26	57.43	12.50	0.91	9.61	5.70	3.90	161.21	9.33	172.43
T_3(Borax 0.2%)	0.29	55.97	12.33	0.87	9.49	5.68	3.82	159.01	7.37	133.70
T_4(Borax 0.4%)	0.23	59.81	12.61	0.93	9.71	5.73	4.04	163.76	8.40	154.30
T_5(NAA 25 ppm)	0.37	48.62	10.00	0.79	9.04	5.51	3.54	142.37	5.43	98.23
T_6(NAA 50 ppm)	0.36	49.50	10.33	0.83	9.17	5.52	3.56	145.51	5.50	101.27
T_7(GA_3 50 ppm)	0.33	50.27	11.00	0.78	9.21	5.54	3.57	149.42	5.53	103.60
T_8(GA_3 100 ppm)	0.32	53.23	11.10	0.84	9.24	5.63	3.71	150.69	6.40	115.30
T_9(Zinc Sulphate 0.8% + Borax 0.4%)	0.20	66.11	13.00	1.15	10.00	5.76	4.17	172.65	9.53	175.70
T_{10}(NAA 50 ppm + $GA_3$100 ppm)	0.22	65.16	12.67	1.12	9.91	5.74	4.12	169.28	6.63	125.50
T_{11}($ZnSO_4$ 0.4% + Borax 0.2% + NAA 25 ppm + GA_3 50 ppm)	0.19	68.11	13.33	1.24	10.02	5.79	4.23	176.17	11.47	225.57
T_{12}($ZnSO_4$ 0.8% + Borax 0.4% + NAA 50 ppm + GA_3 100 ppm)	0.17	68.72	13.50	1.32	10.53	5.88	4.28	185.89	12.10	267.57
S.E. ±	0.007	04.12	0.74	0.063	0.14	0.06	0.06	0.85	0.70	2.04
C.D. at5%	0.022	12.04	2.16	0.183	0.42	0.20	0.18	2.49	1.61	4.72

ratio. A consistent decrease in acid content and increase in TSS resulted into an increase in TSS/acid ratio. It may be due to that the increased sugar and reduced leaf starch content, which was due to more transformation of starch into sugar and its translocation into the fruits. Maximum pectin content might be due to higher concentration of nutrients and plant growth regulators which are responsible for solubilizing the pectin substances from middle lamella with rise in pectin. The higher concentrations of plant regulators increased the ascorbic acid content of fruit. It may due to the possible catalytic influence of these growth regulators on biosynthesis of ascorbic acid from sugars or inhibition of oxidative enzymes or both. These results are in conformity with the findings of Pal *et al.* (2008) and Yadav *et al.* (2011). Zinc (12.10 ppm) and iron (267.57 ppm) concentration of the fruit increased with increasing concentration of zinc because both the nutrient had little synergistic effect on each other. These results are in close conformity with the results reported by Yamdagni *et al.* (1981) in grapes.

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