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Influence of Foliar Feeding of NAA and Boron on Growth, Flowering, Fruiting, and Yield of Winter Season Guava (*Psidium guajava* L.) cv. L–49

Dipankar Singh Badal[1*] and V.K. Tripathi[2]
[1]Ph.D. Scholar, Department of Fruit Science, Kanpur, (Uttar Pradesh). India.
[2]Professor & Head, Department of Fruit Science and Horticulture.
CS Azad University of Agriculture and Technology, Kanpur, (Uttar Pradesh). India.

(Corresponding author: Dipankar Singh Badal)*
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ABSTRACT: An experiment was carried out at Horticulture Garden, Department of Fruit Science, Chandra Shekhar Azad University of Agriculture & Technology Kanpur (U.P.), India, during two consecutive years *i.e.*, 2018-19 and 2019-20 to assess the influence of foliar feeding of NAA and Boron on growth, flowering, fruiting and yield of winter season guava cv. Lucknow-49. The foliar application of micronutrients along with plant growth regulators plays an important role in manipulating many physiological phenomena, improving the yield and quality and enhanced the productivity of plants by fulfilling the nutritional needs of fruit crops. Sixteen treatments *viz.*, four levels each of NAA (0, 50, 75, and 100 ppm) and Boron (0, 0.4, 0.6, and 0.8%) with their combinations were used, which were replicated thrice in FCRD. From the experiments, it is reported that spray of NAA @75 ppm individually, significantly maximized length of the shoot (16.97 and 17.04 cm), diameter of the shoot (0.40 cm during both the years), number of leaves per shoot (15.55 and 15.65), number of flowers per shoot (17.03 and 17.35), fruit percent (72.94 and 73.48%), fruit retention percent (61.71% both the years), higher number of fruits per branch (8.25 and 8.48) and fruit yield per branch (1.61 and 1.65 Kg) with minimum fruit drop (38.29% both the years) respectively during both years of investigation. Application of boron at 0.6% concentration, significantly elongated shoot length (17.76 and 17.80 cm), improved number of leaves per shoot (16.57 and 16.62), number of flowers per shoot (17.48 and 17.87), fruit set percent (73.80 and 74.24%), fruit retention percent (63.42% during both the years), number of fruits per branch (8.78 and 9.05) and fruit yield per branch (1.74 and 1.79 Kg) producing significantly least fruit drop (36.61 and 36.59%) during both years of investigation. In the case of shoot diameter, boron 0.6% and 0.8% concentrations were noted to be at par with each other each producing significantly maximum shoot diameter (0.41 cm both the years). Interactive effect of NAA and boron (N_2 B_2) significantly maximized shoot length (21.35 and 21.40 cm), number of leaves per shoot (19.87 both years of investigation), fruit retention (70.02% during both the years), number of fruits per branch (11.07 and 11.27), fruit yield per branch (2.35 and 2.39 kg) as well as minimized fruit drop (29.98% during both the years).

Keywords: Guava, boron, NAA, Winter Season, Growth, Flowering, Fruiting and Yield.

INTRODUCTION

Guava (*Psidium guajava* L.) is widely grown in the Indian tropics and subtropics being quite a common fruit equally popular among the rich and the poor people due to its ordinary price, nourishing value and flavourful taste. Considerable research work has been done in the country on various aspects such as varieties, propagation, irrigation, training and pruning, etc. to increase the yield and quality of guava fruits. But poor yield and quality of fruits is still a matter of common experience. It would be therefore worthwhile to improve the growth, flowering, fruiting and yield by use of micronutrients and plant bioregulators. The importance of micronutrients and synthetic plant bio-regulators in achieving higher yields has been well recognized in recent years. Micronutrients help in the uptake of major nutrients and play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity hormone synthesis, nitrogen fixation and reduction. On the other hand, through the application of plant bio-regulators, the physical, chemical and reproductive parameters are improved resulting in better fruit set and fruit production without causing any adverse effect on fruit quality. The foliar feeding of fruit trees has gained much importance in recent years as nutrients applied through the soil are needed in higher quantities because some amount leaches down and some become unavailable to the plant due to complex soil reactions. Foliar application is based on the principle that the nutrients are quickly absorbed by leaves and transported to different parts of

the plant specially to works the developing fruits and new growth to fulfill the functional requirement of nutrition. This method plays a very important role in improving fruit set, productivity and quality of fruits.

Naphthalene acetic acid (NAA) is an important bio-regulator of the auxin group, which increases fruit set and decreases fruit drop. Boron plays an important role in the translocation of carbohydrates, auxin synthesis, increased pollen viability and fertilization, ovule development, pollen tube growth and fruit set. These activities improve the width and length of the fruits which ultimately increases the yield of fruits. The work done by earlier researchers revealed that foliar feeding of boron increased fruit set, reduced fruit drop and also improved the fruit quality in various fruits. Keeping this in view, the study was undertaken to assess the influence of foliar feeding of NAA and boron on growth, flowering, fruiting and yield pertaining to guava.

MATERIALS AND METHODS

The present investigation was carried out at the Horticulture Garden, Department of Fruit Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.) during two subsequent years *viz.*, 2018-19 and 2019-20. The experiment was laid out in Factorial Completely Randomized Design with three replications and sixteen treatments. Four levels each of NAA (0, 50, 75 and 100 ppm) and Boron (0, 0.4, 0.6 and 0.8%) along with their combinations were taken for the present study. Spraying was done twice *viz.*, before flowering and after fruit set. All the manurial requirements, cultural practices and plant protection measured were adopted as per norms. Twelve uniform plants of guava cv. L-49 were selected to form the experimental material. Four branches in uniform growth and vigour were selected on each tree. The micronutrient (boron) and plant growth regulator (NAA) were sprayed on the tree. Five newly initiated shoots on the current season's growth were randomly selected and tagged for taking the observations. The observations pertaining to shoot length, shoot diameter, number of leaves, flowers and fruits per shoot including fruit set (%), fruit drop (%) and fruit retention (%) along with fruit yield (kg/branch) were carefully recorded using prescribed standard methodology.

RESULT AND DISCUSSION

A. Growth Parameters

Application of NAA and boron hastened the growth of guava trees in terms of increase in shoot length, shoot diameter and number of leaves during both the years of the experiment (Table 1, 2 and 3). Foliar application of NAA increased shoot length and diameter progressively during the first year of investigation ranging from 11.66 to 16.97 cm and 0.34 to 0.40 cm, respectively, whereas, in the second year the range was 11.70 to 17.04 cm and 0.35 to 0.40 cm, respectively. The treatment with 75 ppm of NAA produced longest shoots with maximum shoot diameter whereas the plants under control expressed shortest shoots with the least shoot diameter. The growth of shoots was also influenced with boron treatments and 10.52 to 17.76 cm long shoots along with 0.32 to 0.41 cm shoot diameter was recorded in the first year, whereas, in the second year, a range of 10.61 to 17.80 cm shoot length along with 0.33 to 0.41 cm shoot diameter was observed.

Table 1: Effect of foliar sprays of NAA, Boron and their interactions on shoot length (cm) of guava cv. L-49.

	2018-19					2019-20				
Treatments	**Control (B_0)**	**B_1 (0.4%)**	**B_2 (0.6%)**	**B_3 (0.8%)**	**Mean**	**Control (B_0)**	**B_1 (0.4%)**	**B_2 (0.6%)**	**B_3 (0.8%)**	**Mean**
Control NAA (N_0)	9.00	10.33	13.29	14.03	11.66	9.03	10.39	13.29	14.10	11.70
NAA 50 ppm(N_1)	9.91	12.59	16.15	17.24	13.97	9.98	12.65	16.20	17.41	14.06
NAA 75 ppm(N_2)	12.02	15.35	21.35	19.16	16.97	12.11	15.45	21.40	19.20	17.04
NAA 100 ppm(N_3)	11.16	14.58	20.27	18.17	16.05	11.31	14.63	20.32	18.24	16.12
Mean	10.52	13.21	17.76	17.15		10.61	13.28	17.80	17.24	
	N	**B**	**N×B**			**N**	**B**	**N×B**		
	C.D.0.408	0.408	0.816			**C.D.**0.415	0.415	0.831		
	S.E. (d)0.200	0.200	0.400			**S.E. (d)**0.204	0.204	0.408		

Table 2: Effect of foliar sprays of NAA, Boron and their interactions on shoot diameter (cm) of guava cv. L-49.

	2018-19					2019-20				
Treatments	**Control (B_0)**	**B_1 (0.4%)**	**B_2 (0.6%)**	**B_3 (0.8%)**	**Mean**	**Control (B_0)**	**B_1 (0.4%)**	**B_2 (0.6%)**	**B_3 (0.8%)**	**Mean**
Control NAA (N_0)	0.30	0.32	0.36	0.38	0.34	0.31	0.33	0.37	0.38	0.35
NAA 50 ppm(N_1)	0.32	0.36	0.40	0.41	0.37	0.32	0.36	0.41	0.42	0.38
NAA 75 ppm(N_2)	0.34	0.39	0.44	0.42	0.40	0.35	0.40	0.44	0.43	0.40
NAA 100 ppm(N_3)	0.33	0.38	0.43	0.42	0.39	0.34	0.39	0.43	0.42	0.39
Mean	0.32	0.36	0.41	0.41		0.33	0.37	0.41	0.41	
	N	**B**	**N×B**			**N**	**B**	**N×B**		
	C.D.0.011	0.011	N.S.			**C.D.**0.014	0.014	N.S.		
	S.E. (d)0.005	0.005	0.010			**S.E. (d)**0.007	0.007	0.014		

Table 3: Effect of foliar sprays of NAA, Boron and their interactions on number of leaves per shoot of guava cv. L-49.

Treatments	2018-19					2019-20				
	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean
Control NAA (N_0)	8.13	9.40	11.40	12.13	10.27	8.47	9.53	11.47	12.33	10.45
NAA 50 ppm(N_1)	8.67	10.80	15.53	16.60	12.90	8.73	11.01	15.60	16.87	13.05
NAA 75 ppm(N_2)	10.27	13.73	19.87	18.33	15.55	10.40	13.93	19.87	18.40	15.65
NAA 100 ppm(N_3)	9.87	12.73	19.47	17.60	14.92	10.07	12.80	19.53	17.80	15.05
Mean	9.23	11.67	16.57	16.17		9.42	11.82	16.62	16.35	
	N B N×B C.D.0.8170.8171.634 S.E. (d)0.4010.4010.802					N B N×B C.D.0.7720.7721.544 S.E. (d)0.3790.3790.758				

The interactive treatment N_2 B_2 revealed a significantly maximum shoot length of 21.35 and 21.40 cm but in the case of shoot diameter, the interactive effect of boron and NAA could not touch the level of significance during both years. The higher shoot length and shoot diameter obtained within 75 ppm NAA as well as in 0.6% boron find support from Parray *et al.,* (2021) in Sweet Cherry, Kumar *et al.,* (2015); Ram *et al.,* (2016) in guava; Shukla *et al.,* (2011) in aonla, who elucidated the result on similar line that growth attributes are stimulated by NAA and Boron application.

The fluctuation in the number of leaves per shoot due to treatments of NAA exhibited a range of 10.27 to 15.55 and 10.45 to 15.65 leaves per shoot, respectively, during both the corresponding years of investigation. The trend in the improvement of the number of leaves in guava was observed in accordance to shoot length and diameter during both years. Boron too consistently and positively affected the production of leaves per shoot and its 0.6% concentration produced a maximum number of leaves (16.57 and 16.62) during 2018-19 and 2019-20. The minimum number of leaves (9.23 and 9.42) were observed under untreated plants (B_0). The increase in growth due to the application of boron could be ascribed to its role in nitrogen metabolism, phytohormones regulation and active cell proliferation. These findings are in accordance with the reports of Prasad and Yadav (2003); Goswami *et al*., (2015) in guava. The interactive effect between NAA and boron significantly improved leaf number (19.87) under the N_2 B_2 treatment and the minimum number (8.13 and 8.47) was obtained under the interactive treatment of N_0 B_0 during both years of experimentation.

B. Flowering and fruiting

Significant improvement in flowering and fruiting components such as the number of flowers per shoot**,** fruit set (%)**,** fruit drop (%) and fruit retention (%) as influenced by increasing levels of NAA and boron treatments was observed during the present investigation (Table 4, 5, 6 and 7). Among all NAA treatments, NAA 75 ppm registered the maximum value for the number of flowers per shoot (17.03 and 17.35), fruit set (72.94 and 73.48%) and fruit retention (61.71% during both years) with the least fruit drop (38.29% during both years) during respective years of study. Similarly, among all boron treatments, 0.6% boron showed maximum value for the number of flowers per shoot (17.48 and 17.87), fruit set (73.80 and 74.24 %) and fruit retention (63.42% during both years) with the least fruit drop (36.61 and 36.59 %) respectively during both the years of investigation. The interactive treatments of NAA in association with boron significantly influence fruit drop and fruit retention but in the case of the number of flowers per shoot as well as fruit set, the interaction being significantly ineffective could only show numerical improvement where the treatment N_2 B_2 proved to be the best for all flowering and fruiting components. These findings are in line with the reports of Tirkey *et al.,* (2018); Parmar *et al.,* (2019) in guava, Tripathi *et al.,* (2018); Singh *et al.,* (2018) in litchi.

Table 4: Effect of foliar sprays of NAA, Boron and their interactions on number of flowers per shoot of guava cv. L-49.

Treatments	2018-19					2019-20				
	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean
Control NAA (N_0)	10.27	12.27	14.57	15.13	13.06	10.33	12.80	14.87	15.40	13.35
NAA 50 ppm(N_1)	11.40	14.00	16.60	17.53	14.88	11.67	14.40	17.33	18.00	15.35
NAA 75 ppm(N_2)	13.53	16.20	19.67	18.73	17.03	13.67	16.87	19.93	18.93	17.35
NAA 100 ppm(N_3)	12.80	16.00	19.07	18.00	16.47	13.27	16.53	19.33	18.47	16.90
Mean	12.00	14.62	17.48	17.35		12.23	15.15	17.87	17.70	
	N B N×B C.D.0.6430.643N.S. S.E. (d)0.2230.2230.446					N B N×B C.D.0.6950.695N.S. S.E. (d)0.3410.3410.682				

Table 5: Effect of foliar sprays of NAA, Boron and their interactions on fruit set (%) of guava cv. L-49.

Treatments	2018-19					2019-20				
	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean
Control NAA (N_0)	63.19	65.38	68.61	69.29	66.62	63.28	66.17	68.87	69.37	66.92
NAA 50 ppm(N_1)	64.50	67.82	72.51	73.64	69.62	64.93	68.39	73.07	74.01	70.10
NAA 75 ppm(N_2)	67.02	71.47	77.48	75.80	72.94	67.63	72.07	78.01	76.20	73.48
NAA 100 ppm(N_3)	66.12	70.27	76.58	74.71	71.92	66.38	70.64	77.01	75.10	72.28
Mean	65.21	68.74	73.80	73.36		65.56	69.32	74.24	73.67	
	N B N×B					N B N×B				
	C.D.1.0721.072N.S.					C.D.1.2641.264N.S.				
	S.E. (d)0.5260.5261.052					S.E. (d)0.6200.6201.240				

Table 6: Effect of foliar sprays of NAA, Boron and their interactions on fruit drop (%) of guava cv. L-49.

Treatments	2018-19					2019-20				
	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean
Control NAA (N_0)	54.73	51.51	45.49	43.86	48.90	54.73	51.51	45.42	43.86	48.88
NAA 50 ppm(N_1)	52.95	46.83	39.34	37.81	44.24	52.28	46.83	39.34	37.81	44.07
NAA 75 ppm(N_2)	48.37	40.85	29.98	33.97	38.29	48.37	40.85	29.98	33.97	38.29
NAA 100 ppm(N_3)	49.89	42.40	31.61	36.00	39.97	49.89	42.40	31.61	36.00	39.97
Mean	51.48	45.40	36.61	37.91		51.32	45.40	36.59	37.91	
	N B N×B					N B N×B				
	C.D.1.2441.2442.489					C.D.1.4691.4692.938				
	S.E. (d)0.6110.6111.222					S.E. (d)0.7210.7211.442				

Table 7: Effect of foliar sprays of NAA, Boron and their interactions on fruit retention (%) of guava cv. L-49.

Treatments	2018-19					2019-20				
	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean
Control NAA (N_0)	45.27	48.49	54.61	56.28	51.16	45.27	48.49	54.61	56.14	51.28
NAA 50 ppm(N_1)	47.05	53.23	60.66	62.18	55.78	47.05	53.17	60.66	62.19	55.76
NAA 75 ppm(N_2)	51.63	59.15	70.02	66.03	61.71	51.63	59.15	70.02	66.03	61.71
NAA 100 ppm(N_3)	50.11	57.60	68.39	64.00	60.02	50.11	57.60	68.39	64.00	60.03
Mean	48.52	54.62	63.42	62.12		48.52	54.60	63.42	62.09	
	N B N×B					N B N×B				
	C.D.1.2451.2452.49					C.D.1.4441.4442.888				
	S.E. (d)0.6110.6111.222					S.E. (d)0.7090.7091.417				

C. Yield Parameters

Yield parameters were also significantly influenced by NAA and boron treatments. Among all NAA treatments, NAA 75 ppm not only registered the maximum value for the number of fruits per branch (8.25 and 8.48) but also displayed the highest yield per branch (1.61 and 1.65 kg) during both the years of study (Table 8 and 9). Similarly, among all boron treatments, 0.6% boron showed maximum value for the number of fruits per branch (8.78 and 9.05) along with maximal yield per branch (1.74 and 1.79 kg) during the respective years of investigation. The interactive treatments of NAA in association with boron significantly influenced the number of fruits per branch as well as yield per branch whereas the treatment N_2 B_2 proved to be the best.

The results are inconformity with the finding of Sharma and Tiwari (2015); Rajput *et al.*, (2016); Tirkey *et al.*, (2018) in guava.

Table 8: Effect of foliar sprays of NAA, Boron and their interactions on number of fruits per branch of guava cv. L-49.

Treatments	2018-19					2019-20				
	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean
Control NAA (N_0)	2.93	4.00	5.80	6.33	4.77	3.00	4.53	6.13	6.53	5.05
NAA 50 ppm(N_1)	3.47	5.27	7.73	8.67	6.28	3.73	5.40	8.07	9.07	6.57
NAA 75 ppm(N_2)	4.87	7.27	11.07	9.80	8.25	5.20	7.47	11.27	10.00	8.48
NAA 100 ppm(N_3)	4.47	6.80	10.53	9.33	7.78	4.87	7.33	10.73	9.87	8.20
Mean	3.93	5.83	8.78	8.53		4.20	6.18	9.05	8.87	
	N B N×B					N B N×B				
	C.D.0.4100.4100.819					C.D.0.470 0.470 0.940				
	S.E. (d)0.2010.2010.402					S.E. (d)0.2310.231 0.461				

Table 9: Effect of foliar sprays of NAA, Boron and their interactions on yield per branch (Kg) of guava cv. L-49.

Treatments	2018-19					2019-20				
	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean	Control (B_0)	B_1 (0.4%)	B_2 (0.6%)	B_3 (0.8%)	Mean
Control NAA (N_0)	0.41	0.60	0.97	1.09	0.77	0.42	0.67	1.03	1.13	0.81
NAA 50 ppm(N_1)	0.50	0.86	1.45	1.67	1.12	0.54	0.88	1.51	1.74	1.17
NAA 75 ppm(N_2)	0.77	1.32	2.35	1.98	1.61	0.82	1.36	2.39	2.02	1.65
NAA 100 ppm(N_3)	0.68	1.21	2.19	1.83	1.48	0.75	1.31	2.23	1.94	1.56
Mean	0.59	1.00	1.74	1.64		0.63	1.06	1.79	1.70	
N B N×B **C.D.**0.1610.1610.322 **S.E. (d)**0.0790.0790.158						**N B N×B** **C.D.**0.1530.1530.307 **S.E. (d)**0.0750.0750.151				

CONCLUSION

Based on results obtained in the present investigation, it is concluded that the doses of NAA (75 ppm) and boron (0.6%) individually or in combination significantly maximized length of the shoot, diameter of the shoot, number of leaves with number of flowers per shoot, fruit percent, fruit retention per cent, number of fruits and fruit yield per branch with minimum fruit drop during both years of investigation in guava cv. L-49. Thus, in the light of the above achievement, 75 ppm NAA in conjunction with 0.6% boron may be recommended safely to the guava growers for profitable crop production under the Gangetic plains of India. The above recommendations if adopted systematically and correctly, possess the potential of improving the economy and prosperity of the country.

FUTURE SCHOPE

Use of plant bio-regulators and micro-nutrients plays an important role in the higher yield of quality fruit production. Since guava is an important fruit crop all over the world. That's why in the future, more studies can be carried out on other cultivars alone or in the combination of both *i.e.*, plant bioregulators and micronutrients on more parameters to standardized techniques according to specific regions.

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Conflict of Interest: Authors have declared that no competing interests exist.

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