Original Research Article

Response of Foliar Application of Naphthalene Acetic Acid and Zinc on yield and quality attributes of Guava (*Psidium guajava* L.) *cv.* L-49

Abstract

An experiment was carried out at Old campus, Horticulture Garden, Department of Fruit Science, Sardar Vallabhbhai Patel University of Agriculture & Technology Meerut, India during two consecutive years i.e., 2021 and 2022 to assess the "Influence of foliar Spray of naphthalene acetic acid & Zinc on growth, flowering, fruiting, yield and quality of Guava under western U.P. conditions". The foliar spray micronutrients along with plant growth regulators play 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. Twelve treatments viz., three level of Naphthalene Acetic Acid (0, 50, and 75 ppm) and four level of Zinc (0, 0.4, 0.6, and 0.8 %) with their combinations were used, which were replicated in factorial Randomized Block Design. Results showed NAA @75 ppm (N_2) individually registered yield of 53.75 and 53.06 kg/p~~-P~~lant the application of Zinc at 0.8 % (Zn_3) concentration recorded yield of 53.86 and 53.17 kg/plant. Interactive effect of naphthalene acetic acid and Zinc (N_2Zn_3) treatments registered yield of 59.56 and 58.81 kg/plant while quality parameter pectin was in the range of ~~(~~0.79 and 0.80 %~~)~~ with treatment naphthalene acetic acid @75 ppm (N_2) and Zinc at 0.8 % (Zn_3) individually outperformed the other treatments. The combination could be ideal and recommended for the production of guava in the Indo-Gangetic plains in western India.

Keywords: *Guava, Zinc, NAA, yield, Pectin*

1. INTRODUCTION

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The guava, often known as the Apple of the Tropics (*Psidium guajava* L.), is India's sixth most popular fruit crop after papaya, mango, banana, and citrus fruits. It is a member of the myrtaceae family and is native to tropical America, spanning from Mexico to Peru **(Agnihotri *et al*. 2013**). The trees were cultivated more than 2000 years ago, and soon after the discovery of the new world by the Spanish and Portuguese, they spread quickly across the globe's tropics. It is now present in tropical and subtropical regions of many nations, including India, Hawaii, Brazil, Mexico, Thailand, New Zealand, Philippines, China, Malaysia, Cuba, Sri Lanka, Venezuela, Australia, Burma, Myanmar, Israel, Pakistan, and Bangladesh. Guava is mostly produced in India such that there are 6967 thousand hectares of land grown to fruit farming, and 102924 thousand metric tonnes of fruit are produced annually. With an annual fruit yield of 4516 thousand metric tonnes, guava is grown on 307 thousand hectares of land in India with a production of 14 MT/ha. A total of 11259.24 thousand metric tonnes of fruit are produced on 505.13 thousand hectares of land in Uttar Pradesh. One advance estimated for 2021–22 suggested~~s~~ that out of these, guava farming would cover 52.25 thousand hectares, producing 983.59 thousand tonnes per year **(Anonymous, 2022)**. The major guava-producing states of India are Uttar Pradesh, Maharashtra, Bihar, Andhra Pradesh, Gujarat, Madhya Pradesh, Karnataka, Punjab, and Orissa. Uttar Pradesh produces the best quality guava, and Allahabad has a distinct reputation for growing the best guava in the country as well as in the world. Mature fruits of guava are rich in nutrition and its composition varies in different cultivars, seasons and not only within the cultivar from place to place but also at one location owing to changes in yearly climatic conditions and cultural practices. The fruit (berry) is an excellent source of vitamin C (210-305 mg/100 g fruit pulp) and pectin (0.5-1.8%) but has low energy (66cal. /100 g). The ripe fruits contain 12.3-26.3% dry matter, 77.9-86.9% moisture, 0.51-1.02% ash, 0.10-0.70% crude fat, 0.82-1.45% crude protein and 2.0-7.2% crude fiber. The fruits are also rich in minerals like phosphorus (22.5-40.0 mg/100g pulp), calcium (10.0-30.0 mg/100g pulp) and iron (0.60-1.39 mg/100g pulp) as well as vitamins like niacin (0.20-2.32 mg/100g pulp), pantothenic acid, thiamine (0.03-0.07 mg/100 g pulp), riboflavin (0.02-0.04 mg/100g pulp) and vitamin- "A" **(Mitra and Bose, 2001)**. It has an astringent property due to which its mature leaves, fruits, roots and bark are used in medicines to treat gastroenteritis, diarrhea and dysentery **(Ojewale*et. al.,* 2008)**. Most of the guava varieties produce medium to small inferior quality fruits having ta greater number of seeds which are hard to chew. During the last 50 years, 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. The production of poor-quality fruits is a matter of common experience; it would be, therefore, worthwhile to improve the yield and quality of fruit crops by use of micronutrients and plant growth regulators. The importance of micronutrients and synthetic plant growth regulators in achieving higher yields and better quality of fruit crops have been well recognized in recent time. 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 **(Das, 2003)**. **The experiment aims to** assess the “Influence of foliar spray of NAA & Zinc on growth, flowering, fruiting, yield and quality of Guava under Western U.P. conditions.

2. MATERIALS AND METHODS

The present investigation was carried out in the Old Campus, Horticulture Garden Department of Fruit Science, College of horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut during two subsequent years 2021-22 and 2022- 23.

2.1 Experimental Design and Treatments

Lucknow-49 Guava cultivar tress uniformly healthy and well established 15-year-old were chosen for the experiment with adherance to the recommended fertilizer doses and other horticultural practices. The experiment was laid out in Factorial Randomized Design with three replications and twelve treatments. Three level of NAA (0, 50 and 75 ppm), and four level of Zinc (0, 0.4, 0.6 and 0.8 %) and their combinations were advocated as treatments as follows:-

Treatment	Treatment Description
T1	Control (water spray)
T2	Zinc 0.4 %
T3	Zinc 0.6 %
T4	Zinc 0.8 %

T5	NAA 50 ppm
T6	NAA 50 PPM + Zinc 0.4 %
T7	NAA 50 ppm + Zinc 0.6 %
T8	NAA 50 ppm + Zinc 0.8 %
T9	NAA 75 ppm
T10	NAA 75 ppm + Zinc 0.4 %
T11	NAA 75 ppm + Zinc 0.6 %,
T12	NAA 75 ppm + Zinc 0.8 %

NAA (water spray), NAA (50 ppm), NAA (75 ppm) are denoted as (N_0, N_1, N_2,) respectively, Zinc (water spray), Zinc 0.4 % , Zinc 0.6 % , Zinc 0.8 % are denoted as (Zn_0, Zn_1, Zn_2, Zn_3) respectively. The micronutrient (Zinc) and Plant growth regulator (NAA) were sprayed on the guava trees. Five newly initiated shoot on the current season's growth were randomly selected and tagged for taking the observation pertaining to Yield (kg/plant) and Pectin (%). These parameters were carefully recorded using prescribed standard methodology.

2.2 PARAMETERS OF STUDY

2.2.1 Yield (kg/Plant)

The weight of fruits was recorded at every harvesting under each treatment and total yield per tree was calculated at the final harvesting.

2.2.2 Pectin (%)

The fruits of each treatment were crushed using a pestle and mortar. About 100 gm of the crushed sample was taken and added 200 ml of water then boiled for half an hour. The process was repeated twice and the extract was made up to 250 ml. The sample was then tested for starch content with 0.1 percent iodine solution, which was negligible. Again 100 ml of the extract was centrifuged to get a clear solution and 50 ml of this solution was taken out for estimation of pectin according to the method of **Kertesz (1995).**

2.3 Statistical analysis

The data were subjected to appropriate model analysis of variance (ANOVA) According to the procedure described by **Panse and Sukhantme (2000).** Critical differences (CD) were calculated to compare the treatment at 1 percent 5 percent level of significance only:

(1) $C.F. = \dfrac{GT^2}{N}$

(2) $T.S.S = (X^2_1 + X^2_2 + X^2_3 \ldots\ldots X^2_n) - C.F.$

(3) S.S. for error = TSS – Tr.S.S.

(4) Table for analysis of variance

3. RESULTS AND DISCUSSION

3.1 Results

Yield kg/ Plant

The applied NAA and Zinc as foliar spray with two different levels alone or in combinations had a numerically influence on guava fruit to increase the yield. All the NAA treatments (Table 1) were significant and treatmentT_9 NAA 75 ppm registered the maximum yield (kg/plant) of 45.89 kg followed by treatment T_5 NAA 50 ppm (45.57 kg/plant). The control treatment (water spray) recorded the minimum yield (kg/plant) (36.75 kg/Plant). Zinc treatments showed significant differences such that treatment T_4 Zinc 0.8% registered the maximum yield (kg/plant) (45.74 kg/plant) followed by T_4 Zinc 0.8% (45.15 kg/plant), T_3 Zinc 0.6 % (42.16 kg/plant) and T_2 Zinc 0.4% (39.70 kg/plant). The same trend in Zinc treatment was observed in the control treatment where minimum yield of 37.23 kg/plant was recorded. All NAA and Zinc treatments were significant such that treatment T_{12} NAA 75 ppm + Zinc 0.8% registered maximum yield (kg/plant) of 59.56 kg/plant followed by treatment T_{11} NAA 75 ppm + Zinc 0.6% (57.63 kg/plant), T_8 NAA 50 ppm + Zinc 0.8% (56.28 kg/plant) and T_{10} NAA 75 ppm + Zinc 0.4% (51.31 kg/plant with minimum yields recorded in T_6 NAA 50 ppm+ Zinc 0.4% (49.84 kg/plant) followed by the control treatment T_1 N_0Zn_o (37.23 kg/plant.

Increasing quantitative yields and improving the quality of fruits are paramount in research. Foliar feeding of micronutrients or growth hormones is known to affect the metabolic activities of plants resulting in increased yields. Treatments with NAA and zinc had a substantial impact on the yield. This rise in output could be due to increase in fruit sets. The highest yields (kg/plant) values were recorded by NAA 75 ppm treatments throughout the research period and similar results were reported by **Dutta and Banik (2007), Awasthi and Lal (2009), Kumar *et al*. (2010**), **Abbas *et al.* (2014), Tirkey*et al*. (2018), Dhakad*et al*. (2020) in mulberry, Bijay*et al*. (2023), Bhoyar and Ramdevputra (2016), Baidya *et al*., (2023).in Pineapple.**

Pectin %

NAA treatments were significant such thatT_9 NAA 75 ppm recorded maximum Pectin content (0.68%) followed by treatment T_5 NAA 50 ppm (0.66 %), while control treatment minimum Pectin content (0.64%) was registered. In Zinc treatments significant differences among treatments wers shown and T_4 Zinc 0.8% recorded maximum Pectin content (0.69%) followed by T_3 Zinc 0.6 % (0.68%) and T_2 Zinc 0.4% (0.65%) while minimum Pectin content (0.64%) was under the control treatment. Results for all NAA and Zinc treatments were significant and treatment T_9 NAA 75 ppm registered the maximum Pectin content (0.69%) followed by T_5 NAA 50 ppm (0.67 %), while the control treatment recorded the minimum Pectin content of 0.66%.

The interaction between NAA and Zinc treatments on the Pectin content inof guava showed significant variation such that treatment T_{12} NAA 75 ppm + Zinc 0.8% recorded the maximum Pectin content (0.89%) and followed by treatment T_8 NAA 50 ppm + Zinc 0.8% (0.86%) and T_{11} NAA 75 ppm + Zinc 0.6% (0.85%) while the minimum Pectin content was observed in T_{10} NAA 75 ppm + Zinc 0.4% (0.77%), T_6 NAA 50 ppm+ Zinc 0.4% (0.75%) and control treatment T_1 N_0Zn_o (0.64%).

Different concentrations of NAA and Zinc, either alone or in combination, significantly impacted the quality of the guava fruit among all NAA treatments. Similar results were reported by **Badal and Tripathi (2021) in guava**, **Malik *et al.*, (2000)** **in kinnow**, **Balakrishnan (2001)**, **Kar *et al.,* (2002)** and, **El-Rahman (2003)**. Zinc treatments may have sped up fruit ripening, which may have resulted in acid breakdown and prevented excessive sugar polymerization and build-up in plant cells. As a result, fruits' reduced acid content may have been caused by this process. Additionally, it seemeds that when acidity decreases in tropical and subtropical fruits, total soluble solids rise. The acid that was affected by zinc may have been transformed into sugars and their derivatives through processes involving the reversal of the glycol tic pathway or may have been utilised in respiration. The higher concentrations of Zinc increased the ascorbic acid content of fruit which may be due to the possible influence of this micronutrient on the biosynthesis of ascorbic acid from sugars or inhibition of oxidative enzymes or both. Zinc is responsible for the improvement of fruit quality is in conformity with the findings by **Kumar and Tripathi (2009),Singh and Bal(2006), and Dodiya *et al.* (2018).**

4. CONCLUSION

In conclusion guava plants treated with a mixture of 75 ppm NAA (naphthalene acetic acid) and 0.8% zinc will improve their vegetative development through blooming, fruiting, yield, and fruit quality. The combination could be ideal and recommended for the production of guava in the Indo-Gangetic plains in western India.

Table 1: Effect of foliar sprays of NAA, Zinc and their interactions on Yield (kg/Plant) of guava cv L- 49.

	2021-22					2022-23				
Treatments	**Control (Zn_0)**	**Zn_1 (0.4%)**	**Zn_2 (0.6%)**	**Zn_3 (0.8%)**	**Mean**	**Control (Zn_0)**	**Zn_1 (0.4%)**	**Zn_2 (0.6%)**	**Zn_3 (0.8%)**	**Mean**
Control NAA(N_0)	37.23	39.70	42.16	45.74	41.21	36.75	39.18	41.62	45.15	40.67
NAA 50ppm (N_1)	46.16	49.84	54.17	56.28	51.61	45.57	49.21	53.48	55.56	50.95
NAA 75ppm (N_2)	46.49	51.31	57.63	59.56	53.75	45.89	50.65	56.90	58.81	53.06
Mean	43.29	46.95	51.32	53.86		42.73	46.35	50.66	53.17	
	N	Z	N x Z				N	Z	N x Z	
C.D	**1.22**	**1.41**	**2.44**			C.D	**1.17**	**1.35**	**2.33**	
S.E.(d)	**0.59**	**0.68**	**1.18**			S.E.(d)	**0.58**	**0.67**	**1.16**	

Table 2: Effect of foliar sprays of NAA, Zinc and their interactions on Pectin (%) of guava cv L- 49

Treatments	2021-22					2022-23				
	Control (Zn_0)	Zn_1 (0.4%)	Zn_2 (0.6%)	Zn_3 (0.8%)	Mean	Control (Zn_0)	Zn_1 (0.4%)	Zn_2 (0.6%)	Zn_3 (0.8%)	Mean
Control NAA(N_0)	0.64	0.65	0.68	0.69	0.67	0.66	0.67	0.69	0.70	0.68
NAA 50ppm (N_1)	0.66	0.75	0.81	0.85	0.77	0.67	0.76	0.83	0.86	0.78
NAA 75ppm (N_2)	0.68	0.77	0.83	0.87	0.79	0.69	0.78	0.85	0.89	0.80
Mean	0.66	0.72	0.78	0.80		0.67	0.74	0.79	0.82	
	N	Z	N x Z				N	Z	N x Z	
C.D	**0.05**	**0.05**	**NS**			C.D	**0.03**	**0.04**	**0.07**	
S.E.(d)	**0.02**	**0.03**	**0.05**			S.E.(d)	**0.02**	**0.02**	**0.03**	

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REFERENCES

1. **A.O.A.C. (1980)**. Official Methods of analysis, association of official analytical Chemist, Washington, D.C. U.S.A.

Comment [H2]: Not cited but listed check

2. **Abbas, M. M., Ahmad, S. and Javaid, M. A. (2014).** Effect of naphthalene acetic acid on flower and fruit thinning of summer crop of guava. *J. Agric. Res,* **52**(1):106- 109.
3. **Abdollahi, M. Eshghi, S. and Tafazoli, E. (2010)** Interaction of paclobutrazol, boron and zinc on vegetative growth, yield and fruit quality of strawberry (*Fragaria* x *ananassa* Duch. *cv.* Selva). Journal of Biological & Environmental Sciences, 4: 11, 67-75.
4. **Adak., Kumar, K., Singh, V. K., and Ganeshamurthy, A, N. (2022)** Response of dashehari mango to different Zn levels on yield and pulp nutrient content grown on sandy loam soils of lucknow*Journal of Horticulture Science*, Vol. **17**(1): 103-109

Comment [H3]: Listed but not cited check

5. **Agnihotri, A.; Tiwari, R. and Singh, O.P. (2013).** Effect of crop regulators on growth, yield and quality of guava. *Annals of plant and soil Research*, **15**(1): 54 57.
6. **Alila, P., Sanyal, D. and Sema, K. A. (2004).** Influence of micronutrient application on quality of papaya *cv*. Ranchi*. Haryana Journal of Horticulture Science*, **33**(1/2): 25-26.
7. **Anand, M.; Kahlon, P.S. and Mahajan, B.V.C. (2003).** Effect of exogeno application of growth regulators on fruit drop, cracking and quality of Litchi (*Litchi chinensis Sonn*.) Dehradun. *Agricultural Digest*, **23** (3): 191-194.

Comment [H4]: Listed but not cited check

8. **Anonymous. (2022).** Area and production of Horticultural crops (1st Advance Estimate- 2021-22- agricoop.nic.in). Ministry of Agriculture, Cooperation and Farmer Welfare, Government of India. New Delhi
9. **Awasthi, P. and Lal, S. (2009).** Effect of calcium, boron and zinc foliar sprays on the yield and quality of guava (*Psidium guajava* L*.). Pantnagar Journal of Research*, **7**(2): 223-225.
10. **Babu, R and Tripathi, V. K. (2022).** Impact of foliar application of NAA, Zinc and boron on growth, yield and quality parameters of guava (*Psidium guajava* L.) *Prog. Agric*. **22**(2): 190-194

Comment [H5]: Listed but not cited check

11. **Badal, D. S and Tripathi, V. K. (2021). (A)** Influence of foliar feeding of NAA and boron on growth flowering, fruiting and yield of winter season guava (*Psidium guajava* L.) *cv*.L-49. *Biological forum-An international journal*,**13** (3): 387-391.
12. **Badal, D. S and Tripathi, V. K. (2021). (B)** Effect of foliar application of NAA and Boron on physico- chemical parameters of winter season guava (*Psidium guajava L*.) *cv.* L-49. *The Pharma Innovation Journal***10**(9): 928-932
13. **Baidya, B. K., Kishore, K., Samant D., Dash, S.N., Panda, R.K., Sahu, A. and Shukla K.K. (2023).** Yield attributing traits and economic efficacy of pineapple as influenced by plant growth regulators and micronutrients. *Biological forum-An international journal,* **15**(1):264-267
14. Bijay*et al*. (2023) cited but not listed

~~13.~~15.

~~14.~~16. **Bakshi, P., Jasrotia, A., Wali, V.K., Sharma, A. and Bakshi, M. (2013).** Influence of pre-harvest application of calcium and micronutrients on growth, yield, quality and shelf-life of strawberry *cv*. Chandler. *Indian Journal of Agriculture Science*,**83**(8): 831-835

Comment [H6]: Listed but not cited check

15.17. **Balakrishnan, K. (2000).** Foliar spray of zinc, iron, boron and magnesium on vegetative growth, yield and quality of guava. *Ann. Plant Physiol.***14** (2): 151-153.

16.18. **Balakrishnan, K. (2001).** Effect of foliar application of micronutrients on guava. *Madras Agric. J.* **88** (4/6): 316-317.

17.19. **Bhatia, S.K.; Yadav, S.; Ahlawat, V.P. and Dahiya, S.S. (2001).** Effect of foliar application of nutrients on the yield and fruit quality of winter season guava *cv.* L-49. *Haryana J. Hort. Sci*., **30** (1/2): 6-7.

18.20. **Bhoyar, M.G. and Ramdevputra, M.V. (2016)**. Effect of foliar spray of zinc, iron and boron on the growth, yield and sensory characters of guava (*Psidium guajava* L...) *cv.* Sardar L-49. *Journal of Applied and Science*, **8** (2): 701-704.

19.21. **Borner, J. (1950).** Plant Biochemistry. Academic Press, New York.

20.22. **Bower, C.A. and Wilcox, L.V. (1965).** Soluble Salts. In: Black, C.A., *et al.,* Methods of Soil Analysis, *American Society of Agronomy*, Madison, 933-940

21.23. **Briggs, R.H. and Leopoid, A.C. (1958).** Amer. C. Botany, **45:** 447-551.

22.24. **Chander, S., Jain, M.C., Pareek, P.K., Bola, P.K., Meena, R.R., Sharma, Y.K and Renuka (2017)** Effect of foliar feeding of borax, zinc sulphate and urea on fruiting and yield of guava (*Psidium guajava* L.) *cv.* Lalit and shweta under high density planting system. *Chemical science review and letters,* 2278-6783.

23.25. **Chauhan, A.S.; Kumar, K.; Saini, P.K.; Singh, V. and Singh, J. P. (2019).** Effect of NAA and Zinc Sulphate on Fruiting, Yield of Litchi (*Litchi chinensis*, Sonn.) *cv.*Calcuttia. *Int. J. Curr. Microbiol.* App. Sci. **8** (3): 836-843.

24.26. **Czaja, A. (1935).** Ber. Deut, Botan. Gea. 53, 221. In Growth substances. Plant Physiology. ISBN 81-224-0517-7.

27. **Das, A; Majumder K. and Majumdar B.C. (2001).** Zinc sulphate induced higher sweetness of rainy season guava fruits. *Indian Agric*. **44** (3&4): 199-201.

28. Dhakad*et al*. (2020 Cited but not listed check

29. Dodiya *et al.* (2018). Cited but not listed check

30. Dutta and Banik (2007) Cited but not listed check

25.31. El-Rahman (2003). Cited but not listed check

26.32. **Giriraj Jat and H. L. Kacha (2014).** Response of guava to foliar application of urea and zinc on fruit set, yield and quality. *Journal Agriculture Research*, **1**(2): 86-91

33. **Goswami, A.K.; Shukla, H.S. and Mishra, D.S. (2014).** Influence of pre-harvest nutrients application on the physico-chemical quality and storage behavior of guava (*Psidium guajava* L.) frut *cv.* L-49, *Progressive Horticulture*, 46:54-57.

34. Kar *et al.,* (2002) Cited but not listed check

35. Kertesz, 1995 Cited but not listed check

36. Kumar *et al*. (2010) Cited but not listed check

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37. Kumar and Tripathi (2009 Cited but not listed check

38. Malik *et al*., (2000) Cited but not listed check

39. Mitra and Bose, 2001 Cited but not listed check

40. Ojewale*et. al.,* 2008 Cited but not listed check

41. Panse and Sukhantme, 2000 Cited but not listed check

42. Singh and Bal (2006) Cited but not listed check

43. Tirkey*et al*. (2018) Cited but not listed check