

Effect of different concentration of NAA and panicle bagging on flowering, yield and quality of mango (*Mangifera indica* L.) cv. Amrapali

Yongkongtula¹, C.S. Maiti^{1*}, Ujjwal Singh¹ and A. Sarkar¹

¹Department of Horticulture, School of Agricultural Sciences, Nagaland University,

Medziphema- 797106 Nagaland, India

*Corresponding author Email: csmaiti@nagalanduniversity.ac.in

ABSTRACT

The current study was conducted on mango cultivar 'Amrapali' to evaluate the impact of different concentration of Naphthalene Acetic Acid (NAA) and panicle bagging on flowering behaviour, yield, and fruit quality under foothill of Nagaland. Treatments involved foliar application of NAA at the prebloom stage with three concentrations T₁ (40 ppm), T₂ (100 ppm), and T₃ (200 ppm) along with panicle bagging performed at the marble stage. The experiment followed a two-factor Randomized Block Design (RBD) with three replications. Foliar application of NAA significantly influenced flowering, fruit yield, and quality traits. Among the treatments, NAA at 100 ppm resulted in the highest number of panicles per branch and improved flowering however the combination of 40 ppm NAA and panicle bagging yielded the highest fruit set and overall yield. Additionally, 200 ppm NAA combined with bagging proved most effective in enhancing fruit set as well as the physical characteristics of the fruit. However, the application of NAA and bagging did not show statistically significant changes in most bio-chemical parameters, except for juice content, ascorbic acid levels, and the TSS: acid ratio.

Keywords: NAA, bagging, flowering, yield, bio-chemical attributes

INTRODUCTION

Mango (*Mangifera indica* L.) is a major fruit crop widely cultivated in tropical regions around the world and is often referred to as the "King of Fruits" [1]. The 'Amrapali' mango variety, developed in 1971 as a hybrid between 'Dashehari' and 'Neelum' by the Indian Agricultural Research Institute (IARI), Pusa, New Delhi, has since been widely adopted across India. This variety is gaining popularity in the North-Eastern Region (NER) due to its dwarf stature, regular bearing habit, clustered fruiting, small-sized fruits, and good shelf life. Though mango is grown as non-conventional commercial fruit crop in the region despite abundant flowering, mango orchards often experience poor fruit yields, primarily due to low initial fruit set and high rates of fruitlet drop [2]. Fruit bagging is known to modify the

microclimate around developing fruits [3], and pre-harvest bagging can enhance fruit quality and yield while also protecting the crop from pests and diseases. However, such practices are seldom used in the North-Eastern states, including Nagaland, where mango is a significant fruit crop. Limited awareness and regional constraints have hindered the adoption of improved technologies. In this context, the present study titled “Effect of pre-treatment of NAA and panicle bagging on flowering, yield and quality of mango cv. Amrapali” was undertaken to explore the potential of Naphthalene Acetic Acid (NAA) as foliar applications at the pre bloom stages and panicle bagging using perforated polythene bags to enhance fruit quality in mango.

MATERIALS AND METHODS

The present study, titled Effect of different concentration of NAA and panicle bagging on flowering, yield and quality of mango cv. Amrapali was conducted at the Horticultural Experimental Farm, NU: SAS. The experiment involved sixteen year old mango trees planted at a spacing of 5 m × 5 m. A two-factor Randomized Block Design (RBD) was employed, comprising eight treatment combinations with three replications per treatment. To evaluate the influence of different concentrations of Naphthalene Acetic Acid (NAA) on flowering, yield, and fruit quality, NAA was applied at three concentrations T_1 (40 ppm), T_2 (100 ppm), and T_3 (200 ppm) during the flower bud initiation stage in the first week of January. For the panicle bagging treatment, perforated non-woven polypropylene bags measuring 52 cm × 35 cm were used to cover the fruit at the marble stage during March.

RESULTS AND DISCUSSION

Flowering characters

Table 1 is depicted the significant influence of different NAA concentrations on flowering characteristics, such as the number of panicles per branch, flowers per panicle, and fruit set per panicle. Among the treatments, T_2 (100 ppm) emerged as the most effective in promoting the highest number of panicles per branch (22.75) and flower production per panicle recording 246.33 male and 115 female flowers in the North-East direction, and 244.58 male and 121.33 female flowers in the South-West direction. In contrast, T_1 (40 ppm) showed better results for fruit set per panicle, with 23.75 fruits in the North-East and 21.67 in the South-West direction. These findings align with those reported by [4], [5], and [6], who noted that NAA application increases flower production in mango trees. With regard to flowering response to NAA might be attributed to elevated auxin levels during

flower bud differentiation, which enhances cell division and enlargement through increased amylase activity and ATP synthesis. Additionally, NAA promotes nucleic acid activity, supporting the development of more female flowers. This is consistent with [7], who associated higher auxin levels with a greater tendency toward female flower formation.

Yield characters

Data presented in Table 2 demonstrates that yield-related traits such as the number of fruits per panicle at the marble stage, fruit drop percentage per panicle, total fruits per tree, yield per tree, and yield per hectare were significantly influenced by different concentrations of NAA and fruit bagging treatments. The combination of T₁ (40 ppm NAA) with fruit bagging produced the highest number of fruits per panicle counted at the marble stage (2.75 in the North-East and 2.83 in the South-West direction), along with the greatest number of fruits per tree 122.17 and the highest yield 21.48 kg/tree and 85.94 quintals/ha. These outcomes may be attributed to improved sunlight penetration, which enhances photosynthesis, and the suppression of abscission layer formation through the inhibition of specific enzymatic actions. These results are consistent with the observations reported by [8],[9],[10], and [11]. The interaction effect of B₁T₁ (bagging + 40 ppm NAA) was found to be significantly better than other treatment combinations. These findings are in line with earlier research by [12], [4], and [5], who also reported enhanced yield due to improved fruit retention, increased fruit size, and weight. Similar conclusions were drawn by [13], [14], [4], and [15] confirming the effectiveness of these treatments in improving yield performance.

Table 1: Effect of various level of NAA on flowering and fruiting characters of mango cv. Amrapali

Treatments	Number of panicle formed per branch		Number of male flower per panicles		Number of female flower per panicle		Number of fruit set per panicles	
	N-E	S-W	N-E	S-W	N-E	S-W	N-S	E-W
T ₀ control	7.92	10.13	86.75	84.79	69.67	87.83	12.75	10.33
T ₁ 40ppm	15.83	14.94	171.29	130.21	91.08	102.46	23.75	21.67
T ₂ 100ppm	18.08	22.75	246.33	244.58	115.00	121.33	21.92	20.42
T ₃ 200ppm	17.88	17.06	120.21	122.29	111.92	99.00	19.75	20.42
SEm(±)	1.03	0.66	11.93	5.67	5.49	7.28	1.53	0.82
CD 5%	3.11	2.01	36.18	17.20	16.67	22.08	4.64	2.49

Physical characters of fruits

Both the individual and combined effects of different NAA concentrations and fruit bagging significantly influenced the physical attributes of mango fruits, including individual fruit weight, size, volume, peel weight, pulp weight, and stone weight (Table 2). However, the interaction effect did not result in a statistically significant difference in fruit size. Among the treatments, T₃ (200 ppm NAA) yielded the best results for fruit weight (190.17 g), size (59.20 cm²), volume (185.33 ml), pulp weight (144 g), and stone weight (25 g). Similarly, bagging treatment B₁ improved physical traits, resulting in a fruit weight of 175.83 g, fruit size of 52.32 cm², volume of 173.42 ml, pulp weight of 140.75 g, and stone weight of 25.08 g.

The highest peel weight (28 g) was observed in the control treatment (T₀ and B₀no NAA and no bagging). Among the interaction treatments, B₁T₃ (bagging + 200 ppm NAA) was the most effective in enhancing nearly all physical parameters, including fruit weight (204.67 g), size (59.74 cm²), volume (220.67 ml), pulp weight (173.67 g), and stone weight (26.67 g). The greatest peel weight (34.67 g) was noted in B₀T₀, while the highest stone weight (28 g) was recorded under B₀T₂ (no bagging + 100 ppm NAA).

Bagging during fruit development was also found to reduce pest and disease incidencesuch as fruit fly, stone weevil, anthracnose, and blemishes on the fruit surface. Pre-harvest bagging altered fruit retention, harvest timing, and improved the physico-chemical properties, shelf life, and pest resistance of mature and ripened fruits, as previously reported by [16]. Using non-woven polypropylene bags for fruit bagging was found to influence fruit appearance, pericarp pigmentation, enzyme activity, sugar content, and the surrounding microenvironment. These changes contributed to significantly enhanced external fruit quality. These findings are consistent with the observations made by [17]and [18].

Table.2: Effect of various levels of NAA and bagging on fruit yield and yield attributing characters of mango cv. Amrapali

Treatments	Number of fruit retain per panicle at marble stage		Percentage of fruit drop per panicle per treatment at marble stage		Number of fruit per tree at maturity	Yield per tree (Kg)	Yield per ha (q)	Weight of individual fruit (g)	Fruit size (cm ²)	Fruit volume (ml)	Peel weight (g)	Pulp weight (g)	Stone weight (g)
NAA	N-E	S-W	N-E	S-W									
T ₀ Control	0.92	1.17	92.63	88.33	28.50	4.08	16.32	156.00	43.68	155.00	34.50	128.17	23.50
T ₁ 40ppm	2.75	2.83	88.07	86.87	122.17	21.48	85.94	166.83	50.87	162.33	26.67	124.67	24.67
T ₂ 100ppm	2.17	2.83	89.54	86.04	97.83	17.68	70.72	174.00	50.99	154.67	23.17	134.50	24.67

T ₃ 200ppm	2.67	2.42	86.23	88.26	75.33	13.79	55.17	190.17	59.20	185.33	23.17	144.00	25.00
SEm (±)	0.30	0.33	2.00	2.15	3.68	1.08	4.32	9.32	0.76	14.95	2.03	9.24	1.58
CD at 5%	0.92	1.00	6.06	6.52	11.16	3.27	13.09	28.27	2.30	45.35	6.17	28.03	4.79
Bagging													
B ₀ (No bagging)	1.63	1.88	91.61	90.58	57.0	11.31	45.27	167.67	50.06	155.25	29.08	124.92	23.83
B ₁ (Bagging)	2.63	2.75	86.64	84.17	104.9	17.20	68.81	175.83	52.32	173.42	24.67	140.75	25.08
SEm (±)	0.21												
CD at 5%	0.65	0.23	1.41	1.52	2.6	0.76	3.05	6.59	0.54	10.57	1.44	6.53	1.12
NAA X Bagging													
B ₀ T ₀ (Control)	0.50	0.33	96.10	96.49	16.00	1.38	5.51	156.67	43.01	156.33	34.67	132.33	22.33
B ₀ T ₁ (No bagging+40ppm)	2.17	2.67	90.40	88.52	87.67	18.33	73.32	163.33	48.86	160.33	28.33	121.33	21.67
B ₀ T ₂ (No bagging+100 ppm)	1.17	2.50	93.17	87.41	71.67	15.05	60.21	175.00	49.70	154.33	28.33	131.67	28.00
B ₀ T ₃ (No bagging+200ppm)	2.67	2.00	86.75	89.91	52.67	10.51	42.03	175.67	58.65	150.00	25.00	114.33	23.33
B ₁ T ₀ (bagging+control)	1.33	2.00	89.17	80.17	41.00	6.78	27.13	155.33	44.35	153.67	34.33	124.00	24.67
B ₁ T ₁ (bagging+40ppm)	3.33	3.17	85.74	85.22	156.67	24.64	98.56	170.33	52.89	164.33	25.00	128.00	27.67
B ₁ T ₂ (bagging+100ppm)	3.17	3.00	85.92	84.66	124.00	20.31	81.23	173.00	52.28	155.00	18.00	137.33	21.33
B ₁ T ₃ (bagging+100ppm)	2.67	2.83	85.72	86.61	98.00	17.08	68.31	204.67	59.74	220.67	21.33	173.67	26.67
SEm (±)	NS	NS	2.82	3.04	5.20	1.53	6.10	13.18	NS	21.14	2.87	13.07	2.23
CD at 5%	NS	NS	8.57	9.23	15.78	4.63	18.52	39.99	NS	64.13	8.7	39.65	6.77

Bio-chemical attributes of fruits

Table 3 indicates that the individual application of NAA had a significant impact on the chemical characteristics of mango fruits. Treatment T₂ (100 ppm) resulted in the highest juice content (31.65%), ascorbic acid content (33.07 mg/100g), and TSS: acid ratio (112.47), along with the lowest acidity level (0.09%). On the other hand, the highest total soluble solids (21.62°Brix), total sugars (14.43%), and non-reducing sugars (10.30%) were observed in treatment T₁ (40 ppm). The greatest reducing sugar content (5.57%) was recorded in the control treatment (T₀). Fruit bagging had no significant effect on juice content, acidity, or non-reducing sugar levels.

As for the interaction effects, the highest juice content (33.40%) was observed in treatment B₀T₃ (no bagging + 200 ppm NAA), while the highest ascorbic acid content (34.13 mg/100g) was nearly identical in both B₁T₂ and B₁T₃. The maximum TSS: acid ratio (117.73) was recorded in treatment B₁T₂. However, the interaction between NAA and bagging did not significantly affect TSS, acidity, or sugar content.

Table.3: Effect of various levels of NAA and bagging on biochemical composition of mango fruits cv. Amrapali

Treatments	Biochemical composition							
	Juice content (%)	TSS (^o B)	Titrateable Acidity (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	Ascorbic acid (mg/100g)	TSS: Acid ratio
T ₀ (control)	25.13	19.00	0.23	12.90	5.57	6.96	24.00	82.60

T ₁ (40 ppm)	31.61	21.62	0.23	14.43	3.59	10.30	32.53	94.00
T ₂ (100ppm)	31.65	21.37	0.19	12.16	3.56	8.17	33.07	112.47
T ₃ (200ppm)	29.85	21.45	0.20	13.07	3.41	9.18	32.00	107.25
SEm (±)	1.13	0.42	NS	0.97	0.30	1.02	1.55	3.321
CD at 5%	3.42	1.26	NS	2.95	0.90	3.10	4.71	11.76
Bagging								
B ₀ (No bagging)	29.99	20.42	0.24	12.23	3.95	7.87	29.33	85.08
B ₁ (Bagging)	29.13	21.30	0.23	14.05	4.12	9.43	31.47	92.60
SEm (±)	NS	0.29	NS	0.69	NS	0.72	1.10	5.42
CD at 5%	NS	0.89	NS	2.09	NS	2.19	3.33	0.828
NAA x Bagging								
B ₀ T ₀ (Control)	22.03	19.30	0.26	12.39	6.14	5.94	23.47	74.23
B ₀ T ₁ (No bagging+ 40ppm)	31.83	21.00	0.23	13.09	3.33	9.27	32.00	91.30
B ₀ T ₂ (No bagging+100ppm)	32.70	20.37	0.19	11.78	3.12	8.23	32.00	107.21
B ₀ T ₃ (No bagging+200ppm)	33.40	21.00	0.21	11.65	3.19	8.04	29.87	100.00
B ₁ T ₀ (Bagging + control)	28.23	18.70	0.21	13.40	5.00	7.98	24.53	89.04
B ₁ T ₁ (Bagging+40ppm)	31.39	22.23	0.23	15.77	3.84	11.33	33.07	96.65
B ₁ T ₂ (Bagging+100ppm)	30.59	22.37	0.19	12.53	4.00	8.10	34.13	117.73
B ₁ T ₃ (Bagging+200ppm)	26.30	21.90	0.19	14.49	3.63	10.31	34.13	115.26
SEm (±)	1.60	NS	NS	NS	NS	NS	2.19	0.04
CD at 5%	4.84	NS	NS	NS	NS	NS	6.66	0.123

CONCLUSION

Based on the results of the study, it can be concluded that treatment T₂ (100 ppm NAA) was most effective in enhancing flowering characteristics in mango plants. The combination of T₁ (40 ppm NAA) with B₁ (fruit bagging) proved superior in maximizing fruit set and overall yield. For improving the physical traits of the fruit, T₃ (200 ppm NAA) combined with B₁ (bagging) gave the best results. However, the combined effect of NAA treatments and bagging did not produce significant differences in the bio-chemical properties of mango fruits. Overall, the most effective treatment for improving flowering, yield, and fruit quality in mango was the combination of T₂ (100 ppm NAA) with B₁ (bagging).

ACKNOWLEDGMENT

This paper received no specific grant from any funding agency in the public, commercial, or non-profit sectors.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this article.

REFERENCE

- [1] Purselove, J.W.: Mangoes west of India. *Acta Horticulturae* 24, 170–174 (1972)
- [2] Singh, Z., Singh, L.: Increased fruit set and retention in mango with exogenous applications of polyamines. *Journal of Horticultural Science* 70(2), 271–277 (1995)
- [3] Sharma, R.R., Reddy, S.V.R., Jhalegar, M.J.: Preharvest fruit bagging: A review. *Journal of Horticulture Science and Biotechnology* 89(2), 101–113 (2014)
- [4] Singh, N.P., Malhi, C.S., Dillion, W.S.: Effect of plant growth regulator on the promotion of flowering in mango cv. Dashehari. *Journal of Research, Punjab Agricultural University* 41(3), 341–344 (2004)
- [5] Kundan, K., Shyamal, M.M.: Effect of anti-malformin, NAA, and urea on floral morphology, phenol and protein content of healthy and malformed panicle of mango cv. Amrapalli. *Indian Journal of Horticulture* 63, 376–378 (2006)
- [6] Sarkar, A., Ghosh, B.: Effect of different growth regulators on fruit retention and yield of mango cv. Amrapali in New Alluvial zone in West Bengal. *The Hort. Journal* 19(2), 73–75 (2006)
- [7] Rudich, J., Halvey, A.H., Kedar, N.: Ethylene evaluation for cucumber plants as related to sex expression. *Plant Physiology* 49, 998–999 (1972)
- [8] Dutta, P., Kundu, S., Ahmed, B.: Effect of plant growth regulator on fruit quality and mineral composition of ripe mango cv. Himsagar. *Indian Agriculturist* 52(3/4), 107–111 (2008)
- [9] Unrath, C.R., Obermiller, J.D., Green, A., McCartney, S.J.: The effects of AVG and NAA treatment on abscission and firmness of ‘Scarletpur Delicious’ apple at normal and delayed harvest. *Horticultural Technology* 19(3), 620–625 (2009)
- [10] Jain, M.C., Dashora, L.K.: Effect of plant growth regulator on physico-chemical characters and yield of Guava cv. Sardar under high density planting system. *The Hort. Journal* 19(1), 28–31 (2006)
- [11] Nkansah, G.O., Ofosu-Anim, J., Mawuli, A.: Gibberellic acid and naphthalene acetic acid affect fruit retention, yield, and quality of Keitt mangoes in the coastal savanna ecological zone of Ghana. *American Journal of Plant Physiology* 7, 243–251 (2013)
- [12] Sirohi, S.C., Satya, P., Rana, P., Singh, R.: Response of mango malformation to foliar application of NAA and pesticides. *Indian Journal of Horticulture* 62(1), 79–80 (2005)
- [13] Bhati, B.S., Yadav: Effect of foliar application of urea and NAA on quality of Ber (*Zizyphus mauritiana* Lamk.) cv. Gola. [Details incomplete – year and journal info needed]
- [14] Barun, N., Kumar, R.: Effect of NAA, ZnSO₄ and urea on growth and yield of litchi (*Litchi chinensis*). *Orissa Journal of Horticulture* 31, 114–118 (2003)

- [15] Wu, H., Wang, S., Shi, S., Ma, W., Zhou, Y., Zhan, R.: Effects of bagging on fruit quality in Zill mango. *Journal of Fruit Science* 5.
- [16] Haldankar, P.M., Parulekar, Y.R., Kireeti, A., Kad, M.S., Shinde, S.M., Lawande, K.E.: Studies on influence of bagging of fruits at marble stage on quality of mango cv. Alphonso. *Journal of Plant Studies* 4(2), 12 (2015)
- [17] El-Kashif, M.E., Wad Medani: Effect of pre- and post-harvest treatments on yield and fruit quality of selected banana cultivars. *Gezira Journal of Agricultural Science* 8(1), 63–75 (2010)
- [18] Shorter, A.J., Joyce, D.C., Beasley, D.R.: Effect of preharvest bagging on fruit calcium levels, and storage and ripening characteristics of ‘Sensation’ mangoes. *Australian Journal of Experimental Agriculture* 37(3), 383–389 (2011)