DOI : 10.58993/ijh/2025.82.3.12

Indian J. Hortic. 82(3), September 2025: 328-333

Effect of pollinator attractants, chemicals and growth regulators on pollination, fruit set and yield of mango cv. Kesar

Radhika J. Lunagariya[*] and D. K. Varu[**]

College of Horticulture, Junagadh Agricultural University, Junagadh 362 001, Gujarat, India

ABSTRACT

The experiment was conducted at Fruit Research Station, Lalbaugh, Junagadh Agricultural University, Gujarat in 2022-23 to 2023-24 using a Randomized Block Design with ten treatments replicated thrice. Results showed that foliar spray of sucrose @ 10% (T_3) recorded the highest number of hermaphrodite flowers per panicle (121.46) and number of fruits at grain stage (73.40). Foliar spray of NAA 25 ppm + boric acid @ 0.2% (T_9) resulted in the highest number of fruits at pea stage (17.39), fruit set per cent at pea stage (23.56%), lowest fruit drop at pea stage (76.44%), highest TSS (23.60 °Brix), reducing sugar (5.25%), non-reducing sugar (10.11%), and total sugar (15.36%).The treatment with NAA 50 ppm + micronutrient mixture Grade-IV @ 1% (T_8) recorded the highest fruit set per cent at grain stage (60.50%), number of fruits at marble stage (3.33), fruit set per cent at marble stage (93.91%), fruits per panicle (2.02), number of fruits per tree (330.96), yield (94.22 kg/tree, 9.42 t/ha), net return (₹3,01,118), BCR (1.77) and lowest fruit drop at marble stage (80.94%).

Key words: Mango, pollinator attractants, micronutrients, growth regulators, fruit set.

INTRODUCTION

Mango (*Mangifera indica* L.) is a major fruit crop in the Anacardiaceae family, with India being the largest producer. States like Uttar Pradesh, Andhra Pradesh, and Gujarat are key contributors. Mango trees are andromonoecious, producing both male and hermaphrodite flowers. Although each panicle bears 5,000–6,000 flowers, only about 0.01% mature into fruit. Flowering is sensitive to climate and often delayed by post-monsoon vegetative flushes, which reduces fruit set and yield.

Mango is predominantly insect-pollinated, with bees and flies playing vital roles. However, poor pollination, sparse flowering, flower and fruit drop, and low pollinator activity limit productivity, all worsened by climate change (Jignasa *et al.,* 4; Sanna, E. and Abd El-Migeed 14; Lunagariya *et al*., 5). Hand pollination is effective but labor-intensive. Eco-friendly bee attractants like jaggery, sugar, honey, and milk solutions improve nectar availability and pollinator visits, enhancing pollination and fruit set. Additionally, chemicals and plant growth regulators (PGRs) such as NAA, boric acid, calcium nitrate, potassium citrate, and putrescine support pollen germination, flower retention, and fruit development. Multi-micronutrient mixtures further aid physiological and reproductive processes (Lunagariya *et al.,* 5).

Despite their potential, limited region-specific studies exist in India. This study aims to evaluate the effects of pollinator attractants, chemicals, and PGRs on pollination, fruit set, and yield in mango cv. Kesar, addressing productivity challenges under changing climates.

MATERIALS AND METHODS

The present study was carried out at the Fruit Research Station, Lalbaug, Junagadh Agricultural University during 2022–23 to 2023–24 on 10-year-old uniformly grown Kesar mango trees. The experiment followed a Randomized Block Design (RBD) with ten treatments and three replications. Treatments included foliar sprays of pollinator attractants, chemicals and growth regulators applied at 50%, 75% and 100% flowering stages using a tractor-mounted sprayer. The treatments included T_1: Control, T_2: Honey solution @ 1.5%, T_3: Sucrose @ 10%, T_4: Boric acid @ 0.2%, T_5: Milk @ 5% + Jaggery @ 5%, T_6: Sucrose @ 10% + Potassium citrate @ 1%, T_7: Potassium citrate @ 2% + Putrescine @ 10 ppm, T_8: NAA 50 ppm + Micronutrient mixture Grade – IV @ 1%, T_9: NAA 25 ppm + Boric acid @ 0.2% and T_{10}: Calcium nitrate @ 0.1% + Boric acid @ 0.2%.

The observations were recorded on different traits, related to fruit set, yield, and quality attributes *viz.* number of hermaphrodite flowers, fruit at grain stage, pea stage, marble stage, fruit set (%) at grain stage, pea stage, marble stage and fruit drop (%) at pea stage, marble stage, number of nubbins per 50 fruits at pea stage to assess treatment effectiveness in Kesar mango.

*Corresponding authors' E-mail : radhikalunagariya8@gmail.com

$$\text{Fruit set (\%) at grain stage} = \frac{\text{Number of fruits at grain stage}}{\text{Total number of hermaphrodite flowers}} \times 100$$

$$\text{Fruit drop (\%) at pea stage} = \frac{\text{No. of fruits at grain stage} - \text{No. of fruits at pea stage}}{\text{No. of fruits at grain stage}} \times 100$$

At harvest, the number of fruits per panicle was recorded. Fruit length and diameter were measured using a digital caliper, while fruit weight and volume were assessed through weighing and the water displacement method. Pulp weight was obtained by removing and weighing the peel and stone separately. Peel and stone weights were also recorded. The pulp:peel and pulp:stone ratios were calculated accordingly. Additionally, the total number of fruits per tree and yield in kg per tree and tones per hectare were documented.

Five mature mango fruits were randomly selected to determine total soluble solids (TSS). Juice was extracted from the pulp and measured using a digital hand refractometer (0–85 range). Acidity of the mango pulp was estimated following AOAC guidelines, and the result was expressed as a percentage.

$$\text{Acidity (\%)} = \frac{\text{Titrate} \times \text{Normality of NaOH} \times \text{Equivalent wt. of citric acid}}{\text{Weight of sample (5 g)} \times 1000} \times 100$$

Reducing, non-reducing, and total sugars in fruit crops are commonly measured using the Lane and Eynon titration method. Reducing sugars are quantified by titrating with Fehling's solution. Total sugars are estimated after acid hydrolysis of non-reducing sugars into reducing forms. The difference between total and reducing sugar gives non-reducing sugar content. Results are expressed as a percentage of fruit pulp. Organoleptic evaluation of mango fruits was conducted by a panel of experts using a 9-point Hedonic scale, scoring appearance, taste, flavour, and colour. To determine the most effective and profitable treatment, an economic analysis was performed. Gross returns per hectare were calculated based on market prices. Cultivation costs included labour, sprays, fertilizers, weeding, irrigation, and other practices. Net profit was calculated by subtracting total costs from gross returns for each treatment.

The Benefit Cost Ratio (BCR) was calculated on the basis of the formula given below:

$$\text{BCR} = \frac{\text{Net realization (₹/ha)}}{\text{Total cost of cultivation (₹/ha)}} \times 100$$

RESULTS AND DISCUSSION

The application of various foliar treatments significantly influenced the fruit set, yield and quality parameters of Kesar mango. Notably, foliar spray of sucrose @ 10% (T_3) induced the highest number of hermaphrodite flowers per panicle (121.46) and number of fruits at grain stage (73.40).

This can be attributed to sucrose's role as a readily available source of energy and a signalling molecule that promotes floral differentiation and reproductive development, ultimately enhancing initial fruit set. Similar results were obtained by Sanna and Abd-El-Migeed (14), Jarande *et al*. (3), Patel *et al*. (11) and Meera (8) on mango, Salah *et al.* (13) on date palm, Anwarulhaq (1) on pomegranate and Lunagariya *et al.* (7).

The treatment comprising NAA 25 ppm + Boric acid @ 0.2% (T_9) emerged as a superior combination for fruit retention and quality. NAA, an auxin, plays a critical role in reducing premature fruit drop by strengthening the fruit-pedicel connection and promoting auxin-cytokinin balance, which favours fruit development. Simultaneously, boron is essential for pollen tube elongation and fertilization in strawberry (Tawseef *et al*., 16).

This synergistic effect resulted in the highest number of fruits at pea stage (17.39), fruit set per cent at pea stage (23.56%), and (Table 1) the lowest fruit drop per cent at pea stage (76.44%), along with improved sugar accumulation reducing sugar (5.25%), non-reducing sugar (10.11%), total sugar (15.36%) and TSS (23.60 °Brix), indicating enhanced metabolic activity and physiological maturity (Fig. 1). NAA stimulates fruit set, cell expansion, and sink strength, promoting efficient translocation of photosynthates. Boric acid plays a key role in sugar transport, membrane integrity, and enzymatic activities related to carbohydrate metabolism. Their synergistic effect boosts sugar biosynthesis and accumulation in fruits.

Additionally, the lowest number of nubbins 50 fruits at pea stage (6.95) in T_9 reflects improved fruit development and reduced malformed fruit incidence

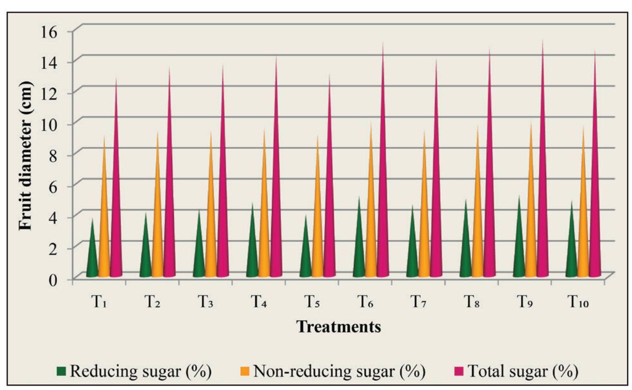

Fig. 1. Effect of pollinator attractants, chemicals and growth regulators on fruit reducing sugar, non-reducing sugar and total sugar in mango cv. Kesar.

Table 1: Effect of pollinator attractants, chemicals and growth regulators on fruit set parameters of mango cv. Kesar.

Treatment	No. of hermaphrodite flower	Number of fruit at			Fruit set (%) at			Fruit drop (%) at	
		Grain stage	Pea stage	Marble stage	Grain stage	Pea stage	Marble stage	Pea stage	Marble stage
T_1	94.20	50.17	8.54	0.96	53.19	16.87	10.95	83.13	89.05
T_2	101.17	57.86	10.25	1.26	57.15	17.61	12.13	82.39	87.87
T_3	121.46	73.40	11.77	1.49	60.28	18.83	12.45	81.17	87.55
T_4	113.47	66.13	15.53	2.58	58.26	21.70	16.47	78.30	83.53
T_5	111.20	64.49	12.61	1.63	57.96	19.48	12.63	80.52	87.37
T_6	115.94	70.23	14.79	2.33	59.23	21.56	15.55	78.44	84.45
T_7	108.30	62.22	14.17	1.99	57.42	21.36	13.69	78.64	86.31
T_8	120.66	72.88	17.00	3.33	60.50	23.11	19.06	76.89	80.94
T_9	120.84	71.07	17.39	3.16	60.06	23.56	18.62	76.44	81.38
T_{10}	120.00	71.38	15.86	2.80	59.47	21.96	17.50	78.04	82.50
S.Em. ±	4.07	1.69	0.47	0.14	0.98	0.62	0.85	1.04	1.56
C.D. at 5%	11.63	4.86	1.36	0.40	2.82	1.74	2.72	2.95	4.45
C.V. %	9.41	6.86	11.39	14.16	4.23	8.37	10.66	3.07	4.31

Table 2: Effect of pollinator attractants, chemicals and growth regulators on morphological parameters of mango cv. Kesar.

Treatment	Number of nubbins per 50 fruits at pea stage	Number of fruits per panicle	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit volume (ml)	Pulp weight (g)	Peel weight (g)
T_1	13.75	0.74	9.67	6.13	218.11	208.95	121.47	52.90
T_2	13.08	0.85	9.91	6.21	222.35	214.00	128.70	50.44
T_3	12.68	1.01	10.13	6.24	233.11	225.44	141.78	49.33
T_4	9.85	1.80	10.88	6.65	257.75	249.72	172.01	48.01
T_5	11.95	1.18	10.35	6.38	245.76	236.28	154.23	49.11
T_6	11.62	1.68	11.10	6.77	251.72	242.33	163.65	48.43
T_7	10.86	1.45	10.60	6.50	263.65	255.22	178.37	47.14
T_8	8.12	2.02	11.76	7.17	278.94	272.11	197.75	44.12
T_9	6.95	1.94	11.58	7.10	276.05	268.73	194.38	44.63
T_{10}	8.89	1.88	11.34	6.92	269.67	261.03	187.65	45.29
S.Em. ±	0.549	0.076	0.312	0.151	5.339	7.892	4.880	1.348
C.D. at 5%	1.55	0.19	0.90	0.43	15.31	22.64	14.00	3.87
C.V. %	10.03	18.52	7.73	5.99	5.82	8.94	9.15	6.49

(Table 2). The similar kind of result was also obtained by Varu *et al.* (19) on mango.

Furthermore, calcium nitrate @ 0.1% + boric acid @ 0.2% (T_{10}) significantly enhanced organoleptic properties. Calcium strengthens cell walls, while boron improves nutrient mobility, contributing to better fruit texture, appearance, and flavour, thus receiving the highest sensory scores. Similar findings were also observed by Mirdehghan *et al*. (9) on grape and Yadav *et al*. (20) on papaya.

NAA 50 ppm + Micronutrient mixture Grade-IV @ 1% (T_8) demonstrated its efficacy in maximizing fruit set at both grain (60.50%) and marble (93.91%) stages, fruit growth parameters *viz*., length (11.76 cm), diameter (7.15 cm), fruit weight (278.94 g), volume (272.11 ml), pulp weight (197.75 g), pulp-to-

Table 3: Effect of pollinator attractants, chemicals and growth regulators on fruit yield and quality parameters mango cv. Kesar.

Treatment	Stone weight (g)	Pulp to peel ratio	Pulp to stone ratio	Number of fruit per tree	Fruit yield		TSS (°Brix)	Acidity (%)
					(kg/tre)	(t/ha)		
T_1	43.75	2.30	2.78	169.12	39.33	3.93	16.78	0.261
T_2	43.21	2.55	2.98	217.43	50.50	5.05	18.10	0.245
T_3	42.01	2.87	3.38	198.92	48.26	4.83	18.64	0.235
T_4	37.74	3.58	4.56	257.84	68.16	6.82	20.57	0.219
T_5	42.43	3.14	3.64	220.59	57.49	5.75	19.10	0.230
T_6	39.65	3.38	4.13	268.73	69.54	6.95	20.07	0.223
T_7	38.15	3.78	4.68	252.85	69.24	6.92	19.91	0.229
T_8	37.08	4.48	5.33	330.96	94.22	9.42	22.00	0.213
T_9	37.04	4.36	5.25	294.86	83.37	8.34	23.60	0.203
T_{10}	36.74	4.14	5.11	289.03	79.24	7.92	21.02	0.213
S.Em. ±	0.846	0.076	0.127	17.362	2.869	0.297	0.445	0.005
C.D. at 5%	2.43	0.22	0.34	55.54	8.23	0.82	1.27	0.014
C.V. %	4.82	7.20	9.41	10.19	15.27	15.27	6.10	4.935

peel (4.48), spulp-to-stone ratio (5.32), number of fruits per tree (330.96) and yield (94.22 kg/tree; 9.42 t/ha) and lowest fruit drop at marble stage (80.94%), peel weight (44.12 g), stone weight (36.74 g), acidity (0.203%) (Table 3).

This might be due to micronutrients support enzyme activity and cell division during early fruit growth, while NAA reduces fruit drop by promoting cell elongation and translocation of photosynthates. Their combined application enhances nutrient uptake, fruit size, and weight, leading to improved fruit development. This synergistic effect significantly increases yield per tree by boosting both fruit count and individual fruit weight. Similar results were also found by Varu *et al.* (18) on custard apple, Varu *et al.* (19) and Naleo *et al.* (10) on mango, Sawale *et al*. (15), Deshlehra *et al*. (2), Rajamanickam *et al*. (12) on acid lime and Tripathi and Viveka (17) on aonla and Lunagariya *et al.* (7). This treatment also provided the highest net return (₹3,01,118) and BCR (1.77) (Fig. 3). This might be due to mango trees treated with sprays showed more fruit set, and higher yield compared to untreated trees, despite identical genetics. This indicates genetic potential alone is insufficient without external support. Timely treatments stimulated flowering, increased fruit number, size, and early harvest, resulting in higher productivity, profitability and greater gross and net economic returns.

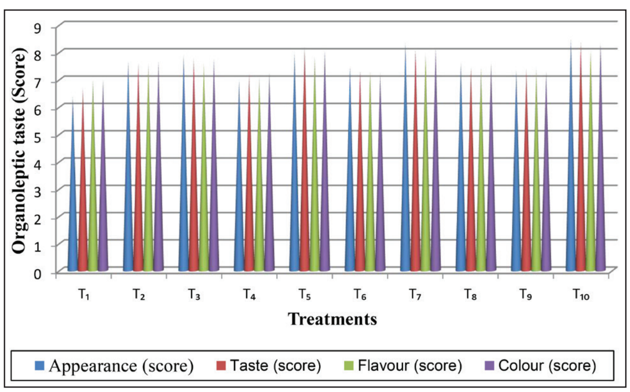

Fig. 2. Effect of pollinator attractants, chemicals and growth regulators on organoleptic taste in mango cv. Kesar.

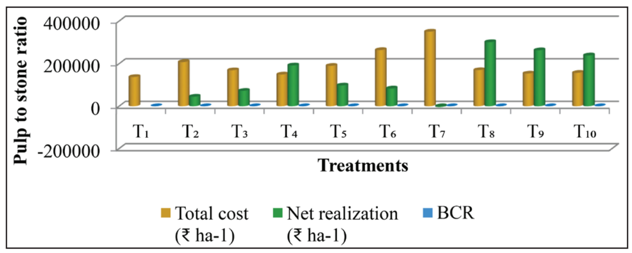

Fig. 3. Effect of pollinator attractants, chemicals and growth regulators on economic in mango cv. Kesar.

Based on the results of the two-year experiment, it can be concluded that foliar application of NAA at 50 ppm combined with a 1% micronutrient mixture (Grade IV) applied at 50%, 75%, and 100% flowering stages significantly enhances fruit set, yield, and quality attributes, including organoleptic characteristics such as taste, flavor, and appearance (Fig. 2). Moreover, this treatment not only improves production efficiency but also ensures a higher net economic return, making it a highly effective and practical strategy for sustainable mango cultivation.

AUTHORS' CONTRIBUTION

Conducted experiments, collected and analyzed data, and prepared the manuscript draft (RJL); Guidance, supervision, critical review and final approval of the manuscript (DKV).

DECLARATION

The authors declare that they do not have any conflict of interest.

ACKNOWLEDGEMENTS

I humbly acknowledge the exceptional guidance of my major guide, full co-operation given by the Head and entire staff, Department of Fruit Science for providing field and other inputs necessary for research problem as well as Department of Agricultural Statistics to analyse the data.

REFERENCES

1. Anwarulhaq, Varu, D. K., Mohammad Ismail Sadat and TayebullahZahid, K. 2021. Effect of foliar spray of multi micronutrient grade IV and different fruit covering bags on yield and different quality of pomegranate cv. Bhagwa. *Int. J. Agric. Sci.* **11**(2): 69-76.

2. Deshlehra, R., Pyasi, R. and Singh, K. V. 2022. Impact of growth regulators and micronutrients on growth, yield and quality of acid lime (*Citrus aurantifolia* Swingle) under HDP system. *J. Pharm. Innov.* **11**(2): 362-366.

3. Jarande, S. D., Patel, B. N., Patel, B. B., Patel, N. R. and Dhuda, H. D. 2013. Effect of sucrose and nutrient elements on fruit set and fruit yield of mango cv. Kesar. *Sci. Hortic.,* **46**(3): 142-145.

4. Jignasa H. Rajatiya, D. K. Varu, Farheen H. Halepotara and Meera B. Solanki 2018. Correlation of climatic parameters with flowering characters of mango. *Int. J. Pure App. Biosci.*, **6**(3): 597-601.

5. Lunagariya, R. J., Bambhaniya, U., Zankat, S. B., Patel, R., Ganvit, D. M., Parmar, V. M., Chitroda, R. L., Kanzaria, D. R., Thhumar, K. P. 2023. Causes and remedies of fruit drop major fruit crop. *Int. J. Appl. Res.,* **10**(6): 27-29.

6. Lunagariya, R. J., Bhuva, S. K., Thanki, D. V. and Gohil, V. M. 2024. Physiological perspective of plant growth regulators in fruit crops. *Agric & Food:e-Newsl,* **6**(4): 7-10.

7. Lunagariya, R. J., Gohil, V. M. and Thanki, D. V. 2024. Pollinator incentives and plant attractants: their significance to increase fruit quality. *Agric & Food:e-Newsl,* **6**(4): 284-287.

8. Meera, B. Solanki, Varu, D. K., Mishra, S., Gohel, B. and Parsana, J. S. 2021. Effect of Chemicals and Agro-techniques on growth and flowering of mango cv. Kesar. *J. Pharm. Innov.* **10**(9): 1212-1217.

9. Mirdehghan, S. H., Rahimi, S. and Esmaeilizadeh, M. 2013b. Improving the postharvest characteristics of table grape by pre harvest application of polyamines. *Acta Hortic.* **10**(12): 293-298.

10. Naleo, S., Akali, S. and Maiti, C. S. 2016. Effect of plant growth regulators and packaging on flowering, fruit quality and shelf life in mango cv. Amrapali. *J. Appl. Sci. Res.* **20**(6): 1-8.

11. Patel, Urvish, D. K. Varu and Jamsu Chaudhary. 2015. Effect of pre-harvest spray of chemicals on shelf life and quality of mango cv. Kesar. *Asian J. Hort.* **10**(2): 187-193.

12. Rajamanickam, C., Muralidharan, B. and Mahadevan, A. 2022. Studies on the effect of micronutrients in acid lime (*Citrus aurantifolia* Swingle) cv. PKM-1. *Madras Agric. J.* **109**(9): 1-11.

13. Salah, A.M., Abd-Elhaleem, F.M., Abd El-Latif, H.E.M., El-Badawy, S.F., El-Gioushy and AbdAlla, B.M. 2019. Fruit set, productivity and fruit quality of Barahi date palm as influenced by foliar application with sugar and boron under coverage and non-coverage conditions. *Middle East J. Agric. Res.* **8**(4): 2077-4605.

14. Sanna, E. and Abd El-Migeed, M. M. M. 2005. Effect of spraying sucrose and some nutrient elements on Fagri Kalan mango trees. *J. Appl. Sci. Res.* **1**(5): 341-346.

15. Sawale, P. V., Patil, M. B., Tummod, A. R. and Pavhane, S. B. 2021. Effect of nutrients on growth & physical attributes of acid lime (*Citrus aurantifolia* L.) cv. Sai Sharbati. *J. Pharm. Innov.* **10**(11): 2063-6.

16. Tawseef, R. B., Angrej, A., Amit, K. and Mohit, H. 2017. Effect of exogenous application of

chemicals, salicylic acid and triacontanol on growth characters and yield of strawberry. *J. Pharm. Innov.* **6**(11): 274-79.

17. Tripathi, V. K. and Viveka, N. 2022. Effect of foliar application of boron, zinc and NAA on fruit retention, yield and quality attributes of aonla. *Progres. Hortic.* **54**(1): 76-81.

18. Varu, D. K., Barad, A. V. 2011. Growth, flowering and yield variability in custard apple selections. *Ann. Arid Zone.* **50**(1): 81-83.

19. Varu, D. K., Patel, K. D., Viradia, R. R. 2012. Post harvest treatments for enhancement of ripening in Kesar mango. *Int. J. Proc. & Post Harvest Technol.* **3**(1): 6-10.

20. Yadav, Lokesh, Varu, D. K., Ghadage, N. J. and Kore, P. N. 2014. Standardization of pre and post harvest treatment for biochemical parameters and sensory evaluation in papaya (*Carica papaya* L.) cv. Madhubindu. *Trend. Biosci.* **7**(24): 4362-4368.

(Received : May, 2025; Revised : September, 2025; Accepted : September, 2025)