



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(11): 724-728
Received: 28-09-2025
Accepted: 30-10-2025

Shiv Kumar Ahirwar
Ph.D. Research Scholar,
Department of Horticulture (Fruit
Science), College of Agriculture,
JNKVV, Jabalpur, Madhya
Pradesh, India

DP Sharma
Department of Horticulture,
Jawaharlal Nehru Krishi Vishwa
Vidyalaya (JNKVV), Jabalpur,
Madhya Pradesh, India

SK Pandey
Department of Horticulture,
Jawaharlal Nehru Krishi Vishwa
Vidyalaya (JNKVV), Jabalpur,
Madhya Pradesh, India

Gyanendra Tiwari
Head of Department of Plant
Physiology, Jawaharlal Nehru
Krishi Vishwa Vidyalaya
(JNKVV), Jabalpur, Madhya
Pradesh, India

Rajnee Sharma
Assistant Professor, Department of
Horticulture, Jawaharlal Nehru
Krishi Vishwa Vidyalaya
(JNKVV), Jabalpur, Madhya
Pradesh, India

Corresponding Author:
Shiv Kumar Ahirwar
Ph.D. Research Scholar,
Department of Horticulture (Fruit
Science), College of Agriculture,
JNKVV, Jabalpur, Madhya
Pradesh, India

Influence of foliar-applied urea, zinc sulphate and PGPR on phenology and initial fruit development in mango (*Mangifera indica* L.) cv. Langra

Shiv Kumar Ahirwar, DP Sharma, SK Pandey, Gyanendra Tiwari and Rajnee Sharma

DOI: <https://www.doi.org/10.33545/2618060X.2025.v8.i11j.4288>

Abstract

The productivity of the mango (*Mangifera indica* L.), an economically significant fruit crop, is profoundly influenced by the timing of early fruit development and flowering phenology. The aim of this study was to evaluate the impact of foliar application of urea, zinc sulfate, and PGPR on the phenological traits of the mango cultivar Langra. In a Factorial Randomized Block Design (FRBD) experiment, 27 treatment combinations were established, incorporating three doses of zinc sulphate (0%, 0.5%, 1.0%), urea (0%, 2%, 4%), and Plant Growth Promoting Rhizobacteria (0%, 0.5%, 1%). There were two applications of foliar sprays: one at the start of the floral bud and the other when 50% of the flowers had opened. Days to 50% panicle emergence, 50% flowering, first fruit set, and first panicle emergence were all recorded. The combined foliar application of nutrients and PGPR had a positive effect on all phenological parameters, even though the results were not statistically significant. The treatment T₂₇ (4% urea + 1% ZnSO₄ + 1% PGPR) had the earliest panicle emergence (24.5 days), 50% emergence (6.0 days), 50% flowering (11.0 days), and the earliest first fruit set (45.0 days). These improvements may be due to better nutrient absorption, hormonal control, and increased assimilate translocation that come with integrated nutrition management. The study's results show that when applied to mango cv. Langra, urea, zinc sulfate, and PGPR may help fruit grow faster, make flowers bloom at the same time, and speed up reproductive phenology. Using this integrated foliar feeding method, commercial mango orchards could make a lot more fruit.

Keywords: Mango, phenology, panicle emergence, foliar nutrients, PGPR, zinc sulphate, urea

1. Introduction

The mango (*Mangifera indica* L.) is one of the most important tropical and subtropical fruit crops in the world. It is both a high-value commercial product and a staple fruit. This fruit is grown in over 100 countries and is one of the most important fruit crops in the world in terms of area and output. India is the world's largest producer of mangoes, growing about 20-21 million tonnes each year on about 2.3 million hectares of land. This accounts for almost half of the world's mango production (National Horticulture Board, n.d.). Average production is still low, and often below what is possible, even though this area and volume are so large (Ahmad *et al.*, 2018)^[2]. This is mostly because the trees aren't getting enough nutrients, they don't produce fruit consistently, and they lose a lot of flowers and fruit. Mangos are a "functional" fruit because they are good for you and are also good for business. Mango pulp is full of carbohydrates, dietary fiber, provitamin A carotenoids, vitamin C, vitamin E, several B vitamins, and minerals like potassium and copper. It also has a lot of bioactive phytochemicals that help it fight free radicals and have other health benefits, such as carotenoids, flavonoids, and phenolic compounds (Maldonado-Celis *et al.*, 2019; Lebaka *et al.*, 2021)^[10, 9]. Maldonado-Celis *et al.* (2019)^[10] assert that regular consumption of mangoes is linked to improved antioxidant levels and potential defense against chronic diseases. The economically important "Langra" variety is grown in the Indo-Gangetic plains and central India. It is known for its rich flavor, good pulp recovery, fiberless meat, and potential for export (Geographical Indications Registry, 2022)^[5]. But cv. Langra, like many other traditional mango varieties, has a wide range of flowering, fruit

set, and fruit retention. These traits are closely linked to the physiological condition of the canopy and the nutrition of the orchard (Geographical Indications Registry, 2022) ^[5]. Early fruit set, panicle emergence, and flowering phenology are the main factors that affect mango production. Timely panicle emergence, 50% flowering, and first fruit set are important because they affect pollination efficiency, stress exposure, and fruit retention (Deb & Reza, 2024) ^[4]. Previous studies indicate that foliar applications of plant growth regulators and micronutrients significantly improve panicle development, yield, floral quality, and fruit retention (Tsomu & Patel, 2019a; Deb & Reza, 2024) ^[19, 4]. The synergistic effects of integrated foliar nutrition employing macronutrients, micronutrients, and bioinoculants on these phenological parameters remain inadequately investigated Abdel-Sattar *et al.* (2024) ^[1].

Nitrogen is needed for protein synthesis, flower development, chlorophyll production, and vegetative growth. Urea is a common source of nitrogen (Chourasia 2021) ^[3]. Ahmad *et al.* (2018) ^[2] say that having enough nitrogen during floral initiation helps panicles grow and gives flowers and fruits the nutrients they need to grow. Numerous studies (Ahmad *et al.*, 2018; Kumar *et al.*, 2023) ^[2, 7] indicate that foliar nitrogen enhances fruit drop and facilitates fruit retention. Micronutrients, especially zinc, are important for auxin biosynthesis, enzyme activation, glucose metabolism, and pollen viability. A lack of zinc is common in calcareous soils used for growing mangoes (Ahmad *et al.*, 2018; Deb & Reza, 2024) ^[2, 4]. Foliar spraying of zinc sulfate (ZnSO₄) has been shown to improve the quality of mango flowers, the number of fruits that set, the number of fruits that stay on the tree, and the overall yield (Deb & Reza, 2024; Negi *et al.*, 2009) ^[4, 14]. Plant Growth Promoting Rhizobacteria (PGPR) are beneficial microorganisms that are known to enhance nitrogen fixation, stress tolerance, phytohormone synthesis, and nutrient utilization efficiency (Vejan *et al.*, 2016; Mohanty *et al.*, 2021) ^[21, 11]. They improve flowering, fruit set, and production, especially when used with plant growth regulators or micronutrients applied to the skin (Mohanty *et al.*, 2021; Kumar *et al.*, 2025) ^[11, 7]. A recent study on the Amrapali cultivar found that foliar treatment with PGPR, ZnSO₄, and growth regulators greatly increased the initial fruit set, improved flowering, and sped up the emergence of 50% of the panicles (Kumar *et al.*, 2025) ^[7]. Despite these advancements, there is limited research on the combined foliar application of urea, ZnSO₄, and PGPR, especially in the mango cultivar Langra, and its effects on essential phenological phases such as the days to first panicle appearance, days to 50% flowering, and first fruit set.

2. Materials and Methods

2.1 Experimental Site

The present study was conducted at the Fruit Research Station, Imalia, Department of Horticulture, Jawaharlal Nehru Krishi Vishwavidyalaya (JNKVV), Jabalpur, Madhya Pradesh. At the Department of Food Science and Technology lab at JNKVV in Jabalpur, fruit samples were chemically tested. The experimental site is in the Kymore Plateau and Satpura Hills agroclimatic zone, which has a subtropical climate with hot summers, moderate monsoon rains, and cold winters. The soil is mostly clay loam, which means it has medium fertility and is a little bit calcareous.

2.2 Plant Material

The study used 45-year-old, uniform, healthy mango trees of the

"Langra" cultivar. There was a distance of 12 meters between them. According to the guidelines given by JNKVV, the trees were kept up with regular gardening tasks like watering, trimming, cleaning the basin, and controlling pests and diseases. There were no extra nutritional sprays used during the trial period, other than the ones that were supposed to be used.

2.3 Experimental Design

The experiment was set up using a Factorial Randomized Block Design (FRBD) with three parts. There were twenty-seven treatment combinations, and the experiment was done twice. There were fifty-four trees in all, and each treatment was given to two trees. The factorial arrangement facilitated the assessment of the individual and synergistic effects of macronutrient, micronutrient, and biofertilizer treatments on phenological and early fruit development traits.

2.4 Treatment Details

The study examined three treatment variables. There were three amounts of urea (0%, 2%, and 4%) used on the skin as part of Factor A. The micronutrient zinc sulfate (ZnSO₄) was present in amounts of 0%, 0.5%, and 1.0%. As part of factor C, plant growth-promoting rhizobacteria (PGPR) were put on the skin at 0%, 0.5%, and 1.0%. These combinations made twenty-seven factorial treatment interactions (3 × 3 × 3). Before spraying, the right amounts of urea, zinc sulfate, and PGPR were carefully measured and mixed with water.

2.5 Mode of Application

We used a foot sprayer to spray the leaves by hand. We chose a regular spray volume of 15 liters per tree based on how big and even the trees' canopies were. Each treatment was evenly sprayed over the tree canopy, making sure that all of the leaves, branches, and flowers were covered. Spraying was done early in the morning to stop evaporation from the sun and make absorption better.

2.6 Time of Application

The foliar sprays were given twice during the reproductive growth phase. The first treatment was given at the floral bud initiation stage, and the second treatment was given at the 50% blooming stage. Both treatment dates were chosen so that nutrients would be available when the plants were blooming and when the fruit was just starting to grow.

2.7 Observations Recorded

To keep track of phenological observations, certain panicles on each tree were tagged and checked on a regular basis. We found out how many days each phenological event took by writing down the dates of the start of the panicle, the flowering, and the first fruit set. Days to first panicle emergence, days to 50% panicle emergence, days to 50% flowering, and days to first fruit set were all used to measure the criteria.

2.8 Statistical Analysis

The Factorial Randomized Block Design (FRBD) model was employed to conduct a statistical analysis of the data collected for the study. We used analysis of variance (ANOVA) to figure out how important the treatment effects were. The Critical Difference (CD) at a 5% probability level was used to compare the means of the treatments. The statistical analysis was done with standard statistical software that is recommended for agricultural research.

3. Results

3.1 Days Before the First Panicle Shows Up

The days to the first panicle emergence, which ranged from 24.5 to 27.0 days, showed that there was very little difference between treatments. T₂₇ (A2B2C2: 4% Urea + 1% ZnSO₄ + 1% PGPR) had the fastest panicle emergence (24.5 days), followed by T₂₁, T₂₄, T₂₃, T₁₉, and T₁₃ (25.0 days). In T₇, where only urea was used, the delayed emergence (27.0 days) was seen. Even though this trend isn't statistically significant, it does show that giving nitrogen, zinc, and PGPR together helped flowers start to bloom earlier. This is probably because it made better use of nutrients, increased the production of chlorophyll, and got the balance of floral hormones going. Quick access to zinc and nitrogen speeds up the transition to reproduction, the emergence of panicles, and the differentiation of floral buds. Integrated foliar nutrition speeds up panicle initiation by making auxin and glucose work better together. Mohanty *et al.* (2021) ^[11] and Kumar *et al.* (2025) ^[7] have also shown that PGPR can help flowers bloom by changing hormones and improving the way plants work.

3.2 Days for 50% Panicle Emergence

It took 6.0 to 10.0 days for 50% of the panicles to show up. The treatments that were not controlled (T₁, T₄, and T₇) lasted the longest (10 days), while T₂₇ lasted the shortest (6.0 days), and T₁₇, T₁₈, and T₂₆ lasted the same amount of time (6.5 days). This indicates that elevated combinations of urea, ZnSO₄, and PGPR expedited and synchronized panicle emergence. These findings align with those of Stino *et al.* (2011) ^[18], who demonstrated that balanced nutrient feeding improves panicle emergence uniformity by enhancing shoot physiological preparedness and nutrient remobilization. Singh and Banik (2011) ^[16] also saw that integrated nutrition management techniques led to fewer days until panicle emergence. Vejan *et al.* (2016) ^[21] say that PGPR treatment can also increase the production of phytohormones, which in turn helps buds grow and panicles appear.

3.3 Days to 50% Blooming

It took between 11 and 15 days for 50% of the flowers to bloom. T₂₇ had the earliest 50% bloom (11.0 days), followed by T₁₇, T₁₈, and T₂₆ (11.5 days). On the other hand, T₁, T₄, and T₇ had delayed blooming (15.0 days). PGPR and the combined foliar application of macro- and micronutrients increased blooming earliness, perhaps by boosting pollen viability, triggering an earlier floral transition, and increasing hormonal activity. Ahmad *et al.* (2018) ^[2] corroborated these findings, indicating that zinc enhances pollen fertility, hormone synthesis, and enzyme activation, thereby augmenting floral activity. Reports say that nitrogen helps floral meristems take in nutrients and grow. Mohanty *et al.* (2021) ^[11] confirmed the importance of PGPR in enhancing flowering through the production of gibberellin and cytokinin.

3.4 Days to initial Fruit Set

The time between the first fruit set was between 45.0 and 48.0 days. T₂₇ and T₂₅ had the earliest fruit set (45.0 days), and T₁₃, T₁₅, T₂₃, and T₂₆ had the next earliest (45.5 days). The longest time (48.0 days) was seen in T₁ and T₄. This means that higher levels of urea, ZnSO₄, and PGPR made the time between flowering and fruit set shorter, which made reproduction more efficient. Zinc improves fruit retention, pollen tube growth, stigmatic receptivity, and the efficiency of fertilization. Auxin and gibberellins produced by PGPR have been shown to

increase fruit set, lower drop, and encourage early retention (Vejan *et al.*, 2016; Tsomu & Patel, 2019b) ^[21, 20]. Reza (2024) says that nitrogen helps fruit grow by making hormonal signalling and carbohydrate movement better.

4. Discussion

The number of days until the first panicle emergence, the number of days until the panicles emergence 50% of the time, the number of days until 50% of the flowers bloom, and the number of days until the initial fruit set are all important signs of fruit output and reproductive efficiency. The current research showed that combining foliar nutrition with urea, zinc sulfate, and PGPR improved phenological responses by making panicles appear faster, flowers bloom at the same time, and fruits grow earlier, even if the changes were not statistically significant. Treatment T₂₇ (A2B2C2), which gave 4% urea, 1% ZnSO₄, and 1% PGPR, always had the best effect on all the measures. Nitrogen is necessary for vegetative growth and flowering because it encourages the production of chlorophyll, cell division, protein synthesis, and general tree health. Urea has been shown in several experiments to improve floral induction by speeding up the maturity of shoots, the nutritional status of leaves, and the accumulation of carbohydrates. All of these things are important for panicle differentiation. When you treat mango flowers with nitrogen, it helps them grow buds, develop panicles, and switch from vegetative to reproductive growth. Zinc sulfate was another important factor that affected when flowers bloomed and how early they did. Zinc is closely linked to auxin production, enzyme activation, meristematic activity, pollen viability, and stigma receptivity. Prior studies demonstrated that zinc supplementation resulted in improved panicle emergence, an increased proportion of hermaphrodite flowers, and an accelerated progression towards 50% blooming, thereby providing substantial evidence for the collaborative role of nitrogen and zinc in enhancing reproductive timing. These findings align with the research conducted by Ahmad *et al.* and Deb & Reza, which indicated that ZnSO₄ facilitated fruit set, enhanced flowering intensity, and improved panicle differentiation. The fact that treatments with PGPR (especially T₂₇, T₂₆, and T₂₅) always had lower values for all phenological variables showed how important PGPR is for improving phenological behavior. PGPR boosts flowering and fruit set by doing a number of things, such as biological nitrogen fixation, micronutrient solubilization, phytohormone production (auxins, gibberellins, and cytokinins), and controlling ethylene levels through ACC deaminase activity. These processes encourage better pollination, more fruit retention, and an early transition to flowering. PGPR accelerates fruit set, diminishes fruit loss, and improves flowering synchronization in mango and other fruit crops, as noted by several authors, including Mohanty *et al.*, Vejan *et al.*, and Kumar *et al.* The combination nutrient treatment (urea + ZnSO₄ + PGPR) appears to have had a synergistic effect by enhancing nutrient absorption efficiency, photosynthetic activity, hormonal regulation, and the translocation of metabolites to reproductive organs (Kavyashree *et al.*, 2025) ^[6]. This is why the integrated treatment (T₂₇) changed all phenological events in the same way, including the earliest panicle emergence, the synchronized 50% panicle emergence, the quicker flowering, and the early fruit set. These results align with the findings of Stino *et al.*, who demonstrated that enhancing tree physiological condition through integrated nutrition management increases fruiting potential, floral uniformity, and reproductive timing. This study corroborates prior research that emphasized the significance of balanced

nutrient application and biological inoculants in improving flowering and fruit set dynamics Pokharel, *et al.* 2023) ^[15]. In general, it shows that using nitrogen, zinc, and PGPR together on the leaves of mango cv. Langra has a positive effect on its reproductive phenology Kundu, *et al.* 2021) ^[8]. The constant numerical trends and biological validation clearly show that combining nutrition and PGPR works to improve mango reproductive performance, even though the changes were not statistically significant.

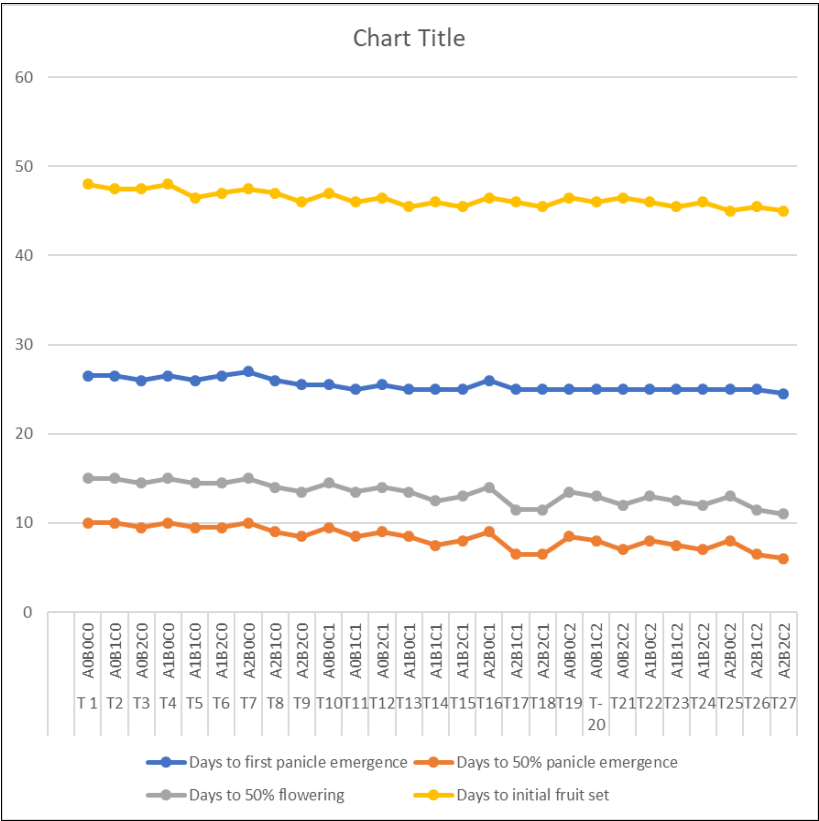


Table 1: Influence of Foliar-Applied Urea, Zinc Sulphate and PGPR on Phenology and Initial Fruit Development in Mango (*Mangifera indica* L.) cv. Langra. 2020-21

Treatments	Symbol	Days to first panicle emergence	Days to 50% panicle emergence	Days to 50% flowering	Days to initial fruit set
T 1	A0B0C0	26.5	10	15	48
T ₂	A0B1C0	26.5	10	15	47.5
T ₃	A0B2C0	26	9.5	14.5	47.5
T ₄	A1B0C0	26.5	10	15	48
T ₅	A1B1C0	26	9.5	14.5	46.5
T ₆	A1B2C0	26.5	9.5	14.5	47
T ₇	A2B0C0	27	10	15	47.5
T ₈	A2B1C0	26	9	14	47
T ₉	A2B2C0	25.5	8.5	13.5	46
T ₁₀	A0B0C1	25.5	9.5	14.5	47
T ₁₁	A0B1C1	25	8.5	13.5	46
T ₁₂	A0B2C1	25.5	9	14	46.5
T ₁₃	A1B0C1	25	8.5	13.5	45.5
T ₁₄	A1B1C1	25	7.5	12.5	46
T ₁₅	A1B2C1	25	8	13	45.5
T ₁₆	A2B0C1	26	9	14	46.5
T ₁₇	A2B1C1	25	6.5	11.5	46
T ₁₈	A2B2C1	25	6.5	11.5	45.5
T ₁₉	A0B0C2	25	8.5	13.5	46.5
T ₂₀	A0B1C2	25	8	13	46
T ₂₁	A0B2C2	25	7	12	46.5
T ₂₂	A1B0C2	25	8	13	46
T ₂₃	A1B1C2	25	7.5	12.5	45.5
T ₂₄	A1B2C2	25	7	12	46
T ₂₅	A2B0C2	25	8	13	45
T ₂₆	A2B1C2	25	6.5	11.5	45.5
T ₂₇	A2B2C2	24.5	6	11	45
SE(m)±		0.362	0.34	0.34	0.33
CD 5%		NS	NS	NS	NS

5. Conclusion

The present investigation clearly demonstrated that the integrated foliar application of urea, zinc sulfate, and PGPR positively influenced the phenological behavior of mango cv. Langra. The combined use of macronutrient (urea), micronutrient (ZnSO₄), and biofertilizer (PGPR) consistently led to early panicle emergence, synchronized flowering, and faster initial fruit set, even though the differences between treatments were not statistically significant. The treatment T₂₇ (4% urea + 1% ZnSO₄ + 1% PGPR) was the most effective at promoting reproductive phenology. It took the least amount of time for the first fruit set (45.0 days), 50% flowering (11.0 days), 50% panicle emergence (6.0 days), and first panicle emergence (24.5 days). The enhancement in early flowering and fruit set may be attributed to heightened physiological activity under integrated nutrition management, increased hormonal regulation (including auxins, cytokinins, and gibberellins), and improved nutrient absorption efficiency. PGPR improved nutrient use even more by making root metabolism, biological nitrogen fixation, and phytohormone synthesis work harder. The study shows that using nitrogen, zinc, and PGPR together on the leaves can help improve mango reproductive phenology, flower synchronization, and early fruit development. All of these things could eventually lead to better fruit retention and production potential. This all-encompassing foliar nutrition method might be a good way to boost yields in commercial mango orchards, especially in soils that don't have a lot of nutrients.

References

1. Abdel-Sattar M, Alhaithloul H, El-Banna MF, Ali HM, Al-Dosari M. Conventional and nano-zinc foliar applications improve fruit quality, nutrient uptake, and productivity of mango trees. *Horticulturae*. 2024;10(10):1096. <https://doi.org/10.3390/horticulturae10101096>
2. Ahmad I, Bibi F, Ullah H, Munir TM. Mango fruit yield and critical quality parameters respond to foliar and soil applications of zinc and boron. *Plants*. 2018;7(4):97. <https://doi.org/10.3390/plants7040097>
3. Chourasia BKM. Effect of foliar application of nitrogen and plant growth regulators on mango (*Mangifera indica*). GKV Society; 2021.
4. Deb P, Reza S. Effect of pre-flowering sprays of micronutrients on flowering, fruit set, fruit drop and yield of mango cv. Amrapali. *Crop Res*. 2024;59:21-30.
5. Geographical Indications Registry. Banaras Langra Aam (Mango): GI Journal No. 166. Government of India; 2022.
6. Kavyashree P, Nataraja KH, Yallesh Kumar HS, Karadiguddi M, Sachinkumar TN, Sabarad AI, *et al.* Impact of various nutrient substances through foliar spray on growth and reproductive attributes in mango (*Mangifera indica* L.) cv. Mallika. *Plant Arch*. 2025;25(Suppl 1):1759-1764. <https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-1.241>
7. Kumar R, Sharma R, Sharma TR, Pandey SK, Pandey CS, Singh D, *et al.* Influence of foliar application of NAA, urea, nano-urea and Biofertilis on fruit drop and retention of mango (*Mangifera indica* L.) cv. Langra. *Pharma Innov J*. 2023;12(11):308-312.
8. Kundu AK, Tarai RK, Nayak A, Senapati B. Influence of plant growth regulators on fruit drop, fruit retention and fruit yield of mango (*Mangifera indica* L.) cv. Amrapali under West Central Table Land zone of Odisha. *Plant Sci Today*. 2021;8(4):881-886. <https://doi.org/10.14719/pst.1243>
9. Lebaka VR, Wee YJ, Ye W, Korivi M. Nutritional composition and bioactive compounds in three different parts of mango fruit. *Int J Environ Res Public Health*. 2021;18(2):741.
10. Maldonado-Celis ME, Yahia EM, Bedoya R, *et al.* Chemical composition of mango (*Mangifera indica* L.) fruit: Nutritional and phytochemical compounds. *Front Plant Sci*. 2019;10:1073. <https://doi.org/10.3389/fpls.2019.01073>
11. Mohanty P, Singh PK, Chakraborty D, Pattnaik R, Mohapatra PK, Tripathy S. Insight into the role of PGPR in sustainable agriculture and food systems. *Front Sustain Food Syst*. 2021;5:667150.
12. Nagraj K, Diwan G, Lal N. Effect of fruit load on yield and quality of litchi (*Litchi chinensis* Sonn.). *J Pharmacogn Phytochem*. 2019;8(6):1929-1931.
13. National Horticulture Board. Mango. Ministry of Agriculture & Farmers Welfare, Government of India; n.d.
14. Negi SS, Singh AK, Singh CP. Effect of foliar application of nutrients on fruit-set, yield and quality of mango cv. Dashehari. *Haryana J Horticult Sci*. 2009;38(1-2):20-22.
15. Pokharel NP, Gurung P, Kharel GP, Parajuli A. Effect of foliar application of growth regulators and micronutrients on fruit yield and quality of mango (*Mangifera indica* L.) cv. Mallika. *Int J Agric Environ Biotechnol*. 2023;16(3):181-186.
16. Singh SR, Banik BC. Response of integrated nutrient management on flowering, fruit setting, yield and fruit quality in mango (*Mangifera indica* L.) cv. Himsagar. *Asian J Hortic*. 2011;6:151-154.
17. Singh Y, Prakash S, Prakash O, Kumar D. Effect of integrated nutrient management on fruit yield and quality of Amrapali mango (*Mangifera indica* L.) under high density planting. *Int J Pure Appl Biosci*. 2017;5(3):67-73.
18. Stino RG, Sahar M, Abd El-Wahab SM, Kelani RA. Productivity and fruit quality of three mango cultivars in relation to foliar sprays of calcium, zinc, boron and potassium. *J Hortic Sci Ornamental Plants*. 2011;3(2):91-98.
19. Tsomu T, Patel HC. Effect of foliar spray of plant growth regulators and micronutrients on yield and physical parameters of mango cv. Mallika. *Int J Chem Stud*. 2019;7(3):4968-4973.
20. Tsomu T, Patel HC. Influence of plant growth regulators and micronutrients on yield and quality attributes of mango cv. Mallika. *J Pharmacogn Phytochem*. 2019;8(4):1240-1247.
21. Vejan P, Abdullah R, Khadiran T, Ismail S, Nasrullahq Boyce A. Role of plant growth promoting rhizobacteria in agricultural sustainability: A review. *Molecules*. 2016;21(5):573. <https://doi.org/10.3390/molecules21050573>