**Foliar application of micronutrient and plant growth regulator to reduce fruit drop and enhance yield in bael (*Aegle marmelos* Correa) cv. NB-9**

**ABSTRACT**

The present study aimed to determine the Foliar application of micronutrient and plant growth regulator to reduce fruit drop and enhance yield in bael (*Aegle marmelos* Correa) cv. NB-9. The experiment was carried out in the Main Experiment Station, Department of Fruit Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.), India, during 2023-2024 on the 20-year-old bael plants which were maintained properly. There were eight treatments along with one control (T1- Control, T2- Boric acid @1.0%, T3- CuSO4 @0.8%, T4- NAA @20 ppm, T5- Boric acid @1.0% + CuSO4 @0.8%, T6- Boric acid @1.0% + NAA @20 ppm, T7- CuSO4 @0.8% + NAA @20 ppm, T8- Boric acid @1.0% + CuSO4 @0.8% + NAA @20 ppm), replicated thrice in Randomized Block Design. Single plant was used as a Unit. The first spray was done at the fruit setting stage and the second spray after two months of the first spray. From the present investigation it is found that the foliar application of Boric acid @1.0% + NAA @20 ppm proved to the most effective treatment for reduction in fruit drop (28.89 %) and increase in fruit set (54.17 %) and fruit retention (71.11%) as well as also yield (85.33 kg/plant and 145.31 q/ha) was also influenced by the combined spray of Boric acid @1.0% + NAA @20 ppm in bael cv Narendra Bael-9.

**Key Words:** Fruit Drop, Fruit Set, Fruit retention, Micronutrient, NAA

**INTRODUCTION**

The application of micronutrients and plant growth regulators has a greater impact on enhancing plant productive efficiency by altering various aspects of horticultural attributes like a biometric response, fruiting potential, and qualitative parameters. All metabolic and cellular processes of fruit crops are influenced by micronutrients. The role of boron and zinc are well-known for nitrogen metabolism, cell division, and hormonal regulation which ultimately end with proliferation in flowering and fruiting by increasing fruit set and reducing fruit drop (Darshan et al., 2022). Micronutrient insufficiency is a serious problem in soil and plants all over the world although proper distinction of micronutrients is compulsory for better growth, and improved physical and qualitative aspects of fruit crops whereas its deficiency leads to a reduction in productivity (Imtiaz et al., 2010; Manna & Singh, 2024). Bael (*Aegle marmelos* Correa) is a significant sub-tropical fruit tree native to India. It belongs to the Rutaceae family. Bael is also known as golden apple, Indian quince and Bengal quince. As per Hindu traditions, the leaves of the bael tree are considered sacred and offered to the Lord Shiva. The bael tree is mentioned in the Yajur Veda with traced to Vedic times (2000 B.C.–800 B.C.). In the period of the ‘Ramayana’ the bael fruit was known and its trees were reported to be growing in ‘Chitrakuta’ hills and ‘Panchvati’. It has great mythological and religious significance in Indian History, Culture and the Indian subcontinent, known since prehistoric times and the fruit is mentioned in the ancient Indian literature i.e., Vedas, Ramayana, Upvan Vinod and Brihat Samhita (Pandey et al., 2020). The bael is cultivated in various parts of South East Asia including India, Sri Lanka, Pakistan, Burma, Bangladesh, Thailand etc. In India, the bael tree is planted near temple of the Lord Shiva. Bael is widely grown in Orissa, Bihar, Jharkhand, Uttrakhand, Uttar Pradesh, Madhya Pradesh, West Bengal and in southern states of India. About 650 hectares area is under bael plantations in Tarai West and Amangardh range of forest division of Uttarakhand (Anonymous, 2020-21). All over India, Orissa shares 55.31%

production which is the maximum in the country followed by Jharkhand with 40.76 per cent of fruit production (Anonymous, 2020-21).

The ripe bael fruit is the most nutritious and provides abundant vitamins and minerals. It is rich source of moisture 61.06%, Energy 138 Kcal, Fiber 4.80%, Vitamin B2 1200 mg, Vitamin B1 13.0 mg, Vitamin A 55 µg, Vitamin C 7.5-8.0 mg/100g and 28-39 % total soluble solids (TSS), Protein 3.64%, Fat 0.43%, Calcium 78.0 mg, Iron 0.55mg, Phosphorus 51.60 mg, Potassium 603 mg etc. (Kaur and Kalia, 2017). It also contains marmelosin and produces 88 calories of energy per 100 g of fruit pulp. Certain biochemical constituents, namely alkaloid, coumarin and steroid have been isolated and identified from different parts of the tree. Pulp of ripe fruits is tasty and can be consumed fresh or made into ‘Sharbat’ one of the most popular drinks in the Indian subcontinent.

The bael tree is deciduous, hardy and has 6–8 meter height with whitish or greenish stem and with trifoliate aromatic leaves. The branches of the bael tree are usually long, shallowly furrowed, corky and have thorns. The flowers are bisexual born in cluster, sweet-scented and greenish-white in colour. The flowers are 2 cm wide. The calyx is shallow with 5 short, board teeth and pubescent the outside. Petal five (rarely four) which are oblong, oval, blunt, thick, pale greenish-white dotted with glands. There are many stamens which may be grouped in bundles. The ovary is oblong-ovoid in shape, with a slight tapering towards the axis and a wide structure. Cells are numerous 8-20 in each ovule small and arranged in a circle pattern. The fruit is a hard-shelled berry usually globose (2-8 inch diameter) with a nearly smooth pericarp. The fruit colour is mainly yellowish green having a diameter of 5.3–7.2 cm. The fruit’s pulp is yellow in colour and mucilaginous. It contains some dots on the outer surface and also contains numerous hard seeds and having a thread-like hairs over their outer surface which is white (A. Sonawane et al., 2020). The bael fruit’s pericarp is usually 2-3 mm thick hard and filled with soft and yellow fragrant pulp. The seeds are numerous, compressed and tightly packed in layers within the cell. They are encased in tough, slimy and transparent mucilage that hardens when drying. The testa is white with wooly hairs and the embryo contains large cotyledons. It can adopt effectively to a wide range of habitats from arid, semi-arid to mesophytic conditions (Arya, Singh et. al. 1986) The bael tree can thrive in poor clay soil (Davis, 1930). The plant produces timber and is especially valuable in reforestation programmes in arid and semi-arid areas and wastelands because of its high drought tolerance and can be cultivated successfully in soils having pH range between 5- 10.

Fruit drop is the detachment of fruit from a branch of plant and fruit shedding occurs in three distinct stages that is post- bloom drop, June drop and pre-harvest drop and cause of fruit drop is probably related to competition among fruitlets for carbohydrates, water and hormones. An imbalance of auxins, cytokinins and gibberellins causes the development of an abscission layer between the plant twig and fruit peduncle which leads to fruit drop (Balal et al., 2011; Banjare et al., 2023). When the concentration of abscisic acid (ABA) increases and the concentration of auxins decreases then the plant drops its fruits (Marinho et al., 2005). Plant growth regulators have a significant impact on both fruit drop and retention in fruit trees. The extent of retention and causes of fruit drooping in bael cultivars NB- 4, NB-5, NB-7 and NB- 9 were recorded. Application of NAA resulted in significantly reduced fruit drop and fruit yield (Iqbal et al. 2009). Foliar application of micronutrients and plant growth regulators is recommended to reduce fruit drop (Modise et al., 2009).

Boron is essential for cell division and growth in the meristematic regions located near the tips of both shoots and roots in plants. It also affects sugar transport and appears to be associated with some of the functions of calcium. Boron plays a role in pollination and the development of viable seeds which in turn affect the normal development of fruit. Borex response was more positive due to boron which plays an important in the translocation of carbohydrates, auxin synthesis to the sink and increased pollen viability and fertilization (Yadav et al., 2013). A shortage of boron also causes cracking and distorted fruit growth. Boron does not easily move around the plant and therefore the effects of deficiency appear first and are usually most acute in young tissues, growing points, root tips, young leaves and developing fruit.

Copper is vital for photosynthesis for the functioning of several enzymes in seed development and for the production of lignin which gives physical strength to shoots and stems. Copper activates many enzymes in plants and assists in chlorophyll synthesis (Ram et al., 2000).

**MATERIALS AND METHODS**

The present investigation was carried out during 2023-24 at Main Experiment Station, Department of Fruit Science and laboratory work in PG Lab, College of Horticulture & Forestry, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh. The plants were prune and maintained properly. All the manures, fertilizer, irrigation and culture practices as well as plant protection measures were adapted accordingly to norms. With eight treatments and three replications of each, the experiment was set up in the form of randomized block design (RBD). The bael plants were strategically spaced at distance of 8×8 m2 in the square system. Every single experiment involved three replications, with two trees designated for each replication. Micronutrients and PGR are applied two time (first spray at fruit set in July and Second spray after two months of the first spray in September). The micronutrient and plant growth regulator were purchased from online store India Mart, supplied by Aries Agro Limited, Govandi, Mumbai. Fruiting and yield attributes are observed under various parameters like- fruit set (%), fruit retention (%), fruit drop (%) and average yield of fruits (kg/tree and q/ha).

**Table 1**: Details of Treatment combinations:

Treatment Treatment combinations

|  |  |
| --- | --- |
| T1 | Control |
| T2 | Boric acid @ 1.0% |
| T3 | CuSO4 @0.8% |
| T4 | NAA @20 ppm |
| T5 | Boric acid @1.0% + CuSO4 @0.8% |
| T6 | Boric acid @1.0% + NAA @20 ppm |
| T7 | CuSO4 @0.8% + NAA @20 ppm |
| T8 | Boric acid @1.0% + CuSO4 @0.8% + NAA @20 ppm |
|  | |

**Result and Discussion**

On the basis of Impact of foliar spray of micronutrients and plant growth regulator on fruit set (%), fruit retention (%), fruit drop and fruit yield (kg/plant and q/ha) in Table 2, the results are presented here. The data derived on fruit set percent were subjected to statistical analysis. It is obvious from the foliar spray of micronutrients that plant growth regulators proved significantly effective in improving the fruit set percent. The highest fruit set percent (54.17) and fruit retention percent (71.33) was observed in T6 followed by T8 fruit set per cent (49.08) and fruit retention per cent (58.98). However, The plant under control, showed considerably lowest fruit set percent (31.42) and fruit retention percent (43.33). It was noticed that the fruit drop percentage reduced to the highest in T6 which was closely followed by T8 while highest fruit drop percent (57.00) was observed under control (T1). Fruit set percent and fruit drop percentage were influenced considerably with different nutrients as compared to control. The highest number of fruit set percentage (54.17) and minimum fruit drop percentage 28.89) were recorded by foliar spray of Boric acid @1.0% + NAA @20 ppm which was followed Boric acid @1.0% + CuSO4 @0.8% + NAA @20 ppm. Borax response was more positive due to boron which plays an important role in the translocation of carbohydrates auxin synthesis to the sink and increased pollen viability and fertilization. The lowest number of fruit set percent and highest number of fruit drop percentage were recorded under control (water spray). Similar results were also observed by Yadav et al., Awasthi and Lal and Ram et al. in guava. Data recorded on fruit yield kg/plant due to the effect of micro-nutrients and plant growth regulator yield is present in Table No. 2 which indicates that the maximum fruit yield (85.33 kg/plant) observed with treatment T6 (Boric acid @1.0% + NAA @20 ppm) followed by T8 (Boric acid @1.0% + CuSO4 @0.8% + NAA @20 ppm) and minimum fruit yield was observed under Control. Similar results were also found by Tomas Zewska et al. (1970), where maximum fruit yield from plants spray with Borax and NAA.

**Table 2**: Effect of foliar application of micro-nutrients and plant growth regulator on fruiting attributes and yield parameter of bael cv. NB-9

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Treatment | Fruit set (%) | Fruit drop (%) | Fruit retention (%) | Fruit yield | |
| kg/plant | q/ha |
| T1 | 31.42 | 57.00 | 43.00 | 20.33 | 30.00 |
| T2 | 39.17 | 50.88 | 49.12 | 45.00 | 70.33 |
| T3 | 38.33 | 54.15 | 45.85 | 58.67 | 90.00 |
| T4 | 40.75 | 48.00 | 52.00 | 53.33 | 83.33 |
| T5 | 46.17 | 45.22 | 54.78 | 80.67 | 126.04 |
| T6 | 54.17 | 28.89 | 71.11 | 93.00 | 145.31 |
| T7 | 43.17 | 46.58 | 53.42 | 65.67 | 102.60 |
| T8 | 49.08 | 41.02 | 8.98 | 85.33 | 133.33 |
| SE(m) ± | 0.67 | 0.22 | 0.24 | 4.21 | 4.69 |
| C.D. @ 5 % | 2.01 | 0.67 | 0.73 | 12.76 | 14.22 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |

**Conclusion**

The maximum number of fruit set, fruit retention and minimum fruit drop percentage were obtained with foliar application of Boric acid @1.0% + NAA @20 ppm. However, the foliar spray Boric acid @1.0% + NAA @20 ppm is most effective followed by Boric acid @1.0% + CuSO4 @0.8% + NAA @20 ppm for better fruit set percent, fruit retention percentage and fruit drop percentage and as well as also increase fruit yield with Boric acid @1.0% + NAA @20 ppm followed by Boric acid @1.0% + CuSO4 @0.8% + NAA @20 ppm. Therefore, Boric acid @1.0% + NAA @20 ppm and Boric acid @1.0% + CuSO4 @0.8% + NAA @20 ppm may be recommended to bael cv.Narendra Bael-9 growers for obtaining better yield and quality under Ayodhya region.

**Disclaimer (Artificial intelligence)**

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

**REFERENCES**

Anonymous (2020-21). National Horticultural Board. Ministry of Agriculture & Farmer’s Welfares, Government of India.

Arya, H. C., and Shekhawat, N. S. 1986. Clonal multiplication of tree species in the Thar desert through tissue culture. For. Ecol. Mana. 16(1-4): 201-208.

Balal RM, Ashraf MY, Khan MM, Jaskani MJ, Ashfaq M. 2011. Influence of salt stress on growth and biochemical parameters of citrus rootstocks. Pak. J. Bot. 43: 2135- 2141.

Davis, D. (1930). A descriptive account of the Bahraich forest division, United Provinces. Ind.For. 56: 108-115.

Iqbal, M., Khan, M. Q., Rehman, K., & Munir, M. 2009. Effect of foliar application of NAA on fruit drop, yield and physico-chemical characteristics of guava (Psidium guajava L.) cultivar red flesh. J. Agri. Res. 47(3):259

Kaur, A., & Kalia, M. 2017. Physico chemical analysis of bael (*Aegle Marmelos*) fruit pulp, seed and pericarp. Chemical Science Review and Letters. 6(22): 1213-1218.

Marinho CS, Oliveira L, Serrano JC, Carvalho J. 2005. Effects of gibberellic acid and fungicides on post-bloom fruit drop in Tahiti acid lime. Laranja. 26(1):47-57.

Modise DM, Likuku AS, Thuma M, Phuti R 2009. The influence of exogenously applied 2,4-dichlorophenoxyacetic acid on fruit drop and quality of navel oranges (Citrus sinensis L.). Afr. J. Biotechnol. 8: 2131-2137.

Pandey D., Misra A.K., Garg, N., Shukla, P.K., Gundappa., Shukla, S.K. and S.Rajan 2020. Bael Cultivation. Pub. ICAR-CISH, Lucknow, 1-40.

Ram, R.A. and Bose, T. K. 2000. Effect of foliar application of magnesium and micronutrients on growth, yield and fruit quality of Mandarin orange (Citrus reticulta Blanco). Ind. J. Horti. 57(3): 215-220.

Yadav, V., P.N. Singh and Prakash Yadav 2013. Effect of foliar fertilization of boron, zinc and ironon fruit growth and yield of low-chill peach cv. Sharbati. International Journal Scientific and Research Publications. 3(8): 1-6.

Luckwill, L. C. (1953). Studies of fruit development in relation to plant hormones: I. Hormone production by the developing apple seed in relation to fruit drop. *Journal of horticultural science*, *28*(1), 14-24. Luckwill, L. C. (1953). Studies of fruit development in relation to plant hormones: I. Hormone production by the developing apple seed in relation to fruit drop. *Journal of horticultural science*, *28*(1), 14-24.

Yadav HC, Yadav AL, Yadav DK, Yadav PK. Effect of foliar application of micro-nutrients and GA3 on fruit yield and quality of rainy season guava (Psidium guajava L.) cv. L-49. Plant Archives. 2011; 11(1):147–9.

Awasthi P, Lal S. Effect of calcium, boron and zinc foliar sprays on the yield and quality of guava (Psidium guajava L.). Pantnagar J Res. 2009; 7(2):223–5.

Banjare, R., Nidhi, N., & Sood, A. (2023). Physiological Aspects of Flowering, Fruit Setting, Fruit Development and Fruit Drop, Regulation and their Manipulation: A Review. Int. J. Environ. Clim. Change, 13(12), 205-224.

Darshan, D., Hota, D., Devi, R., & Shukla, J. K. (2022). Micronutrients and plant growth regulators affecting the yield and quality of fruit crops: A review. Emergent Life Sciences Research, 8, 92-103.

M. Imtiaz, A. Rashid, P. Khan, Memon, M. Y. and M. Aslam (2010). The role of micronutrients in crop production and human health. Pak. J. Bot., 42: 2565-2578.

Manna S, Singh D. Study on Effect of Plant Growth Regulators (PGR) and Training System on Growth and Yield of Cucumber. Int. J. Plant Soil Sci. [Internet]. 2024 Jun. 24 [cited 2025 Feb. 20];36(7):633-42. Available from: https://journalijpss.com/index.php/IJPSS/article/view/4774