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Influence of foliar-applied boron and Gibberellic Acid (GA₃) on fruit retention in Rambutan (*Nephelium lappaceum* L.)

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Abstract

A field experiment was carried out during 2025-26 at a farmer's field in Kedor village, Brahmavar, Udupi, Karnataka, to assess the effect of foliar application of boron and gibberellic acid on the reproductive performance of rambutan (*Nephelium lappaceum* L.). The experiment was conducted in a randomized complete block design with nine treatments and three replications, consisting of boron at 0.1 and 0.2 percent, GA₃ at 50 and 75 ppm, their combinations and an untreated control. Boron was applied before flower initiation, whereas gibberellic acid was applied at 50 percent fruit set. The treatments significantly influenced flowering and fruit development. The earliest first flowering was recorded in T₆ (boron 0.1% + GA₃ 50 ppm) at 120.18 days, whereas the control required 159.40 days. The earliest 50 percent flowering was observed in T₉ (boron 0.2% + GA₃ 75 ppm) at 151.93 days compared with 197.35 days in the control. T₉ also recorded the highest number of panicles (17.48 m⁻²) and fruits (64.10 m⁻²), while the control recorded 9.93 and 38.30 m⁻², respectively. The minimum duration for fruit development up to marble-size stage was recorded in T₉ (183.61 days), compared with 245.24 days in the control. Among the treatments with recorded fruit-set values, the highest fruit set was observed in T₉ (1.71%), followed by T₈ (1.56%). Overall, the sequential application of boron and gibberellic acid, particularly T₉, improved the reproductive performance of rambutan under the conditions of the study.

Keywords: Rambutan, boron, Gibberellic acid, flowering, fruit set, reproductive performance

Introduction

Rambutan (*Nephelium lappaceum* L.) is an important tropical fruit crop belonging to the family Sapindaceae and is believed to have originated in the Malay Archipelago, particularly Indonesia, Malaysia and Southern Thailand. The crop is widely cultivated in Southeast Asia and is also grown in other tropical regions, including India. In India, rambutan cultivation is mainly concentrated in humid tropical regions of Kerala, Tamil Nadu and Karnataka. The attractive appearance, pleasant flavour and nutritional value of its fruits have contributed to its increasing market demand and commercial importance (Tripathi *et al.*, 2014; Jahurul *et al.*, 2020) [21, 8].

Despite its commercial potential, rambutan productivity is often constrained by poor flowering, low fruit set, excessive flower and fruit drop, inadequate fruit retention and irregular fruit development. These problems may arise due to nutritional imbalance, inadequate hormonal regulation and environmental conditions, ultimately affecting yield and fruit quality. Improving reproductive performance during flowering and early fruit development is therefore important for enhancing productivity in rambutan (Hang and Chau, 2019, Uddin *et al.*, 2024, Gomasta *et al.*, 2026) [7, 22, 6].

Boron is an important micronutrient involved in several physiological processes, particularly those associated with reproductive development. It plays a vital role in pollen germination, pollen tube growth, fertilization, cell wall formation and carbohydrate translocation. Adequate boron nutrition can therefore improve flowering, fruit set and fruit retention, while its deficiency may result in poor fertilization, increased fruit drop and reduced yield (Roygrong *et al.*, 2006, Shukla, 2011, Ullah *et al.*, 2012) [15, 17, 23]. Similarly, gibberellic acid is an important plant growth regulator that promotes cell division, cell elongation and fruit

development and has been reported to influence flowering, fruit retention and yield in several fruit crops (Rao and Rao, 1963, Singh and Lal, 1980, Chaudhary *et al.*, 2018) [14, 20, 3]. Foliar application provides an efficient means of supplying micronutrients and plant growth regulators during critical stages of crop development. The combined application of boron and gibberellic acid may provide complementary effects by supporting reproductive processes through improved pollen performance and fertilization while promoting subsequent fruit development.

Materials and Methods

The investigation was undertaken on six-year-old rambutan trees maintained at 5 m × 5 m spacing at Kedor, Brahmavar, Udipi, Karnataka, during 2025-26. A randomized complete block design (RCBD) was adopted with nine treatments and three replications. Treatments included boron at 0.1 and 0.2 percent, GA₃ at 50 and 75 ppm, their combinations and an untreated control. Boron sprays were given before flower initiation, whereas gibberellic acid was applied at 50 percent fruit set. Treatments were T₁ control, T₂ boron 0.1%, T₃ boron 0.2%, T₄ GA₃ 50 ppm, T₅ GA₃ 75 ppm, T₆ boron 0.1% + GA₃ 50 ppm, T₇ boron 0.1% + GA₃ 75 ppm, T₈ boron 0.2% + GA₃ 50 ppm and T₉ boron 0.2% + GA₃ 75 ppm. Flowering time, panicle production, fruit development, fruit number and fruit set were assessed. Data were analysed under RCBD and treatment differences were tested using CD at 5 percent.

Results and Discussion

The treatments showed considerable variation in the time taken for the onset of flowering. The earliest first flowering was recorded in T₆ (boron 0.1% + GA₃ 50 ppm) at 120.18

days, followed by T₉ (boron 0.2% + GA₃ 75 ppm) at 123.85 days and T₇ (boron 0.1% + GA₃ 75 ppm) at 125.33 days. The control (T₁) recorded the latest first flowering at 159.40 days.

The advancement in flowering with boron and gibberellic acid application attributed to improved physiological activity during the reproductive phase. Boron plays an important role in reproductive development, while gibberellic acid influences plant growth and developmental processes. Similarly, Pandey *et al.* (2012) [12] demonstrated that foliar feeding with a combination of ZnSO₄ (0.5%), borax (0.5%), and GA₃ (10 ppm) significantly reduced the days to flowering initiation and days to 50% flowering in ber, indicating an acceleration in the flowering process.

The duration required to attain 50 percent flowering was shortest in T₉ (boron 0.2% + GA₃ 75 ppm), which reached this stage at 151.93 days. T₇ and T₈ recorded 153.87 and 158.37 days, respectively, whereas the control required 197.35 days. Thus, the sequential application of boron and gibberellic acid resulted in earlier attainment of 50 percent flowering compared with the untreated control. The earlier completion of flowering under the combined treatments could be related to better regulation of reproductive growth. Boron supports reproductive processes, while gibberellic acid modifies growth and developmental responses. The increase in number of flowers per shoot might be due to the effect of gibberellic acid in accelerating the differentiation of inflorescence and rapid elongation of peduncle, leading to full development of flower buds having functional reproductive parts Parouissi *et al.*, 2002 [13]. The result is in conformity with the findings of (Anwal *et al.*, 2015) [2] in pomegranate, (Singh, 2017) [18] in phalsa and (Lal *et al.*, 2013) [11] in guava.

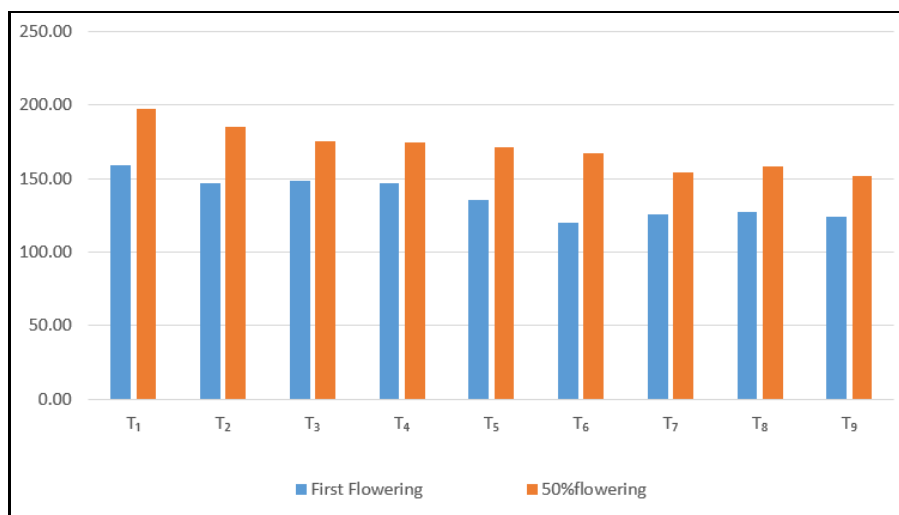


Fig 1: Effect of boron and gibberellic acid application on days required for first flowering and 50% flowering in rambutan.

The number of panicles produced per square metre increased with the application of boron and gibberellic acid. T₉ (boron 0.2% + GA₃ 75 ppm) recorded the highest number of panicles (17.48 m⁻²), followed by T₈ (15.08 m⁻²) and T₇ (14.43 m⁻²). The minimum number of panicles was observed in T₁(control), with 9.93 panicles m⁻².The greater panicle production under sequential application treatments associated with improved nutrient availability and enhanced

growth of reproductive shoots. Boron is particularly important for reproductive development, while gibberellic acid promotes cell division and elongation and modifies plant growth. The stronger response of T₉ suggests that the higher boron concentration together with gibberellic acid 75 ppm provided a favourable condition for panicle development, Singh *et al.* (2017) [18] found similar results with phalsa.

Table 1: Effect of foliar application of boron and gibberellic acid on Days required for first flowering, Days required for 50 percent flowering and No. of panicles per square meter

Treatment	Days required for first flowering	Days required for 50 percent flowering	No. of panicles per square meter
T ₁ : Control	159.40	197.35	9.93
T ₂ : Boron (0.1%)	147.13	184.75	12.13
T ₃ : Boron (0.2%)	148.79	175.15	12.63
T ₄ : GA ₃ (50 ppm)	146.39	174.68	12.88
T ₅ : GA ₃ (75 ppm)	135.23	171.06	13.39
T ₆ : Boron (0.1%) + GA ₃ (50 ppm)	120.18	166.77	13.86
T ₇ : Boron (0.1%) + GA ₃ (75 ppm)	125.33	153.87	14.43
T ₈ : Boron (0.2%) + GA ₃ (50 ppm)	127.20	158.37	15.08
T ₉ : Boron (0.2%) + GA ₃ (75 ppm)	123.85	151.93	17.48
S.Em (±)	0.35	0.33	0.16
CD @ 5%	1.05	1.01	0.50

Days required for fruit development up to marble-size fruits

Marked differences were observed in the duration required for fruits to reach the marble-size stage. T₉ (boron 0.2% + GA₃ 75 ppm) recorded the shortest duration of 183.61 days, followed by T₈ (boron 0.2% + GA₃ 50 ppm) (191.50 days) and T₇ (boron 0.1% + GA₃ 75 ppm) (196.40 days). In contrast, fruits under the control treatment required 245.24 days to reach the same stage. The faster progression of fruit development in the treated plants may be attributed mainly to the influence of gibberellic acid on cell division and cell enlargement, together with the role of boron in maintaining reproductive growth and assimilate movement. These results are consistent with study by Singh *et al.* (2017) [18] who observed that plant growth regulators, particularly gibberellic acid, significantly reduce the crop duration and

promote early maturation in various fruit crops. Similar trend was also reported by Ferree *et al.*, 2004 [5].

The highest number of fruits per square metre was recorded in T₉ (boron 0.2% + GA₃ 75 ppm), with 64.10 fruits m⁻². This was followed by T₇ (boron 0.1% + GA₃ 75 ppm) 59.66 fruits m⁻² and T₈ (boron 0.2% + GA₃ 50 ppm) 58.29 fruits m⁻². The control recorded the lowest value of 38.30 fruits m⁻². The increased fruit number under the combined treatments may be a consequence of improved flowering, fruit establishment and subsequent fruit retention. According to findings published by (Kumar *et al.*, 2023 and Alam *et al.*, 2017) [10, 1] in phalsa and Shah *et al.*, 2015 [16] in grapes, the application of gibberellic acid at 150 ppm produced the highest number of fruits per node and fruiting nodes per shoot in phalsa.

Table 2: Effect of foliar application of boron and gibberellic acid on Days required for fruit development up to marble-size fruits, No. of fruits per square meter and Fruit set

Treatment	Days required for fruit development up to marble-size fruits	No. of fruits per square meter	Fruit set (%)
T ₁ : Control	245.24	38.30	0.91
T ₂ : Boron (0.1%)	233.42	45.64	1.36
T ₃ : Boron (0.2%)	234.42	48.46	1.39
T ₄ : GA ₃ (50 ppm)	224.84	49.78	1.43
T ₅ : GA ₃ (75 ppm)	217.88	52.34	1.47
T ₆ : Boron (0.1%) + GA ₃ (50 ppm)	207.41	54.54	1.52
T ₇ : Boron (0.1%) + GA ₃ (75 ppm)	196.40	59.66	1.54
T ₈ : Boron (0.2%) + GA ₃ (50 ppm)	191.50	58.29	1.56
T ₉ : Boron (0.2%) + GA ₃ (75 ppm)	183.61	64.10	1.71
S.Em (±)	0.44	0.32	0.04
CD @ 5%	1.33	0.98	0.14

The recorded fruit-set values ranged from 0.91 to 1.71 percent among the treatments for which values were available. The highest value was recorded in T₉ (boron 0.2% + GA₃ 75 ppm) at 1.71 percent, followed by T₈ (boron 0.2% + GA₃ 50 ppm) at 1.56 percent and T₇ (boron 0.1% + GA₃ 75 ppm) at 1.54 percent. The lowest recorded value was observed in T₁ (boron 0.1%) control at 0.91 percent. The relatively higher fruit set under the sequential treatments associated with the complementary functions of boron and gibberellic acid during reproductive development. Boron is important for pollen germination, pollen tube growth and fertilization, while gibberellic acid can promote fruit development and retention. The outcomes are in line with those of Singh *et al.*, 1966 [19] who found that applying gibberellic acid and 2,4, 5-T to phalsa significantly increased fruit set. The present findings are in agreement

with Dixit *et al.* (2013) [4], who reported that boron application improved fruit set and retention by enhancing reproductive processes in litchi. Kaur (2017) [9] also observed improvement in fruit quality and reproductive characters through application of boron and growth regulators in litchi.

The foliar application of boron and gibberellic acid improved the reproductive performance of rambutan compared with the control. T₉ (boron 0.2% + GA₃ 75 ppm) was particularly effective in advancing 50 percent flowering, increasing panicle and fruit production and reducing the time required to reach the marble-size stage and recorded the highest fruit-set value among the treatments for which observations were available. These findings indicate that the sequential use of boron and gibberellic acid can favour reproductive development and

early fruit establishment in rambutan under the conditions of the present study.

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