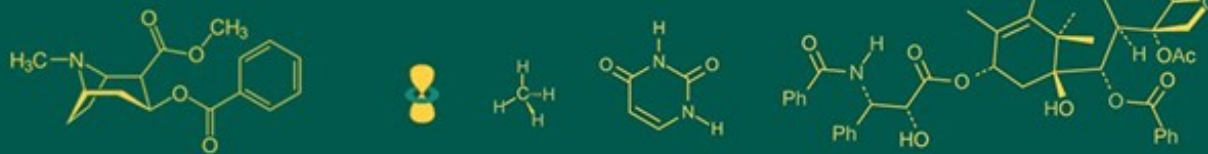


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Effect of foliar application of boron, zinc and potassium on flowering, fruiting and yield of avocado (*Persea americana* Mill.) cv. Hass

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ABSTRACT

The present investigation was conducted during 2025–26 at Varashree Farm and Nursery, Sakrebylu, Gajanuru, Shivamogga district, Karnataka, India, to evaluate the influence of foliar application of boron, zinc and potassium on flowering, fruiting and yield of avocado (*Persea americana* Mill.) cv. Hass. The experiment was laid out in a Randomized Complete Block Design (RCBD) with 21 treatments and two replications. The treatments comprised individual and combined applications of boron, zinc and potassium, along with a water-sprayed control. Foliar sprays were applied fifteen days prior to flower-bud induction and fifteen days after anthesis, in addition to the common recommended dose of fertilizers. Significant differences were observed among treatments for the number of panicles per square metre of canopy, fruits per panicle, fruits per tree, fruit yield per tree and fruit yield per acre. Treatment T8 [boron 0.2 per cent + zinc 0.2 per cent] recorded the maximum number of panicles per square metre of canopy (8.40) and fruits per panicle (5.10) and was statistically on par with T18 [boron 0.2 per cent + zinc 0.2 per cent + potassium 0.5 per cent] and T19 [boron 0.2 per cent + zinc 0.2 per cent + potassium 1.0 per cent], which recorded 8.16 and 7.72 panicles per square metre of canopy and 4.86 and 4.62 fruits per panicle, respectively. Treatment T18 recorded the highest number of fruits per tree (143.50), fruit yield per tree (38.25 kg) and fruit yield per acre (8.49 t) and was statistically on par with T8, which recorded 138.60 fruits per tree and 36.00 kg fruit yield per tree. These results indicated that balanced foliar application of boron, zinc and potassium improved reproductive performance and yield in avocado cv. Hass. Under the present conditions, T18 [boron 0.2 per cent + zinc 0.2 per cent + potassium 0.5 per cent] recorded the highest for overall fruiting and yield.

Keywords: Avocado, Boron, Flowering, Foliar nutrition, Potassium, Yield, Zinc

Introduction

Avocado (*Persea americana* Mill.) is an important subtropical fruit crop belonging to the family Lauraceae and is widely valued for its nutritional and economic importance. The crop originated in Mexico and Central America and has subsequently been introduced into several tropical and subtropical regions of the world. In India, avocado cultivation is mainly confined to Karnataka, Tamil Nadu, Kerala, Maharashtra, Sikkim and the north-eastern states, where its cultivation is gradually expanding.

The reproductive biology of avocado is highly complex. The flowers exhibit Protogynous Diurnally Synchronous Dichogamy (PDSD), which influences pollination and fruit set. Although the trees produce an abundance of flowers, the fruit-set is only 0.1 per cent (Whiley *et al.*, 1994) [1]. Consequently, poor fruit-set and excessive fruit drop are important constraints limiting avocado productivity. In addition to environmental conditions and pollination, the nutritional status of the tree plays a major role in flower development, fertilization, fruit-set and subsequent fruit retention.

Boron is an essential micronutrient for reproductive development and plays an important role in pollen viability, pollen germination and pollen tube growth. Adequate boron nutrition can therefore improve fertilization and fruit-set and foliar application of boron together with zinc has been reported to enhance fruit set, yield and fruit quality in avocado. Zinc is another important micronutrient involved in several physiological and biochemical processes, including enzyme activation and auxin synthesis and adequate zinc nutrition is important for the normal growth and productivity of avocado. Potassium plays an important role in photosynthesis, enzyme activation, osmotic regulation and translocation of photosynthates. During the reproductive phase, balanced availability of these nutrients may improve flower initiation, fertilization, fruit set, fruit retention and subsequent yield.

Considering the importance of balanced nutrient management during the reproductive phase of avocado, the present investigation was undertaken to study the influence of foliar application of boron, zinc and potas

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sium, individually and in combination, on flowering, fruiting and yield of avocado cv. Hass.

Materials and methods

The present investigation was conducted during 2025–26 at Varashree Farm and Nursery, Sakrebylu, Gajanuru, Shivamogga district, Karnataka, India. The experiment was conducted on four-year-old plants of avocado (*Persea americana* Mill.) cv. Hass. The experiment was laid out in a Randomized Complete Block Design with twenty-one treatments and two replications. Each replication comprised of three plants. All experimental trees received a common recommended dose of fertilizer consisting of 400 g nitrogen, 120 g phosphorus and 240 g potash along with 30 kg farmyard manure per tree. The foliar nutrient treatments were applied in addition to this common fertilizer application.

The experiment comprised twenty-one treatments, namely, T₁ – control (water spray), T₂ – boron (0.2%), T₃ – boron (0.3%), T₄ – zinc (0.2%), T₅ – zinc (0.4%), T₆ – potassium (0.5%), T₇ – potassium (1.0%), T₈ – boron (0.2%) + zinc (0.2%), T₉ – boron (0.3%) + zinc (0.4%), T₁₀ – boron (0.2%) + potassium (0.5%), T₁₁ – boron (0.2%) + potassium (1.0%), T₁₂ – boron (0.3%) + potassium (0.5%), T₁₃ – boron (0.3%) + potassium (1.0%), T₁₄ – zinc (0.2%) + potassium (0.5%), T₁₅ – zinc (0.2%) + potassium (1.0%), T₁₆ – zinc (0.4%) + potassium (0.5%), T₁₇ – zinc (0.4%) + potassium (1.0%), T₁₈ – boron (0.2%) + zinc (0.2%) + potassium (0.5%), T₁₉ – boron (0.2%) + zinc (0.2%) + potassium (1.0%), T₂₀ – boron (0.3%) + zinc (0.4%) + potassium (0.5%) and T₂₁ – boron (0.3%) + zinc (0.4%) + potassium (1.0%). The first foliar spray was applied fifteen days prior to flower-bud induction, while the second spray was applied fifteen days after anthesis.

Observations recorded

Number of panicles per square metre of canopy was recorded at full bloom using a one metre × one metre quadrat. The number of fruits per panicle was recorded from tagged panicles after fruit set. The number of fruits per tree was recorded by counting the fruits retained on each tagged tree until harvest. Fruit yield per tree was expressed in kilograms per tree, while fruit yield per acre was calculated from the plot yield and expressed in tonnes per acre.

Statistical analysis

The data recorded for different flowering, fruiting and yield parameters were subjected to analysis of variance appropriate for a Randomized Complete Block Design. Treatment means were compared using the critical difference (CD) at five per cent level of significance.

Results and discussion

Number of panicles per square metre of canopy

Foliar application of potassium and micronutrients significantly affected the number of panicles per square metre of canopy and the number of fruits per panicle in avocado cv. Hass.

The highest number of panicles per square metre of canopy was recorded with T₈ [Boron (0.2 %) + Zinc (0.2 %)] with 8.40 panicles,

which was statistically on par with T₁₈ [Boron (0.2 %) + Zinc (0.2 %) + Potassium (0.5 %)] with 8.16 panicles and T₁₉ [Boron (0.2 %) + Zinc (0.2 %) + Potassium (1.0 %)] with 7.72 panicles (Table 1). The lowest number was recorded in the control, T₁, with 2.91 panicles. Zinc is required for tryptophan and auxin metabolism and supports leaf chlorophyll formation, protein synthesis and several enzyme systems. Boron supports meristematic activity, cell-wall development and carbohydrate movement. An adequate supply of both nutrients during the period preceding flowering may therefore have favoured the differentiation and emergence of more inflorescences per unit canopy area. The result is consistent with the observations of Mans (1996) [2], Crowley *et al.* (1994) [3].

Number of fruits per panicle

A similar response was observed for number of fruits per panicle. Treatment T₈ recorded the maximum number of fruits per panicle (5.10), which was statistically on par with T₁₈ (4.86) and T₁₉ (4.62). The minimum number of fruits per panicle was observed in T₁ (2.55) (Table 1). The superior response of T₈ suggests that the direct combination of boron and zinc at moderate concentrations was particularly effective in improving reproductive efficiency at the panicle level. The increased number of fruits per panicle may be related to enhanced pollen viability, pollen germination and pollen-tube progression due to boron along with improved auxin synthesis and enzyme activity due to zinc. Abdel-Karim *et al.* (2015) [4] observed a positive synergistic effect of boron and zinc on fruit set in avocado.

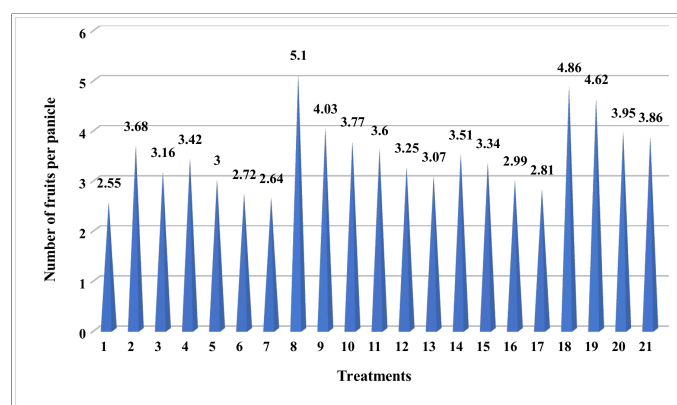


Figure 1. Influence of foliar application of potassium and micronutrients on number of fruits per panicle

Number of fruits per tree

The maximum number of fruits per tree was recorded in T₁₈ with 143.50 fruits, which was statistically on par with T₈ with 138.60 fruits per tree, T₁₉ recorded 132.20 fruits per tree. The lowest number of fruits per tree was recorded in the control T₁, with 80.75 fruits (fig 2). The superiority of the combined treatment may be attributed to the complementary functions of boron, zinc and potassium during flowering, fertilization, fruit set and subsequent fruit retention. The present response agrees with Jaganath and Lovatt (1995) [5], Dixon *et al.* (2006) [6].

Table 1. Effect of foliar application of potassium and micronutrients on flowering and fruiting of avocado cv. Hass

Treatment	Treatment details	Panicles m ⁻² canopy	Fruits panicle ⁻¹
T ₁	Control (water spray)	2.91	2.55
T ₂	Boron (0.2 %)	5.89	3.68
T ₃	Boron (0.3 %)	4.51	3.16
T ₄	Zinc (0.2 %)	5.20	3.42
T ₅	Zinc (0.4 %)	3.82	3.00
T ₆	Potassium (0.5 %)	3.36	2.72
T ₇	Potassium (1.0 %)	3.13	2.64

(continued on next page)

Treatment	Treatment details	Panicles m ⁻² canopy	Fruits panicle ⁻¹
T ₈	Boron (0.2 %) + Zinc (0.2 %)	8.40	5.10
T ₉	Boron (0.3 %) + Zinc (0.4 %)	6.81	4.03
T ₁₀	Boron (0.2 %) + Potassium (0.5 %)	6.12	3.77
T ₁₁	Boron (0.2 %) + Potassium (1.0 %)	5.66	3.60
T ₁₂	Boron (0.3 %) + Potassium (0.5 %)	4.84	3.25
T ₁₃	Boron (0.3 %) + Potassium (1.0 %)	4.28	3.07
T ₁₄	Zinc (0.2 %) + Potassium (0.5 %)	5.43	3.51
T ₁₅	Zinc (0.2 %) + Potassium (1.0 %)	4.97	3.34
T ₁₆	Zinc (0.4 %) + Potassium (0.5 %)	4.05	2.99
T ₁₇	Zinc (0.4 %) + Potassium (1.0 %)	3.59	2.81
T ₁₈	Boron (0.2 %) + Zinc (0.2%) + Potassium (0.5 %)	8.16	4.86
T ₁₉	Boron (0.2 %) + Zinc (0.2%) + Potassium (1.0 %)	7.72	4.62
T ₂₀	Boron (0.3 %) + Zinc (0.4%) + Potassium (0.5 %)	6.58	3.95
T ₂₁	Boron (0.3 %) + Zinc (0.4%) + Potassium (1.0 %)	6.35	3.86
	S. Em ±	0.43	0.29
	C.D. @ 5%	1.28	0.86

Fruit yield per tree

Treatment T₁₈ recorded the highest fruit yield per tree (38.25 kg) and was statistically on par with T₈ (36.00 kg) and T₁₉ (34.74 kg). The minimum fruit yield per tree was recorded in the control T₁, with 13.04 kg (Table 2). Boron probably improved fertilization and initial fruit set, zinc maintained metabolic activity and hormonal balance and potassium strengthened the source-sink relationship by facilitating assimilate synthesis and translocation towards developing fruits. The findings also agree with El-Sherif *et al.* (2000)^[7], Abdel-Karim *et al.* (2015)^[4].

Fruit yield per acre

The maximum fruit yield was recorded in T₁₈ with 8.49 t per acre. This treatment was followed by T₈ with 7.99 t per acre and T₁₉ with 7.71 t per acre. The lowest fruit yield per acre was recorded in the control, T₁, with 2.89 t per acre. The higher yield in T₁₈ may be attributed to the cumulative effect of increased fruit number per tree, fruit yield per tree and improved fruit growth. The present findings are in agreement with Dutta (2004)^[8], Banik *et al.* (1997)^[9].

Table 2. Effect of foliar application of potassium and micronutrients on yield attributes of avocado cv. Hass

Treatment	Treatment details	Fruits tree ⁻¹	Fruit yield tree ⁻¹ (kg)	Fruit yield (t acre ⁻¹)
T ₁	Control (water spray)	80.75	13.04	2.89
T ₂	Boron (0.2 %)	93.02	17.23	3.82
T ₃	Boron (0.3 %)	84.84	15.14	3.36
T ₄	Zinc (0.2 %)	88.93	16.18	3.59
T ₅	Zinc (0.4 %)	82.79	14.09	3.12
T ₆	Potassium (0.5 %)	90.97	19.33	4.29
T ₇	Potassium (1.0 %)	86.88	18.28	4.05
T ₈	Boron (0.2 %) + Zinc (0.2 %)	138.60	36.00	7.99
T ₉	Boron (0.3 %) + Zinc (0.4 %)	97.11	20.38	4.52
T ₁₀	Boron (0.2 %) + Potassium (0.5 %)	111.42	28.77	6.38
T ₁₁	Boron (0.2 %) + Potassium (1.0 %)	105.29	26.67	5.92
T ₁₂	Boron (0.3 %) + Potassium (0.5 %)	107.33	25.08	5.57
T ₁₃	Boron (0.3 %) + Potassium (1.0 %)	101.20	22.48	4.99
T ₁₄	Zinc (0.2 %) + Potassium (0.5 %)	109.38	27.72	6.15
T ₁₅	Zinc (0.2 %) + Potassium (1.0 %)	103.24	25.63	5.69
T ₁₆	Zinc (0.4 %) + Potassium (0.5 %)	99.15	23.53	5.22
T ₁₇	Zinc (0.4 %) + Potassium (1.0 %)	95.06	21.93	4.87
T ₁₈	Boron (0.2 %) + Zinc (0.2 %) + Potassium (0.5 %)	143.50	38.25	8.49
T ₁₉	Boron (0.2 %) + Zinc (0.2 %) + Potassium (1.0 %)	132.20	34.74	7.71
T ₂₀	Boron (0.3 %) + Zinc (0.4 %) + Potassium (0.5 %)	115.51	30.87	6.85
T ₂₁	Boron (0.3 %) + Zinc (0.4 %) + Potassium (1.0 %)	113.47	29.82	6.62
	S. Em ±	8.23	1.88	0.45
	C.D. @ 5%	24.28	5.53	1.34

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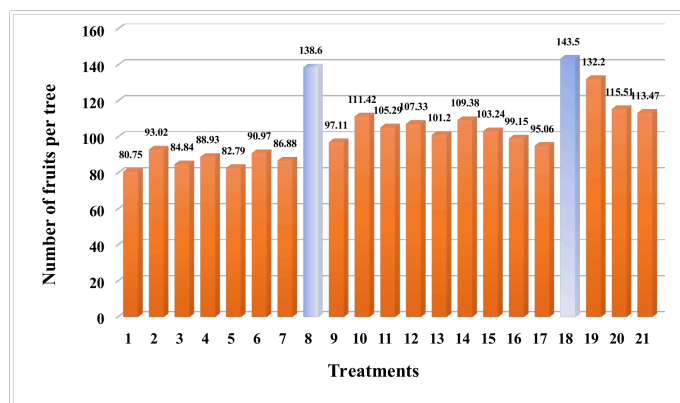


Figure 2. Effect of foliar application of potassium and micronutrients on number of fruits per tree

Conclusion

The present investigation demonstrated that foliar application of boron, zinc and potassium significantly influenced flowering, fruiting and yield of avocado cv. Hass.

Boron at 0.2 per cent combined with zinc at 0.2 per cent was the most effective treatment for improving the number of panicles per square metre of canopy and number of fruits per panicle. However, the combined foliar application of boron at 0.2 per cent, zinc at 0.2 per cent and potassium at 0.5 per cent was superior for overall fruiting and yield, recording the highest number of fruits per tree (143.50), fruit yield per tree (38.25 kg) and fruit yield per acre (8.49 t).

The results indicated that boron and zinc were particularly important for improving flowering and initial fruit-set, whereas the addition of potassium contributed to improved fruit retention and final yield. Therefore, foliar application of boron at 0.2 per cent + zinc at 0.2 per cent + potassium at 0.5 per cent was found to be the most effective nutrient combination for improving fruiting and yield of avocado cv. Hass under the conditions of the present investigation.

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