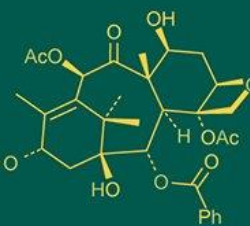
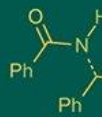
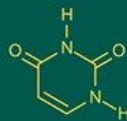
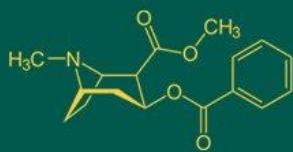


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Studies on the effect of foliar sprays on flowering, fruit quality and yield of acid lime (*Citrus aurantifolia* Swingle) cv. Balaji in Ambe Bahar crop

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Abstract

The experiment titled “Studies on the effect of foliar sprays on flowering, fruit quality, and yield of acid lime (*Citrus aurantifolia* Swingle) cv. Balaji in Ambe Bahar Crop” was conducted during 2024-25 at Jaggannapeta village near Dr. Y.S.R. Horticultural University, Andhra Pradesh. The study aimed to evaluate the impact of various foliar sprays combining plant growth regulators and micronutrients on flowering, fruit quality, and yield. Using a Randomized Block Design with three replications and eight treatments, significant variations were observed among treatments. The treatment GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) produced the highest fruit set per shoot (12.60), flower number (19.61), fruit weight (43.60 g), juice content (48.94%), TSS (8.90 °Brix), ascorbic acid (30.20 mg/100 g), chlorophyll content (61.00 SPAD), total sugars (1.90%), reducing sugars (0.92%) and non-reducing sugars (0.98%). It also resulted in the minimum peel thickness (2.10 mm) and peel weight (7.07 g), the greatest number of fruits per tree (760.33), maximum yield (33.15 kg/tree) and recorded the highest benefit-cost ratio (1.85). Meanwhile, 2,4-D @ 25 ppm with micronutrients showed the highest fruit retention (57.03%) and lowest fruit drop (40.06%). The control treatment exhibited the poorest performance. Thus, GA₃ @ 50 ppm combined with micronutrients is recommended as the most effective treatment for enhancing flowering, fruit quality, and yield in acid lime cv. Balaji.

Keywords: Acid lime, foliar spray, yield, quality and growth regulators

Introduction

Citrus cultivation plays a vital role in tropical and subtropical regions, with India ranking among the top producers. During 2023-24, citrus occupied 336.29 thousand ha, yielding 2.81 million tonnes with 8.36 MT/ha productivity (NHB, 2024). Major citrus fruits include acid lime, lemon, mandarin and sweet orange, contributing 12.4% to total fruit production. Andhra Pradesh and Gujarat lead in acid lime production, with 905.9 and 636.4 thousand tonnes, respectively (Sidhu, 2025).

Acid lime (*Citrus aurantifolia* Swingle), a Rutaceae member with 2n = 18 chromosomes, likely originated in tropical Asia. Valued for its aromatic, acidic fruit and medicinal properties, it ranks third in India's citrus hierarchy after mandarin and sweet orange. Among its cultivars, ‘Balaji’, developed by Dr. YSR Horticultural University, is known for high productivity (800-1200 fruits/tree), thin rind, high juice (45-50%), and disease tolerance (Reddy *et al.*, 2015; Patil *et al.*, 2017) [22, 15].

Ambe Bahar is a critical flowering season aligning with peak summer demand. However, low fruit set from poor pollination limits yield. Foliar sprays of plant growth regulators (PGRs) and micronutrients effectively enhance flowering, fruit set and quality. GA₃ promotes fruit growth and yield, 2,4-D and NAA reduce fruit drop, while kinetin improves leaf and shoot vigour. Micronutrients such as Zn, Fe and B improve chlorophyll formation, pollen viability, fruit retention, juice content and total soluble solids (Rajamanickam *et al.*, 2022; Noor *et al.*, 2019) [16, 14]. Supplementary nutrients like KNO₃ and urea boost flowering and yield, whereas salicylic acid increases stress tolerance and fruit shelf life. Hence, integrating PGRs and micronutrients via foliar sprays is vital for maximizing yield and quality of acid lime cv. Balaji during Ambe Bahar in Andhra Pradesh.

Materials and Methods

The experiment was conducted on a twelve-year-old acid lime orchard at a farmer's field in Jaggannapeta village, Tadepalligudem Mandal, West Godavari District, Andhra Pradesh, near Dr. Y.S.R. Horticultural University, Venkataramannagudem. The study was laid out in a Randomized Block Design with eight treatments replicated thrice, using six trees per treatment. Forty-eight uniformly grown trees, spaced at 6 × 6 m and maintained under similar agro-climatic conditions and cultural practices, were selected. Treatments included GA₃ @ 50 ppm, NAA @ 100 ppm, 2,4-D @ 25 ppm, kinetin @ 50 ppm, salicylic acid @ 200 ppm, urea 2% and KNO₃ 2%, each combined with ZnSO₄ (1%), FeSO₄ (1%) and borax (0.6%), along with a control (water spray). Observations on flowering, fruit quality and yield parameters were recorded and analysed statistically.

Preparation of Plant Growth Regulators and micro nutrients solutions

Stock solutions of plant growth regulators (GA₃, NAA, 2,4-D, kinetin and salicylic acid) were prepared by dissolving the required quantities in 5 mL absolute ethyl alcohol to ensure complete dissolution, followed by dilution to 1000 mL with distilled water in volumetric flasks. The concentrations prepared were GA₃ @ 50 ppm (50 mg/L), NAA @ 100 ppm (100 mg/L), 2,4-D @ 25 ppm (25 mg/L), kinetin @ 50 ppm (50 mg/L) and salicylic acid @ 200 ppm (200 mg/L).

Micronutrient and fertilizer solutions, including urea 2% (20 g/L), KNO₃ 2% (20 g/L), ZnSO₄ 1% (10 g/L), FeSO₄ 1% (10 g/L) and borax 0.6% (6 g/L), were prepared by directly dissolving the weighed quantities in distilled water and making up the volume to 1000 mL. All solutions were mixed thoroughly to ensure uniformity before application.

Observations Recorded

For data collection, 20 shoots per tree were selected from four directions, tagged and used for recording flowering and fruiting parameters.

Reproductive parameters

No. of flowers per shoot

Five flowering shoots were randomly selected and tagged from each tree per replication. The flowers on each shoot were counted and the average number of flowers per shoot was calculated for each treatment.

Fruit set percentage (%)

Fruit set (%) was calculated by recording the number of flowers that developed into fruits on five tagged shoots per treatment and expressing it as a percentage.

Fruit drop (%)

Fruit drop was recorded by counting the number of fruits dropped at various stages and subtracting the same from the initial fruit set and expressed as a percentage. The fruit drop per cent was calculated by the following equation (Sharma *et al.*, 2021) ^[24]

$$\text{Fruit drop (\%)} = \frac{\text{Number of fruits set} - \text{Number of fruits retained}}{\text{Number of fruits set}} \times 100$$

Physical parameters

Five fruits selected on each random selected five branches of each treatment and tagged for recording various physical parameters.

Juice content per fruit (mL)

Juice was extracted from five fruits per treatment, squeezed manually, filtered through muslin cloth and measured in milliliters.

Fruit length (cm)

The length of the fruits was measured at harvest by recording the vertical diameter of each fruit in centimeters using digital Vernier callipers. Measurements were taken on five fruits randomly selected from each of five different branches and the average length was calculated.

Fruit weight (g)

The weight of five observational fruit was recorded on the digital weighing balance. The values were summed up and average fruit weight was computed by dividing total weight of fruits by total number of fruits.

$$\text{Average fruit weight} = \frac{\text{Total weight of fruits (g)}}{\text{Number of fruits}}$$

Peel weight (g)

For recording peel weight, ten fruits were randomly chosen and the total fruit weight was measured. The peel was then carefully removed from each fruit and weighed separately, with the peel weight expressed in grams.

Bio-chemical parameters

Total soluble solids (°Brix)

The total soluble solids were determined by using an ERMA hand refractometer and expressed as °Brix (Ranganna, 1986) ^[18].

Titration acidity (%)

The acidity percentage of acid lime juice was determined using Ranganna's (1986) ^[18] method. Ten ml of homogenized juice was diluted to 100 ml, filtered and 10 ml of filtrate was titrated with 0.1 N NaOH using phenolphthalein indicator. Titration ended when a persistent light pink colour appeared for 15 seconds.

$$\text{Titration acidity (\%)} = \frac{\text{Titre value} \times \text{Normality of NaOH} \times 0.006}{\text{Volume of aliquot taken}} \times 100$$

Ascorbic acid (mg/100 ml juice)

For estimation of ascorbic acid about 10 ml of extracted fruit juice was taken and the volume was made up to 100 ml with 3 percent met phosphoric acid. 10 ml of this aliquot solution was taken and titrated with standard dye (2,6 dichlorophenol indophenol) till a pink end point is reached. (Ranganna, 1986) ^[18]. The ascorbic acid content was estimated using the given formula and expressed as milligrams per 100 grams of juice.

$$\text{Ascorbic acid} = \frac{\text{Titre value} \times \text{Dye factor} \times \text{Volume made up}}{\text{Wt. of sample} \times \text{Aliquot taken}} \times 100$$

$$\text{Dye factor} = 0.5/(\text{Titre value})$$

Yield attributes characters

Number of fruits per tree

The total number of fruits per plant was counted separately for at each picking and average number of fruits per plant was calculated.

3.6.2. Fruit yield per plant (kg)

The fruit of each plant were weighed separately by electrical digital balance and average yield per plant was recorded at each picking.

$$\text{Yield kg/plant} = \frac{\text{No. of fruits} \times \text{Fruit weight (g)}}{1000}$$

Results and discussion

The data presented in tables 1, 2, 3, 4, 5 and 6 results revealed that the number of flowers per shoot, fruit drop percentage, fruit set percentage, Juice Content per Fruit, Fruit Length, Fruit Weight, Peel weight, TSS, titrable acidity, ascorbic acid content, number of fruits per tree and fruit yield per plant were significantly influenced by different concentrations of treatments.

No. of flowers per shoot

The data on the number of flowers per shoot influenced by foliar sprays in acid lime cv. Balaji showed significant differences among treatments. The highest number of flowers per shoot (19.61) was recorded in T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) followed by T₇-KNO₃ 2% + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) with 18.30 flowers. The control (water spray) had the lowest count (11.17). This increase is due to gibberellic acid and micronutrients enhancing floral bud differentiation, nutrient mobility and photosynthesis. GA₃ promotes cell elongation and hormonal balance, zinc and iron aid chlorophyll synthesis and enzyme activation and boron support flower formation and pollen viability. Similar results were reported in pomegranate, guava, sweet orange, papaya, and acid lime by Kumar *et al.* (2017) [17], Yadav *et al.* (2018) [29], Sankhla and Vashistha (2019) [23].

Fruit set (%)

The data on fruit set (%) influenced by foliar sprays in acid lime cv. Balaji showed that T₃-2,4-D @ 25 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) recorded the highest fruit set (62.00%), followed by T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) with 58.30%. The lowest fruit set (35.00%) was in the control (T₈). 2,4-D, a synthetic auxin, enhances cell division in the floral meristem, improving flower initiation, ovary formation and pollen viability. Zinc, iron and boron support chlorophyll production, enzymatic activity, auxin synthesis, pollen tube growth and assimilate transport, collectively optimizing Fertilization and fruit retention. These findings align with Chouhan *et al.* (2018) [2] and Rangaraj *et al.* (2022) [19].

Fruit drop percentage (%)

The data on fruit retention (%) showed significant differences among treatments. The highest retention (60.26%) was in T₃ (2,4-D @ 25 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) by T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) at 57.03%. The control (T₈) had the lowest retention (32.43%). 2,4-D delays abscission layer formation and reduces ethylene, slowing

fruit drop. FeSO₄ boosts chlorophyll and photosynthesis, ZnSO₄ supports auxin synthesis, and borax aids pollen viability and carbohydrate transport, collectively enhancing fruit attachment and nutrient supply. This aligns with findings by Kumar *et al.* (2016) [19], Gaikwad *et al.* (2019) [4] in various fruit crops.

Juice content per fruit (mL)

The data shows that foliar sprays significantly influenced juice content in acid lime cv. Balaji. The highest juice content (48.94 mL) was recorded with T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%), closely followed by T₇-KNO₃ 2% + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) 48.73 mL, while the lowest (34.75 mL) was in control (T₈). The increased juice content may be attributed to the synergistic effects of GA₃ and micronutrients enhancing fruit growth and juice accumulation. GA₃ promotes cell elongation, expansion and photosynthetic activity, while zinc and iron improve assimilate formation, and boron enhances sugar transport. Similar results were reported by Tagad *et al.* (2018), Singh *et al.* (2022), and Kumari *et al.* (2024) in citrus.

Fruit length (cm)

Data revealed that foliar sprays significantly influenced fruit length in acid lime cv. Balaji. The longest fruits (4.60 cm) were recorded with T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%), followed by T₇-KNO₃ 2% + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) (4.50 cm), while the shortest (3.70 cm) occurred in control (T₈). The improvement in fruit length may result from enhanced cell elongation, nutrient translocation and a prolonged growth phase induced by GA₃ and micronutrients. GA₃ promotes cell division and photosynthetic efficiency, while zinc, iron and boron enhance nutrient uptake and sugar transport. The combined action of these inputs likely improved overall fruit growth and contributed to better shape and size. Similar findings were reported by Kumar *et al.* (2018) [2].

Fruit weight (g)

Data revealed that foliar sprays significantly affected fruit weight in acid lime cv. Balaji. The highest fruit weight (43.60 g) was obtained with T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%), followed by T₇-KNO₃ 2% + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) (42.31 g), while the lowest (35.50 g) was recorded in control (T₈). The increase in fruit weight may be attributed to the synergistic effects of GA₃ and micronutrients enhancing cell division, elongation, photosynthesis and nutrient translocation, resulting in better fruit development. Similar findings were reported by Ghosh *et al.* (2012) [5] and Baviskar *et al.* (2015) [1].

Peel weight (g)

Foliar spray treatments significantly influenced peel weight in acid lime cv. Balaji. The lowest peel weight (7.07 g) was obtained with T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%), followed by T₇-KNO₃ 2% + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) (7.34 g), whereas the highest (8.70 g) was recorded in the control (T₈). The reduction in peel weight may be attributed to enhanced translocation of assimilates to the pulp and improved cell elongation in the mesocarp. GA₃ promotes enzymatic activity and carbohydrate mobilization, increasing pulp

growth while reducing peel thickness. Micronutrients like zinc, iron and boron further improved chlorophyll synthesis, nutrient transport and cell wall flexibility, contributing to thinner peels. Similar findings were reported by Nehete *et al.* (2011) ^[13] and Singh *et al.* (2020) ^[26].

Total soluble solids (°Brix)

Foliar sprays significantly influenced the total soluble solids (TSS) content in acid lime cv. Balaji. The highest TSS (8.90 °Brix) was recorded with T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%), followed by T₇-KNO₃ 2% + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) (8.60 °Brix), while the lowest (7.50 °Brix) occurred in control (T₈). The increase in TSS may be attributed to enhanced enzyme activity, photosynthesis and carbohydrate accumulation promoted by GA₃ and micronutrients. Zinc and iron improved chlorophyll synthesis and assimilate production, contributing to higher sugar content in fruits. Similar results were reported by Debbarma and Hazarika (2016) ^[3] and Ranganna *et al.* (2017) ^[17]

Titration acidity (%)

Foliar sprays significantly affected the acidity of acid lime fruits. The lowest acidity (4.23%) was recorded with T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%), followed by T₇-KNO₃ 2% + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) (4.67%), while the highest (6.81%) was noted in control (T₈). The reduction in acidity may be due to GA₃-induced fruit growth and maturation, coupled with enhanced enzymatic activity and organic acid metabolism influenced by micronutrients. This combination improves nutrient utilization and balances fruit metabolism, leading to better flavour and quality. Similar results were reported by Jawed *et al.* (2016) ^[6]

Ascorbic acid content (mg/100 mL juice)

Foliar sprays significantly influenced the ascorbic acid content of acid lime cv. Balaji. The highest value (30.20 mg/100 mL) was recorded with T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%), followed by T₇-KNO₃ 2% + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) (29.40

mg/100 mL), while the lowest (25.00 mg/100 mL) was observed in control (T₈). The increase in ascorbic acid may be attributed to GA₃-induced enzymatic activity and improved nutrient metabolism supported by zinc, iron and boron. These treatments enhanced vitamin C synthesis and overall fruit quality. Similar findings were reported by Tripathi *et al.* (2022) ^[28] and Masood *et al.* (2024) ^[11].

No. of fruits per tree

Foliar application of different treatments had a marked influence on the number of fruits per tree in acid lime cv. Balaji. The highest fruit count (760.33) was obtained with T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%), closely followed by T₇-KNO₃ 2% + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) (719.63), whereas the control (T₈) recorded the lowest number (440.31). The increase in fruit load may be attributed to the combined influence of GA₃ and micronutrients, which enhance flowering, fruit set, and nutrient utilization. GA₃ aids in cell division, elongation and hormonal regulation, while zinc, iron and boron improve enzyme activity, photosynthetic efficiency and pollination success. This coordinated effect promoted better fruit development and yield, corroborating the results of Rathore *et al.* (2010) ^[21], Naik and Babu (2013) ^[12]

Fruit yield per tree (kg)

Foliar sprays significantly influenced fruit yield per tree in acid lime cv. Balaji. The highest yield (33.15 kg/tree) was obtained with T₁-GA₃ @ 50 ppm + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%), followed by T₇-KNO₃ 2% + ZnSO₄ (1%) + FeSO₄ (1%) + borax (0.6%) (30.46 kg/tree), while the control (T₈) recorded the lowest yield (15.63 kg/tree). The increased yield may be attributed to GA₃-promoted cell division and fruit development, enhanced by micronutrients that improve enzymatic activity, chlorophyll synthesis and nutrient translocation. These treatments collectively improved fruit set, reduced fruit drop and optimized nutrient allocation. Similar findings were reported by Rao and Laxmi (2020) ^[20] and Kumar and Joshi (2021) ^[8].

Table 1: Effect of foliar sprays on no. of flowers per shoot in acid lime cv. Balaji

Treatments	No. of flowers per shoot
T ₁ -GA ₃ @ 50 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	19.61
T ₂ -NAA @ 100 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	16.98
T ₃ -2,4-D @ 25 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	17.31
T ₄ -Kinetin @ 50 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	15.88
T ₅ -Salicylic acid @ 200 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	13.64
T ₆ -Urea 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	14.21
T ₇ -KNO ₃ 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	18.30
T ₈ -Control (Water spray)	11.17
SEm (±)	0.24
CD at 5%	0.74

Table 2: Effect of foliar sprays on Fruit set (%) and Fruit drop (%) in acid lime cv. Balaji

Treatments	Fruit set (%)	Fruit drop (%)
T ₁ -GA ₃ @ 50 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	58.30 (49.58) *	40.06 (39.31) *
T ₂ -NAA @ 100 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	52.00 (46.65) *	47.23 (43.24) *
T ₃ -2,4-D @ 25 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	62.00 (51.67) *	39.36 (39.29) *
T ₄ -Kinetin @ 50 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	49.30 (44.85) *	43.60 (40.95) *
T ₅ -Salicylic acid @ 200 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	43.00 (41.03) *	44.56 (41.51) *
T ₆ -Urea 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	48.90 (43.59) *	43.06 (41.34) *
T ₇ -KNO ₃ 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	54.90 (47.05) *	42.50 (40.35) *
T ₈ -Control (Water spray)	35.00 (36.18)*	50.06 (44.69) *
SEm (±)	0.37	0.44
CD at 5%	1.15	1.35

* Figures in parentheses indicate angular transformed values

Table 3: Effect of foliar sprays on Juice content per fruit (%) in acid lime cv. Balaji

Treatments	Juice content per fruit (%)
T ₁ -GA ₃ @ 50 ppm + ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	48.94 (44.22) *
T ₂ -NAA @ 100 ppm + ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	41.75 (40.25) *
T ₃ -2,4-D @ 25 ppm + ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	39.84 (38.83) *
T ₄ -Kinetin @ 50 ppm + ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	43.96 (41.15) *
T ₅ -Salicylic acid @ 200 ppm + ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	37.44 (38.01) *
T ₆ -Urea 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	41.00 (39.48) *
T ₇ -KNO ₃ 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	48.73 (44.55) *
T ₈ -Control (Water spray)	34.75 (35.34) *
SEm (±)	0.35
CD at 5%	1.09

*Figures in parentheses indicate angular transformed values

Table 4: Effect of foliar sprays on fruit length(cm) fruit weight (g) and peel weight (g) in acid lime cv. Balaji

Treatments	Fruit length (cm)	Fruit weight (g)	Peel weight (g)
T ₁ -GA ₃ @ 50 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	4.60	43.60	7.07
T ₂ -NAA @ 100 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	4.20	40.20	7.95
T ₃ -2,4-D @ 25 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	4.30	41.20	7.54
T ₄ -Kinetin @ 50 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	4.00	38.30	8.16
T ₅ -Salicylic acid @ 200ppm + ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	3.89	37.40	8.36
T ₆ -Urea 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	4.10	39.20	7.75
T ₇ -KNO ₃ 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	4.50	42.31	7.34
T ₈ -Control (Water spray)	3.70	35.50	8.70
SEm (±)	0.06	0.17	0.05
CD at 5%	0.20	0.54	0.16

Table 5: Effect of foliar sprays on titable acidity, TSS and ascorbic acid in acid lime cv. Balaji

Treatments	Titration acidity (%)	TSS (°Brix)	Ascorbic acid content (mg/100 g)
T ₁ -GA ₃ @ 50 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	4.23 (2.29) *	8.90	30.20
T ₂ -NAA @ 100 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	5.38 (2.53) *	8.20	28.20
T ₃ -2,4-D @ 25 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	5.02 (2.64) *	8.40	27.60
T ₄ -Kinetin @ 50 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	5.14 (2.47) *	7.90	26.40
T ₅ -Salicylic acid @ 200 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	6.29 (2.69) *	7.80	27.00
T ₆ -Urea 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	5.75 (2.60) *	8.10	28.80
T ₇ -KNO ₃ 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	4.67 (2.37) *	8.60	29.40
T ₈ -Control (Water spray)	6.81 (2.79) *	7.50	25.00
SEm (±)	0.007	0.01	0.19
CD at 5%	0.02	0.03	1.18

*Figures in parentheses indicate square root transformed values

Table 6: Effect of foliar sprays on Juice content per fruit (%) in acid lime cv. Balaji

Treatments	No. of fruits per tree	Fruit yield per tree (kg)
T ₁ -GA ₃ @ 50 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	760.33	33.15
T ₂ -NAA @ 100 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	640.01	25.73
T ₃ -2,4-D @ 25 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	681.45	28.07
T ₄ -Kinetin @ 50 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	561.19	21.44
T ₅ -Salicylic acid @ 200 ppm+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	520.19	19.46
T ₆ -Urea 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	600.26	21.72
T ₇ -KNO ₃ 2%+ ZnSO ₄ (1%) + FeSO ₄ (1%) + borax (0.6%)	719.63	30.46
T ₈ -Control (Water spray)	440.31	15.63
SEm (±)	0.68	0.04
CD at 5%	2.08	0.13

Summary and Conclusions

Foliar application of GA₃ (50 ppm) + ZnSO₄ (1%) + FeSO₄ (1%) + Borax (0.6%) T₁ significantly improved biochemical, physical, reproductive, and yield traits of acid lime, resulting in superior fruit quality, yield, and economic returns. Hence, T₁ is recommended for achieving maximum productivity and profitability in acid lime cultivation.

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