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# Effect of growth regulators, micronutrients and chemicals on reproductive and quality of acid lime cv- Vikram in Ambebahar under High density planting system (*Citrus aurantifolia* Swingle)

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## Abstract
The experiment was conducted in Randomized Complete Block Design with three replications during 2016-17 & 2017-18 to assess the performance of growth regulators, micronutrients and chemicals on reproductive and quality of acid lime. The experiment was conducted on the Experimental area, College of Agriculture, Gwalior (M.P.).The role of growth regulators, micronutrients and chemicals is very crucial in growth and quality improvement of fruit crops. Study was undertaken to investigate the different combinations of plant growth regulators ($GA_3$ and NAA), micronutrients($FeSO_4$ and Boron) and chemicals ($KNO_3$ and Salicylic acid). Treatment $GA_3$ 100 ppm + $KNO_3$ 2% + Salicylic acid 200 ppm + $FeSo_4$ 1% + Boron 1% ($T_{11}$) shows significant variance regarding days to flower budinitiation (38.5 days), days to 50% flowering (49.0 days), days to fruit setting (72.0 days), fruit setting percentage (87.1 %), fruit retention percentage (84.5 %) and fruit drop percentage (15.5 %), total soluble solid (8.93 $^0$Brix), total acid (6.62 %) and ascorbic acid (29.9 mg).

**Keywords:** $GA_3$, NAA, $FeSO_4$, boron, fruit setting, fruit drop, TSS, ascorbic acid

## Introduction
Acid lime (*C. aurantifolia* Swingle), a member of Rutaceae family, is native of India. The acid lime is extensively grown in almost all parts of tropical and subtropical regions. It is highly polyembryonic distinct species of lime has great commercial importance. The flowering and fruiting takes place throughout year. India ranks fifth among major lime and lemon producing countries in the world. India is the largest producer of acid lime in the world.
Acid lime is rich in vitamin C, minerals and salts. The seasonality of production leads to market glut which results in poor returns to the farmers. In recent years, chemical regulation of flowering and fruiting has been successfully proven in several fruit crops. In citrus, use of plant growth regulators for promoting or inhibiting flowering has been suggested by Moss (1969) [5] and Iwahori and Oohata (1981) [4]. GA3 is well-known in promoting flower growth and development, its involvement in controlling the delay of senescence is less clear. There have been reports that GA3 has little effect as an ethylene inhibitor, inhibiting both climacteric ethylene production and flower senescence (Beyer, 1976).

## Method and Material
The experiment will be laid out in Randomized Block Design with three replications. The experiment comprised of 13 treatments consisting of use of plant growth regulators, micronutrients and chemicals during 2016-17 & 2017-18. Treatment consisted of $T_{1:}$ Control (water spray), $T_{2:}$ $GA_3$ 50 ppm + $KNO_3$ 1%, $T_3$: $GA_3$ 100 ppm + $KNO_3$ 2%, $T_{4:}$ $GA_3$ 50 ppm + Salicylic acid 100ppm, $T_{5:}$ $GA_3$ 100 ppm + Salicylic acid 200ppm, $T_{6:}$ NAA 200ppm + $KNO_3$ 1%, $T_{7:}$ NAA 300ppm + $KNO_3$ 2%, $T_{8:}$ NAA 200ppm + Salicylic acid 100ppm, $T_{9:}$ NAA 300ppm + Salicylic acid 200ppm, $T_{10:}$ $GA_3$ 50 ppm + $KNO_3$ 1% + Salicylic acid 100ppm + $FeSo_4$ 0.5% + Boron 0.5%, $T_{11:}$ $GA_3$ 100 ppm + $KNO_3$ 2% + Salicylic acid 200ppm + $FeSo_4$ 1% + Boron 1%, $T_{12:}$ NAA 200ppm +$KNO_3$ 1% + Salicylic acid 100ppm + $FeSo_4$ 0.5% + Boron 0.5%, $T_{13:}$ NAA 300ppm +$KNO_3$ 2% + Salicylic acid 200ppm + $FeSo_4$ 1% + Boron 1%.
All treatments replicated thrice. One tree will be used for each treatment. The treatment imposed four months before flowering in October followed by January-February through foliar spray.

The data were recorded for reproductive and quality traits *viz.*, days to flower budinitiation, days to 50% flowering, days to fruit setting, fruit setting percentage, fruit retention percentage, fruit drop percentage, total soluble solid, total acid and ascorbic acid.

## Result and Discussion

Pooled data analysis showed significant difference in days to flower budinitiation, days to 50% flowering, days to fruit setting, fruit setting percentage, fruit retention percentage, fruit drop percentage, total soluble solid, total acid and ascorbic acid for both years (Table 1). Minimum days to flower budinitiation were recorded in treatment ($T_{11}$) (38.5 days) which was significantly at par with treatment ($T_{13}$) (39.5 days). Minimum days to 50% flowering were premeditated in treatment ($T_{11}$) (49.0 days) which was significantly at par with treatment ($T_{13}$) (50.0 days) and ($T_{12}$) (52.5 days) which was significantly followed by ($T_{10}$) (54.2 days). Minimum days to fruit setting were premeditated in treatment ($T_{11}$) (72.0 days). Maximum fruit setting percentage were premeditated in treatment ($T_{11}$) (87.1%) which was significantly at par with treatment ($T_{13}$) (85.0%) followed significantly by ($T_{12}$) (82.6 %), ($T_{10}$) (80.3%), ($T_9$) (78.1%) and ($T_8$) (75.2 %).Maximum fruit retention percentage were premeditated in treatment ($T_{11}$) (84.5 %) which was significantly at par with treatment ($T_{13}$) (82.5 %) and ($T_{12}$) (80.1%). Minimum fruit drop percentage was premeditated in treatment ($T_{11}$) (15.5 %) which was significantly at par with treatment ($T_{13}$) (17.5 %). Maximum TSS was premeditated in treatment ($T_{11}$) recorded maximum TSS (8.93 $^0$Brix) which was significantly at par with treatment ($T_{13}$) (8.92 $^0$Brix), ($T_{12}$) (8.83 $^0$Brix), ($T_{10}$) (8.81 $^0$Brix), ($T_9$) (8.79 $^0$Brix) and ($T_8$) (8.76 $^0$Brix). Minimumtotal acid was premeditated in treatment ($T_{11}$) recorded minimum total acid (6.62 %). Maximum ascorbic acid was recorded in treatment ($T_{11}$) recorded maximum ascorbic acid (29.9 mg) which was significantly at par with treatment ($T_{13}$) (28.6 mg), ($T_{12}$) (27.5 mg) and ($T_{10}$) (26.7 mg) (Table 1).

This was result of boost of growth regulators to provide stability to flowers by constant supply of nutrients leads to increase in earliness in flowering traitsespecially growth regulators such as $GA_3$ and NAA (Bhati A. *et al.* (2016) [2] and Tagad S.S. *et al.* (2018) [7]. Flow of proper nutrition enhances TSS quality of fruit.Best combination of micronutrients and growth regulators reflects into decrease in total acids. Treatments with increasing growth regulator and micronutrient dosage found with decreasing total acid (Ganga, R. *et al.* (2019) [3]. Ascorbic acid mainly influences by micronutrient and growth regulators influence on fruit acidity. Decreasing in fruit total acidity and increase in TSS results in increase of ascorbic acid content in fruit. This condition build up base for good fruit quality and effect was precisely seeing in bothyears (Bhati A. *et al.* (2016) [2], Ranganna, G.*et al.* (2017) [6].

**Table 1:** Effect of growth regulators, micronutrients and chemicals onreproductive and quality traits of acid lime

| Treatments | DFBI | D50%F | DFS | FS (%) | FR (%) | FD (%) | TSS ($^0$Brix) | TA (%) | AA (mg) |
|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | 60.5 | 71.0 | 94.0 | 55.9 | 53.4 | 46.6 | 7.69 | 8.01 | 19.7 |
| $T_2$ | 56.3 | 66.8 | 89.8 | 59.0 | 56.4 | 43.6 | 7.78 | 7.70 | 21.5 |
| $T_3$ | 54.5 | 65.0 | 88.0 | 61.8 | 59.3 | 40.7 | 8.00 | 7.59 | 21.8 |
| $T_4$ | 49.7 | 60.2 | 83.2 | 69.2 | 66.7 | 33.3 | 8.59 | 7.30 | 23.2 |
| $T_5$ | 48.8 | 59.3 | 82.3 | 71.9 | 69.3 | 30.7 | 8.73 | 7.22 | 24.1 |
| $T_6$ | 53.2 | 63.7 | 86.7 | 64.1 | 61.6 | 38.4 | 8.16 | 7.49 | 22.3 |
| $T_7$ | 51.7 | 62.2 | 85.2 | 65.8 | 63.3 | 36.7 | 8.34 | 7.40 | 23.0 |
| $T_8$ | 46.8 | 57.3 | 80.3 | 75.2 | 72.7 | 27.3 | 8.76 | 7.14 | 25.0 |
| $T_9$ | 45.5 | 56.0 | 79.0 | 78.1 | 75.5 | 24.5 | 8.79 | 7.01 | 25.8 |
| $T_{10}$ | 43.7 | 54.2 | 77.2 | 80.3 | 77.7 | 22.3 | 8.81 | 6.90 | 26.7 |
| $T_{11}$ | 38.5 | 49.0 | 72.0 | 87.1 | 84.5 | 15.5 | 8.93 | 6.62 | 29.9 |
| $T_{12}$ | 42.0 | 52.5 | 75.5 | 82.6 | 80.1 | 19.9 | 8.83 | 6.79 | 27.5 |
| $T_{13}$ | 39.5 | 50.0 | 73.0 | 85.0 | 82.5 | 17.5 | 8.92 | 6.75 | 28.6 |
| SEm ± | 1.164 | 1.285 | 1.771 | 1.061 | 1.061 | 1.290 | 0.102 | 0.063 | 1.347 |
| CD 5% | 3.275 | 3.615 | 4.985 | 2.986 | 2.986 | 3.630 | 0.288 | 0.176 | 3.789 |

*$T_1$: Control (water spray), $T_2$:$GA_3$ 50 ppm + $KNO_3$ 1%, $T_3$: $GA_3$ 100 ppm + $KNO_3$ 2%, $T_4$: $GA_3$ 50 ppm + Salicylic acid 100ppm, $T_5$: $GA_3$ 100 ppm + Salicylic acid 200ppm, $T_6$: NAA 200ppm + $KNO_3$ 1%, $T_7$: NAA 300ppm + $KNO_3$ 2%, $T_8$: NAA 200ppm + Salicylic acid 100ppm, $T_9$: NAA 300ppm + Salicylic acid 200ppm, $T_{10}$: $GA_3$ 50 ppm + $KNO_3$ 1% + Salicylic acid 100ppm + $FeSo_4$ 0.5% + Boron 0.5%, $T_{11}$: $GA_3$ 100 ppm + $KNO_3$ 2% + Salicylic acid 200ppm + $FeSo_4$ 1% + Boron 1%, $T_{12}$: NAA 200ppm +$KNO_3$ 1% + Salicylic acid 100ppm + $FeSo_4$ 0.5% + Boron 0.5%, $T_{13}$: NAA 300ppm +$KNO_3$ 2% + Salicylic acid 200ppm + $FeSo_4$ 1% + Boron 1%

*Days to flower budinitiation: DFBI, Days to 50% flowering: D50%F, Days to fruit setting: DFS, Fruit setting (%): FS (%), Fruit retention (%): FR (%),Fruit drop (%): FD (%),Total soluble solid($^0$Brix): TSS ($^0$Brix), Total acid (%): TA (%),Ascorbic acid (%): AA (mg).

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