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# Management of *Hasta bahar* in Acid Lime cv. *Kagzi*

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**Abstract**

A field experiment was conducted on acid lime cv. Kagzi for management of *Hasta bahar* with 15 treatments comprising of chemicals applied through *foliar* spray *viz.*, $GA_3$ (50 and 75 ppm), NAA (400 & 500 ppm, $KNO_3$ (1 & 1.5%), *Cycocel* (1000 & 1500 ppm), $PP_{333}$ (1000 & 2000 ppm), applied through soil drenching *viz.*, $PP_{333}$ (2.5 & 5 ml plant$^{-1}$), cultural practices (Root pruning + exposure and withholding of irrigation water) and control. Cycocel @1000 ppm in the month of September gave early induction of flowering (2, November), maximum number of flowers shoot$^{-1}$ (60.0), fruit set (19.50%), highest fruit retention (49.0%), maximum number of fruits tree$^{-1}$ (634), highest yield tree$^{-1}$ (30.50 kg) and yield ha$^{-1}$ (8.47 t) and best quality parameters such as high ascorbic acid (39.20 mg 100ml$^{-1}$ juice), juice per cent (52.78), organoleptic score (8.95) with higher B:C ratio (3.46).

**Key Words**: Hasta bahar, Acid lime, PGRs, Crop regulation.

## Introduction

Acid lime (*Citrus aurantifolia* Swingle.) is the third important citrus fruit crop in India next to mandarins and sweet orange (Anonymous, 2013). It is a good source of vitamin C and has good antioxidant properties. It is an appetizer, stomachic, antiscorbutic, antihelmintic and it check biliousness (Basak, 2006). The acid lime tree bears flowers round the year with main season of flowering during January-February (Spring season) and gave fruits during July-August (*ambe bahar*) create glut in the market which result in poor return to growers. The crop from October-November flowering matures fruit during of April-May i.e., *haste bahar* fetch good price. The major constraint faced by the growers of acid lime is the peak and lean production in the same year. The present study was therefore under taken to investigate the effective agro chemical (s) ($GA_3$, NAA, $KNO_3$, Cycocel) and cultural practices for better flowering and fruiting on acid lime.

## Materials and Methods

An experiment was conducted at Farmer field under KVK, Sirohi and Department of Horticulture, Rajasthan College of Agriculture, Udaipur during the year 2012-13. The experiment was laid out in one way analysis with fifteen treatments replicated thrice with plot size 20 m × 20 m and crop geometry at of 6 m × 6 m consisting of 9 plants each. Eight year old uniform seeded acid lime trees were selected for the experiment. The abiotic factors *viz.*, average minimum and maximum temperatures were 28.0° ± 5.0°C and 38.0° ± 5.0°C, average relative humidity of 58.0 ± 10.0% and 585.0 mm rainfall per annum were recorded during the experimentation. The soil texture of experimental plot was sandy loam with pH 7.5, having organic carbon 0.55%, available P 27.5 ha$^{-1}$ and K 375.0 kg ha$^{-1}$. The treatments tried were $T_0$ (absolute control), $T_1$(foliar spray of $GA_3$@ 50 ppm in the month of June), $T_2$ (foliar spray of $GA_3$@ 75 ppm in the month of June), $T_3$ (foliar spray of NAA@ 400 ppm in the month of October), $T_4$ (foliar spray of NAA @ 500 ppm in the month of October), $T_5$ (foliar spray of $KNO_3$ @ 1per cent in the month of October), $T_6$ (foliar spray of $KNO_3$ @ 1.5 per cent in the month of October), $T_7$ (foliar spray of paclobutrazoal @ 1000 ppm in the month of August), $T_8$ (foliar spray of paclobutrazoal @ 2000 ppm in the month of August), $T_9$ (foliar spray of Cyococel @1000 ppm in the month of September), $T_{10}$ (foliar spray of Cyococel @1500 ppm in the month of September), $T_{11}$ (paclobutrazoal soil drenching @2.5 ml plant$^{-1}$ in the month of July), $T_{12}$ (paclobutrazoal soil drenching @ 5 ml plant$^{-1}$ in the month of July), $T_{13}$ (with holding irrigation in September-October), $T_{14}$ (root pruning and exposure in October). Light irrigation was applied uniformly 22-25 days after treatment application. The intercultural operations (weeding, manuring, fertilizer application, mulching, insecticide spray etc.) were done as and when necessary. *Ambe bahar* crop has been avoided in all treatment plants. Observation on date to flower initiation, number of flowers shoot$^{-1}$, per cent fruit set, per cent fruit retention, number of fruits, fruit weight and yield tree$^{-1}$, yield ha$^{-1}$ were recorded at appropriate time by standard methods. Acidity (as citric acid) was determined by using standard N/10 NaOH solution in the presence of phenolphthalein as an indicator (AOAC, 1990). The vitamin 'C' (ascorbic acid) content of the juice was estimated by visual titration method with 2, 6-dichlorophenol-indonenol dye solution (AOAC, 1990). Organoleptic score (consumer preference) of fruits juice was tested by a panel of five semi-trained judges using 9 point hedonic scale (Amerine *et al.*, 1965). Net financial returns were calculated by subtracting the cost of each treatment from the gross return and the benefit: cost ratio was determined by net income divided by cost of cultivation. The data were subjected to analysis of variance (ANOVA) to

determine significant differences followed by Tukey's test for comparisons of means at significance level of $P \leq 0.05$.

**Results and Discussion**

Number of days to first flowering is an important factor that governs either delay or earliness of a crop. It is influenced by diverse factors like genetic, environmental, physiological, nutritional, hormonal and cultural. In the present study, the different treatment induced the flowering. The earliest flowering and maximum number of flowers shoot$^{-1}$ and fruit set were observed in trees sprayed with $T_9$ (foliar spray of Cyococel @1000 ppm) by nearly 14 days in compare to control. This might be due to Cycocel, a growth retardant acted as an antigibberellin compound and arrested the vegetative bud development, nucleic acid synthesis and protein metabolism by specific anti metabolities, which induce flower formation. Similar results were also reported by Brahmachari *et al.*, (1996) in guava.

The highest fruit retention (57.0%) was noticed in trees sprayed with $T_4$ (foliar spray of NAA @ 400 ppm) probably due to auxin inhibition activity of the hydrolytic enzyme polygalactoronose and cellulose, which are responsible for the degradation of the cell wall and the middle lamella in the abscission zone (Goren, 1993). The synthetic auxin α- naphathalene acetic acid (NAA) gave positive result in retention of the fruits. Further, treatment $T_9$ (foliar spray of Cyococel @1000 ppm in the month of September) recorded maximum number of flowers shoot$^{-1}$ (60.0), highest fruit set (19.50%) and fruit retention (49.0%), with highest fruits tree$^{-1}$ (634), fruit yield tree$^{-1}$ (30.50 kg) and yield ha$^{-1}$ (8.47 t). However, both Cycocel treatments i.e., $T_9$ and $T_{10}$ were *at par* with these parameters. The increase in yield might be due to more flowers, fruit set and number of fruits per tree. These results are in agreement with the findings of Shrestha (1988), Sadawarte *et al.* (2010) and Mahalle *et al.*, (2010).

A perusal of data presented in table-2 indicated that the acid lime plant received foliar spray of cycocel @ 1000 ppm in the month of September ($T_9$) exhibited maximum value of juice (52.78%), ascorbic acid (39.20mg 100ml$^{-1}$ juice) and organoleptic observation (8.95). This may be because of cycocel induced early and uniform flowering and fruiting so accumulate more photosynthates with controlled vegetative growth may enhance organic acid content of fruits in treated plants. Ilango and Vijaylakshmi (2002) observed that application of 1500 ppm CCC has significantly increased the tartaric acid content, ascorbic acid, TSS, protein, carbohydrate, reducing, non-reducing and total sugar content of tamarind pod over control.

As far as relative economics of the treatment is concerned, $T_{10}$ treatment exhibited highest net return (Rs. 160246.0), whereas the highest B: C ratio (3.46:1) with Rs. 155331.0 net return was observed in $T_9$ treatment. This might be due to the significantly higher yield and comparatively low cost of cultivation over $T_{10}$ treatment.

Thus, foliar spray of Cycocel @1000 ppm in the month of September followed by 22-25 days with holding of irrigation gave early induction of flowering and maximum in number of flowers shoot$^{-1}$, fruit set, number of fruits and higher B: C in Kegzi lime.

Table 1. Effect of crop regulation treatments on flowering and yield parameters of acid lime cv. Kagzi

| Treatments | Date of flower initiation | Number of flowers shoot$^{-1}$ | Fruit set (%) | Fruit retention (%) | Number of fruits tree$^{-1}$ | Yield per tree (kg) | Estimated yield ha$^{-1}$ (t) |
|---|---|---|---|---|---|---|---|
| $T_0$ | 16 November | 35 | 15.00 | 37 | 496 | 17.33 | 4.81 |
| $T_1$ | 4 November | 38 | 17.50 | 45 | 580 | 22.13 | 6.15 |
| $T_2$ | 5 November | 40 | 18.00 | 49 | 560 | 22.71 | 6.31 |
| $T_3$ | 13 November | 42 | 20.00 | 55 | 605 | 26.98 | 7.50 |
| $T_4$ | 14 November | 44 | 19.00 | 57 | 616 | 27.78 | 7.72 |
| $T_5$ | 11 November | 50 | 16.00 | 39 | 518 | 18.86 | 5.24 |
| $T_6$ | 10 November | 48 | 15.00 | 43 | 526 | 20.06 | 5.57 |
| $T_7$ | 12 November | 44 | 16.50 | 45 | 516 | 20.00 | 5.56 |
| $T_8$ | 9 November | 42 | 16.00 | 47 | 520 | 21.13 | 5.87 |
| $T_9$ | 2 November | 60 | 19.50 | 49 | 634 | 30.50 | 8.47 |
| $T_{10}$ | 3 November | 58 | 19.00 | 47 | 620 | 28.63 | 7.95 |
| $T_{11}$ | 12 November | 42 | 16.00 | 45 | 566 | 25.03 | 6.95 |
| $T_{12}$ | 8 November | 44 | 15.50 | 43 | 556 | 24.00 | 6.67 |
| $T_{13}$ | 6 November | 42 | 17.50 | 45 | 546 | 22.30 | 6.19 |
| $T_{14}$ | 7 November | 48 | 17.00 | 41 | 534 | 20.80 | 5.78 |
| SEm ± | - | 1.18 | 0.45 | 1.25 | 14.63 | 0.86 | 0.24 |
| CD at 5% | - | 3.41 | 1.31 | 3.63 | 42.28 | 2.50 | 0.69 |

Table 2. Effect of crop regulation treatments on quality and economics of acid lime cv. Kagzi

| Treatments | Fruit weight (g) | Acidity (%) | Ascorbic acid (mg/100 mljuice) | Juice (%) | Organoleptic score (out of 9) | Total cost ha$^{-1}$ (Rs.) | Net return (Rs.) | B:C |
|---|---|---|---|---|---|---|---|---|
| $T_0$ | 38.00 | 4.12 | 35.50 | 32.40 | 7.17 | 40749 | 79511 | 1.95 |
| $T_1$ | 38.16 | 4.15 | 36.90 | 34.24 | 7.22 | 43529 | 109741 | 2.52 |
| $T_2$ | 40.56 | 4.20 | 37.25 | 36.25 | 7.25 | 44919 | 112373 | 2.50 |
| $T_3$ | 43.20 | 4.50 | 37.45 | 40.65 | 7.47 | 43557 | 126665 | 2.91 |
| $T_4$ | 43.00 | 4.90 | 37.90 | 38.50 | 7.57 | 44259 | 128749 | 2.91 |
| $T_5$ | 36.4 | 4.25 | 37.60 | 42.25 | 7.65 | 41583 | 88989 | 2.14 |
| $T_6$ | 38.15 | 4.40 | 36.50 | 32.80 | 7.80 | 42000 | 96963 | 2.31 |
| $T_7$ | 38.76 | 4.60 | 37.30 | 34.65 | 8.20 | 44919 | 93582 | 2.08 |
| $T_8$ | 40.65 | 5.00 | 36.40 | 36.12 | 8.60 | 49089 | 97292 | 1.98 |
| $T_9$ | 46.18 | 5.26 | 39.20 | 52.78 | 8.95 | 44919 | 155331 | 3.46 |
| $T_{10}$ | 47.20 | 5.72 | 39.00 | 50.96 | 8.82 | 47004 | 160246 | 3.41 |
| $T_{11}$ | 44.24 | 5.70 | 37.40 | 46.46 | 6.67 | 42774 | 130627 | 3.05 |
| $T_{12}$ | 43.17 | 5.50 | 38.20 | 34.80 | 6.87 | 44919 | 121298 | 2.70 |
| $T_{13}$ | 40.86 | 4.75 | 37.40 | 32.75 | 7.20 | 40749 | 113745 | 2.79 |
| $T_{14}$ | 38.96 | 5.71 | 38.65 | 38.60 | 7.52 | 41484 | 102588 | 2.47 |
| SEm ± | 1.25 | 0.15 | 0.61 | 1.02 | 0.20 | - | - | - |
| CD at 5% | 3.62 | 0.45 | 1.77 | 2.94 | 0.58 | - | - | - |

Cost of chemicals per 250 g or ml was Rs. 6950 for GA, Rs. 877.5 for NAA, Rs. 521 for CCC, Rs. 104 for KNO3 and Rs. 1042.5 for Pp333.

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