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Effect of Growth Regulators and Chemicals on Fruit Yield and Quality of Hasta Bahar Flowering in Acid Lime (*Citrus aurantifolia* Swingle) cv. Balaji.

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Research Article

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ABSTRACT

Acid lime (*Citrus aurantifolia* Swingle) flowers and fruits almost all round the year. There are three important flushes, Ambia bahar (Jan-Feb), Mrig bahar (June-July) and Hasta bahar (Sep-Oct). Among all these hasta bahar crop which comes to harvest during summer gets highest remunerative price. It is very difficult to impose bahar treatment during September - October months in Andhra Pradesh because of the north east monsoon rains. Hence, a field trial was conducted to assess the effectiveness of different combinations plant growth regulators (GA_3 & Cycocel / Lihocin) and chemicals (KNO_3 & Salicyclic acid) in inducing hasta bahar flowering on ten year old Acid lime Balaji plants during 2011-13 at AICRP on Tropical Fruits (Citrus), Dr.YSRHU, Citrus Research Station, Tirupati, Andhra Pradesh. The experiment was laid out in randomized block design with 11 different treatment combinations *i.e.,* GA_3 (50 and 100ppm), Cycocel (1000 ppm), KNO_3 (1% and 2%) Salicyclic acid (100 and 200 ppm) along with control. The treatments were imposed four months before flowering (June) followed by September-October foliar sprays. Results have indicated that the foliar spray of GA_3 (50 ppm in June followed by Cycocel 1000 ppm in September and KNO_3 1% in October was found superior with respect to number of fruits per tree (529.34), fruit weight (41.12 g), yield (24.08 kg/ tree) and quality (juice content 34.34ml and TSS 6.92^0 Brix) during summer (2011-12 and 2012-13). However, the treatment with application of GA_3 100 ppm in June and Cycocel 1000 ppm in September recorded highest benefit cost ratio of 2.42 followed by foliar spray of GA_3 50 ppm in June and Cycocel 1000 ppm in September (2.19).

INTRODUCTION

Sweet orange (*Citrus sinensis* Linn. Osbeck) cv. Sathgudi is an important citrus fruit grown in South Indian states Among different citrus species, Acid lime (*Citrus aurantifolia* Swingle) is the third important citrus fruit crop of India which is native of South- East Asia. In India it is commercially grown in Andhra Pradesh, Gujarat, Orissa, Karnataka and Maharashtra. In Andhra Pradesh the largest area is in semi-arid regions of Nellore, YSR district, West Godavari, East Godavari, Guntur, Prakasam, Nalgonda Mahaboobnagar, Ananthapur and Khammam districts. Acid lime fruits are rich in vitamin C and are used in making pickles.

Acid lime flowers normally thrice in a year i.e., Ambia bahar (Jan-Feb), Mrig bahar (June-July) and Hasta bahar (Sep-Oct). Among all these hasta bahar crop which comes to harvest during summer gets highest remunerative price. In Andhra Pradesh, it is very difficult to impose bahar treatment during

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September - October months because of the monsoon rains. Hence, hasta bahar management through the use of plant growth regulators and chemicals play an important role to get maximum fruit yields during summer. The present study was therefore under taken to investigate the effect of different combinations of plant growth regulators (GA_3 and Cycocel) and chemicals (KNO_3 and Salicyclic acid) on fruit yield and quality of acid lime.

MATERIALS AND METHODS

A field investigation was carried out to assess the effectiveness of different combinations plant growth regulators (GA_3 and Cycocel / Lihocin) and chemicals (KNO_3 and Salicyclic acid) in inducing hasta bahar flowering at AICRP on Tropical Fruits (Citrus), Dr.YSR Horticultural University, Citrus Research Station, Tirupati, Andhra Pradesh during 2011-13. Ten years old trees of Acid lime cultivar Balaji were used as experimental plants. The trees were uniform in age and size and trained to single stem. The trees were grown under drip irrigation following common cultural practices during the study period. The experiment was laid out in randomized block design with eleven treatments replicated thrice. Two trees were used for each treatment. The treatments were imposed four months before flowering (June) followed by September-October foliar sprays. The treatments tried were T_1-Control (water spray),T_2-GA_3 50 ppm June + Cycocel 1000 ppm September, T_3- GA_3 100 ppm June + Cycocel 1000 ppm September, T_4 -T_2 + KNO_3 1% in October, T_5-T_2 + KNO_3 2% in October, T_6-T_2 + Salicyclic acid 100 ppm in October,T_7-T_2 + Salicyclic acid 200 ppm in October,T_8-T_3 + KNO_3 1% in October,T_9-T_3 + KNO_3 2% in October, T_{10}-T_3 + Salicyclic acid 100 ppm in October and T_{11}-T_3 + Salicyclic acid 200 ppm in October. Observations on fruit weight, number of fruits per tree, yield, juice content and TSS were recorded and presented.

RESULTS AND DISCUSSION

In the present investigation, data on effect of plant growth regulators and chemicals on summer fruit yield of acid lime are furnished in Table1. The highest average fruit weight (41.12g) number of fruits (529.34) and yield per tree (24.08 kg) were obtained in trees sprayed with GA_3 50 ppm in June + cycocel 1000 ppm in September+ KNO_3 one percent in october (T_4) followed by 50 ppm in June + cycocel 1000 ppm in September+ KNO_3 two percent in october (T_5). The increased fruit yield or number of fruits is attributed to the synthesis of chlorophyll from source to sink which leads to increased carbohydrate metabolism. This might be due to more vegetative growth attained with GA_3, which increased the vegetative shoot development at the initial sprays. This is in conformity with the findings of Hari babu *et al.* [3] in acid lime, Greenburg *et al.* [2] in clemantin mandarin and Brosh and Israel [1] in pummelo. Cycocel (Lihocin) sprays during september, acted as anti-gibberellin compound by inhibiting vegetative growth, nucleic acid synthesis and protein metabolism thereby enhancing flower bud initiation. Similar results were also reported by Parthiban, *et al*. [6] in acid lime. Potassium nitrate (KNO_3) sprays at later stages also helps to set more fruits. These results are in agreement with the findings of Saraswathi *et al.* [5] in kinnow mandarin and Thirugnanavel *et al*. [7] in acid lime.

Table 1: Effect of plant growth regulators and chemicals on summer fruit yield of acid lime at Tirupati

Treatments	Fruit Weight(g)			No. of fruits/tree			Yield/tree (kg)		
	2011-12	2012-13	Mean	2011-12	2012-13	Mean	2011-12	2012-13	Mean
T1	28.50	34.33	31.42	205.00	496.67	350.84	5.74	20.00	12.87
T2	40.00	38.00	39.00	280.00	601.67	440.84	11.48	26.00	18.74
T3	38.50	38.33	38.42	290.00	627.67	458.84	10.00	30.00	20.00
T4	42.25	40.00	41.12	352.00	706.67	529.34	14.15	34.00	24.08
T5	40.12	39.07	39.60	295.00	636.67	465.84	14.00	32.33	23.17
T6	38.15	37.67	37.91	276.00	583.33	429.67	11.80	28.00	19.90
T7	37.75	39.00	38.38	270.00	586.67	428.34	10.17	28.33	19.25
T8	36.50	35.33	35.92	265.00	590.00	427.50	9.54	26.00	17.77
T9	35.40	36.67	36.04	252.00	566.67	409.34	9.27	26.00	17.64
T10	34.00	37.00	35.50	245.00	566.67	405.84	8.82	24.67	16.75
T11	33.75	33.00	33.38	236.00	578.67	407.34	8.33	26.33	17.33
CD@5%	3.32	3.03	--	0.56	0.78	--	1.56	2.85	--

T_1-Control (water spray),T_2-GA_3 50 ppm June + Cycocel 1000 ppm September, T_3-GA_3 100 ppm June + Cycocel 1000 ppm September, T_4-T_2 + KNO_3 1% in October T_5-T2 + KNO_3 2% in October,T_6-T2 + Salicyclic acid 100 ppm in October,T_7-T_2 + Salicyclic acid 200 ppm in October,T_8-T_3 + KNO_3 1% in October,T_9-T3 + KNO_3 2% in October, T_{10}-T_3 + Salicyclic acid 100 ppm in October, T_{11}-T_3 + Salicyclic acid 200 ppm in October

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Regarding the quality of fruits (Table 2), the treatment with foliar schedule of GA_3 50 ppm in June + cycocel 1000 ppm in September + KNO_3 one percent in october (T_4) registered highest juice content (34.34ml/fruit) and TSS(6.92^0 Brix) followed by GA_3 50 ppm in June + cycocel 1000 ppm in September+ KNO_3 two percent in october (T_5). GA_3 increased the TSS content of the fruit by stimulating the functioning of enzymes involved in physiological processes. Cycocel and Potassium nitrate sprays increased the TSS due to due to increase in the mobilization of carbohydrates from source to sink. Similar results of increased levels of Juice and TSS were also obtained by Nath and Barauh in Assam lemon and Parthiban., *et al*., in acid lime.

An analysis was made to assess the possible impact due to adoption of recommended technology from this study. The benefit cost ratio was highest with foliar spray of GA_3 50 ppm June + Cycocel 1000 ppm September (T_2) followed by GA_3 100 ppm June + Cycocel 1000 ppm September (T_3) eventhough the treatment T_4 (T2 + KNO_3 1% in October) recorded maximum yields with best quality acid lime fruits. This was particularly attributed to additional spray cost of Potassium nitrate during October month.

Treatments	Juice(ml)			TSS(^{0}) Brix			Benefit cost ratio
	2011-12	2012-13	Mean	2011-12	2012-13	Mean	
T1	30.00	28.00	29.00	6.20	6.40	6.30	1.41
T2	31.60	28.67	30.14	6.50	7.06	6.78	2.43
T3	30.00	30.00	30.00	7.00	7.05	7.03	2.19
T4	35.00	33.67	34.34	6.92	6.93	6.92	1.84
T5	33.40	32.00	32.70	6.80	6.83	6.82	1.26
T6	32.50	30.00	31.25	6.85	6.95	6.90	1.96
T7	31.90	29.67	30.79	6.75	6.73	6.74	1.80
T8	32.50	30.33	31.42	6.70	6.83	6.77	0.92
T9	29.58	28.33	28.96	6.80	6.83	6.82	0.59
T10	31.00	30.67	30.84	6.58	6.50	6.54	1.20
T11	29.00	29.32	29.16	6.50	6.59	6.55	1.24
CD@5%	2.20	2.54	--	0.05	0.06	--	

T_1-Control (water spray),T_2-GA_3 50 ppm June + Cycocel 1000 ppm September, T_3-GA_3 100 ppm June + Cycocel 1000 ppm September, T_4-T_2 + KNO_3 1% in October T_5-T_2 + KNO_3 2% in October,T_6-T_2 + Salicyclic acid 100 ppm in October,T_7-T_2 + Salicyclic acid 200 ppm in October,T_8-T_3 + KNO_3 1% in October,T_9-T_3 + KNO_3 2% in October, T_{10}-T_3 + Salicyclic acid 100 ppm in October, T_{11}-T_3 + Salicyclic acid 200 ppm in October

CONCLUSION

The foliar spray with GA_3 50 ppm June + Cycocel 1000 ppm September is the most promising and economically viable technology for maximizing the fruit yield, quality and benefit cost ratio (2.43) for the Acid lime growers during summer in Andhra Pradesh.

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