

Original Research Article

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Effect of Foliar Application of Growth Regulators and Micronutrients on Fruit Yield Attributes of Acid Lime (*Citrus aurantifolia* Swingle)

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The present study was conducted at the Agrotechnology Park, Krishi Vigyan Kendra, College of Agriculture, Gwalior, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during the year 2015-16 and 2016-17. The experiment was laid out in Randomized Block Design (RBD). Seventy four uniform healthy acid lime trees, planted at 6 x 6 m distance were selected under the present study. The experiment consisted of 24 treatment combinations out of six the combination of growth regulators and micronutrients with control and four acid lime varieties. In this manuscript various yield parameters such as number of fruits per tree, fruits yield per tree and fruits yield per hectare have discussed here in respect of foliar application of growth regulators and micronutrients on acid lime varieties.

Introduction

Acid lime (*Citrus aurantifolia* Swingle) is one of the most important fruit crop of India, is generally known as 'Nimbu'. It belongs to the family Rutaceae probably originated in India and then spread to the Middle East and other tropical and subtropical countries (Salunkhe and Desai, 1984). It is mainly cultivated for its multi - fold nutritional and medicinal values, which made acid lime more important among the fruits. Its attractive appearance, penetrating aroma of peel and excellent taste gives a remarkable position to acid lime which is grown widely throughout the world (Babu, 2001). The genus Citrus is economically very important and is known for its juice and pulp throughout the world. In

India, acid lime is grown in a variety of agro-climates comprising from the northern plains and central highlands having hot semi-arid eco-region with black and red soils. There is difficulty in fruit set because of incomplete pollination, hence plant growth regulators and micronutrients may be effectively used to increase fruit set as well increase fruit yield.

Nutritional deficiencies are closely associated with the poor plant growth and fruit set, heavy fruit drop, inferior quality of produce and also make the tree vulnerable to diseases, pests and other disorders. Nutrients like nitrogen, phosphorus and potash play a vital role in promoting the plant vigour and productivity, whereas micronutrients like zinc, boron, copper and Magnesium perform a specific role

in the growth and development of plant, quality produce and uptake of major nutrients. On the other hand, plant growth regulators refer to organic compounds other than nutrients which in small quantities promote, inhibit or otherwise modify any plant physiological process. Plant hormones refer to bio-regulators produced by the plant which usually move within the plant from the site of production to the site of action and regulate plant physiological process at very low concentration. Plant growth substances have key role in different physiological processes related to growth and development of crops. It is obvious that changes in the level of endogenous hormones due to biotic and abiotic stress alter the crop growth and any sort of manipulation including exogenous application of growth substances would help for yield improvement or at least sustenance of the crop.

Materials and Methods

Eight year old bearing Acid lime trees of uniform vigour and size were selected for the present study. The experiment consisted of 24 treatment combinations out of six the combination of growth regulators and micronutrients and four acid lime varieties.

Treatment details

Factor A – Growth regulators and micronutrients (5 + 1 control)

A₁ – GA₃ 50ppm + KNO₃ (0.2%)

A₂ - GA₃ 50ppm + KNO₃ (0.2%) + ZnSO₄ (0.3%)

A₃- GA₃ 50ppm + KNO₃ (0.2%) + ZnSO₄ (0.3%) + Boron (0.1%)

A₄ - GA₃ 50ppm+ Cycocel 1000ppm+ KNO₃ (0.2%) + ZnSO₄ (0.3%) + Boron (0.1%)

A₅- GA₃ 50ppm + Cycocel 2000ppm+ KNO₃ (0.2%) + ZnSO₄ (0.3%) + Boron (0.1%)

A₆- Control

Factor B – Varieties (4)

B₁ – Kagzi lime

B₂ – Vikram

B₃ --Pramalini

B₄ --Sai Sarbati

To test the significance of variation in the data obtained from various characters. The technique of analysis of variance was adopted as suggested by Fisher (1950) for randomized block design.

Results and Discussion

Number of fruits per tree

The data concerning the number of fruits per tree are shown in (Table 1). Maximum number of fruits per tree counted under A₅ (GA₃ 50 ppm + Cycocel 2000 ppm+ KNO₃ @ 0.2% + ZnSO₄ @ 0.3% + Boron @ 0.1%) i.e. 878.49, 918.60 and 898.54 followed by A₄ (GA₃ 50 ppm + Cycocel 1000 ppm+ KNO₃ @ 0.2% + ZnSO₄ @ 0.3% + Boron @ 0.1%) i.e. 811.64, 849.88 and 830.76, A₃ (GA₃ 50 ppm + KNO₃ @ 0.2% + ZnSO₄ @ 0.3% + Boron @ 0.1%) i.e. 772.35, 809.00 and 790.68 while the minimum number of fruits per tree recorded under A₆ (Control) i.e. 654.21, 686.23 and 670.22 during first year, second year and pooled data.

Among the different varieties, B₄ (Sai Sarbati) noted maximum number of fruits per tree i.e. 773.79, 805.67 and 789.73. It was followed by B₃ (Pramalini) i.e. 767.90, 809.85 and 788.88 and B₂ (Vikram) i.e. 758.74, 794.49 and 776.61 while the minimum number of fruits per tree recorded with B₁ (Kagzi lime) i.e. 749.84, 784.34 and 767.09 during first year,

second year and pooled data. All the varieties were found insignificant to each other.

Yield per tree

An assessment of data presented in Table 2 revealed that the maximum yield per tree observed under A₅ (GA₃ 50 ppm + Cycocel 2000 ppm+ KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) *i.e.* 44.55 kg, 49.47 kg and 47.01 kg followed by A₄ (GA₃ 50 ppm + Cycocel 1000 ppm+ KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) *i.e.* 38.30 kg, 41.73 kg and 40.02 kg, A₃ (GA₃ 50 ppm + KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) *i.e.*

34.85 kg, 38.12 kg and 36.49 kg while the minimum yield per tree recorded under A₆ (Control) *i.e.* 25.41 kg, 28.15 kg and 26.78 kg during first year, second year and pooled data.

The variety B₄ (Sai Sarbati) recorded maximum yield per tree *i.e.* 35.30 kg, 39.16 kg and 37.16 kg. It was followed by B₃ (Pramalini) *i.e.* 34.71 kg, 38.21 kg and 36.46 kg and B₂ (Vikram) *i.e.* 33.90 kg, 37.10 kg and 35.50 kg while the minimum yield per tree recorded with B₁ (Kagzi lime) *i.e.* 33.10 kg, 36.21kg and 34.66 kg during first year, second year and pooled data. All the varieties were found insignificant to each other.

Table.1 Effect of foliar application of growth regulators and micronutrients on number of fruits per tree of different acid lime varieties as influenced by growth regulators and Micronutrient treatments

(A) PGR and micronutrients	Number of fruits per tree		
	IY	IY	IY
A ₁	708.95	743.29	726.12
A ₂	749.77	784.52	767.15
A ₃	772.35	809.00	790.68
A ₄	811.64	849.88	830.76
A ₅	878.49	918.60	898.54
A ₆	654.21	686.23	670.22
SE (m)	7.00	8.29	4.99
CD (5%)	19.96	23.63	14.21
(B) Varieties			
B ₁	749.84	784.34	767.09
B ₂	758.74	794.49	776.61
B ₃	767.90	809.85	788.88
B ₄	773.79	805.67	789.73
SE(m)	5.72	6.77	4.07
CD (5%)	16.30	19.29	11.60

Table.2 Effect of foliar application of growth regulators and micronutrients on yield per tree (kg) of different acid lime varieties as influenced by growth regulators and micronutrient treatments

(A) PGR and micronutrients	Yield per tree (kg)		
	IY	IY	IY
A ₁	29.54	32.56	31.05
A ₂	32.86	35.98	34.42
A ₃	34.85	38.12	36.49
A ₄	38.30	41.73	40.02
A ₅	44.55	49.47	47.01
A ₆	25.41	28.15	26.78
SE (m)	0.33	0.68	0.37
CD (5%)	0.95	1.94	1.04
(B) Varieties			
B ₁	33.10	36.21	34.66
B ₂	33.90	37.10	35.50
B ₃	34.71	38.21	36.46
B ₄	35.30	39.16	37.23
SE (m)	0.27	0.56	0.30
CD (5%)	0.77	1.59	0.85

Table.3 Effect of foliar application of growth regulators and micronutrients on yield per ha (q) of different acid lime varieties as influenced by growth regulators and micronutrient treatments

(A) PGR and micronutrients	Yield per ha (q)		
	IY	IY	IY
A ₁	81.82	90.18	86.00
A ₂	91.01	99.68	95.35
A ₃	96.54	105.60	101.07
A ₄	106.09	115.59	110.84
A ₅	123.41	137.03	130.22
A ₆	70.38	77.96	74.17
SE (m)	0.92	1.89	1.01
CD (5%)	2.62	5.38	2.89
(B) Varieties			
B ₁	91.68	100.30	95.99
B ₂	93.91	102.77	98.34
B ₃	96.13	105.83	100.98
B ₄	97.77	108.46	103.12
SE (m)	0.75	1.54	0.83
CD (5%)	2.14	4.39	2.36

Yield per hectare

It is evident from the data presented in (Table 3). Maximum yield per hectare calculated under A₅ (GA₃ 50 ppm + Cycocel 2000 ppm+ KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) i.e. 123.41 q, 137.03 q and 130.22 q followed by A₄ (GA₃ 50 ppm + Cycocel 1000 ppm+ KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) i.e. 106.09 q, 115.59 q and 110.84 q, A₃ (GA₃ 50 ppm + KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) i.e. 96.54 q, 105.60 q and 101.07 q while the minimum yield per hectare recorded under A₆ (Control) i.e. 70.38 q, 77.96 q and 74.17 q during first year, second year and pooled data.

Among the varieties, B₄ (Sai Sarbati) recorded maximum yield per hectare i.e. 97.77 q, 108.46 q and 103.12 q. It was followed by B₃ (Pramalini) i.e. 123.41 q, 137.03 q and 130.22 q and B₂ (Vikram) i.e. 123.41 q, 137.03 q and 130.22 q while the minimum yield per hectare recorded with B₁ (Kagzi lime) i.e. 123.41 q, 137.03 q and 130.22 q during first year, second year and pooled data. All the varieties were found insignificant to each other.

Yield parameters and yield viz., number of fruits per tree, yield per tree and yield per hectare were significantly increased by different varieties. B₄ (Sai Sarbati) recorded highest number of fruits per tree, yield per tree as well as yield per hectare followed by B₃ (Pramalini) and B₁ (Kagzi lime) while the minimum values were observed with B₂ (Vikram).

Present investigation revealed that various yield parameters like number of fruits per tree, yield per tree and yield per hectare were significantly increased by application of different PGR and micronutrients. Higher number of fruits per trees was recorded in A₅ (GA₃ 50 ppm + Cycocel 2000 ppm+ KNO₃

@ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) followed by A₄ (GA₃ 50 ppm + Cycocel 1000 ppm+ KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) and A₃ (GA₃ 50 ppm + KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) while the maximum values was found under A₆ (Control). The results are in conformity with findings of Tripathi and Dhakal (2005) and Devi *et al.*, (2011) in acid lime. Go Guey (1990) reported increase in the number of fruits per tree with the application of GA₃, Cycocel, KNO₃, ZnSO₄ and Boron significantly increases number of fruits per panicle and tree particularly in pruned mango trees. Maximum number of fruits could be due to increase the hormonal activity by pruning and increase number of perfect flowers, flower set, fruit set and retention by cycocel application. Jagtap *et al.*, (2013) who reported significant increase in the number of fruits per tree with the application of GA₃ 200 ppm in Kagzi lime. The increase the number of fruits per tree with the application of GA₃, Cycocel, KNO₃, ZnSO₄ and Boron could be attributed to increase flower set observed with the treatments initially resulting in the more number of fruits per tree.

Highest yield per tree as well as per hectare was recorded in A₅ (GA₃ 50 ppm + Cycocel 2000 ppm+ KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) followed by A₄ (GA₃ 50 ppm + Cycocel 1000 ppm+ KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) and A₃ (GA₃ 50 ppm + KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) while the maximum values was found under A₆ (Control). The increased fruit yield attributed to the synthesis of chlorophyll from source to sink which leads to increase carbohydrate metabolism. This might be due to more vegetative growth attained with GA₃, which increased the vegetative shoot development at the initial sprays. Cycocel sprays enhancing flower bud initiation. KNO₃ sprays could have helped to set more fruits leading highest yield per tree.

The results are in accordance with the findings of Mukunda *et al.*, (2014) with spraying GA₃ 50 ppm during June + CCC @ 1000 ppm during September + KNO₃ 2% during October on acid lime cv. Balaji reported the highest tree yield.

Yield is the culmination of the inter play of several factors like biochemical, physiological and yield parameters. The increase in yield might be due to more fruit set, fruit retention and number of fruits per tree. An increase in fruit yield per tree might be due to more availability of gibberellic acid. Gibberellic acid promotes cell elongation, cell enlargement, increases in number of cells and also helps in increasing fruit volume, diameter and weight ultimately the fruit yield per tree.

The results are in agreement with the findings of Thirugnanavel *et al.*, (2007) in acid lime, Jain *et al.*, (2014) high yield noticed with GA₃ 100 ppm in Nagpur mandarin. Narayanlal *et al.*, (2013) who reported the highest yield per plant was found in 50 ppm GA₃ in guava. Debbarma and Hazarika (2016) also reported the GA₃ @ 100 ppm + CCC @ 1000 ppm + KNO₃ 1 % increases the yield in acid lime. Combined effect of varieties and PGR and micronutrients had exerted non-significant influence on yield and yield parameters.

The present result on acid lime concludes that different PGR and varieties significantly increased various yield parameters in comparison to control. Besides it, A₅ (GA₃ 50 ppm + Cycocel 2000 ppm+ KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%), A₄ (GA₃ 50 ppm + Cycocel 1000 ppm+ KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) and A₃ (GA₃ 50 ppm + KNO₃ @ 0.2% +ZnSO₄ @ 0.3% + Boron @ 0.1%) helped more to achieve the desired value for different yield parameters. So it is recommended to use these in combinations to obtain more yield and better quality of acid lime and to achieve

maximum benefit under the existing agro-climatic conditions of Gwalior region of Madhya Pradesh. On the other hand there were little differences observed within the varieties which were tested. B4 (Sai Sarbati), B3 (Pramalini), B2 (Vikram) and B1 (Kagzi lime) respond well with different PGR and micronutrients.

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