Original Research Article

EFFECT OF MICRONUTRIENTS ON YIELD OF ACID LIME (*Citrus aurantifolia* Swingle) cv. KAGZI LIME

ABSTRACT

The present investigation entitled "Effect of micronutrients on yield of Acid Lime (*Citrus aurantifolia* Swingle) cv. Kagzi Lime" was carried out during *Ambe bahar* 2019 at the Horticultural Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District: Banaskantha, Gujarat. Experiment was laid out in Randomized Block Design with three replications. Total fifteen treatments were evaluated with respect to yield parameters of acid lime. Among various treatments, treatment $ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 % (T_8) was significantly superior over rest of treatments with respect to yield. Results revealed that maximum fruit diameter (4.58 cm), average fruit weight (44.06 g), fruit volume (43.83 cc), number of fruits per tree (946.00), fruit yield (41.68 kg per tree) and total fruit yield (115.46 quintal per hectare) were recorded with treatment $ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 % (T_8) compared to other treatments and control.

Keywords: Micronutrients, yield, zinc sulfate, ferrous sulfate, borax and acid lime

INTRODUCTION

Acid Lime *(Citrus aurantifolia* Swingle), belongs to the family Rutaceae. Citrus is the third largest fruit crop grown in India next to mango and banana. It is generally grown under both tropical and subtropical climatic conditions. It is a rich source of vitamin C and has good antioxidant properties. Fruits being acidic in nature, they are largely used for garnishing and flavoring several vegetarian and non-vegetarian dishes. Besides its value-added products like pickle, juice, squash *etc.,* lime peel oil, peel powder *etc* are also in great demand in soap and cosmetic industry (Debaje *et al*. 2011).

Zinc is required to obtain good fruit set and size. Its role in flowering is due to synthesis of tryptophan which is a precursor of auxin and promotes flowering. It also helps in the process of translocation of metabolites to the bud itself or to the site of bud development. Its deficiency produces small and narrow leaves, shorter shoot internodes and terminal dieback (Ryugo, 1988).

Iron is required for the synthesis of enzymes responsible for chlorophyll synthesis. Iron deficiency is expressed as yellow leaves due to low levels of chlorophyll (chlorosis), which first appears on the younger upper leaves in interveinal tissues. Severe iron deficiency may cause leaves to turn completely yellow or almost white and then brown as leaves die (Pandey and Sinha, 2006).

Boron is important element for flowering, fruiting, growth and quality of fruits. Boron also increase the chlorophyll content of leaves and play an important role in enzymatic activities. Foliar application of boron (B) improves tree growth, productivity and fruit quality in citrus. Deficiency of boron in citrus has serious consequences for tree health and crop production and also leads to low sugar content, granulation and excessive fruit abortion as well as rind thickness, symptoms that are seen regularly in fruit grown. So it has to be need of foliar application of boron for its role in the yield and fruit quality of citrus (Prasad *et al*. 2013).

Effective use of micronutrients in acid lime is one such research gap. Micronutrients can tremendously boost up acid lime flowering and fruiting quality. The problem of micronutrients deficiency in acid lime causes great concern to fruit growers and also flower drop as well as fruit drop major problem.

MATERIAL AND METHOD

Experiment was carried out during *Ambe bahar* of the year 2019 under field condition at the Horticultural Instructional Farm, C. P. College of Agriculture, Department of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Dist. Banaskantha, Gujarat. The investigation was conducted on 15 years old plants of acid lime cultivar “Kagzi Lime”. All the plants selected were uniform in growth and size which planted at the distance of 6m × 6 m and were subjected to uniform application of cultural practices like weeding, irrigation, manures, fertilizers and plant protection measures *etc*.

Experiment was laid out in randomized block design with three replications. Total fifteen treatments were evaluated in the present study *viz*., T_1: Control; T_2: $ZnSO_4$ 0.5 %; T_3: $ZnSO_4$ 1 %; T_4: $FeSO_4$ 0.5 %; T_5: $FeSO_4$ 1 %; T_6: Borax 0.2 %; T_7: Borax 0.4 %; T_8: $ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 %; T_9: $ZnSO_4$ 0.5 % + $FeSO_4$ 1 % + Borax 0.2 %; T_{10}: $ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.4 %; T_{11}: $ZnSO_4$ 0.5 % + $FeSO_4$ 1 % + Borax 0.4 %; T_{12}: $ZnSO_4$ 1 % +

$FeSO_4$ 0.5 % + Borax 0.2 %; T_{13}: $ZnSO_4$ 1 % + $FeSO_4$ 1 % + Borax 0.2 %; T_{14}: $ZnSO_4$ 1 % + $FeSO_4$ 0.5 % + Borax 0.4 %; T_{15}: $ZnSO_4$ 1 % + $FeSO_4$ 1 % + Borax 0.4 %.

RESULT AND DISCUSSION

Fruit diameter (cm)

The data related to effect of micronutrients on fruit diameter are presented in Table 1. The maximum fruit diameter (4.58 cm) was observed with treatment T_8 ($ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 %) which was statistically at par with treatment T_9, T_{10} and T_{11}. Whereas, the minimum fruit diameter (3.50 cm) was recorded with the treatment T_1 (control).

Increased in fruit diameter might be due to the favorable effect was attributed to the fact that zinc is essential in the nitrogen metabolism (Asana *et al.,* 1971) and it also increase the synthesis of auxin which promote the cell size (Agarwala and Sharma, 1978). The cumulative effect of combination of Zn + Fe + B on faster cell division, cell expansion and increase volume of intercellular spaces in mesocarpic cells. It could also be due to higher mobilization of food and minerals from other parts of plants towards the developing fruit that are extremely active metabolic sink. Similar results were also found by Venu *et al.* (2016) in acid lime, Meena *et al.* (2016) in Nagpur mandarin, Trivedi *et al.* (2012) in guava, Razzaq *et al.* (2013) in mango, Yadav *et al.* (2014) in pomegranate, Meena *et al.* (2014) and Ambaliya and Masu (2018) in aonla.

Average fruit weight (g)

The data showed that the effect of micronutrients on average fruit weight are presented in Table 1. was found significant. The maximum average fruit weight (44.06 g) was observed with treatment T_8 ($ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 %) which was statistically at par with treatment T_9, T_{10}, T_{11}, T_{12}, T_{13} and T_{14}. Whereas, the minimum average fruit weight (34.40 g) was recorded with the treatment T_1 (control).

Increased in fruit weight might be due to the zinc which plays a vital role to promote starch formation, iron required to suitable cell enlargement and cell division and boron actively involved in transportation of carbohydrates in plants. Thus, the cumulative effect of combined treatment of Zn + Fe + B might have resulted higher fruit weight. The possible reason for increase in fruit weight by the micronutrients might be due to faster loading and mobilization of photo assimilates to fruits and involvement in cell division and cell expansion which ultimately reflected into more weight of fruit in treated plants (Brahamchari *et al.*, 1995). These findings are supported by the results obtained by Venu *et al.* (2016) in acid lime, Tariq *et al.* (2007) in sweet orange, Meena *et al.* (2016) in Nagpur mandarin, Nehete *et al.* (2011) and Razzaq *et al.* (2013) in mango, Modi *et al.* (2012) in papaya, Ningavva *et al.* (2014) in banana, Bhoyar and Ramdevputra (2017) in guava and Ambaliya and Masu (2018) in aonla.

Fruit volume (cc)

The data regarding effect of micronutrients on fruit volume are presented in Table 1. Data showed that effect of micronutrients on fruit volume was found significant. The maximum fruit volume (43.83 cc) was observed with treatment T_8 ($ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 %) which was statistically at par with treatment T_9, T_{10}, T_{11} and T_{12}. Whereas, the minimum fruit volume (32.96 cc) was recorded with the treatment T_1 (control).

These might be due to the Zn plays vital role to promote starch formation, iron required to suitable cell enlargement and cell division and B actively involved in transportation of carbon in plants. Thus, the cumulative effect of combination of Zn + Fe + B on faster cell division and cell expansion reflected on higher fruit volume. Similar results were also noted by Venu *et al.* (2016) in acid lime, Tariq *et al.* (2007) in sweet orange, Meena *et al.* (2016) in Nagpur mandarin, Goswami *et al.* (2012), Jat and Kacha (2014) and Bhoyar and Ramdevputra (2017) in guava, Yadav *et al.* (2014) in pomegranate and Ambaliya and Masu (2018) in aonla.

Number of fruits per tree

A perusal of data presented that effect of micronutrients on number of fruits per tree was found significant. The maximum number of fruits per tree (946.00) was observed with treatment T_8 ($ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 %) which was statistically at par with treatment T_9, T_{10}, T_{11} and T_{12}. Whereas, the minimum number of fruits per tree (698.83) was recorded with the treatment T_1 (control).

All the micronutrients when sprayed alone or in combination involved directly in various physiological processes and enzymatic activity. This might have resulted into better photosynthesis, greater accumulation of starch in fruits and involvement of Zn in auxin synthesis and B in translocation of starch to fruits. The balance of auxin in plant regulates the fruit drop or retention in plants, which altered the control of fruit drop and increased the total number of fruits per tree. Similar findings have been observed by Venu *et al.* (2018) in acid lime, Gurjar and

Rana (2014) and Reetika *et al.* (2018) in kinnow mandarin, Bhowmick *et al.* (2011) and Gurjar *et al.* (2015) in mango, Suman *et al.* (2016) in guava, Dhurve *et al*. (2018) in pomegranate and Ambaliya and Masu (2018) in aonla.

Fruit yield (kg per tree)

The data pertaining to effect of micronutrients on fruit yield are presented in Table 1. The maximum fruit yield (41.68 kg per tree) was observed with treatment T_8 ($ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 %) which was statistically at par with treatment T_9, T_{10} and T_{11}. Whereas, the minimum fruit yield (24.04 kg per tree) was recorded with the treatment T_1 (control).

An increased in fruit yield per tree might be due to cumulative effect of number of fruits, reduction in fruit drop and higher fruit weight by effect of foliar spray of micronutrients. Promotion of starch formation followed by rapid transportation of carbohydrates in plants is activated by Zn and B is well established. Iron (Fe) is highly associated with chlorophyll synthesis which later on boosted up the photosynthesis. Foliar spray of micronutrients might have affected the physiological processes resulting into higher yield. This finding is in the accordance with the result of Deshmuk *et al.* (2015) and Venu *et al.* (2018) in acid lime, Sajid *et al.* (2010) in sweet orange, Ilyas *et al.* (2015) in kinnow mandarin, Bhalerao and Patel (2015) in papaya, Gurjar *et al.* (2015) in mango, Suman *et al.* (2016) in guava, Abhijith *et al.* (2018), Ambaliya and Masu (2018) and Jangid *et al*. (2018) in aonla and Dhurve *et al*. (2018) in pomegranate.

Total fruit yield (quintal per hectare)

Data regarding to total fruit yield are presented in Table 1. Data showed that effect of micronutrients on total fruit yield was found significant. The maximum total fruit yield (115.46 quintal per hectare) was observed with treatment T_8 ($ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 %) which was statistically at par with treatment T_9, T_{10} and T_{11}. Whereas, the minimum total fruit yield (66.59 quintal per hectare) was recorded with the treatment T_1 (control).

The increase in total fruit yield by application of micronutrient treatments may be due to the direct or indirect involvement of nutrients which provide better mobilization of nutrients and metabolites for the growth and development of fruits by increase in metabolic activities and better cellular pathways. These activities improve their size, weight and volume, number of fruit and thereby synergistically increased the total fruit yield. These results are in confirmation with those of Deshmuk *et al.* (2015) and Venu *et al.* (2018) in acid lime, Sajid *et al.* (2010) in sweet orange, Ilyas *et al.* (2015) in kinnow mandarin, Gurjar *et al.* (2015) in mango, Suman *et al.* (2016) in guava and Abhijith *et al.* (2018) in aonla.

Table 1: Effect of micronutrients on yield parameters (cm)

Code	Treatment	Fruit diameter (cm)	Average fruit weight (g)	Fruit volume (cc)	Number of fruits per tree	Fruit yield (kg per tree)	Total fruit yield (quintal per hectare)
T_1	Control	3.50	34.40	32.96	698.83	24.04	66.59
T_2	$ZnSO_4$ 0.5 %	3.87	38.93	38.46	809.17	31.50	87.25
T_3	$ZnSO_4$ 1 %	3.72	36.89	36.42	774.67	28.58	79.16
T_4	$FeSO_4$ 0.5 %	3.80	38.04	37.96	797.17	30.33	84.01
T_5	$FeSO_4$ 1 %	3.68	36.21	35.87	758.83	27.48	76.11
T_6	Borax 0.2 %	3.74	37.41	37.20	786.00	29.41	81.46
T_7	Borax 0.4 %	3.61	35.90	35.28	752.83	27.03	74.86
T_8	$ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 %	4.58	44.06	43.83	946.00	41.68	115.46
T_9	$ZnSO_4$ 0.5 % + $FeSO_4$ 1 % + Borax 0.2 %	4.38	43.15	42.58	901.00	38.88	107.68
T_{10}	$ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.4 %	4.32	42.79	41.96	881.67	37.72	104.49
T_{11}	$ZnSO_4$ 0.5 % + $FeSO_4$ 1 % + Borax 0.4 %	4.28	42.03	41.06	868.67	36.51	101.13
T_{12}	$ZnSO_4$ 1 % + $FeSO_4$ 0.5 % + Borax 0.2 %	4.18	41.45	40.87	851.67	35.30	97.79
T_{13}	$ZnSO_4$ 1 % + $FeSO_4$ 1 % + Borax 0.2 %	4.13	41.15	40.29	847.17	34.92	96.72
T_{14}	$ZnSO_4$ 1 % + $FeSO_4$ 0.5 % + Borax 0.4 %	4.08	40.43	39.25	834.00	33.72	93.40
T_{15}	$ZnSO_4$ 1 % + $FeSO_4$ 1 % + Borax 0.4 %	3.96	39.04	38.82	821.83	32.08	88.87
	S.Em. ±	0.13	1.58	1.21	33.40	1.89	5.22
	C.D. (P = 0.05)	0.38	4.57	3.50	96.74	5.46	15.13
	C.V. %	5.69	6.93	5.38	7.04	10.01	10.01

CONCLUSION

On the basis of experimental results, the combined application of $ZnSO_4$ 0.5 % + $FeSO_4$ 0.5 % + Borax 0.2 % was found effective and promising in increasing fruit diameter, fruit volume, fruit weight, number of fruits per tree, fruit yield per tree and total fruit yield per hectare of Acid Lime (*Citrus aurantifolia* Swingle) cv. Kagzi Lime.

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