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Effect of Micronutrient Application on Flowering, Fruiting and Yield of Acid Lime (*Citrus Aurantifolia* L.)". cv. Kagzi Lime

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ABSTRACT: *The present experiment was carried out at The Madhadibaug Farm, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) during 2013. The experiment was laid out in Factorial Randomized Block Design with eight treatments and three replications. The treatments comprising two levels of each zinc sulphate* viz., Z_0 *(control),* Z_1 *(zinc sulphate @ 0.5%), borax* viz., B_0 *(control),* B_1 *(borax @ 0.4%) and ferrous sulphate* viz., F_0 *(control),* F_1 *(ferrous sulphate @ 0.4%). Two sprays were done at the full bloom stage and second at one month later of first spray. The results revealed that the interaction effect of zinc, boron and iron ($Z_1B_1F_1$) were found significant on yield attributing characters like number of flowers per shoot (22.37), fruit set (49.33%) with minimum fruit drop (24.33%), while number of fruits per shoot (8.53), number of fruits per plant (925.00), fruit yield per plant (27.07 kg) and per hectare (74.97qt), however quality attributing characters like volume of fruit (29.67 ml), fruit weight (42.67 g), fruit girth (13.20 cm), fruit length (4.80 cm), minimum peel weight (5.17 g), maximum TSS (8.90 Brix^0), ascorbic acid (33.83 mg/10ml of juice), with minimum acidity (1.32 %), reducing sugars (0.83%), non-reducing sugars (0.51%) and total sugars (1.32%).*

INTRODUCTION

Acid lime (*Citrus aurantifolia* L.) is sub-tropical in its climacteric requirements and originated from sub-tropical Southeast Asia, where it can still be found wild. It is a most important and tenderest fruit crop in citrus group which occupies probably the third position among the sub-tropical countries after banana and mango in production of fruits. India is the largest producer of acid lime in the world followed by USA, Spain and Israel.

It is cultivated in almost all the states in India, mainly in Andhra Pradesh, Maharashtra, Tamil Nadu, Karnataka, and Gujarat. The total area and production under acid lime in India is estimated 255.2 thousand hectares and 2,523.5 thousand metric tonns respectively. Acid lime is one of the important fruit crop in Gujarat state. The area, production and productivity of acid lime is 40.80 thousand hectares, 433.12 thousand metric tonns and 10.6 MT/ha, respectively (Anon., 2013).

It is good source of vitamin C (62.95mg/100ml), vitamin B_1 (0.02mg/100ml), vitamin B_2 (0.06mg/100ml), calcium (90mg/100ml), phosphorous (20mg/100ml) and iron (0.3mg/100ml). They are also rich source of bioflavonoid, acids and volatile oils. Special interest in limes has been flavonoids called flavonol glycosides, including many kaempferol-related molecules. While these flavonoids have been shown to stop cell division in many cancer cell lines, they are perhaps most interesting for their antibiotic effects. They also contain coumarins such as bergapten which sensitizes the skin to sun light. Bergapten is sometimes added to tanning preparation since it promotes pigmentation in the skin, though it can cause dermatitis or allergic responses in some people (Prasad and Kumar, 2012). Acid lime starts bearing flowers and fruits from the fourth year onwards after planting. Under natural conditions the trees flower all the year round each flush put forth new blossom.

The acid lime flowers thrice in a year, i.e. February, June-July and October. The respective *bahars* are called "*Ambe*", "*Mrig*" and "*Hasta*" *bahars*. Thus, acid lime in this part seems to bear fruits almost

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throughout the year. Among all of these three *bahars* "*Ambebahar*" crop gives more fruit production than other *bahars* during June- July season.

The fruits mature in six months after flowering. Harvesting of acid lime differ with different varieties and region of cultivation. The followings are some common varieties of acid lime *viz*., Pramalini, Vikram, SaiSarbati and Jai Devi. "Kagzi lime" is dominant cultivar found on large area in Gujarat state. A good acid lime plant (7 year old) may give average yield of 600-800 fruits/ plant.

Micronutrients like Zn, Fe and B, play a vital role in plants. Foliar application of micronutrients are more successful than soil application. Among the several factors responsible for poor yield and declining health in citrus, deficiency of micronutrients is considered to be the major one (Edward raja, 2009).

Effective use of micronutrients in Kagzi lime is one such research gap. Micronutrients can tremendously boost Kagzi lime flowering and fruiting quality. The problem of micro nutrients deficiency in Kagzi lime causes great concern to the fruit growers and also flower drop as well as fruit drop is a major problem. Use of micronutrients will boost up the yield and quality of Kagzi lime than ultimately farmers will get economical benefits.

MATERIALS AND METHODOLOGY

The present investigation entitled "Effect of micronutrients application on flowering, fruiting and yield of Acid lime (*Citrus aurantifolia* L.) cv. Kagzi lime" was conducted at Madhadibaug Farm, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, during the year 2013. Junagadh is situated at 21.5° N latitude and 70.5° E longitudes with an altitude of 60 meters above the mean sea level on the western side at the foot hills of the mount 'Girnar'. The present study was conducted on twenty 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 × 6m and were subjected to uniform application of cultural practices like weeding, irrigation, manures, fertilizers and plant protection measures *etc*. The zinc sulphate, ferrous sulphate and borax were used for the present investigation and supplied through Department of Horticulture, Junagadh Agricultural University. The experiment was laid out in Factorial Randomized Block Design with eight treatments and three replications. The treatments comprising two levels of each zinc sulphate *viz*., Z_0 (control), Z_1 (zinc sulphate @ 0.5%), borax *viz*., B_0 (control), B_1 (borax @ 0.4%) and ferrous sulphate *viz*., F_0 (control), F_1 (ferrous sulphate @ 0.4%). Two sprays were done at the full bloom stage and second at one month later of first spray.

RESULTS AND DISCUSSION

Flowering Parameters

$Z_1B_1F_1$ produced maximum number of flowers (22.37) per shoot (Table 1). This indicated the positive combined effect of micronutrients on flowering. Zinc enhanced the synthesis of auxin in plants (Ryugo, 1988). Iron is credited with a definite role in the synthesis of chlorophyll molecule (Pandey and Sinha, 2006). Boron regulates metabolism involved in translocation of carbohydrates, cell wall development and RNA synthesis (Brown *et al*. 1995).

The maximum fruit set (49.33%) was observed in treatment $Z_1B_1F_1$ (Table.1). All the micronutrients when sprayed in combination involved directly in various physiological processes and enzymatic activities. It seems to have helped to increase the fruits set either by improving pollen germination or by

Table 1
Interaction Effect of Micronutrients Application on Flowering and Yield Parameters of Acid Lime

Treatments		*Number of flowers*	*Fruit set %*	*Fruit drop %*	*Number of fruits /shoot*	*Number of fruits / plant*	*Fruit yield (kg / plant)*	*Fruit yield (qt /ha)*
Zn_0	B_0F_0	12.33	27.33	42.50	4.60	573.33	16.50	45.70
	B_0F_1	16.80	33.33	36.33	6.53	695.00	19.43	53.82
	B_1F_0	16.00	38.33	35.00	7.43	640.00	21.33	59.09
	B_1F_1	18.83	40.33	32.67	7.67	675.00	20.73	57.43
Zn_1	B_0F_0	19.00	41.67	32.00	8.07	693.33	22.43	62.14
	B_0F_1	14.33	35.33	34.67	6.63	661.67	19.43	53.82
	B_1F_0	18.67	36.33	35.67	7.27	813.33	22.83	63.25
	B_1F_1	22.37	49.33	24.33	8.53	925.00	27.07	74.97
S.Em		1.63	3.84	2.87	0.70	37.66	1.77	4.90

helping the growth of pollen tubes and thus facilitate in timely fertilization before the stigma loses its receptivity or the style becomes non-functional. (Kumar *et al*. 2009 and Shukla, 2011)

The minimum fruit drop (24.33%) was observed in $Z_1B_1F_1$ (Table 1) due to the indirect action of micronutrients in auxin synthesis that delayed formation of abscission layer during early stage of fruit development (Skoog, 1940 and Yadav *et al*. 2011).

The number of fruits per tree influenced significantly by the application of foliar sprays of micronutrients. The maximum number of fruits per shoot was observed (8.53) in $Z_1B_1F_1$ (Table 1) that might be due to cumulative effect of micronutrients involved directly in various physiological process and enzymatic activities (Afria, 1999 and Bhambota, 1962).

Yield Parameters

The maximum number of fruits per plant was observed (925.00) in $Z_1B_1F_1$ (Table 2). All the micronutrients when sprayed in combination involved directly in various physiological processes and enzymatic activity. Involvement of Zn in auxin synthesis and B in translocation of start to fruit resulted into better photosynthesis, greater accumulation of starch in fruits 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 plant. (Banik *et al.* 1997, Singh *et al.* 2003 and Dutta 2004).

The treatment $Z_1B_1F_1$ gave the maximum yield per tree (27.07 kg) and per hectare (74.97qt) followed by treatment $Z_1B_1F_0$ (Table.2). The cumulative effect of micronutrients might have helped to increase the fruit size and fruit weight and thereby increase in fruit yield (Saraswathy *et al*. 2004).

Physical Parameters

The maximum fruit volume was observed (29.67 ml) in $Z_1B_1F_1$ (Table.2). Zn plays vital role to promote starch formation 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 fruit volume hence, resulted into higher fruit volume. (Tariq, 2007 and Samant *et al*. 2008).

The maximum fruit weight (42.67 g) was found in treatment $Z_1B_1F_1$ (Table 2). The maximum fruit weight has direct correlation with accumulation of more photosynthates for which boron play key role (Shukla, 2011), optimal concentration of iron required to maintain optimal growth and suitable cell enlargement and cell division (Salisburry and Ross, 1922).

The combined sprays of zinc iron and boron increased girth of fruit. The maximum girth of fruit (13.20 cm) was found in treatment ($Z_1B_1F_1$). This might be due to cumulative effect of micronutrients. The enlargement of fruit size is caused by drawing of photosynthesis to the fruit as consequence of intensification of the sink; it helps in cell division and elongation process (Rath *et al*. 1978).

The maximum fruit length (4.80 cm) was found in treatment $Z_1B_1F_1$ (Table 2). The maximum length of fruit with these nutrients might be due to their involvement in 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. (Singh and Rajput 1976).

The minimum peel weight (5.17 g) was found in treatment $Z_1B_1F_1$ (Table 2). The minimum weight of peel general solitary application of nutrients caused reduction in peel weight as compared to the control (Ram and Bose 2000).

CONCLUSION

From the foregoing discussion it can be concluded that for getting maximum flowering and fruiting with

Table 2
Interaction Effect of Micronutrients Application on Physical Parameters of Acidlime

Treatments		*Volume of fruit (ml)*	*Fruit weight (g)*	*Girth of fruit (cm)*	*Length of fruit (cm)*	*Peel weight (g)*
Zn_0	B_0F_0	19.00	26.00	10.40	3.20	6.80
	B_0F_1	24.13	35.60	11.13	3.58	6.00
	B_1F_0	26.67	34.33	11.70	4.13	5.77
	B_1F_1	25.87	40.33	12.10	4.17	5.97
Zn_1	B_0F_0	25.20	39.77	12.33	4.37	6.20
	B_0F_1	20.73	33.87	11.20	4.10	6.13
	B_1F_0	23.33	36.00	11.67	3.70	5.93
	B_1F_1	29.67	42.67	13.20	4.80	5.17
S.Em		2.06	2.64	0.49	0.25	0.28

better quality of fruits in acid lime cv. Kagzi lime should be sprayed with 0.5% zinc sulphate, 0.4% ferrous sulphate and 0.4% borax at flowering stage and second spray at one month after first spray.

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