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EFFECT OF ZINC, BORON, AND IRON APPLICATION ON PHYSICO-CHEMICAL PARAMETERS OF ACID LIME (*CITRUS AURANTIFOLIA*L.) "CV. KAGZI LIME

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ABSTRACT
An experiment was undertaken to improve the fruit quality of acid lime crop by use of different micronutrients combinations. The experiment was laid out in Factorial Randomized Block Design with eight treatments and three replications.The treatment scomprising 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.Effect of zinc, boron and iron ($Z_1B_1F_1$)with interaction gave significant effect on physical parameters 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), as well as chemical parameters like maximum TSS (8.90 Brix^0), ascorbic acid (33.83 mg/10ml of juice),reducing sugars (0.83%), non-reducing sugars (0.51%), total sugars (1.32%) and minimum acidity (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, 433.12thousand metric tonns and 10.6 MT/ha, respectively (Anon., 2014).

Micronutrients like Zn, Fe and B, play a vital role in plants. Foliar applications 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).

Zinc plays a major role in the metabolic activities of plant. The principle functions of zinc in plant are as a metal activator of enzymes like dehydrogenase (pyridine nucleotide, glucose-6 phosphodiesterase, carbonic anhydrase etc.). It is involved in the synthesis of tryptophane, a precursor of IAA, it is associated with water up take and water retention in plant bodies (NoggleandFritz, 1980). Boron, on the other hand is considered to be necessary for hormone metabolism, photosynthetic activities, cellular differentiation and water absorption in plant parts. It is also involved in reproduction, germination of pollen tube and fertilization. In case of boron deficiency, flowers are produced least and more sterile, fruits are de formed and render themselves commercially use less (Yawalkar *et al.*,1992).Iron is essential for the activity of several enzymatic systems and plant components such as Catalase, Cytochrome, Frodoxin, Frichrome, Hematin, Hem and Cytochrome oxidase. In addition, it seems iron be involved in nucleic acids metabolism in chloroplast. Usually relation between iron and vegetative growth of fruit trees is more complex than other nutrient elements (Saatsi and Yamur, 2000).Under various application techniques and their effects on Indianconditions, no systematic work was carried out on the role of micronutrients in kagzi lime and qualitative production. Hence, this present investigation was planned to evaluate the effect of micronutrients on physico-chemical parameters of kagzi lime.

MATERIALS AND METHODS

The present investigation was conducted at Madhadibaug farm, Department of Horticulture, Junagadh Agricultural University, Junagadh, during the year 2013-14.The present

study was conducted on twenty years oldplants 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 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 observations were volume of fruit, fruit weight, fruit girth, fruit length, peel weight, TSS (Brix^0), ascorbic acid (mg/10ml of juice), reducing sugars, non-reducing sugars, total sugars and acidity recorded in laboratory conditions.

RESULTS AND DISCUSSION

The maximum fruit weight (42.67 g) was found in treatment $Z_1B_1F_1$ (Table 1). Because of getting the maximum fruit weight has direct correlation with accumulation of more photosynthates for which boron play key role (Shukla, 2011), optimal concentration of zinc and iron required to maintain optimal growth and suitable cell enlargement and cell division (Salisburry and Ross, 1992).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, Saraswathy *et al*., 2004, Kumar *et al*., 2009, Shukla, 2011 and Yadav *et al*., 2011). The maximum fruit length (4.80 cm) was found in treatment $Z_1B_1F_1$(Table 1). Getting of maximum length of fruits 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 (5.17g) was observed in treatment $Z_1B_1F_1$ (Table 1). The minimum weight of peel general solitary application of nutrients caused reduction in peel weight as compared to the control (Ram and Bose 2000). The maximum fruit volume was observed (29.67 ml) in treatment $Z_1B_1F_1$ (Table 1). 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).

Chemical parameters

The result indicates that TSS was significantly increased with use of different levels of zinc, iron and boron. Treatment $Z_1B_1F_1$gave maximum TSS (8.90) (Table 2). This might be due to its converting complex substances into simple sugar, which enhances the metabolic activity in fruits and resulted in increased TSS of fruit (Kavitha *et al*. 2000and Yaseen and Ahemad, 2010).The result indicates that gave maximum reducing sugars (0.83%) and non-reducing sugars (0.51%) were significantly increased with treatment of $Z_1B_1F_1$.Might be

Table 1: 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	250.	28

Table 2: Interaction effect of micronutrients application on chemical parameters of acidlime

Treatments		TSS (Brix^0)	Acidity (%)	Ascorbic acid (mg/100ml of juice)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)
Zn_0	B_0F_0	7.47	1.67	27.50	0.70	0.44	1.16
	B_0F_1	8.00	1.42	29.63	0.74	0.45	1.21
	B_1F_0	8.37	1.38	29.67	0.79	0.47	1.27
	B_1F_1	8.13	1.40	31.50	0.78	0.43	1.23
Zn_1	B_0F_0	8.40	1.36	31.33	0.80	0.48	1.28
	B_0F_1	8.07	1.46	29.77	0.76	0.46	1.22
	B_1F_0	8.30	1.43	30.00	0.77	0.50	1.28
	B_1F_1	8.90	1.32	33.83	0.83	0.51	1.32
S.Em		0.24	0.04	0.85	0.02	0.01	0.03

due to that zinc, boran and iron promoted hydrolysis of starch in to sugars (Ghosh and Besera, 2000, Edward Raja, 2009, Chaitanya and kumar, 1997, Dutta 2004, and Balakrishanan (2001).

The minimum acidity (1.32%) was recorded in $Z_1B_1F_1$(Table.2)due to either speedily converted into sugars and their derivatives by reactions involving reverse glycolytic pathways or might have been used in respiration or both (Javid*et al*. 2004 and Ahmad *et al*. 1998).

The maximum ascorbic acid content (33.83%) was recorded in $Z_1B_1F_1$(Table.2) The higher ascorbic acid content was due to the increased in total sugar content owing to the efficient translocation of available photosynthates to fruit pulp rather than to other parts(Singh and Rajput, 1976).

The maximum total sugar was recorded (1.32%) in $Z_1B_1F_1$(Table.2). An association of zinc with synthesis of auxins in plants played a vital role along with the increase in enzymatic activities. It also acts as a catalyst in oxidation-reduction processes in plants. Fe is associated with the development flavo-proteins. Besides, Zn helps in the enzymatic reactions like transformation of carbohydrates, activity of hexokinase and formation of cellulose and change in sugar are considered due to its action on zymohexose (Singh *et al*., 2003, Banik *et al*., 1997 and Dutta and Dhua (2002), Singh and Chhonkar1983).

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