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Effect of nutrients on growth & physical attributes of acid lime (*Citrus aurantifolia* L.) cv. Sai Sharbati

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Abstract
The present investigation entitled "Studies on effect of nutrients on fruitdrop, yield and quality of acid lime" was conducted at Sweet Orange Research Station, Badnapur. The objective of this experiment was to study the effect nutrients on fruitdrop, yield and quality of acid lime. The experiment was laid out in Randomized Block Design (RBD) with three replication and 9 treatments. Comprising spraying of along with nutrients of T_1- Urea @ 1%, T_2-Urea @ 1.5%, T_3-Borax 0.5%, T_4- Borax 0.6% ,T_5- Zinc sulphate@ 0.4%, T_6- Zinc sulphate0.5%,T_7- nutrients com bination of both i.e. Urea@ 1% +Borax @0.5%+Zinc sulphate@ 0.4%, T_8-Urea@ 1.5% +Borax@ 0.6%+Zinc Sulphate @0.5, T_9- Control. The observations on growth & physical attributes parameter on maximum plant height (0.20m), plant spread (0.87m), number of flowers per plant (1748.45), Fruit set (64.06%), fruit length (4.8 cm), fruit diameter (4.52cm), fruit weight (54.76 gm), fruit volume (56.7ml), peelthickness (1.20mm) was recorded with foliar application of T_8-Urea@ 1.5% +Borax@ 0.6%+Zinc Sulphate @0.5. However, the minimum values of all attributes were recorded under the T9- Control.

Keywords: Nutrients, physical, lime, attributes, *Citrus aurantifolia* L.

Introduction
Kagzi lime (*Citrus aurantifolia* L.) belongs to family *Rutaceae*, originated in India. It is commercially grown in tropical and subtropical region of India. Kagzi lime is the third most important fruit after mandarin and sweet orange and India ranks fifth among major lime producing countries (Anonymous, 2001).

Acid lime is highly poly-embryonic. Tree small, bushy, and rarely taller than 12 feet with slender branches armed with short spines. Its dense foliage consists of small, pale green, blunt-pointed leaves with narrowly winged petioles (leaf stalks). The flowers are small and white, in axillary clusters (around the stalk). Flowering occurs throughout the year. Fruits mature irregularly throughout the year, greenish yellow in colour and juice is highly acidic (Debbarma and Hazarika, 2016) [5]. The fruit are very small, round to oval. Fruits have very thin, smooth and leathery rind, greenish yellow at maturity. Flesh is greenish yellow, juicy, highly acidic with distinctive aroma. The fruit juice mainly contains sugar and fruit acids, mainly citric acid (Prasad and Kumar, 2012) [10]. In India, acid lime is mainly grown in the states of Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh, Bihar, Assam, Jharkhand and Chhattisgarh. The area under acid lime in India is 255.20 thousand hectares with production of 2523.50 thousand MT andproductivity9.9 MT, while in Maharashtra, it is cultivated on 45.00 thousand hectares with production of 246.00 thousand MT with 5.5 MT productivity (Annon., 2017 -18). In Maharashtra, the main acid lime growing districts are Ahmednagar, Solapur, Akola, Jalgaon, Pune, Nagpur, Beed, Jalna and Aurangabad.

Micronutrients like Zn, Fe and B play a vital role in plants. Foliar application of micronutrients is 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) [6]. Effective use of micronutrients in kagzi lime is one such research gap. Micronutrients can tremendously boost kagzi lime flowering and fruiting quality (Venu *et al.*, 2014).Boron (B) as a micronutrient plays significant role in growth and productivity of citrus. It increases pollen grain germination, pollen tube elongation consequently fruit set percentage and finally the yield (Abd-Allah, 2006) [3]. Boron is important element for flowering, fruiting, growth and quality of fruits. Boron also increases the chlorophyll content of leaves and plays an important role in enzymatic activities. 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 role in the yield and fruit quality of citrus (Prasad *et al*., 2013) [11].

Among the different essential mineral nutrients, zinc (Zn) is an important micronutrient involved in enzymatic systems essential for protein synthesis, seed production and rate of maturity in plants (Swietlik, 1999, 2002) [13]. It is required for synthesis of tryptophan, which is a precursor of indole acetic acid. It also plays an important role in starch metabolism in plants (Alloway, 2008) [4]. It is well known that Zn acts as a co-factor of many enzymes and affects many biological processes such as photosynthesis, nucleic acids metabolism, and biosynthesis of proteins and carbohydrates (Marschner, 1995) [8]. The positive effects of Zn sprays on nutritional status, increase flowering, fruit set, fruit size and control fruit drop and ultimately increase the yield. Foliar application of Zn can improve the citrus fruit yield and quality and control the premature fruit drop (Rodriguez *et al*., 2005; Ashraf *et al*., 2012) [12]. To being with and to have guidelines for future work on this aspects, the present studies were planned to find out;

Materials and Methods

The present investigation entitled "Studies on effect of nutrients on fruit drop, yield and quality of Acid lime (*Citrus aurantifolia* L.) Cv. Saisharbati". The experiment was conducted on well-established orchard of 5 year old orchard which are planted at 6.0 X 3.0 m spacing was carried out 2018 during ambia bahar season Sweet Orange Research Station, Badnapur. The experiment was laid out in Randomized Block Design (RBD) with three replication and nine treatments *viz*.., T_1- Urea @ 1%, T_2-Urea @ 1.5%, T_3-Borax @ 0.5%, T_4-Borax@0.6%, T_5- Zinc sulphate@ 0.4%, T_6- Zinc sulphate@ 0.5%,T_7- nutrients combination of both i.e. Urea@ 1% +Borax @0.5%+Zinc sulphate@ 0.4%, T_8-Urea@ 1.5% +Borax@ 0.6%+Zinc Sulphate @0.5, T_9- Control. The nutrients were sprayed at two times. First spraying of nutrients was carried at petal fall stage in the second week of March and second spraying 45 days after first spray separately in the last week of April, 2019. Spraying was done early in the morning. Each tree was sprayed heavily by taking care to wet the complete tree. It was fully ensured that all the sides of the tree were covered completely by the spraysolution.

Plant height increased (m): The height of the plants was measured (from ground level to the terminal shoot) with the help of measuring device at the time of fertilizer application and at harvest and calculation of increase in plant height during the experimental period with the help of following formula:

Increase in plant height (m) = (P2 – P1), Where:P2 = Plant height at harvest

Plant spread East-West increased (m): The spread of plants was recorded in N-S direction with the help of measuring tape in meters at the time of fertilizer application and at harvest and calculation of increase in plant spread during the experimental period with the help of following formula:

Increase in plant spread (m) = (P2 – P1), Where: P2 = Plant spread at harvestP1 = Plant spread at the time of treatment application, P1 = Plant height at the time of treatment application.

Plant spread North-South increased (m): The spread of plants was recorded in East-West direction with the help of measuring tape in meters at the time of treatment application and at the time of harvest and plant spread during the experimental period is calculated with the help of following formula:

Increase in Plant spread (m) = (P2 – P1), Where

P2 = Plant spread at harvest

P1 = Plant spread at the time of treatment application

Number of flowers per plant: Number of flowers per plant counted manually from March to July every day and their average were calculated.

Fruit setting (%): Five flowers were randomly selected on each randomly selected four branches of a tree and tagged and were counted at full bloom stage separately on each branch after that number of fruits set counted. The fruit setting per cent is calculated with following formula:

Fruit setting (%) = (Number of set fruits/ Total Number of flowers) x 100

Fruit length (cm): The length of fruits was measured from stem end to calyx end in centimeters at harvest with the help of Vernier calipers.

Fruit diameter (cm): The diameter of the fruits was measured from the centre of the fruits in centimeters at harvest with the help of Vernier Caliper.

Fruit weight (g): The average weight of fruit was calculated after the final picking as per the formula given below:

Average fruit weight = Total weight of fruits (g)/ Number of fruits

Volume of fruit (ml): The volume of fruit was recorded by water displacement method with the help of measuring cylinder and expressed in milliliters.

Peel thickness: To measure the thickness of peel, the fruits were equally divided into two pieces by cutting and length between peel was measured with the help of Vernier calliper.

Result and Discussion

Plant height (m)

Table.1 represented the data on plant height which was influenced by set of treatment, depicted by figure 1. Effect of treatment was found to be non –significant on plant height throughout the *bahar* period. East-West

Plant spread (m)

Effect of treatments was found to be non-significant on plant spread East-West direction North –south Plant spread (m) Effect of treatments was found to be non- significant on plant spread in North-South direction. It is evident from the data presented in the preceding chapter that different treatments had non- significant effect on growth parameters of tree i.e. plant height, plant spread N-S direction and E-W direction.

Number of flowers per plant

Data revealed that number of flowers per plant was

significantly affected by the foliar spray of Urea, $ZnSO_4$ and borax over control. The significantly maximum number of flowers (1748.45) was recorded in the treatment T_8 Urea (1.5%)+Borax (0.6%)+$ZnSO_4$ @ 0.5%.It was statiscally at par with T_7 (Urea1.0%)+Borax (0.5%)+$ZnSO_4$ (0.4%),T_4 (Borax 0.6%) and T_3 (Borax0.5%). Whereas, minimum fruit set (35.73%) was observed in treatment T_9 (Control).

The increase in reproductive parameters may be due to that the nitrogen is an important component of protoplasm and it helped in chlorophyll synthesis which increase in photosynthetic rate resulting more accumulation of carbohydrates leading to flower initiation and profuse flowering.

Fruit set (%)

Fruit set percent was significantly influenced by different nutrients treatment as indicated in Table no. 1. Treatment T_8 (Urea1.5%) + Borax (0.6%)+$ZnSO_4$ (0.5%), recorded maximum number of fruit set percent (64.06).which was at par with treatment T_7 (Urea1%)+Borax (0.5%)+$ZnSO_4$ (0.4%). Whereas, minimum fruit set (35.73%) was observed in treatment T_9 (Control).Minimum.

Fruit length (cm)

The data related to fruit length are presented in Table no.1**.** Revealed that foliar application of nutrients Urea, Borax, $ZnSO_4$ with different combination influence, significantly on fruit length over Control. The significantly maximum fruit length (4.8cm) was observed with application of treatmentT_8 that is (Urea1.5) +Borax (0.6%)+$ZnSO_4$ (0.5%). However treatment T_7 (Urea1.%)+Borax (0.5%)+$ZnSO_4$ (0.4%). was at par with T_7 followed by treatment T_1 (Urea1%), T_2 (Urea1.5%) T_6 $ZnSO_4$ (0.5%). While lowest fruit length was found in treatment T_9 that is Control. The increase in length of fruit may be due to increase in either flesh or seeds or in both. This is primarily due to the stimulation in the growth of flesh (Yadav and Rana., 2006) [19].

Fruit diameter (cm)

The data related to fruit diameter are presented in Table no.1. revealed that the response of Urea, Borax, $ZnSO_4$ on fruit diameter was found statiscally significant over Control. The maximum fruit diameter. (4.52cm) was observed with application of Urea (1.5%)+Borax (0.6%)+$ZnSO_4$+ (0.5%) treatment T_8. Which was at par with T_7 (Urea1%) + Borax (0.5%) + $ZnSO_4$ (0.4%), T_6 $ZnSO_4$ (0.5%) and T_2 (Urea1.5%). However the minimum fruit diameter (3.53cm) was found in treatment T_9 that is Control. Boron increased fruit diameter because it play an important role in translocation of carbohydrate, synthesis of auxin and enhancing pollen viability and fertilization (Wet *et al.*, 1989) [18]. Boron also required for increase in stigma receptivity and pollen tube growth / extension by formation of boron-sorbitol (sugar-borate) complex that promotes absorption, translocation and metabolism of sugar in pollen and synthesis of pectin material for the cell wall of growing pollen tube and reduction of abscission layer resulting promote flowering (Negi *et al*., 2011) [9].

Fruit weight (g)

It is apparent from Table no.1. Average weight of fruit was significantly improved by foliar application of Urea, Borax, and ZnSO4 alone or in different combination over control.

The significantly maximum weight of fruit (54.76gm) was recorded in the treatment T_8 Urea (1.5%) + Borax (0.6%) + $ZnSO_4$ (0.5%). Which was statistically at par with T_7 Urea (1.0%) + Borax (0.5%) + $ZnSO_4$ (0.4%). Whereas, minimum weight fruit (31.16 gm) was observed in treatment T_9 (Control).

Fruit volume (ml)

The data showed that the maximum volume of fruit (56.7ml) was recorded and treatment T_8 (Urea1.5%) + Borax (0.6%) + ZnSO4 (0.5%). Which was statistically at par with T_7 (Urea1%) + Borax (0.5%) + ZnSO4 (0.5%). Whereas minimum volume of fruit (34.94ml) was observed in treatment T_9 (Control). This may be due to that urea stimulates the synthesis of chlorophyll and increased photosynthetic activity which results in increased stored food material in the tissue lead to increase in volume of fruit (Jat and Kacha, 2014) [7]. Similar results were also obtained by Singh and Rajput (1977) [16].

Peel Thickness (mm)

The data clearly showed that, the minimum peel thickness is presented in Table no. 1..The significantally minimum thickness of peel (1.20mm) was recorded in the treatment T_8 (Urea1.5%)+Borax (0.6%)+$ZnSO_4$ (0.5%). which was statiscally at par with T_7 (Urea1%) + Borax (0.5%) + $ZnSO_4$ (0.4%). Whereas maximum peel thickness (1.63 mm) was observed in treatment T_9 (control).

Table 1: Effect of nutrients on growth and physical attributes of Acid lime Cv. Saisharbati.

Tr. No.	Treatment detail	Plant height increased (m)	Plant Spread Increased (m)	Number of flowers per plant	Fruit Set (%)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit volume (ml)	Peel Thickness (mm)
T_1	Urea (1%)	0.16	0.43	1501.7	39.93	4.6	4.04	46.16	44.68	1.43
T_2	Urea (1.5%)	0.10	0.38	1391.66	43.9	4.6	4.23	47.26	47.68	1.60
T_3	Borax (0.5%)	0.14	0.63	1702.39	56.99	4.03	4.03	41	43.33	1.55
T_4	Borax (0.6%)	0.17	0.28	1756.39	58.21	4.2	4.03	45.96	50.35	1.57
T_5	Zinc Sulphate (0.4%)	0.13	0.66	1557.79	54.56	4.5	4.9	48.5	47.11	1.44
T_6	Zinc Sulphate (0.5%)	0.14	0.55	1650.79	54.33	4.6	4.10	49.06	49.48	1.49
T_7	Urea (1%)+Borax (0.5%)+Zinc Sulphate (0.4%)	0.16	0.08	1733.72	62.76	4.7	4.37	50.26	49.86	1.30
T_8	Urea (1.5%)+Borax (0.6%)+Zinc Sulphate (0.5%)	0.20	0.46	1748.45	64.06	4.8	4.52	54.76	56.7	1.20
T_9	Control	0.06	0.21	1143.33	35.73	3.03	3.53	31.16	34.94	1.63
	S.E.+-	NS	NS	26.15	0.93	0.23	0.15	1.19	1.49	0.37
	C.D at 5%	NS	NS	78.74	2.81	0.70	0.47	3.60	4.51	0.113

Conclusion

On the basis of results obtained in present investigation it is concluded that foliar spray of T8 (Urea 1.5% + Borax 0.6% + ZnSO4 0.5%) was found to be the best for maximum increase inplant height, plant spread, number of flowers per plant, Fruit set , fruit length, fruit diameter, fruit weight, fruit volume, peel thickness of fruit per plant.

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