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Effect of nutrients on fruit drop, yield & quality 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 fruit drop, 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 fruit drop, 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 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 observations on fruit drop, yield and quality parameter on manimum fruit drop per cent (35.81(36.76)*, Number of fruits per plant (987),Fruit yield per plant (45.70 kg), TSS (8.73^0) and Acidity (5.54%), TSS: Acid ratio (1.28), Ascorbic acid (30.14mg) 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 T_9- Control.

Keywords: Nutrients, attributes, lime, Sai Sharbati, *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) [10]. 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). 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.

Fruits of acid lime possess great medicinal and nutritional value. It is an appetizer, stomachic, antiscorbutic and antihelmintic. It is a rich source of vitamin "C" and has good antioxidant properties (Thirugnanavel *et al*., 2007) [21]. 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, lime peel oil, peel powder are also in great demand in soap and cosmetic industry (Debaje *et al.*, 2011) [9].

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). Effective use of micronutrients in kagzi lime is one such research gap.

It increases pollen grain germination, pollen tube elongation consequently fruit set percentage and finally the yield (Abd-Allah, 2006). Deficiency of boron in citrus has seriousconsequences 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) [14].

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) [18, 19]. 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) [13]. 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) [16, 5]. 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 ambiabahar season Sweet Orange Research Station, Badnapur. The experiment was laid out in Randomized Block Desing (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.

Fruit drop (%): The fruit drop percent was calculated by the following equation:

Fruit drop (%) = Total number of fruit set – Total number of fruits at harvest time / total number of fruit set X 100

Number of fruits per tree: The number of fruits plant was recorded separately for each picking. Fruit yield (kg) per plant. The fruit of each plant were weighed separately in top pan balance and recorded at each picking.

Total Soluble Solids (˚Brix): All the fruits of each plant were crushed to form a homogenized sample and then the juice was extracted through muslin cloth. The extract was used for determination of TSS in ˚Brix by hand refractometer. A few drops of juice were placed on the surface of prism. The hinged part was placed back. The refractometer was then placed against the sun, then reading was noted by revolving the eyepiece at room temperature. (A.O.A.C.,1970).

Juice (%): Cut the sample in pieces and squeeze each pieces extracted all the juice with an extractor. The extracted juice is then Filtered through muslim cloth.

Calculation of juice content

Juice% = Total weight of juice (g) – beaker weight (g) X 100/ Total weight of fruit (g)

Acidity (%): Acidity was estimated by simple acid-alkali titration method as described in A.O.A.C in (1970). 20 ml fruit juice solution was taken by pipette and transferred into a 100 ml flask and then distillated water was added to 100 ml. It was shaken well to dissolve 0.25 ml of diluted fruit juice which was taken by pipette and transferred into a 250 ml beaker, then 3 drops of phenophthalene indicator were added in this solution. The burette was filled with constant stirring till the pink end point was reached. End point readings were recorded and the percentage acidity was calculated by the formula and expressed in therms of citric acid.

Total acidity percent= 0.128 X titer value.

TSS: Acid ratio: Total soluble solids percent was divided by acidity percent to obtain TSS: acid ratio.

Ascorbic acid (mg/100g): Assay method was followed given by Ranganna (1977). Preparation of 3 percent Meta phosphate acid (HPO_3), Preparation of standard ascorbic acid solution, Preparation of dye solution, standardization of dye. One milligram of ascorbic acid was used per ml of dye to determine the dye factor of follows:

Dye factor = 0.5 / Titre value

Preparation of sample: 10 gram of sample eas blended with 100 ml of 3% HPO3 after that it was filtered. Assay of ascorbic acid content of the sample was calculated using the following foemula:

Ascorbic acid = Titre X dye factor X volume made up Alliquot extract taken for estimation X 100 X weight of sample taken for (mg/100 g pulp) estimation.

Result and Discussion

Fruit drop (%)

The data pertaining fruit drop percent are presented in Table no. 1. Revealed that the foliar spray of Urea, $ZnSO_4$ and Borax. Infuluenced significantly on fruit percent over control. The significantly minimum fruit drop (35.81%) was recorded in treatment T_8 (Urea@1.5%) + (Borax@0.6%) + ($ZnSO_4$@0.5%). It was statistically at par with T_7(urea@1%)+(Borax@0.5%)+($ZnSO_4$@0.4%) and T_5($ZnSO_4$@0.4%). Whereas maximum fruit drop (49.50%) was observed in treatment T_9 (Control).

Zinc play important role in auxin synthesis and boron in translocation of start to fruit resulted into better photosynthesis, grater accumulation of starch in fruits. Balance of auxin in plant regulates the fruit drop in plants, which altered the control of fruit drop and increased the total number of fruit per plant (Venu *et al.* 2014) [22]. Similar results is obtained by Banik *et al.*, (1997) [6].

Number of fruits per plants

The data clearly showed that, the maximum number of fruits per plant presented in table no. 1. The significantly maximum number of fruits per plant (987) was recorded in T_8 (Urea@1.5%)+(Borax@0.6%)+($ZnSO_4$ @0.5%) and T_6

(957.11). whereas minimum fruits per tree (553.66) was observed in treatment T_9 (control). The results indicated that the number of fruits per plant was significantly increased due to different levels of urea. The urea has helped in more fruit set, which resulted in increasing number of fruits per play results were found by (Dudi *et al*., 2004) [8]. The cumulative effect of nitrogen on photosynthetic as well metabolic activities has helped to increases the fruit size and fruit weight and thereby increase the fruit yield (Jat and Kacha 2014) [11].

Fruit Yield per plant (Kg)

The data pertaining number of fruits per plant is presented in table no. The significantly maximum yield per plant (45.70 kg) was recorded in treatment T_8 (Urea@1.5%) +(Borax@0.6%)+($ZnSO_4$ @0.5%). Which was statistically at par with T_7 (Urea@1%) +(Borax@0.5%)+($ZnSO_4$ @0.4%) and followed by T_6 ($ZnSO_4$ @0.5%.) And T_5 ($ZnSO_4$@0.4%.) Whereas minimum yield of plant (27.3 kg) was observed in treatment T_9 (Control). The significant increase in yield by boron application may be accrideted to the positive effect of boron on increasing the rates of carbohydrates, cell wall development and RNA metabolism which enhance profuse flowering and fruit setting resulting increase in yield per plant (Bhatt *et al*. 2012) [7]. The result line with (Rawat *et al*. (2010) [17]

Total soluble solids (˚Brix)

The data pertaining to TSS (˚Brix) is presented in table no.1. The significantly maximum TSS (8.73˚Brix) was recorded in the treatment T_8 (Urea@1.5%) + (Borax@0.6%) +($ZnSO_4$ @0.5%) it was statically at par with T_7(urea@1%)+(Borax@0.5%)+(ZnSO4@0.4%). Whereas minimum TSS (6.53˚Brix) was observed in treatment T_9 (Control).

Acidity (%)

It is evident from the results presented in Table no.1. Revealed that the foliar application of urea, zinc sulphate and borax with different combination had significantly influenced the acidity over control. Ehen urea, zinc sulphate and borax applied treatment T_8 (Urea@1.5%)+(Borax@0.6%)+($ZnSO_4$ @0.5%) the minimum acidity (5.54%) was observed. Different level of urea, borax and zinc sulphate when sprayed in significantly reduced fruit acidity T_7(urea@1%)+(Borax@0.5%)+(ZnSO4@0.4%) (5.80%) which is followed by the treatment T_3 (6.11), T_4 (6.05) and T_5(6.20%). The maximum fruit acidity found with T_9 (Control).

Juice (%)

It is evident from the present result depicted in table no. 1. The juice percent was significantly influenced by the application of Urea, borax and zinc sulphate with different combination on juice percent over control. The significantly maximum juice (59.09%) 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%)+(Borax@0.5%)+(ZnSO4@0.4%) and T_6 ($ZnSO_4$ @0.5%.) whereas minimum fruit juice (31.88%) was observed in treatment T_9 (Control). Boron increase in fruit diameter and fruit length might be due to the involvement in hormonal metabolism, increase in cell division and expansion of cell. Beside this, boron is also known to stimulate rapid. mobilization of water and sugar in the fruit that might be a reason for increase in fruit weight, volume and juice percent (Lakshmipathi *et al* 2015) [12].

TSS: Acid ratio

Statically analyzed data regarding TSS/Acid ratio are present in Table no.1 revealed that the application of urea, zinc sulphate and borax with different combinations influenced significantly on the TSS/Acid ratio over control. The data pertaining to increase in TSS/Acid ratio as influenced by nutrients. Significantly maximum (1.28) TSS: Acid ratio i.e. T_8 (Urea@1.5%)+(Borax@0.6%)+($ZnSO_4$ @0.5%. Which at par with treatment T_7 (1.27), T_6, T_5, T_4, T_3, T_2, T_1 and T_9.

Ascorbic Acid (mg/100ml)

Nutrients treatment significantly influenced ascorbic acid contain (mg/100ml) acid lime juice. Ascorbic acid contain increased significantly in treatment T_8. Over all other treatment. Significantly maximum ascorbic acid (30.14mg/100ml) of juice was recorded in the treatment T_8 (Urea1.5%)+Borax(0.6%)+$ZnSO_4$(0.5%), which was statically at par withT_7 Urea(1%)+Borax(0.5%)+$ZnSO_4$(0.4%) and T_6 $ZnSO_4$(0.5%).Whereas minimum ascorbic acid (23.01mg/100ml) of juice was observed in treatment T_9 (Control).

Table 1: Effect of nutrients on fruit drop, yield and quality attributes of Acid lime Cv. Saisharbati

Tr. No.	Treatment detail	Fruit drop (%)	Number of plants per plant	Fruits yield (kg) per plant	TSS (^{0}Brix)	Juice (%)	Acidity (%)	TSS: acid ratio	Ascorbic acid (mg/100g)
T_1	Urea (1%)	44.66 (41.60)*	827.55	37.25	6.69	46.38	6.53	1.08	25.65
T_2	Urea (1.5%)	42.41 (40.63)*	844.89	34.05	7.42	51.36	6.34	1.16	26.78
T_3	Borax (0.5%)	40.76 (39.67)*	878.66	33.45	7.7	39.79	6.24	1.20	27.07
T_4	Borax (0.6%)	40.25 (39.37)*	900.66	38.15	7.93	46.49	6.11	1.22	27.34
T_5	Zinc Sulphate (0.4%)	37.23 (37.55)*	907	40.13	8.63	51.37	6.07	1.23	28.45
T_6	Zinc Sulphate (0.5%)	44.00 (41.55)*	957.11	41.73	7.86	54.81	6.02	1.25	28.87
T_7	Urea (1%)+Borax (0.5%)+Zinc Sulphate (0.4%)	37.45 (37.73)*	973.33	44.24	8.43	57.16	5.80	1.27	29.50

T_8	Urea (1.5%)+Borax (0.6%)+Zinc Sulphate (0.5%)	35.81 (36.76)*	987	45.70	8.73	59.09	5.54	1.28	30.14
T_9	Control	49.5 (44.71)*	553.66	27.73	6.53	31.88	6.57	1.06	23.01
	S.E.+-	1.35	20.20	1.09	0.23	1.71	0.19	0.09	0.62
	C.D at 5%	4.07	60.82	3.30	0.70	5.17	0.60	0.29	1.88

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 minimum fruit drop per cent (Number of fruits per plant, Fruit yield per plant, TSS and Acidity, TSS: Acid ratio, Ascorbic acid.

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