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Influence of foliar nutrition of urea, borax and zinc sulphate on growth, yield and quality of guava (*Psidium guajava* L.) cv. Rewa-72

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Abstract
A field experiment entitled Influence of foliar nutrition on growth, yield and quality of guava (*Psidium guajava* L.) cv. Rewa-72 was conducted at the *Instructional cum research fruit orchard* Department of Fruit Science KNK College of Horticulture, Mandsaur (MP) during 2016-17. The experiment was consisted of 15 treatments having two doses of urea (1% and 1.5%) and three doses of each borax (0.2%, 0.4% and 0.6%) and zinc sulphate (0.2%, 0.4% and 0.6%). The experiment was laid out in randomized block design with three replications. Result revealed that urea (1.5%) + borax (0.6%) + zinc sulphate (0.6%) (T_{15}) was found significantly superior over control and rest of treatments with respect to growth, yield and quality attributes of guava.

Keywords: Foliar spray, urea, borax, zinc sulphate, growth, quality, yield

Introduction

Guava (*Psidium guajava* L.) is an important fruit crop of India. It is also known as “Apple of tropics”. It belongs to the natural order Myrtal and the botanical family Myrtaceae. The fruit type is berry is an excellent source of vitamin-“C” (210-305mg/ 100g fruit pulp) and pectin (0.5-1.8%). It is largely grown in warmer tropical countries of the world. The Portuguese introduced it in India in the 17th century. Guava is classified under genus *Psidium*, which consists of 150 species but only *Psidium guajava* L. has been exploited commercially. It is popular in India due to its delightful taste, pleasant flavor, high palatability and digestive value. It has paramount importance as a source of ascorbic acid in human diet, content of which is three to five times more than that in fresh orange juice. It is a very rich source of vitamin A and C along with minerals like iron, calcium and phosphorus. It is also contains substantial quantities of carbohydrates, sugars and pectin. Owing to excellent taste and flavor, high nutritional value and wide availability at moderate price the fruit is often called as "Poor man's apple".

It is one of the fourth most important fruit crop in India after mango, banana and citrus. In India, it occupies nearly 2.68 lakh hectares of area with production of 36.67 lakh metric tonnes and average productivity of 13.7 metric tonnes. In Madhya Pradesh, the area covered by guava is around 24.37 (000’ha) with a production of 912.00 (000’ MT) and productivity 37.43 MT/ha in guava crop (Anonymous, 2016) [3].

Nitrogen is one of the inevitable major nutrients and an adequate supply of nitrogen is very essential for growth and development. It is an indispensable constituent of protein and nucleic acid molecules. Troug (1973) [17] mentioned that N application increases the assimilating process through glycolsis and fatty acid synthesis. Every increment of nitrogen dose significantly increased the shoot yield. The increase nitrogen supply is known to accelerate the synthesis of chlorophyll and amino acid resulting in increased vegetative growth.

Borax acts as catalyst in the oxidation and reduction processes and also has great importance in the sugar metabolism; it might have improved the physical characters of guava fruit and thus increased the yield per tree assumed in our finding. Heavier fruits with more fruit weight under borax treatment might be due to the high level of auxin in the various parts of the fruit plant maintained by borax. Borax increases pollen grain germination, pollen tube elongation, consequently fruit set percentage and finally the yield (Abd-Allah, 2006) [2].

Zinc is an essential micro element for plants. It is involved in many enzymatic reactions. For growth and development of plant, zinc is necessary.

It is also involved in regulating the protein and carbohydrate metabolism. It's availability to plants is reduced in high pH soils. Zinc is known to have an important role either as a metal component of enzymes or as a functional, structural or regulatory factor of a large number of enzymes (Trivedi *et al*., 2012) [18].

Application of fertilizers through soil are needed in higher quantities because some amount of fertilizers are lost through leaching and some amount of fertilizers become unavailable to the plants due to complex chemical reactions. Therefore, foliar application of nutrients through foliage is an alternative way in fruit crops.

Materials and Methods

The experiment was conducted during 2016-17 at the *Instructional cum research fruit orchard* Department of Fruit Science KNK College of Horticulture, Mandsaur (MP) on ten year- old guava tree cv. Rewa- 72. This experiment was laid out in randomized block design (RBD) consisted fifteen treatments i.e. T_1 -control (water spray), T_2 -urea (1%), T_3 -urea (1.5%), T_4-urea (1%) + borax (0.2%), T_5 -urea (1%) + borax (0.4%), T_6 -urea (1%) + borax (0.6%), T_7 -urea (1.5%) + borax (0.2%), T_8 -urea (1.5%) + borax (0.4%), T_9 -urea (1.5%) + borax (0.6%), T_{10} - urea (1%) + borax (0.2%) + zinc sulphate (0.2%), T_{11} - urea (1%) + borax (0.4%) + zinc sulphate (0.4%), T_{12} - urea (1%) + borax (0.6%) + zinc sulphate (0.6%), T_{13}- urea (1.5%) + borax (0.2%) + zinc sulphate (0.2%), T_{14} - urea (1.5%) + borax (0.4%) + zinc sulphate (0.4%) and T_{15} - urea (1.5%) + borax (0.6%) + zinc sulphate (0.6%). The plain distilled water was sprayed on the plants under control. The treatments were applied separately during flowering stage, after selection of vigorous uniform size and bearer plants of guava. A single plant was kept as unit treatment and replicated three times. The canopy volume was calculated as per the Westwood *et al.* (1963) [21], Canopy volume (m^3) = $4/3\pi a^2 b$, Where: π = 22/7, a = ½ of the plant height, b = average of east-west and north-south spread.

Acidity was estimated by simple acid-alkali titration method as described in A.O.A.C. (1970) [1]. Hand refractometer was used for determination of TSS in ^{0}Brix. Assay method of ascorbic acid was followed given by Ranganna (1977) [13]. Chlorophyll content in leaves was estimated by using instrument SPAD-505 chlorophyll meter. Average fruit weight was recorded with the help of electronic balance. Mature fruits were harvested periodically in each treatment separately and the weight was recorded with the help of single pan balance and expressed in kg. Further, estimated fruit yield per ha were calculated by multiplying the fruit yield/plant to the number of plants/ha.

Results and Discussion

Growth and Physical characteristics

The results of the present investigation revealed that influence of foliar nutrition on different growth parameters influenced significantly. It is clear from the results (Table-1) that maximum plant height (4.86 m), canopy spread E-W direction (3.84 m), canopy spread N-S direction (3.95 m), canopy volume (39.63 m^3), fruit length (6.67 cm), fruit diameter (7.15 cm) and pulp thickness (1.67 cm) was recorded with plant received urea (1.5%) + borax (0.6%) + zinc sulphate (0.6%) (T_{15}). The beneficial effect of nitrogen in increased tree growth might be due to the fact that absorbed nitrogen combined with carbohydrates synthesis leads to the formation of nitrogenous compound such as protein, nucleic acids, nucleotides, enzymes and co-enzymes to build up new tissues. Urea stimulates the synthesis of chlorophyll and increased photosynthetic activity which results in increased stored food material in the tissue. This caused increase in volume of fruit Jat and Kacha (2014) [7]. Boron increases the phenolic compounds which regulate polar auxin transport, the increased auxin activity results in increased vegetative growth characters. The present results are in line with those of Ullah *et al*. (2012) [19] and Gurjar *et al.* (2015) [6]. Boron improves ultimately due to increased width, length and fruit weight. The results are in close conformity with the finding of Kumar *et al.* (2010) [8] in guava cv. L-49. Zinc increased tree height and leaf size in the treated trees might be due to the active synthesis of tryptophan in the presence of zinc, the precursor of auxin, which in turn causes an increase in the rate of chlorophyll synthesis which ultimately accelerates the photosynthetic activity, consequently it increased tissue growth and development. Similar results were found by Sajid *et al*. (2010) [15] and Rawat *et al.* (2010) [14]. The increase in fruit size due to the increase in volume of guava fruit may be explained due to fact that higher concentration of mineral nutrients (boron and zinc) appears to have indirect role in hastening the process of cell division and cell elongation due to which volume of fruits might have improved. The results corroborated with the finding of Pal *et al*. (2008) [11].

Table 1: Influence of foliar nutrition of urea, borax and zinc sulphate on growth and physical characteristics of guava (*Psidium guajava* L.) cv. Rewa-72

Treatments	Plant height (m)	Canopy spread E-W (m)	Canopy spread N-S (m)	Canopy volume (m^3)	Fruit length (cm)	Fruit diameter (cm)	Pulp thickness (cm)
T_1-Control (Water spray)	3.86	2.40	2.81	21.09	5.75	5.73	1.17
T_2 -Urea (1%)	3.91	2.53	2.90	22.24	5.80	6.17	1.21
T_3 -Urea (1.5%)	4.09	3.03	3.26	26.39	5.98	6.33	1.24
T_4-Urea (1%) + Borax (0.2%)	3.96	2.79	3.13	24.52	6.00	6.37	1.30
T_5 -Urea (1%) + Borax (0.4%)	4.00	2.87	3.22	25.61	6.07	6.47	1.37
T_6 -Urea (1%) + Borax (0.6%)	4.01	2.64	2.92	23.79	6.12	6.50	1.53
T_7 -Urea (1.5%) + Borax (0.2%)	4.16	3.11	3.33	28.27	6.17	6.53	1.27
T_8 -Urea (1.5%) + Borax (0.4%)	4.23	3.20	3.42	29.38	6.22	6.57	1.43
T_9 -Urea (1.5%) + Borax (0.6%)	4.28	3.33	3.47	30.46	6.28	6.64	1.58
T_{10} - Urea (1%) + Borax (0.2%) + Zinc sulphate (0.2%)	4.35	3.38	3.60	31.80	6.33	6.72	1.30
T_{11} - Urea (1%) + Borax (0.4%) + Zinc sulphate (0.4%)	4.48	3.41	3.63	33.05	6.37	6.77	1.45
T_{12} - Urea (1%) + Borax (0.6%) + Zinc sulphate (0.6%)	4.65	3.54	3.69	35.27	6.40	6.80	1.64
T_{13}- Urea (1.5%) + Borax (0.2%) +	4.77	3.63	3.77	36.94	6.52	6.83	1.28

Zinc sulphate (0.2%)							
T_{14} - Urea (1.5%) + Borax (0.4%) + Zinc sulphate (0.4%)	4.81	3.76	3.82	38.18	6.60	7.07	1.49
T_{15} - Urea (1.5%) + Borax (0.6%) + Zinc sulphate (0.6%)	4.86	3.84	3.95	39.63	6.67	7.15	1.67
S.Em. ±	0.081	0.074	0.087	0.94	0.089	0.11	0.03
C.D. at 5%	0.23	0.21	0.25	2.73	0.26	0.33	0.10

Quality Attributes

It is clear from (Table-2) that minimum acidity (0.31%), maximum total soluble solids (12.68 ^{0}Brix), TSS: acid ratio (41.42), ascorbic acid (188.55 mg/100 gm pulp) and chlorophyll content SPAD value (45.83) were recorded with foliar nutrition of urea (1.5%) + borax (0.6%) + zinc sulphate (0.6%) (T_{15}). Foliar spray of urea decreased the acidity. The minimum acidity was observed in that guava which was sprayed with urea. It is in conformity with the observations of Jat and Kacha (2014) [7] in guava. The absorbed urea increased the nitrogen content, which ultimately caused dark green foliage and thus higher status of chlorophyll Dubey *et al.* (2001) [5] had also reported similar line of results. Total soluble solids might be due to the efficient translocation of photosynthates to the fruit by regulation of boron. The results are similar to the findings of Rawat *et al*. (2010) [14] in guava cv. Lucknow-49 and Trivedi *et al*. (2012) [18]. It might be attributed to the fact that boron directly affects the photosynthesis activity of plant and helps in sugar transport. Besides, the boron also plays an important role in activating the synthesis of ascorbic acid. Augmentation of ascorbic acid percentage of guava fruit might have been due to higher synthesis of nucleic acid, on account of maximum availability of plant metabolism Baranwal *et al.* (2017) [4] in guava. The importance of those nutrients for increasing the ascorbic acid content the guava fruits have also reported by Pal *et al*. (2008) [11] in guava cv. Sardar. Foliar application of zinc sulphate reduced the acid content in guava fruits. Lower acidity in fruits results due to higher accumulation of sugar, better translocation of sugar into fruit tissues conversion of organic acids into sugars. Similar findings have also been reported by Rawat *et al.* (2010) [14] in guava cv. L-49 and Kumar *et al.* (2015) [9] in guava. Foliar application of $ZnSO_4$ increased the TSS contents by increasing photosynthetic activity of the plants resulting into the production of more sugars. It is an established fact that zinc is credited with definite role in the hydrolysis of complex polysaccharides into simple sugars, synthesis of metabolites and rapid translocation of photosynthetic products and minerals from other parts of the plants to developing fruits. This finding was corroborated with the findings of Rawat *et al.* (2010) [14] and Parmar *et al*. (2014) [12].

Table 2: Influence of foliar nutrition of urea, borax and zinc sulphate on quality and yield characteristics of guava (*Psidium guajava* L.) cv. Rewa-72

Treatments	Acidity (%)	TSS (^{0}Brix)	TSS: acid ratio	Ascorbic acid (mg/100 g pulp)	Chlorophyll content (SPAD value)	Number of fruits per tree	Fruit weight (g)	Fruit yield (Kg/tree)	Fruit yield (q/ha)
T_1-Control (Water spray)	0.46	8.70	18.38	124.38	38.47	168.50	158.80	26.76	74.33
T_2 -Urea (1%)	0.45	9.17	20.08	129.11	38.70	172.30	160.14	27.60	76.65
T_3 -Urea (1.5%)	0.44	9.43	21.46	133.30	39.77	174.36	162.43	28.32	78.68
T_4-Urea (1%) + Borax (0.2%)	0.43	9.53	22.37	141.40	40.97	178.32	163.50	29.15	80.98
T_5 -Urea (1%) + Borax (0.4%)	0.42	9.70	23.29	146.18	41.69	183.73	163.61	30.06	83.49
T_6 -Urea (1%) + Borax (0.6%)	0.41	9.83	23.99	148.80	41.92	187.41	164.89	30.90	85.84
T_7 -Urea (1.5%) + Borax (0.2%)	0.40	10.17	25.42	156.65	42.64	190.27	186.65	35.49	98.58
T_8 -Urea (1.5%) + Borax (0.4%)	0.39	10.47	27.74	158.08	42.99	196.57	186.95	36.75	102.08
T_9 -Urea (1.5%) + Borax (0.6%)	0.38	10.53	27.05	165.33	43.08	202.03	187.05	37.79	104.97
T_{10} - Urea (1%) + Borax (0.2%) + Zinc sulphate (0.2%)	0.37	11.10	30.30	168.00	43.18	208.14	188.09	39.15	108.75
T_{11} - Urea (1%) + Borax (0.4%) + Zinc sulphate (0.4%)	0.36	11.17	30.74	169.55	43.45	210.78	196.28	41.37	114.91
T_{12} - Urea (1%) + Borax (0.6%) + Zinc sulphate (0.6%)	0.35	11.37	32.23	175.22	43.63	213.53	201.68	43.06	119.61
T_{13}- Urea (1.5%) + Borax (0.2%) + Zinc sulphate (0.2%)	0.34	12.15	35.72	183.97	44.03	215.98	209.38	45.22	125.62
T_{14} - Urea (1.5%) + Borax (0.4%) + Zinc sulphate (0.4%)	0.33	12.41	37.59	185.85	44.10	219.53	214.60	47.09	130.80
T_{15} - Urea (1.5%) + Borax (0.6%) + Zinc sulphate (0.6%)	0.31	12.68	41.42	188.55	45.83	221.68	219.11	48.57	134.92
S.Em. ±	0.001	0.26	1.51	1.90	0.69	2.10	3.55	1.23	1.90
C.D. at 5%	0.03	0.76	4.39	5.51	2.01	6.09	10.29	3.57	5.52

Yield and yield attributing characters

The data presented in Table-2 reveals that various treatments had resulted significant increase in the fruits yield/plant and yield/ha as compared to control. The maximum number of fruits per tree (221.68), fruit weight (219.11 g), yield per tree (48.57 kg) and yield per hectare (134.92 q/ha) was recorded with plant received urea (1.5%) + borax (0.6%) + zinc sulphate (0.6%) (T_{15}). The cumulative effect of nitrogen on photosynthetic as well metabolic activities has helped to increase the fruit size and fruit weight and thereby increase the fruit yield. The urea has helped in more fruit retention per shoot, which resulted in increasing number of fruits per plant. Similar results were found by Jat and Kacha (2014) [7]. An increase in fruit weight was observed in fruits harvested from the plants sprayed with urea due to an accumulation of sugars and higher pulp percentage of fruits. Similar results were found by Kumar *et al*. (2017) [10] in guava. The significant increase in yield by boron application may be accredited 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 per shoot resulting increase in yield per plant. The results are in line with Rawat *et al*. (2010) [14]. Zinc play important role in auxin synthesis and boron 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 fruit per plant (Venu *et al.* 2014) [20]. Zinc has helped in more fruit retention per shoot, which results in increased number of fruits per plant. Similar results were found by Jat and Kacha (2014) [7] in guava. The cumulative effect of zinc has helped to increase the fruit size and fruit weight and thereby increase the fruit yield. Similar results were found by Sarolia *et al.* (2007) [16] in guava and Jat and Kacha (2014) [7].

Conclusion
On the basis of results obtained in present investigation it might be concluded that foliar nutrition of urea (1.5%) + borax (0.6%) + zinc sulphate (0.6%) was most efficient to increase the growth of the plant, quality of fruit and increased the yield of guava cv. Rewa-72.

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