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IMPROVING FRUIT QUALITY CHARACTERISTICS AND YIELD OF GUAVA (*PSIDIUM GUAJAVA* L.) WITH MICRONUTRIENT MANAGEMENT

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ABSTRACT

To improve the fruit quality and yield of guava cultivar L-49 under rainfed conditions, an experiment was laid comprising of twenty-four different treatments of Zinc sulphate and Boric acid applied individually or in combination with check as control. Foliar spray of different treatments was done twice during last week of October and last week of November. Highest values for fruit weight (158.52gm), fruit volume (151.72cm^3), specific gravity (1.04), fruit length (6.76cm), fruit breadth (5.64cm), pulp weight (156.51gm) and fruit yield (34.60 kg/tree) were observed in the guava trees applied with 0.75 percent Zinc sulphate + 0.50 percent Boric acid. Similarly, maximum values for total soluble solid content (10.86^{o}B), ascorbic acid content (212.91mg/100gm), total sugars (8.56%), reducing sugar (5.18%) and non-reducing sugar (3.21%) were recorded in the trees applied with 0.75 percent Zinc sulphate + 0.50 percent Boric acid. The study indicated that foliar application of 0.75 percent Zinc sulphate + 0.50 percent fruit characteristics and yield of guava cultivar L-49 over other treatments.

Key words : Guava, Micronutrient, Physical fruit characters, Bio-chemical fruit characters.

Introduction

Guava (*Psidium guajava* L.) is a tropical fruit crop belonging to family Myrtaceae, however, it has very well adapted to sub-tropical conditions. It is fourth most important fruit crop in India in terms of area and production after mango, banana and citrus (Pedapati *et al.*, 2014). Fruits are rich source of vitamin C, pectin, moderately good source of iron, calcium and a fair source of phosphorus, besides being rich sources of dietary fiber. In India guava occupies an area of 261 thousand hectare with annual production of 3916 thousand MT (Anonymous, 2018a), which is very less as compared to other three leading fruit crops in India. In Jammu and Kashmir it is cultivated on an area of 2340 hectare with production of 7943 MT (Anonymous, 2018b). Though, guava is a hardy plant and can tolerate adversities of weather to a greater extent and fetches good price in the market, but the price gained in the market by any commodity depends particularly on quality of the fruits. Quality of a fruit is related to its physico-chemical characteristics which in turn depends upon the health of the plant and plant protection measures adopted. Application of fertilizers through soil are needed in higher quantities because of lesser nutrient use efficiency, whereas, foliar feeding has been found to be 10-20 times more effective than soil application (Zaman and Schumann, 2006). Besides, application of both macro and micronutrients are essential to avoid the hidden nutrient hunger and to promote the optimum growth and performance of plants. If nutrients are deficient, poor is the health of the plant and poor will be quality of the fruits produced. Nutritional deficiencies in fruit crops significantly hamper the physiological processes of plants, thus reducing yield and producing inferior fruit and making the plant vulnerable to a number of biotic and abiotic stresses. It is an established fact that Indian soils, particularly North Indian soils are deficient in micronutrients particularly Zinc and Boron. Therefore, foliar application of nutrients particularly micronutrients is an alternative way in improvement of fruit quality characters in guava. Besides other nutrient elements, micro-nutrients particularly Zinc and Boron plays vital role in growth, development, retention and quality of fruits. Zinc constituent several enzyme systems, which regulate various metabolic reactions in the plant. It is essential for auxin and protein synthesis, seed production and proper maturity of fruit while boron has a key role in cell division and elongation, thus effecting increase in weight of fruit, so Zinc increases fruit size as well as fruit yield. Similarly, application of Boron on the guava plant also results in enhancement of fruit yield and quality. Keeping in view the agro-climatic condition of Jammu region and the role of Zinc and Boron in increasing the yield and improving the quality, the present investigations were aimed to evaluate the influence of Zinc and Boron on the yield and fruit quality of guava under Jammu subtropics with the objective to assess the effect of Zinc and Boron on yield and fruit quality of guava cultivar L-49.

Materials and Methods

Experimental trial to access the effect of zinc and boron on growth the fruit, yield and fruit quality of guava was conducted on 12-year-old trees of L-49 cultivar grown in the private orchard located in rainfed area of district Samba, Jammu situated at an elevation of 332 m above mean sea level and lies at 32°39" North latitude and 74° 53" East longitude. The experiment comprised of twenty five treatments including 0.25 percent Zinc sulphate (T_1), 0.50 percent Zinc sulphate (T_2), 0.75 percent Zinc sulphate (T_3), 1.00 percent Zinc sulphate (T_4), 0.25 percent Boric acid (T_5), 0.50 percent Boric acid (T_6), 0.75 percent Boric acid (T_7), 1.00 percent Boric acid (T_8), 0.25 percent Zinc sulphate + 0.25 percent Boric acid (T_9), 0.25 percent Zinc sulphate + 0.50 percent Boric acid (T_{10}), 0.25 percent Zinc sulphate + 0.75 percent Boric acid (T_{11}), 0.25 percent $ZnSo_4$ + 1.00 percent Boric acid (T_{12}), 0.50 percent Zinc sulphate + 0.25 percent Boric acid (T_{13}), 0.50 percent Zinc sulphate + 0.50 percent Boric acid (T_{14}), 0.50 percent Zinc sulphate + 0.75 percent Boric acid (T_{15}), 0.50 percent $ZnSo_4$ + 1.00 percent Boric acid (T_{16}), 0.75 percent Zinc sulphate + 0.25 percent Boric acid (T_{17}), 0.75 percent Zinc sulphate + 0.50 percent Boric acid (T_{18}), 0.75 percent Zinc sulphate + 0.75 percent Boric acid (T_{19}), 0.75 percent Zinc sulphate + 1.00 percent Boric acid (T_{20}), 1.00 percent Zinc sulphate + 0.25 percent Bori acid (T_{21}), 1.00 percent Zinc sulphate + 0.50 percent Boric acid (T_{22}), 1.00 percent Zinc sulphate + 0.75 percent Boric acid (T_{23}), 1.00 percent Zinc sulphate + 1.00 percent Boric acid (T_{24}) and control (T_{25}) laid in Randomized Complete Block Design with three replications. Different concentration of zinc sulphate and boric acid was sprayed twice i.e. last week of October and last week of November. Fruit weight, fruit size and fruit volume were recorded by taking average of 10 fruits from each replication of all the treatments. Specific gravity was calculated by dividing the average fruit weight with average fruit volume. Fruit pulp was calculated by subtracting the seed weight from the total fruit weight and expressed in gram (g). Seed weight (g) was recorded by weighing 100 seed from freshly harvested fully mature fruits under each replication. The total soluble solids (TSS) of the fruit juice were recorded with the help of Erma hand refractometer (0-32°B) as per standard procedure given in A.O.A.C. (1995) and expressed as degree Brix (°B) at room temperature. A temperature correction was applied when the readings were taken at a temperature other than 20^{0}C. The refractometer was calibrated with distilled water before use. Titratable acidity in fresh fruits was determined by the method as suggested in A.O.A.C. (1995). Total sugars, reducing sugar and non-reducing sugar and ascorbic acid content were calculated by the procedure described in A.O.A.C. (1995). Fruit yield was estimated from the average weight of the fruits by multiplying total number of fruits picking per tree and calculated in kg/tree. Data collected was subjected to statistical analyses as per method described by Panse and Sukhatme (1989) to get the relevant inferences.

Results and Discussion

Micronutrients play an important role in plant growth and fruit development and their deficiency leads to lowering the quality and quantity of fruits. They help in the uptake of major nutrients and play active role in the plant metabolism like cell wall development, photosynthesis, chlorophyll formation, enzyme activity, nitrogen fixation and oxidation-reduction reaction. Guava respond significantly to applied micronutrients like zinc and boron for improving yield and fruit quality.

Physical fruit parameters

Fruit weight of guava cultivar L-49 was significantly increased with the foliar application of Zinc sulphate and Boric acid alone as well as in combinations presented in table 1 which indicate that maximum fruit weight (158.52

g) was obtained with the application of 0.75% Zinc sulphate + 0.50% Boric acid (T_{18}), which was statistically at par with 157.82 g fruit weight under the treatment T_{19} (0.75% Zinc sulphate + 0.75% Boric acid), followed by 156.75 g fruit weight under T_{20} (0.75% Zinc sulphate + 1.00% Boric acid), 155.23 g fruit weight under T_{21} (1.00% Zinc sulphate + 0.25% Boric acid), and 155.14 g under T_{17} (0.75% Zinc sulphate + 0.25% Boric acid) which was significantly higher than the fruit weight (126.64 g) under control. Table 1 also revealed that Zinc sulphate and Boric acid sprayed separately also increased the fruit weight over control. Treatments T_3 (0.75% Zinc sulphate), T_4 (1.00% Zinc sulphate), T_2 (0.50% Zinc sulphate) T_6 (0.50% Boric acid) produced the fruit weight of 141.30 g, 140.94 g, 139.31 g and 138.75 g, respectively which was higher than fruit weight under control. Increase in fruit weight with application of Zinc may be due to the fact that it increased the production of metabolites and consequently the fruit weight. Similarly, Boron is also actively involved in transportation of carbohydrates in plants. It could be due to higher mobilization of photosynthates from other parts of the plant towards the developing fruits that are extremely active metabolic sink. Similar findings have been documented by Bhardwaj *et al*. (2019) in guava cultivar Allahabad Safeda. The data in Table 1 revealed that there was a significant increase in fruit volume of guava cultivar L-49 at different levels of Zinc sulphate and Boric acid sprayed alone as well as in combination. The highest fruit volume (151.72 cm^3) was recorded under the treatment was obtained with the application of 0.75% Zinc sulphate + 0.50% Boric acid (T_{18}) followed by 151.24 cm^3, 151.18 cm^3, 151.12 cm^3, 150.86 cm^3 and 150.84 cm^3 obtained under treatments T_{19} (0.75% Zinc sulphate + 0.75% Boric acid), T_{20} (0.75% Zinc sulphate + 1.00% Boric acid), T_{21} (1.00% Zinc sulphate + 0.25% Boric acid), T_{17} (0.75% Zinc sulphate + 0.25% Boric acid) and T_{22} (1.00% Zinc sulphate + 0.50% Boric acid), respectively. Minimum fruit volume (125.38 cm^3) was obtained with plain water spray (control). Table 1 also showed that Zinc sulphate and Boric acid sprayed separately also aided in increase in fruit volume where the treatment T_3 (0.75% Zinc sulphate), T_4 (1.00% Zinc sulphate), T_2 (0.50% Zinc sulphate) and T_6 (0.50% Boric acid) resulted in fruit volume of 139.43 cm^3, 139.16 cm^3, 137.46 cm^3 and 136.71 cm^3 respectively. The increase in fruit volume is directly proportional to fruit weight and fruit size. The increased fruit volume might be due to the involvement of micronutrients in hormonal metabolism, increased cell division and expansion of cells. Present findings are also in close conformity with Yadav *et al*. (2017) who revealed that the maximum fruit volume of guava cultivar L-49 was recorded with Zinc sulphate (1.00%) + Borax (1.00%) which was closely followed by lower concentration of Zinc sulphate (1.00%) + Borax (0.5%), whereas minimum fruit volume was recorded under control. Maximum fruit length (6.76 cm) was recorded with the treatment combination of 0.75 percent Zinc sulphate + 0.50 percent Boric acid (T_{18}) which was which was statistically at par with fruit length of 6.74 cm under treatment T_{19} (0.75% Zinc sulphate + 0.75% Boric acid) followed by 6.62 cm, 6.57 cm, 6.41 cm, 6.39 cm, 6.36 cm and 6.35 cm fruit length under treatments T_{20} (0.75% Zinc sulphate + 1.00% Boric acid), T_{17} (0.75% Zinc sulphate + 0.25% Boric acid), T_{21} (1.00% Zinc sulphate + 0.25% Boric acid), T_{14} (0.50% Zinc sulphate + 0.50% Boric acid), T_{15} (0.50% Zinc sulphate + 0.75% Boric acid) and T_{22} (1.00% Zinc sulphate + 0.50% Boric acid) respectively, however, minimum fruit length (5.23 cm) was recorded under control (T_{25}). Fruit breadth of guava cultivar L-49 significantly increased as compared to control with the foliar application of different levels of Zinc sulphate and Boric acid and is indicated in Table 1. Results reveal that the fruit breadth of guava cultivar L-49 was maximum (5.64 cm) under the treatment T_{18} (0.75% Zinc sulphate + 0.50% Boric acid) which was statistically at par with 5.62 cm under treatment T_{19} (0.75% Zinc sulphate + 0.75% Boric acid), and was followed by 5.57 cm, 5.56 cm, 5.51 cm, 5.47 cm and 5.46 cm fruit breadth obtained under treatments T_{20} (0.75% Zinc sulphate + 1.00% Boric acid), T_{17} (0.75% Zinc sulphate + 0.25% Boric acid), T_{14} (0.50% Zinc sulphate + 0.50% Boric acid), T_{13} (0.50% Zinc sulphate + 0.25% Boric acid) and T_{21} (1.00% Zinc sulphate + 0.25% Boric acid), respectively and was significantly higher than control (T_{25}). Higher fruit length due to combined application of Zinc and Boron may be attributed to their involvement in cell division, cell expansion and increase in 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 developing fruit that are extremely metabolic. Singh and Kaur (2019) obtained maximum fruit length and fruit breadth with the application of 1 percent Zinc Sulphate and minimum length and breadth with control in guava cultivar Sardar. The data presented in Table 1 revealed that the application of Zinc sulphate and Boric acid had significant effect on the specific gravity of guava cultivar L-49 fruits. Maximum specific gravity (1.04 g/cc) was observed with the application of 0.75 percent Zinc sulphate + 0.50 percent Boric acid (T_{18}), which was statistically at par with the treatment T_{19} (0.75% Zinc sulphate + 0.75% Boric acid) and T_{20} (0.75% Zinc sulphate + 1.00% Boric acid) and was closely followed by the specific gravity under the treatments T_{21} (1.00% Zinc sulphate + 0.25% Boric acid), T_{17} (0.75% Zinc sulphate + 0.25% Boric acid), T_{22} (1.00% Zinc

Table 1 : Effect of Zinc and Boron on physical fruit characters and yield of guava cultivar L-49.

Treatments	Fruit weight (g)	Fruit volume (cm^3)	Specific gravity (g/cm^3)	Fruit length (cm)	Fruit breadth (cm)	Pulp weight (g)	Seed weight (g)	Number of seeds per fruit	Yield (kg/tree)
0.25% $ZnSo_4$	137.63	135.35	1.01	5.67	5.06	135.54	2.10	146.29	20.55
0.50% $ZnSo_4$	139.31	137.46	1.01	5.98	5.11	137.22	2.09	144.69	23.40
0.75% $ZnSo_4$	141.30	139.43	1.01	6.22	5.22	139.22	2.08	143.13	26.83
1.00% $ZnSo_4$	140.94	139.16	1.01	6.11	5.12	138.86	2.08	143.98	25.32
0.25% H_3BO_3	137.37	135.28	1.02	5.65	5.05	135.27	2.09	146.68	22.51
0.50% H_3BO_3	138.75	136.71	1.01	6.08	5.26	136.67	2.08	146.90	25.83
0.75% H_3BO_3	138.58	137.19	1.01	6.02	5.24	136.50	2.08	147.93	25.23
1.00% H_3BO_3	137.64	136.54	1.01	5.97	5.21	135.57	2.07	148.67	24.16
0.25% $ZnSo_4$ + 0.25% H_3BO_3	142.14	140.28	1.01	6.22	5.37	140.05	2.09	139.79	23.56
0.25% $ZnSo_4$ + 0.50% H_3BO_3	146.83	144.72	1.01	6.36	5.45	144.75	2.08	137.76	26.92
0.25% $ZnSo_4$ + 0.75% H_3BO_3	146.71	145.69	1.01	6.32	5.43	144.63	2.08	137.80	26.52
0.25% $ZnSo_4$ + 1.00% H_3BO_3	146.28	144.27	1.01	6.21	5.39	144.21	2.07	138.22	25.21
0.50% $ZnSo_4$ + 0.25% H_3BO_3	149.29	147.51	1.01	6.33	5.47	147.23	2.06	134.15	25.79
0.50% $ZnSo_4$ + 0.50% H_3BO_3	152.11	148.86	1.01	6.39	5.51	150.06	2.05	132.57	28.33
0.50% $ZnSo_4$ + 0.75% H_3BO_3	151.85	150.16	1.01	6.36	5.45	149.80	2.05	132.79	28.15
0.50% $ZnSo_4$ + 1.00% H_3BO_3	151.27	150.34	1.01	6.31	5.44	149.23	2.04	133.34	25.65
0.75% $ZnSo_4$ + 0.25% H_3BO_3	155.14	150.86	1.02	6.57	5.56	153.11	2.03	126.98	28.96
0.75% $ZnSo_4$ + 0.50% H_3BO_3	158.52	151.72	1.04	6.76	5.64	156.51	2.01	124.18	34.60
0.75% $ZnSo_4$ + 0.75% H_3BO_3	157.82	151.24	1.04	6.74	5.62	155.81	2.01	124.97	33.28
0.75% $ZnSo_4$ + 1.00% H_3BO_3	156.75	151.18	1.03	6.62	5.57	154.73	2.02	125.96	32.31
1.00% $ZnSo_4$ + 0.25% H_3BO_3	155.23	151.12	1.02	6.41	5.46	153.20	2.03	126.64	26.24
1.00% $ZnSo_4$ + 0.50% H_3BO_3	154.98	150.84	1.02	6.35	5.41	152.95	2.03	126.75	24.12
1.00% $ZnSo_4$ + 0.75% H_3BO_3	153.78	150.21	1.02	6.32	5.37	151.74	2.04	127.27	22.45
1.00% $ZnSo_4$ + 1.00% H_3BO_3	152.43	149.67	1.01	6.22	5.25	150.38	2.05	127.98	21.32
Control	126.64	125.98	1.00	5.23	4.83	124.52	2.12	159.29	18.58
$CD_{0.05}$	1.27	1.21	0.01	0.03	0.04	1.37	0.01	1.43	0.56

sulphate + 0.50% Boric acid) and T_{23} (1.00% Zinc sulphate + 0.75% Boric acid). Minimum specific gravity of the fruit was observed as 1.00 g/cc under control (T_{25}). These results are also in agreement with the findings of Yadav *et al.* (2017) in guava cultivar L-49.

Fruit pulp weight of guava cultivar L-49 fruits was found to be significantly increased as compared to control with the foliar application of different levels of Zinc sulphate and Boric acid sprayed singly and in combination. The data presented in Table 1 revealed that the pulp weight of guava cultivar L-49 fruit was maximum (156.51 g) with the application of 0.75% Zinc sulphate + 0.50% Boric acid (T_{18}) which was which was statistically at par with 155.81 g pulp weight under the treatment T_{19} (0.75% Zinc sulphate + 0.75% Boric acid) followed by 154.73 g pulp weight under T_{20} (0.75% Zinc sulphate + 1.00% Boric acid), 153.20 g pulp weight under T_{21} (1.00% Zinc sulphate + 0.25% Boric acid), and 153.11 g under T_{17} (0.75% Zinc sulphate + 0.25% Boric acid) and 152.95 g of the pulp weight under underT_{22} (1.00% Zinc sulphate + 0.50% Boric acid), whereas. minimum pulp weight (124.52 g) of the guava cultivar L-49 fruits was obtained with control (T_{25}). It is pertinent to mention that many reports in literature suggest that application of Zinc and Boron may increase the pulp weight due to cell multiplication and cell enlargement or may be due to enhanced uptake of water and accumulation of sugar and other food reserves in greater amount as well as increased volume of intercellular spaces in the pulp of fruits, which ultimately added to the pulp. Pippal *et al.* (2019) concluded that foliar spray of Zinc and Boron significantly improved the pulp weight of guava fruit where the maximum pulp weight was recorded with 0.75 percent Zinc sulphate and 0.3 percent Boric acid application individually. Seed weight in guava cultivar L-49 fruit as depicted in Table 1 revealed that the foliar application of different levels of Zinc sulphate and Boric acid had significant effect on the seed weight and showed decreasing trend with the increase in the concentration of Zinc sulphate and Boric acid. Maximum seed weight (2.12 g) in the guava cultivar L-49 fruits resulted under the treatment T_{25} (control) followed by seed weight 2.10 g under the treatment T_1 (0.25% Zinc Sulphate), 2.09 g under T_2 (0.50% Zinc Sulphate). The minimum seed weight (2.01 g) in guava cultivar L-49 was recorded under the treatment T_{18} (0.75% Zinc sulphate + 0.50% Boric acid) which is statistically at par with T_{19} (0.75% Zinc sulphate + 0.75% Boric acid) , closely followed by 2.02 g seed weight under the treatment T_{20} (0.75% Zinc sulphate + 1.00% Boric acid), 2.03 g with the treatment T_{21} (1.00% Zinc sulphate + 0.25% Boric acid) , T_{22} (1.00% Zinc sulphate + 0.50% Boric acid) and T_{17} (0.75% Zinc sulphate + 0.25% Boric acid). This might be due to the dominating role of Zinc and Boron in the accumulation of flesh in the fruits which considerably decreased number of seeds and so the seed weight also reduced. Kumar *et al.* (2017) also recorded maximum seed weight of guava fruits under the treatment control. The perusal of data in Table 1 shows a considerable reduction in number of seeds per fruit in the plants of guava cultivar L-49 with the foliar application of various levels of Zinc sulphate and Boric acid. Least number of seeds per fruit (124.18) were observed under the treatment T_{18} (0.75% Zinc sulphate + 0.50% Boric acid) which was at par with 124.97 and 125.96 number of seeds per fruit under treatments T_{19} (0.75% Zinc sulphate + 0.75% Boric acid) and T_{20} (0.75% Zinc sulphate + 1.00% Boric acid), respectively. Highest number of seeds per fruit (159.29) were recorded under treatment T_{25} (control). The increase in the pulp content of fruits may have resulted in the decrease of seeds per fruit. The results in present study are also in close conformity with Singh and Kaur (2019) who reported that the maximum seed count (328.67) was recorded under control and lowest seed count (235.33) found under 0.5 percent Zinc Sulphate treatment in guava cultivar Sardar.

Fruit yield : It is evident from the data presented in Table 1 that the application of Zinc sulphate and Boric acid singly and their combination exerted a significant effect on the fruit yield per tree of guava cultivar L-49. Maximum fruit yield (34.60 kg/tree) was observed under the treatment 0.75% Zinc sulphate + 0.50% Boric acid (T_{18}), which was closely followed by treatment T_{19} (0.75% Zinc sulphate + 0.75% Boric acid), T_{20}(0.75% Zinc sulphate + 1.00% Boric acid), T_{17} (0.75% Zinc sulphate + 0.25% Boric acid), T_{14} (0.50% Zinc sulphate + 0.50% Boric acid) and T_{15} (0.50% Zinc sulphate + 0.75% Boric acid) with the respective fruit yield as 33.28 kg/tree, 32.31 kg/tree, 28.96 kg/tree, 28.33kg/tree and 28.15 kg/tree, respectively. While, minimum fruit yield (18.58 kg/tree) was recorded under control (T_{25}) which was significantly lower than all other treatments. Individual treatments of Zinc sulphate and Boric acid also showed significantly higher yield with the increase in concentration over control. Application of Zinc and Boron individually *i.e.* 0.75% Zinc sulphate, 0.50% Boric acid, 1.00% Zinc sulphate and 0.50% Boric acid also increased the fruit yield as 26.83 kg/tree, 25.83 kg/tree, 25.32 kg/tree and 25.23 kg/tree, respectively. These results are in line with the findings of Bhoyar *et al*. (2016), who reported that application of 0.5 percent Zinc Sulphate + 0.5 percent Ferrous Sulphate + 0.3 percent Borax resulted in highest fruit yield of guava cultivar L-49 as 57.1 kg per tree as compared to other treatments and minimum fruit yield as 37.1 kg per tree under control. Similar findings have been documented by Bhardwaj *et al*. (2019) in guava cultivar

Allahabad safeda who reported that the foliar application of Zinc sulphate along with Boric acid increased the yield of fruits in guava.

Biochemical fruit parameters

It is clear from the results presented in Table 2 that maximum total soluble solid content (10.86°B) in guava cultivar L-49 fruits was recorded in plants which were sprayed with 0.75 percent Zinc sulphate + 0.50 percent Boric acid (T_{18}) and was followed by 10.83°B and 10.81°B total soluble solids under treatments T_{19} (0.75% Zinc sulphate + 0.75% Boric acid) and T_{20} (0.75% Zinc sulphate + 1.00% Boric acid), respectively. Minimum total soluble solids (7.56°B) in the fruits, however, recorded under control (T_{25}). Alila and Achumi (2012) also reported that pre-harvest application of 4 percent Boric acid resulted in higher total soluble solids in litchi fruits. The reason for increase in total soluble solids might be that Boron helps in trans-membrane sugar transport. They reported that boron, by virtue of its ability to make complex with sugar (sugar borate complex) facilitated the transport of sugars in plants. However, Zinc acts as a catalyst in the oxidation and reduction processes and it has great importance in the sugar metabolism. The increase in total soluble solids might be due to the action of Zinc in converting complex substances into simple ones, which enhances the metabolic activity in fruits and it resulted in increased total soluble solids of fruits. Results of present study are also in close conformity with the results achieved by Hada *et al.* (2018) in guava. Data presented in Table 2 indicate that titratable acidity of guava cultivar L-49 fruits was affected with the application of Zinc and Boron. Maximum titratable acidity (0.52%) was observed under control (T_{25}), whereas, minimum titratable acidity (0.35%) was recorded with T_{18} (0.75% Zinc sulphate + 0.50% Boric acid) which is statistically at par with T_{19} (0.75% Zinc sulphate + 0.75% Boric acid) having titratable acidity of 0.36 percent. Titratable acidity reduced with application of Boric acid and Zinc sulphate which might be due to early ripening induced by the treatment during which

Table 2 : Effect of Zinc and Boron on biochemical fruit characters of guava cultivar L-49.

Treatments	TSS (°B)	Titratable acidity (%)	Ascorbic acid (mg/100g)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)
0.25% $ZnSo_4$	8.84	0.46	181.07	6.98	4.27	2.57
0.50% $ZnSo_4$	9.12	0.43	184.93	7.48	4.54	2.79
0.75% $ZnSo_4$	9.22	0.41	188.56	7.85	4.72	2.97
1.00% $ZnSo_4$	9.19	0.42	187.22	7.74	4.62	2.96
0.25% H_3BO_3	8.86	0.45	182.44	7.01	4.22	2.65
0.50% H_3BO_3	9.20	0.42	184.18	7.52	4.48	2.89
0.75% H_3BO_3	9.09	0.43	183.90	7.42	4.45	2.82
1.00% H_3BO_3	8.99	0.44	182.43	7.36	4.42	2.79
0.25% $ZnSo_4$ + 0.25% H_3BO_3	9.35	0.42	187.91	7.29	4.48	2.67
0.25% $ZnSo_4$ + 0.50% H_3BO_3	9.49	0.41	195.44	7.47	4.62	2.71
0.25% $ZnSo_4$ + 0.75% H_3BO_3	9.48	0.43	194.77	7.41	4.58	2.69
0.25% $ZnSo_4$ + 1.00% H_3BO_3	9.46	0.44	193.35	7.34	4.54	2.66
0.50% $ZnSo_4$ + 0.25% H_3BO_3	9.68	0.41	198.68	7.88	4.64	3.08
0.50% $ZnSo_4$ + 0.50% H_3BO_3	9.75	0.40	206.93	7.96	4.68	3.12
0.50% $ZnSo_4$ + 0.75% H_3BO_3	9.74	0.40	206.21	7.87	4.61	3.10
0.50% $ZnSo_4$ + 1.00% H_3BO_3	9.72	0.41	205.24	7.77	4.56	3.05
0.75% $ZnSo_4$ + 0.25% H_3BO_3	10.34	0.38	206.99	8.21	4.94	3.11
0.75% $ZnSo_4$ + 0.50% H_3BO_3	10.86	0.35	212.91	8.56	5.18	3.21
0.75% $ZnSo_4$ + 0.75% H_3BO_3	10.83	0.36	211.66	8.49	5.14	3.18
0.75% $ZnSo_4$ + 1.00% H_3BO_3	10.81	0.37	210.49	8.37	5.09	3.12
1.00% $ZnSo_4$ + 0.25% H_3BO_3	10.62	0.39	209.75	8.17	5.02	2.99
1.00% $ZnSo_4$ + 0.50% H_3BO_3	10.58	0.41	208.46	7.99	4.99	2.85
1.00% $ZnSo_4$ + 0.75% H_3BO_3	10.55	0.42	206.52	7.91	4.92	2.84
1.00% $ZnSo_4$ + 1.00% H_3BO_3	10.51	0.43	205.34	7.82	4.86	2.81
Control	7.56	0.52	151.45	6.46	4.01	2.33
$CD_{0.05}$	0.02	0.01	1.31	0.02	0.02	0.03

degradation of acid might have occurred. It also appears that total soluble solids increased at the expense of acidity in these fruits. The acid under the influence of Borax and Zinc sulphate might be rapidly converted into sugars and their derivatives by the reaction involving the reversal of glycolytic pathway. The results are also in agreement with Hada *et al*. (2018) who found that acidity of fruits was reduced with the application of Zinc and Boron. It is evident from the results of the present investigation that the total sugars, reducing sugars and no-reducing sugars increased considerably with the increased application of Zinc sulphate and Boric acid. Among all the treatments, highest content of total sugars (8.56%), reducing sugar and non-reducing sugar was observed as 8.56 percent, 5.18 percent and 3.21 percent respectively under treatment T_{18} (0.75% Zinc sulphate + 0.50% Boric acid), whereas, minimum total sugar, reducing sugar and non-reducing sugar was 6.46 percent, 4.01 percent and 2.33 percent respectively in control. These results are in conformity with the finding of Yadav *et al.* (2018) who reported that the highest content of total sugars, reducing sugar and non-reducing sugar with the foliar spray of 1.00 percent Zinc Sulphate + 1.00 percent Borax, whereas, the lowest content of total sugars was obtained with control in guava cultivar Lalit. Maximum ascorbic acid (212.91 mg/100g) was observed under the treatment T_{18} (0.75% Zinc sulphate + 0.50% Boric acid) which was statistically at par with the 211.66 mg/100g ascorbic acid under the treatment T_{19} (0.75% Zinc sulphate + 0.75% Boric acid). Minimum ascorbic acid content (151.45 mg/100g) in fruits of guava cultivar L-49 was obtained under the control (T_{25}). Higher ascorbic acid content with the application of Boron may be due to the fact that Boron activates the synthesis of ascorbic acid. Similar results were recorded by Hada *et al.* (2018) who revealed that the foliar spray of Borax (0.4%) + Zinc sulphate (0.8%) resulted in maximum ascorbic acid content in guava cultivar L-49.

Conclusion

It is concluded from the study that the guava plants of cultivar L-49 treated with 0.75 percent Zinc sulphate + 0.5 percent Boric acid exhibited highest fruit yield and best fruit quality parameters under rainfed conditions of Jammu sub-tropics.

Conflict of interest : All authors declare that they have no conflict of interest.

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