Current Journal of Applied Science and Technology

39(1): 43-51, 2020; Article no.CJAST.51260
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Effect of Foliar Fertilization of Boron, Zinc and Iron on Fruit Quality and Leaf Nutrients Content of Peach cv. Shan-e-Punjab

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Authors' contributions

This work was carried out in collaboration between both authors. Author BM performed the statistical analysis, wrote the protocol, managed the literature searches and wrote the first draft of the manuscript. Author AKG designed the study and managed the analyses of the study. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2020/v39i130479
Editor(s):
(1) Dr. Aleksey Aleksandrovich Hlopitskiy, Department of Technology Inorganic Substances, Ukrainian State University of Chemical Technology, Dnepropetrovsk, Ukraine.
Reviewers:
(1) Georgiana Eurides de Carvalho Marques, Federal Institute of Education, Science and Technology of Maranhão, Brazil.
(2) Rahul Datta, Mendel University, Czech Republic.
Complete Peer review History: http://www.sdiarticle4.com/review-history/51260

Original Research Article

Received 02 December 2019
Accepted 07 February 2020
Published 10 February 2020

ABSTRACT

Aims: To study the effect of different micronutrients and number of foliar spray on fruit quality and leaf nutrient content of peach.

Study Design: The experiment comprised of seven treatments and conducted on seven years old plants in Randomized Block Design with three replications.

Place and Duration of Study: The experiment was conducted at the experimental orchard of Department of Horticulture, CCS Haryana Agricultural University, Hisar during the year 2018.

Methodology: The treatments included in the study consisted of three micro-nutrients [T_1- $ZnSO_4$ @ 0.2%, T_2- $ZnSO_4$ @ 0.3%, T_3- $FeSO_4$ @ 0.2%, T_4- $FeSO_4$ @ 0.3%, T_5- Boric acid @ 0.1%, T_6- Boric acid @ 0.2%, T_7- Control (water spray)] each applied as foliar spray at different concentration as single and double spray.

Results: The results showed that foliar spray of micronutrients significantly improved quality and leaf nutrient status in peach cv. Shan-e-Punjab. The foliar spray of $FeSO_4$ @ 0.2% (T_3) found to be the best treatment with respect to TSS (11.06%), ascorbic acid (8.18 mg/100 g pulp) and leaf iron

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content (345.51 ppm). The highest TSS: ratio (23.88), leaf zinc content (35.42 ppm) and lowest acidic fruits (0.45%) was observed from the plants sprayed with T_1 ($ZnSO_4$ @ 0.2%), whereas, highest leaf boron content (91.02 ppm) was recorded with T_6 (Boric acid @ 0.2%). Double foliar spray of micronutrients (Fe, Zn and B) at first week of March + April significantly TSS, TSS: acidity, ascorbic acid, leaf zinc, iron, and boron content and reduced acidity fruits then single foliar spray in first week of March.

Conclusion: The foliar spray of $ZnSO_4$ @ 0.2% (T_1) proved to be best treatment in terms of quality. A double spray of micronutrients (Fe, Zn and B) significantly increased total soluble solids, TSS: acidity, ascorbic acid, leaf (zinc, iron, and boron) content and reduced fruit acidity as compared to single spray.

Keywords: Foliar spray; leaf nutrient; micronutrients; peach; quality attributes; Shan-e-Punjab.

1. INTRODUCTION

Peach [Prunus persica (L.) Batsch] is a juicy fruit with excellent appearance and quality. It belongs to the family rosaceae and sub family prunoidae. It is distinct in its group (stone fruit) along with plum in having lower chilling requirement than other temperate fruits like apple, pear etc. The fruit achieve best quality fruits in area where summers are warm to hot. A distinct group of cultivar which requires low chilling hours for bud burst and growth is known as low chill peach.

Peach tree requires all the essential nutrient elements for optimum growth and productivity like other fruit plants. Deficiency of any one of these nutrients can lead to the problem with vegetative growth, tree health, yield and quality [1]. The foliar application of nutrients on fruit trees has gained more importance in recent years as fertilizers applied through the soil are needed in higher quantities because some amount leach down and some become unavailable to the plants due to complex soil reaction. Application of micronutrients through foliage can be 10 to 20 times efficient as compare to soil application. However, this efficiency is not always achieved in actual practice due to weather extremes, application of the wrong spray mix, or of the right mix at the wrong time [2]. The beneficial effect of foliar application of nutrients is based on the fact that the nutrients reach directly to the leaves which are the sites of metabolism [3]. Foliar fertilization of micronutrients has an advantage of low application rates, uniform distribution of fertilizer materials and quick responses to applied nutrients [4]. Foliar application of micronutrients like boron, zinc, and iron seems to be an effective tool to correct the deficiency symptoms as well as increase the yield of the plant. It is also increased resistance to disease and insect pests and improved drought tolerance [5].

Various micronutrients play complex roles in plant composition and production. Although most of micronutrients participate in the functioning of number of enzyme systems but there is considerable variation in the specific functions of the micronutrients in plant and microbial growth processes. For example iron is capable for acting as electron carriers in the enzyme system that bring about oxidation-reduction reactions in plants. These are essential steps in photosynthesis and many other metabolic processes. Zinc function in many enzyme systems as bridge to connect the enzyme with the substrate upon which it is meant to act [6].

Zinc plays a vital role in photosynthesis and related enzymes resulting in cumulative sugar and reducing fruit acidity [7]. Soil application of Zn is not very practical because the roots of fruit crops occupy deep into the soil layers, and zinc does not easily move in the soil, therefore, foliar sprays are more effective method [8]. Foliar application of Zn increases the growth, yield and also improves the quality of the peach [3]. Boron is also an essential microelement required for the healthy growth of the plant. The deficiency of this element Induced dense branching, shortening of internodes, leaves may narrow, brittle, curled and necrotic at the tips. The essentiality of boron for sugar transport in plants is discovered by Gauch and Dugger [9]. Reduction in fruit set, fruit growth and yield in boron deficient plant is reported in pear [10]. Boron increases the germination of pollen grains and enlargement of pollen tube, fruits setting and yield in peach orchards [11]. Iron plays an important role in chlorophyll biosynthesis pathway [12] thus deficiency of this element reduced the net photosynthesis [13] which causes huge reduction in fruit yield [14]. The Iron chlorosis has harmful effects on fruit quality parameters such as colour, firmness, or acidity and affecting fruit production, dropping the number of fruits per tree, fruit size and yield [15].

Keeping this into consideration, the present investigation was conducted to determine the effects of foliar application of micronutrients (B, Zn, and Fe) on fruit growth, yield of peach cv. Shan-e-Punjab.

2. MATERIALS AND METHODS

The present study to study the effect of foliar fertilization of boron, zinc and iron on fruit quality amid leaf nutrient content of peach was carried out during 2017-18 at the experimental farm, Department of Horticulture, CCS HAU, Hisar, Haryana (India). The experiment was laid out on seven years old trees planting at 6 m × 6 m spacing in Randomized Block Design with three replications. The trees were kept under uniform conditions of orchard management during the study period. All cultural practices were carried out as per the package of practices. Details of treatments are given below:

T_1- ZnSO4 @ 0.2%
T_2- ZnSO4 @ 0.3%
T_3- FeSO4 @ 0.2%
T_4- FeSO4 @ 0.3%
T_5- Boric acid @ 0.1%
T_6- Boric acid @ 0.2%
T_7- Control (water spray)

2.1 Time and Number of Spray

S_1- First week of March (one spray)
S_2 - First week of March and April (one spray each month)

The total soluble solids of the randomly selected fruit was determined at room temperature by using Pocket Digital Refractometer having a range of 0-32% by putting a drop of juice obtained by pressing the pulp on the prism and taking the readings. Titratable acidity and ascorbic acid were determined as per the method suggested by AOAC [16]. The ratio of total soluble solid to acidity was determined by dividing the total soluble solid with total acid.

For determining the leaf nutrients status, five-month old healthy leaf samples from non-fruiting shoots were collected in August and washed under running tap water followed by 0.1% HCl and two time washings through distilled water. The washed leaf samples were surface dried and then oven-dried at 70°C for 48 hours. The dried samples were ground and sieved through muslin cloth for further analysis as per the procedure suggested by Chapman [17]. The digestion of leaf samples for nutrient analysis was done the procedure described by Piper [18]. The DTPA extractable Zn and Fe was estimated by using the method of Lindsay and Norvell [19]. The digested leaf samples were analyzed for determining zinc concentration on atomic absorption spectrophotometer and their contents were expressed in ppm. The boron content of leaf was determined from the digested leaf extract by Spectrophotometer using azomethine-H reagent as suggested by Wolf [20] and value expressed in ppm.

The data were analyzed according to the procedure for analysis of randomized block design (RBD) as given by Gomez and Gomez [21]. The overall significance of difference among the treatments was tested, using critical differences (C.D.) at 5% level of significance. The results were statistically analyzed with the help of a windows-based computer package OPSTAT [22].

3. RESULTS AND DISCUSSION

The results obtained from the present investigation (Table 1) revealed that the total soluble solids increased with the foliar application of micronutrients as compared to control. The maximum total soluble solids in fruits (11.05%) were noted from the plants sprayed with T_4 ($FeSO_4$ @ 0.3%) which was statistically at par with T_2 (10.88%) and T_3 (10.81%), whereas, lowest was recorded from control (9.46%). Foliar spray of micronutrient in first week of (March + April) significantly increased the total soluble solids (10.84%) in peach fruit as compared to single spray in March (10.30%). The interactive effect of treatments and number of spray was found significant and highest total soluble solid content (11.64%) was observed with T_4S_2 (double spray of $FeSO_4$ @ 0.3%) treatment combination over the rest of its single or double micronutrient sprayed treatments.

The analysis of variance of TSS: acid of peach fruits treated with various micronutrient spray and number of spray showed significant variation, whereas, the interactions amongst the factors were absent (Table 2). Maximum TSS/ acid ratio (23.88) was found in T_1 ($ZnSO_4$ @ 0.2%), which was statistically at par with T_3 (23.34), while minimum TSS/ acid ratio (17.41) was recorded in control (T_7) followed by T_6 (20.63) and T_5 (20.91). The foliar spray of micronutrients in the first week March and April was found to be also increased the TSS: acidity (22.58) as compared to single spray in the first week of March (20.55).

Table 1. Effect of micronutrients (Fe, Zn and B) and number of spray on TSS of fruit in peach cv. Shan-e-Punjab

Treatments	Number of spray		Mean
	Single spray (S_1)	Double spray (S_2)	
T_1- $ZnSO_4$ @ 0.2%	10.46	10.90	10.68
T_2- $ZnSO_4$ @ 0.3%	10.76	11.01	10.88
T_3- $FeSO_4$ @ 0.2%	10.43	11.18	10.81
T_4- $FeSO_4$ @ 0.3%	10.47	11.64	11.06
T_5- Boric acid @ 0.1%	10.14	10.79	10.47
T_6- Boric acid @ 0.2%	10.36	10.90	10.63
T_7- Control	9.46	9.46	9.46
Mean	**10.30**	**10.84**	
CD at 5%	**A**	**B**	**A × B**
	0.16	0.29	0.41
SE(m)	0.05	0.10	0.14

**A = Number of spray, B = Micronutrients; A × B = number of spray × micronutrients; S_1 = Single spray (first week of March), S_2 = double spray (first week of March + April)*

Table 2. Effect of micronutrients (Fe, Zn and B) and number of spray on TSS: acidity of fruit in peach cv. Shan-e-Punjab

Treatments	Number of spray		Mean
	Single spray (S_1)	Double spray (S_2)	
T_1- $ZnSO_4$ @ 0.2%	22.66	25.11	23.88
T_2- $ZnSO_4$ @ 0.3%	21.52	23.78	22.65
T_3- $FeSO_4$ @ 0.2%	21.77	24.91	23.34
T_4- $FeSO_4$ @ 0.3%	20.96	23.32	22.14
T_5- Boric acid @ 0.1%	19.85	21.96	20.91
T_6- Boric acid @ 0.2%	19.67	21.58	20.63
T_7- Control	17.41	17.41	17.41
Mean	**20.55**	**22.58**	
CD at 5%	**A**	**B**	**A × B**
	0.64	1.19	NS
SE(m)	0.22	0.41	0.58

**A = Number of spray, B = Micronutrients; A × B = number of spray × micronutrients; S_1 = Single spray (first week of March), S_2 = double spray (first week of March + April)*

The increased TSS and TSS acid ratio due to the spray of nutrients combination might be because of the increased photosynthesis activity, translocation of sugars from source to the sink and conversion of complex form of sugars (polysaccharides) to simple sugars (glucose and fructose) in fruits [23] due to the increased activities of enzymes by zinc. The results of present study are supported by the findings of El-Shewy and Abdel-Khalek [24] they reported highest total soluble solids and TSS to acid ratio with the foliar spray of combinations of micronutrients in peach cv. Florida Prince and Desert Red. Finally, from the above mentioned results, it could be concluded that, two or three sprays yearly were more effective in increasing TSS and TSS/ acid ratio. The results of present study are in close confirmation with the findings of Dhotra et al. [25] and Yadav et al. [3], who also reported the total soluble solids and TSS: acid increased significantly with the foliar application of micronutrients in peach.

It is revealed from the data presented in Table 3, that the per cent of acidity was reduced significantly with micronutrients spray as compared to control. The lowest acidic fruit (0.45%) was harvested from the plants sprayed with T_1 ($ZnSO_4$ @ 0.2%), which was statistically at par with T_3 (0.46%) and followed by T_2 (0.48%). The maximum acidity (0.54%) was observed from control. Regarding number spray of micronutrients, twice spray in first week of March and April was found to reduce the per cent of acidity (0.48%) significantly than single spray in March (0.50%). The interaction between of micronutrients and number of spray with respect to the per cent acidity was found non-significant.

The decreased acidity in fruit juice because of nutrients spray might be due to the metabolic transformation of organic acids into sugars and rapid utilization of organic acids in respiration [26]. The available literature indicates that the application of non-chelated form of micronutrients (Fe + Zn + Mn) produced higher acidic fruits compared to the chelated form in Florida Prince and peach [11]. However, no significant differences were recorded regarding the effect of number of sprays on total acidity of Desert Red peach [24]. However, The results of present study are contrary to the findings of Dhotra et al. [25], who reported the plants sprayed with 0.1% H_3BO_3 + 0.5% $ZnSO_4.7H_2O$ + 0.5% $FeSO_4.7H_2O$ produced more acidic fruits compared to control in peach cv. Shan-e-Punjab.

It is inferred from data presented in Table 4, the ascorbic acid content in peach fruit was significantly influenced by different treatments of micronutrient and number of spray; however the interactive effect between these treatments was found non-significant. The highest ascorbic acid content (8.18 mg/100 g pulp) was found in the fruits harvested from T_4 ($FeSO_4$ @ 0.3%) treated plants and it was found at par with T_2 (8.14 mg/100g pulp), while lowest ascorbic acid content (7.43 mg/100g pulp) was recorded in control. In case of number of spray, double spray of micronutrients in first week of March and April increased the ascorbic acid content (8.00 mg/100g pulp) significantly as compared to single spray in first week of March (7.76 mg/100 g pulp). Higher levels of sugar with the application of micronutrients including boron might be the possible cause of increased content of ascorbic acid, which is synthesized from sugar [27]. Zinc plays an active role in the synthesis of Auxins and increased synthesis of Auxins has been reported to increase the accumulation of ascorbic acid content [28]. Similar results was observed with the study of Dhotra et al. [25], they found maximum vitamin C (6.7 and 6.8 mg/100 ml) content with foliar spray of where all the micronutrients (0.1% H_3BO_3 + 0.5% $ZnSO_4.7H_2O$ + 0.5% $FeSO_4.7H_2O$) were applied, whereas, minimum vitamin C (5.65 and 5.70 mg/100 ml) content was reported in control in peach. These results revealed that foliar spray of micronutrients has a positive effect on vitamin C content. Hassan et al. [29] reported similar findings by applying micronutrients on plum orchards.

The analysis of data with regards to zinc content of leaf indicated significant difference amongst all micronutrient sprays as well as number of spray (Table 5). The maximum zinc content in peach leaf (35.42 ppm) recorded in treatment, which was sprayed with zinc sulphate ($ZnSO_4$) at rate 0.2% (T_1) and it was at par with T_2 (35.22 ppm), T_4 (35.22 ppm), T_5 (35.04 ppm), T_6 (35.04 ppm) and T_3 (33.93 ppm), while minimum zinc content (29.36 ppm) in leaf was observed from control (T_7). Double spray of micronutrients (first week of March + April) significantly increased zinc content (35.17 ppm) of leaf than single spray in March (33.18 ppm). The interactive effect between micronutrients and number of spray with respect of zinc content of leaf was also found significant. The highest leaf zinc content (38.14 ppm) was recorded with the T_2S_2 (double spray of $ZnSO_4$ @ 0.3%) treatment combination, which was found at par with T_1S_2 (37.64 ppm), whereas, minimum was observed with T_7S_1 (29.36 ppm) and T_7S_2 (29.36 ppm). In peach trees Zn is quite mobile and it had also greater concentrations in plant tissues in first year compared to second year [30]. Spraying the trees twice or thrice a year was more effective than spraying once a year in improving nutritional status of the trees besides correcting Zn deficiency in peach [11]. These finding are supported by the work of Ali et al. [31] who the Fe concentration in leaves increased with all the treatments over the untreated (control).

The data pertaining to iron content of peach leaf as influenced by micronutrient spray presented in Table 6. Significant variation in different treatments was observed during seasonal growth under investigation. The highest total iron content (345.51 ppm) was recorded in the sprayed plants with $FeSO_4$ @ 0.3% (T_4); which was statistically at par with T_3 (302.99 ppm), whereas, lowest leaf iron content (214.95 ppm) was observed from the plants sprayed with T_7 (control), which was statistically at par with T_1 (227.43 ppm), T_6 (244.56 ppm) and T_2 (256.46 ppm).

Twice foliar application of micronutrients in first week of March and April increased leaf iron content in peach (284.85 ppm) significantly than single foliar applicant of micronutrients in March (251.62 ppm). In case of interaction between of micronutrients and number spray on iron content of peach was found non-significant. Spraying the trees twice or thrice a year was more effective than spraying once a year in improving nutritional status of the trees besides correcting Zn deficiency in peach [11]. These results agree with the findings of El-Shewy and Abdel-Khalek [24] they reported that foliar application of Fe (0.6 g/l) increase iron content in peach leaves.

Table 3. Effect of micronutrients (Fe, Zn and B) and number of spray on acidity of fruit (%) in peach cv. Shan-e-Punjab

Treatments	Number of spray		Mean
	Single spray (S_1)	Double spray (S_2)	
T_1- $ZnSO_4$ @ 0.2%	0.47	0.44	0.45
T_2- $ZnSO_4$ @ 0.3%	0.50	0.46	0.48
T_3- $FeSO_4$ @ 0.2%	0.48	0.45	0.46
T_4- $FeSO_4$ @ 0.3%	0.50	0.50	0.50
T_5- Boric acid @ 0.1%	0.51	0.49	0.50
T_6- Boric acid @ 0.2%	0.53	0.50	0.51
T_7- Control	0.54	0.54	0.54
Mean	**0.50**	**0.48**	
CD at 5%	**A**	**B**	**A × B**
	0.01	0.02	NS
SE(m)	0.004	0.007	0.01

**A = Number of spray, B = Micronutrients; A × B = number of spray × micronutrients; S_1 = Single spray (first week of March), S_2 = double spray (first week of March + April)*

Table 4. Effect of micronutrients (Fe, Zn and B) and number of spray on ascorbic acid of fruit (mg/100 g pulp) in peach cv. Shan-e-Punjab

Treatments	Number of spray		Mean
	Single spray (S_1)	Double spray (S_2)	
T_1- $ZnSO_4$ @ 0.2%	7.84	8.04	7.94
T_2- $ZnSO_4$ @ 0.3%	8.01	8.27	8.14
T_3- $FeSO_4$ @ 0.2%	7.63	7.75	7.69
T_4- $FeSO_4$ @ 0.3%	7.85	8.51	8.18
T_5- Boric acid @ 0.1%	7.70	7.94	7.82
T_6- Boric acid @ 0.2%	7.84	8.05	7.95
T_7- Control	7.43	7.43	7.43
Mean	**7.76**	**8.00**	
CD at 5%	**A**	**B**	**A × B**
	0.11	0.20	NS
SE(m)	0.04	0.07	0.10

**A = Number of spray, B = Micronutrients; A × B = number of spray × micronutrients; S_1 = Single spray (first week of March), S_2 = double spray (first week of March + April)*

Table 5. Effect of micronutrients (Fe, Zn and B) and number of spray on zinc content leaf (ppm) in peach cv. Shan-e-Punjab

Treatments	Number of spray		Mean
	Single spray (S_1)	Double spray (S_2)	
T_1- $ZnSO_4$ @ 0.2%	33.19	37.64	35.42
T_2- $ZnSO_4$ @ 0.3%	32.31	38.14	35.22
T_3- $FeSO_4$ @ 0.2%	32.55	35.31	33.93
T_4- $FeSO_4$ @ 0.3%	35.64	34.80	35.22
T_5- Boric acid @ 0.1%	34.74	35.35	35.04
T_6- Boric acid @ 0.2%	34.48	35.60	35.04
T_7- Control	29.36	29.36	29.36
Mean	**33.18**	**35.17**	
CD at 5%	**A**	**B**	**A × B**
	0.89	1.66	2.34
SE(m)	0.30	0.57	0.80

**A = Number of spray, B = Micronutrients; A × B = number of spray × micronutrients; S_1 = Single spray (first week of March), S_2 = double spray (first week of March + April)*

Table 6. Effect of micronutrients (Fe, Zn and B) and number of spray on Fe content of leaf (ppm) in peach cv. Shan-e-Punjab

Treatments	Number of spray		Mean
	Single spray (S_1)	Double spray (S_2)	
T_1- $ZnSO_4$ @ 0.2%	220.37	234.48	227.43
T_2- $ZnSO_4$ @ 0.3%	225.93	286.98	256.46
T_3- $FeSO_4$ @ 0.2%	287.30	318.68	302.99
T_4- $FeSO_4$ @ 0.3%	311.32	379.70	345.51
T_5- Boric acid @ 0.1%	266.30	305.18	285.74
T_6- Boric acid @ 0.2%	235.17	253.95	244.56
T_7- Control	214.95	214.95	214.95
Mean	**251.62**	**284.85**	
CD at 5%	**A**	**B**	**A × B**
	29.64	55.46	NS
SE(m)	10.14	18.97	26.83

**A = Number of spray, B = Micronutrients; A × B = number of spray × micronutrients; S_1 = Single spray (first week of March), S_2 = double spray (first week of March + April)*

Table 7. Effect of micronutrients (Fe, Zn and B) and number of spray on boron content of leaf (ppm) in peach cv. Shan-e-Punjab

Treatments	Number of spray		Mean
	Single spray (S_1)	Double spray (S_2)	
T_1- $ZnSO_4$ @ 0.2%	63.33	88.75	76.04
T_2- $ZnSO_4$ @ 0.3%	60.83	69.58	65.21
T_3- $FeSO_4$ @ 0.2%	79.62	90.42	85.02
T_4- $FeSO_4$ @ 0.3%	82.92	85.42	84.17
T_5- Boric acid @ 0.1%	80.50	91.67	86.08
T_6- Boric acid @ 0.2%	89.54	92.50	91.02
T_7- Control	59.01	59.01	59.01
Mean	**73.68**	**82.48**	
CD at 5%	**A**	**B**	**A × B**
	2.11	3.95	5.59
SE(m)	0.72	1.35	1.91

**A = Number of spray, B = Micronutrients; A × B = number of spray × micronutrients; S_1 = Single spray (first week of March), S_2 = double spray (first week of March + April)*

Data pertaining to leaf boron content as influenced by different micronutrient spray and number of spray presented in Table 7. The perusal of data showed that the boron content of leaf significantly increased (91.02 ppm) with the spray of T_6 (Boric acid @ 0.2%) over rest of the treatments. Whereas, minimum leaf boron content (59.01 ppm) was observed in control (T_7) followed by T_2 (65.21 ppm). In case of number of spray of micronutrients, twice foliar spray in first week of March and April increased leaf boron content (82.48 ppm) significantly compared to the single spray in March (73.68 ppm). Interaction between micronutrients and number of spray varied significantly among the treatments. The treatment combination T_6S_2 (Boric acid @ 0.2%) significantly increased the leaf boron content (92.50 ppm) except T_5S_2 (91.67 ppm), T_6S_1 (89.54) and T_1S_2 (88.75 ppm), whereas minimum leaf boron content (59.01 ppm) was observed from T_7S_1 and T_7S_2 which was statistically at par with T_2S_1 (60.83 ppm) and T_1S_1 (63.33 ppm) treatment combinations.

The increase in leaf boron content with foliar spray might be due to B translocate readily in the xylem, but once in the leaves it becomes one of the least mobile of the micronutrients [32]. The results of present study closely agree with the findings of Ali et al. [31], who also found boron content in peach leaves increased with the foliar application of this micronutrient. The findings of present experiment in respect of leaf B content are supported by Rease [10] in Bartlett pears and Stilianidis et al. [33] in peach, who revealed the pre-harvest Ca–B sprays increased leaf B concentrations.

4. CONCLUSION

From the present study, we conclude that the foliar spray of $ZnSO_4$ @ 0.2% (T_1) proved to be best treatment in terms of quality. Double spray of micronutrients (Fe, Zn and B) significantly increased TSS, TSS: acidity, ascorbic acid, leaf (zinc, iron and boron) content and reduced fruit acidity over single spray.

ACKNOWLEDGEMENTS

I would like to express my very great appreciation to Dr. A. K. Godara for his valuable and constructive suggestions during the planning and development of this research work. My sincere thanks also go to government of Afghanistan, ICAR and CCS Haryana Agricultural University, Hisar for providing me opportunity of higher studies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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