Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(2): 3881-3884
Received: 17-01-2018
Accepted: 20-02-2018

Sandeep Verma
Department of Horticulture, Chauras Campus, H.N.B. Garhwal University, Srinagar Garhwal, Uttarakhand, India

RK Bairwa
Department of Horticulture Collage of Agriculture, SKRAU, Bikaner, Rajasthan, India

DK Rana
Department of Horticulture, Chauras Campus, H.N.B. Garhwal University, Srinagar Garhwal, Uttarakhand, India

Tanuja Dimri
Department of Horticulture, Chauras Campus, H.N.B. Garhwal University, Srinagar Garhwal, Uttarakhand, India

CK Dotaniya
Department of Soil Science and Agricultural Chemistry Collage of Agriculture, SKRAU, Bikaner, Rajasthan, India

Correspondence
RK Bairwa
Department of Horticulture Collage of Agriculture, SKRAU, Bikaner, Rajasthan, India

Influence of different concentrations of zinc, boron and iron on yield characters of strawberry (*Fragaria* x *ananassa* Duch.) cv. chandler under valley condition of Garhwal Himalaya

Sandeep Verma, RK Bairwa, DK Rana, Tanuja Dimri and CK Dotaniya

Abstract
The field experiment was conducted at Horticultural Research Centre and Department of Horticulture, Chauras Campus, H.N.B. Garhwal University, Srinagar Garhwal, Uttarakhand during the year 2016-17. The experiment was laid out in RBD with 13 treatments in 3 replication on different concentration of micronutrients. The treatments include Zn (0.2%, 0.4%, 0.6%), B (0.2%, 0.4%, 0.6%), Fe (0.2%, 0.4%, 0.6%), and their combination Zn+B+Fe (0.2%), Zn+B+Fe (0.4%), Zn+B+Fe (0.6%), and control. The results observed that the Yield of fruits/plant (253.33g) and yield ton/h (8.42 ton) were obtained by T_{11}(Zn+B+Fe) 0.4%. The least values were recorded in the control.

Keywords: Micro-Nutrients, yield characters and strawberry

Introduction
The cultivated species *Fragaria x ananassa* Duch. has chromosome number (2n) of 56. It is monoecious octoploid hybrid of two largely dioecious octoploid species, *Fragaria chiloensis* and *Fragaria virginiana*. *Fragaria* species belongs to family Rosaceae. The fruit is known for its characteristic aroma, bright red color, juicy texture, and sweetness. The cultivated strawberry is one of the attractive, delicious, tasty and nutritious fruit and distinct and pleasant flavour. It has a unique place among cultivated berry fruits. In India the cultivation was confined only to hilly tracts of Himachal Pradesh, Deharadun and Nanital (U.K.), Mumbai (Maharastra) and Kashmir valley. It is grown commercially in China (38.7%) USA (17%) Mexico (4.9%), Italy (5%), Rusia (4%), Turkey (4.8%), Poland (4%) of world production. The area, production and productivity of strawberry in India during 2016-17 was reported 1000 HA, 5000MT and 7MT/HA respectively (NHB, 2016-17).
The strawberry required an optimum day temperature of 22^0 C to 23^0 C and night temperature of 7^0 C to 13^o C for maximum growth and development. In cold climate, frost damage as well as winter injury seriously reduces yield of strawberry. Frost may damage center of the open flowers, causing the characteristic “Black eye”. Flowers before opening and after set are slightly more resistant to frost damage. Strawberry can be grown on a wide range of soils from heavy clays to light sand and gravels. However, strawberry Plants performers well in sandy loam soil with pH 5.5 to 6.5 (Anon. 1956), “Albinism” is a physiological disorder which affects yield and quality of berries caused by certain climatic conditions and extremes in nutrition. Organic fertilizers improve soil fertility by modifying soil structure, pH, biophysical conditions and availability of essential nutrients (Atiyeh *et al.*, 2002). Micronutrients such as zinc, boron and iron play an important role in increasing vegetative growth, flowering, fruit yield and quality characters (Dotaniya *et al.*, 2013) [4]. This is the common observations that zinc deficient plants have poor growth, reduced fruit set, fruit size and yield, whereas, the fruit set, number of fruits per plants, fruit volume, weight and yield per plant were increased with increasing zinc concentration in strawberry. Optimum boron content in the plant leaves correspond to maximum growth of strawberry plants. Lack of boron resulted in abortion of flowers, decreased fruit setting and poor yield in strawberry. The foliar nutrition of micro-nutrients have very important role in improving fruit set, productivity and quality of fruits. Foliar nutrition at proper time improved quality and quantity strawberry (Abdollahi *et al.*, 2010).

Materials and Methods
The experiment was carried out at Horticultural Research Centre and Department of Horticulture, Chauras Campus, H.N.B.

Garhwal University, Srinagar Garhwal, Uttarakhand during the year 2016-17. The Srinagar valley is spread between latitude 30º 12' 0"to 30º 13' 14" North longitude and 78º 0' 45" to 78º 0' 50" East longitude while attitudinally located at 540 metre above mean sea level in the lower Himalayan region.

Preparation of micronutrient solution stock solution of micronutrients viz; Ferrous Sulphate ($FeSO_4$), Zinc Sulphate ($Znso_4$) and Boric acid (H_3BO_3) were prepared by weighing 6 g in each case and dissolved in a one liter of water.

$$\text{Quantity (g/mg)} = \frac{\text{Required volume in ml x Required conc. (ppm)}}{1000000}$$

The working solution of Zn, Bo, Fe (0.2%, 0.4% and 0.6%) in each case along and with combinations was prepared by diluting the required amount of stock solution with distilled water for spraying the crop.

$$\text{Stock solution} = \frac{\text{ppm required (conc. required) x Vol. required}}{\text{ppm of stock solution}}$$

Yield Parameters Days taken to emergence of flower from the date of transplanting of the five respective plants were recorded individually and the mean days taken to produce first flower was worked out.
Analysis of variance for RBD Analysis of variance for individual character was done on the basis of mean values as suggested by Panse and Sukhatme (1976). The model of analysis of variance adopted for it is given below.
Standard error of difference between genotype mean was calculated as:

$$SE_d = \sqrt{\frac{2EMS}{r}}$$

Result and Discussion
The data on achieved with regards to the effect of micronutrient viz. zinc, iron and boron on the growth, yield and quality characters are being described here with suitable heads.

Yield of fruits/plant (g)
A critical observation of the table shows that the treatment T_{11} ($ZnSO_4$ + H3BO_3 + $FeSO_4$) @ 0.4%, (253.33) fruit per plant followed by T_{10} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.2 %, (251) and T_5 (H_3BO_3) @ 0.4 % (236.33). Minimum number (177.66) of fruit per plant is observed in treatment T_0 (control). crop to increase in chlorophyll content of leaves, photosynthetic efficiency, translocation of metabolites from the source to sink as and when needed by the crop and it may be responsible for retaining more number of fruits. Similar results were reported by Kazi *et al.*, 2012, Singh and Saravanan 2012, Singh *et al.*, 2015 [6, 8, 9, 10] on strawberry.

Yield of fruit per plot (kg)
The observations on Yield of fruit per plot (kg) were statistically analysed and have been presented. A critical observation of the table shows that number of fruit per plant was influence by micronutrient at different stage of reproductive growth. The treatment T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%, (1.51) fruit per plot followed by T_{10} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.2%, (1.50) and T_5 (H_3BO_3) @ 0.4 % (1.41). Minimum number (1.06) of fruit per plot is recorded in treatment T_0 (control). The above findings are in agreement with Singh *et al.*, 2015, Yadav *et al.*, 2013, Balaji *et al.*, 2016 [9, 10, 11, 1].

Yield of fruit/ha (ton)
A critical observation of the table shows that yield of fruit/ha was influence by micronutrient at different stage of reproductive growth. The treatment T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%, showed the best performance with (8.42) followed by T_{10} ($ZnSO_4$ + H_3BO_3 + FeSO4) @ 0.2% (8.34) and T_5 (H_3BO_3) @ 0.4 % (7.84). Minimum (5.88) yield of fruit/ha is observed in treatment T_0 (control).

Days taken to first flowers opening
Data on the mean days to produce first flower as influenced by different level of micronutrient are showed a remarkable response on the mean days to produce first flower after transplanting. A perusal of the table shows that effect of micronutrient that treatment T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%, took significantly minimum days 64.30 after transplanting followed by 66.26 with T_{12} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.6%. There was a significant difference between all the treatments. Maximum numbers of days to produced first flower 72.66 were taken by T_0 (control). Similar results were reported by **Kazi *et al.*, 2012, Singh and Saravanan 2012, Singh *et al.*, 2015 [6, 8, 9, 10]** on strawberry.

No. of flower per plant
The critical observation of the table shows micronutrient that management had significant effect on the number of flowers on strawberry. Maximum number of flowers found in treatment. T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%, (21.22) followed by 21.13 under T_3 ($FeSO_4$) @ 0.2%. The minimum number of flowers 16.66 was recorded under T_0 (control).

Days taken flowering to fruit set
The Minimum days taken flowering to fruit set (4.8) showed in treatment T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%, followed by T_3 ($FeSO_4$) @ 0.2%. and T_4 ($ZnSO_4$) @ 0.4%, (5.4). The maximum days taken flowering to fruit set (6.2) was observed under treatment T_0 (control).

Fruit length (mm)
The present data shown in table 1 that the treatment showed significant effect on fruit length. The maximum fruit length (39.21) was observed under treatment T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%, followed by T_{10} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.2 % (38.89) and T_3 ($FeSO_4$) @ 0.2%. (38.88). Minimum fruit length is (35.14) observed in treatment T_0 (control). The increase in size of fruit as a result of foliar application of micronutrients in present investigation might be because it improved the internal physiology of developing fruit in terms of better supply of water, nutrients, and other compounds vital for their proper growth and development The above findings are in agreement with Singh *et al.*, 2015, Yadav *et al.*, 2013, Balaji *et al.*, 2016 [9, 10, 11, 1].

Fruit width (mm)
The present data shown in table 1 that the treatment showed significant effect on fruit width. The maximum fruit width (29.91) was observed under treatment T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%, followed by T_{10} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.2 % (29.21) and T_7 ($ZnSO_4$) @ 0.6%, (27.84). Minimum fruit width is (25.33) observed in treatment T_0 (control).

Length: diameter ratio

The present data shown in table 2 that the treatment showed non significant effect on length: diameter ratio of fruits. The maximum length – diameter ratio of fruit (1.41) was observed under treatment T_3 ($FeSO_4$) @ 0.2% and T_{12} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.6 %, followed by T_1 ($ZnSO_4$) @ 0.2%, (1.39). Minimum length: diameter ratio of fruit is (1.30) observed in treatment T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%. The above findings are in agreement with Singh *et al.,* 2015, Yadav *et al.,* 2013, Balaji *et al.,* 2016 [9, 10, 11].

No. of fruit per kg

The present data shown in table 3 that the treatment showed non significant observations on number of fruits per kg were statistically analysed. A critical observation of the table shows that number of fruit per kg was influence by micronutrient at different stage of reproductive growth. The minimum fruits per kg observed under treatment T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%, (43.08) followed by T_5 (H_3BO_3) @ 0.4 %, (45.04). Maximum number (57.98) of fruit per kg is showed in treatment T_0 (control).

Yield of fruits/plant (g)

The observations on number of fruits per plant were statistically analyzed and have been presented in table 3. A critical observation of the table shows that the treatment T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%, (253.33) fruit per plant followed by T_{10} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.2 %, (251) and T_5 (H3BO3) @ 0.4 % (236.33). Minimum number (177.66) of fruit per plant is observed in treatment T_0 (control). The above findings are in agreement with Singh *et al.,* 2015, Yadav *et al.,* 2013, Balaji *et al.,* 2016 [9, 10, 11, 1].

Yield of fruit per plot (kg)

The observations on Yield of fruit per plot (kg) were statistically analysed and have been presented in table 3. A critical observation of the table shows that number of fruit per plant was influence by micronutrient at different stage of reproductive growth. The treatment T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%, (1.51) fruit per plot followed by T_{10} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.2%, (1.50) and T_5 (H_3BO_3) @ 0.4 % (1.41). Minimum number (1.06) of fruit per plot is recorded in treatment T_0 (control).

Yield of fruit/ha (ton)

The observations on Yield of fruits per hac (ton) were statistically analyzed and have been presented in table 3. A critical observation of the table shows that yield of fruit/ha was influence by micronutrient at different stage of reproductive growth. The treatment T_{11} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.4%, showed the best performance with (8.42) followed by T_{10} ($ZnSO_4$ + H_3BO_3 + $FeSO_4$) @ 0.2% (8.34) and T_5 (H_3BO_3) @ 0.4 % (7.84). Minimum (5.88) yield of fruit/ha is observed in treatment T_0 (control). The increase in fruit weight with the application of boron, zinc and iron might be due to its role in cell division, cell elongation, sugar metabolism and accumulation of carbohydrates and other photosynthates.

Table 1: Effect of foliar application of micro-nutrients on yield characters on days taken to first flowers opening, no. of flowers per plant, days taken flowering to fruit set.

Treatments	Days taken to first flower opening	No. of flowers per plant	Days taken flowering to fruit set
T_1 (Zn@ 0.2%)	71.46	16.78	5.66
T_2 (B@ 0.2%)	71.66	17.28	5.86
T_3 (Fe@ 0.2%)	72.06	21.13	5.46
T_4 (Zn@ 0.4%)	67.06	18.63	5.46
T_5 (B @0.4%)	67.60	19.53	5.66
T_6 (Fe @0.4%)	69.40	17.56	5.73
T_7 (Zn@ 0.6%	72.40	18.55	6.06
T_8 (B@ 0.6%)	70.26	18.72	6.13
T_9 (Fe@ 0.6%)	72.33	18.66	5.80
T_{10} (Zn+B+Fe @ 0.2%)	72.13	20.78	5.53
T_{11} (Zn+B+Fe @ 0.4%)	64.30	21.22	4.86
T_{12} (Zn+B+Fe @ 0.6%)	66.26	19.36	6.00
T_0(Control)	72.66	16.66	6.26
S.Em+	0.74	0.56	0.18
C.D. (5%)	2.16	1.64	0.53

Table 2: Effect of foliar application of micro-nutrients on yield characters on fruit length (mm), fruit width (mm), length: diameter ratio

Treatments	Fruit length (mm)	Fruit width (mm)	Length: diameter ratio
T_1 (Zn@ 0.2%)	35.47	25.42	1.39
T_2 (B@ 0.2%)	36.00	26.16	1.37
T_3 (Fe@ 0.2%)	38.88	27.47	1.41
T_4 (Zn@ 0.4%)	37.21	27.54	1.34
T_5 (B @0.4%)	37.15	27.55	1.34
T_6 (Fe @0.4%)	36.24	26.51	1.36
T_7 (Zn@ 0.6%	36.55	27.84	1.31
T_8 (B@ 0.6%)	37.03	27.13	1.36
T_9 (Fe@ 0.6%)	36.83	27.13	1.35
T_{10} (Zn+B+Fe @ 0.2%)	38.89	29.21	1.32
T_{11} (Zn+B+Fe @ 0.4%)	39.21	29.91	1.30
T_{12} (Zn+B+Fe @ 0.6%)	37.11	26.09	1.41
T_0(Control)	35.14	25.33	1.38
S.Em+	0.38	0.46	0.02
C.D. (5%)	1.13	1.36	NS

Table 3: Effect of foliar application of micro-nutrients on yield characters on no. of fruit per kg, yield of fruits/plant(g), yield of fruit per plot (kg), yield of fruit/ha.(ton)

Treatments	No. of fruit per kg	Yield of fruits/plant(g)	Yield of fruit per plot (kg)	Yield of fruit/ha.(ton.)
T_1 (Zn@ 0.2%)	53.84	202.93	1.20	6.68
T_2 (B@ 0.2%)	50.37	203.33	1.21	6.75
T_3 (Fe@ 0.2%)	48.70	216.40	1.29	7.18
T_4 (Zn@ 0.4%)	55.66	216.53	1.29	7.18
T_5 (B @0.4%)	45.04	236.33	1.41	7.84
T_6 (Fe @0.4%)	49.53	215.20	1.28	7.10
T_7 (Zn@ 0.6%	49.38	205.46	1.22	6.81
T_8 (B@ 0.6%)	49.53	212.73	1.27	7.04
T_9 (Fe@ 0.6%)	55.22	214.13	1.28	7.14
T_{10} (Zn+B+Fe @ 0.2%)	47.98	251.00	1.50	8.34
T_{11} (Zn+B+Fe @ 0.4%)	43.08	253.33	1.51	8.42
T_{12} (Zn+B+Fe @ 0.6%)	50.08	223.06	1.33	7.40
T_0(Control)	57.98	177.66	1.06	5.88
S.Em+	3.46	2.80	0.01	0.08
C.D. (5%)	NS	8.19	0.04	0.25

Conclusion

The Studies Depict That Treatment T7 T_{11} ($Znso_4$ + H_3BO_3 + $Feso_4$) @ 0.4% Was Recorded yield of fruit/ha (Ton) (8.42) As Best Treatment In Terms Of Better Yield of Strawberry.

References

1. Balaji T, Pandiyan M, Veeramani P, Ramasamy M. Effect of foliar spray of micronutrient on plant growth character and yield of banana. Advance Reserch Journal of Crop Improvement. 2016; 7:68-71.
2. Chaturvedi OP, Singh AK, Tripathi VK, Dixit AK. Effect of Zinc and Iron on Growth, Yield and Quality of Strawberry Cv. Chandler. Acta., Hort. 2005; 6(96):237-240.
3. Dotaniya ML, Datta SC, Biswas DR, Dotaniya CK, Meena BL, Rajendiran S *et al.* Use of sugarcane industrial by-products for improving sugarcane productivity and soil health. Int J Recycl Org Waste Agricult 2016; 5:185-194.
4. Dotaniya ML, Meena HM, Lata M, Kumar K. Role of phytosiderophores in iron uptake by plants. Agric. Sci. Digest. 2013; 33(1):73-76.
5. Kazemi M. Effect of foliar application of iron, calcium and zinc sulfate reproductive growth, yield and some qualitative characteristics of strawberry fruit J Biol. Environ. Sci. 2014; 8(22):1-9.
6. Kazi SS, Ismail Syed, Joshi KG. Effect of multi-micronutrient on yield and quality attributes of the sweet orange. African Journal of Agricultural Research. 2012; 7(29):4118-4123.
7. Rout GR, Sahoo S. Role of iron in plant growth and metabolism, Reviews in Agric. Sci. 2015; 3:1-24.
8. Singh S, Saravanan S. Effect of bio-fertilizers and micronutrients on yield and quality of strawberry (Fragaria x ananassa Duch) cv. Chandler. The Asian journal of horticulture. 2012; 7:533-536.
9. Singh Sandeep, Gautam, Deepak Kumar, Singh Amar. Effect of micronutrient (zinc, boron) and different combination with apsa-80 on growth, yield and quality and economic of strawberry (Fragaria ananassa Duch.). ISSN: 0974-4908 Res. Environ. Life Sci. 2015; 8(3):416-418.
10. Singh Y, Prasad VM, Singh SS, Singh R. Effect of micro-nutrients and bio-fertilizers supplementation on growth, yield and Quality of strawberry (Fragaria x ananassa Duch) cv. Chandler. A Journal of Multidisciplinary Advance Research. 2015; 4(1):57-59.
11. Yadav V, Yadav P, Singh PN. Response of foliar fertilization of micronutrients on fruit growth and yield of low-chill peach cv. Sharbati. The Asian journal of horticulture. 2013; 8:690-695.
12. Webb RA, Hallas DG. The effect of iron supply on strawberry, var. royal sovereign, J Hort. Sci. 2015; 41(2):179-188.