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EFFECT OF ZINC SULPHATE, BORIC ACID AND IRON SULPHATE ON VEGETATIVE GROWTH, YIELD AND QUALITY OF STRAWBERRY (*FRAGARIA × ANANASSA*. DUCH.) CV. CHANDLER

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ABSTRACT
An experiment was conducted during 2015-16 at Babasaheb Bhimrao Ambedkar University, Lucknow which shows effect of the foliar application of zinc sulphate (0.4%) produced the tallest strawberry plant (17.973cm) which was statistically at par with (17.820 cm) iron sulphate (0.2%), but significantly superior over other treatments and minimum plant height was obtained (15.410cm) boric acid (0.1%). The total yield per plant was recorded highest (109.093 g) with iron at (0.2%) concentration, followed by (107.817g) zinc at (0.4%). The minimum yield (82.403g) was recorded in case of control. Higher level of zinc and iron also decreases the yield of fruits per plant. The amount of ascorbic acid was recorded highest (67.823 mg/100gm) in case of (0.8%) zinc sulphate followed by (67.437 mg/100gm) zinc sulphate (0.6%). However, the minimum amount of (65.320 mg/100gm) of ascorbic acid was recorded in boric acid (0.1%).

INTRODUCTION

The cultivated strawberry (*Fragaria x ananassa* Duch.) originated from the hybridization between two American species (*Fragaria chilionensis* Duch. X *Fragaria virginiana* Duch.) in France in the 17th century. It belongs to family Rosaceae and is octaploid in nature having 56 somatic chromosome numbers. At least sixteen spp. of wild strawberry are believed to occur all over the world, but in India only four species of Fragaria have been reported viz., F. *chiloensis,* F. *daltoniana,* F. *nilgerrernsis* and F. *vesca* (Anon, 1956). The fruits of strawberry are attractive with distinct aroma and pleasant flavor, a rich source of vitamin C. Vitamin B1, proteins and minerals like P, K, Ca and Fe (Joolka, 2001). It is a valuable food in the diet of millions of people around the globe. In addition to flesh consumption it has a special demand by the fruit processing industries by the jam, ice-creams, syrups and confectionaries. It's popularity can be judged from the very fact that is total area and production in the world has increased over the past decade. It occupies an area of 2, 17, 766 hectares with a total production of 2, 98, 813 metric tonnes (Anon., 2005). "Albinism" is a physiological disorder which affects yield and quality of berries caused by certain climatic conditions and extremes in nutrition (Sharma *et al*., 1998).

Micronutrients such as zinc, boron and iron play an important role in increasing vegetative growth, flowering, fruit yield and quality characters. 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 lemon and guava plants. 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 (Leiten, 1999, Geoffrey *et al*., 1993, Jitendra *et al*., 2015, M. kazemi, 2014, Sharad *et al*., 2014 and Jones *et al*,. 1967). *The present study was carried out to* find out the effect of different concentration of zinc, iron and boron on vegetative, reproductive and physicochemical characters of strawberry plant.

MATERIALS AND METHODS

The present investigation was carried out at Horticulture Research Farm of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow (U.P.) during winter season. The experiment was laid out in Randomized Block Design with 12 treatments i.e., T_0 (Control), T_1 (Zn 0.2%), T_2 (Zn 0.4%), T_3 (Zn 0.6%), T_4 (Zn 0.8%), T_5 (Fe 0.2%), T_6 (Fe 0.4%), T_7 (Fe 0.6%), T_8 (Fe 0.8%), T_9 (B 0.1%), T_{10} (B 0.2%), T_{11} (B 0.3%) and T_{12} (B 0.4%) and three replication, micronutrients Zinc sulphate, Ferrous sulphate and Boric acid were sprayed with their respective concentration in thrice 25 October, 09 November, 24

November. Observations of flowering and fruiting behavior like Physical Characters like plant height, number of leaves, number of runners, yield character like number of flowers, number of fruit set, yield per plant, weight of berry, days to ripening, number of fruit per plant, and Quality Characters of fruits like Total Soluble Solids (T.S.S.), Ascorbic acid, Acidity, Total sugar and Shelf life of fruits were recorded (A. O. A. C. 1980 , Sagar, Samaul, 2005 and Saini *et al.,* 2001).

RESULTS AND DISCUSSION

The data presented in the table 1 showed that all the parameters were influenced by the foliar spray of micronutrients. The foliar application of zinc sulphate (0.4%) produced the tallest strawberry plant (17.973) which was statistically at par with (17.820) iron sulphate (0.2%), but significantly superior over other treatments and minimum plant height was obtained (Yadav *et al.,* 2004, Chaturvedi *et al.,* 2005) (15.410) boric acid (0.1%). The maximum number of leaves per plant (22.097) was noted zinc sulphate (0.4%) (Chaturvedi *et al.,* 2005, Kumar and Tripathi 2007, Lieten *et al.,* 2002) followed by (21.937) zinc sulphate (0.6%). Foliar treatment of iron sulphate (0.2%) proved more effective in increasing the number of runners per plant. It gave maximum number (3.790) of runners (Kumar and Tripathi 2007, Wooldridge *et al.,* 1997 and Yadav *et al.,* 2004) followed by control that gave (2.407) number of runners per plant. The maximum number of flowers (22.323) per plant (Lieten 1993) were recorded in case of iron sulphate (0.4%) treatment followed by zinc sulphate (0.4%) treatment, whereas, minimum number (17.653) were recorded in boric acid (0.1%). Boric acid at (0.4%) level cause higher (18.473) (Lieten 1994) fruits set followed by iron sulphate (0.4%). Minimum number of fruits set (16.400) was observed at untreated plants. The total yield per plant was recorded highest (109.093) with iron at (0.2%) concentration, followed by (107.817) zinc at (0.4%). The minimum (Payadas *et al.,* 1998, Tripathi and Shukla 2004) yield (82.403) was recorded in case of control. Higher level of zinc and iron also decreases the yield of fruits per plant. Weight of berry observed maximum (May and Pritts 1992, Lieten *et al.,* 2002) in treatment T_2 zinc sulphate (0.4%) and minimum in T_8 ferrous sulphate (0.8%). Boric acid (0.1%) level took minimum days to ripening (26.240) followed by (0.2%) concentration of iron, whereas, the maximum days to ripening (28.013) were taken by untreated plants. Foliar treatment of zinc at (0.4%) increased the total number of fruits (Chaturvedi *et al.,* 2005, Lalithya *et. al.,* 2014, Zaiter *et al.,* 1993) (16.323) per plant followed by iron at (0.2%) (16.313).The minimum number (13.620) was recorded in control, whereas, higher concentration of iron (0.8%) reduced the total number of fruits (14.183). Application at (0.4%) zinc sulphate resulted in maximum amount of Total soluble solid (9.350^0 Brix) which was at par with boric acid (0.4%) Chaturvedi *et al.,* (2005) (9.300^0 Brix).The lowest total soluble solid (8.477^0 Brix) was observed in boric acid (0.1%).The amount of ascorbic acid was recorded highest (67.823 mg/100gm) (Chaturvedi *et al.,* 2005, Kumar and Tripathi 2007) in case of (0.8%) zinc sulphate followed by (67.437 mg/100gm) zinc sulphate (0.6%). However, the minimum amount of (65.320 mg/100gm) of ascorbic acid was recorded in boric acid (0.1%). Foliar feeding of zinc

Table 1: Effect of zinc sulphate, boric acid and iron sulphate on vegetative growth, yield and quality of strawberry (*Fragaria* × *ananassa.* Duch.) cv. Chandler

Treatments	Average height of plant (cm)	Average number of leaves per plant	Number of runners per plant	Number of flowers per plant	Number of fruit set per plant	Cumulative yield (g)	Berry weight (g)	Number of days to ripening	Cumulative number of fruits	T.S.S.	Amount of Ascorbic acid (mg/100g)	Percentage of titrable acidity	Total sugar (%)	Shelf life (in days)
T_0 (Control)	15.423	15.900	2.407	17.767	16.400	82.403	6.580	28.013	13.620	8.483	66.627	0.970	5.143	1.833
T_1 (Zn 0.2%)	16.823	20.360	3.147	20.557	16.663	104.157	6.163	26.677	15.480	9.233	66.483	0.981	5.257	1.913
T_2 (Zn 0.4%)	17.973	22.097	3.327	22.173	18.307	107.817	6.687	27.457	16.323	9.350	66.253	0.977	5.437	2.043
T_3 (Zn 0.6%)	16.893	21.937	3.023	21.473	16.883	96.063	6.070	27.857	15.167	9.000	67.437	0.973	5.657	2.198
T_4 (Zn 0.8%)	16.527	20.937	2.890	20.463	15.873	90.317	5.830	27.993	14.840	8.717	67.823	0.983	5.173	1.863
T_5 (Fe 0.2%)	17.820	21.530	3.790	22.323	19.097	109.093	6.240	26.607	16.313	9.150	66.593	0.978	5.200	1.950
T_6 (Fe 0.4%)	16.790	20.950	3.113	20.600	18.447	102.040	6.103	27.473	15.473	8.967	66.840	0.976	5.450	2.037
T_7 (Fe 0.6%)	16.133	20.060	2.977	19.970	17.743	93.487	6.240	27.167	14.950	8.733	66.413	0.981	5.340	1.787
T_8 (Fe 0.8%)	16.407	19.177	2.787	18.970	16.947	87.363	5.527	27.033	14.183	8.583	65.883	0.983	5.223	1.680
T_9 (B 0.1%)	15.410	16.387	2.813	17.653	16.707	87.133	5.587	26.240	14.667	8.477	65.320	0.981	5.357	1.960
T_{10} (B 0.2%)	16.083	16.937	3.193	18.487	17.173	93.593	5.867	26.667	15.107	8.700	65.537	0.976	5.520	2.027
T_{11} (B 0.3%)	16.890	17.657	3.460	19.047	17.880	99.077	6.033	27.147	15.680	9.000	66.733	0.976	5.550	2.220
T_{12} (B 0.4%)	17.033	18.033	3.883	19.413	18.473	104.617	6.320	27.460	15.957	9.300	67.127	0.971	5.673	2.283
SE (d)	0.127	0.202	0.107	0.182	0.220	2.047	0.059	0.095	0.120	0.068	0.364	0.002	0.042	0.032
C.D.	0.265	0.419	0.222	0.378	0.457	4.250	0.122	0.198	0.250	0.142	0.756	0.003	0.088	0.066

sulphate (0.8%) and iron sulphate (0.8%) maximum percentage of acidity (0.983) followed by zinc sulphate (0.2%) and iron sulphate (0.6%). The berries having maximum total sugar content (5.673) were estimated for the plant treated with boric acid (0.4%) which was at par with (5.657) zinc sulphate (0.6%). Foliar spray of boron increased the shelf life of fruits. The maximum shelf life of fruits (2.283 days) was recorded with boric acid (0.4%). The next best treatment was (2.220 days) boric acid (0.3%). The minimum shelf life (Jurgens 1990) has been reported as 1.680 days iron sulphate (0.8%) (Geoffrey *et al.*, 1993, Jitendra *et al.,* 2015, M. Kazemi, 2014 and Sharad bisen *et. al.,* 2014.)

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