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Effect of Micronutrients Foliar Feeding on Growth and Yield of Pomegranate (*Punica granatum* l.) cv. Sindhuri.

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ABSTRACT: *A study entitled "Effect of micronutrients foliar feeding on growth and yield of Pomegranate (*Punica granatum *L.) Cv. Sindhuri." was carried out at Fruit Research Farm, Department of Fruit Science, College of Horticulture and Forestry, Jhalawar during 2013. The experiment was laid out in randomized block design with 27 treatments with three replications. The results revealed that application of T_{26} treatment ($Zn_2B_2Fe_2$ i.e. 0.4 per cent zinc sulphate + 0.4 per cent boric acid + 0.4 per cent ferrous sulphate) was found significantly superior with respect to increase in plant spread (East-West and North-South), canopy volume, chlorophyll content,diameter of fruit, fruit weight, fruit volume, number of arils per fruit, fruit set percent, number of fruits per plant and yield over control which was closely followed by treatment T_{25} ($Zn_2B_2Fe_1$ i.e. zinc sulphate @ 0.4 per cent + boric acid @ 0.4 per cent + ferrous sulphate@ 0.2 per cent). Further this treatment has also given maximum increase in plant height, and significantly reduced days taken to first harvesting and days taken to complete harvesting in pomegranate.*

Keywords: *Pomegranate;Micronutrients; Plant growth; and yield.*

INTRODUCTION

Pomegranate (*Punica granatum* L.) belonging to Punicaceae family, is one of the favourite table fruit grown in tropical and sub-tropical regions of the world. This plant is native of Iran and grown extensively inthe arid and semi-arid regions of world for its edible fruits. Pomegranate one is of the most important commercial fruit being eaten fresh and also processed for jams, jellies, syrups, pomegranate juice products and is used for medical purposes (Aarabi*et al.*, 2008). The fruit peel, tree stem, root bark and leaves are good source of secondary metabolites such as tannins, dyes and alkaloids. (Eiada and Mustafa, 2013).

India is the largest producer of pomegranate in the world. The total area under Pomegranate cultivation in India is 113.2 thousands hectares with annual production of 745 thousands MTand productivity of 6.6 MT/ha. India's share in the global export market is 6.4 per cent. It is commercially cultivated in Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Madhya Pradesh, Tamil Nadu and Rajasthan. (Anonymous, 2013).

Nutrition plays pivotal role for production of any fruit crop. Likewise, in pomegranate application of macro as well as micro nutrients improves the quality and quantity of production. Foliar application of different micronutrients at proper stage helps in improving fruit yield, quality and physiochemical characteristics of pomegranate. It also helps in rectefying micronutrients deficiency and improves quality and physiochemical characteristics of pomegranate. The micronutrients like zinc, boron, and ferrous are very important micronutrients required for growth and development of plants.

MATERIALS AND METHODS

The present investigation was carried out on five years old pomegranate (*Punica granatum* L.) cv. 'Sindhuri' of uniform size and growth at the Fruit Research Farm, Department of Fruit Science, College of Horticulture and Forestry, Jhalawar during July, 2013 to December, 2013.The experiment was consisting of 27 treatments having three levels of each Zinc sulphate (0, 0.2 and 0.4 per cent), Boric acid (0, 0.2 and 0.4 per cent), and Ferrous sulphate (0, 0.2 and 0.4 per cent). The experiment was laid out in randomized block design with three replications.

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RESULTS AND DISCUSSION

Plant Growth Characteristic

It is evident from the results obtained, that the application of different micronutrient treatments at different concentrations had significantly influenced various vegetative growth characters as compared to control. In the present investigation, it was observed that the effect of zinc, boron and iron was significant on per cent increase in plant height, plant spread (East-West and North-South), canopy volume and leaf chlorophyll content of pomegranate. The increase in plant height of pomegranate on 120 days after treatment was recorded maximum (11.36%) at treatment T_{25}, while maximum per cent increase in East-West plant spread (7.77%), North-South plant spread (7.96%), maximum chlorophyll content in leaves (0.62 mg/g) and canopy volume (29.20%) was recorded with at T_{26} treatment. (Table 1). The present results are supported by the finding of Sarolia *et al.* (2007) in guava, Pathak *et al.* (2011) in banana, and Eiada and Mustafa, (2013) in pomegranate.

This might be due to the favourable influence of applied micronutrients (zinc + boron + iron) on vegetative growth characteristics because of their catalytic or stimulatory effect on most of the physiological and metabolic process of plants. Zn plays an important role in starch metabolism, and acts as co-factor for many enzymes, affects photosynthesis reaction, nucleic acid metabolism and protein biosynthesis there by positively contributing it increased tissue growth and development (Ram and Bose, 2000) and (Alloway, 2008). In case of boron, it increases the phenolic compounds which regulate polar auxin transport. The increased auxin activity results in increased vegetative growth characters. And iron plays an important role in the activation of chlorophyll and in the synthesis of many proteins such as different cytochromes, which participate in different functions in the plant metabolism.

Physical Characteristics of Fruits

It is evident from the present results that application of various micronutrients at different concentrations significantly improved physical characteristics of fruits like diameter of fruit, fruit weight, fruit volume, fruit set per cent, fruit retention per cent, number of fruits per tree, number of arils per fruit, days taken to first harvesting and total days taken to complete harvesting as compared to control.

The data recorded on polar and transverse diameter of fruit clearly indicate that the foliar spray of zinc, boron and iron showed better response in improving the fruit diameter. The maximum increase in polar diameter (9.58 cm) and transverse diameter (7.47 cm) were observed with T_{26} treatment, which was closely followed by T_{25} treatment as compared to minimum in control (Table 2). The higher fruit diameter due to combined application of zinc, boron and iron may be attributed to their stimulatory effect of plant metabolism. The results are in conformity with the observations recorded by Das *et al.* (2000) and Rawat *et al.* (2010) in guava. The increase in yield was obviously due to the consolidated effect of increased size and weight of fruits caused by foliar spray of zinc, boron and iron.

The fruit weight and fruit volume of pomegranate differed significantly with the sprays of zinc, boron and iron alone or in combination. The maximum fruit weight (213 g) and volume (204 cc) were recorded with T_{26} treatment. It was closely followed by T_{25} treatments while, the minimum were measured under control (Table 2). The findings are similar to those reported by Babu and Singh (2001) in litchi, and Sohrab *et al.* (2013) in pomegranate. The increase in fruit weight and volume might be due to increased rate of cell division and cell enlargement leading to more accumulation of metabolites in the fruit (Babu and Singh, 2001).

The application of micronutrient treatments had significantly increased the fruit set per cent and fruit retention per cent (Table 2). The maximum fruit set per cent (54.17%) was recorded with T_{26} and maximum fruit retention per cent (70.43%) was recorded with T_{23} treatment. Increase in fruit set and fruit retention per cent might be due to reduction in the fruit drop. Nijjar (1985) reported that Zn is required for preventing the abscission layer formation and consequently, the reduction in pre-harvest fruit drop. Similarly the present results were obtained by Trivedi *et al.* (2012) in guava. Zinc and boron application reduced fruit drop and increase fruit retention might be due to the fact that zinc plays an important role in biosynthesis of IAA (Alloway, 2008) and iron increases photosynthesis and carbohydrate synthesis and in reproductive growth of fruit in organs of the plant acts as a strong sink (Sohrab *et al.* 2013).

The application of different micronutrients at various concentrations increased the number of fruits per tree (Table 2). The maximum number of fruits per plant (23.67) was recorded with treatment T_{26}. The increase in number of pomegranate fruits by application of micronutrient treatments may be due to increased fruit set and reduced fruit drop as a result of zinc, boron and iron spray could give higher number of fruits and consequently the yield. The present results are in conformity with the findings of Singh and Maurya (2004) in mango, Singh *et al.* (2005) in papaya, and Rajkumar *et al.* (2014) in guava.

The number of arils per fruit of pomegranate was significantly improved by application of different micronutrient treatments at various concentrations (Table 2). It is evident from the data obtained that application of zinc sulphate @ 0.4 percent + boric acid @ 0.4 percent + ferrous sulphate@ 0.4 percent concentration under (T_{26}) had exhibited highest number of arils (457.67) per fruit as compared to control (362.67). The variation in the number of arils per fruit due to application of different micronutrients might be due to overall increase in fruit weight and fruit diameter as show by the result of this experiment.

It is evident from the data (Table 2) that, the minimum days taken to first harvesting (118.67 days) and minimum total days taken to complete harvesting (138.33 days) were recorded with T_{25} (zinc sulphate @ 0.4 per cent + boric acid @ 0.4 per cent + ferrous sulphate@ 0.2 per cent) which was closely followed by $T_{26.}$ The maximum days taken to first harvesting (132.33 days) and maximum days taken to first harvesting (132.33 days) were recorded at control. It might be due to early flowering and reduced maturity duration which could be attributed to enhancing effect of zinc in enzymatic reaction, cell division as well in growth (Supriya and bhattacharya, 1993) and Yadav *et al.* (2013).

Fruit Yield

The data on yield showed that the application of different micronutrients at various concentrations had significantly increased the yield of pomegranate fruits over control in the present investigation. Amongst the various micronutrient treatments attempted, the maximum yield of 5.00 kg/plant was recorded at zinc

Table 1
Effect of Micronutrients Spray on Per cent Increase in Plant Height, Plant Spread, Canopy Volume, Leaf chlorophyll content and Yield of Pomegranate (*Punica granatum* L.)cv. Sindhuri

Treatments		*Plant height (%)*	*East-West Plant spread (%)*	*North-South plant spread (%)*	*Canopy volume (%)*	*Leaf chlorophyll content (mg/g)*	*Yield (kg /plant)*
T_0	$Zn_0 B_0 Fe_0$	5.05	3.58	4.05	12.48	0.48	2.90
T_1	$Zn_0 B_0 Fe_1$	5.65	4.80	4.09	14.75	0.49	3.45
T_2	$Zn_0 B_0 Fe_2$	6.13	5.28	4.21	16.19	0.49	3.53
T_3	$Zn_0 B_1 Fe_0$	6.61	4.05	4.46	14.50	0.49	3.47
T_4	$Zn_0 B_1 Fe_1$	6.07	4.61	4.28	16.83	0.50	3.71
T_5	$Zn_0 B_1 Fe_2$	5.94	4.83	4.82	16.22	0.53	4.01
T_6	$Zn_0 B_2 Fe_0$	6.77	4.96	5.02	17.78	0.57	4.10
T_7	$Zn_0 B_2 Fe_1$	6.84	5.68	6.05	19.05	0.51	4.22
T_8	$Zn_0 B_2 Fe_2$	6.95	5.18	5.44	18.41	0.51	4.38
T_9	$Zn_1 B_0 Fe_0$	7.09	4.91	5.24	18.57	0.52	3.75
T_{10}	$Zn_1 B_0 Fe_1$	8.22	6.58	6.03	22.34	0.52	4.04
T_{11}	$Zn_1 B_0 Fe_2$	6.31	5.41	5.53	18.27	0.55	4.38
T_{12}	$Zn_1 B_1 Fe_0$	7.02	6.01	5.37	19.98	0.55	3.74
T_{13}	$Zn_1 B_1 Fe_1$	6.77	5.34	5.23	18.42	0.55	4.16
T_{14}	$Zn_1 B_1 Fe_2$	7.41	5.95	6.51	20.77	0.56	4.39
T_{15}	$Zn_1 B_2 Fe_0$	8.47	6.29	6.33	22.68	0.58	3.87
T_{16}	$Zn_1 B_2 Fe_1$	7.80	6.13	5.94	21.27	0.59	4.55
T_{17}	$Zn_1 B_2 Fe_2$	9.41	6.40	6.93	24.20	0.59	4.83
T_{18}	$Zn_2 B_0 Fe_0$	8.99	6.32	7.05	24.41	0.60	4.06
T_{19}	$Zn_2 B_0 Fe_1$	8.68	6.11	6.73	23.04	0.57	4.44
T_{20}	$Zn_2 B_0 Fe_2$	9.20	6.71	7.35	24.40	0.57	4.67
T_{21}	$Zn_2 B_1 Fe_0$	10.46	7.75	7.78	29.74	0.59	4.19
T_{22}	$Zn_2 B_1 Fe_1$	9.87	6.94	7.23	25.84	0.59	4.53
T_{23}	$Zn_2 B_1 Fe_2$	10.88	7.83	7.42	28.41	0.60	4.66
T_{24}	$Zn_2 B_2 Fe_0$	11.36	7.72	7.27	29.91	0.61	4.61
T_{25}	$Zn_2 B_2 Fe_1$	11.52	7.28	7.93	29.14	0.62	4.93
T_{26}	$Zn_2 B_2 Fe_2$	11.12	7.43	7.75	28.93	0.61	5.00
	SEm ±	0.18	0.22	0.19	0.56	0.004	0.23
	C.D. at 5%	0.51	0.64	0.55	1.60	0.004	0.65

Zn_0 – Zinc sulphate – 0%, B_0 – Boric acid– 0%, Fe_0 – Ferrous sulphate– 0%
Zn_1 – Zinc sulphate – 0.2%, B_1 – Boric acid– 0.2%, Fe_1 – Ferrous sulphate– 0.2%
Zn_2 – Zinc sulphate – 0.4%, B_2 – Boric acid– 0.4%, Fe_2 –Ferrous sulphate– 0.4%

Table 2
Effect of Micronutrients Spray on Physical Characteristics of Pomegranate (*Punica granatum* L.)cv. Sindhuri

Treatments		*Diameter of fruit (cm)*		*Weight of fruit (g)*	*Volume of fruit (cc)*	*Fruit set %*	*Fruit retention %*	*No. of fruit/plant*	*No. of arils/fruit*	*Days taken to first harvesting*	*Days taken to complete harvesting*
		Polar	*Transverse*								
T_0	$Zn_0 B_0 Fe_0$	7.70	6.35	171.00	159.67	44.97	59.73	17.00	362.67	132.33	153.00
T_1	$Zn_0 B_0 Fe_1$	7.87	6.15	175.33	163.67	46.17	62.07	19.67	375.67	129.33	150.33
T_2	$Zn_0 B_0 Fe_2$	8.07	6.32	179.33	165.67	46.83	62.47	19.67	386.00	128.67	149.67
T_3	$Zn_0 B_1 Fe_0$	8.26	6.35	182.67	170.00	46.60	62.77	19.00	383.67	128.67	149.00
T_4	$Zn_0 B_1 Fe_1$	8.06	6.27	179.33	167.67	47.60	63.23	20.67	385.33	127.33	147.33
T_5	$Zn_0 B_1 Fe_2$	8.38	6.58	188.00	174.67	47.93	64.13	21.33	399.67	126.67	146.00
T_6	$Zn_0 B_2 Fe_0$	8.38	6.51	186.33	173.33	46.87	63.03	22.00	399.67	126.67	147.00
T_7	$Zn_0 B_2 Fe_1$	8.55	6.36	191.67	179.00	48.60	64.03	22.00	409.67	125.67	146.00
T_8	$Zn_0 B_2 Fe_2$	8.87	6.57	196.00	184.67	49.03	65.50	22.33	419.33	125.00	144.67
T_9	$Zn_1 B_0 Fe_0$	8.03	6.20	178.67	166.33	46.70	62.03	21.00	383.67	127.67	147.33
T_{10}	$Zn_1 B_0 Fe_1$	8.39	6.53	186.33	174.00	48.97	64.63	21.67	396.33	125.67	145.33
T_{11}	$Zn_1 B_0 Fe_2$	9.01	6.88	196.33	185.33	49.00	65.70	22.33	421.00	125.00	144.67
T_{12}	$Zn_1 B_1 Fe_0$	8.47	6.56	187.00	176.00	48.17	64.40	20.00	400.67	125.00	144.33
T_{13}	$Zn_1 B_1 Fe_1$	8.96	7.01	198.00	188.33	50.03	65.73	21.00	423.00	124.67	144.67
T_{14}	$Zn_1 B_1 Fe_2$	9.19	7.12	202.67	193.00	47.73	68.20	21.67	437.00	121.67	142.33
T_{15}	$Zn_1 B_2 Fe_0$	8.69	6.77	193.33	182.00	48.60	65.13	20.00	414.67	124.67	144.00
T_{16}	$Zn_1 B_2 Fe_1$	9.23	7.18	206.67	197.67	51.27	67.50	22.00	444.00	123.67	142.67
T_{17}	$Zn_1 B_2 Fe_2$	9.45	7.22	210.00	199.33	51.87	67.50	23.33	450.00	119.33	140.33
T_{18}	$Zn_2 B_0 Fe_0$	8.03	6.26	179.33	166.00	48.23	63.57	22.67	384.67	127.67	147.33
T_{19}	$Zn_2 B_0 Fe_1$	8.95	6.94	198.67	188.00	49.73	65.33	22.33	427.67	126.00	144.67
T_{20}	$Zn_2 B_0 Fe_2$	9.18	7.07	203.33	192.67	49.67	66.73	23.00	436.67	123.67	142.67
T_{21}	$Zn_2 B_1 Fe_0$	8.91	7.01	199.67	190.00	49.07	65.67	21.00	428.67	124.67	144.33
T_{22}	$Zn_2 B_1 Fe_1$	9.08	7.28	202.67	192.33	50.70	67.67	22.33	437.33	120.67	140.00
T_{23}	$Zn_2 B_1 Fe_2$	9.50	7.41	211.67	202.67	52.30	70.43	22.00	456.33	120.67	141.33
T_{24}	$Zn_2 B_2 Fe_0$	9.12	7.07	200.33	190.33	50.07	66.30	23.00	433.00	123.00	142.33
T_{25}	$Zn_2 B_2 Fe_1$	9.50	7.41	211.33	201.67	52.40	69.23	23.33	456.00	118.67	138.33
T_{26}	$Zn_2 B_2 Fe_2$	9.58	7.47	213.00	204.00	54.17	68.30	23.67	457.67	119.33	139.67
	SEm ±	0.10	0.08	2.21	2.48	0.68	0.40	1.09	5.44	0.44	0.39
	C.D. at 5 %	0.30	0.24	6.28	7.04	1.94	1.13	3.09	15.44	1.25	1.12

Zn_0 – Zinc sulphate – 0%, B_0 – Boric acid– 0%, Fe_0 – Ferrous sulphate– 0%
Zn_1 – Zinc sulphate – 0.2%, B_1 – Boric acid– 0.2%, Fe_1 – Ferrous sulphate– 0.2%
Zn_2 – Zinc sulphate – 0.4%, B_2 – Boric acid– 0.4%, Fe_2 –Ferrous sulphate– 0.4%

sulphate @ 0.4 per cent + boric acid @ 0.4 per cent + ferrous sulphate@ 0.4 per cent treatment (T_{26}). The minimum yield of 2.90 kg/plant was observed at control.

The increase in yield of pomegranate fruits by application of micronutrient treatments may be due to its synergistic effect in yield contributing characters like size and weight of fruits, fruit set percent, fruit retention per cent as evident by the present study which finally increased the yield. Increased fruit set and reduced fruit drop as a result of zinc, boron and iron spray could give higher number of fruits and consequently the yield. The present results are in conformity with the findings of Trivedi*et al.* (2012) in guava, Eiada and Mustafa (2013) in pomegranate.

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