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

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Keywords

Pomegranate; Micronutrients; Physical and Chemical characteristics

A B S T R A C T

A study entitled "Effect of micronutrients spray on physical and chemical characteristics 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 and 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 indiameter of fruit, fruit weight, fruit volume, number of arils per fruit, fruit set percent, number of fruit 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 TSS/Acid ratio, ascorbic acid, juice per cent and sensory score and significantly reduced days taken to first harvesting, total days taken to complete harvesting and acidity per cent of fruits.

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 is one of the most important commercial fruit is 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 vital role for production of any fruit crop. Likewise, in pomegranate 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 correcting 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 oldpomegranate (*Punica granatum* L.) cv. 'Sindhuri' of uniform size and growthat 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.

Results and Discussion

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 (Table 1 and Table 2).

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 1). 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 inconformity 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 1). 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 (Table 1) 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.

Table.1 Effect of micronutrients spray on physical characteristics (diameter of fruit, weight of fruit, volume of fruit and fruit set per cent) of pomegranate (*Punica granatum* L.) cv. Sindhuri

Treatments		Diameter of fruit (cm)		Weight of fruit (g)	Volume of fruit (cc)	Fruit set (%)
		Polar	Transverse			
T_0	Zn_0 B_0 Fe_0	7.70	6.35	171.00	159.67	44.97
T_1	Zn_0 B_0 Fe_1	7.87	6.15	175.33	163.67	46.17
T_2	Zn_0 B_0 Fe_2	8.07	6.32	179.33	165.67	46.83
T_3	Zn_0 B_1 Fe_0	8.26	6.35	182.67	170.00	46.60
T_4	Zn_0 B_1 Fe_1	8.06	6.27	179.33	167.67	47.60
T_5	Zn_0 B_1 Fe_2	8.38	6.58	188.00	174.67	47.93
T_6	Zn_0 B_2 Fe_0	8.38	6.51	186.33	173.33	46.87
T_7	Zn_0 B_2 Fe_1	8.55	6.36	191.67	179.00	48.60
T_8	Zn_0 B_2 Fe_2	8.87	6.57	196.00	184.67	49.03
T_9	Zn_1 B_0 Fe_0	8.03	6.20	178.67	166.33	46.70
T_{10}	Zn_1 B_0 Fe_1	8.39	6.53	186.33	174.00	48.97
T_{11}	Zn_1 B_0 Fe_2	9.01	6.88	196.33	185.33	49.00
T_{12}	Zn_1 B_1 Fe_0	8.47	6.56	187.00	176.00	48.17
T_{13}	Zn_1 B_1 Fe_1	8.96	7.01	198.00	188.33	50.03
T_{14}	Zn_1 B_1 Fe_2	9.19	7.12	202.67	193.00	47.73
T_{15}	Zn_1 B_2 Fe_0	8.69	6.77	193.33	182.00	48.60
T_{16}	Zn_1 B_2 Fe_1	9.23	7.18	206.67	197.67	51.27
T_{17}	Zn_1 B_2 Fe_2	9.45	7.22	210.00	199.33	51.87
T_{18}	Zn_2 B_0 Fe_0	8.03	6.26	179.33	166.00	48.23
T_{19}	Zn_2 B_0 Fe_1	8.95	6.94	198.67	188.00	49.73
T_{20}	Zn_2 B_0 Fe_2	9.18	7.07	203.33	192.67	49.67
T_{21}	Zn_2 B_1 Fe_0	8.91	7.01	199.67	190.00	49.07
T_{22}	Zn_2 B_1 Fe_1	9.08	7.28	202.67	192.33	50.70
T_{23}	Zn_2 B_1 Fe_2	9.50	7.41	211.67	202.67	52.30
T_{24}	Zn_2 B_2 Fe_0	9.12	7.07	200.33	190.33	50.07
T_{25}	Zn_2 B_2 Fe_1	9.50	7.41	211.33	201.67	52.40
T_{26}	Zn_2 B_2 Fe_2	9.58	7.47	213.00	204.00	54.17
	SEm ±	0.10	0.08	2.21	2.48	0.68
	C.D. at 5 %	0.30	0.24	6.28	7.04	1.94

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 (fruit retention per cent, number of fruit per plant, number of arils per fruit, days taken to first harvesting and days taken to complete harvesting) of pomegranate (*Punica granatum* L.) cv. Sindhuri

Treatments		Fruit retention (%)	No. of fruit/plant	No. of arils/fruit	Days taken to first harvesting	Days taken to comp. harvesting
T_0	Zn_0 B_0 Fe_0	59.73	17.00	362.67	132.33	153.00
T_1	Zn_0 B_0 Fe_1	62.07	19.67	375.67	129.33	150.33
T_2	Zn_0 B_0 Fe_2	62.47	19.67	386.00	128.67	149.67
T_3	Zn_0 B_1 Fe_0	62.77	19.00	383.67	128.67	149.00
T_4	Zn_0 B_1 Fe_1	63.23	20.67	385.33	127.33	147.33
T_5	Zn_0 B_1 Fe_2	64.13	21.33	399.67	126.67	146.00
T_6	Zn_0 B_2 Fe_0	63.03	22.00	399.67	126.67	147.00
T_7	Zn_0 B_2 Fe_1	64.03	22.00	409.67	125.67	146.00
T_8	Zn_0 B_2 Fe_2	65.50	22.33	419.33	125.00	144.67
T_9	Zn_1 B_0 Fe_0	62.03	21.00	383.67	127.67	147.33
T_{10}	Zn_1 B_0 Fe_1	64.63	21.67	396.33	125.67	145.33
T_{11}	Zn_1 B_0 Fe_2	65.70	22.33	421.00	125.00	144.67
T_{12}	Zn_1 B_1 Fe_0	64.40	20.00	400.67	125.00	144.33
T_{13}	Zn_1 B_1 Fe_1	65.73	21.00	423.00	124.67	144.67
T_{14}	Zn_1 B_1 Fe_2	68.20	21.67	437.00	121.67	142.33
T_{15}	Zn_1 B_2 Fe_0	65.13	20.00	414.67	124.67	144.00
T_{16}	Zn_1 B_2 Fe_1	67.50	22.00	444.00	123.67	142.67
T_{17}	Zn_1 B_2 Fe_2	67.50	23.33	450.00	119.33	140.33
T_{18}	Zn_2 B_0 Fe_0	63.57	22.67	384.67	127.67	147.33
T_{19}	Zn_2 B_0 Fe_1	65.33	22.33	427.67	126.00	144.67
T_{20}	Zn_2 B_0 Fe_2	66.73	23.00	436.67	123.67	142.67
T_{21}	Zn_2 B_1 Fe_0	65.67	21.00	428.67	124.67	144.33
T_{22}	Zn_2 B_1 Fe_1	67.67	22.33	437.33	120.67	140.00
T_{23}	Zn_2 B_1 Fe_2	70.43	22.00	456.33	120.67	141.33
T_{24}	Zn_2 B_2 Fe_0	66.30	23.00	433.00	123.00	142.33
T_{25}	Zn_2 B_2 Fe_1	69.23	23.33	456.00	118.67	138.33
T_{26}	Zn_2 B_2 Fe_2	68.30	23.67	457.67	119.33	139.67
	SEm ±	0.40	1.09	5.44	0.44	0.39
	C.D. at 5 %	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%

Table.3 Effect of micronutrients spray on chemical characteristics of pomegranate (*Punica granatum* L.) cv. Sindhuri

Treatments		TSS (^{0}B)	Total Acidity (%)	Total sugar (%)	Juice (%)	TSS / acid ratio	Ascorbic acid (mg/100 ml)	Sensory score (out of 10)
T_0	Zn_0 B_0 Fe_0	12.67	1.43	8.57	24.33	8.84	10.17	7.27
T_1	Zn_0 B_0 Fe_1	12.83	1.40	8.60	25.33	9.20	10.27	7.33
T_2	Zn_0 B_0 Fe_2	13.50	1.30	8.67	25.00	10.43	10.40	7.47
T_3	Zn_0 B_1 Fe_0	13.33	1.17	8.67	25.33	11.44	10.40	7.33
T_4	Zn_0 B_1 Fe_1	13.33	1.13	8.77	25.67	11.79	10.43	7.57
T_5	Zn_0 B_1 Fe_2	13.83	1.27	8.77	26.00	10.39	10.27	7.50
T_6	Zn_0 B_2 Fe_0	13.33	1.27	8.70	25.67	10.32	10.27	7.60
T_7	Zn_0 B_2 Fe_1	13.83	1.23	8.63	26.33	10.83	10.43	7.67
T_8	Zn_0 B_2 Fe_2	13.67	1.17	8.73	27.33	12.01	10.57	8.20
T_9	Zn_1 B_0 Fe_0	13.00	1.03	8.87	25.33	13.41	10.57	7.70
T_{10}	Zn_1 B_0 Fe_1	13.17	1.03	9.03	27.00	13.37	10.63	7.90
T_{11}	Zn_1 B_0 Fe_2	13.33	1.10	9.00	27.33	12.05	10.57	7.43
T_{12}	Zn_1 B_1 Fe_0	13.17	1.00	9.00	27.00	13.78	10.63	7.90
T_{13}	Zn_1 B_1 Fe_1	13.67	1.03	8.93	28.00	12.77	10.57	8.10
T_{14}	Zn_1 B_1 Fe_2	14.17	0.93	9.10	28.67	14.33	10.63	8.80
T_{15}	Zn_1 B_2 Fe_0	13.67	1.00	9.07	27.00	13.42	10.63	7.90
T_{16}	Zn_1 B_2 Fe_1	14.00	0.90	9.07	28.33	15.50	10.83	8.97
T_{17}	Zn_1 B_2 Fe_2	14.00	0.97	9.10	28.67	14.35	10.83	9.03
T_{18}	Zn_2 B_0 Fe_0	13.00	0.87	9.17	25.67	16.02	10.90	7.37
T_{19}	Zn_2 B_0 Fe_1	13.83	0.90	9.13	28.00	15.29	10.90	8.57
T_{20}	Zn_2 B_0 Fe_2	13.83	0.97	9.20	27.67	14.76	10.93	8.60
T_{21}	Zn_2 B_1 Fe_0	13.33	0.83	9.20	26.67	16.85	11.13	8.03
T_{22}	Zn_2 B_1 Fe_1	14.17	0.90	9.27	29.00	15.88	11.00	8.97
T_{23}	Zn_2 B_1 Fe_2	13.83	0.83	9.30	29.33	17.06	11.17	9.00
T_{24}	Zn_2 B_2 Fe_0	13.83	0.87	9.23	28.00	16.02	11.30	8.70
T_{25}	Zn_2 B_2 Fe_1	14.17	0.80	9.53	29.67	17.70	11.33	9.53
T_{26}	Zn_2 B_2 Fe_2	14.33	0.83	9.37	29.33	17.06	11.33	9.07
SEm ±		0.16	0.05	0.05	0.45	0.73	0.04	0.07
C.D. at 5%		0.47	NS	NS	NS	NS	0.14	0.20

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%

Similarly the present results were obtained by Trivedi *et al.,* (2012) in guava. Zinc and boron application reduce fruit drop and increase fruit retention might be due to the fact that zinc play 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 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) was recorded with T_{25} which was closely followed by T_{26} (119.33 days). The maximum days taken to first harvesting (132.33 days) was recorded at control. Similar results of minimum total days taken to complete harvesting (138.33 days) were recorded with T_{25} which was closely followed by T_{26} (139.67 days). The maximum days taken to first harvesting (132.33 days) was recorded at control. It might be recorded 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. (Yadav *et al.*, 2013).

Chemical or quality attributing characteristics of fruits

It is evident from the results that application of micronutrients on pomegranate had significantly improved the nutritional quality of fruits in terms of TSS, ascorbic acid content, and sensory score of fruit as compared to control. It is further evident from the present results that amongst the various treatments of micronutrients in pomegranate, the application of $ZnSO_4$, H_3BO_3, and $FeSO_4$ at different concentrations enhanced superior nutritional quality parameters of the fruit. However, the highest TSS (14.33 ^{0}B), was recorded under T_{26} while maximum juice per cent (29.67 %), TSS/Acid ratio (17.70), ascorbic acid (11.33 mg), sensory score (9.53) and lowest total acidity (0.80 %) were recorded under T_{25} treatment. However, application of zinc, boron and iron micronutrients could not bring significant variation in respect to total acidity per cent, total sugar per cent, juice per cent and TSS/Acid ratio of fruit (Table 3).

Present investigation clearly indicated that combined application of micronutrients (Zn + B + Fe) treatments had significant effect on chemical characteristics of pomegranate fruit. Among treatments T_{26} and T_{25}were better over control and at par with each other (Table 3).

The improvement in quality of fruit might be due to the fact that micronutrients directly play an important role in plant metabolism as zinc is needed in enzymatic reaction like hexokinase, formation of carbohydrate and protein synthesis (Pamila *et al.*, 1992). Further, boron facilitated sugar transport through boron-sugar complexand it also increase hydrolysis of saccharides into simple sugar (Shanmugavelu *et al.*, 1973) and iron play an important role in photosynthetic efficiency that cause higher photosynthetic rate. Given that the main product of photosynthesis is sugar, so increasing the photosynthesis, lead to increase the sugar compounds and cause more soluble solids in fruit juice. The reduction in acidity might be due to accumulation of reducing and non-reducing sugars (Sohrab *et al.*, 2013). Thus, the quality of fruit in term of TSS, total sugar, reducing sugar was improved by zinc, boron and iron. The findings of present study are in accordance with those of Babu and Yadav (2005) in khasi mandarin, Rawat *et al.*, (2010) in guava, Shukla *et al.*, (2011) in aonla, Sajid *et al.*, (2012) in sweet orange, Bhatt *et al.*, (2012) in mango, Eiada and Mustafa (2013) in pomegranate, Singh *et al.*, (2013) in mango, Sohrab *et al.*, (2013) in pomegranate, and Bakshi *et al.*, (2013) in strawberry.

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