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Effect of boron and zinc on fruit yield and quality of pomegranate (*Punica granatum* L.), cv. Bhagwa

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Abstract
A field experiment was conducted during Rabi season of 2015-16. Geographically Lucknow is situated at $26^{0}50'$ N latitude, $80^{0}52'$ E longitude and altitude of 111 miter above mean sea level (MSL)at Horticulture Research Farm-1, Babasaheb Bheemrao Ambedkar University Vidya Vihar, Rae Bareli Road, Lucknow, (U.P.) 226025, Studies on the "Effect of boron and zinc on Physical characters, Yield attributing characters and Bio-chemical aspects of fruits, yield and quality of pomegranate (*Punica granatum* L.), cv. Bhagwa", revealed that Physical characters *viz*. Fruit weight(101.33g), Fruit length (0.53m), fruit diameter maximum (0.39m), Fruit volume (89.67ml) and Pericarp thickness (0.17mm), Peel weight(0.039g), Number of aril/fruit (302.67) and Aril weight(0.06 g), Aril length (0.48), Aril diameter (0.30), Yield attributing characters *viz*. Fruit yield g/plant (435.35g), Fruit yield kg/ha(299.67kg/ha), and Bio-chemical aspects *viz*. Specific gravity of fruit (2.07), Titratable Acidity (0.43%), Ascorbic acid (10.80mg/100g), Total Soluble Solids (14.47^{0} Brix), Total sugars (6.00%), Reducing sugar (4.63%), Non-reducing sugar, (1.91%), of fruits were maximized. When we use with recommended dose of micronutrients (Boron 0.2%) + (Zinc 0.5%).

Keywords: Pomegranate, boron and zinc, yield and quality, bio-chemical aspects of fruits

Introduction
Pomegranate (*Punica granatum* L.) is one of important fruit crop of India which belongs to family Punicaceae and 2n=2x=18. Pomegranate is characterized by having two types of flowers on the same tree: hermaphroditic bisexual flowers and functionally male flowers. This condition, defined as functional andromonoecy, can result in decreased yields resulting from the inability of male flowers to set fruit. It is mainly grown in subtropical and tropical regions of the world (S.K. Naik and P.K. Chand (2011) [22]. It is native of Iran and cultivated in extensively in Mediterranean and Central Asian countries of the world. It is suitable for growing under arid and semi-arid regions due to its versatile adaptability is, hardy nature, low cast maintenance and high returns.

India is the largest producer of pomegranate in the world around 82300 MT from 13800 ha Area (Anonymous, 2007). Pomegranate can be grown throughout India due to its better adaptability to arid climate, commercial cultivation is being done in Maharashtra, Karnataka and Rajasthan. Other state, where it is grown to lesser extent is Uttar Pradesh, Himachal Pradesh, Punjab, Haryana, Tamil Nadu and Andhra Pradesh.

Pomegranate plant can withstand frost (temperature up to-10 ^{0}C) and can grow up to an altitude of 1600 meters above mean sea level. It thrives best under hot and dry summers with cool winters provided irrigation facilities are available. It is a hardy plant and can withstand considerable amount of drought, but does better when water is made available. Trees with best quality fruits are produced in areas with cold winters and hot dry summers. Thus, mid-hills of Himachal Pradesh have congenial climate.

The chemical composition of pomegranate fruits and recorded that the edible parts represented 52% of the total fruit weight comprising 78%, juice and 22% seeds. The fresh juice contained 85.4% moisture, 10.6% total sugar, 1.4% pectin, 0.1g/100ml total acidity (as citric acid), 19.6 mg/100ml free amino nitrogen and 0.05 g/100mlash. The seed were a rich source of total lipids, protein, crude fiber and as representing 27.2, 13.2, 35.3 and 2.0% respectively and also contains 6. Pectin, 4.7% total sugar. Dadashi *et al*., (2013) [10] reported that pomegranate seed contains about 15% oil with a high refractive index iodine value and very low melting point. The oil has a potential for industrial use. The seeds (100g) also contain 1.09 mg oestrone and 0.036 mg

coumestrol (anon steroid oestrogel) (Moneam *et al*., 1988) [20], Melgarejo *et al*. 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. The fruit peel, tree stem, root bark and leaves are good source of secondary metabolites such astannins, dyes and alkaloids. (Eiada and Mustafa, 2013) [6].

Micro-elements such as Cu, Zn, B, Fe, Mn, Mo etc. are the essential elements required by plants in minute quantities. These are vital to the growth and development of plant. Micro-element deficiencies often limit the productivity in many fruit crops. Boron is an important micro-nutrient governing many physiological and biochemical plant processes and its beneficial effects on horticultural crops have been reported (Dutta *et al.*, 2003) [11]. It plays a significant role in flowering, fruiting, nitrogen metabolism, hormone movement and its action, and cell division. Its deficiency results in shoot dieback, cork spot and cracking of fruits. Boron increases fruit set of many species. Zinc is also an important nutrient element for growth, flowering and quality of fruits. It is involved in the biosynthesis of plant hormone Indole acetic acid. Zinc plays an important role in nucleic acid and protein synthesis and helps in the utilization of phosphorous and nitrogen. Favorable effects of zinc sprays on vegetative growth and health of fruit trees have been observed.

Materials and Methods

The field experiment was conducted at Horticulture Research Farm of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, (A Central University), Vidya-vihar, Rae Bareli Road, Lucknow-226025 (U.P.), India during Rabi season of 2015-16. Geographically Lucknow is situated at $26^{0}50'$ N latitude, $80^{0}52'$ E longitude and altitude of 111 meters above mean sea level (MSL). Lucknow has humid subtropical climate with an average annual rainfall of about 110 cm. The winters are severe and summer is dry and hot. The maximum temperature generally goes up to (43 ^{0}C) in summers and minimum up to 2 ^{0}C in winter. Monsoon generally sets in during the third week of June and recedes by the end of September with heavy rainfall during monsoon season. The weather parameters which prevailed during the course of investigation were recorded at the Meteorological Observatory of the Indian Institute of Sugarcane Research (IISR), Lucknow. Experiment laid out randomized block design with 9 different treatment combination and replicate thrice.

The treatments were T_0 Control (water spray), T_1 (Zinc @0.3%, T_2 Zinc @0.5%), T_3 Boron @0.2%, T_4 Boron @0.5%, T_5 Zinc @0.3% + Boron @0.2%, T_6 Zinc @0.3% + Boron @0.3%, T_7 Zinc @0.5% + Boron @0.2%, T_8 Zinc @0.5% + Boron @0.3%. Observations were recorded for Physical characters *viz*. Fruit weight, Fruit length, fruit diameter maximum, Fruit volume and Pericarp thickness, Peel weight, Number of aril/fruit and Aril weight, Aril length, Aril diameter, Yield attributing characters *viz*. Fruit yield g/plant, Fruit yield kg/ha, and Bio-chemical aspects *viz*. Specific gravity of fruit, Titratable Acidity, Ascorbic acid Total Soluble Solids, Total sugars, Reducing sugar, Non-reducing sugar, of fruits were maximized. When we use with recommended dose of micronutrients (Boron 0.2%) + (Zinc 0.5%).

Result and Discussion

The results obtained during the investigation in respect to Boron and Zinc on growth parameters *viz.* Maximum (101.33g) fruit weight was recorded under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 (Boron @0.2%) and minimum (30.67g) was recorded under treatment T_0 (control). Data reflected that maximum (0.53 m) fruit length under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 and minimum (0.18 m) was recorded under treatment T_0 (control). And represented that fruit diameter maximum (0.39 m) fruit diameter under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 and minimum (0.11m) was recorded under treatment T_1 (control). Showed that maximum (89.67ml) fruit volume under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 (Boron @0.2%) and minimum (29.67ml) was recorded under treatment T_0 (control). Represented that maximum (0.17mm) pericarp thickness under treatment T_8 (Zinc @0.5% + Boron @0.3%) followed by treatment T_6 (Zinc @0.3% + Boron @0.3%) and minimum (0.09mm) was recorded under treatment T_4 (control). showed that maximum (89.67ml) fruit volume under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 (Boron @0.2%) and minimum (29.67ml) was recorded under treatment T_0 (control). It is obvious fruit that peel weight maximum (0.039g) peel weight under treatment T_2 (Zinc @0.5%) followed by treatment T_5 (Zinc @0.3% + Boron @0.2%) and minimum (0.021g) was recorded under treatment T_0 (control). It is apparent from that maximum (302.67) number of aril per fruit under treatment T_5 followed by treatment T_3 and minimum (114.33) was recorded under treatment T_8 (Zinc @0.5% + Boron @0.3%). Clearly revealed that maximum (0.06g) aril weight fruit under treatment T_2 (Zinc @0.5%) followed by treatment T_5 and minimum (0.03 gm) was recorded under treatment T_0 (control). It is showed that maximum (0.48) aril length find treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 and minimum (0.27) was recorded under treatment T_1 (Zinc @0.3%). And maximum (0.30) aril diameter find treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 and minimum (0.167) was recorded under treatment T_0 (control). Revealed that maximum (0.30) aril diameter find treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 and minimum (0.167) was recorded under treatment T_0 (control). These findings are in conformity with those of Pandey *et al.* (1988) [14]. Meena *et al*. (2004) [21]. Sharma *et al*., (1984) [25].

The maximum (435.35g) Fruit yield (g/plant) was recorded under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 (Boron @0.2%) and minimum (81.33g) was found under treatment T_0 control. And the maximum (299.67kg/ha) fruit yield (kg/ha) was recorded under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 (Boron @0.2%) and minimum (56.33kg/ha) was found under treatment T_0 control. These results are in accordance with those of Chaudhar *et al*. (1993) [8] pomegranate. Dutta *et al*. (2000) [9] in improving fruit quality of litchi., Sharma *et al*. (2001) [26] fruit set and quality of litchi cv. Dehradun and Meena *et al*. (2004) [21] in ber.

Specific gravity was recorded of fruit maximum (2.07) specific gravity of fruit under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 and minimum (0.58) was recorded under treatment T_6. And data showed that maximum (0.43%) titratable acidity was recorded under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_2 (Zinc @0.5%) and minimum (0.30%) was recorded under treatment T_1. These results are in accordance with those of Dutta *et al*., (2000) [9]. And indicated that ascorbic acid (vitamin c) was maximum (10.80mg/100g) under treatment T_3 (Boron @0.2%) followed by treatment T_5 (Zinc @0.3% + Boron @0.2%) and minimum (8.00mg/100 g) was recorded under treatment T_8. These results are in accordance with that of Sharma *et al*.,

(2001) [26, 27] in apple. And indicated that TSS was maximum (14.47 ^{0} Brix) as soluble solids under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_3 (Boron @0.2%) and minimum (10.13 ^{0}Brix) was measured under treatment T_1. These results are in accordance with that of Sharma (2001) [26, 27], in apple. Showed that total sugar was maximum (6.00%) was recorded under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_1 (Zinc @0.3%) and minimum (4.56%) was measured under treatment T_0 (control). These results are in accordance with that of Sharma *et al.*, (2001) [26, 27] in apple. And the maximum (4.63%) reducing sugar was recorded under treatment T_1 (Zinc @0.3%) followed by treatment T_2 (Zinc @0.5%), T_4 (Boron @0.5%) and T_6 (Zinc @0.3% + Boron @0.3%) and minimum (3.84) was recorded under treatment T_0 (control). These findings are in conformity with those of in Litchi. Sharma (2001) [26, 27] in apple and Rani and Asrey Ram (2006). The maximum (1.91%) non-reducing sugar was recorded under treatment T_7 (Zinc @0.5% + Boron @0.2%) followed by treatment T_1 (Zinc @0.3%) and minimum (0.95) was recorded under treatment T_2 (Zinc @0.5%). These findings are in conformity with those of Brady, C, J. (1987) [6] in Litchi. Sharma *et al*., (2001) [26, 27] in apple, Dutta *et al*. (2000) [9] in improving fruit quality of litchi. Fruit set and quality of litchi cv. Dehradun and Meena *et al*. (2004) [21] in ber.

Table 1: Effect of boron and zinc on physical characters of fruits.

Treatments Details	Fruit physical characters				
	Fruit weight(gm)	Fruit length (cm)	Fruit diameter (cm)	Pericarp thickness (mm)	Fruit volume (ml)
T_0 (Control)	30.67	0.18	1.04	0.13	29.67
T_1 (Zinc @0.3%)	51.00	0.18	0.94	0.12	54.33
T_2 (Zinc @0.5%)	62.00	0.33	0.99	0.12	66.33
T_3 (Boron @0.2%)	93.00	0.47	1.54	0.08	87.33
T_4 (Boron @0.5%)	38.00	0.24	0.43	0.09	60.33
T_5 (Zinc @0.3% + Boron @0.2%)	87.67	0.27	1.43	0.13	61.33
T_6 (Zinc @0.3% + Boron @0.3%)	52.33	0.24	0.58	0.16	49.33
T_7 (Zinc @0.5% + Boron @0.2%)	101.33	0.54	2.07	0.09	89.67
T_8 (Zinc @0.5% + Boron @0.3%)	78.00	0.22	1.39	0.18	56.00
CD at 5% (P = 0.05)	4.316	0.017	0.019	0.086	3.465
SE (m) ±	1.427	0.006	0.006		1.146

Table 2: Effect of boron and zinc on physical characters of fruit.

Treatments Details	Fruit physical characters				
	Peel weight (g) /fruit	Number of aril/fruit	Aril weight (g)	Aril length (mm)	Aril diameter (mm)
T_0 (C9ontrol)	0.02	157.00	0.03	0.25	0.17
T_1 (Zinc @0.3%)	0.03	167.00	0.04	0.27	0.17
T_2 (Zinc @0.5%)	0.04	194.67	0.06	0.43	0.22
T_3 (Boron @0.2%)	0.03	296.00	0.05	0.436667	0.29
T_4 (Boron @0.5%)	0.03	196.33	0.03	0.30	0.25
T_5 (Zinc @0.3% + Boron @0.2%)	0.04	302.67	0.05	0.3	0.17
T_6 (Zinc @0.3% + Boron @0.3%)	0.03	129.00	0.04	0.28	0.23
T_7 (Zinc @0.5% + Boron @0.2%)	0.02	199.67	0.04	0.483333	0.30
T_8 (Zinc @0.5% + Boron @0.3%)	0.03	114.33	0.04	0.43	0.29
CD at 5% (P = 0.05)	0.054	3.042	0.003	0.024	0.014
SE (m) ±	0.021	1.006	0.001	0.008	0.005

Table 3: Effect of boron and zinc on fruit yield.

Treatments Details	Fruit yield	
	Fruit yield (g)/plant	Fruit yield (kg)/ha
T_0 (Control)	81.33	56.33
T_1 (Zinc @0.3%)	85.00	53.33
T_2 (Zinc @0.5%)	142.67	93.92
T_3 (Boron @0.2%)	227.67	149.89
T_4 (Boron @0.5%)	89.00	58.67
T_5 (Zinc @0.3% + Boron @0.2%)	122.33	83.78
T_6 (Zinc @0.3% + Boron @0.3%)	157.67	104.67
T_7 (Zinc @0.5% + Boron @0.2%)	435.33	299.67
T_8 (Zinc @0.5% + Boron @0.3%)	219.67	156.23
CD at 5% (P = 0.05)	427.017	283.012
SE (m) ±	208.289	139.205

Table 4: Effect of boron and zinc on Bio-chemical characters of fruit.

	Treatments Details	Fruit chemical characters						
		Specific gravity of fruit (g/ml)	Titratable Acidity (%)	Ascorbic acid (Vitamin C) (mg. /100g.)	Total Soluble Solid (T.S.S. ^{0} Brix)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)
T_0		1.04	0.32	9.30	11.50	4.56	3.84	1.07
T_1	(Zinc @0.3%)	0.94	0.30	8.05	10.13	5.54	4.63	1.83
T_2	(Zinc @0.5%)	0.99	0.40	9.00	13.30	5.19	4.08	0.95
T_3	(Boron @0.2%)	1.54	0.40	10.80	14.37	5.00	3.91	1.44
T_4	(Boron @0.5%)	0.43	0.365	9.51	13.13	5.28	4.08	1.24
T_5	(Zinc @0.3% + Boron @0.2%)	1.43	0.39	10.70	10.40	5.19	4.07	1.16
T_6	(Zinc @0.3% + Boron @0.3%)	0.58	0.40	9.23	13.83	5.31	4.08	1.57
T_7	(Zinc @0.5% + Boron @0.2%)	2.07	0.43	10.18	14.47	6.00	3.84	1.91
T_8	(Zinc @0.5% + Boron @0.3%)	1.39	0.40	8.00	13.70	5.51	3.96	1.55
CD at 5% (P = 0.05)		0.139	0.015	0.619	0.377	0.162	0.060	0.033
SE (m) ±		0.46	0.005	0.205	0.046	0.054	0.020	0.011

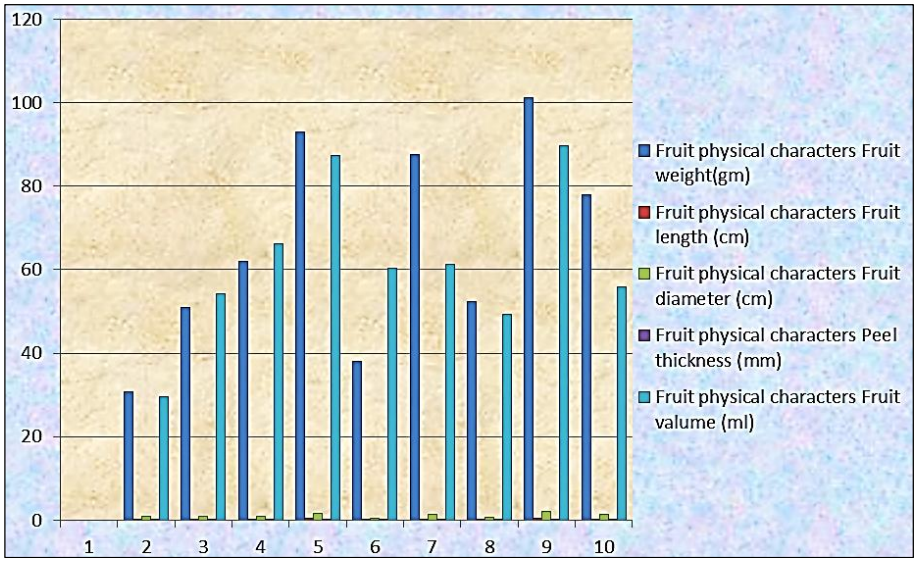

Fig 1: Effect of boron and zinc on physical characters of fruits.

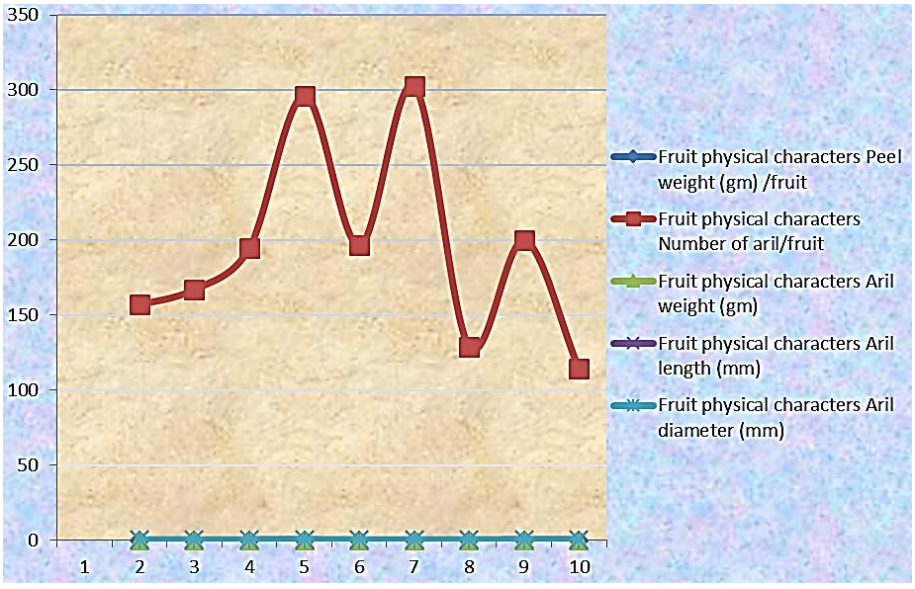

Fig 2: Effect of boron and zinc on physical character of fruits

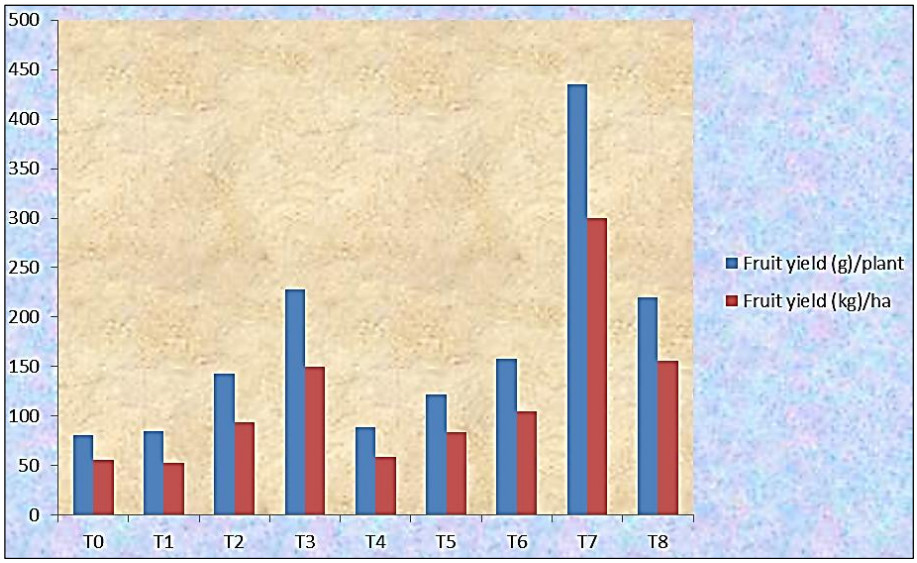

Fig 3: Effect of boron and zinc on fruit yield.

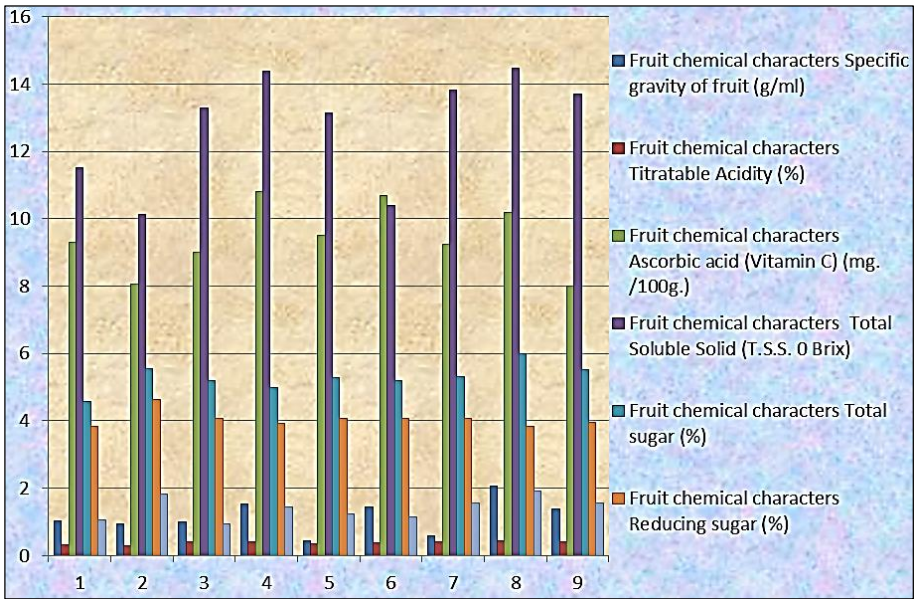

Fig 4: Effect of boron and zinc on fruit chemical characters.

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