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Effect of different grade and time of application of micronutrients on fruit and chemical characters of pomegranate cv. Bhagwa

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Abstract
A research called "Studies on different grades and time of application of micronutrient mixture on growth, yield and quality of pomegranate (*Punica granatum* L.) cv. Bhagwa" was carried out during the year 2021-22. The experiment was conducted with different grades of micronutrient application compared with control in Randomized Block Design with three replications. The result disclosed that among the different treatments, treatment (T6) RDF + Grade-2 @30g/ thrice exhibited better in terms of highest percent of fruit set (43.42%), minimum percent of fruit drop (9.00%), maximum number of arils per fruit (382.39), maximum weight of 100 arils (44.39 g), and maximum juice percent (54.90%) whereas maximum weight of rind (92.03 g) was observed in (T5) RDF + Grade-2 @30g/ twice. Chemical attributes *viz*., maximum total soluble solids (15.27%), maximum ascorbic acid (14.38 mg/100g), maximum reducing sugars (13.03%), maximum non reducing sugars (1.32%), and maximum total sugars (14.36%) were observed in treatment (T9) RDF + Grade-1 chelated (12.5g) + Grade-2 (15g)/thrice as compared to control T10. The treatment T6 was recorded minimum Titratable acidity (0.33%), maximum anthocyanin content (16.65 mg) and highest benefit: cost ratio (2.84) of pomegranate.

Keywords: Pomegranate, bhagwa, grade I micronutrient, grade II micronutrient

Introduction
Pomegranate (*Punica granatum* L.) is a popular fruit crop in arid and semiarid climates. It belongs to the Punicaceae family. It's one of the most well-known edible fruits. The Latin term "pomegranate" means "apple with numerous seeds." The pomegranate is regarded as a symbol of wealth and ambition (Duman *et al*., 2009) [7]. According to Smith (1976) [24] *Punica granatum* has 2n=2x=16, 18 chromosomes. This fruit crop's amazing flexibility is evident in how well it performs in both hotter (44 °C) and lower (-12 °C) temperatures (Westwood, 1978) [27].
India has first rank in terms of area and production in world. Spain has the highest productivity (18.5 t/ha), followed by the United States (18.3 t/ha). Spain's export contribution is (37.8%) of total exports despite its small size (2000 ha.) with the highest production (37,000 t), followed by Israel (23.5%) and the United States (15.5%) while India has lowest share in export (7%) (NHB, 2020-21). Pomegranate-growing states in India includes Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu, and a portion of Rajasthan. Maharashtra is known as „bowl of pomegranate" producing more than 70% of the country's pomegranates followed by Karnataka and Andhra Pradesh. Pomegranate production in Maharashtra is primarily concentrated in western Maharashtra and Marathwada region like Solapur, Sangli, Pune, Ahmednagar, Nasik, Dhule, Aurangabad, Satara, Osmanabad and Latur. Bhagwa is the most popular and widely used pomegranate cultivar in the Maharashtra with largest area under cultivation. There are various names for this cultivar like Shendri, Jai Maharashtra, Kesar, Asthagandh, Mastani and Red Diana in Maharashtra.
In India, variety of soil type has deficit with different micronutrients. The deficit of micronutrients leads to stunted growth, chlorosis, and delayed maturity. Chelating agents are organic compounds that have the ability to trap other molecules or encapsulate metal ions such as Ca, Mg, Fe, Co, Cu, Zn, and Mn and then slowly release these metal ions so that they are available for plants to absorb upwards (Sekhon, 2003) [19]. Considering the concept of „Soil Nutrient Index" the soils of the study in parbhani area found in the category of „low fertility statuses for zinc (1.59), iron (1.50) and boron (1.48) micronutrient.

Material and Methods

The experiment entitled, "Studies on different grades and time of application of micronutrient mixture on growth, yield and quality of pomegranate (*Punica granatum* L.) cv. Bhagwa" was carried out during *Ambe bahar* 2021-22 under the agro climatic conditions of Parbhani at Department of Horticulture, VNMKV, Parbhani (Maharashtra). The experiment was laid out in Randomized Block Design (RBD) with ten treatments which are replicated thrice. The treatments were *viz*., (T_1) RDF + Grade-1 chelated @ 25g/ once, (T_2) RDF + Grade-1 chelated @ 25g/ twice, (T_3) RDF + Grade-1 chelated @25g/ thrice, (T_4) RDF + Grade-2 @ 30g/once, (T_5) RDF + Grade-2 @ 30g/ twice, (T_6) RDF + Grade-2 @ 30g/ thrice, (T_7) RDF + Grade-1 + Grade-2 (50:50)/once, (T8) RDF + Grade-1 + Grade-2 (50:50) twice, (T_9) RDF + Grade-1 + Grade-2 (50:50) thrice and (T_{10}) RDF only (control).

The pomegranate plants age of 8 years were grown on medium black soil which having uniform growth and vigour were subjected to bahar treatment by withholding irrigation. The various operations like land preparation, removal and disposal of diseased fruits of previous bahar was done. All the plants were pruned uniformly to remove the last season"s growth, disease; pest infected branches and dried branches. The RDF (625:250:250g NPK/tree) was applied to every treatment after 45 + .0 of withholding water, after that first light irrigation was applied. Nitrogen is applies in two split doses with one month interval while Phosphorus and Potash were applied as single dose For preparation of chelated micronutrient @25g/tree, mixing 25g of Grade-1 chelated in 4 lit. of water and drenching was done similarly for Grade-2 micronutrient @30g/tree, 30g of Grade-2 micronutrient was dissolved in 4 lit. water and spray as foliar application.

Treatments T1, T4 and T7 applied as one time immediately after full flowering. Treatments T2, T5 and T8 exercised as spray/drench twice at fortnight interval after full flowering. Likewise Treatments T3, T6 and T9 applied three times with the fine sprayer. Grade-1 and Grade-2 micronutrients are applied as soil and foliar application respectively.

Result and Discussion

The perusal of the data presented in Table 1 and Table 2 regarding fruit and chemical characters of pomegranate as influence by different grades and time of application of micronutrient are discussed below.

Table 1: Effect of different grade and time of application of micronutrients on fruit characters of pomegranate cv. Bhagwa.

Treat. No.	Treatment	Fruit set%	Fruit drop %	Number of arils fruit-1	Weight of 100 arils (g)	Juice percent (%)	Weight of rind (g)
T1	RDF + Grade-1 chelated @25g/ once	40.19	13.01	354.33	38.64	47.53	85.60
T2	RDF + Grade-1 chelated @25g/ twice	40.53	12.32	372.31	39.44	49.60	89.51
T3	RDF + Grade-1 chelated @25g/ thrice	41.01	11.75	375.53	40.77	51.87	87.77
T4	RDF + Grade-2 @ 30g/ once	40.30	12.47	369.40	37.53	48.40	88.09
T5	RDF + Grade-2 @ 30g/ twice	41.53	9.98	381.14	42.45	52.33	92.03
T6	RDF + Grade-2 @ 30g/ thrice	43.42	9.00	382.39	44.39	54.90	91.15
T7	RDF + Grade-1 + Grade-2 (50:50)/once	40.57	11.05	370.47	38.80	47.23	88.09
T8	RDF + Grade-1 + Grade-2 (50:50)/twice	41.14	10.10	364.40	40.97	49.20	87.54
T9	RDF + Grade-1 + Grade-2 (50:50)/thrice	42.27	9.30	381.01	42.38	52.27	91.00
T10	RDF only. (control)	37.03	15.24	358.68	36.24	40.90	83.31
S.E. ±		0.73	0.86	2.69	0.48	0.95	1.62
CD at 5%		2.17	2.56	8.00	1.42	2.82	4.80

Percent of fruits set

The maximum percent of fruit set (43.42%), in pomegranate was recorded in T6 while minimum percent of fruit set (37.03%) was recorded in T10 control. The increase in fruit set percentage caused by micronutrient treatments may be attributable to greater fruit set and decreased fruit drop as a result of zinc, boron, and iron sprays that could result in a better fruit yield. The current findings are consistent with those of Singh and Maurya (2004) [23] in mango, Singh *et al*., (2005) [14] in papaya, and Rajkumar *et al*., (2014) in guava.

Percent of Fruit Drop

The treatment T6 was recorded minimum percent of fruit drop per plant (9.00%), while significantly maximum percent of fruit drop (15.24%) was recorded in T10 control. Reduced fruit drop may have contributed to an increase in fruit set and fruit retention percentage. According to Nijjar (1985) [16], Zn is necessary for inhibiting the establishment of the abscission layer, which reduces fruit drop before harvest. Similar to how Trivedi *et al*., (2012) [25] discovered the present results in guava. The application of zinc and boron prevents fruit from dropping and increases fruit retention, which may be because zinc is crucial for the production of IAA (Alloway, 2008) [3].

Number of arils per fruit

The maximum number of arils per fruit (382.39) was noticed in the treatment T6 while minimum number of arils per fruit (354.33) was recorded in T10, control. The variation in the number of arils fruit-1 may be due to application of different micronutrients like Grade-1 + Grade-2 micronutrients of different concentration might be due to increase in fruit weight, juice content and fruit diameter as show by the result of this experiment.

Weight of 100 Arils (g)

The treatment T6 (RDF + Grade-2 @30g/ thrice) was showed maximum weight of 100 arils (44.39 g), while significantly minimum weight of 100 arils was recorded in T10 (36.24 g) control. The variation in the weight of 100 arils may be due to application of different micronutrients like Grade-1 + Grade-2 micronutrients of different concentration, might be due to increase in fruit weight, juice content and fruit diameter as show by the result of this experiment.

Juice Percent

The treatment RDF + Grade-2 @30g/ thrice (T6) was recorded significantly maximum juice percent (54.90%), while significantly minimum juice percent was recorded in T10 (40.90%) control. This may be due to boron which plays an important role in more absorption of water, nutrients and

increase the volume of inter cellular spaces in the pulp. Significantly highest weight of fruit, volume of fruit and pulp weight hence maximum pulp percent. Similar results were found by Singh *et al*., (2015) [6] in mango.

Weight of Rind (g)

The treatment T5 RDF + Grade-2 @30g/ twice was recorded maximum weight of rind (92.03), while significantly minimum weight of rind was recorded in T10 (83.31) control. The increase in the weight of rind might have occurred due to increased rind thickness and fruit size.

Table 2: Effect of different grade and time of micronutrient application on chemical composition and economics of pomegranate cv. Bhagwa

Treat. No.	Treatment	TSS (%)	Ascorbic acid (mg/100g)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)	Titratable acidity (%)	Anthocyanin (mg)	B:C Ratio
T1	RDF + Grade-1 chelated @25g/ once	14.24	13.40	12.44	1.15	13.59	0.39	15.27	2.27
T2	RDF + Grade-1 chelated @25g/ twice	14.52	13.73	12.64	1.21	13.84	0.37	15.29	2.31
T3	RDF + Grade-1 chelated @25g/ thrice	14.95	13.78	12.76	1.22	13.98	0.37	15.60	2.43
T4	RDF + Grade-2 @ 30g/ once	14.29	13.48	12.21	1.17	13.38	0.40	15.61	2.27
T5	RDF + Grade-2 @ 30g/ twice	15.05	14.13	12.81	1.25	14.07	0.36	16.07	2.75
T6	RDF + Grade-2 @ 30g/ thrice	15.16	14.21	12.85	1.26	14.11	0.33	16.65	2.84
T7	RDF + Grade-1 + Grade-2 (50:50)/once	14.23	13.36	12.51	1.04	13.55	0.39	15.11	2.36
T8	RDF + Grade-1 + Grade-2 (50:50)/twice	15.10	13.82	12.69	1.19	13.89	0.36	15.46	2.38
T9	RDF + Grade-1 + Grade-2 (50:50)/thrice	15.27	14.38	13.03	1.32	14.36	0.34	16.21	2.70
T10	RDF only. (control)	13.47	12.70	11.23	0.86	12.09	0.45	14.59	2.05
S.E. ±		0.08	0.05	0.03	0.03	0.04	0.005	0.08	
CD at 5%		0.24	0.16	0.10	0.09	0.13	0.015	0.23	

Total soluble solids (%)

The treatment T9 was recorded significantly maximum TSS (15.27%), while minimum TSS of fruits was recorded in T10 (13.47%) control. Total soluble solids may have increased because zinc aids in enzymatic processes such carbohydrate conversion, hexokinase activity, cellulose production, and sugar change due to its effect on zymohexose, and boron aids in sugar transport, both of which may be feasible to increase TSS and total sugars. Arora and Singh (1972) [28] and Chaitanya *et al*., (1997) [29] both observed similar outcomes in guava.

Ascorbic acid (mg/100g)

The significantly maximum ascorbic acid (14.38 mg/100g) content was found in treatment T9 while minimum ascorbic acid content of fruits was recorded in T10 (12.70 mg/100g) control. The increased total sugar content resulted from the efficient transfer of available photosynthates to fruit pulp as opposed to other sections, which led to the higher ascorbic acid level. Singh and Rajput obtained comparable outcomes (1976).

Reducing sugars (%)

The maximum reducing sugars (13.03%) content was noticed in treatment T9 at the same time minimum reducing sugars of fruits (11.23%) was recorded in T10 control. This might be as a result of potassium sulphate enhancing photophosphorylation and the dark response of photosynthesis, which led to the accumulation of more carbohydrates in the fruits and improved nutritional accessibility to developing fruits. The findings published by Kumar *et al*., (2017) in guava are consistent with the results of the current investigation.

Non reducing sugar (%)

The treatment T9 was recorded significantly maximum non reducing sugars (1.32%), in the time significantly minimum non reducing sugars of fruits (0.86%) was detected in T10 control. This might be as a result of potassium sulphate's role in enhancing photophosphorylation and the dark reaction of photosynthesis, which led to the accumulation of more carbohydrates in the fruits and improved the accessibility of nutrients to the growing fruits. The findings published in guava by Kumar *et al*., (2017) and the results of the current investigation are consistent.

Total Sugars (%)

The maximum total sugars (14.36%) was noticed in treatment T9 while minimum total sugars of fruits (12.09%) were recorded in T10 control. Increase in total soluble solids and total sugars may be attributable to zinc's assistance in enzymatic processes such carbohydrate transformation, hexokinase activity, and cellulose production. In addition, boron aids in sugar transport, which may make it feasible to increase TSS and total sugars. Arora and Singh (1972) [28] and Chaitanya *et al*., (1997) [29] both observed similar outcomes in guava.

Titratable acidity (%)

The treatment T6, (RDF + Grade-2 @30g/ thrice) was recorded significantly minimum titratable acidity (0.33%), at that time maximum titratable acidity of fruits (0.45%) was recorded in T10 control. The rise in total soluble solids was the primary cause of the decline in titrable acidity. The outcomes likewise agreed well with those. The least amount of acidity was caused by either being quickly transformed into sugars and their derivatives through reactions involving reverse glycolytic pathways or maybe being employed in respiration, or both. These findings concurred with those of Ahmad *et al*., (1998) [2].

Anthocyanin (mg/100ml)

The maximum anthocyanin content (16.65), was found in treatment T6 while minimum anthocyanin content of fruits (14.59) was recorded in T10 control. Fruit chemical quality *i.e.*, TSS, Total sugars and Anthocyanin were recorded by Zn foliar spraying, treatments reduced the phenomenon of white grains in fruits which reflected by increasing anthocyanin in fruits and increase color, as well as enhanced nutritional status of pomegranate The results of the current study concur with those published in pomegranate.

Benefit cost ratio (B: C ratio)

The treatment T6 was recorded significantly maximum B:C ratio (2.84), while significantly minimum B:C ratio (2.05) was recorded in T10 control. The maximum benefit cost ratio in T6

treatment was due to higher yield (139.96 q/ha) and NMR (5,03,448 rupees). The obtained results are line with, reported that better gross monetary returns in guava results in high benefit cost ratio.

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