Environment and Ecology 40(4A): 2266—2271, October—December 2022
ISSN 0970-0420

Phenology and Fruit Quality of Pomegranate cv Bhagwa as Influenced by Micronutrients

Vikram Meena, S. Maji, Razauddin, A. K. Goyal, Mayaram, R. C. Meena

Received 4 July 2022, Accepted 27 August 2022, Published on 4 November 2022

ABSTRACT

The present investigation was carried out at Department of Horticulture, Babasaheb Bhimrao Ambedkar University Lucknow, Uttar Pradesh, India during 2020-21 with an aim to see the effect of various micronutrients on phenology, fruit yield and quality of pomegranate cv Bhagwa. There were 7 treatment combinations having different levels of zinc, iron and manganese laid out with three replications following Randomized Block Design (RBD). Results revealed that application of two foliar spray (before flowering and at fruit set stage) of $ZnSO_4$ 0.5% + $FeSO_4$ 0.4% + $MnSO_4$ 0.5% caused early flowering, improved fruit let development and there by increased fruit yield. It also increased fruit diameter and length, arils content, peel/pulp ratio, reducing, non- reducing and total sugar and TSS. Thus, it can be concluded that two spray of micronutrients $ZnSO_4$ 0.5% + $FeSO_4$ 0.4% + $MnSO_4$ 0.5% may be suggested for better fruiting and superior fruit quality.

Vikram Meena[1], A. K. Goyal[2],
Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow 226025, UP, India

S. Maji*[3], Razauddin[4], Mayaram[5], R. C. Meena[6]
[3]Assistant Professor, [4,5,6]Research Scholar
Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow 226025, UP, India
Email : majisutanu@gmail.com
*Corresponding author

Keywords Pomegranate, Micronutrient, Phenology, Fruit quality.

INTRODUCTION

Pomegranate (*Punica granatum* L.) belongs to Punicaceae family and is one of the oldest known as edible fruits. Pomegranates are widely grown in many tropical and subtropical countries, especially in the moderate climate of the Mediterranean regions (Solaheddin and Kader 1984). In addition, pomegranate trees have greater adaptability to adverse climatic conditions, such as drought tolerance and climate change (Sepulveda *et al*. 2000). Pomegranate is a good source of vitamin C (28 mg), vitamin K and potassium (666 mg), as well as several other key nutrients helpful for nerval system and healthy heart. Globally, pomegranates are currently the 18th most consumed fruit and will become the 10th most consumable fruit within next ten years. Pomegranate cultivation is spread all over the country due to hardy nature, high yield, fetching good price in the market and good keeping quality. In India, pomegranate is commercially cultivated in Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Madhya Pradesh, Tamil Nadu and Rajasthan.

Area under this crop is increasing enormously in spite of higher cost of fertilizers, leaching and washing away of nutrients by runoff, low fertilizer use efficiency and low productivity under conventional fertilizer application methods. Fertilizers are the most important inputs which directly affect the plant growth, development, yield and quality of produce. Application of fertilizers to the growing crops along with irrigation water through drip system, provide nutrients to the active root zone at different time intervals in accordance to crop growth stages, thus preventing losses of expensive nutrients, which ultimately helps in improving productivity and quality of produce. Foliar application of different micronutrients at proper stage helps in improving fruit yield, quality and physico-chemical characteristics of pomegranate. It also helps in correcting micronutrients deficiency and improves quality and physico-chemical characteristics of pomegranate. The important tools used in quality production are providing balance nutrition, control of pest and diseases and maintaining the optimum crop load on the tree. The foliar application of nutrients for quality production of fruits is becoming very popular among the pomegranate growers. The exact information about the specific chemical, its concentration and stage of application is lacking. The farmers are asking for schedule of nutrient application through foliage for quality production.

Among micronutrients, Zn, Mn and Fe have much significance due to poor nutrient status of soil. Zinc (Zn) is an essential trace element for plants, being involved in many enzymatic reactions and is necessary for their good growth and development specially in regulating the protein and carbohydrate metabolism (Swietlik 1999). Zn in plants is required in the synthesis of tryptophan which is a precursor of indole acetic acid and the formation of this growth substance is directly influenced by Zn and also affects many biological processes such as photosynthesis reactions, nucleic acids metabolism, protein and carbohydrate biosynthesis (Marschner 1996). Zn significantly increased final yield through increasing fruit weight, fruit set and decreasing fruit drop and splitting of fruit in pomegranate (Eiada and Mustafa 2013).

Foliar application of 0.3% boron as boric acid and 0.3% Zn as zinc sulphate after two and eight weeks from full bloom had higher yield, less cracking per cent and improved quality in pomegranate (Hoda and Hoda 2013). Iron is also an essential micronutrient required for normal growth and plant function. It plays an important role in the activation of chlorophyll and in the synthesis of many proteins such as different cytochrome, which participate in different functions in the plant metabolism (Al- Bamarny *et al*. 2010). Lack of iron causes the classical symptoms of interveinal yellowing which in turn lead to losses of yield and reduced quality. Keeping this background the present investigation was planned to assess the effect of zinc, iron and manganese on fruiting of pomegranate grown at subtropical climate.

MATERIALS AND METHODS

The present investigation was carried out at Horticulture Research Farm, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow -226025 (UP), India Horticulture research form during 2020-21. The climate of Lucknow is characterized by sub-tropical with hot, dry summer and cool winters. This region receives an averages annual rainfall of 650–750 mm with peak period during July-August. It also receives scattered showers during winter months. The coldest month is January, while the maximum temperature observed during May-June. The temperature governs the evaporation from the crop and soil of the experimental field. During the experiment maximum temperature ranged from 37.2°C to 48°C and minimum temperature 20.2°C to 27.3°C. During the experiment the utmost relative humidity was highest in the month of July (93%) although the lowest relative humidity was recorded in the month of April (26%). There were 7 treatment combinations having different levels of zinc, iron and manganese [T_0-Control (Water Spray), T_1-Zinc Sulphate, T_2-Manganese Sulphate, T_3- Iron Sulphate, T_4-Zinc Sulphate + Manganese Sulphate, T_5-Zinc Sulphate+ Iron Sulphate, T_6- Manganese Sulphate + Iron Sulphate, T_7- Zinc Sulphate + Manganese Sulphate + Iron Sulphate]. The treatments were laid down with three replications following Randomized Block Design (RBD). Micronutrients were applied on the foliage of pomegranate plants cv. Bhagwa selected for the study. The observations on flowering and fruiting was observed and physico-chemical study was done at the laboratory following standard biochemical methods (Ranganna 1986). Observed data was analyzed statistically by OPSTAT (http://14.139.232.166/opstat) and significance study was done at 5% probability level among the treatment means.

Table 1. Phenology and fruit yield as affected by different treatments of zinc, iron and manganese.

Treatments	Days taken to first flower-ing (days)	Days taken to fruit let develop-ment (days)	Days taken to first flowering to 50% fruit set (days)	Fruit diameter (cm)	Fruit length (cm)	Number of fruits/ plant	Weight of fruit (g)	Fruit yield per plant (kg)
T_0 : Control (Water spray)	59.66	12.50	18.00	7.18	7.56	65.66	269.56	17.70
T_1 : Zinc Sulphate	56.61	11.60	17.25	7.43	7.84	75.00	284.53	21.34
T_2 : Manganese Sulphate	54.77	11.00	16.60	7.64	7.88	67.33	288.16	19.40
T_3 : Iron Sulphate	52.66	10.25	15.75	7.71	8.25	75.66	283.06	21.42
T_4 : Zinc Sulphate + Manganese Sulphate	58.99	12.00	17.75	7.68	8.03	80.66	313.83	25.31
T_5 : Zinc Sulphate + Iron Sulphate	57.88	11.75	17.50	7.80	8.37	82.00	316.63	25.96
T_6 : Manganese Sulphate + Iron Sulphate	54.00	10.80	16.50	7.73	8.20	71.66	302.06	21.65
T_7 : Zinc Sulphate + Manga-nese Sulphate + Iron Sulphate	55.11	11.25	16.80	8.08	8.64	80.66	337.20	27.20
SEm ±	0.76	0.38	0.30	0.001	0.005	1.30	10.65	1.75
CD (P= 0.05)	2.24	1.13	0.88	0.004	0.022	3.83	31.26	5.13

RESULTS AND DISCUSSION

Flowering and fruiting phenology

Significantly early flowering (52.66 days) were observed (Table 1) in the treatments T_3 followed by T_6 (54.00 days) and late flowering (59.66 days) was observed in control followed by T_4 (58.99 days) and T_5 (57.88 days), respectively. El-Saida (2001) also reported that Washington Navel orange trees budded on sour orange rootstock, showing Fe, Zn and Mn deficiency symptoms, while received foliar nutrition of 400 ppm of Na, Fe EDTA, Na, Zn EDTA and Mn EDTA 3 times a year (at the beginning of flowering, after fruit set, and 4 weeks later) either solely or at different combinations, improved growth parameters (shoot percentage and shoot length of different growth flushes) and leaf chlorophyll content. Similarly, minimum days was required for fruit let development was noticed in the treatment T_3 preceded by T_6. While, the maximum days for fruit let development were noted in control.

Treatment T_3 exhibited the minimum days requirement to 50% fruit set followed by T_6 and T_7 (Table 1). While, the maximum days for 50% fruit set were noted in T_0 (control). Similar result were observed by Kumar and Shukla (2010) who reported that the ber plants supplied with boron (0.3 and 0.6% borax) and zinc (0.2 and 0.4% zinc sulphate) at two stages viz. before flowering and after fruit set caused early and highest fruit set. Modi *et al.* (2012) also revealed that individual application of $ZnSO_4$ (0.5%) and borax (0.3%) exerted great influence on plant height, stem girth and number of leaves as well as earlier initiation of flower bud and minimum days taken from fruit setting to first harvest of papaya (*Carica papaya* L.) cv Madhu Bindu.

Yield parameters

The maximum fruits per plant (82.00) was recorded under the treatment T_5 followed by T_7 and T_4 and the minimum fruit per plant was recorded in the treatment T_0 (Table 1). The result corroborated the finding of Rajkumar *et al.* (2014) who reported that combined foliar application of zinc and boron resulted in maximum yield (135.10 kg/tree). Hasani *et al.* (2012) also observed the maximum number of fruits/tree (31.12) and highest yield/tree (8.1 kg) in the trees treated with foliar sprays of 0.6% $MnSO_4$ and 0.3% $ZnSO_4$. Similar result were also found by Ebeed *et al.* (2001) who reported that the foliar spray of some micronutrients (Fe + Zn + Mn, Fe + Mn) at flower-

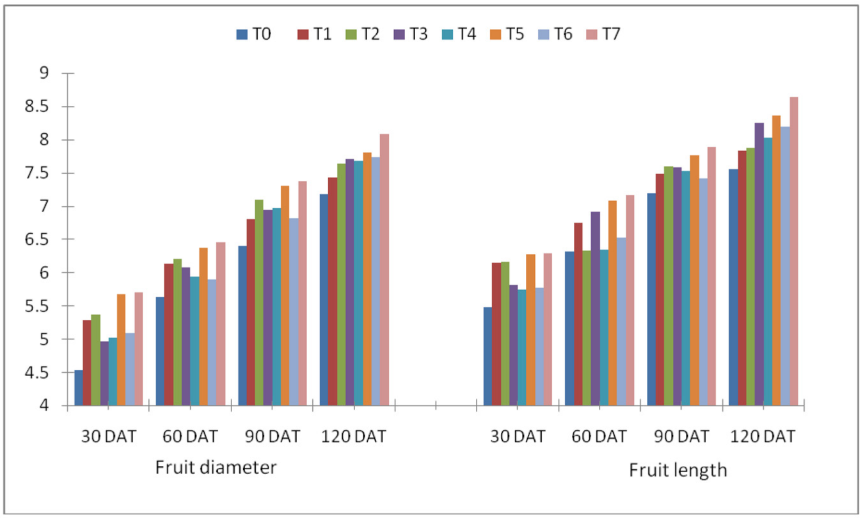

Fig. 1. Effect of zinc, ferrous and manganese on change of fruit diameter and fruit length of pomegranate at various growth stages.

ing stages recorded highest yield in mango. Singh and Maurya (2004) stated that foliar spray of $ZnSO_4$ (0.4%), $FeSO_4$ (0.4%), $MnSO_4$ (0.2%) and H_3BO_3 (0.2%) alone and in combinations were responsive to increase flowering, fruiting and yield of mango.

Physico-chemical parameters

T_7 (Zinc Sulphate + Manganese Sulphate + Iron Sulphate) showed (Table 1) the maximum weight (337.20 g) of fruit followed by T_5 and minimum weight of fruit was noticed in T_0. Similar result were observed by Kumar *et al.* (2013) who concluded that foliar spray of $ZnSO_4$ 0.8% + borax 0.4% + NAA 50 ppm + GA_3 100 ppm and found best to increase volume of fruit, pulp thickness, pulp weight, pulp per cent, length and diameter of fruit, average fruit weight, and reduced the seed per cent and seed pulp ratio which ultimately increased the yield per tree in guava cv Chittidar. Trivedi *et al.* (2012) suggested that the combined foliar application of zinc sulphate @ 0.6% and boric acid @ 0.5% before fruit set and after fruit set resulted in higher yield and fruit weight in guava.

The maximum fruit length and diameter (Table 1) was also recorded in the treatments T_7 followed by T_5 and the minimum was noted in control which was in the line of experimental results reported by Goswami *et al.* (2012) in guava. Shekhar *et al.* (2010) evaluated the influence of foliar feeding of micronutrients on yield of papaya fruits and found higher yield with maximum fruit weight and fruit size (length and width) with borax 0.1% followed by copper sulphate 0.25%. Mirzapour *et al.* (2013) studied the effectiveness of soil and foliar application of Iron (Fe) and Zinc (Zn) fertilizer on pomegranate and similar result was also recorded by Bakshi *et al.* (2013) in strawberry cv Chandler. Similar result in the present experiment was also evident from Fig. 1.

The minimum peel percentage (Table 2) was found also in treatment T_7 followed by T_5 (Zinc Sulphate+ Iron Sulphate). Aril content in fruit is one of the important quality parameters for consumer acceptance and the maximum arils was also recorded under the treatment T_7 preceded by T_6 in the present study. The peel and pulp ratio (Table 2) was significantly influenced by the various treatments of foliar spray of micronutrients. The maximum ratio (1:1.97) of peel and pulp was noticed under the treatment T_7 followed by T_5 (1:1.79). However, the minimum (1:1.46) ratio of peel and pulp were observed in the control treatment. Saleh and Monem (2003) also observed that foliar application of 0.3% potassium + 0.5% boric acid was most effective to improve pulp weight of mango. Similar result was also reported by Kumar *et al.* (2013) who concluded that application of $ZnSO_4$

Table 2. Effect of zinc, ferrous and manganese on peel, arils, peel-pulp ratio and chemical qualities of pomegranate fruits.

Treatments	Peel (%)	Arils (%)	Peel : Pulp	Total sugars (%)	Reducing sugar (%)	Non-reducing sugar (%)	Total soluble solids (°brix)	Acidity (%)	TSS : Acid ratio
T_0 : Control (Water Spray)	36.75	53.79	1:1.46	9.85	9.18	0.676	14.10	0.381	37.01
T_1 : Zinc Sulphate	36.13	57.27	1:1.58	9.97	9.27	0.703	15.20	0.354	42.94
T_2 : Manganese Sulphate	37.54	56.22	1:1.57	10.47	9.77	0.706	15.41	0.362	42.57
T_3 : Iron Sulphate	36.75	55.15	1:1.49	9.99	9.29	0.700	14.26	0.361	39.50
T_4 : Zinc Sulphate + Manganese Sulphate	37.64	55.23	1:1.46	10.63	9.89	0.743	15.49	0.359	43.15
T_5 : Zinc Sulphate + Iron Sulphate	32.75	58.65	1:1.79	9.95	9.21	0.740	16.40	0.348	47.13
T_6 : Manganese Sulphate + Iron Sulphate	33.42	59.01	1:1.76	10.62	9.91	0.716	16.20	0.365	44.38
T_7 : Zinc Sulphate + Manganese Sulphate + Iron Sulphate	30.93	61.56	1:1.97	10.76	9.92	0.836	17.23	0.366	47.08
SEm ±	0.61	1.04	0.04	0.100	0.10	0.32	0.24	0.002	0.045
CD (P = 0.05%)	1.80	3.05	0.11	0.296	0.029	0.94	0.71	0.008	0.124

0.8% + borax 0.4% + NAA 50 ppm + GA_3 100 ppm increased pulp thickness, pulp weight and pulp per cent in guava cv Chittidar.

The total soluble solids (Table 2) increased significantly by the application of different micronutrients over the control. The maximum total soluble solids was recorded in the treatment T_7 followed by T_5. Similar result were also observed by Bhatt *et al.* (2012) who reported that the trees sprayed with 0.5% borax showed maximum TSS, reducing sugar, non reducing sugar and ascorbic acid content in mango and same was also found by Hasani *et al.* (2012) and Sajid *et al.* (2012). Total sugars content was statistically significant due to the application of micronutrients. The application of T_7 (Zinc Sulphate + Manganese Sulphate + Iron Sulphate) exhibited the maximum total sugars followed by T_4. The minimum total sugar was recorded under the treatment T_0. The result was in line of findings of El-Khagawa (2007) who observed the highest TSS (16.9 0Brix), maximum total sugars (12.2 %) and maximum reducing sugar (11.2 %) with application of 4000 ppm zinc sulphate. Trivedi *et al.* (2012) also reported the similar result where combined foliar application of zinc sulphate @ 0.6% and boric acid @ 0.5% before fruit set resulted higher TSS (15.40 %), acidity (0.550 %), ascorbic acid (221.51 mg/100 g fruit pulp), total sugars (8.66%), non-reducing sugar (3.76%) and sugar-acid ratio (15.76) in guava.

Table 2 also showed that treatment T_7 recorded the maximum reducing sugar followed by T_6. Whereas, the minimum reducing sugar was found in control treatment (T_0). Alila and Achumi (2012) also reported that pre-harvest application of 4% boric acid resulted in higher TSS and lower acidity content in litchi fruits during storage. Total sugars (15.92%) and reducing sugars (11.94%) were also enhanced with 4% boric acid pre-harvest application which was similar to the result observed by Bhatt *et al.* (2012) who reported that the trees sprayed with 0.5% borax showed maximum fruit yield, fruit weight, fruit volume, TSS, reducing sugar, non reducing sugar and ascorbic acid content in mango.

It is evident from Table 2 that the non-reducing sugar significantly increased by the application of different micronutrients. The maximum (0.836) non- reducing sugar was observed in the treatment T_7 followed by T_6. Similar result were recorded by Trivedi *et al*. (2012) who concluded that the combined foliar application of zinc sulphate @ 0.6% and boric acid @ 0.5% before fruit set and after fruit set resulted in higher TSS (15.40%), acidity (0.550%), ascorbic acid (221.51 mg/100 g fruit pulp), total sugar (8.66%), non-reducing sugar (3.76%) and sugar-acid ratio (15.76) in guava.

Similarly, the minimum acidity was found in treatment T_7 (Zinc Sulphate + Manganese Sulphate + Iron Sulphate) which was *at par* with the treatment T_6. However, maximum TSS : acid ratio was estimated in T_5 followed by T_7. Same was also reported by Ashraf *et al.* (2013) with foliar applications of 2, 4-D, SA, K and Zn which significantly improved the fruit weight, number of fruits per plant juice percentage, total soluble solids (TSS), ascorbic acid content, acidity and TSS/acid ratio, and reduced the fruit drop of kinnow mandarin.

CONCLUSION

The application of 2 foliar spray of $ZnSO_4$ 0.5% + $FeSO_4$ 0.4% + $MnSO_4$ 0.5% (T_7) increased fruit physico-chemical characters along with fruit yield. Thus, it can be concluded that two spray of micronutrients $ZnSO_4$ 0.5% + $FeSO_4$ 0.4% + $MnSO_4$ 0.5% may be suggested for better fruiting and superior fruit quality of pomegranate cv Bhagwa in the subtropical climate of Lucknow having slightly alkaline soil.

REFERENCES

Ashraf MY, Ashraf M, Akhtar M, Mahmood K, Saleem M (2013) Improvement in yield, quality and reduction in fruit drop in kinnow (*Citrus reticulata* Blanco) by exogenous application of plant growth regulators, potassium and zinc. *Pak J Bot* 45(1): 433—440.

Chandra S, Yadav C, Singh AL, Singh MK (2010) Influence of micronutrients on plant growth, yield and quality of papaya fruit (*Carica papaya* L.) cv Washington. *Asian J Hort* 5 (2) : 326—329.

Ebeed S, Gazzar EL, Bedier R (2001) Effect of foliar application of some micronutrients and growth regulators on fruit drop, yield, fruit quality of mango. *Ann Agric Sci* 39 (2) : 1279—1296.

Eiada AO, Mustafa Eiada AA (2013) Effect of Foliar Application with Manganese and Zinc on Pomegranate Growth, Yield and Fruit Quality. *J Hort Sci Ornament Pl* 5 (1) : 41—45.

El-Khagawa AS (2007) Reduction in fruit cracking in pomegranate following a foliar application with paclobutrazol and zinc sulphate. *J Appl Sci Res* 3 (9) : 837—840.

El-Saida SAG (2001) Effect of some growth regulators and zinc sulphate treatments on yield and quality of Washington navel orange. *Ann Agric Sci* 39 : 1199—1212.

Goswami AK, Shukla HS, Kumar P, Mishra DS (2012) Effect of pre-harvest application of micro-nutrients on quality of guava (*Psidium guajava* L.) cv Sardar. *Hort Flora Res Spect* 1 (1) : 60—63.

Hasani M, Zamani Z, Savaghebi G, Fatahi R (2012) Effects of zinc and manganese as foliar spray on pomegranate yield, fruit quality and leaf minerals. *J Soil Sci Pl Nutr* 12 (3) : 471—480.

Hoda AK, Hoda SHA (2013) Cracking and fruit quality of pomegranate (*Punica granatum* L.) as affected by Pre-harvest sprays of some Growth regulators and mineral nutrients. *J Hort Sci Orna Pl* 5 (2) : 71—76.

Kumar R, Tiwari R, Kumawat BR (2013) Quantitative and qualitative enhancement in guava (*Psidium guajava* L.) cv Chittidar through foliar feeding. *Int J Agric Sci* 9 (1) : 177—181.

Kumar S, Shukla AK (2010) Improvement of old ber cv Gola orchard through bunding and micro-nutrients management. *Ind J Hort* 67 (3) : 322—327.

Marschner H, Kirkby EA, Cakmak I (1996) Effect of Mineral Nutritional Status on Shoot-Root Partitioning of Photo assimilates and Cycling of Mineral Nutrients. *J Exp Bot* 47 : 1255—1263.

Mirzapour MH, Khoshgoftarmanesh AH (2013) Effect of soil and foliar application of iron and zinc on quantitative and qualitative yield of pomegranate. *J Pl Nutr* 36 (1) : 55—66.

Saleh MMS, Monem AE (2003) Improving the productivity of "Fagrikalan" mango trees grown unders and soil condition using potassium, boron and sucrose as foliar spray. *Ann Agric Sci* 48 (2) : 747—756.

Sepulveda E, Galletti L, Saenz C, Tapin M (2000) Minimal processing of pomegranate var wonderful. *CIHEA Mopt Medit* 2 : 237—242.

Singh J, Maurya AN (2004) Effect of micronutrients on bearing of mango cv Mallika.

Singh JK, Prasad J, Singh HK (2007) Effect of micro-nutrients and plant growth regulators on yield and physico-chemical characteristics of aonla fruits in cv Narendra Aonla-10. *Ind J Hort* 64 (2) : 216—218.

Solaheddin ME, Kader AA (1984) Postharvest physiology and storage behavior of pomegranate fruits. *Sci Hort* 24 : 287—298.

Swietlik D (1999) Zinc nutrition in horticultural crops. *Hort Rev* 23 : 109—178.

Tiwari, R JP, Lal Shant (2014) Effect of foliar application of zinc and boron on fruit yield and quality of winter season guava (*Psidium guajava*) cv Pant Prabhat. *Annals Agric Bio Res* 19 (1) : 105—108.

Trivedi N, Singh D, Bahadur V, Prasad VM, Collis JP (2012) Effect of foliar application of zinc and boron on yield and fruit quality of guava (*Psidium guajava* L.). *Hort Flora Res Spect* 1 (3) : 281—283.