Journal of Horticultural Science and Technology 2(2): 49-53 (2019)
ISSN: 2617-3220 (Print), 2664-9489 (Online)
http://www.pshsciences.org

Original Research

Effect of Boric Acid, Potassium Nitrate and Magnesium Sulphate on Managing Fruit Cracking and Improving Fruit Yield and Quality of Pomegranate

Muhammad Azhar Bashir[a], Ammara Noreen[a]*, Muhammad Ikhlaq[a], Kashif Shabir[a], Faheem Altaf[b] and Naheed Akhtar[b]
[a]Horticultural Research Station, Bahawalpur, Pakistan
[b]Horticultural Research Sub-Station, Dera Ghazi Khan, Pakistan

ABSTRACT

Pomegranate is a drought tolerant fruit crop and is well adapted to sub-tropical and tropical climates. Fruit cracking is a major disorder in pomegranate which causes significant economic losses. In the present work, effect of foliar application of boric acid (0.05%), potassium nitrate (1.0%) and magnesium sulphate (1.0%) alone or in combinations was investigated to manage fruit cracking and improve fruit yield and quality of pomegranate cv. Golden. First treatment (foliar spray) was applied one month after fruit setting (April) and repeated twice during May and June each year. Application of foliar sprays affected fruit yield and quality positively. The maximum number of fruits per plant (254), average fruit weight (192 g), yield per plant (58.3 kg), number of arils per fruit (592), juice content (41.1%) as well as the minimum fruit cracking (3.9%) were recorded when 0.05% boric acid, 1% potassium nitrate and 1% magnesium sulphate were applied in combination. Fruit size and total soluble solids (TSS) of fruit juice were not affected by the applied treatments. Thus, combined application of boric acid, potassium nitrate and magnesium sulphate could be recommended for reducing fruit cracking and improving yield and quality of pomegranate fruits under semi-arid conditions of Southern Punjab, Pakistan.

Keywords: *Arils, foliar sprays, juice content, Punica granatum.*

Article History: *Received 04 April 2019; Revised 15 May 2019; Accepted 14 June 2019; Published 30 June 2019.*

INTRODUCTION

Pomegranate (*Punica granatum* L.) belongs to family Punicaceae. It is one of the oldest known fruits. It is among the fruits mentioned in the Holy Quran (Khalil and Aly, 2013). Pomegranate is widely cultivated throughout the tropical and subtropical regions of the world and it gives quality production in arid and semi-arid climates (Sheikh and Manjula, 2012). It is mainly cultivated in Iran, India, China, Afghanistan, Spain, Turkey, Egypt, Morocco, Myanmar, Russia, Bulgaria, dry areas of Malaya, South East Asia, the East Indies and hot and dry regions of Latin America as well as United States (Korkmaz et al., 2016). It can withstand frost, but when temperature falls below -10 °C its survival becomes difficult. It is also capable to grow in areas with hot climatic conditions. For production of best quality pomegranate, dry climate and 38 °C temperature during fruit development play an important role (Gozlekci et al., 2011a). Studies on vegetative physiology have shown that it can tolerate drought, salts and iron chlorosis (Singh et al., 2003; Ramezanian et al., 2009). High temperature and relative humidity affect the quality of fruit and the fruits produced under such conditions are less sweet in taste (Gozlekci et al., 2011b).

Iran is the major producer and exporter of pomegranate followed by India. Production of pomegranate in Pakistan was 37.692 thousand tonnes over an area of 7.293 thousand hectares, during 2016-17. Largest share with respect to area and production was of Baluchistan province with 26.868 thousand tonnes production from an area of 5.778 thousand hectares. Total production of pomegranate in Punjab province was 8.873 thousand tonnes from an area of 1.328 thousand hectares, while Khyber Pakhtunkhwa produced 1.951 thousand tonnes over an area of 0.187 thousand hectares (Anonymous, 2018). However, the area and production of pomegranate decreased compared to preceding years due to various production problems faced by the local farmers including fruit cracking.

Some fruits are prone to cracking during fruit development, causing a great loss to farmers. Marketability of such fruits is severely affected due to cracks. Cracking is also a major physiological disorder in pomegranate, as it is very sensitive to soil temperature fluctuations and drought conditions, which tend to harden the peel of fruit. If there is rainfall or irrigation is applied at that stage, it leads to cracking of pomegranate fruit (Abd El-Rhman, 2010). Cracked fruits further lead to sunburn, making about 30-60% fruit unmarketable (Melgarejo et al., 2004; Bakeer, 2016). Possible causes of fruit cracking include poor orchard management practices and deficiency of macro and micronutrients, such as boron, magnesium, potassium, zinc and calcium (Khalil and Aly, 2013). These deficiencies are due to leaching down of nutrients, exhaustive cropping pattern and low organic matter in soils (Hasani et al., 2012). Extreme differences

* Corresponding author Phone +92 62 9255432
E-mail: ammaranoreen91@gmail.com (A. Noreen)

in day and night temperature also contribute towards boron deficiency in young developing fruits (Korkmaz et al., 2016). It has been reported that spraying of macro and micronutrients had positive impact on fruit yield and quality. Studies also revealed that application of nitrogen, phosphorus, potash, boron and magnesium improved fruit growth, quality and yield of pomegranate (Digrase et al., 2016). Khalil and Aly (2013) also reported that foliar application of boron and controlled and systematic watering reduced cracking thus improved fruit quality and yield in pomegranate fruits. Bambal et al. (1991) also reported that foliar application of boron along with other micronutrients reduced the incidence of cracking in pomegranate fruits. However, information regarding the effects of different chemicals such as potassium nitrate, magnesium sulphate and boron to control the cracking of pomegranate fruit under semi-arid conditions of Bahawalpur (Southern Punjab), Pakistan is limited. So, the present study was conducted to evaluate the effect of foliar application of boric acid, potassium nitrate and magnesium sulphate to control cracking as well as improving the yield and quality of pomegranate fruits.

MATERIALS AND METHODS

The experiment was conducted during 2013-14 and repeated twice during 2014-15 and 2015-16 on well-established plants of pomegranate cv. Golden in experimental orchard of Horticultural Research Station, Bahawalpur (Altitude 214 m, Longitude 71.64 °E, Latitude 39.38 °N), Punjab, Pakistan. Climatic conditions of the area thrive from arid to semi-arid and subtropical. The experiment was conducted to evaluate the effect of different chemicals on fruit cracking as well as on yield and fruit quality indices of pomegranate. The experiment was laid out in randomized complete block design with eight treatments and three replications. Twenty-four plants of pomegranate cv. Golden having uniform age (10 years), size, shape and vigour, spaced in square system (plant to plant = 5 m and row to row = 5 m). All plants received uniform inputs and cultural practices. The following treatments were applied.

T_1 = control (no spray of any chemical)
T_2 = 0.05% Boric acid (H_3BO_3)
T_3 = 0.1% Boric acid (H_3BO_3)
T_4 = 1% Potassium nitrate (KNO_3)
T_5 = 1% Magnesium sulphate ($MgSO_4$)
T_6 = 0.05% H_3BO_3 + 1% KNO_3
T_7 = 0.05% H_3BO_3 + 1% $MgSO_4$
T_8 = 0.05% H_3BO_3 + 1% KNO_3 + 1% $MgSO_4$

These chemicals were applied as foliar spray one month after fruit set (end of April) and repeated after 30 days (end of May) and 60 days (end of June) of fruit set. The solutions of chemicals were prepared by dissolving them in water. The treatments were applied with hand spray machine. Spraying was done in the morning in a clear and mild day to increase efficiency. The control plants were sprayed with water only.

Data were recorded regarding different parameters related to productivity i.e. number of fruits per plant was counted, average fruit weight (g) was calculated by weighing 10 fruits on digital weighing balance (SF-400A, China) and taking their average, fruit size (cm^2) was determined by measuring length and width of fruit with a Vernier's Caliper and computed by multiplication of length and width. Yield per plant (kg) was calculated by taking overall plant yield. Fruit cracking (%) was calculated by counting cracked and total fruits and by using the following formula.

$$\text{Fruit cracking (\%)} = \frac{\text{Cracked fruits}}{\text{Total fruits}} \times 100$$

The other parameters depicting quality of fruits were number of arils per fruit (it was counted and averaged from 10 fruits), total soluble solids (TSS in ^{o}Brix) recorded by Refractometer (BX-1 Atago, Japan) and juice content determined by measuring the juice weight and total weight of fruit by applying the following formula.

$$\text{Juice (\%)} = \frac{\text{Juice weight (g)}}{\text{Fruit weight (g)}} \times 100$$

Data were analyzed using statistical software Statistix 8.1 and mean differences were compared by Duncan's Multiple Range Test (DMRT) at 5% probability level (Steel et al., 1997).

RESULTS

Three years results of each parameter under study were consolidated, averaged and presented in Table 1 (productivity parameters) and Table 2 (quality parameters) for a logical conclusion. Foliar application of different chemicals affected the yield and quality of pomegranate fruits along with reduced cracking incidence. Foliar applications of all the chemicals i.e., 0.05-0.1% H_3BO_3, 1% KNO_3 and 1% $MgSO_4$ alone or in combination, improved the fruit yield and quality but their combined effect was more effective as apparent from data recorded for 3 years and estimated means of 3 years. Different treatments significantly affected yield and quality related parameters including number of fruits per tree, fruit weight, number of arils per fruit, fruit cracking and juice content of pomegranate.

Mean data of 3 years on number of fruit per tree showed that the maximum number of fruits per tree (254) was recorded in the plants treated with combined application of 0.05% H_3BO_3 + 1% KNO_3 + 1% $MgSO_4$ (T_8), but it shared statistical similarity with all other treatments except control that had the minimum number of fruits (223) (Table 1). Average from 3-year data indicated that significantly heavier fruits (192 g) were born in response to 0.05% H_3BO_3 + 1% KNO_3 + 1% $MgSO_4$ (T_8) and significantly lighter fruits (136 g) were found in untreated control plants. All other treatments were in between and statistically at par with each other. The trend was almost same regarding fruit weight during 3 years (2014-16) as was in mean data (Table 1). Mean of 3 years' data regarding fruit size remained statistically non-significant as was during middle year or highly productive year (2015). Preceding (2014) and proceeding (2016) years showed variability with respect to fruit size (Table 1). Mean of 3 years' data indicated that the highest yield (58.3 kg) of pomegranate was found in the plants sprayed with mixture of all the three chemicals (T_8) as compared to control (38.3 kg). Combined application of 0.05% H_3BO_3 + 1% $MgSO_4$ (T_7) and 0.05% H_3BO_3 + 1% KNO_3 (T_6) both as well as 0.05% H_3BO_3 (T_2) alone shared the

Table 1: Effect of foliar application of boric acid, potassium nitrate and magnesium sulphate on productivity of pomegranate cv. Golden.

	No. of fruits per plant				Fruit weight (g)				Fruit size (cm^2)				Yield per plant (kg)			
	2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean
T_1	237bc	205c	227c	223b	136.0d	192.0c	140.2d	136c	34.2b	43.5a	37.8b	38.4a	31.6c	50.8d	32.5d	38.3d
T_2	258a	237b	240b	245ab	142.0d	199.5c	147.5d	173b	36.6b	42.9a	43.6b	39.8a	45.5b	59.5b	36.0cd	47.0b
T_3	248a	215c	257a	240ab	161.7b	197.0c	157.3cd	176b	43.6a	45.6a	39.7b	43.1a	47.9b	46.5d	40.6c	45.0c
T_4	246a	236b	250a	244ab	154.7bd	219.0bc	163.0c	163b	35.4b	47.6a	42.9b	42.3a	44.0b	50.9d	41.0bc	45.3c
T_5	229c	238b	253a	240ab	161.3b	206.5c	149.0d	162b	42.2ab	46.2a	38.4b	41.6a	46.4b	49.5d	43.0b	46.3c
T_6	235bc	220c	241b	232ab	176.7a	222.0b	193.0b	171b	41.6ab	45.5a	51.8a	45.6a	48.4b	55.9b	46.6b	50.3b
T_7	243b	265a	239b	249a	166.3ab	232.0b	191.0b	174b	37.2b	49.7a	51.1ab	46.2a	44.5b	61.6ab	49.0b	51.7b
T_8	245b	275a	242b	254a	180.3a	253.0a	214.0a	192a	49.7a	50.4a	56.2a	45.8a	53.4a	65.5a	56.0a	58.3a

Means sharing similar letter(s) in each group under each parameter are statistically non-significant (DMR test at $\alpha = 0.05$). T_1 = control (sprayed with water), T_2 = 0.05% H_3BO_3, T_3 = 0.1% H_3BO_3, T_4 = 1% KNO_3, T_5 = 1% $MgSO_4$, T_6 = 0.05% H_3BO_3 + 1% KNO_3, T_7 = 0.05% H_3BO_3 + 1% $MgSO_4$, and T_8 = 0.05% H_3BO_3 + 1% KNO_3 + 1% $MgSO_4$.

same effect with respect to yield per plant. Similarly, 0.1% H_3BO_3 (T_3), 1% KNO_3 (T_4) and 1% $MgSO_4$ (T_5) were non-significant with each other (Table 1). Second year (2015) showed improved yield compared to 1st year (2014) and 3rd year (2016).

Similarly, 3 years' mean for number of arils per fruit expressed that the maximum number of arils (592) was recorded in fruits from plants which received 0.05% H_3BO_3 + 1% KNO_3 + 1% $MgSO_4$ (T_8). This was followed by 538 arils in fruits from plants sprayed with 0.05% H_3BO_3 + 1% $MgSO_4$ (T_7), both were non-significant with each other depicting that combined application of H_3BO_3 and $MgSO_4$ was more effective in increasing number of arils per fruit. The minimum number of arils (439) was counted in fruits from untreated control plants (Table 2). The lowest fruit cracking (3.9 %) was noted in plants supplied with 0.05% H_3BO_3 + 1% KNO_3 + 1% $MgSO_4$ (T_8), but it was statistically at par with both treatments of H_3BO_3 @ 0.05 and 0.1% (T_2 & T_3) depicting that boron has specific role in minimizing fruit cracking. Untreated control plants resulted in the maximum fruit cracking (17.9%) (Table 2). Means of 3 years' data regarding total soluble solids indicated that the parameter was not affected due to applied foliar treatments as remained during middle year or good year (2015). Preceding (2014) and proceeding year (2016) showed variation in total soluble content (Table 2). As for as juice content was concerned, 3 years' means explicit that significantly higher juice content (41.1%) was found in fruits of the plants sprayed with mixture of all the three chemicals (T_8), while significantly lower content (28.8%) was in fruits from untreated control plants (Table 2).

Combined application of 0.05% H_3BO_3 + 1% KNO_3 + 1% $MgSO_4$ gave the maximum values in most of the parameters under study except fruit cracking (%) which was minimum as per desired characteristic in response to different treatments application during 3 years as well as the means of 3 years. The cause of improvement in yield may be the minimum fruit cracking during 2015 that ranged from 1.5% in response to 0.05% H_3BO_3 + 1% KNO_3 + 1% $MgSO_4$ (T_8) and the maximum of 7% in untreated control plants, while it was 18% during 2014 and 21% during 2016 in the same plants which were untreated control. Similar trend with respect to years was noted in case of fruit weight as a 2nd cause of improvement in yield per plant during 2015. However, non-treated plants gave the minimum values in almost all parameters except fruit cracking that remained the highest in fruits from plants which were untreated control and it was not the desired characteristic.

DISCUSSION

Pomegranate fruits are prone to fruit cracking at the time of maturity because of a number of factors, due to which quality of the fruits is largely affected. Various scientists are working to minimize fruit cracking in pomegranate by using different chemicals. This experiment was also planned to minimize fruit cracking and improving fruit quality of pomegranate. Foliar application of different chemicals (boric acid, potassium nitrate and magnesium sulphate), used in this study, significantly affected the fruit productivity parameters i.e. number of fruits per plant, fruit weight, fruit size and yield per plant, as well as fruit quality parameters i.e., number of arils per fruit, fruit cracking (%), total soluble solids and juice content when compared with values obtained from untreated control for different years of the experiment. However, 3 years' mean data of fruit size and total soluble solids and the data obtained during 2015 on the same parameters were not affected significantly.

Foliar application of boric acid, potassium nitrate and magnesium sulphate significantly reduced fruit cracking. Sharma and Singh (2007) reported that boron helps in translocation of photosynthetic products as well as synthesis of cell wall components thus strengthening the cell wall of fruit. Potassium is found to be effective in maintaining cell turgidity by regulating osmotic balance. Magnesium application helps in absorption and translocation of phosphorus. So, it is possible that combined application of these chemicals minimized the cracking incident by strengthening the cell wall of pomegranate fruits by maintaining cell turgidity and regulating osmotic balance. Potassium is now extensively used in vegetables and other field crops to cope with drought stress. Similar findings were also reported by Sharma and Belsare (2011), Sheikh and Manjula (2012) and Korkmaz and Askin (2015) who concluded that foliar application of boric acid decreased the fruit cracking as compared to control.

Foliar application of 0.05% boric acid, 1% potassium nitrate and 1% magnesium sulphate improved fruit yield and quality of pomegranate cv. Golden. These results are in accordance with the findings of Sharma and Belsare (2011), Sheikh and Manjula

Table 2: Effect of foliar application of boric acid, potassium nitrate and magnesium sulphate on fruit quality of pomegranate cv. Golden.

	No. of arils / fruit				Fruit cracking (%)				TSS (°Brix)				Juice content (%)			
	2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean	2014	2015	2016	Mean
T_1	429c	536c	451e	439d	18.0a	7.0a	21.0a	17.9a	11.1b	13.1a	12.0b	12.1a	26.5c	32.5c	27.3	28.8e
T_2	542b	564c	490de	503bc	6.5b	3.2b	7.3b	5.6de	13.8b	14.2a	12.4b	13.5a	37.9a	38.2a	34.0b	36.7bc
T_3	527b	579c	473de	495bd	6.4b	3.0b	6.3bc	5.7de	14.5a	13.2a	13.7b	13.8a	38.2a	37.6a	35.8a	37.2b
T_4	502b	615bc	505cd	486bcd	7.2b	3.7b	9.6b	8.5bc	11.3b	13.0a	12.4b	12.2a	36.2a	34.3b	33.6b	34.7cd
T_5	526b	580c	460de	468cd	6.6b	4.5b	7.6b	9.6b	13.9b	14.1a	13.6b	13.9a	33.9b	34.9b	32.3b	33.7d
T_6	549b	658b	547bc	515b	5.3b	3.5b	7.7b	6.5cd	12.6b	13.2a	14.7ab	13.5a	34.4ab	36.5ab	37.1a	36.0bc
T_7	506b	649b	596b	538ab	7.0b	3.0b	7.0bc	6.4cd	12.3b	14.7a	13.4b	13.5a	35.8a	37.5a	35.6a	36.3bc
T_8	608a	716a	667a	592a	3.2c	1.5c	4.0c	3.9e	16.2a	16.1a	15.0a	15.8a	39.2a	41.5a	42.6a	41.1a

Means sharing similar letter(s) in each group under each parameter are statistically non-significant (DMR test at $\alpha = 0.05$). T_1 = control (sprayed with water), T_2 = 0.05% H_3BO_3, T_3 = 0.1% H_3BO_3, T_4 = 1% KNO_3, T_5 = 1% $MgSO_4$, T_6 = 0.05% H_3BO_3 + 1% KNO_3, T_7 = 0.05% H_3BO_3 + 1% $MgSO_4$, and T_8 = 0.05% H_3BO_3 + 1% KNO_3 + 1% $MgSO_4$.

(2012), Davarpanah (2016) and Korkmaz et al. (2016) who concluded that foliar spray of boric acid significantly increased the yield per plant in pomegranate. As boron plays important role in fruit setting ultimately increasing fruit yield. Boron also plays vital role in fruit retention by activating dehydrogenase enzymes and synthesis of certain cell wall components (Sharma and Singh, 2007). Potassium plays important role in regulating osmotic balance in cells. These findings were also similar to those of Khayyat et al. (2012) who found that foliar application of potassium nitrate significantly increased fruit weight in pomegranate and date palm. Sharma and Belsare (2011) and Korkmaz and Askin (2015) also reported similar findings that foliar application of boric acid and calcium nitrate increased fruit weight in pomegranate as compared to control. Korkmaz and Askin (2015) as well as Davarpanah (2016) stated that external application of boric acid was found to increase the number of fruits and number of arils per fruit in pomegranate. Magnesium application is effective in improving juice content in citrus by stimulating certain enzymes (Sharma and Singh, 2007). Khayyat et al. (2012) also concluded that foliar application of potassium nitrate significantly increased juice content in pomegranate. So the increased juice contents in pomegranate fruits might be due to combined application of boric acid, magnesium sulphate and potassium nitrate. Fruit size and total soluble solids were not significantly affected by spraying these chemicals. These results are also similar to the findings of Khayyat et al. (2012) who reported that sprays of boric acid and magnesium sulphate alone or in combination have positive but non-significant effect on total soluble solids.

CONCLUSION

Results conclude that foliar application of boric acid, potassium nitrate and magnesium sulphate in combination significantly increased number of fruits per plant, fruit weight, yield per plant, number of arils per fruit and juice content in pomegranate. Moreover, the lowest cracking percentage was also noted in this treatment. So in order to control fruit cracking and improve fruit quality, foliar application of chemicals (0.05% H_3BO_3 + 1.0% KNO_3 + 1.0% $MgSO_4$) is recommended. First foliar spray can be applied one month after fruit setting. While, second and third applications can be done one and two months after first application, respectively.

REFERENCES

Abd El-Rhman, I.E. 2010. Physiological studies on cracking phenomena of pomegranates. *Journal of Applied and Scientific Research*, 6: 696-703.

Anonymous. 2018. Fruits, Vegetables & Condiments Statistics of Pakistan, 2016-17. Ministry of National Food Security and Research, Economic Wing, Govt. of Pakistan, Islamabad.

Bakeer, M. 2016. Effect of ammonium nitrate fertilizer and calcium chloride foliar spray on fruit cracking and sunburn of Manfalouty pomegranate trees. *Scientia Horticulturae,* 209: 300-308.

Bambal, S.B., Wavhaland, K.N. and Nasalkar, S.D. 1991. Effect of foliar application of micronutrients on fruit quality and yield of pomegranate (*Punica granatum* L. cv. Ganesh). *Maharashtra Journal of Horticulture*, 5(2): 32-36.

Davarpanah, S., Tehranifara, A., Davarynejada, G., Abadíab, J. and Khorasani, R. 2016. Effects of foliar applications of zinc and boron nano-fertilizers on pomegranate (*Punica granatum* cv. Ardestani) fruit yield and quality. *Scientia Horticulturae,* 210: 1-8.

Digrase, S.S., Tambe, T.B., Kadam, A.S. and Kalalbandi, B.M. 2016. Effect of different plant growth regulators and chemicals on growth and yield of pomegranate (*Punica granatum* L.) cv. Bhagwa. *Advance Research Journal of Crop Im*provement, 7(1): 96-99.

Gozlekci, S., Ercisli, S., Okturen, F. and Sonmez, S. 2011a. Physico-chemical characteristics at three development stages in pomegranate cv. 'Hicaznar'. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca,* 39(1): 241-245.

Gozlekci, S., Saracoglu, O., Onursal, E. and Ozgen, M. 2011b. Total phenolic distribution of juice, peel and seed extracts of four pomegranate cultivars. *Pharmacognosy Magazine,* 7(26): 161-164.

Hasani, M., Zamani, Z., Savaghebi, G. and Fatahi, R. 2012. Effects of zinc and manganese as foliar spray on pomegranate yield, fruit quality and leaf minerals. *Journal of Soil Science and Plant Nutrition,* 12(3): 471-480.

Khalil, H.A. and Aly, H.S.H. 2013. Cracking and fruit quality of pomegranate (*Punica granatum* L.) as affected by pre-harvest sprays of some growth regulators and mineral nutrients. *Journal of Horticultural Sciences and Ornamental Plants,* 5(2): 71-76.

Khayyat M., Tehranifar, A., Zaree, M., Karimian, Z., Aminifard, M.H., Vazifeshenas, M.R., Amini, S., Noori, Y. and Shakeri, M. 2012. Effects of potassium nitrate spraying on fruit characteristics of Malas Yazdi pomegranate. *Journal of Plant Nutrition*, 35(9): 1387-1393.

Korkmaz, N. and Askin, M.A. 2015. Effects of calcium and boron foliar application on pomegranate (*Punica granatum* L.) fruit quality, yield and seasonal changes of leaf mineral nutrition. *Acta Horticulturae,* 1089(5): 413-422.

Korkmaz, N., Askin, M.A., Ercisli, S. and Okatan, V. 2016. Foliar application of calcium nitrate, boric acid and gibberellic acid affects yield and quality of pomegranate (*Punica granatum* L.). *Acta Scientiarum Polonorum Hortorum Cultus,* 15(3): 105-112.

Melgarejo, P., Martinez, J.J., Hernandez, F., Martinez-Font, R., Barrows, P. and Erez, A. 2004. Kaolin treatment to reduce pomegranate sunburn. *Scientia Horticulturae,* 100: 349-353.

Ramezanian, A., Rahemi, M. and Vazifehshenas, M.R. 2009. Effects of foliar application of calcium chloride and urea on quantitative and qualitative characteristics of pomegranate fruits. *Scientia Horticulturae,* 121: 171-175.

Sharma, B.D. and Singh, I.S. 2007. Mineral nutrition in fruit crops. In: Yadav, P.K. (ed.). Fruit Production Technology. International Book Distributing Co., Lucknow, India, pp. 101-106.

Sharma, N. and Belsare, C. 2011. Effect of plant bio-regulators and nutrients on fruit cracking and quality in pomegranate (*Punica granatum* L.) 'G-137' in Himachal Pradesh. *Acta Horticulturae,* 890: 347-352.

Sheikh, M.K. and Manjula, N. 2012. Effect of chemicals on control of fruit cracking in pomegranate (*Punica granatum* L.) var. Ganesh. *Options Méditerranéennes. Séries A: Mediterranean Seminars,* 103: 133-135.

Singh, D.B., Sharma, B.D. and Bhargava, R. 2003. Effect of boron and GA_3 to control fruit cracking in pomegranate (*Punica granatum*). *Current Agriculture,* 27: 125-127.

Steel, R.G.D., Torrie, J.H. and Dickey, D.A. 1997. Principles and Procedures of Statistics: A Biometrical Approach (3rd Ed.). McGraw Hill Book Co. Inc., New York, pp. 400-428.