International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 378-382

Received: 28-05-2019
Accepted: 30-06-2019

KH Nurbhanej
Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

DK Varu
Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Correspondence
KH Nurbhanej
Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Effect of biostimulants and biofertilizers on flowering and fruiting of pomegranate (*Punica granatum* L.) cv. Bhagwa

KH Nurbhanej and DK Varu

Abstract
The present experiment entitled "Effect of biostimulants and biofertilizers on flowering and fruiting of pomegranate (*Punica granatum* L.) cv. Bhagwa" was carried out at farmer's field at Vadla, Ta. & Dist. – Junagadh (Gujarat) during 2016-17 and 2017-18. The experiment was laid out in Randomized Block Design with Factorial concept (FRBD) consisting two factors with three replications. The treatment comprised with four biostimulants *viz*., water spray, seaweed extract @ 1%, cytozyme @ 0.4%, humic acid @ 1% (first spray at full bloom stage and second spray at 15 days after fruit set) and four treatments of biofertilizers *i.e*. Without biofertilizers, *Azotobacter* + PSB + KSB each @ 3 ml/plant, *Azotobacter* + PSB + KSB each @ 4 ml/plant and *Azotobacter* + PSB + KSB each @ 5 ml/plant (at the time of first spray of biostimulants).
The results of the study indicated that application of different biostimulants and biofertilizers had produced non-significant effect on flowering parameters *viz*., number of male flowers per shoot, number of hermaphrodite flowers per shoot and number of flowers per shoot during in pooled season.
The fruiting parameters were significantly influenced by various biostimulants. Among the various biostimulants, foliar application of humic acid @ 1% was found significant and maximum fruit set (80.11%) with minimum fruit drop (15.94%) and fruit cracking (8.33%) during in pooled season. Similarly, the variation was also found significant due to different treatments of biofertilizers. The maximum fruit set (81.90%), minimum fruit drop (15.49%) and fruit cracking (7.91%) were noted in treatment of *Azotobacter* + PSB + KSB each @ 5 ml/plant during in pooled season.
The interaction effect of biostimulants and biofertilizers were found non-significantly influenced the various flowering and fruiting parameters during in pooled season.

Keywords: Biostimulants, biofertilizers, pomegranate, Bhagwa

Introduction
Pomegranate is an important fruit crop of arid and semiarid regions of the world. It is one of the oldest known edible fruit crop belongs to the family Punicaceae. It has both cultivated (*Punica granatum* L.) and wild types (*Punica protopunica*). The cultivated types are adapted to the Mediterranean regions of Central Asia, Africa and Europe.
It is commonly known as 'Annar' in Hindi and 'Dalimbe' in Kannada. Pomegranate was domesticated in 2000 BC and was one of the first five fruit crops (date palm, fig, olive, grape and pomegranate) to be domesticated by mankind. The usage of pomegranate is deeply embedded in human history with references in many ancient cultures for its use as food and medicine. Its history dates to very ancient times. This fruit tree is one of the species mentioned in the Bible and the Quran and is often associated to fertility. It is native to Iran and perhaps some surrounding areas. The pomegranate tree has a wide geographical distribution that spans from Iran to the Himalayas in northern India, and has been cultivated since ancient times throughout the Mediterranean regions of Asia, Africa and Europe [4].
The cultivation of the pomegranate (*Punica granatum* L.) is mainly confined to semi-arid mild-temperate to subtropical climate and naturally adopted to regions with hot summers and cool winters, such as Mediterranean countries, Afghanistan, Iran, India, China, Japan and United States [15]. India is one of the largest producers of pomegranate in the world. During 2016-17, pomegranate was cultivated over 2.09 lakh ha with an annual production of 24.42 lakh tones and productivity of 11.70 tones ha^{-1} in India [2]. At present, Maharashtra is the leading state in average covering about 68.7 per cent of the area under pomegranate. Similarly around 70.2 per cent of total production from Maharashtra. India is the only country in the

world, where pomegranate is available throughout the year (January – December).

In Gujarat, pomegranate was cultivated over 18,540 ha area with an annual production of 2.78 lakh tones and productivity of 15.00 tones ha^{-1}. The highest area and production was goes to Banaskantha, Kachchh, Mehsana, Sabarkantha, and Rajkot district of Gujarat [2].

Biostimulants are products of natural and organic origin that stimulate plants to achieve their highest growth and yield potential. Biostimulants are akin to biofertilizers as they also promote crop growth and yield. The use of biostimulants along with fertilizers could reduce chemical fertilizer to a large extent and as much as 50% as they supplement the soil with essential nutrients. The biostimulants are compatible with conventional fertilizers and pesticides. Biostimulants aid in improves microbial activity in soil and soil tilth, thereby also enhancing the effect of biofertilizers.

These biostimulants affect different parameters such as root and shoot development, flowering, fruiting, stomatal opening / elongation, stress tolerance and yield parameters such as grain size and grain weight. Biostimulants used in horticultural crop are seaweed extract, cytozyme and humic acid.

Biofertilizers are microbial preparations containing living cells of different microorganisms which have the ability to mobilize plant nutrients of soil from unusable to usable form through biological process. They are environmental friendly and play significant role in crop production. It is mainly used for field crops but now-a-days it is also used for fruit crops. Biofertilizers are used in live formulation of beneficial microorganism which on application to seed, root or soil, mobilize the availability of nutrients particularly by their biological activity and help to build up the lost micro flora and in turn improve the soil health in general[9].

These biostimulants and biofertilizers are cost effective renewable energy source and play a crucial role in reducing the inorganic chemical or fertilizer application and at the same time increasing the flowering, fruiting, growth, yield and quality of crop. Hence, considering the above facts, the present study was under taken to find out "Effect of biostimulants and biofertilizers on flowering, fruiting, yield, and quality of pomegranate (*Punica granatum* L.) cv. Bhagwa".

Materials and Methods

Experimental site

The present research was carried out to study the "Effect of biostimulants and biofertilizers on flowering, fruiting, yield and quality of pomegranate (*Punica granatum* L.) cv. Bhagwa" at Vadla, Ta. & Dist. – Junagadh (Gujarat) during 2016-17 and 2017-18.

Geographical and climatological features of the experimental site

Junagadh is situated in Saurashtra region of Gujarat state. Geographically, this place is situated at 21.5^0 N latitude and 70.5^0 E longitudes with an altitude of 60 meters above the mean sea level and 80 kilometers away from Arabian Sea coast on Western side at the foothill of the mount Girnar. This place enjoy the typical sub-tropical climate, characterized by fairly cold and dry winter, hot and dry summer and moderately humid monsoon.

Climate of Junagadh is typically subtropical, characterized by fairly cool and dry winter, hot and dry summer and warm and moderately humid monsoon. The annual precipitation ranges between 800 to 900 mm in normal year and exceeds 1000 mm during wet year. Usually, monsoon commences by third week of June and ends in September. July and August are the months of heavy precipitation.

Winter sets in the month of November and continues till the months of February. January is the coldest month of winter. Summer commences in the second fortnight of February and ends in the middle of June. April and May are the hottest months of summer.

The experiment was carried out during *Hast bahar* of 2016-17 and 2017-18. Ninety six representative uniform Bhagwa pomegranate plants were selected for the study. In a view to give proper bahar treatment to the plants water stress for about two months was given to the plants during August and September. During the bahar treatment the cultural operations like ploughing, hoeing, cleaning, training, spraying were undertaken. At initiation of bahar, the recommended dose of manures and fertilizers were applied to each plant and light irrigation was given. Regular irrigation was given afterwards through drip irrigation system.

Treatment details

Factor A (Biostimulants)

1. B_1 Control (Water spray)
2. B_2 Seaweed extract @ 1%
3. B_3 Cytozyme @ 0.4%
4. B_4 Humic acid @ 1%

Factor B (Biofertilizers)

1. F_1 Control (Without biofertilizer)
2. F_2 *Azotobacter* + PSB+ KSB each @ 3 ml/plant
3. F_3 *Azotobacter* + PSB+ KSB each @ 4 ml/plant
4. F_4 *Azotobacter* + PSB+ KSB each @ 5 ml/plant

Where, PSB (Phosphate Solubilizing Bacteria)
KSB (Potash Solubilizing Bacteria)

Table 1: Treatment combination

Treatment combinations	Treatment details
B_1F_1	Control
B_1F_2	*Azotobacter* + PSB + KSB each @ 3 ml/plant
B_1F_3	*Azotobacter* + PSB + KSB each @ 4 ml/plant
B_1F_4	*Azotobacter* + PSB + KSB each @ 5 ml/plant
B_2F_1	Seaweed extract @ 1%
B_2F_2	Seaweed extract @ 1% + [*Azotobacter* + PSB + KSB each @ 3 ml/plant]
B_2F_3	Seaweed extract @ 1% + [*Azotobacter* + PSB + KSB each @ 4 ml/plant]
B_2F_4	Seaweed extract @ 1% + [*Azotobacter* + PSB + KSB each @ 5 ml/plant]
B_3F_1	Cytozyme @ 0.4%
B_3F_2	Cytozyme @ 0.4% + [*Azotobacter* + PSB + KSB each @ 3 ml/plant]
B_3F_3	Cytozyme @ 0.4% + [*Azotobacter* + PSB + KSB each @ 4 ml/plant]

B_3F_4	Cytozyme @ 0.4% + [*Azotobacter* + PSB + KSB each @ 5 ml/plant]
B_4F_1	Humic acid @ 1%
B_4F_2	Humic acid @ 1% + [*Azotobacter* + PSB + KSB each @ 3 ml/plant]
B_4F_3	Humic acid @ 1% + [*Azotobacter* + PSB + KSB each @ 4 ml/plant]
B_4F_4	Humic acid @ 1% + [*Azotobacter* + PSB + KSB each @ 5 ml/plant]

Preparation of solution and application method

(A) Biostimulants

The solution of biostimulants were prepared by dissolving them in water directly. The solution of chemicals were sprayed with the help of foot sprayer.

Spraying was done in a clear and calm day during the morning hours to obtain better effect. The spraying was done till the leaves and twigs were wet and droplets of solutions started trickling down.

Before spraying, 0.5 ml of wetting agent (Indtron-AE) per liter of solution was added as surfactant to reduce surface tension and to facilitate the absorption of solution. Three liters of the solution was sprayed on each plant.

(B) Biofertilizers

Biofertilizers were calculated as per as treatment and applied by making ring of 15 cm in depth and 60 cm away from the main trunk through drenching.

Time of application

Biostimulants: 1st spray at full bloom stage and 2nd spray at 15 days after fruit set.

Biofertilizers: The biofertilizers were applied at the time of 1st spray of biostimulants

Experimental plot

The site of experimental plot was medium black soil. Tissue culture plants of Bhagwa variety of pomegranate was planted at distance of 12 x 10 feet. The trees were three years old.

Observations recorded

For this studies, ninety six plants of pomegranate cv. Bhagwa were randomly selected and replicated thrice. The observations were recorded from these ninety six plants and tagged in each replication with appropriate procedure. The observations on flowering and fruiting parameters of each treatment were computed and statistically analyzed.

Result and Discussion

The effect of various treatments were recorded and the results obtained during the course of investigation were discussed with reasoning and supporting references. The entire results and discussion has been presented in following head:

Effect on flowering parameters

(A) Effect of biostimulants

The data revealed that application of different biostimulants had produced non-significant effect on flowering parameters *viz*., number of male flowers per shoot, number of hermaphrodite flowers per shoot and number of flowers per shoot during in pooled (Table 2).

(B) Effect of biofertilizers

In case of biofertilizers, the variation was also found non-significant on flowering parameters *viz*., number of male flowers per shoot, number of hermaphrodite flowers per shoot and number of flowers per shoot during in pooled (Table 2).

(C) Interaction effect of biostimulants and biofertilizers

The data from present investigation as reported that the interaction effect between biostimulants and biofertilizers were also found non-significant on flowering parameters *viz*., number of male flowers per shoot, number of hermaphrodite flowers per shoot and number of flowers per shoot during in pooled (Table 2).

Table 2: Effect of biostimulants and biofertilizers on number of male flower per shoot, number of hermaphrodite flower per shoot and number of flower per shoot of pomegranate cv. Bhagwa

Treatments	Number of male flower per shoot	Number of hermaphrodite flower per shoot	Number of flower per shoot
Level of Biostimulants (B)			
B_1 – Control (Water spray)	2.46	3.59	6.35
B_2 – Seaweed extract @ 1%	2.60	3.65	6.53
B_3 – Cytozyme @ 0.4%	2.56	3.64	6.48
B_4 – Humic acid @ 1%	2.64	3.66	6.60
S.Em.±	0.060	0.080	0.110
C.D. at 5%	NS	NS	NS
Level of Biofertilizers (F)			
F_1 – Control (Without biofertilizer)	2.47	3.60	6.39
F_2 – *Azoto.* + PSB+ KSB each @ 3 ml/plant	2.54	3.63	6.43
F_3 – *Azoto.* + PSB+ KSB each @ 4 ml/plant	2.58	3.65	6.49
F_4 – *Azoto.* + PSB+ KSB each @ 5 ml/plant	2.69	3.67	6.66
S.Em.±	0.060	0.080	0.110
C.D. at 5%	NS	NS	NS
Interaction (B X F)			
S.Em.±	0.129	0.161	0.221
C.D. at 5%	NS	NS	NS
CV%	11.39	10.84	8.32
Year			
S.Em.±	0.042	0.057	0.078
C.D. at 5%	0.12	0.16	NS

Y X B			
S.Em.±	0.084	0.114	0.156
C.D. at 5%	NS	NS	NS
Y X F			
S.Em.±	0.084	0.114	0.156
C.D. at 5%	NS	NS	NS
Y X B X F			
S.Em.±	0.169	0.228	0.312
C.D. at 5%	NS	NS	NS

Effect on fruiting parameters

(A) Effect of biostimulants

The data from investigation revealed that application of different biostimulants exerted significant influence on fruiting parameters *viz*., fruit set, fruit drop and fruit cracking during in pooled (Table 3).

Significantly, maximum fruit set percentage (80.11%), minimum fruit drop percentage (15.94%) and fruit cracking percentage (8.33%) were recorded with the foliar application of humic acid @ 1% (B_4) during in pooled. However, it was found at par with seaweed extract 1% (B_2) in all fruiting parameters during in pooled. While, poor performance was recorded with the application of water spray (B_1) in all fruiting parameters during in pooled.

The improvement in fruit set and fruit retention have resulted in increased fruit yield plant^{-1}. Fruit drop and fruit cracking are one of the serious problems of pomegranate production. Humus substances present in humic acid could have mobilized the reserve food materials to the sink through increased activity of hydrolyzing and oxidizing enzymes. This would have helped the better availability and utilization of nutrients. The application of humic acid has approved an excellent source of soil conditioner leading to enhance overall soil health and quality. Humic acid have long been used as a soil conditioner, fertilizer and soil supplement. The efficiency of applied inorganic fertilizer is quite low due to calcareous nature and alkaline conditions of the soil. The application of humic acid works as a chelating agent for nutrients already present in the soil and make them available to plant. The scientific literature has recently demonstrated that humic acid exert directly or indirectly effects on plant growth processes such as morphological, physiological, genetic and biochemical process. The results are in conformity with those found by [5] [11] in pomegranate; [13] in mango; [1] in kinnow mandarin; [6] [7] in apricot and [11] in apple.

(B) Effect of biofertilizers

Similar trend of biostimulants was also observed in biofertilizers and variation due to different biofertilizers was also observed significantly for all fruiting parameters *viz*., fruit set, fruit drop and fruit cracking during in pooled (Table 3).

Significantly, maximum fruit set percentage (81.90%), minimum fruit drop percentage (15.49%) and fruit cracking percentage (7.91%) were registered with an application of *Azotobacter* @ 5 ml/plant + PSB @ 5 ml/plant + KSB @ 5 ml/plant (F_4) during in pooled. Furthermore, lower performance was registered in treatment control (without biofertilizer) in all parameters during in pooled.

The increasing fruit set may be due to increased nutrient availability from the biofertilizers might have increased various endogenous hormonal levels in the plant tissue might be responsible for enhanced pollen germination and tube growth, ultimately increased the fruit set percentage. The minimizing the fruit drop and fruit cracking may be due to presence of *Azotobacter* was involved in fixation of atmospheric nitrogen, phosphorus solubilizing bacteria and potassium solubilizing bacteria in the treatments, which are responsible to make more and more nitrogen, phosphorus and potassium available to plants. Which was increase in levels of nutrients in assimilating area of crop due to which the rate of dry matter production was enhanced. The finding have close conformity with [14] in pomegranate; [3] [8] in guava; [16] in aonla; [12] in ber and [17] in papaya.

(C) Interaction effect of biostimulants and biofertilizers

It is obvious from the data analyzed that an interaction between biostimulants and biofertilizers failed to produce any significant effect on fruiting parameters *viz*., fruit set percentage, fruit drop percentage and fruit cracking percentage of pomegranate during in pooled (Table 3).

Table 3: Effect of biostimulants and biofertilizers on fruit set, fruit drop and fruit cracking of pomegranate cv. Bhagwa

Treatments	Fruit set (%)	Fruit drop (%)	Fruit cracking (%)
Level of Biostimulants (B)			
B_1 – Control (Water spray)	71.52	20.25	10.49
B_2 – Seaweed extract @ 1%	79.13	16.69	8.58
B_3 – Cytozyme @ 0.4%	77.80	17.23	9.00
B_4 – Humic acid @ 1%	80.11	15.94	8.23
S.Em.±	1.579	0.318	0.123
C.D. at 5%	4.47	0.90	0.35
Level of Biofertilizers (F)			
F_1 – Control (Without biofertilizer)	72.08	19.88	10.32
F_2 – *Azoto.* + PSB+ KSB each @ 3 ml/plant	75.75	18.07	9.38
F_3 – *Azoto.* + PSB+ KSB each @ 4 ml/plant	78.83	16.67	8.69
F_4 – *Azoto.* + PSB+ KSB each @ 5 ml/plant	81.90	15.49	7.91
S.Em.±	1.58	0.318	0.123
C.D. at 5%	4.47	0.90	0.35
Interaction (B X F)			
S.Em.±	3.157	0.636	0.245
C.D. at 5%	NS	NS	NS
CV%	10.03	8.88	6.62

Year			
S.Em.±	1.116	0.225	0.087
C.D. at 5%	3.16	0.64	0.25
Y X B			
S.Em.±	2.233	0.450	0.173
C.D. at 5%	NS	NS	NS
Y X F			
S.Em.±	2.233	0.450	0.173
C.D. at 5%	NS	NS	NS
Y X B X F			
S.Em.±	4.465	0.899	0.347
C.D. at 5%	NS	NS	NS

Conclusion

On the basis of results obtained in the present investigation, it is concluded that, individually two times foliar application (1st at full bloom and 2nd at 15 days after fruit set) of humic acid @ 1% and one time drenching (at full bloom) of *Azotobacter* + PSB + KSB each @ 5 ml/plant improved flowering and fruiting of pomegranate cv. Bhagwa.

References

1. Abbas T, Ahmad S, Ashraf M, Shahid MA, Yasin M, Balal RM *et al*. Effect of humic and application at different growth stages of kinnow mandarin on the basis of physio-biochemical and reproductive responses. Academia Journal of Biotechnology. 2013; 1(1):14-20.
2. Anonymous. The Indian Horticulture Database. National Horticulture Board, Gurgaon. Available at, 2017. http://nhb.gov.in/statistics/State_Level/201718 (1st%20Adv.%20Est).pdf accessed on 25 June, 2018.
3. Baksh H, Yadav R, Dwivedi R. Effect of INM on growth, yield, yield attributing characters and quality of guava (*P. guajava* L.) cv. Sardar. Prog. Agric. 2008; 8(2):141-144.
4. Behzadi SH. Genetic diversity of pomegranate genotypes in Iran, Nashr Amoozesh Keshavarzi, Tehran, Iran. (in persian), 1998.
5. Eman EK, Abd-Ella, Mervate SS, Wafaa AZ. Effect of some organic and mineral fertilizer applications on growth and productivity of pomegranate trees. Alexandria Science Exchange Journal. 2010; 31(3):296-304.
6. Fathy MA, Gabr MA, El Shall SA. Effect of humic acid treatments on 'Canino' apricot growth, yield and fruit quality. New York Science Journal. 2010; 3(12):110-115.
7. Fatma KMS, Morsey MM, Thanaa ShMM. Influence of spraying yeast extract and humic acid on fruit maturity stage and storability of Canino apricot fruits, International Journal of Chem. Tech Research. 2015; 8(6):530-543.
8. Godage SS, Parekh NS, Nehete DS. Influence of biofertilizers and chemical fertilizers on growth, flowering and fruit characters of guava (*Psidium guajava* L.) cv. Allahabad Safeda. International J. Agric. Sci. 2013; 9(1):309-313.
9. Hazarika BN, Ansari S. A review Department of Horticulture, Assam Agricultural University. Jorhat-785 013 Assam, India, Biofertilizers in Fruit Crops, 2007, 28(1).
10. Hidayatullah, Khan A, Mouladad, Mirwise, Ahmed N, Shah SA. Effect of humic acid on fruit yield attributes, yield and leaf nutrient accumulation of apple trees under calcareous soil. Indian J of Sci. and Tech. 2018; 11(15):1-8.
11. Khattab MM, Shaban AE, El-Shrief AH, El-Deen AS. Effect of humic acid and amino acids on pomegranate trees under deficit irrigation on growth, flowering and fruiting. Journal of Horticultural Science & Ornamental Plants. 2012; 4(3):253-259.
12. Mahendra, Singh HK, Singh JK. Effect of integrated nutrient management on yield and quality of ber (*Zizyphus mauritiana* Lank.) cv. Banarasi Karaka. Asian J. Hort. 2009; 4(1):47-49.
13. Momin SK, Gaikwad SS, Patel RJ, Amarcholi JJ, Sharma KM. Effect of foliar application of chemicals on fruiting and quality parameters of mango (*Mangifera indica* L.) cv. Kesar. Research Journal of Agricultural Sciences. 2016; 7(1):143-144.
14. Shazia M. Studies on the influence of fertilizers and biofertilizers on growth, flowering, fruiting, yield and quality of pomegranate cv. Bhagwa. Ph.D. (Horti.) thesis submitted to College of Agriculture, Jabalpur (M.P), 2016.
15. Stover E, Mercure EW. The pomegranate: a new look at the fruit of paradise. Hort Science. 2007; 42:1088-1092.
16. Yadav DK, Singh Ganesh, Singh AK, Yadav AL. Effect of integrated nutrient management on productivity and fruit quality of aonla (*Emblica officinalis* Gaertn.). Plant Archives. 2009; 9(1):387-389.
17. Yadav PK, Yadav AL, Yadav AS, Yadav HC, Singh YP. Effect of integrated nutrient nourishment on yield attributes and economics of papaya (*Carica papaya* L.) cv. Pusa Dwarf. Plant Archives. 2011; 11(1):307-09.