International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(5): 392-396

Received: 08-07-2017
Accepted: 09-08-2017

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Effect of Ethrel and banana pseudostem sap on fruit yield and yield attributes of pomegranate (*Punica granatum* L.) cv. Bhagwa

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Abstract
The present investigation on "Effect of ethrel and banana pseudostem sap on fruit yield and yield attributes of pomegranate (*Punica granatum* L.) cv. Bhagwa" was carried out at farmer's field, which is near to Junagadh Agricultural University, Junagadh, during the year of 2016-17. The treatments comprised of three different levels of ethrel (E) *viz*., E_1= 150 ppm, E_2= 200 ppm and E_3= 250 ppm and four different levels of banana pseudostem sap (S) *viz*., S_1= 0.5 %, S_2= 1 %, S_3= 1.5 % and S_4= 2 %. The experiment was laid out in Factorial Randomized Block Design (FRBD) with thirteen treatments combinations along with three replications.

Among the different three concentrations of ethrel, ethrel @ 250 ppm (E_3) showed significantly minimum fruit drop (20.39 %), maximum number of fruits per plant (86.57), fruit set (37.13 %), fruit retention (79.71 %), minimum days taken to first harvesting (177.58 days), maximum weight of 100 arils (40.62 g), fruit weight (277.75 g), fruit volume (230.42 ml), fruit length (7.17 cm), fruit circumference (26.01 cm) and fruit yield (23.90 kg/plant and 26.55 t/ha).

Similar trend observed for the different four levels of banana pseudostem sap, the 1 % banana pseudostem sap (S_2) noted significantly minimum fruit drop (16.22 %), minimum days taken for harvesting (176.44 days), maximum number of fruits/plant (95.09), fruit set (40.15 %), fruit retention (79.71 %), weight of 100 arils (43.64 g), fruit weight (290.22 g) and fruit volume (248.67 ml), fruit length (7.44 cm) and fruit circumference (28.42 cm) and fruit yield (27.63 kg/plant and 30.70 t/ha).

Key words: pomegranate, ethrel, banana pseudostem sap, yield

Introduction
Pomegranate (*Punica granatum* L.) fruit crop has wider adaptability and is grown in tropical and subtropical regions of the world. It belongs to the family Punicaceae and is one of the favorite table fruits in the world, due to its refreshing juice with nutritional and medicinal properties. The total area under cultivation of pomegranate in India is 107.00 thousand ha and production is around 743.00 thousand tones [7].

In India, pomegranate is commercially cultivated in Maharashtra and parts of Karnataka where good quality fruits are produced due to dry and hot climate. Recently, the area under pomegranate in Gujarat is increasing to large extent due to its drought hardy nature, wider adaptability and suitability to marginal lands. 'Bhagwa' has gained popularity by virtue of its larger fruit, pink and sweet aril and soft seeded characters.

Pomegranates are native to central Asia, but since the pomegranate tree is highly adaptive to a wide range of climates and soil conditions, it is grown in many different geographical regions including the Mediterranean basin, Asia, and California. Recent scientific findings corroborate traditional usage of the pomegranate as a medical remedy and indicate that pomegranate tissues of the fruit, flowers, bark, and leaves contain bioactive phytochemicals that are antimicrobial, reduce blood pressure and act against serious diseases such as diabetes and cancer. These findings have led to a higher awareness of the public to the benefits of the pomegranate fruit, particularly in the western world and consequently to a prominent increase in the consumption of its fruit and juice. The development of industrial methods to separate the arils from the fruit and improvement of growing techniques resulted in an impressive enlargement of the extent of pomegranate orchards.

The fruit, which advances the pomegranate's individual purpose of reproduction, provides values for animals and humans as food. However, commonly it is served as a drink in the Middle East, as a syrup used in cocktail mixing and ground up to be used in traditional recipes.

Wild pomegranate seeds are sometimes used as a spice, most notably in Indian and Pakistani cuisine. In Turkey, it is served as salads and is fermented to make high-quality wine. In Greece, pomegranate is used in many recipes, as a glaze, in a relish, as a dip or made into a liqueur for popular Greek sweets.

During the last three decades innovative farmers took real initiative and pomegranate crop has been acclimatized from typically temperate zones to semi-arid and arid areas of India. Only few commercial varieties are regularly cultivated viz. Ganesh, Bhagwa, Ruby, Arakta, Mridula and Jalore Seedless. Super Bhagwa variety emerged only later. With the rapidly changing socio-economic scenario imposed by climate change, water scarcity, small land holding etc. This crop is getting popular and thriving well due to its wider adaptability not only in Deccan plateau but also in terai regions of Northern hills, and in the dry regions of North-East as it provides unmatchable return on investment from unit area of land. Global warming has adversely affected apple cultivation in the lower hills of North India, where farming communities adopted climate resilient horticultural practices by replacing apple orchards with pomegranate crop.

Although pomegranate can never compete with other conventional and regularly available fruits in India yet in the coming years it may not be surprising to see large number of pomegranate based dietary supplements, cosmetic and pharmaceutical products being readily available on the supermarket shelves. Similarly, in the coming years urban Indian households would routinely include fruit juice or other fruit based RTS beverages in morning breakfast similar to that of the west. Here, pomegranate based products will play a key role due to more and more awareness about anti-ageing/anti-cancer properties of this mighty fruit.

It is interesting to note the wide adaptability of pomegranate from temperate regions to semi-arid agro eco system in India due to its xerophyte nature. However, the inherent immunity of these plants is getting hampered due to hi-tech and hi-input cultivation that resulted in severe impact on various biotic stresses. Bacterial blight, once endemic to one locality in India, gained epiphytotic proportions due to continuous monoculture of cv. Bhagwa and use of intensive and sometimes unnecessary inputs. Of the several horticulture products in India, the global demand for pomegranate has been increasing at a much faster rate compared to others. Pomegranate is currently ranked 18th in terms of fruits consumed in the world. It is thought that as a result of its health benefits, it is expected to move to 10th place in next 10 years. However, exports from India are only ~35,000 tons which is about 6 – 7 % of the total pomegranate trade. This is despite the fact that Indian varieties are widely accepted amongst the best fruit.

Due to non-adoption of improved cultivation practices and several other horticultural practices, the yield is generally poor. Among different elite horticultural practices, growth regulators and other organic liquid fertilizer have been advantageously used in the recent time to increase the quantitative and qualitative characters of fruit.

In recent years considerable attention has been given to increase fruit set and to check fruit drop of many fruit crops with the help of plant growth regulators and other organic liquid fertilizer like banana pseudostem sap. Present invention is to assess suitability of banana pseudostem sap and its enriched formulation in enhancing crop productivity and role as an organic fertilizer. With taking into account of this fact the present experiment was conducted to study the "Effect of ethrel and banana pseudostem sap on flowering, 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 ethrel and banana pseudostem sap on flowering, yield and quality of pomegranate (*Punica granatum* L.) cv. Bhagwa" during 2016 to 2017 at farmer's field in Junagadh which is near to Junagadh Agricultural University, Junagadh.

Geological and climatological features

Junagadh is situated in Saurashtra region of Gujarat state. Geographically, this place is situated at 20.31^0 N Latitude and 70.36^0 E Longitude with an altitude of 60 meters above the mean sea level and 80 kilometres away from Arabian Sea coast on Western side at the foothills of the mount Girnar.

The climate of this area is typically subtropical, characterized by fairly hot summer, moderate cold winter and humid warm monsoon. The annual precipitation range between 800 to 900 mm in normal year and exceeds 1000 mm during net year. In general monsoon commences during the second week of June and ends by the second fortnight of September. However, pre-monsoon rains in the last week of May and first week of June are not uncommon. The rainfall during the monsoon season of year 2015 was regular. Winter starts in the month of November and continues till the month of February. Summer commences in the first fortnight of March and ends in the last week of May. April and May are hottest month of the summer.

The experiment was conducted based on *Hasta bahar* flowering that occur in September-October. The shoots were pruned one month before the flowering.

Treatment details

(a) Levels of banana pseudostem sap (S)

S_1= 0.5 %
S_2= 1 %
S_3= 1.5 %
S_4= 2 %

(Note = Banana pseudostem sap sprayed at every 15 days interval from full bloom stage to mature stage)

(b) Levels of Ethrel (E)

E_1= 150 ppm
E_2= 200 ppm
E_3= 250 ppm

(Note = Ethrel apply at full bloom stage)

Treatment Combinations

Table 1

Tr. No.	Treatment	Treatment combination
T_1	S_1 E_1	Banana pseudostem sap @ 0.5 % + Ethrel @ 150 ppm
T_2	S_1 E_2	Banana pseudostem sap @ 0.5 % + Ethrel @ 200 ppm
T_3	S_1 E_3	Banana pseudostem sap @ 0.5 % + Ethrel @ 250 ppm
T_4	S_2 E_1	Banana pseudostem sap @ 1 % + Ethrel @ 150 ppm

T_5	S_2 E_2	Banana pseudostem sap @ 1 % + Ethrel @ 200 ppm
T_6	S_2 E_3	Banana pseudostem sap @ 1 % + Ethrel @ 250 ppm
T_7	S_3 E_1	Banana pseudostem sap @ 1.5 % + Ethrel @ 150 ppm
T_8	S_3 E_2	Banana pseudostem sap @ 1.5 % + Ethrel @ 200 ppm
T_9	S_3 E_3	Banana pseudostem sap @1.5 % + Ethrel @ 250 ppm
T_{10}	S_4 E_1	Banana pseudostem sap @ 2 % + Ethrel @ 150 ppm
T_{11}	S_4 E_2	Banana pseudostem sap @ 2 % + Ethrel @ 200 ppm
T_{12}	S_4 E_3	Banana pseudostem sap @ 2 % + Ethrel @ 250 ppm
T_{13}	Control	Water spray

Preparation of spray solution

(A) Banana pseudostem sap

The banana pseudostem sap manufactured by Soil Water Management Research Unit, Navsari Agricultural University, Navsari was used for the experiment. To prepare 1 l solution of 1 percent concentration, 10 ml banana pseudostem sap was measured and mixed in tap water and the volume was made up to required quantity. Thus, for preparing 8 l solution, 80 ml banana pseudostem sap was utilized. Likewise, 0.5 %, 1.5 % and 2 % solutions were prepared.

(B) Ethrel

Stock solution of ethrel was prepared by adding 1 ml in 100 ml water than volume made up 1 liter with adding distilled water. The required concentrations of ethrel were obtained by diluting stock solution with addition of water of required quantity.

Experimental plot

The site of experimental plot was on medium black soil. Tissue culture plants of Bhagwa variety of pomegranate was planted at distance of 3 m × 3 m. The trees were three years old.

Observation recorded

Observations should be recorded with appropriate procedure.

Results and Discussion

The effects 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 of ethrel and banana pseudostem sap on fruit yield and yield attributes parameters

The mean data on the yield and yield attributes parameters *viz*., fruit set (%), fruit drop (%), fruit retention (%), days taken to first harvesting, fruit length (cm) and fruit circumference (cm) [Table 2], fruit weight (g), weight of 100 arils (g), fruit volume (ml), number of fruits/plant and fruit yield (kg/plant and yield t/ha) [Table 3] as influenced by different concentrations of ethrel and banana pseudostem sap were found significant and results of control vs rest was also found significant but their interaction was found non-significant.

Effect of ethrel on fruit yield and yield attributes parameters

The maximum fruit set (37.13 %), minimum fruit drop (20.39 %) and maximum fruit retention percentage (79.71 %) were registered in ethrel @ 250 ppm (E_3). Thus increasing fruit set and fruit retention might be due to linked with delicate balance between C: N ratio along with auxins. Similar findings have been reported by [14] in cape gooseberry. While in case of minimum fruit drop is might be due to initial growth of ovaries and reduce magnitude the peak of abscission. This result was confirmed by [10] in pomegranate.

In case of days taken to first harvesting, the minimum days (177.58 days) were registered in ethrel @ 250 ppm (E_3) and it was at par with ethrel @ 200 ppm (E_2). It might be due to an increase in ethylene production in plant. Ethephon increases the endogenous level of ethylene in plant by autocatalytic stimulation so leading to early maturity. Similar finding have been reported by [14] in cape gooseberry.

The significantly the maximum fruit length (7.17 cm), fruit circumference (26.01 cm), fruit weight (277.75 g), weight of 100 arils (40.62 g), fruit volume (230.42 ml), number of fruits/plant (86.57) recorded with application of ethrel @ 250 ppm (E_3) and it was at par with ethrel @ 200 ppm (E_2). It might be due to increase in size and diameter of fruits. Similar results were reported by [14] in cape gooseberry, [6] in plum, [8] in Date palm and [2] in guava. In case of fruit yield significantly the maximum fruit yield (23.90 kg/plant and 26.55 t/ha) was registered in ethrel @ 250 ppm (E_3) and it was at par with ethrel @ 200 ppm (E_2). It might be due to minimum fruit drop, highest fruit retention, fruit weight and fruit diameter leads to increase the fruit yield. Similar results were confirmed by [4] in pomegranate and [15] in cape gooseberry.

Effect of banana pseudostem sap on fruit yield and yield attributes parameters

The highest fruit set percentage (40.15 %), highest fruit retention percentage (79.71 %) and lowest fruit drop percentage (16.22 %) was obtained in banana pseudostem sap @ 1 % (S_2) followed by banana pseudostem sap @ 1.5 % (S_3). It might be due to banana pseudostem sap contains good amount of essential macro and micro nutrients which have direct or indirect effect on fruit set, fruit retention and fruit drop. The banana pseudostem sap contains small amount of essential nutrients and growth boosters and these constituents are known to have positive effect on fruiting parameters of the crops. It has been confirm by [11] in mango.

It is evident that significantly minimum days taken to first harvesting (176.44 days) were obtained in banana pseudostem sap @ 1 % (S_2) and it was at par with banana pseudostem sap @ 1.5 % (S_3). Banana pseudostem sap contain GA_3 so synthesis of GA_3 in plant increases the physiological activities leading to early maturity.

It is evident that significantly maximum fruit length (7.44 cm), fruit circumference (28.42 cm), fruit weight (290.22 g), weight of 100 arils (43.64 g), fruit volume (248.66 ml) and number of fruits/plant (95.09) were obtained in banana pseudostem sap @ 1 % (S_2) followed by banana pseudostem sap @ 1.5 % (S_3). It might be due to banana pseudostem sap contain nitrogen so effect of nitrogen increased the efficiency of metabolic process of the trees and thus encouraged the growth of pomegranate plant in general and consequently the various parts of the plant including fruits. Similar findings were observed by [5] in pomegranate. In case of fruit

circumference, fruit length and fruit weight similar results were found by [12] in onion and [9] in garlic.

The significantly maximum fruit yield (27.63 kg/plant and 30.70 t/ha) was obtained in banana pseudostem sap @ 1 % (S_2) followed by banana pseudostem sap @ 1.5 % (S_3). It might be due to the juvenility of the plant and also due to promotion of more vegetative growth. Similar results were obtained by [1] in banana, [5], [9] in garlic, [13] in cowpea and [3] in chilli.

Table 2: Effect of ethrel and banana pseudostem sap on fruit set (%), fruit drop (%), fruit retention (%), days taken to first harvesting, fruit length (cm) and fruit circumference (cm) of pomegranate

Treatments	Fruit set (%)	Fruit drop (%)	Fruit retention (%)	Days taken to first harvesting	Fruit length (cm)	Fruit circumference (cm)
Ethrel (E)						
E_1= 150 ppm	33.53	22.42	77.58	181.17	6.64	24.49
E_2= 200 ppm	34.52	21.26	78.74	179.08	6.79	25.30
E_3= 250 ppm	37.13	20.39	79.71	177.58	7.17	26.01
S. Em±	0.51	0.47	0.79	0.96	0.13	0.36
C.D. at 5 %	1.49	1.36	2.05	2.79	0.38	1.06
Banana pseudostem sap (S)						
S_1= 0.5 %	31.25	26.16	73.84	181.56	6.14	21.77
S_2= 1 %	40.15	16.22	83.78	176.44	7.44	28.42
S_3= 1.5 %	35.40	19.61	80.39	178.56	6.67	26.40
S_4= 2 %	34.77	23.30	76.70	180.56	7.22	24.48
S. Em±	0.59	0.54	0.91	1.11	0.15	0.42
C.D. at 5 %	1.72	1.57	2.66	3.23	0.44	1.23
Interaction (E × S)						
S. Em±	1.02	0.93	1.58	1.91	0.26	0.73
C.D. at 5 %	NS	NS	NS	NS	NS	NS
Control vs rest						
Control	28.42	28.52	71.48	190.66	6.00	19.5
Rest	35.39	21.33	78.67	179.27	6.86	25.23
SE(d)	1.06	0.96	1.64	1.99	0.27	0.75
C.D. at 5 %	2.19	2.00	3.38	4.11	0.56	1.56
C.V. %	5.07	7.37	3.89	4.84	6.65	5.09

Table 3: Effect of ethrel and banana pseudostem sap on fruit weight (g), weight of 100 arils (g), fruit volume (ml), number of fruits per plant and fruit yield (kg/plant and t/ha of pomegranate

Treatments	Fruit weight (g)	Weight of 100 arils (g)	Fruit volume (ml)	Number of fruits per plant	Fruit yield (kg/plant)	Fruit yield (t/ha)
Ethrel (E)						
E_1= 150 ppm	259.08	37.53	217.00	83.97	21.98	24.43
E_2= 200 ppm	269.92	38.78	224.38	85.24	22.97	25.52
E_3= 250 ppm	277.75	40.62	230.42	86.57	23.90	26.55
S. Em±	3.94	0.64	3.41	0.76	0.51	0.56
C.D. at 5 %	11.50	1.87	9.95	2.17	1.48	1.64
Banana pseudostem sap (S)						
S_1= 0.5 %	249.44	34.24	197.89	73.96	18.30	20.33
S_2= 1 %	290.22	43.64	248.67	95.09	27.63	30.70
S_3= 1.5 %	275.00	39.47	232.50	89.35	24.53	27.26
S_4= 2 %	261.00	38.55	216.67	82.15	21.33	23.70
S. Em±	4.55	0.74	3.94	1.25	0.58	0.65
C.D. at 5 %	13.28	2.15	11.49	3.66	1.71	1.90
Interaction (E × S)						
S. Em±	7.88	1.28	6.82	2.17	1.01	1.12
C.D. at 5 %	NS	NS	NS	NS	NS	NS
Control vs rest						
Control	226.66	31.66	189.33	65.84	14.95	16.61
Rest	268.91	38.97	223.93	85.14	22.94	25.49
SE(d)	8.20	1.33	7.09	2.26	1.05	1.17
C.D. at 5 %	16.93	2.74	14.64	4.66	2.17	2.41
C.V. %	5.14	5.76	5.34	4.49	7.85	7.85

Conclusion

Based on the results obtained from the present investigation, it can be concluded that, individually foliar application of ethrel @ 250 ppm at full bloom stage and banana pseudostem sap @ 1% at every 15 days interval from full bloom to mature fruit stage showed better performance for getting higher yield in pomegranate.

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