International Journal of Minor Fruits, Medicinal and Aromatic Plants. Vol. 9 (1) : 50- 59, June 2023

Effect of different planting materials and chemicals on the fruit quality of Pomegranate (*Punica granatum* L.) cv. Bhagwa

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Received : 23.03.2023 ; Revised : 17.04.2023 ; Accepted : 18.04.2023

DOI : 10.53552/ijmfmap.9.1.2023.50-59

ABSTRACT

The quality parameters like total aril weight, percentage of aril weight, 100 aril weight, TSS, titrable acidity and anthocyanin content were seen in plants grown from tissue culture plants, followed, in that order, by grafts and air layers. Soil drenching with paclobutrazol (0.375 g of the active ingredient per metre of canopy diameter), foliar spray of nitrobenzene (2.0 ml/l) 60 days following the measures to induce stress and methyl jasmonate were the most effective treatments to increase the total aril weight (108.57 g, 122.73 g), percentage of aril weight (57.06%, 57.42%), 100 aril weight (28.77g, 32.86g), TSS (19.54 ^{0}B, 15.01 ^{0}B), titrable acidity (0.44%, 0.61%) and anthocyanin content (3.59 mg / 100g, 4.62 mg / 100 g) in ambe bahar and hastha bahar seasons. Soil drenching of paclobutrazol @ 0.365 g a.i. m^{-1} canopy diameter, foliar spray of nitrobenzene @ 2.0 ml litre^{-1} and methyl jasmonate @ 200 ppm litre^{-1} were most effective in improving fruit quality and anthocyanin content.

***Keywords*:** Methyl jasmonate, nitrobenzene, paclobutrazol, planting material, *Punica granatum*

INTRODUCTION

The pomegranate (*Punica granatum* L.), which is thought to be the oldest species of tree with edible fruit, is a significant fruit crop in terms of nutrition (Asghari *et al*. 2019). Pomegranates are becoming more and more common in arid and semi-arid areas because they are resilient, adaptable to a variety of climates, low care, produce well, and have a favourable cost:benefit ratio (Marathe *et al*., 2016). Pomegranate will withstand drought, salinity and able to grow in low fertile soils. This, combined with its perennial habit and some degree of salinity tolerance, makes pomegranate particularly suitable for better exploitation of soil moisture and marginal lands. Also, drier environments have superior fruit quality. The fruit is widely preferred by consumers and is in high demand even outside of the production regions. Pomegranate production in India is the highest in the world (Jadhav and Sharma, 2007). It is produced annually in 4.5 million tonnes on an area of 0.31 million hectares (National Horticultural Board, 2022).

Hardwood cuttings, air layering, grafting (grafted on 'Daru' rootstock) and tissue culture are all methods used to grow pomegranates. Tissue culture plantlets are frequently used to start orchards. It has not yet been thoroughly investigated how to get good quality fruits from plants produced from grafts and tissue culture plants.

When fruits are plucked too early, they may not ripen correctly and lose their flavour. Because it is a "non-climacteric" fruit crop, pomegranate fruits should be harvested as soon as they are fully developed on the plant itself (Pal and Babu, 2014; Gaikwad *et al*., 2014). Furthermore, it is preferable to avoid picking fruits too late because it reduces their shelf life and increases the prevalence of physiological disorders like Internal Breakdown. Because of this, it's essential to select pomegranate fruits at the right stage of development to guarantee exceptional quality and a longer shelf life. Although a great deal of research has been done on how to use chemicals like naphthalene acetic acid, gibberellic acid, salicylic acid, and ethrel to improve quality with superior-quality fruits in pomegranate, the potential of a few other PGRs like methyl jasmonate, nitrobenzene, and paclobutrazol to obtain similar benefits in pomegranate and other fruit crops has not yet been fully explored. In light of this, the current study was conducted with the goal of better understanding how chemicals and plants raised through different propagation methods affect the quality of pomegranate "Bhagwa."

MATERIALS AND METHODS

The studies were carried out at the experimental farm of the Indian Institute of Horticultural Research in Hessaraghatta, Bengaluru, which is situated at 13°7 N and 77°29 E. The location is 890 metres above mean sea level. Pomegranate plants (cv. "Bhagwa") cultivated at a spacing of 5.0 m × 6.0 m and raised from tissue-cultured plantlets, grafts, and air layers made up the experimental material. The plants were five years old. The experiment was conducted during *ambe bahar* (January to February flowering) and *hastha bahar* (September to October flowering) during 2020-2021. Average maximum and minimum temperatures during the experimental period were 36.08°C and 25.43°C, respectively, with relative humidity and rainfall totalling 85.04% and 79.95 mm, respectively. The chemicals imposed were T_1: Nitrobenzene @ 1.0 ml / litre, T_2: Nitrobenzene @ 1.5 ml / litre, T_3: Nitrobenzene @ 2.0 ml / litre, T_4: Methyl Jasmonate (MeJA) @ 100 ppm, T_5: Methyl Jasmonate (MeJA) @ 150 ppm, T_6: Methyl Jasmonate (MeJA) @ 200 ppm, T_7: Soil drenching of paclobutrazol @ 0.375 g a.i. m^{-1} canopy diameter 30 days after bahar treatment, T_8: Soil drenching of paclobutrazol @ 0.375 g a.i. m^{-1} canopy diameter 45 days after bahar treatment, T_9: Soil drenching of paclobutrazol @ 0.375 g a.i. m^{-1} canopy diameter 60 days after bahar treatment, T_{10}: Control (Water spray). The following regimen is used in the experiment to induce stress: two months of no watering, surface soil removal to expose the roots just a little, light pruning, and ethephon (marketed as Ethrel, 2.0 ml / litre mixed with 5.0 g / l diammonium phosphate) spraying to promote defoliation. This practice followed during both *ambe bahar* and *hastha bahar*. In order to encourage profuse flowering, irrigation was restarted right away after covering the exposed roots with soil mixed with farmyard manure. By drip irrigation, the suggested fertiliser doses were given. The same system was continued even after the monsoon season. To record total aril weight, percentage of aril weight, juice weight, 100 Aril weight, TSS, titrable acidity, and anthocyanin content, twelve trees (four per replication) were chosen for each treatment.

Total aril weight (g)

Each treatment's nine randomly chosen fruits were split into their individual arils, which were then weighed separately. The average aril weight was given as grams (g $fruit^{-1}$).

Percentage of aril weight

The percentage of aril weight was calculated by using the formula:

$$\frac{\text{Aril weight}}{\text{Fruit weight}} \times 100$$

Fruit Juice percentage

The juice percentage was calculated by using the formula:

$$\frac{\text{Juice weight}}{\text{Fruit weight}} \times 100$$

Hundred Aril weight (g)

By removing 100 arils from each of the nine randomly chosen fruits in each treatment, the weight of 100 arils was calculated, and the mean value was represented in grams.

Total soluble solids (^{0}B)

Using a hand-held refractometer (Carl-Zeiss), the total soluble solids content of the fruit was measured, and the mean result was given in ^{0}Brix. The refractometer's prism was cleaned after each reading using tissue paper and methanol, then dried before being rinsed with distilled water.

Titrable acidity of juice (%)

By using the titration method, juice acidity was determined (AOAC, 2000). A measuring cylinder was used to weigh 10 grams of juice, and distilled water was used to dilute the juice to a volume of 50 ml. This filtrate was titrated with 0.01N NaOH using Phenolphthalein as an indicator using 10 ml of the filtrate. Using a standard curve, acidity was estimated as mg of citric acid equivalents per 100 g of fresh weight.

Anthocyanin content (mg 100g $^{-1}$)

The Srivastava and Kumar method (2003) was used to determine the anthocyanin content of arils. By combining 10 g of the sample with 10 ml of ethanolic HCL and then pouring the mixture into a 100 ml volumetric flask, anthocyanin was extracted from the sample. The volume was prepared, the solution was chilled to 4°C, and whatman No.1 filter paper was used to filter the mixture. At 520 nm, the filtrate's optical density was measured.

Anthocyanin content (mg 100g $^{-1}$) =

$$\frac{\text{O.D.520} \times \text{Volume made up}}{\text{Weight of sample}} \times 100$$

RESULTS AND DISCUSSION

Total aril weight /fruit

Significant variations in total aril weight across the propagules were noted in *ambe bahar*, according to the findings (Table 1). The plants developed from grafts (grafted on 'Daru' rootstock) had the highest overall aril weight (108.57 g), and their arils were also noticeably wider than those of the trees raised from air layers. Regarding growth regulators, the maximum total aril weight was reported with nitrobenzene at 2.0 ml / litre plant^{-1} (106.54 g fruit^{-1}). The combination of nitrobenzene @ 2.0 ml / litre plant^{-1} and grafted plants showed noticeably the highest overall aril weight (130.93 g).

The grafted plants recorded the highest total aril weight during *hastha bahar* (122.73 g fruit^{-1}), which was considerably different from the air layer plants. Nitrobenzene application at 1.5 ml / litre plant^{-1} increased the overall aril weight among the compounds (134.27 g fruit^{-1}). Regarding total aril weight, there were no appreciable differences seen between the interactions of chemicals and propagules. Nonetheless, when foliar treated with nitrobenzene @ 2.0 ml / litre plant^{-1}, grafted plants produced fruits with a high total aril weight (142.03 g fruit^{-1}).

Nitrobenzene treatment increased the total aril weight in grafted plants in both growing seasons. That might be because nitrobenzene has auxin-like properties, which may have encouraged fruit cell division and cell elongation to increase the weight of the aril. The buildup of water, carbohydrates, and other soluble substances in higher amounts as a result of the translocation of metabolites towards the fruit may also be the cause of the increased cell size and intercellular gaps. According to Wetzstein *et al*. (2011), there is a strong link between pomegranate fruit weight and mean aril weight. As a result, fruits from grafted plants that were larger in size had mean arils that were heavier. The alleged observations in pomegranate cv. Bhagwa are in agreement with Vidya *et al*. (2016).

100 Aril weight (g)

In *ambe bahar*, there were noticeable differences in 100 Aril weight across the propagules, with grafted plants exhibiting the highest 100 Aril weight (28.77 g) (Table 1). Sixty days after bahar treatment, soil drenching with paclobutrazol at 0.375 g a.i. m^{-1} canopy diameter recorded the greatest 100 aril weight (31.81 g). With a foliar application of nitrobenzene @ 2.0 ml / litre plant^{-1}, the fruits of grafted plants recorded the greatest 100 aril weight (32.59 g).

During *hastha bahar*, grafted plants with higher 100 Aril weights (32.86 g) than the remainder of the propagules were observed. Considering the impact of chemicals, nitrobenzene foliar spray at 1.5 ml / litre plant^{-1} has been linked to an increase in 100 aril weight (33.86 g). With the treatment of nitrobenzene @ 2.0 ml / litre plant^{-1}, the grafted plants recorded the highest 100 aril weight (36.35 g).

In the current study, fruits from nitrobenzene-treated grafted plants showed high mean 100 aril weights over the two growing seasons. According to Yahya *et al*. (2017), fruiting characteristics including fruit weight, length, width, and volume as well as quality indicators like the total weight of the arils and the weight of 100 arils are directly proportional to one another. The current investigation takes into account these conclusions.

Juice weight (g)

The findings showed that the fruit juice weight (g) of *ambe bahar* varied significantly across the propagules, with the propagule tissue culture plants recording the greatest juice weight (86.58 g fruit^{-1}) (Table 2). The greatest juice weight was recorded

Table 1: Effect of different seasons and plant growth regulators on total aril weight and 100 aril weight in pomegranate cv. Bhagwa

	Total aril weight (g)/fruit								100 Aril weight (g)							
	Ambebahar				*Hasthabahar*				*Ambebahar*				*Hasthabahar*			
Propagules	P_1	P_2	P_3	**Mean**	P_1	P_2	P_3	**Mean**	P_1	P_2	P_3	**Mean**	P_1	P_2	P_3	**Mean**
T_1, Nitrobenzene 1.0 ml / litre	102.00	92.60	59.82	**84.81**	113.55	99.62	94.14	**102.43**	26.04	23.92	25.10	**25.02**	29.86	31.34	29.41	**30.20**
T_2, Nitrobenzene 1.5ml / litre	102.31	100.43	60.84	**87.86**	137.25	122.52	98.74	**119.50**	28.66	25.07	22.14	**25.29**	30.44	32.70	30.14	**31.09**
T_3, Nitrobenzene 1.0 ml / litre	107.96	111.91	68.95	**96.27**	101.75	107.44	91.59	**100.26**	25.15	25.80	20.01	**23.65**	32.21	30.56	29.29	**30.68**
T_4, Methyl Jasmonate @ 100 ppm	102.63	117.12	66.88	**95.54**	120.46	133.46	126.84	**126.92**	26.66	31.67	22.94	**27.09**	33.46	33.86	33.07	**33.46**
T_5, Methyl Jasmonate @ 150 ppm	100.46	120.80	81.32	**99.16**	132.58	138.68	131.55	**134.27**	29.25	32.26	26.29	**29.27**	32.65	35.18	33.76	**33.86**
T_6, Methyl Jasmonate @ 200 ppm	105.07	130.93	83.63	**106.54**	132.01	142.03	124.73	**132.92**	28.47	32.59	27.22	**29.42**	30.46	36.35	34.29	**33.70**
T_7, Paclobutrazol soil drenching 30 days after bahar treatment	104.75	106.00	81.89	**97.54**	116.22	132.41	115.30	**121.31**	29.58	29.67	29.95	**29.73**	30.59	32.83	32.02	**31.81**
T_8, Paclobutrazol soil drenching 45 days after bahar treatment	106.89	110.13	88.41	**101.81**	110.95	121.84	112.95	**115.24**	31.52	30.92	31.81	**31.41**	30.93	32.43	30.81	**31.39**
T_9, Paclobutrazol soil drenching 60 days after bahar treatment	112.31	113.09	86.03	**103.81**	107.07	134.06	107.07	**116.07**	32.24	31.3	31.91	**31.81**	31.05	34.07	31.15	**32.09**
T_{10}, Control	95.35	82.73	57.23	**80.14**	91.57	95.29	86.32	**91.06**	23.19	24.55	19.55	**22.43**	28.51	29.26	28.32	**28.70**
Mean	**103.97**	**108.57**	**73.50**		**116.34**	**122.73**	**108.92**		**28.07**	**28.77**	**25.69**		**31.02**	**32.86**	**31.22**	
	P	**T**	**PXT**		**P**	**T**	**PXT**		**P**	**T**	**PXT**		**P**	**T**	**PXT**	
SE(m)	1.19	2.18	3.78		2.33	4.27	7.39		0.39	0.71	1.23		0.17	0.32	0.56	
C.D (5%)	3.39	6.19	10.73		6.63	12.12	N.S		1.10	2.01	3.49		0.50	0.92	1.59	

P_1 – Tissue culture plants, **P_2** – Grafted plants, **P_3** – Air layer plants

Table 2: Effect of different seasons and plant growth regulators on fruit juice weight and juice percentage in pomegranate cv. Bhagwa

	Fruit juice weight (g)								Juice percentage (%)							
	Ambebahar				*Hasthabahar*				*Ambebahar*				*Hasthabahar*			
Propagules	**P_1**	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**
$T_{1,}$ Nitrobenzene 1.0 ml / litre	64.10	78.23	59.15	**67.16**	98.75	98.88	80.57	**92.73**	35.87	43.21	38.62	**39.23**	33.23	31.70	27.63	**30.85**
T_2, Nitrobenzene 1.5ml / litre	78.82	77.61	50.69	**69.04**	103.91	89.76	89.70	**94.45**	42.36	42.46	32.94	**39.25**	34.28	26.69	30.57	**30.51**
$T_{3,}$ Nitrobenzene 1.0 ml / litre	84.23	83.38	58.12	**75.24**	105.43	110.58	89.56	**101.86**	44.69	45.00	35.92	**41.87**	34.61	34.05	30.05	**32.90**
T_4, Methyl Jasmonate @ 100 ppm	85.47	96.31	55.41	**79.06**	114.21	97.5	102.85	**104.85**	43.56	48.22	33.70	**41.83**	32.21	32.12	30.07	**31.46**
$T_{5,}$ Methyl Jasmonate @ 150 ppm	92.03	99.62	70.90	**87.51**	147.04	100.93	116.79	**121.59**	46.43	49.33	38.36	**44.70**	40.76	34.59	33.56	**36.30**
$T_{6,}$ Methyl Jasmonate @ 200 ppm	92.72	106.66	70.85	**90.08**	165.23	126.95	118.92	**137.03**	46.54	52.05	38.52	**45.70**	45.71	34.06	34.81	**38.19**
T_7, Paclobutrazol soil drenching 30 days after bahar treatment	100.34	79.11	81.06	**86.84**	132.7	101.51	103.19	**112.46**	50.08	41.31	42.82	**44.74**	38.31	33.37	30.69	**34.12**
$T_{8,}$ Paclobutrazol soil drenching 45 days after bahar treatment	104.34	86.51	83.88	**91.57**	93.85	92.68	96.12	**94.22**	51.12	44.81	44.05	**46.66**	28.03	24.85	29.80	**27.56**
$T_{9,}$ Paclobutrazol soil drenching 60 days after bahar treatment	105.41	88.8	87.95	**94.05**	114.03	110.51	104.11	**109.55**	50.96	45.31	45.81	**47.36**	35.61	27.05	33.20	**31.95**
$T_{10,}$ Control	58.38	64.92	51.66	**58.32**	96.3	87.92	81.78	**88.67**	34.34	39.19	35.11	**36.21**	34.92	29.91	30.71	**31.84**
Mean	**86.58**	**86.11**	**66.97**		**117.14**	**101.72**	**98.36**		**44.60**	**45.09**	**38.58**		**35.77**	**30.84**	**31.11**	
	P	**T**	**PXT**		**P**	**T**	**PXT**		**P**	**T**	**PXT**		**P**	**T**	**PXT**	
SE(m)	1.50	2.74	4.75		2.42	4.43	7.67		0.62	1.13	1.96		0.71	1.30	2.25	
C.D (5%)	4.26	7.78	13.48		6.88	12.57	N.S		1.76	3.22	5.58		2.02	3.68	N.S	

P_1 – Tissue culture plants, **P_2** – Grafted plants, **P_3** – Air layer plants

Table 3: Effect of different seasons and plant growth regulators on total soluble solids and titrable acidity in pomegranate cv. Bhagwa

	Total soluble solids (^oB)								Titrable acidity (%)							
	Ambebahar				*Hasthabahar*				*Ambebahar*				*Hasthabahar*			
Propagules	**P_1**	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**
$T_{1,}$ Nitrobenzene 1.0 ml / litre	18.87	15.02	14.65	**16.18**	14.40	14.80	14.89	**14.69**	0.55	0.44	0.49	**0.49**	0.63	0.57	0.82	**0.67**
T_2, Nitrobenzene 1.5ml / litre	19.90	14.50	14.60	**16.33**	14.53	14.73	14.73	**14.66**	0.45	0.46	0.46	**0.46**	0.57	0.79	0.71	**0.69**
$T_{3,}$ Nitrobenzene 2.0 ml / litre	19.91	14.94	14.60	**16.48**	15.40	15.66	15.46	**15.51**	0.39	0.42	0.46	**0.43**	0.52	0.85	0.78	**0.72**
T_4, Methyl Jasmonate @ 100 ppm	19.12	13.53	14.11	**15.59**	15.00	15.60	14.80	**15.13**	0.48	0.40	0.49	**0.46**	0.58	0.49	0.83	**0.63**
$T_{5,}$ Methyl Jasmonate @ 150 ppm	19.46	13.44	14.41	**15.77**	15.46	15.26	16.00	**15.57**	0.41	0.40	0.51	**0.44**	0.68	0.82	0.86	**0.79**
$T_{6,}$ Methyl Jasmonate @ 200 ppm	19.25	13.93	14.55	**15.91**	14.53	14.86	16.11	**15.17**	0.49	0.43	0.48	**0.46**	0.54	0.74	0.81	**0.70**
T_7, Paclobutrazol soil drenching 30 days after bahar treatment	20.37	14.67	14.73	**16.59**	14.86	14.46	14.71	**14.68**	0.42	0.47	0.50	**0.46**	0.64	0.96	0.85	**0.82**
$T_{8,}$ Paclobutrazol soil drenching 45 days after bahar treatment	19.52	15.12	14.57	**16.40**	16.00	12.93	15.06	**14.66**	0.40	0.42	0.47	**0.43**	0.68	0.77	1.14	**0.87**
$T_{9,}$ Paclobutrazol soil drenching 60 days after bahar treatment	20.44	15.05	15.07	**16.85**	15.86	15.20	15.06	**15.37**	0.45	0.43	0.50	**0.46**	0.55	0.87	0.80	**0.74**
$T_{10,}$ Control	18.57	13.82	13.88	**15.42**	13.26	13.86	13.33	**13.48**	0.60	0.53	0.53	**0.55**	0.70	0.97	1.03	**0.90**
Mean	**19.54**	**14.40**	**14.52**		**14.93**	**14.74**	**15.01**		**0.46**	**0.44**	**0.49**		**0.61**	**0.78**	**0.86**	
	P	**T**	**PXT**		**P**	**T**	**PXT**		**P**	**T**	**PXT**		**P**	**T**	**PXT**	
SE(m)	0.12	0.23	0.39		0.18	0.33	0.58		0.01	0.02	0.04		0.03	0.05	0.10	
C.D (5%)	0.35	0.65	N.S		N.S	0.95	N.S		0.03	0.07	N.S		0.09	0.16	N.S	

P_1 – Tissue culture plants, **P_2** – Grafted plants, **P_3** – Air layer plants

Table 4: Effect of different seasons and plant growth regulators on anthocyanin content and percentage of aril weight in pomegranate cv. Bhagwa

	Anthocyanin content (mg 100 g^{-1})								Percentage of aril weight (%)							
	Ambebahar				*Hasthabahar*				*Ambebahar*				*Hasthabahar*			
Propagules	**P_1**	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**	**P_1**	**P_2**	**P_3**	**Mean**
T_1, Nitrobenzene 1.0 ml / litre	3.13	3.98	1.66	**2.92**	2.52	4.44	3.95	**3.64**	52.37	51.35	39.25	**49.24**	49.00	50.94	55.21	**51.72**
T_2, Nitrobenzene 1.5ml / litre	3.22	3.68	2.19	**3.03**	2.51	5.65	3.74	**3.96**	52.74	55.1	39.67	**49.96**	53.96	55.00	58.00	**55.65**
T_3, Nitrobenzene 1.0 ml / litre	3.96	4.27	2.62	**3.61**	2.88	8.41	4.48	**5.25**	57.3	60.51	42.63	**53.48**	54.49	57.46	55.82	**55.92**
T_4, Methyl Jasmonate @ 100 ppm	2.40	3.25	1.91	**2.52**	1.79	6.18	3.86	**3.94**	52.3	59.24	40.75	**50.76**	64.77	59.94	58.93	**61.21**
T_5, Methyl Jasmonate @ 150 ppm	2.69	3.64	1.85	**2.73**	2.68	4.25	3.23	**3.38**	52.27	59.93	44.45	**50.81**	61.74	62.45	58.68	**60.96**
T_6, Methyl Jasmonate @ 200 ppm	3.46	3.93	2.20	**3.19**	2.58	3.86	2.14	**2.86**	55.11	63.95	45.45	**54.04**	68.71	65.60	59.22	**64.51**
T_7, Paclobutrazol soil drenching 30 days after bahar treatment	2.85	3.76	2.13	**2.91**	2.63	4.40	3.59	**3.54**	54.22	55.4	43.28	**50.32**	56.06	56.38	53.93	**55.45**
T_8, Paclobutrazol soil drenching 45 days after bahar treatment	2.52	3.79	2.53	**2.95**	2.62	2.32	3.68	**2.87**	57.12	56.98	46.48	**51.94**	53.64	59.12	52.25	**55.00**
T_9, Paclobutrazol soil drenching 60 days after bahar treatment	2.50	3.34	2.43	**2.76**	2.56	4.89	3.68	**3.71**	59.11	57.92	44.81	**52.32**	51.93	58.43	52.66	**54.34**
T_{10}, Control	2.31	2.24	1.73	**2.09**	2.56	1.85	1.40	**1.93**	48.06	50.21	39.12	**49.48**	46.53	48.92	50.76	**48.74**
Mean	**2.90**	**3.59**	**2.12**		**2.53**	**4.62**	**3.37**		**54.06**	**57.06**	**42.59**		**56.08**	**57.42**	**55.54**	
	P	**T**	**PXT**		**P**	**T**	**PXT**		**P**	**T**	**PXT**		**P**	**T**	**PXT**	
SE(m)	0.04	0.07	0.12		0.09	0.17	0.30	0.04	0.67	1.22	2.12		0.57	1.05	1.83	
C.D (5%)	0.11	0.21	0.36		0.27	0.50	0.87	0.11	1.9	N.S	6.04		N.S	3.00	5.20	

P_1 – Tissue culture plants, **P_2** – Grafted plants, **P_3** – Air layer plants

by the chemical paclobutrazol soil drenching at 0.375 g a.i. m^{-1} canopy diameter 60 days after the bahar treatment (94.05 g $fruit^{-1}$). The impact of chemicals on juice weight varied greatly across the propagules, with nitrobenzene foliar spraying at a rate of 2.0 ml / litre per plant per grafted plant being implicated in improving the juice weight (106.66 g $fruit^{-1}$).

The results showed that fruit juice weight (g) varied significantly among the propagules during *hastha bahar*, with propagule tissue culture plants recording the greatest juice weight (110.26 g), which was significantly different from the juice weight of the other propagules. In comparison to the other chemicals used, nitrobenzene administration at 2.0 ml / litre $plant^{-1}$ as a foliar spray was associated with increasing juice weight (137.03 g). Chemical effects on juice weight did not differ significantly across propagules.

The rise in juice appears to be the result of water and glucose moving around in the arils. The percentage of seed had naturally decreased in proportion to the juice content as the water content of arils increased. These findings are consistent with pomegranate reports by Supe and Saitwal (2016).

Juice percentage (%)

The data in Table 2 for *ambe bahar* showed that the juice percentage (%) varied significantly among the propagules and was highest in the propagule-grafted plants (45.09%). Among the compounds, paclobutrazol soil drenching at 0.375 g a.i. m^{-1} canopy diameter increased juice percentage (47.36%) 60 days after bahar treatment. Chemicals had a considerably different impact on fruit juice percentage throughout the propagules, however nitrobenzene foliar spraying at 2.0 ml / litre $plant^{-1}$ on grafted plants increased fruit juice percentage (52.05%).

The data in Table 2 showed that during *hastha bahar*, the propagule juice percentage (%) varied significantly. The propagule tissue culture plants recorded the highest juice percentage (35.77%) and it differed significantly from the other propagules. Nitrobenzene @ 2.0 ml / litre $plant^{-1}$ was one chemical that had an additive impact on juice percentage (38.19%).

According to the observations made on the percentage of juice, the fruit's juice content grew as it ripened. The progressive decline in the percentage of seeds may be the cause of the increase in fruit juice content. These findings support the theory put forth by Vidya *et al*. (2016), who suggested that as a fruit matured, its juice content would rise and its seed content would fall. At the same time, during fruit maturity, peel and seeds percentage declined significantly, while the percentage of aril and juice (of whole fruit) increased significantly (Zarei *et al*., 2011).

Total soluble solids (^{0}B)

Total soluble solids (^{0}B) varied significantly among the propagules in the case of *ambe bahar*, and the fruits grown in tissue culture plants had the greatest TSS (19.54 ^{0}B), which was statistically different from the rest of the propagules (Table 3). Among the compounds, paclobutrazol at 0.375 g a.i. m^{-1} canopy diameter soil soaking increased total soluble solids 60 days after bahar treatment (16.85 ^{0}B). The soil drenched with paclobutrazol @ 0.375 g a.i. m^{-1} canopy diameter 60 days after bahar treatment, which resulted in the fruits from tissue culture plants having the highest TSS (20.44 ^{0}B).

Total soluble solids (^{0}B) did not significantly vary among the propagules during *hastha bahar*, however the propagule air layer plants produced fruits with a high TSS content (15.01 ^{0}B). Among the compounds, nitrobenzene foliar spray at 1.5 ml / litre $plant^{-1}$ has been linked to increasing the TSS content of fruits (15.57 ^{0}B). Table 3 made it clear that there were no notable variances in how chemicals interacted with propagules for total soluble solids. Yet, when foliar sprayed with nitrobenzene @ 2.0 ml / litre $plant^{-1}$, the fruits produced by air layer plants recorded a higher TSS concentration of (16.11 ^{0}B).

Despite the fact that there was no discernible difference in TSS level, after two seasons of paclobutrazol application, the fruits of both tissue culture and air layer plants had high TSS content. Increased amounts of sucrose, starch, and sugar, as a result of decreased vegetative growth and the absence of other potentially competitively active growing sinks, can be used to explain this. This led to a greater allocation of nutrients to fruits (Abdel Rahim *et al*., 2011). Our results are consistent with those of Wani *et al*. (2007) in the Red Delicious apple variety.

Titrable acidity (%)

The data in Table 3 for *ambe bahar* showed that all propagules significantly affected the titrable acidity content, although the fruits grown from grafted plants had less titrable acidity (0.44%). The least titrable acidity (0.43%) was recorded by paclobutrazol soil soaking at 0.375 g a.i. m^{-1} canopy diameter 45 days after bahar treatment, out of all the chemicals. Regarding the effect of chemicals on titrable acidity across the propagules, significant changes were not visible. From tissue culture plants, however, foliar spraying with methyl jasmonate at 200 ppm / litre $plant^{-1}$ resulted in fruits with less acidity (0.39%).

The data in Table 3 demonstrate that all propagules were considerably affected by *hastha bahar* in terms of titrable acidity content, although fruits produced from tissue culture plants had less titrable acidity (0.61%). In comparison to other agents, nitrobenzene foliar spray at 1.0 ml / litre $plant^{-1}$ resulted in fruits with reduced titrable acidity (0.63%). Regarding the influence of chemicals on titrable acidity across the propagules, significant changes were not visible. Nevertheless, grafted plants that received a foliar spray of nitrobenzene at 1.0 ml / litre $plant^{-1}$ produced fruits with less titrable acidity (0.49%).

Increased total soluble solids, which may be the result of the rapid metabolic conversion of starch and pectin into soluble substances and the rapid translocation of sugars from leaves to growing fruits, may be the cause of the reduction in fruit juice acidity during both seasons. The current findings are consistent with those made by Ghosh *et al*. (2009) in the Ruby variety of pomegranate.

Anthocyanin content (mg / 100 g)

Table 4 clearly shows that all the propagules in the case of *ambe bahar* were significantly impacted in terms of anthocyanin content. The anthocyanin content in fruits grown from grafted plants was the highest (3.59 mg / 100g). Methyl jasmonate, one of the chemicals, had an incremental influence on the anthocyanin content of fruits (3.61 mg / 100g), and it differed significantly from the other chemicals used. When the grafted plants were foliar sprayed with methyl jasmonate at 200 ppm / litre $plant^{-1}$, the fruits they produced had the highest anthocyanin content (4.27 mg / 100 g).

The data in Table 4 show that all propagules were considerably impacted by *hastha bahar* in terms of anthocyanin concentration. The highest anthocyanin content (4.62 mg / 100 g) was found in the fruits produced by grafted plants, which was significantly higher than that of the other propagules. Methyl jasmonate, one of the compounds, had an incremental impact on the anthocyanin content of fruits when applied as a foliar spray at 200 ppm $litre^{-1}$ $plant^{-1}$ (5.25 mg / 100 g). When the grafted plants were foliar treated with methyl jasmonate at 200 ppm / litre $plant^{-1}$, the fruits they produced had the highest anthocyanin content (8.41 mg / 100 g).

Methyl jasmonate has been linked to increasing the amount of anthocyanin in fruits grown from grafted plants over two seasons. The principal source of anthocyanin products is sugar, particularly glucose. An increase in phenol concentration and simultaneous activation of the phenylalanine enzyme can be related to an increase in anthocyanin content. The expression of the gene pUFGluT linked to the anthocyanin expression in pomegranate juice may also contribute to the increase in anthocyanin content. Similar results were found in apple cv. Tsugaru by Satoru *et al*. (2002).

Percentage of aril weight (%)

Grafted plants in *ambe bahar* had the highest proportion of aril weight (57.06%), which was significantly higher than the rest of the propagules (Table 4). Nitrobenzene foliar spray, 2.0 ml / litre $plant^{-1}$, increased percentage of aril weight (54.04%). Nitrobenzene was sprayed over the leaves of grafted plants at a rate of 2.0 ml / litre per plant, which increased the percentage of aril weight to 63.95%.

The fruits grown from grafted plants had the highest proportion of aril weight (57.42%) during *hastha bahar*. Regarding the impact of chemicals on the percentage of aril weight, there have been observed to be significant variances. Nitrobenzene foliar spray at 2.0 ml / litre of plant per improved percentage of aril weight (64.51%). Nitrobenzene foliar spray applied to tissue culture plants at a rate of 2.0 ml / litre $plant^{-1}$ has a cumulative effect on the percentage of aril weight (68.71%).

ACKNOWLEDGEMENT

The laboratory facility and the chemicals provided by Dr V.K. Rao, Principal Scientist, Division of plant physiology and Bio chemistry, ICAR – Indian Institute of Horticultural Research, Bengaluru were duly acknowledged.

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