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Use of Chemicals to Realize the Productivity Potential in Pomegranate through Increased Flowering and Fruiting

S. Firoz Hussain[1*], P. Sampath Kumar[1], B.N.S. Murthy[2], K.K. Upreti[4], M.L.N. Reddy[3], J. Satisha[1] and R.H. Laxman[4]

[1]Division of Fruit Crops, ICAR - IIHR, Hesaraghatta, Bengaluru, Karnataka, India
[2]Horticulture Commissioner, Government of India, India
[3]Dr YSRHU, Venkataramannagudem, A.P., India
[4]Division of Plant Physiology and Bio Chemistry, ICAR - IIHR, Hesaraghatta, Bengaluru, Karnataka, India
**Corresponding author*

A B S T R A C T

To realize the productivity potential of pomegranate cv. Bhagwa, studies were conducted on the effects of chemicals (Nitrobenzene (1.0, 1.5 and 2.0 ml plant^{-1}), Cycocel (500, 1000 and 1500 ppm plant^{-1}) and Uracil (25 and 50 ppm plant^{-1}) on flowering behavior and fruit yield during the years 2016-17. Highest number of hermaphrodite flowers (264.66), fruit yield (27.10 kg tree^{-1} and 18.86 t ha^{-1}) and fruit number tree^{-1} (154) were realized with application of uracil @ 50 ppm. However, the uracil treatment did not influence significantly the number of male and intermediate flowers. Application of Cycocel @ 1000 ppm in combination with Uracil @ 25 ppm plant^{-1} has recorded highest fruit weight (197.55g). At flowering stage, the gas exchange parameters like the photosynthetic rate (16.48 µmol m^{-2} s^{-1}) was higher in plants treated with Uracil @ 50 ppm while transpiration rate was higher (7.72 mmol m^{-2} s^{-1}) with uracil @ 25 ppm. Higher stomatal conductance (0.44 mol m^{-2} s^{-1}) was recorded under nitrobenzene @ 1.5ml plant^{-1} treatment. During fruit set stage, photosynthetic rate was high (12.55 µmol m^{-2} s^{-1}) in plants treated with nitrobenzene @ 1.5 ml plant^{-1} whereas, transpiration rate (6.19 mmol m^{-2} s^{-1}) and stomatal conductance (0.18 mol m^{-2} s^{-1}) were higher in plants treated with Cycocel @ 1000 ppm + Uracil @ 25 ppm plant^{-1}. Thus Uracil @ 50 ppm alone seems to be effective in enhancing fruit yield and the beneficial effects were associated following increases in gas exchange parameters and bisexual flowers.

Keywords

Pomegranate, Gas exchange parameters, Flowering and Fruit yield.

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Introduction

Pomegranate (*Punica granatum* L.) is nutritionally an important commercial fruit crop of arid and semi - arid regions of the world (Pal *et al.*, 2014), possessing 2n = 16 or 18 number of chromosomes. The varieties Double Flower (ornamental type) and Vellodu consisted of 2n = 18 chromosome number. The genus *Punica* consisted of two species *Punica granatum* (cultivated type) and *Punica protopunica* (wild type). The cultivated pomegranate species *Punica granatum* possesses two sub - species, *viz.*, *Punica granatum* ssp. *Chlorocarpa* and *Punica granatum* ssp. *Porphyrocarpa*, which are popularly grown in Mediterranean regions especially Morocco, Spain, Egypt and

Afghanistan. It is also grown to some extent in countries like Myanmar, China, Japan, USA, Russia, Bulgaria and Southern Italy.

Globally, India is the leader both in area and production of pomegranate. It produces 2.19 MT of pomegranate from an area of 0.19 m ha (Anonymous, 2016). Among the states, Maharashtra is considered as '*pomegranate basket of India*' because of high cultivation area and production followed by Karnataka, Andhra Pradesh and Rajasthan. In past few years, the area under pomegranate cultivation in India is increasing due to its versatile adaptability, hardy nature, drought tolerance, low maintenance cost, high remunerative nature and good keeping quality, besides owing of medicinal properties due to presence of anthocyanins *viz.,* Cyanidin 3, 5 - diglucoside, Cyanidin 3 – glucoside, Delphinidin 3, 5- diglucoside, Delphinidin 3 – glucoside, Pelargonidin 3, 5 – diglucoside and Pelargonidin 3 - glucoside (Du *et al.,* 1975). Pomegranate is also rich in ellagic acid and punicalgins, which are believed to be potent antioxidants.

The flowering habit of pomegranate is influenced by the prevailing climatic conditions of the geographical region where it is being grown (Pareek and Sharma, 1993). The inflorescence is a dichasial cyme. Flowers can appear solitary, in pairs or in clusters. There are three kinds of flowers borne on the same plant viz., staminate, hermaphrodite and intermediate which occur in about 1 month after bud break on newly developed branches of the same year, mostly on spurs or short branches (Babu *et al.*, 2009). The male flowers are companulate (bell – shaped) whereas the hermaphrodite flowers are urcerate (vase – shaped). The intermediate ones are tubular in shape. If fruit set takes place in such flowers, they may drop before reaching maturity, even if some fruits which reach maturity tend to be misshaped. The ovary of the male flower is rudimentary whereas that of intermediate flowers are of the degenerating type. The ovary in bisexual is well developed with a broad base. The fruit set in pomegranate depends upon hermaphrodite flowers (Chaudari and Desai, 1993). In tropical climates, pomegranate flowers almost throughout the year whereas in subtropics, once a year. In temperate regions, during winter, the plant is deciduous, but in tropical conditions, it is evergreen and flower throughout the year (Hayes, 1957). Since the crop behaves as evergreen under tropical climatic conditions of India, it flowers continuously throughout the year resulting lower yield and poor quality fruit due to depletion of plant reserves. Thus, synchronization of flowering is an ideal option for fetching better yield and quality fruits. Plant growth chemicals play an important role in manipulation of flowering and fruiting in many perennial fruit crops like citrus, grapes and mango etc. Thus in the present investigation, we studied the effects of plant growth chemicals like Nitrobenzene, Cycocel and Uracil applied at different concentrations on flowering and fruiting besides physiological parameters in cv Bhagwa during *Ambe bahar* (January – February) season.

Materials and Methods

The present study was conducted on healthy and uniformly grown tissue culture plants of pomegranate cv Bhagwa procured from M/S Jain Irrigation Pvt Ltd, Jalgoan (Maharashtra) at ICAR- Indian Institute of Horticultural Research, Hesaraghatta farm, Bengaluru during *Ambe bahar* (January to February) season of the years 2016-17. ICAR - IIHR is situated at an altitude of 890 meter above mean sea level at 13^0 7` North latitude and $77^0$ 29` East longitude respectively. The maximum and minimum temperatures recorded during the experiment were 33.08^0C and 20.43^{0}C and relative humidity and rainfall recorded were 75.04% and 74.95 mm respectively. The experiment consisted of eleven treatments which were replicated thrice and the statistical design used was Randomized Block Design (RBD). The treatments included were T_1 – Nitrobenzene (NB) @ 1.0 ml litre^{-1} plant^{-1}, T_2 – NB @ 1.5 ml litre^{-1} plant^{-1}, T_3 – NB @ 2.0 ml litre^{-1} plant^{-1}, T_4 – Cycocel (CCC) @ 500 ppm litre^{-1} plant^{-1}, T_5 – CCC @ 1000 ppm litre^{-1} plant^{-1}, T_6 – CCC @ 1500 ppm litre^{-1} plant^{-1}, T_7 – Uracil @ 25 ppm litre^{-1} plant^{-1}, T_8 – Uracil @ 50 ppm litre^{-1} plant^{-1}, T_9 – T5 + T7, T_{10} – T6 + T8 and T_{11} – Control. Six plants were selected under each treatment. The standard cultural practices such as pruning of twigs, defoliation with ethrel @ 2.0 ml litre^{-1} and desuckering were adopted prior to and during the investigation.

After fifteen days of treatment, observations were recorded on flower types, fruit yield and physiological parameters at flowering and fruit set stages. Number of male, hermaphrodite and intermediate flowers plant^{-1} were recorded by selecting the one quarter of tree canopy and counting of flower number under each quadrant and multiplying the number with four. The fruit set was determined by counting the lemon sized fruits present on entire plant. The individual fruit weight was recorded by randomly selecting nine fruits under each treatment, and the mean value was expressed in g fruit^{-1}. The percentage of fruit set was calculated by formula:

$$\frac{\text{Number of fruits harvested}}{\text{Number of hermaphrodite flowers}} \times 100$$

At harvest, the number of fruits from all the treatments was counted and the mean value was expressed as number of fruits tree^{-1}. Fruit yield was recorded by recording weight of fruits harvested at maturity and expressed as kg tree$^{-1.}$ The gas exchange parameters (photosynthesis rate (P_N), transpiration rate (E) and stomatal conductance (g_s) were measured using the Infra-Red Gas Analyser, (LC PRO portable gas exchange system (ADC BioScientific Ltd, Hoddesdon, UK).

Water use efficiency (WUE) was calculated by ratio between P_N: E. For all these measurements, young fully expanded leaf (second or third leaf counting from the shoot apex) was selected. Measurements were carried out in the morning (9.00 – 11.00 a.m.) at steady light intensity (> 900 mol m^{-2} s^{-1}). The data was analyzed as per the method of variance outlined by Panse and Sukhatme (1985). Statistical significance was tested by F value at 5% level of significance. Critical difference at 0.05 levels was worked out for the effects which were significant.

Results and Discussion

Number of flowers

The data presented in table 1 showed that the treatments significantly increased the number of hermaphrodite flowers (264.7) with Uracil @ 50 ppm being relatively more effective. No significant differences were recorded in male and intermediate flowers number by the imposed treatments. The increase in hermaphrodite flower by Uracil might be the effect of Uracil induced increase in RNA content (Ramteke and Somkumar, 2005) as Uracil is an entity of RNA, which plays role in protein synthesis and gene expression, and thereby phytohormone production for better production (Mathur and Sharma, 1968).

Yield and its attributes

The data presented in table 2 indicated that application of CCC @ 1000 ppm along with Uracil @ 25 ppm plant^{-1} (T_9) realized significantly higher fruit weight (197.55 g) as compared to control. The increase in fruit weight with CCC could be attributed to its inhibitory action by exhibiting anti – gibberellin response, and possible diversion of photosynthates for flowering and fruiting (Guha, 1993; Mansuroglu *et al.*, 2009). In contrast, maximum number of fruits (154.00), fruit yield (27.10 kg tree^{-1} and 18.86 t ha^{-1}) were recorded in plants applied with Uracil @ 50 ppm plant^{-1} (T_8), which could be the result of observed increase in hermaphrodite flowers under this treatment. Chaudari and Desai (1993) reported positive relationship between the percentage of hermaphrodite flowers and bearing capacity in pomegranate cv Mridula. However, no significant differences were apparent among the treatments with respect to percentage of fruit set.

Table.1 Induction of flowering in pomegranate cv Bhagwa as influenced by different growth chemicals

Treatments	Number of Male Flowers	Number of Hermaphrodite Flowers	Number of Intermediate Flowers
T_1 - NB @ 1.0 ml plant^{-1}	277.83	215.66	179.66
T_2 – NB @ 1.5 ml plant^{-1}	287.66	206.66	201.83
T_3 – NB @ 2.0 ml plant^{-1}	241.00	211.66	198.66
T_4 – CCC @ 500 ppm plant^{-1}	274.00	193.33	197.16
T_5 – CCC @ 1000 ppm plant^{-1}	264.66	196.66	195.66
T_6 – CCC @ 1500 ppm plant^{-1}	258.00	190.66	196.66
T_7 – Uracil @ 25 ppm plant^{-1}	268.66	259.66	195.66
T_8 – Uracil @ 50 ppm plant^{-1}	288.33	264.66	194.33
T_9 – T5 + T7	275.33	201.33	207.83
T_{10} – T6 + T8	258.00	196.00	226.66
T_{11} – Control	312.33	188.66	190.00
C.D. at 5%	N.S.	44.10	N.S
S.Em (±)	16.74	14.84	12.27
CV %	10.61	12.16	10.70

*NB – Nitrobenzene and CCC – Cycocel

Table.2 Effect of different chemicals on fruit yield and its attributes in pomegranate cv Bhagwa

Treatments	Fruit weight (g)	Percentage of fruit set	Number of fruits plant^{-1}	Fruit yield (kg tree^{-1})	Fruit yield (t ha^{-1})
T_1 - NB @ 1.0 ml plant^{-1}	177.80	66.30	139.16	24.73	8.51
T_2 – NB @ 1.5 ml plant^{-1}	187.07	55.76	113.83	21.50	9.89
T_3 – NB @ 2.0 ml plant^{-1}	183.00	62.77	132.00	24.18	9.66
T_4 – CCC @ 500 ppm plant^{-1}	196.31	51.67	99.66	19.61	7.82
T_5 – CCC @ 1000 ppm plant^{-1}	193.66	54.22	105.00	20.36	8.13
T_6 – CCC @ 1500 ppm plant^{-1}	187.25	52.01	99.16	18.70	7.42
T_7 – Uracil @ 25 ppm plant^{-1}	176.82	59.09	153.00	26.98	10.82
T_8 – Uracil @ 50 ppm plant^{-1}	176.88	58.16	154.00	27.10	18.86
T_9 – T5 + T7	197.55	55.55	107.00	20.98	8.45
T_{10} – T6 + T8	187.43	56.08	106.00	19.84	7.94
T_{11} – Control	166.54	52.05	98.33	16.31	6.65
C.D. at 5%	15.66	N.S.	31.90	6.39	--
S.Em (±)	5.27	7.00	10.73	2.15	--
CV %	4.94	21.40	15.65	17.05	--

*NB – Nitrobenzene and CCC – Cycocel

Table.3 Gas Exchange parameters in pomegranate cv Bhagwa as influenced by different chemicals during flowering and fruit set stages

	Flowering stage			Fruit set stage		
Treatments	**Photosynthesis (P_N) (µmol m^{-2} s^{-1})**	**Transpiration (E) (mmol m^{-2} s^{-1})**	**Stomatal conductance (g_s) (mol m^{-2} s^{-1})**	**Photosynthesis (P_N) (µmol m^{-2} s^{-1})**	**Transpiration (E) (mmol m^{-2} s^{-1})**	**Stomatal conductance (g_s) (mol m^{-2} s^{-1})**
T1 - NB @ 1.0 ml plant^{-1}	15.22	3.49	0.43	9.80	4.45	0.19
T2 – NB @ 1.5 ml plant^{-1}	13.41	4.92	0.44	12.55	4.83	0.14
T3 – NB @ 2.0 ml plant^{-1}	11.63	5.07	0.38	9.48	4.94	0.16
T4 – CCC @ 500 ppm plant^{-1}	14.65	4.21	0.23	10.63	5.32	0.14
T5 – CCC @ 1000 ppm plant^{-1}	14.12	5.56	0.31	11.71	5.73	0.16
T6 – CCC @ 1500 ppm plant^{-1}	13.28	6.53	0.31	10.87	5.08	0.13
T7 – Uracil @ 25 ppm plant^{-1}	15.22	7.72	0.31	10.67	3.44	0.14
T8 – Uracil @ 50 ppm plant^{-1}	16.48	7.03	0.26	9.55	3.85	0.15
T9 – T5 + T7	11.53	7.03	0.21	11.88	6.19	0.18
T10 – T6 + T8	13.84	7.69	0.24	10.26	4.58	0.13
T11 – Control	10.47	2.37	0.09	9.00	3.48	0.13
CD @ 5%	4.21	1.74	0.16	3.24	1.89	0.07
CV %	18.17	18.32	32.66	17.98	23.51	28.01
S.Em (±)	1.42	0.59	0.05	1.09	0.64	0.02

*NB – Nitrobenzene and CCC – Cycocel

Table.4 Influence of different chemicals on intrinsic water use efficiency in pomegranate cv Bhagwa

	Flowering stage	**Fruit set stage**
T_1 - NB @ 1.0 ml plant^{-1}	4.34	2.45
T_2 – NB @ 1.5 ml plant^{-1}	2.80	2.62
T_3 – NB @ 2.0 ml plant^{-1}	2.30	1.88
T_4 – CCC @ 500 ppm plant^{-1}	3.81	2.00
T_5 – CCC @ 1000 ppm plant^{-1}	2.54	2.04
T_6 – CCC @ 1500 ppm plant^{-1}	2.06	2.14
T_7 – Uracil @ 25 ppm plant^{-1}	1.98	3.09
T_8 – Uracil @ 50 ppm plant^{-1}	2.40	2.53
T_9 – T5 + T7	4.52	1.93
T_{10} – T6 + T8	1.79	2.29
T_{11} – Control	1.65	2.66
C.D. at 5%	1.135	N.S.
S.Em (±)	0.382	0.274
CV %	24.088	20.362

*NB – Nitrobenzene and CCC – Cycocel

Gas exchange characteristics

All the treatments were significantly influenced the gas exchange parameters both at flowering and fruiting stages. At flowering stage, higher photosynthetic rate (16.48 µmol m^{-2} s^{-1}) was registered with the application of Uracil @ 50 ppm $plant^{-1}$ (T_8) while its 25 ppm $plant^{-1}$ (T_7) treatment registered higher transpiration rate (7.72 mmol m^{-2} s^{-1}). The stomatal conductance (0.44 mol m^{-2} s^{-1}) was high in plants applied with Nitrobenzene @ 1.5 ml $plant^{-1}$. There was reduction in gas exchange parameters at fruit set stage compared to flowering stage, which could be attributed to the higher demand for photosynthates for the onset of flowering as reported by Monselise and Lenz (1980). In further support to this Masarovicova and Novara (1994) reported in Apple, higher photosynthesis rate in leaves adjacent to developing flowers as compared to those adjacent to vegetative shoots (Table 3).

Intrinsic Water use Efficiency (WUE)

Water use efficiency (WUE) was significantly increased under T_9 followed by T_1 at flowering stage as compared to fruiting stage. The higher WUE is attributed to greater increase in photosynthetic rate over transpiration rate which is required for the initiation of flowering. Higher WUE helps plants in achieving better flowering, as water availability is crucial for its onset and further development (Table 4).

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References

Anonymous, 2016. 2nd Advance Estimate. National Horticulture Board. Pp – 6.

Babu, K.D., Chandra R., Jadhav, V.T and Sharma, J. 2009. Blossom biology of pomegranate cv. Bhagwa under semiarid tropics of western India. Abstracts of 2nd International Symposium on Pomegranate and Minor Including Mediterranean Fruits, June 23-27, 2009, University of Agricultural Sciences, Dharwad, India, pp 88-89.

Chaudari, S.M., and Desai, U.T. 1993. Effects of plant growth regulators on flower sex in pomegranate (*Punica granatum*). *Indian Journal of Agricultural Sciences*. 63: 34-35.

Du, T., Wang, P.C and Francis, F.J. 1975. Anthocyanins of pomegranate. *J. Sci*. 40: 417-418.

Ferree, D.C., and Palmer, J, W. 1992. Effect of spur defoliation and ringing during bloom on fruiting, fruit mineral level and net photosynthesis of Golden Delicious apple. *J. Amer. Soc. Hort. Sci.* 107: 1182-1186.

Guha, D., 1993. Regulation of tree growth and yield in Golden Delicious apple with Cycocel and ethrel. *South Indian J. Hort*., 41(6): 333-340.

Hayes, W.B., 1957. Fruit Growing in India. 3rd Edn, Kitabistan, Allahabad, pp. 502.

Mansuroglu, S., Karaguzel, O, Ortacesme, V and Sayan, M.S. 2009. Effect of Paclobutrazol on flowering, leaf and flower colour of *Consolida orientalis*. *Pakistan J. Bot*. 41: 2323-2332.

Masarovicova, E., and Novara, J. 1994. Influence of fruit load on CO_2 exchange, water uptake and biomass of apple trees. *Gartenbauwissenchaft*. 59: 132-138.

Mathur, S.N., and Sharma, R.A. 1968. Effect of Uracil and 5 – Nitrouracil on Growth and Flowering of Tomato. *Physiologia Plantarum*. 21: 911-917.

Monselise, S.R., and Lenz, F. 1980. Effect of fruit load on photosynthetic rates of budded apple trees. *Gartenbauwissenchaft*. 45: 220-224.

Pal, R.K., Dhinesh Babu, K., Singh, N.V., Ashish Maity and Nilesh Gaikwad. 2014. Pomegranate Research in India – Status and future challenges. *Progressive Horticulture*. 46(2):184-20.

Panse, V. S., and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers, ICAR, New Delhi.

Pareek, O.P., and Sharma, S. 1993. Genetic resources of under exploited fruits. In: Chadha KL, Pareek, OP (Eds) *Advances in Horticulture* (Vol1), Malhotra Publication, New Delhi, pp 189-225.

Ramteke, S.D., and Somkumar, R.G. 2005. Effect of quantum on increasing growth, yield and quality of grapes. *Karnataka J. Agric Sci*. 18(1): 13-17.

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