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Improve the fruit setting and quality of pomegranate (*Punica granatum* L.), cv. Bhagwa by spraying the plant growth regulators under Allahabad agro climatic conditions

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Abstract
An experiment was conducted at Central Research Field, Dept. of Horticulture, Sam Higgin bottom University of Agriculture, Technology & Sciences, Naini, Allahabad, during 2017-18. The experiment was laid out in randomized block design with ten treatments and each replicated thrice, to study the response of various plant growth regulators at different concentrations namely, ethrel (50, 75, 100 ppm), GA_3 (25, 40, 60 ppm) and 2,4-D (5, 7.5, 10 ppm) on fruit set and fruit quality of pomegranate cv. Bhagwa. The results indicated that T_6 (GA_3 60 ppm) was found beneficial in increasing plant height (236.66 cm), plant spread (198.00 cm), number of branches (9.67) and minimum total acidity (0.37 %). T_3 (ethrel 100 ppm) best perform in term of number of flower per plant (115.33), minimum days taken to first ripe fruit (169.33), number of fruit per plant (29.33), yield per plant (5.51 kg), fruit yield per hectare (2204.00 kg), fruit weight (188.16 g), specific gravity (1.005), pH (4.50), and ascorbic acid (10.25 mg/ 100 g) then T_9 (2, 4-D 10 ppm) best in term of total soluble solid (14.80 ^{0}Brix).

Keywords: PGR, GA_3, ethrel, 2, 4-D, vegetative growth, quality

Introduction
Pomegranate is native to Persia (Iran), Afghanistan and Baluchistan (De Candolle, 1967) [1]. The fruit is commercially cultivated in countries like Morocco, Pakistan (Baluchistan), Iraq, Iran, China, Japan, Russia and India. Although, pomegranate was adapted to Mediterranean climate, yet it thrives well under hot dry summer with cool winter. However, it is a hardy plant and can also withstand considerable amount of drought. It can tolerate frost to a considerable extent during dormant stage but gets injured at temperature below -11 °C (Kaulgud, 2001) [2]. It was introduced into Spanish America in the late 16th century and California, by Spanish settlers, in 1769. Today, it is widely cultivated throughout the Middle East and Caucasus region, north and tropical Africa, the Indian subcontinent, Central Asia, the drier parts of South East Asia, and parts of the Mediterranean Basin. It is also cultivated in parts of Arizona and California. In recent years, it has become more common in the commercial markets of Europe and the Western Hemisphere.
According to the National Horticulture Board of India there is a undersized increase in the area of pomegranate cultivation in India from 109.83 thousand ha in 2015-16 to 121.09 thousand ha in 2016-17; similarly, the production has increased from 1924.22 thousand tons to 2038.44 thousand tone (NHB database 2016-2017).
Maharashtra is the leading State with 136.75 thousands hectare area under pomegranate cultivation, followed by Karnataka and Gujarat with 28.09 thousand hectare and 18.54 thousand hectare respectively. Andhra Pradesh and Madhya Pradesh stood at fourth and fifth position with 7.71 and 9.23 thousand ha of pomegranate cultivation in India.
There is a growing demand for good quality fruits both in the form of fresh and processed products such as juice, syrup, anardana and wine. The rind of the pomegranate fruit contains tannins, which are successfully used in leather industry and pharmaceuticals (Siddappa, 1943) [8]**.** The rind of fruit is also a source of dye which has been used for dying the wool and silk (Patil and Karale, 1985) [4]**.** The pomegranate rind is used in the preparation of medicines that has properties of curing intestinal disorders (Salunkhe, *et al*. 1963) [9]. It has high therapeutic values for sickness; indigestion and leprosy cure (Sheikh, 2006) [10].

Nutritional composition per 100 g edible portion

Minerals - Magnesium 3%, Manganese 5%, Phosphorus 5%, Zinc 3%.

Vitamins - Vitamin C 17%, Vitamin K 14%, Thiamin 5.5%, Riboflavin 4%,

Other - Energy 4%, Carbohydrate 14%, Protein 3%, Fat 6%, Fiber 11%,

Materials and Methods

The present experiment was conducted in Central Research Farm, Department of Horticulture, N.A.I., Sam Higginbottom University of Agriculture, Technology and sciences, Allahabad-211007, (U.P.) during 2017-18. The experiment was tested in Randomized Block Design (RBD) with three replications and consisted of 10 treatments namely Treatment combination T_0 Control, T_1 Ethrel (50 ppm), T_2 Ethrel (75ppm), T_3 Ethrel (100 ppm), T_4 GA_3 (25 ppm), T_5 GA_3 (40 ppm), T_6 GA_3 (60 ppm), T_7 2, 4-D (5ppm), T_8 2, 4-D (7.5 ppm), T_9 2, 4-D (10ppm). Observations are recorded on plant height (cm), plant spread (cm), number of branches, number of flowers plants^{-1}, Days taken to first fruit**,** number of fruit plant^{-1}**,** Fruit yield plant^{-1} (kg)**,** Fruit yield ha^{-1} (kg), Weight of fruit (g), Specific gravity, Total soluble solids (^{0}Brix), pH of the fruit juice, Total acidity (%), Ascorbic acid (mg/100g of fruits).

Results and Discussion

Table-1 and Fig-1 show the growth of pomegranate plant was significantly influenced by GA_3, Ethrel and 2, 4-D. Maximum plant height (236.66 cm) Pandey (1999) [5], plant spread (198.00 cm), number of branches (9.67) and minimum total acidity (0.37 %) were recorded by the application of T_6 (GA_3 60 ppm) followed by treatments comprising of T_3 (Ethrel 100 ppm) where plant height (235.66 cm), plant spread (192.66cm), number of branches (9.33) and total acidity (0.39 %) then maximum number of flower per plant (115.33), minimum days taken to first ripe fruit (169.33), number of fruit per plant (29.33), yield per plant (5.51 kg), Reddy and Prasad (2012) [7]**,** fruit yield per hectare (2204.00 kg), Table-2 and Fig-2 show the maximum fruit weight (188.16 g), Pawar, *et al.* (2005) [6]**,** specific gravity (1.005), pH (4.50), and ascorbic acid (10.25 mg/100 g), were recorded by the application of cent per cent T_3 (Ethrel 100 ppm) followed by treatments comprising of T_6 (GA_3 60 ppm) where maximum number of flower per plant (109.00), minimum days taken to first ripe fruit (170.33), number of fruit per plant (28.00), yield per plant (5.15 kg), fruit yield per hectare (2060.00 kg), fruit weight (184.00 g), specific gravity (1.004), pH (4.30), and ascorbic acid (9.90 mg/ 100 g) found T_2 (ethrel 75 ppm) then maximum total soluble solids (T.S.S.) (^{0}Brix) was recorded inT_9 (2, 4-D 10 ppm) with (14.80 ^{0}Brix), Mohamed (2004) [3], followed by T_8 (2, 4-D 7.5 ppm) with (14.60 ^{0}Brix).

Conclusion

On the basis of results obtained, It is concluded that the treatment T_3 (Ethrel 100 ppm) was found to be the best in terms of maximum yield (2204.00 kg) and quality of pomegranate with net return (121255Rs/ha.) and maximum benefit cost ratio (3.90).

Plant growth regulators have become powerful tools to modify several physiological process in plants which are extensively and profitably used in horticultural crops. They are also used for increasing yield and improving quality of fruits to exogenous application of plant growth regulators has been reported by several workers.

Table 1: Effect of different plant growth regulators on vegetative growth & yield of pomegranate *(Punica granatum l.)* cv. Bhagwa under Allahabad agro climatic condition

Treatments	Plant height	Plant spread	Number of branches	Days taken for first ripe fruit	no. of flower/plant	fruit/plant	yield/plant (kg)	yield/ha (kg)
T_0 Control	179.66	146.50	7.33	190.66	51.66	13.00	1.40	560.00
T_1 Ethrel (50ppm)	189.66	173.41	9.00	176.33	82.00	20.33	3.36	1344.00
T_2 Ethrel (75ppm)	215.00	178.16	8.33	174.33	87.33	22.33	3.26	1304.00
T_3 Ethrel (100ppm)	235.66	187.58	9.33	169.33	115.33	29.33	5.51	2204.00
T_4 GA_3 (25ppm)	220.00	183.75	9.00	174.00	86.00	22.00	3.28	1312.00
T_5 GA_3 (40ppm)	217.50	190.00	9.33	175.66	95.33	25.00	3.92	1568.00
T_6 GA_3 (60ppm)	236.66	198.00	9.67	170.33	109.00	28.00	5.15	2060.00
T_7 2, 4-D (5ppm)	216.33	192.66	7.67	174.00	78.66	20.00	2.90	1160.00
T_8 2, 4-D (7.5ppm)	228.83	183.25	8.33	172.66	73.00	20.33	2.93	1172.00
T_9 2, 4-D (10ppm)	221.33	171.71	7.67	176.00	70.66	21.00	2.37	948.00
F- test	S	S	S	S	S	S	S	S
S. Ed. (±)	2.882	3.866	0.58	1.112	3.653	2.145	0.423	6.964
C. D. (P = 0.05)	5.948	7.980	1.22	2.295	7.539	4.427	0.874	14.375

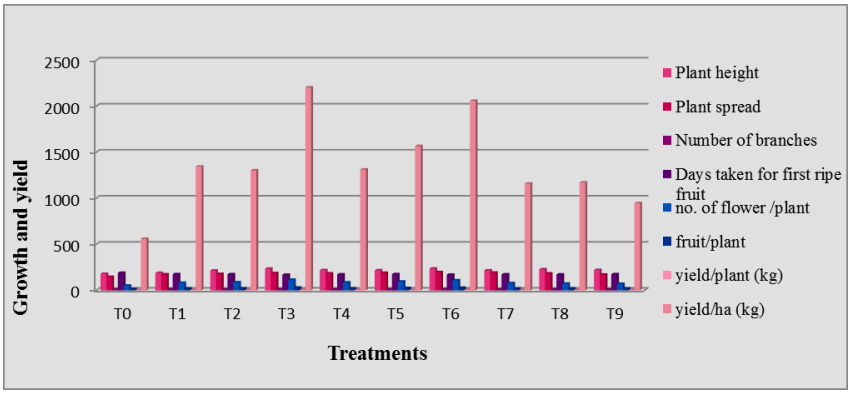

Fig 1: Effect of different plant growth regulators on vegetative growth & yield of pomegranate *(Punica granatum* L.) cv. Bhagwa

Table 2: Effect of different plant growth regulators on physical and chemical properties of pomegranate (*Punica granatum* L.) cv. Bhagwa under Allahabad agro climatic condition

Treatments	Average Fruit Weight (gm)	Specify Gravity	TSS	pH	Acidity	Ascorbic Acid	Benefit Cost Ratio
T_0 Control	108.00	0.997	10.66	3.60	0.50	8.22	1.02
T_1 Ethrel (50ppm)	168.50	0.980	13.66	4.00	0.43	9.45	2.39
T_2 Ethrel (75ppm)	146.33	0.970	13.83	4.16	0.42	9.90	2.31
T_3 Ethrel (100ppm)	188.16	1.005	14.00	4.50	0.39	10.25	3.90
T_4 GA_3 (25ppm)	149.33	0.990	12.45	4.30	0.44	9.30	2.33
T_5 GA_3 (40ppm)	157.16	0.960	13.33	3.80	0.41	8.82	2.79
T_6 GA_3 (60ppm)	184.00	1.004	12.33	4.25	0.37	8.96	3.66
T_7 2, 4-D (5ppm)	145.00	0.900	14.20	3.60	0.45	9.75	2.07
T_8 2, 4-D (7.5ppm)	144.33	1.000	14.60	4.06	0.40	9.00	2.09
T_9 2, 4-D (10ppm)	113.33	0.998	14.80	3.90	0.46	8.50	1.69
F- test	S	NS	S	NS	S	S	
S. Ed. (±)	2.369	0.249	0.593	0.219	0.177	0.386	
C. D. (P = 0.05)	4.890	0.333	1.044	0.633	0.184	0.796	

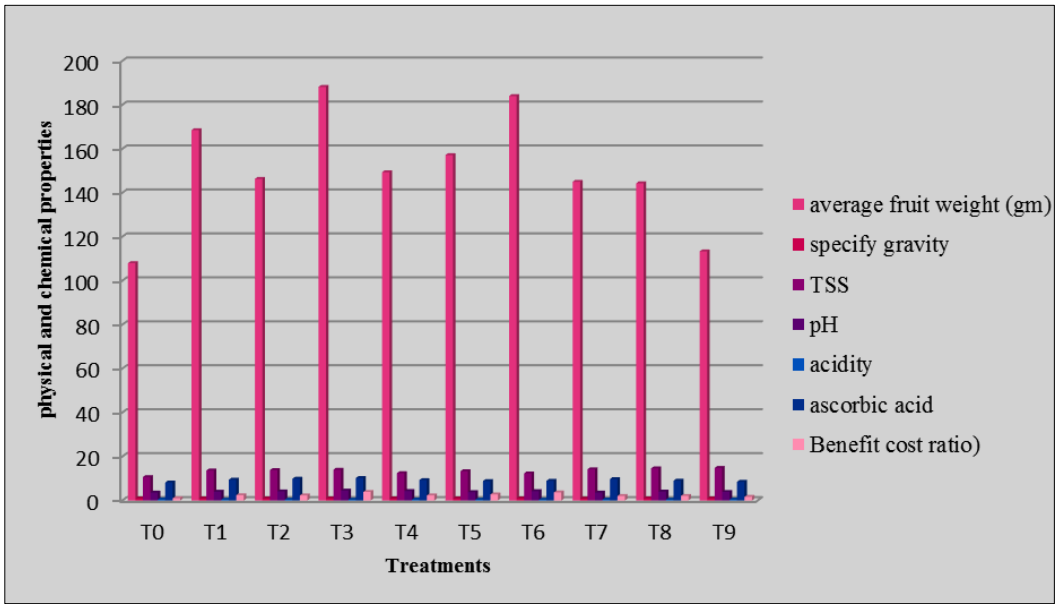

Fig 2: Effect of different plant growth regulators on physical and chemical properties of pomegranate *(Punica granatum l.)* cv. Bhagwa

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