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Studies on foliar application of plant growth regulators and chemicals on yield & quality of pomegranate cv. Phule Bhagwa super

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Abstract
The present investigation entitled "studies on foliar application of plant growth regulators and chemicals on yield & quality of pomegranate cv. Phule Bhagwa Super" was undertaken at experimental farm of Horticulture section, College of Agriculture, Dhule. The experiment was laid out in the Randomised Block Design with twelve treatments and three replications with fifteen days interval from fruit set stage. The experimental results indicated that, there were significant difference in fruit set %, average fruit weight (gm), number of fruits plant^{-1}, length of fruit (gm), diameter of fruit (cm) and yield plant^{-1} which was highest in $FeSO_4$ – 0.5% + $ZnSO_4$ – 0.5% + GA_3 - 50ppm. Days from flowering to fruit set were not influenced by the treatments studied. The economics of pomegranate cultivation with foliar application of plant growth regulator and chemicals showed a wide range of variation in cost of cultivation, gross monetary returns, net monetary returns and B:C ratio (2.85) were obtained in the treatment T_{11} ($FeSO_4$ - 0.5% + $ZnSO_4$ - 0.5% + GA_3 - 50ppm) and lowest was observed in the treatment T_{12}(control). The overall results indicated that foliar application of $FeSO_4$– 0.5% + $ZnSO_4$ – 0.5% + GA_3 - 50ppm was significantly found to be beneficial to the economically important characters viz. fruit set, number of fruits, average fruit weight and yield plant^{-1} and the cost benefit ratio was 2.85.

Keywords: yield characters, quality characters, plant growth regulator, pomegranate

Introduction
Pomegranate (*Punica granatum* L.) belongs to the *Punicaceae* family. It is native to Persia (Iran) and widely cultivated in the Mediterranean region [1]. The edible part called aril of the fruit is consumed fresh or processed in to jams, jellies, wine, and beverages [2-4] the processed product anardana is famous in North India. Pomegranate is known to have been domesticated in the Middle East about 5000 years ago [5-6]. It is highly suitable for growing under arid and semiarid regions due to its versatile adaptability, hardy nature, low cost maintenance and high returns. In recent past, its significance in health, nutrition and livelihood security has been recognized which resulted in heavy demand for fruits not only in India but throughout the globe. Its versatile adaptability, hardy nature, less cost in orchard management, high yield potential, excellent keeping quality, fine table and therapeutical values have made this fruit more lucrative and remunerative. To highlight its importance, it was chosen as a symbol of the 18th International Horticultural Congress held during 1970, showing it in a basket. Pomegranate is one of the first five domesticated edible fruit crops along with fig, date palm, grape and olive. It has been the symbol of health, fertility and rebirth as mentioned in many ancient cultures. Pomegranate is one of the richest sources of Riboflavin. Rind of the fruit, bark of stem and root of pomegranate contain more than 28 per cent gallotannic acid and dye which is useful in tanning as natural bio-dye. Pomegranates are rich in polyphenols, specifically ellagic acid and punical-gins, which can act as potent antioxidants. Ellagic acid is found in the fleshy testa of the pomegranate besides other red coloured berries. Punicalgins are found only in the outer skin of the pomegranate and are estimated to have twice the antioxidant capability of red wine and green tea [6].

Materials and Methods
The experiment was conducted at horticultural farm, horticulture section, and college of agriculture Dhule, during 2017-18 on Phule Bhagwa Super planted at a spacing of 4.5 × 3 m.

The experimental trees were four years old. Totally, 12 different treatments of GA3, KNO_3, K_2SO_4, $FeSO_4$ and $ZnSO_4$ at different concentrations these were T_1 (GA_3 – 25 ppm), T_2 (GA_3 - 50ppm), T_3 (GA_3 - 75 ppm), T_4 (KNO_3- 0.5%), T_5 (K_2SO_4 – 0.5%), T_6 (KNO_3 0.5% + K_2SO_4 0.5%), T_7 ($FeSO_4$ – 0.5%), T_8 ($ZnSO_4$ – 0.5%), T_9 ($FeSO_4$ 0.5%+ $ZnSO_4$ 0.5%), T_{10} (KNO_3- 0.5% + K_2SO_4 – 0.5% + GA_3 - 50ppm) T_{11} ($FeSO_4$ – 0.5% + $ZnSO_4$ – 0.5% + GA_3 - 50ppm) and T_{12} (Control) sprayed in pomegranate orchard with three replications. The experiment was laid out in a Randomized Block Design. The growth regulators were sprayed after fruit set stage. Two plants were sprayed in each treatment. Fruit set was estimated as four branches of one meter length were selected on each tree in all directions. The number of flowers present on these branches was counted 20 days after full bloom, the number of fruits were also counted as fruit set. Average fruit weight was calculated by taken five fruits from each observational plant were selected randomly and their weight was recorded on electronic weighing balance, the weight was expressed in grams (g). The yield was recorded at the time of harvest and expressed in terms of kg plant^{-1}. The physiological loss in weight was recorded by taking readings at 4 days intervals after harvest. The data recorded was analyzed using the statistical procedures as described by [7].

Result and Discussion

Yield character

In the present study, the economic yield contributing characters *viz*., fruit set, days from flowering to fruit set, fruit weight, number of fruits plant^{-1}, fruit length, fruit diameter, yield kg plant^{-1} was significantly increased by spraying of plant growth regulator and chemicals. Among the different treatments tried, sprayed with combination of FeSO4 (0.5%) + $ZnSO_4$ (0.5%) +GA_3 (50ppm) produced the highest fruit set (32.31%), least days for flowering to fruit set (37.00), fruit weight (245.18 g), number of fruits plant^{-1} (60.18), fruit length (7.41cm), fruit diameter (6.95 cm), yield kg plant^{-1} (14.75 kg plant^{-1}). The lowest yield parameters were recorded by control (T_1) water spray. This might be due to the foliar application of Zn alone or in combination had a significant effect on reduction in flower drop and improve the fruit set percentage as reported by [8] in pomegranate. Highest fruit set (32.31%) was observed in the treatment FeSO4 (0.5%) + $ZnSO_4$ (0.5%) + GA_3 (50ppm). Similarly [9] reported that the zinc sulphate which plays an important role in translocation of carbohydrates and auxin synthesis to the sink, increased pollen viability and fertilization. The number of days taken for fruit set in relation to different growth regulators was found to be non-significant. Among the different treatments, the plants treated with FeSO4 (0.5%) + $ZnSO_4$ (0.5%) + GA_3 (50ppm) showed minimum days (37.00) taken for fruit set as against FeSO4 (0.5%) (41.83). Zinc is essential for auxin and protein synthesis, seed production and proper maturity and increase in weight of fruits (245.18 g) might be high level of auxins maintained by zinc application and also due to the increase in fruit length (7.41cm) and fruit diameter (6.95 cm) this may be due to immediate absorption of auxins, which increased the endogenous auxin level this resulted in cell elongation which in Turn accelerated the development of fruits. Beneficial effects of GA3 were also recorded by [10] for all the parameters in pomegranate [11]. Reported that the increased fruit weight due to GA3 application might be due to greater size of fruit and certain changes in metabolism of fruit which reflected in more accumulation of water and enhanced deposition of soluble solids.

Table 1: Effect of plant growth regulator and chemicals on fruit set (%), days from flowering to fruit set, average fruit weight (gm), number of fruits plant^{-1}, diameter (cm), length (cm), yield (kg plant^{-1})

Treatment No.	Treatment Details	Fruit set %	Days from flowering to fruit set	Average fruit Weight (gm)	Number of fruits plant^{-1}	Diameter (cm)	Yield (kg plant^{-1})	Length (cm)
T_1	GA_3 – 25 ppm	21.26	37.83	205.18	38.97	6.17	8.00	6.15
T_2	GA_3 - 50ppm	22.79	38.67	213.25	39.88	6.76	8.50	6.72
T_3	GA_3 - 75 ppm	25.33	37.50	212.15	44.96	6.73	9.52	6.78
T_4	KNO_3- 0.5%	23.80	41.50	210.14	35.75	6.07	7.51	5.82
T_5	K_2SO_4 – 0.5%	22.72	39.83	212.40	37.73	6.16	8.01	5.97
T_6	KNO_3 (0.5%) + K_2SO_4 (0.5%)	22.71	40.00	206.08	37.93	6.05	7.79	6.18
T_7	$FeSO_4$ – 0.5%	27.53	41.83	223.45	45.95	6.30	10.28	6.10
T_8	$ZnSO_4$ – 0.5%	26.85	40.17	214.32	45.84	6.60	9.81	6.39
T_9	$FeSO_4$ (0.5%)+ $ZnSO_4$(0.5%)	27.37	37.50	228.48	49.44	6.83	11.29	6.51
T_{10}	KNO_3- 0.5% + K_2SO_4 – 0.5% + GA_3 - 50ppm	27.87	38.17	224.74	50.50	6.72	11.55	6.71
T_{11}	$FeSO_4$ – 0.5% + $ZnSO_4$ – 0.5% + GA_3 - 50ppm	32.31	37.00	245.18	60.18	7.74	14.75	7.41
T_{12}	Control	17.98	41.33	168.68	31.88	4.93	5.47	4.46
	S. E. ±	1.0801	1.1411	5.0552	2.6447	0.2306	0.6615	0.2135
	C. D. 0.5%	3.1679	3.3468	14.8264	7.7566	0.6764	1.9401	0.6262

The data revealed that the different treatments had significant effect on yield parameters (Table 1). The maximum number of fruits per plant (60.18), yield in (14.75 kg plant^{-1} and 109.19 qt ha^{-1}) was recorded with application of FeSO4 (0.5%) + $ZnSO_4$ (0.5%) + GA_3 (50ppm). This may be due to the better physiology of developing fruits in terms of better supply of water, nutrients and other compounds vital for their proper growth and development which resulted in improved size and ultimately greater yield because of GA_3. Beneficial effects of GA_3 were recorded by [10] in cv. Ruby, [12] in cv. [12] in cv. Sindhuri of pomegranate [13]. reported that Zinc assists the translocation of metabolites from source to sink, which leads to retention of more number of fruits on tree. The combined application of zinc with iron significantly increased number of fruits and yield.

Effect of plant growth regulator and chemicals on quality characters

Pomegranate has been of recent interest for its nutritional, chemical and antioxidant characteristics. The composition of mineral nutrients and chemical properties of fruit differs depending on cultivar, growing region, climate, maturity and

cultural practice [14] Minerals and plant growth hormones affect production and fruit quality either directly or indirectly. Most effects are indirect and act via alteration of vigor and capacity, and thereby the partitioning of primary and secondary photosynthetic metabolites such as carbohydrates, organic acids, proteins, growth regulators and flavor compounds [15].

Table 2: Effect of plant growth regulator and chemicals on Total soluble solids (tss)˚ brix, Total sugar, Acidity, Physiological loss in weight, Shelf life (days).

Treatment No.	Treatment Details	Total soluble solids (tss)˚brix	Total sugar	Acidity	Physiological loss in weight	Shelf life (days)
T_1	GA_3 – 25 ppm	13.88	13.12	0.34	28.54	20.34
T_2	GA_3 - 50ppm	13.89	13.23	0.33	28.31	21.17
T_3	GA_3 - 75 ppm	14.35	14.03	0.31	28.13	21.70
T_4	KNO_3- 0.5%	14.01	13.61	0.39	29.77	19.76
T_5	K_2SO_4 – 0.5%	14.01	13.39	0.39	29.71	20.33
T_6	KNO_3 (0.5%) + K_2SO_4 (0.5%)	14.43	13.58	0.37	28.75	20.45
T_7	$FeSO_4$ – 0.5%	14.15	13.54	0.31	29.01	21.13
T_8	$ZnSO_4$ – 0.5%	14.28	13.69	0.32	28.87	21.30
T_9	$FeSO_4$ (0.5%)+ $ZnSO_4$(0.5%)	14.26	13.99	0.32	28.17	22.68
T_{10}	KNO_3- 0.5% + K_2SO_4 – 0.5% + GA_3 - 50ppm	14.16	13.91	0.36	27.89	22.67
T_{11}	$FeSO_4$ – 0.5% + $ZnSO_4$ – 0.5% + GA_3 - 50ppm	15.52	15.13	0.30	26.21	24.72
T_{12}	Control	12.49	12.04	0.56	32.23	19.17
	S. E. ±	0.2807	0.3181	0.01027	0.7962	0.5308
	C. D. 0.5%	0.8232	0.9329	0.03012	2.3353	1.5568

The results of the present experiment on improving the quality of pomegranate fruits indicated that spraying thrice with FeSO4 (0.5%) + $ZnSO_4$ (0.5%) + GA_3 (50ppm) had recorded the maximum total soluble solids (TSS) (15.52˚brix), total sugar (15.13), acidity (0.30), physiological loss in weight (26.21) and shelf life (24.72 days) and the lowest was recorded in control (Table 2).

Singh and [16] recorded, increase in sugar and TSS (15.52) by zinc might be due to the active enzymatic reaction like transformation of carbohydrates, activity of hexokinase and formation of cellulose (table 2). According to [17] Gibberellins increase the total sugar (15.13) content by inducing synthesis of α-amylase which is responsible for conversion of starch into sugars in fruits. The possible reason for the increasing shelf life (24.72) and reduced weight loss (26.21) was by growth regulators might be due to some chemical changes within the fruits, resulting in retention of more water against the rate of evaporation or transpiration [18].

Conclusion

From the above results it can be concluded that the foliar application of three sprays of $FeSO_4$ – 0.5% + $ZnSO_4$ – 0.5% + GA_3 - 50ppm starting from fruit set stage at 15 days interval resulted in high yield and yield contributing characters *viz.* fruit set, days for flowering to fruit set, fruit weight, number of fruits plant^{-1}, fruit length, fruit diameter, yield kg plant^{-1} and also improves quality characters like total soluble solids (TSS), total sugar, acidity, physiological loss in weight and shelf life of pomegranate cv. Phule Bhagwa Super.

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