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Influence of fertigation and growth regulators on yield and quality of pomegranate (*Punica granatum* L.) cv. Sinduri

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ABSTRACT

An investigation was carried out by the Department of Fruit Science, College of Horticulture and Forestry, Jhalawar. The experiment was conducted in the pomegranate orchard established under high density planting system at the Krishi Vigyan Kendra, Jhalawar, from July 2018 to December 2018 and again from July 2019 to December 2019. The experiment was laid out in Factorial Randomized Block Design, and each treatment was replicated thrice. The experiment comprised of 27 treatment combinations consisting of plant growth regulators levels (NAA 0, 50 and 100 ppm and ethrel 0, 150 and 250 ppm) and fertigation levels (0, 75 and 100 % recommended dose of fertilizers). Among the various levels of plant growth regulators and fertigation treatment, maximum mean yield per plant (6.80 kg), yield per hectare (75.52 quintal), TSS (14.00 °Brix), ascorbic acid (12.97 mg/100g), reducing sugar (9.50 %), non-reducing sugar (1.79 %), total sugar (11.28 %), sugar: acid ratio (11.26) and juice (36.09 %) along with minimum acidity (1.03 %) was recorded in F2 (Fertigation 100 per cent recommended dose of fertilizers) while maximum mean anthocyanin (14.75 mg/g) was recorded under 250 ppm ethrel (E2). However, it is inferred that the interaction effect of NAA, ethrel and fertigation was relatively superior to their individual effect. In interaction effect maximum mean TSS(15.02°B), ascorbic acid (14.19 mg/100g), reducing sugar (10.09 %), non-reducing sugar (2.43 %), total sugar (12.52 %), sugar: acid ratio (14.64), anthocyanin (15.82 mg/g) and juice (38.83 %) along with minimum acidity (0.84 %) was recorded under treatment combination of 100 ppm NAA + 250 ppm ethrel + 100 per cent recommended dose of fertilizers through fertigation (N2E2F2) which was highest among all treatments including control.

Keywords: *Punica granatum* L., NAA, Ethrel, Fertigation, High density planting, Pomegranate, Sinduri

INTRODUCTION

Pomegranate (*Punica granatum* L.) is one of the most valuable fruit crops of India. It is generally known in a distinct family *Lythraceae*. The plant growth regulators have been used for various beneficial effects such as to modify a crop by changing the rate or pattern or both of its response to the internal and external factors that govern development from germination through vegetative growth, reproductive development, maturity and senescence or aging, promoting root growth and the number of flowers, increasing the fruit set, fruit size, quality and for inducing early and uniform fruit ripening as well as postharvest preservation. Application of fertilizers through fertigation, improves fertilizer and water use efficiency, helps to maintain nutritional balance and nutrient concentration at optimum level, provides opportunity to apply the nutrients at critical stages of crop growth and minimizes hazard of ground water pollution due to nitrate leaching as compared to conventional practice of fertilizers application. Plant growth regulators and fertigation are the most important inputs which directly affect the plant growth, development, yield and quality of produce. In any production system, the primary goal is to achieve maximum fruit yield per unit area without affecting the fruit quality. In pomegranate, apart from average fruit weight, the quality is determined by total soluble solids, sugars (reducing, non reducing and total), sugar acid ratio, ascorbic acid, acidity and anthocyanin. Farmers are using solid fertilizers for fruit crop production but these are not completely water soluble and hence are less accessible to plants and several of the fertilizers hold salts of sodium and chloride which not only influence the quality of crop but they are also dangerous to the soil. However, the information regarding plant growth regulators and fertigation scheduling in pomegranate under high density planting system is lacking. Keeping these aspects in view, the present investigation was undertaken to study the influence of fertigation along with plant growth regulators application on yield and fruit quality attributes of pomegranate cv. Sinduri under high density system of planting.

MATERIALS AND METHODS

An investigation was carried out under the Department of Fruit Science, College of Horticulture

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and Forestry, Jhalawar (Agriculture University, Kota). The experiment was conducted in the pomegranate orchard established under high density planting system (3 m × 3 m) at the Krishi Vigyan Kendra, Jhalawar in the near vicinity of the college during July 2018 to December 2018 and again during July 2019 to December 2019. Six years old pomegranate plants of uniform size and growth were selected at the Krishi Vigyan Kendra, Jhalawar, (Agriculture University, Kota) for experimentation. The experiment was laid out in Factorial Randomized Block Design and each treatment was replicated thrice and per treatment two plants were used. The treatments consisted of two different plant growth regulators namely NAA and ethrel, and fertigation of recommendation dose of fertilizers with three levels of each (NAA 0, 50 and 100 ppm and ethrel 0, 150 and 250 ppm) and fertigation levels (0, 75 and 100 % recommended dose of fertilizers). Recommended dose of urea, phosphoric acid and muriate of potash were applied @ 625, 250 and 250 g per plant respectively, for six years old pomegranate plants. Water soluble fertilizers were applied through drip irrigation system (fertigation). Amount of water soluble fertilizers were determined by calculating amount of nitrogen, phosphorus and potassium in recommended dose. The plain distilled water and basal dose of fertilizers were applied on the plants for control. In this way total twenty seven treatments were used in this experiment. The plant growth regulators were sprayed at pre flowering and post flowering stage and fertigation were applied monthly in four equal split dose from 1 July to 1 October on both years, after recording initial (base) growth and development parameters of plants. The desired quantities of plant growth regulators and fertilizers were procured from different sources for the purpose of experiment and required quantities of these materials were applied on individual plant. Yield per plant (kg) was calculated by total number of fruits at each harvest was weighed for each plant on pan balance till the last harvest, yield per hectare (quintal) was calculated by multiplying the value of yield per plant (kg) by total number of plants per hectare and dividing the result by hundred. Total soluble solids content of the fruit was determined by using a digital TSS meter, the acidity and ascorbic acid of the fruit juice was measured the method given by A.O.A.C. (2), sugar: acid ratio was estimated mathematically by dividing the value of total sugars with titrable acidity and the data so obtained was expressed as sugar: acid ratio, sugars content was measured by the fehling's solution method, juice was weighed with the help of balance and the percentage of juice was worked out on the basis of total weight of fruit and weight of juice, for anthocyanin weighing 5.0 g of the homogenized pomegranate samples were dissolved in 25 ml methanolic hydrochloric acid (85:15) solution and samples were kept for 24 hours at cool temperature (4-5 ^{o}C) for the extraction of anthocyanin pigment. The flocculate was filtered off by a Whatman filter paper No. 1 and the absorbance of the resulting clear liquid was measured at 535 nm in Spectrophotometer.

RESULTS AND DISCUSSION

The data obtained on yield in response to application of different levels of plant growth regulators and fertigation are summarized in Table 1. Among the various levels of NAA treatment, the maximum mean number of fruits per plant (33.03), yield (6.77 kg/plant) and (75.26 quintal/hectare) was recorded in the treatment N_2. Significant difference on yield per plant was observed among the various levels of ethrel treatment. The maximum number of fruits per plant and yield were recorded in the treatment E_2 having values of (32.47 fruits/plant), (6.49 kg/plant) and (72.13 quintal/hectare) respectively. Yield per plant was significantly different among the fertigation treatments during 2018 and 2019. The maximum mean number of fruits per plant (32.81), yield (6.80 kg/plant) and (75.52 quintal/hectare) was observed in treatment F_2 which consist of 100 per cent recommended dose of fertilizers. The data in Table 2 further reveal that interaction effect of NAA, ethrel and fertigation was significantly observed in yield of pomegranate. The number of fruits per plant (36.42) and yield (8.09 kg/plant) and (89.85 quintal/hectare) were recorded maximum with treatment combination of $N_2E_1F_2$ (NAA @ 100 ppm + ethrel @ 150 ppm + fertigation @ 100 % RDF). The increase in yield of pomegranate fruits by application of plant growth regulators and fertigation treatments may be due to its leads to improvement in yield contributing characters like size and weight of fruits, fruit set percent, fruit retention per cent as evident by the present study which finally increased the yield. Furthermore, uniform application and quantity of nutrients directly in vicinity of the root zone throughout crop growth period increased the nutrient use efficiency which leads to enhance yield of crop coupled with increase in physiological processes and efficient translocation of photosynthates towards reproductive growth. Same trends on yield attributes by fertigation also recorded by Haneef *et al.* (5) in pomegranate. However, the increase in yield of pomegranate by application of plant growth regulators may be attributed to the fact that partitioning of assimilates by NAA more towards the fruit development which may leads to improvement in yield contributing characters like size and weight of fruits as evident by the present study which ultimately increased the yield Similar finding is in agreement with the findings in pomegranate by Gaikwad *et al.,* (4). The low yield recorded in the control might be due to the poor accessibility of nutrients, resulting in lower effectiveness of photosynthetic accumulation of assimilates and slighter dry matter production. The yield attributing traits like fruit weight, volume, diameter, aril weight etc. was also low in the above said treatment. Similar reports on yield decrease due

Table 1. Effect of plant growth regulators and fertigation on yield and quality attributes of pomegranate cv. 'Sinduri' under HDP (pooled 2018 and 2019)

Treatment	Number of fruits/ plant	Yield per plant (kg)	Yield per hectare (q)	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100g)
N_0	28.63	5.32	59.13	13.20	1.27	11.68
N_1	32.65	6.46	71.82	13.64	1.11	12.43
N_2	33.03	6.77	75.26	13.96	1.05	12.83
SEm±	0.10	0.03	0.31	0.02	0.01	0.03
C.D. at 5%	0.28	0.07	0.87	0.05	0.02	0.08
E_0	29.78	5.66	62.92	13.34	1.22	11.91
E_1	32.06	6.41	71.16	13.68	1.12	12.44
E_2	32.47	6.49	72.13	13.77	1.09	12.60
SEm±	0.10	0.03	0.31	0.02	0.01	0.03
C.D. at 5%	0.28	0.07	0.87	0.05	0.02	0.08
F_0	29.91	5.34	59.36	12.94	1.33	11.21
F_1	31.58	6.42	71.34	13.86	1.07	12.77
F_2	32.81	6.80	75.52	14.00	1.03	12.97
SEm±	0.10	0.03	0.31	0.02	0.01	0.03
C.D. at 5%	0.28	0.07	0.87	0.05	0.02	0.08
Treatment	Reducing sugar (%)	Non- reducing sugar (%)	Total sugar (%)	Sugar: acid ratio	Anthocyanin (mg/100g)	Juice (%)
N_0	8.90	1.23	10.13	8.10	13.81	32.66
N_1	9.24	1.55	10.79	10.05	14.22	34.82
N_2	9.48	1.71	11.18	11.11	14.44	35.74
SEm±	0.02	0.01	0.02	0.06	0.04	0.06
C.D. at 5%	0.05	0.04	0.07	0.17	0.11	0.17
E_0	9.01	1.36	10.37	8.70	13.34	33.27
E_1	9.28	1.51	10.79	10.06	14.37	34.78
E_2	9.33	1.61	10.94	10.50	14.75	35.16
SEm±	0.02	0.01	0.02	0.06	0.04	0.06
C.D. at 5%	0.05	0.04	0.07	0.17	0.11	0.17
F_0	8.70	1.01	9.71	7.33	13.68	31.51
F_1	9.42	1.69	11.11	10.67	14.34	35.62
F_2	9.50	1.79	11.28	11.26	14.45	36.09
SEm±	0.02	0.01	0.02	0.06	0.04	0.06
C.D. at 5%	0.05	0.04	0.07	0.17	0.11	0.17

N_0 – NAA 0 ppm E_0 – Ethrel 0 ppm F_0 – RDF 0% Fertigation
N_1 – NAA 50 ppm E_1 – Ethrel 150 ppm F_1 – RDF 75% Fertigation
N_2 – NAA 100 ppm E_2 – Ethrel 250 ppm F_2 – RDF 100% Fertigation

to lower nutritional levels were made by Chandel (3) in kiwi fruit.

The data on total soluble solids (°B) content of pomegranate fruits as influenced by the application of different plant growth regulators and fertigation treatments. The data evident from the Table 1 indicated that total soluble solids of pomegranate enhanced significantly by the application of NAA, ethrel and fertigation during 2018 and 2019. Among the various levels of NAA treatment, application of 100 ppm NAA (N_2) recorded maximum mean TSS (13.96 ^{0}Brix) and ascorbic acid (12.83 mg/100 g). In the ethrel treatment maximum mean TSS (13.77 ^{0}Brix) and ascorbic acid (12.60 mg/100 g) was observed under the 250 ppm ethrel (E_2). Total soluble solids was significantly influenced by the fertigation treatments. Under the different levels of fertigation treatments, maximum mean TSS (14.00 ^{0}Brix) and ascorbic acid (12.97 mg/100 g) was noticed in F_2 which consist of 100 per cent RDF through

Table 2. Interaction effect of plant growth regulators and fertigation on yield and quality attributes of pomegranate cv. 'Sinduri' under HDP (pooled 2018 and 2019)

Treatment	Number of fruits/ plant	Yield per plant (kg)	Yield per hectare (q)	TSS (^{0}Brix)	Acidity (%)	Ascorbic acid (mg/100g)
$N_0E_0F_0$	25.83	4.38	48.67	12.68	1.46	10.56
$N_0E_0F_1$	27.17	5.11	56.77	13.30	1.23	11.73
$N_0E_0F_2$	29.08	5.51	61.19	13.34	1.22	11.88
$N_0E_1F_0$	28.08	4.91	54.50	12.78	1.40	11.06
$N_0E_2F_0$	28.50	5.00	55.55	12.82	1.37	11.11
$N_1E_0F_0$	29.17	5.17	57.47	12.85	1.34	11.13
$N_2E_0F_0$	29.42	5.23	58.13	12.93	1.33	11.17
$N_0E_1F_1$	28.83	5.50	61.12	13.43	1.20	12.06
$N_0E_1F_2$	30.00	5.78	64.20	13.44	1.19	12.18
$N_0E_2F_1$	29.67	5.76	64.01	13.47	1.17	12.26
$N_0E_2F_2$	30.50	5.96	66.19	13.49	1.15	12.33
$N_1E_1F_0$	32.17	5.77	64.14	12.97	1.29	11.30
$N_1E_2F_0$	32.17	5.82	64.66	13.01	1.28	11.41
$N_1E_0F_1$	31.17	6.12	67.97	13.62	1.13	12.52
$N_1E_0F_2$	32.50	6.48	71.98	13.68	1.10	12.58
$N_2E_1F_0$	31.83	5.92	65.77	13.14	1.26	11.48
$N_2E_2F_0$	32.00	5.88	65.33	13.26	1.25	11.67
$N_2E_0F_1$	31.83	6.41	71.18	13.83	1.08	12.79
$N_2E_0F_2$	31.83	6.56	72.91	13.87	1.07	12.86
$N_1E_1F_1$	33.33	6.90	76.70	14.08	1.06	13.11
$N_1E_2F_2$	34.92	7.35	81.63	14.27	0.91	13.43
$N_1E_1F_2$	34.58	7.41	82.33	14.20	0.92	13.28
$N_1E_2F_1$	33.83	7.15	79.48	14.11	0.95	13.15
$N_2E_1F_1$	34.17	7.37	81.84	14.36	0.89	13.45
$N_2E_2F_2$	36.42	8.04	89.37	15.02	0.84	14.19
$N_2E_1F_2$	35.50	8.09	89.85	14.70	0.87	14.01
$N_2E_2F_1$	34.25	7.47	82.97	14.52	0.88	13.84
SEm ±	0.30	0.08	0.92	0.05	0.02	0.09
C.D. at 5%	0.84	0.22	2.60	0.14	0.05	0.25

N_0 – NAA 0 ppm E_0 – Ethrel 0 ppm F_0 – RDF 0% Fertigation
N_1 – NAA 50 ppm E_1 – Ethrel 150 ppm F_1 – RDF 75% Fertigation
N_2 – NAA 100 ppm E_2 – Ethrel 250 ppm F_2 – RDF 100% Fertigation

fertigation. However, minimum mean acidity (1.05 %, 1.09 % and 1.03 %) was recorded in the N_2, E_2 and F_2 respectively. Further, treatment combination of NAA 100 ppm + ethrel 250 ppm + fertigation 100 % RDF ($N_2E_2F_2$) was recorded maximum mean TSS (15.02 ^{0}Brix) and ascorbic acid (14.19 mg/100 g) along with minimum acidity (0.84 %) as compared to other treatments including control (Table 2). However, treatment combination NAA 100 ppm + ethrel 150 ppm + fertigation 100 % RDF ($N_2E_1F_2$) was found at par with it. The maximum TSS is might be due to nitrogen stimulates the functioning of enzymes in the physiological processes, which have improved the total soluble solids content of the fruits. Further, NAA have been known to be concerned in synthesis of α-amylase which renovate starch into sugars and accordingly, increase osmotic pressure of the cell wall which results in accumulation of water and other solutes and increases TSS Macwan *et al.,* (7). The increase in TSS due to application of ethrel in the present investigation might be because of its action on converting starch into sugars through higher respiration activity during ripening process. The increase in ascorbic acid content with the application of NAA might be due to perpetual synthesis of glucose-6-phosphate throughout the period of growth and development of fruits which was thought to be the precursor of Vitamin C Arunadevi *et al.,*(1). In the same way, increase ascorbic acid when applied fertigation might be due to the potassium available all over the growing stages of tree favours the breakdown and translocation of starch, synthesis of protein, carbohydrate synthesis and neutralization of physiologically imperative organic acids. NAA and ethrel significantly decreased the acidity in pomegranate. During the fruit maturation and harvesting stage, the concentration of acidity in pomegranate was also affected by changes in sugars and other compounds due to increasing levels of various plant growth regulators in plant parts, which might have shown beneficial role in improving the quality of fruit by reducing the acidity per cent. Same result on reduction of acidity by the foliar application of ethrel was also found by Hazarika *et al.,* (6) in papaya while reduced acidity by the foliar application of NAA was reported by Shukla *et al.,* (11) in guava.

NAA at 100 ppm (N_2) gave good response on sugars content of pomegranate. The maximum mean reducing sugar (9.48 %), non-reducing sugar (1.71 %) and total sugar (11.18 %) was observed with respective level of NAA. Similarly, 250 ppm ethrel (E_2) confer maximum reducing sugar (9.33 %), non-reducing sugar (1.61 %) and total sugar (10.94 %). In the fertigation treatment, maximum mean reducing sugar (9.50 %), non-reducing sugar (1.79 %) and total sugar (11.28 %) was noticed in the (F_2) 100 per cent RDF through fertigation (Table 1). Further, in interaction effect plant growth regulators and fertigation were found to be quite superior to their individual effect. Among the treatment combinations $N_2E_2F_2$ exhibited significantly higher values of reducing sugar (10.09 %), non-reducing sugar (2.43 %) and total sugar (12.52 %) as compared to other treatments and control (Table 3). The highest sugar was attributed to the application of NPK through fertigation may be explained by the fact that phosphorus enters into the composition of phospholipids and nucleic acid, the latter combination with proteins and results in the formation of nucleo-proteins which are important constituents of the nuclei of the cell. These carbohydrates and coenzymes are beneficial in the improvement of fruits quality and nitrogen enhances the uptake of phosphorus and potassium due to the chain reaction in these components might have possibly caused important in quality of fruits. The present results are in agreement with that of in pomegranate by Haneef *et al.,* (5). The increase in sugars due to application of NAA in the present investigation might be due to translocation of more photosynthetic assimilates to the fruits and breakdown of starch during ripening. The plants treated with ethrel had higher quantity of soluble carbohydrate in the sap and glucose concentration was strikingly high due to marked increase in carbon assimilation Yadav *et al.,* (13).

It is evident from the data presented in the Table 1 that NAA, ethrel and fertigation levels had significant effect on the fruit quality attributes. NAA level 100 ppm (N_2) recorded maximum mean sugar: acid ratio (11.11), anthocyanin (14.44 mg/100 g) and juice (35.74 %). Similarly, different levels of ethrel had significant effect on the fruit quality attributes and maximum mean sugar: acid ratio (10.50), anthocyanin (14.75 mg/100 g) and juice (35.16 %). was observed in the ethrel 250 ppm (E_2). Among the different levels of fertigation, maximum mean sugar: acid ratio (11.26), anthocyanin (14.45 mg/100 g) and juice (36.09 %) was recorded in the treatment fertigation 100 per cent RDF (F_2). The interaction effect of NAA, ethrel and fertigation (Table 3) were found to be quite better to their individual effect. Maximum mean sugar: acid ratio (14.64), anthocyanin (15.82 mg/100 g) and juice (38.83 %) was recorded in $N_2E_2F_2$ which consists of NAA 100 ppm + ethrel 250 ppm + fertigation 100 % RDF. The reason for increasing sugar: acid ratio by plant growth regulators and fertigation treated fruit might be due related to increased sugars content and reduced acid content of fruits. Anthocyanin is responsible for red color in pomegranate and is another important quality parameter. Maximum

Table 3. Interaction effect of plant growth regulators and fertigation on chemical attributes of pomegranate cv. 'Sinduri' under HDP (pooled 2018 and 2019)

Treatment	Reducing sugar (%)	Non- reducing sugar (%)	Total sugar (%)	Sugar: acid ratio	Anthocyanin (mg/100g)	Juice (%)
$N_0E_0F_0$	8.43	0.85	9.28	6.34	12.91	28.11
$N_0E_0F_1$	8.97	1.28	10.25	8.37	13.32	33.01
$N_0E_0F_2$	9.01	1.32	10.32	8.50	13.54	33.35
$N_0E_1F_0$	8.60	0.92	9.52	6.79	13.78	31.34
$N_0E_2F_0$	8.64	0.94	9.57	6.99	13.82	31.47
$N_1E_0F_0$	8.67	0.94	9.62	7.21	13.08	31.55
$N_2E_0F_0$	8.69	0.98	9.67	7.34	13.12	31.72
$N_0E_1F_1$	9.06	1.37	10.42	8.65	13.97	33.84
$N_0E_1F_2$	9.12	1.44	10.55	8.90	14.02	34.01
$N_0E_2F_1$	9.14	1.47	10.61	9.05	14.34	34.22
$N_0E_2F_2$	9.18	1.51	10.69	9.29	14.58	34.62
$N_1E_1F_0$	8.74	1.03	9.77	7.59	13.93	31.88
$N_1E_2F_0$	8.79	1.08	9.87	7.70	14.20	32.14
$N_1E_0F_1$	9.25	1.64	10.89	9.65	13.46	35.05
$N_1E_0F_2$	9.30	1.66	10.96	10.01	13.52	35.25
$N_2E_1F_0$	8.86	1.10	9.96	7.89	14.05	32.51
$N_2E_2F_0$	8.92	1.22	10.14	8.11	14.21	32.90
$N_2E_0F_1$	9.36	1.77	11.13	10.33	13.41	35.63
$N_2E_0F_2$	9.41	1.83	11.24	10.51	13.71	35.78
$N_1E_1F_1$	9.53	1.86	11.39	10.75	14.71	36.50
$N_1E_2F_2$	9.71	1.94	11.65	12.84	14.94	37.37
$N_1E_1F_2$	9.64	1.89	11.54	12.59	14.77	37.02
$N_1E_2F_1$	9.56	1.88	11.44	12.12	15.38	36.59
$N_2E_1F_1$	9.94	1.96	11.89	13.36	15.00	37.42
$N_2E_2F_2$	10.09	2.43	12.52	14.64	15.82	38.83
$N_2E_1F_2$	10.02	2.06	12.08	14.04	15.15	38.53
$N_2E_2F_1$	9.99	2.01	12.00	13.75	15.51	38.34
SEm ±	0.05	0.04	0.07	0.18	0.11	0.18
C.D.at 5%	0.14	0.11	0.21	0.52	0.33	0.51

N_0 – NAA 0 ppm E_0 – Ethrel 0 ppm F_0 – RDF 0% Fertigation
N_1 – NAA 50 ppm E_1 – Ethrel 150 ppm F_1 – RDF 75% Fertigation
N_2 – NAA 100 ppm E_2 – Ethrel 250 ppm F_2 – RDF 100% Fertigation

anthocyanin pigment was recorded under treatment, $N_2E_2F_2$ it might be due to the nutrients involved in the physiological and biochemical processes particularly the phenylalanine ammonia lyase (PAL) activity, which is the major cause in increasing the red pigment and Red colour (Monika *et al.,* 8). However, Singh *et al.* (12) found that spray of ethrel in apple orchard significantly increased in colour. Maximum fruit juice was observed under treatment $N_2E_2F_2$. These results are in line with those of Sen and Chauhan (10) who reported an increase in nitrogen rate resulting in greater absorption of water and minerals from the soil, resulting in augmented juice per cent in pomegranate. Also, Rokaya *et al.,* (9) reported that the increase in juice percentage of fruits might be explained by the fact that hormones play a regulating role in the mobilization of metabolites within a plant and it is well established fact that developing fruits are extremely active metabolic "sinks" which mobilize metabolites and direct their flow from vegetative structure.

AUTHORS' CONTRIBUTION

Conceptualization of research (MCJ); Designing of the experiments (MCJ, JS, PB, MS); Contribution of experimental materials (MCJ, JS, PB); Execution of field/lab experiments and data collection (MS, MCJ, PB, JS); Analysis of data and interpretation (MS, MCJ); Preparation of the manuscript (MS, MCJ).

DECLARATION

The authors declare no conflict of interest.

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