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Different Levels of RDF with NAA Combinations Transform the Growth and Qualitative characteristics of Pomegranate (*Punica granatum* L.)

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ABSTRACT: The present investigation was conducted at Jawaharlal Nehru Krishi Vishwavidyalaya, KVK, Chhindwara (M.P.), India, during 2019-2020 and 2020-2021 to investigate the impact of NAA and RDF levels on plant growth and fruit quality of pomegranate (*Punica granatum* L.) in central India condition. Lot of work has been done in different part of India, however there is very limited work on pomegranate crop in central India specially Madhya Pradesh. The investigation was carried out on a seven-year-old Bhagwa plantation at a distance of 12 by 8 feet. Eighteen treatment combinations were used in the experiment, with three levels of the recommended dose of fertilizers (100%, 75%, and 125%), three levels of NAA (0 ppm, 10 ppm, and 20 ppm), and fertigate applied at intervals of 15 and 30 days with three replications using asymmetrical factorial RBD. The analysis showed that minimum days to bloom appearance, days to fruit initiation, and maximum juice (%) as well as aril (%) were observed under T13 (100% RDF + NAA 20 ppm + fertigate) at a 15-day interval. while the maximum plant height, chlorophyll content, days to bloom appearance, and days to fruit initiation were observed in treatment (125% RDF + 20ppm NAA + fertigation 15 days), while the minimum plant height, chlorophyll content, juice, and aril (%) were recorded under the combination 75% recommended dose of fertilizers + 0 ppm naphthalene acetic acid + fertigation 30 days during both years. The production and quality characteristics of pomegranates were strongly impacted by the use of chemical fertilizers (N, P, and K) as well as plant growth hormones (NAA).

Keywords: Pomegranate, Naphthalene acetic acid, RDF, Chlorophyll, qualitative attributes.

INTRODUCTION

Pomegranate (*Punica granatum*. L), known as "Dadima" in Ayurveda is an important fruit crop in arid and semiarid region. Fruits are large round and modified berry with tough golden or orange rind. Seeds are numerous surrounded by acidic juicy pulp known as 'aril' which is an edible portion. Dried seeds with pulp are called Anar-dana which is an important condiment. It is one of the main fruit crops grown in semi-arid and dry areas. It is thought to have originated in Iran. It is a member of the Punicaceae family, which includes both wild and cultivated pomegranates (*Punica protopunica* Balf and *Punica granatum* L.). There are several unique and interesting characteristics of the pomegranate. Its extensive adaptability, comparatively low cultivation expenses, drought tolerance, substantial economic rewards, and great export potential have led to reports that it now occupies a broader region. Furthermore, it is gaining popularity on the international market as a result of its wider industrial use (Aviram and Dornfeld 2001). Pomegranate is also significant in human medicine, and there are several therapeutic uses for its constituents (Lansky and Newman 2007). The world's largest pomegranate producer is India. India grows pomegranates over 288 thousand hectares of land, producing 3271 thousand MT of fruit annually. Pomegranates cover 6.74 thousand hectares in MP, with a productivity of 75.16 thousand MT NHB (2021). For sweets, fruit is mostly used. There's a good selection of fresh fruits and processed items like syrup, jelly, and bottled juice that people like. It's reported that drinking this juice helps those with leprosy. Fermenting the juice is easy, and it may be used to produce wine. In medicine, the juice of wild pomegranates is used to make citric acid and sodium citrate. Dysentery and diarrhea are some of the conditions it is used to treat. The therapy for chronic gastric disease is the most well-known (Sudhakar and Murthy 2015). This fruit crop is hardy enough to survive on subpar soil. Pomegranate production practices are closely monitored because of their perennial nature, cumulative fertilizer treatments, and unpredictable input responses. Its strict farming practices, which include bahar treatment (plant hormone manipulation of flowering and fruit setting) without adequate nutrition management, are causing the plants' health to deteriorate. Because of this, the plants become more susceptible to many biotic and abiotic

stresses (NRCP, 2011). In recent times, there has been widespread recognition of the significance of synthetic plant growth regulators in attaining increased production and improved quality of horticulture crops. In the case of the pomegranate fruit crop, plant growth regulators have produced good results (Anawal *et al.,* 2015). Since the majority of plant growth regulators have a wide range of effects, one PGR may have an impact on many distinct processes. Additionally, plant growth regulators increase crop output and facilitate quick changes in physiological and biochemical characteristics. Plant growth regulator treatments are one of the agricultural strategies that may boost fruit yield and enhance the quality of numerous different fruit crops. Fruit size, TSS, and yield were all enhanced by NPK fertilization. Singh *et al*. (1988) found that one of the most crucial management strategies for raising crop output is fertilization, particularly with nitrogen. It is well recognized that one of the most important nutrients for plant nutrition and development is nitrogen (N). Being a component of all proteins, nucleic acids, and enzymes, it has significance. El-Salhy *et al*. (2013); Dhankar *et al*. (2010) found that plants grown with fertigation at 100% of the prescribed fertilizer dosage on alternate days had considerably higher physico-chemical properties and vegetative development. raising fruit production and quality, particularly by N, P, and K fertilization.

MATERIALS AND METHODS

The investigation was conducted at KVK, Chhindwara, JNKVV, Jabalpur, (M.P.) India, during the years 2019-20 and 2020-21 on a seven-year-old pomegranate orchard. Throughout the experiment, every tree was cared for according to an equivalent cultural calendar. Each plant received the necessary amount of fertilizer and manure, along with light watering. A drip irrigation system was then used to provide regular irrigation. Using three replications and eighteen treatments per replication, the experiment was set up in a symmetrical factorial RBD. A total of eighteen treatments were combined with the plant growth regulator NAA, the prescribed fertilizer dose, and fertigation schedule, which were as follows: RDF at 75, 100, and 125%; NAA at 0, 10, and 20 ppm; and fertigation at intervals of 15 and 30 days. Application of fertilizer as a basal dosage at the beginning of the experiment; fertigation began at intervals of 15 and 30 days following the commencement of the flowers; two NAA sprays were conducted, the first at the initiation of the flowers and the second at the 50% blooming stage.

A. Treatment combinations

T1 (100% RDF + Fertigation 15 days + NAA (0 ppm)- $H_0F_0D_1$, T2 (100% RDF + Fertigation 30 days + NAA (0 ppm)- $H_0F_0D_2$, T3 (75% RDF + Fertigation 15 days + NAA (0 ppm)- $H_0F_1D_1$, T4 (75% RDF + Fertigation 30 days + NAA (0 ppm)- $H_0F_1D_2$, T5 (125% RDF + Fertigation 15 days + NAA (0 ppm)- $H_0F_2D_1$, T6 (125% RDF + Fertigation 30 days + NAA (0 ppm)- $H_0F_2D_2$, T7 (100% RDF + Fertigation 15 days + NAA (10 ppm)- $H_1F_0D_1$, T8 (100% RDF + Fertigation 30 days + NAA (10 ppm)- $H_1F_0D_2$, T9 (75% RDF + Fertigation 15 days + NAA (10 ppm)- $H_1F_1D_1$, T10 (75% RDF + Fertigation 30 days + NAA (10 ppm)- $H_1F_1D_2$, T11 (125% RDF + Fertigation 15 days + NAA (10 ppm)- $H_1F_2D_1$, T12 (125% RDF + Fertigation 30 days + NAA (10 ppm)- $H_1F_2D_1$, T13 (100% RDF + Fertigation 15 days + NAA (20 ppm)- $H_2F_0D_1$, T14 (100% RDF + Fertigation 30 days + NAA (20 ppm)- $H_2F_0D_2$, T15 (75% RDF + Fertigation 15 days + NAA (20 ppm)- $H_2F_1D_1$, T16 (75% RDF + Fertigation 30 days + NAA (20 ppm)- $H_2F_1D_2$, T17 (125% RDF + Fertigation 15 days + NAA (20 ppm)- $H_2F_2D_1$ and T18 (125% RDF + Fertigation 30 days + NAA (20 ppm)- $H_2F_2D_2$

RESULT AND DISCUSSION

A. Plant height (m)

The application of plant growth hormone (NAA), RDF levels, and fertigation had an effect on the plant height at the end of the experiment, according to the investigation data presented in Table 1. The maximum plant height at the end of the experiment was noted at 4.07, 4.05, and 4.00 m under the combination of 125% recommended doses of fertilizer (781:313:313 g NPK per plant), 20 ppm naphthalene acetic acid per plant, and fertigate at a 15-day interval. The minimum plant height at the end of the experiment was noted to be 2.92, 3.17, and 3.04m under a combination of 75% recommended doses of chemical fertilizer (468:188:188 g NPK per plant), 0 ppm naphthalene acetic acid per plant, and fertigate at a 30-day interval, respectively. The use of NPK fertilizers has been linked to increased nutrient efficiency when combined with the balanced use of inorganic nutrient sources. According to Kumar *et al*. (2008) and Hassan *et al*. (2001), the enhancement in plant height and spread could be due to improved soil physical properties and higher nutrient uptake due to increased proliferation and activities of microorganisms, which manifested in the form of enhanced growth and carbohydrates production. Plant development and growth are directly impacted by chemical fertilizers and plant growth regulators used in fertigation processes. These outcomes are consistent with Suman *et al*. (2020) pomegranate research.

B. Chlorophyll content

The application of NAA, the recommended dose of fertilizer (RDF), and fertigation significantly affected chlorophyll content at the fruit development stage during the investigation. The information displayed in Table 1 demonstrated the outcomes of treatment T13, where the highest chlorophyll content was observed (41.26, 40.68, and 40.97) under the combination of 125% RDF (781:313:313 g NPK per plant), 20 ppm naphthalene acetic acid per plant, and fertigation of NPK at a 15-day interval. The minimum chlorophyll content was (29.69, 29.11, and 29.40) noted under the combination of 75% RDF (468:188:188 g NPK plant^{-1}), 0 ppm naphthalene acetic acid per plant, and fertigate with NPK at a 30-day interval, respectively, while the combination of 125% RDF + fertigation at 15 days + 20 ppm NAA was significantly superior over all the other combinations. The increase in the area of the canopy

consisting of height, spread, and chlorophyll content might be due to the induction of more height, spread, and chlorophyll with the use of the 125% recommended dose of NPK and plant growth regulator. These findings concur with the conclusions made by Mohamed *et al.* (2014) on pomegranate trees and Pathak and Ram (2005), who observed improvements in vegetative growth parameters in guavas with the application of fertilizers. A similar result was reported by Digrase *et al*. (2016) in pomegranate, Bhogave and Raut (2014) in papaya, and Saima *et al*. (2014) in strawberry.

Table 1: Effect different levels of RDF & NAA combinations on plant height and chlorophyll content of pomegranate.

Treatment combination		Plant height at end of experiment (m)			Chlorophyll content		
		2020	2021	Pooled	2020	2021	Pooled
T1	$H_0F_0D_1$	3.20	3.53	3.37	38.16	37.12	37.64
T2	$H_0F_0D_2$	3.17	3.52	3.35	37.82	36.67	37.24
T3	$H_0F_1D_1$	2.95	3.20	3.08	30.36	29.27	29.82
T4	$H_0F_1D_2$	2.92	3.17	3.04	29.69	29.11	29.40
T5	$H_0F_2D_1$	3.81	3.72	3.76	40.69	39.55	40.12
T6	$H_0F_2D_2$	3.50	3.65	3.58	40.24	39.17	39.70
T7	$H_1F_0D_1$	3.42	3.67	3.54	39.87	38.79	39.33
T8	$H_1F_0D_2$	3.28	3.50	3.39	39.26	38.18	38.72
T9	$H_1F_1D_1$	2.99	3.42	3.21	30.66	30.02	30.34
T10	$H_1F_1D_2$	2.96	3.22	3.09	30.49	29.50	30.00
T11	$H_1F_2D_1$	3.90	3.73	3.82	41.17	40.24	40.71
T12	$H_1F_2D_2$	3.84	3.66	3.75	40.12	39.21	39.67
T13	$H_2F_0D_1$	3.53	3.63	3.54	40.03	39.04	39.54
T14	$H_2F_0D_2$	3.23	3.57	3.39	39.82	38.71	39.27
T15	$H_2F_1D_1$	3.05	3.51	3.28	31.69	30.70	31.19
T16	$H_2F_1D_2$	3.00	3.33	3.17	30.82	29.82	30.32
T17	$H_2F_2D_1$	4.07	4.05	4.00	41.26	40.68	40.97
T18	$H_2F_2D_2$	3.97	3.88	3.93	39.48	39.88	39.68
SEm ±		**0.078**	**0.066**	**0.064**	**0.055**	**0.056**	**0.132**
CD at 5%		**NS**	**0.187**	**0.182**	**0.157**	**0.158**	**0.375**

C. Days to first bloom appearance

Application of plant growth hormone (NAA), RDF levels, and fertigation had a significant effect on days taken to bloom appearance during the investigation, according to the data presented in Table 2. The number of days taken to bloom appearance was noted (37.00, 29.00, and 33.67) with a combination of 125% RDF (781:313:313 g NPK per plant), plant growth hormone (0 ppm naphthalene acetic acid per plant), and fertigate with NPK at a 30-day interval. The minimum days taken to bloom appearance were noted (32.00, 25.00, and 27.50) with a combination of 100% RDF (625:250:250 g NPK per plant), 20 ppm naphthalene acetic acid per plant, and fertigate with NPK at a 15-day interval, respectively. While the combination of 100% RDF + fertigation at 15 days + 20 ppm NAA showed significantly superiority over all the other combinations, As a result, it's possible to conclude that using more chemical fertilizer than the prescribed amount delayed the reproductive period, including bud development and initiation, as well as panicle emergence. Because nitrogen feeding is linked to plant development, increasing the dosage may have increased plant growth, particularly in terms of leaf quantity and size. The increased nitrogen dose stimulates vegetative development at the expense of the reproductive stage's beginning. These findings are consistent with Verma and Chouhan (2013). Auxins promote the start of floral buds. Therefore, higher photosynthesis may have contributed to the rise in blooming, increasing the chance that trees would produce early flower buds. This experiment's conclusion about early blooming aligns with studies by Kannan *et al.* (2009) in paprika and Bhujbal *et al.* (2013) in sapota, which found that applying NAA considerably reduced the number of days needed for flower initiation.

D. Days to first fruit initiation

The application of plant growth hormone (NAA), RDF levels, and fertigation (NPK) had a significant effect on days taken to first fruit initiation during both years, as well as pooled the data presented in Table 2. The more days taken to first fruit initiation were noted (65.00, 64.00, and 64.00) under the combination of the 125% recommended dose of fertilizer (781:313:313 g NPK per plant), plant growth hormone (0 ppm naphthalene acetic acid per plant), and fertigate with NPK at a 30-day interval, which exhibited a far better result than any of the other combinations. The minimal days taken to first fruit initiation were noted (55.00, 59.00, and 57.00) with a combination of 100% recommended doses of chemical fertilizer (625:250:250 g NPK per plant), 20 ppm naphthalene acetic acid per plant, and fertigate with NPK at 15-day intervals, respectively. Naphthalene acetic acid continued to be physiologically more active in order to accumulate enough food reserves for blossoming blooms. It is also known that auxins promote the start of floral buds. Similar results have been reported by Phawa *et al.* (2017) in pomegranate. Utilizing N, P, and K at a balanced rate

proved beneficial in improving the trees' fruit-setting and blooming behaviors at the expense of their vegetative development characteristics. When N, P, and K fertilizers were applied at a balanced rate, the ratio of total carbohydrates to N was positively adjusted. In these circumstances, the quantity of flowers significantly increased. Because of the use of N, P, and K, most nutrients were decreased. This conclusion is limited to the pomegranate data given by Moawad *et al*. (2014).

Table 2: Effect of different levels of RDF & NAA combinations on Days taken to bloom appearance and Days taken to fruit initiation of pomegranate.

Treatment combination		Days taken to bloom appearance			Days taken to first fruit initiation		
		2020	2021	Pooled	2020	2021	Pooled
T1	$H_0F_0D_1$	33.00	26.00	30.67	56.00	59.00	57.50
T2	$H_0F_0D_2$	33.67	27.00	30.83	60.00	61.00	60.50
T3	$H_0F_1D_1$	34.00	27.00	33.17	59.00	61.00	60.00
T4	$H_0F_1D_2$	35.00	28.00	32.17	61.00	61.00	61.00
T5	$H_0F_2D_1$	36.00	29.00	31.67	61.00	62.00	61.50
T6	$H_0F_2D_2$	37.00	29.00	33.67	65.00	64.00	64.00
T7	$H_1F_0D_1$	32.00	25.00	27.83	55.00	59.00	57.00
T8	$H_1F_0D_2$	34.00	27.00	29.33	58.00	60.00	59.00
T9	$H_1F_1D_1$	36.00	28.00	31.33	63.00	61.00	62.00
T10	$H_1F_1D_2$	37.00	29.00	32.33	63.00	62.00	62.50
T11	$H_1F_2D_1$	35.00	27.00	30.67	58.00	60.00	59.00
T12	$H_1F_2D_2$	35.00	28.00	30.83	60.00	61.00	60.50
T13	$H_2F_0D_1$	32.00	25.00	27.50	55.00	59.00	57.00
T14	$H_2F_0D_2$	33.00	26.00	28.50	57.00	60.00	58.50
T15	$H_2F_1D_1$	34.00	26.00	30.50	59.00	60.00	59.50
T16	$H_2F_1D_2$	33.00	28.00	31.50	59.00	60.00	59.50
T17	$H_2F_2D_1$	36.00	28.00	29.00	62.00	61.00	61.50
T18	$H_2F_2D_2$	37.00	29.00	30.50	63.00	62.00	62.50
SEm ± CD at 5%		**0.203 0.575**	**0.175 0.498**	**0.149 0.423**	**0.322 0.914**	**0.266 NS**	**0.279 0.791**

Juice (%). The application of plant growth hormone (NAA), RDF levels, and fertigation had a significant effect on juice percent during both years as well as pooled data, respectively, presented in Table 3. The highest juice percent was shown (53.90, 52.48, 53.19) under the combination of 100% recommended doses of inorganic fertilizer (625:250:250 g NPK per plant), PGR (20 ppm NAA per plant), and fertigate with NPK at a 15-day interval. The minimum juice percent was noted (49.65, 48.82, and 49.23) under the combination of a 75% recommended dose of inorganic fertilizer (468:188:188 g NPK per plant), 0 ppm naphthalene acetic acid per plant, and fertigate with NPK at a 30-day interval, respectively. While the interaction of NAA 20 ppm + 100% RDF + fertigation at 15 days showed significantly superior values over all the other combinations, The use of chemical fertilizers may have improved the absorption and quantity of nutrients accessible to the plant, resulting in good fruit quality. These results are consistent with Kashya *et al*. (2012); Mengel *et al.* (2001); Robertse and Stassen (2004) in pomegranate.

Table 3: Effect of different levels of RDF & NAA combinations on juice and aril (%) of pomegranate.

Treatment combination		Juice (%)			Aril (%)		
		2020	2021	Pooled	2020	2021	Pooled
T1	$H_0F_0D_1$	51.53	50.49	51.01	59.80	60.67	60.24
T2	$H_0F_0D_2$	49.98	49.20	49.59	54.10	55.52	54.81
T3	$H_0F_1D_1$	49.97	48.97	49.47	51.98	52.40	52.19
T4	$H_0F_1D_2$	49.65	48.82	49.23	51.34	51.99	51.67
T5	$H_0F_2D_1$	50.32	49.26	49.79	52.54	53.48	53.01
T6	$H_0F_2D_2$	50.14	49.00	49.57	52.03	53.07	52.55
T7	$H_1F_0D_1$	53.31	52.23	52.77	62.47	63.37	62.92
T8	$H_1F_0D_2$	51.45	50.31	50.88	55.55	56.67	56.11
T9	$H_1F_1D_1$	50.36	49.53	49.95	52.45	52.82	52.64
T10	$H_1F_1D_2$	50.24	49.26	49.75	51.88	52.43	52.16
T11	$H_1F_2D_1$	51.04	50.04	50.54	53.45	54.24	53.84
T12	$H_1F_2D_2$	50.61	49.57	50.09	52.87	54.00	53.44
T13	$H_2F_0D_1$	53.90	52.48	53.19	63.70	65.12	64.41
T14	$H_2F_0D_2$	52.47	51.42	51.95	58.03	60.22	59.13
T15	$H_2F_1D_1$	50.92	49.92	50.42	53.50	53.29	53.40
T16	$H_2F_1D_2$	50.82	49.64	50.23	52.52	53.12	52.82
T17	$H_2F_2D_1$	52.20	51.47	51.84	60.79	62.26	61.53
T18	$H_2F_2D_2$	50.06	50.01	50.04	55.14	56.30	55.72
SEm± CD at 5%		**0.195 0.555**	**0.098 0277**	**0.148 0.420**	**0.253 0.718**	**0.205 0.581**	**0.290 0.822**

Aril (%). The application of plant growth hormone (NAA), RDF levels, and fertigation had a significant effect on aril percent during both years, as well as pooled data, respectively, presented in Table 3. The highest aril percent was noted (63.70, 65.12, and 64.41) under a combination of 100% recommended doses of inorganic fertilizer (625:250:250 g NPK per plant), 20 ppm NAA per plant, and fertigation at a 15-day interval. The minimum aril percent was recorded (51.34, 51.99, 51.67) under the combination of a 75% recommended dose of fertilizer (468:188:188 g NPK per plant), 0 ppm naphthalene acetic acid per plant, and fertigate with NPK at a 30-day interval, respectively. While the combination of naphthalene acetic acid (20 ppm) + 100% RDF + fertigate with NPK at 15 days showed significantly superior results over all the other combinations, The current results are consistent with pomegranate research by Adi and Prasad (2012); Goswami *et al*. (2013).

CONCLUSIONS

Based on the results of this experiment, it can be determined that the combination of 100% RDF + 20 ppm NAA + 15 days of fertigation had a substantial impact on days to bloom appearance, days to fruit initiation juice (%) and aril (%) than all other treatment combinations, and the maximum plant height and chlorophyll content recorded under the combination of 125% RDF (781:313:313 g NPK per plant), 20 ppm naphthalene acetic acid per plant, and fertigation with NPK at a 15-day interval The treatment combination of 75% RDF + 0 ppm naphthalene acetic acid + fertigation with NPK at a 30-day interval had the lowest significant effect on days to bloom appearance, days to fruit initiation, plant height, chlorophyll content, juice, and aril (%) than any other combination of treatments. A considerable increase in fruit growth and quality was seen upon the application of inorganic fertilizer and naphthalene acetic acid.

FUTURE SCOPE

1. The RDF and fertigation might be used to enrich soil fertility to enhance the productivity.
2. Different levels of plant growth hormones NAA with combination of RDF and fertigation improve fruit retention as well as fruit physico-chemical characteristics.
3. Different levels of RDF + fertigation and plant growth regulators (NAA) improves yield and yield attributes.

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Conflict of Interest. None.

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