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Effect of Paclobutrazol and NAA Application on Yield Attributing Characters of Jamun *(Syzygium cuminii* Skeels.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Jamun (*Syzygium cuminii* Skeels.) is the medicinally important indigenous fruit tree of India belongs to the Myrtaceae family. The antidiabietic properties of Jamun brought higher market demand which stimulates to increase the fruit production and also brought the off season concept for commercial exploitation by paclobutrazol application. An investigation was carried out to study the effect of paclobutrazol and NAA application on yield attributing characters of nine years old jamun trees during 2017-18. The various treatment combinations are paclobutrazol (PBZ - 0, 0.50, 1.0 and 1.5 g a.i. m^{-1} of canopy diameter) and foliar spray of NAA (0, 50 ppm, 75 ppm and 100 ppm) application at

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different concentrations. The experiment results revealed that fruit length (2.87 cm), pulp – seed ratio (6.54), fruit weight (14.05 g), fruit retention (65.04 per cent) and yield (68.31 kg tree^{-1}) were observed higher in the treatment combination of PBZ 1.0 g a.i. application with 75 ppm of NAA followed by PBZ 1.5 g a.i. application with 100 ppm of NAA and the lower values were registered in control. Jamun trees treated with paclobutrazol and NAA aided in early induction of enhanced flowering and yield attributing characters.

Keywords: Jamun; fruit length; girth; weight; retention; yield; off season.

1. INTRODUCTION

Jamun (*Syzygium cuminii* Skeels.) is a nutritive rich and important indigenous under exploited fruit tree belongs to the Myrtaceae family. It is an evergreen tree of Indian sub-continent. The tree is 25 m to 30 m tall, with oblong, opposite leaves with a turpentine smell. Edible berries are purplish-black oval in colour with single seed. Fruit contains rich source of anthocyanins, pectin, phenols and protein. It possess good iron source apart from being the source of other minerals, sugars and phytochemical properties. The antioxidant activity of fresh jamun fruit is due to anthocyanin properties. Seed contains jambosin (alkaloid) and jambolin (glycoside) which stops diastatic enzyme activity that converts the starch into sugars. The volatile oil from jamun seed extract act as an effective medicine against diabetes, liver and heart troubles. The medicinal value is due to the presence of malic acid, oxalic acid, gallic acid and tannins [1].

The tree flowers once in a year during the month of March - April and fruiting comes during the month of June - July. Flowers are borne in terminal and axillary inflorescences on about 5 months to one year- old branches. It is observed that fruit drop in jamun starts just after fruit set to maturity. Only 15 – 30 per cent fruits reach maturity. The maximum fruit set (32.6 to 36.0%) was obtained when pollination was done one day after anthesis and thereafter, a sharp decline was observed in fruit set [2].

It bears heavily in every growing season, a large number of new shoots emerge majority of which are lateral and a few are terminal. After one year most of the lateral shoots dry out, while terminal shoots put forth extension growth. Since jamun flowers and fruits are borne on current season growth, a light annual pruning is considered necessary to manage a canopy of jamun which will facilitate harvesting and also encourage new shoots after the harvest. The market demand for the jamun fruits are increasing day by day which brings off season fruit production by regulate flowering to get higher returns to the growers than the income receive during other season.

Plant growth regulators influence flower-bud initiation in both woody and herbaceous plants [3]. Successful use of triazole growth regulators (anti-giberellin compound), in particular paclobutrazol retards vegetative growth and enhance flowering of fruit trees. NAA is a synthetic auxin plant hormone which has been shown to greatly increase cellulose fiber formation in plants. In majority of fruit plants, fruit drop is controlled by spraying of NAA in different fruit crops in different concentration. It is applied after blossom fertilization to increase number of flowers/panicle, percentage of hermaphrodite flowers and fruit drop control which resulted in yield enhancement.

So far there is not much research interventions on off season production of jamun by growth regulator application. Due to the rich medicnal properties, its increasing demand for commercial exploitation stimulates the off season concept by paclobutrazol application, added a major advantage to increase jamun fruit production. Hence the aim of the experiment was to study the influence of paclobutrazol and NAA application on yield attributing characters in jamun.

2. MATERIALS AND METHODS

The experiment was conducted at Department of Fruit Science, Horticulture College and Research Institute, Periyakulam, during 2017-18. Nine years old full bearing trees of Ra-jamun, a commercial type were selected and spaced at 8 × 8 m distance. The experiment was laid out in factorial randomized block design with two factors and replicated thrice. The various treatment combinations of paclobutrazol (PBZ - 0, 0.50, 1.0 and 1.5 g a.i. m^{-1} of canopy diameter) and foliar spray of NAA (0,50 ppm, 75 ppm and

100 ppm) application were taken at different concentrations. Paclobutrazol was applied once as soil drench during 1st week of October, 2017 by spreading a circular band of 25 cm width at 75 cm radial distance from the tree trunk. NAA was foliar sprayed during 50% of flowering stage and water was applied to the untreated trees (control). The fruit length and width were measured by using vernier caliper and expressed in cm. Fruit weight was taken from randomly selected ten mature fruits from each replication and weighed by using electronic balance and expressed in grams. Fruit yield was weighed from each treatment by using electronic balance and expressed in kilograms. The pulp and seed from the freshly harvested fruit were weighed separately and expressed in grams. The percentage of pulp was calculated by dividing the weight of seed from the total weight of fruit. The percentage of seed was calculated by dividing the weight of seed from the total weight of fruit. The pulp- seed ratio was calculated by dividing the weight of seed from the weight of pulp. Firmness of fruit was measured using penetrometer and the average was expressed as kg cm^{-2}. For the determination of fruit retention (%) from the twenty tagged branches on the experimental tree, the number of fruit at 7 days after anthesis and number of fruit before harvesting was calculated.

Data on number of days taken from flowering to harvest and yield were also recorded in both treated and untreated trees. Data collected on yield attributing parameters were statistically analyzed as per the methods suggested by Panse and Sukhatme (1967) using agres statistical software.

3. RESULTS AND DISCUSSION

3.1 Fruit Length and Girth (cm)

The data pertaining to fruit length and girth was significantly influenced by paclobutrazol, NAA application and to their interaction effect (Table 1 & 2). Among different treatment, the highest fruit length was recorded in PBZ 1.0 g a.i. application **(**2.79 cm) and in 75 ppm of NAA (2.80 cm). Their interaction effect resulted in higher fruit length of 2.87 cm (D_3S_3) compare to untreated trees (2.58 cm). The highest fruit girth was recorded in PBZ 1.5 g a.i. application (1.80 cm) and in 100 ppm of NAA (1.72 cm). Interaction effect significantly influenced in fruit girth of about 1.83 cm (D_4S_3).

Paclobutrazol reduces the fruit cell division and promote cell enlargement which resulted in larger fruits and also it induces the growth restriction which may tend to reduce photo assimilate demand of growing shoot in favour of superfluous sink (fruits). The increase in fruit length and fruit girth might be due to the accelerated involvement of plant growth regulators which enlarges the intercellular space in mesocarpic cells by the application of NAA. Similar results were reported by Kurian et al. [4] in mango and Hedge et al. [5] in jamun.

3.2 Fruit Retention

The fruit retention was significantly influenced by the application of Paclobutrazol and NAA in jamun (Table 3). Among different concentration, PBZ @ 1.0 g a.i. (63.93 per cent) and 75 ppm of NAA (63.49 per cent) resulted in higher fruit retention. Interaction effect of both treatment was significantly influenced in D_3S_3 (65.04 per cent) and the minimum fruit retention was recorded in untreated trees (57.37 per cent).

Table 1. Effect of paclobutrazol and NAA application on Jamun fruit length (cm)

Treatments	S_1(0 ppm)	S_2(50 ppm)	S_3(75 ppm)	S_4(100 ppm)	Mean D
D_1 (0)	2.58	2.63	2.68	2.73	2.66
D_2(0.5 g)	2.75	2.75	2.81	2.78	2.77
D_3(1.0 g)	2.72	2.79	2.86	2.80	**2.79**
D_4(1.5 g)	2.75	2.70	**2.87**	2.81	2.78
Mean S	2.70	2.72	**2.80**	2.78	
Factors				**C.D.**	**SE(d)**
Factor (D – Drenching, g a.i. m^{-1} of canopy diameter)				0.03	0.02
Factor (S – Spray)				0.03	0.02
Interaction D X S				0.07	0.03

Table 2. Effect of paclobutrazol and NAA application on jamun fruit girth (cm)

Treatments	S_1(0 ppm)	S_2(50 ppm)	S_3(75 ppm)	S_4(100 ppm)	Mean D
D_1 (0)	1.65	1.62	1.65	1.69	1.65
D_2(0.5 g)	1.65	1.59	1.61	1.67	1.63
D_3(1.0 g)	1.66	1.77	1.77	1.72	1.73
D_4(1.5 g)	1.78	1.78	**1.83**	1.80	**1.80**
Mean S	1.69	1.69	1.71	**1.72**	
Factors				**C.D.**	**SE(d)**
Factor (D – Drenching, g a.i. m^{-1} of canopy diameter)				0.02	0.01
Factor (S – Spray)				0.02	0.01
Interaction D X S				0.04	0.02

Table 3. Effect of paclobutrazol and NAA application on jamun fruit retention per cent

Treatments	S_1(0 ppm)	S_2(50 ppm)	S_3(75 ppm)	S_4(100 ppm)	Mean D
D_1 (0)	57.37	59.23	61.57	60.95	59.78
D_2(0.5 g)	60.40	60.55	63.56	63.37	61.97
D_3(1.0 g)	63.77	62.06	**65.04**	64.85	**63.93**
D_4(1.5 g)	61.90	62.13	63.80	61.86	62.42
Mean S	60.86	60.99	**63.49**	62.76	
Factors				**C.D.**	**SE(d)**
Factor (D – Drenching, g a.i. m^{-1} of canopy diameter)				0.72	0.36
Factor (S – Spray)				0.72	0.36
Interaction D X S				1.43	0.72

The positive effect of paclobutrazol application attributes the limited vegetative growth during the period of fruit growth to harvest which could reduces the food reserves competition in developing fruits. The external (foliar) application of NAA had significantly increased the fruit retention per cent. It might be the cause of balancing the internal auxin status which responsible for inhibiting the formation of abscission layer which putforth the production of enhanced fruit numbers at various fruit development stages. Similar results have been reported by Kurian et al. [4] in mango, Singh and Singh [6] in aonla and Arunadevi et al. [7] in Acid lime.

3.3 Fruit Weight (g)

Higher fruit weight was significantly influenced by the paclobutrazol, NAA application and with their interaction (Table 4). The fruit weight is higher in 1.0 g a.i. of Paclobutrazol (13.03 g) and NAA 75 ppm (13.52 g) and their interaction effect is about 14.05g (D_3S_3). However, lower fruit weight of 11.57 g recorded in untreated trees.

Increase in fruit weight in paclobutrazol treated fruits could be a consequence of better resource mobilization. Similar results were reported by Allan et al. [8], who found that paclobutrazol significantly increased yield (22.1%) by

Table 4. Effect of paclobutrazol and NAA application on jamun fruit weight (g)

Treatments	S_1(0 ppm)	S_2(50 ppm)	S_3(75 ppm)	S_4(100 ppm)	Mean D
D_1 (0)	11.57	11.83	12.82	11.96	12.04
D_2(0.5 g)	12.24	12.42	13.51	13.07	12.81
D_3(1.0 g)	12.57	12.46	**14.05**	13.03	**13.03**
D_4(1.5 g)	12.39	12.79	13.69	12.95	12.95
Mean S	12.19	12.37	**13.52**	12.75	
Factors				**C.D.**	**SE(d)**
Factor (D – Drenching, g a.i. m^{-1} of canopy diameter)				0.15	0.08
Factor (S – Spray)				0.15	0.08
Interaction D X S				0.30	0.15

Table 5. Effect of paclobutrazol and NAA application on jamun pulp – seed ratio

Treatments	S_1(0 ppm)	S_2(50 ppm)	S_3(75 ppm)	S_4(100 ppm)	Mean D
D_1 (0)	4.41	4.55	5.18	4.59	4.68
D_2(0.5 g)	5.14	5.40	6.07	6.25	5.71
D_3(1.0 g)	5.78	5.84	**6.54**	6.19	**6.14**
D_4(1.5 g)	5.82	5.94	6.10	6.32	6.05
Mean S	5.29	5.43	**6.02**	5.84	
Factors				**C.D.**	**SE(d)**
Factor (D – Drenching, g a.i. m^{-1} of canopy diameter)				0.07	0.03
Factor (S – Spray)				0.07	0.03
Interaction D X S				0.14	0.07

increasing mean fruit weight (12.7 %) rather than the number of fruits per tree in peach.

NAA might have increased the fruit weight by increasing the fruit pulp content and fruit size. In the interaction of paclobutrazol along with NAA application because of their both action fruit weight improving properties might have enhanced to increase the fruit weight synergistically compare to their individual treatment and untreated trees. Similar effect was reported by Hedge et al. [5] in jamun.

3.4 Pulp – Seed Ratio

Data depicted in Table (5) above indicated that pulp:seed ratio increased significantly by the 1.0 g a.i. Paclobutrazol (6.02), 75 ppm - NAA application (6.14) and their interaction of about 6.54 in D_3S_3. Pulp: seed ratio is a necessary character for table purpose jamun (Patel et al. 2005). The increase in pulp seed ratio of paclobutrazol treatment might be due to better resource mobilization and increased sugars. The NAA application resulted in cell enlargement and division, increase in intercellular spaces in the mesocarpic cells and higher translocation of photosynthates and mineral nutrients from vegetative parts towards the developing fruits that are extremely active metabolic sink. These results are in accordance with Singh and Singh [6] in aonla and Sarkar et al. (1998) in mango.

3.5 Yield (kg $tree^{-1}$)

The data pertaining to yield per tree was significantly influenced by paclobutrazol, NAA application and their interaction (Table 6). Among different treatments, PBZ 1.0 g a.i. application (67.01 kg $tree^{-1}$) with 75 ppm of NAA (66.51 kg $tree^{-1}$) resulted in higher yield per tree. Interaction effect significantly influenced in 68.31 kg $tree^{-1}$. The lowest yield per plant was recorded in untreated trees (62.12 kg $tree^{-1}$).

The yield increase in paclobutrazol and NAA treated trees was due to their synergetic effect which resulted in enhanced flowering, lower fruit drop, higher fruit retention and fruit weight. They alter the source sink relationship of plant which directly distributes the carbohydrate reserves by suppressing vegetative growth. Application of paclobutrazol before the bud break during vegetative growth will not only suppress the enhanced growth but also promote the yield. Similar synergistic effect on increasing yield was reported by Krishna et al. [9] in mango, Hedge et al. [5] in jamun and Arunadevi et al. [7] in Acid lime.

Table 6. Effect of paclobutrazol and NAA application on jamun yield per tree (Kg)

Treatments	S_1	S_2	S_3	S_4	Mean D
D_1	62.12	62.72	64.15	63.88	63.22
D_2	64.05	64.86	66.09	65.96	65.24
D_3	66.17	67.56	**68.31**	66.01	**67.01**
D_4	65.44	66.11	67.50	66.83	66.47
Mean S	64.45	65.31	**66.51**	65.67	
Factors				**C.D.**	**SE(d)**
Factor (D – Drenching, g a.i. m^{-1} of canopy diameter)				0.76	0.38
Factor (S – Spray)				0.76	0.38
Interaction D X S				NS	0.66

4. CONCLUSION

The jamun trees treated with paclobutrazol and NAA aided in early induction of enhanced flowering and yield attributing characters. The synergetic effect pertaining to the increased fruit retention by reducing flower drop, fruit weight and yield were obtained in PBZ 1.0 g a.i. application with 75 ppm of NAA increases the fruit production and the market value of jamun fruit.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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