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Effect of Flower Enhancing Plant Growth Regulators and Fruit Set Improving Chemicals on Vegetative Growth, Early Flower Initiation and Fruit Yield of Mango (*Mangifera indica* L.) cv. Banganpalli

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ABSTRACT

Field experiment was conducted during 2011-12 at Fruit research station, Sangareddy to study the influence of flower enhancing plant growth regulators and fruit set improving chemicals on mango cv. Banganpalli. Trees applied with paclobutrazol (3ml.m-1 of canopy diameter) alone significantly reduced the vegetative growth in terms of minimum number of new flushes and internodal length compared to control trees. Paclobutrazol alone and in combinations with fruit set improving chemical significantly minimized the number of days taken for panicle initiation and increased the number of days taken for 50% and 100% flowering, duration of flowering when compares to control trees. Significantly highest fruits.tree-1 and yield was recorded in paclobutrazol (42.17 % over control) alone applied trees compare to control. Among the combination, maximum increase in yield over control was recorded in paclobutrazol application along with spermidine (63.11 %), NAA + spermidine (57.59 %), NAA + boron (60.03 %).

Key words: *Vegetative growth, Panicle initiation, Paclobutrazol, Polyamines, Mango.*

INTRODUCTION

Mango (*Mangifera indica* L.) is the king of fruit, and is grown in Andhra Pradesh, Uttar Pradesh, Bihar, Karnataka, Maharashtra, West Bengal and Gujarat. The fruits of mango are valued because of its excellent flavor, delicious taste, and nutritive value. Andhra Pradesh ranks first in the production of mango. In Andhra Pradesh, mango occupies an area of 4.89 lakh ha, with a production of 44,406.9 M.T with a productivity of 9.0 T. ha¯1 [18]. Of late, the production and productivity of mango cv. Banganpalli has been decreased in the past 4-5 years[5]. There are several reasons for poor productivity in mango cv. Banganpalli in Andhra Pradesh. Among them, poor and erratic flowering coupled with poor or nil fruit set in mango cv. Banganpalli is one of the major reasons for poor productivity. The flowering and fruit set in mango is majorly influenced by the temperature during flowering[10].

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A night temperature of less than 150C for 3-4 weeks is necessary for mango to flower, a night temperature above 140C is needed for proper fruit set[11]. The climatic changes especially temperature during flowering and fruit set period has been attributed to erratic flowering and poor fruit set in mango cv. Banganpalli[5]. Modulation of flowering and fruit set by spraying of various hormones and chemicals is the best alternative to mitigate or reduce the climate change effect on mango.

MATERIALS AND METHODS

The experiment was carried out during 2011-12 at Fruit Research Station Sangareddy, Medak district, Dr.YSRHU, A.P. Fifteen years old, well grown, uniform statured trees of mango cv. Banganpalli were selected for the experiment. Trees were spaced with 8 m and planted in square system. Paclobutrazol concentration was calculated based on the diameter of the tree, and applied @ 3 $ml.m^{-1}$ of canopy diameter. The required paclobutrazol was dissolved in 10 litre of water, applied as soil drench 120 days before bud break [5]. 75 mg of NAA was dissolved in 50 ml of ethanol and diluted it in 1 litres of water to get 80ppm of NAA, Sprayed 30 days before flowering [11]. 1.45 mg of spermidine was dissolved in 1 litre of water to get 0.01 mM of spermidine. 20mg of spermine was dissolved in 1 litre of water to get 0.1 mM of spermine. 1.25 gm of boron (20%) was dissolved in 1 litre of water to get 1.25 $g.l^{-1}$ of boron. Fruit set improving chemicals (spermidine, spermine and boron) were sprayed at full bloom stage.

The statistical design adopted was Factorial Randomised block design with 12 treatments which were replicated thrice. Data on time taken for initiation of panicle emergence after spraying, number of days taken for 50% flowering, 100% flowering and fruit set per panicle was recorded. The data were subjected to statistical analysis as per the procedure out lined by Panse and Sukhatme[22].

RESULTS AND DISCUSSION

The data (Table 1) revealed that there is significant difference in number of new flushes among different flower enhancing plant growth regulators at the initial time of new flushes emergence (October 15th) and 20 days after initial stage of new flush emergence (November 5th) Flower enhancing plant growth regulator treatments did not differ significantly at 40 days after initial stage of new flush emergence (November 30th). Minimum number of new flushes was recorded in application of paclobutrazol (P_1) (14.49), which was on par with NAA (P_2) (18.82). Maximum number of new flushes was recorded in untreated control (P_0) (20.66) at the initial time of new flushes emergence (October 15th). Minimum number of new flushes was recorded in application of Paclobutrazol (P_1) (5.16), NAA (P_2) (6.07) which were on par with each other. Maximum number of new flushes was recorded in untreated control (P_0) (8.91) at 20 days after initial stage of new flush emergence (November 5th).

The results on internodal length after application of different flower enhancing plant growth regulators and fruit set improving chemicals are presented in the table 2. The data revealed that there is significant difference among flower enhancing plant growth regulators with respect to internodal length of mango. Minimum length was recorded in application of paclobutrazol (P_1) (7.99). Maximum internodal length was observed in untreated control (P_0) (8.67), which was on par with application of NAA (P_2) (8.59).

The data presented in table 3 is indicating that early panicle initiation was recorded in trees applied with paclobutrazol (P_1) (40.41), followed by NAA (P_2) (46.58). Maximum days was recorded in untreated control (P_0) (51.91).

There is significant difference among flower enhancing plant growth regulators with respect to number of days taken for 50% (Table 4) and 100 % (Table 5) flowering of mango. Minimum number of days taken for 50% flowering was recorded in untreated control (P_0) (23.41), followed by NAA (P_2)

(28.83).Maximum days was recorded in application of Paclobutrazol (P_1) (29.74) (Table 4). Minimum number of days taken for 100% flowering was recorded in untreated control (P_0) (38.41), followed by NAA (P_2) (42.08).Maximum number of days was recorded in application of Paclobutrazol (P_1) (43.58) (Table 5). Fruit set improving chemical treatments have been sprayed during flowering and hence, it might not have influenced the vegetative parameters like number of new flushes, internodal length and flowering parameters like time taken for panicle initiation, days taken for 50% flowering and 100% flowering were recorded before flowering. However, there was significant differences in the number of new flush among the fruit set improving chemical. These differences might have resulted from the factors other than fruit set improving chemical which were sprayed after the data on vegetative growth and flowering has been recorded.

The results on total number of fruits produced on a tree after application of different flower enhancing plant growth regulators and fruit set improving chemicals are presented in the table 6. The data revealed that there is significant difference among flower enhancing plant growth regulators with respect to number of fruits per tree of mango. Maximum number of fruits was recorded in application of paclobutrazol (P_1) (146.83) and minimum number of fruits per tree was recorded in untreated control (P_0) (130.74), which was on par with application of NAA (P_2) (133.74). Fruit set improving chemical treatments had significant influence on number of fruits per tree of mango. Maximum number of fruits was recorded in application of spermidine (F_1) (146.99), which was on par with application of boron (F_3) (140.77). Minimum number of fruits was recorded in untreated control (F_0) (127.66), which was on par with spermine (F_2) (132.99).

The interaction effect between flower enhancing plant growth regulators and fruit set improving chemicals on number of fruits per tree was significant. Maximum number of fruits per tree was recorded in paclobutrazol along with spermidine application (P_1F_1) (157.00), which was on par with application of NAA along with spermidine (P_2F_1) (152.66), paclobutrazol alone application (P_1F_0) (150.33), NAA along with boron application (P_2F_3) (148.3) paclobutrazol along with spermine application (P_1F_2) (145.66), spraying of boron alone (P_0F_3) (139.66) and spraying of spermine alone (P_0F_2) (137.33). Minimum number of fruits per tree was recorded with control (P_0F_0) (114.66).

The presented in table 7 revealed that there is significant difference in yield (kg.tree-1) among different flower enhancing plant growth regulators. Maximum yield was recorded in application of paclobutrazol (P_1) (43.03), which was on par with application of NAA (P_2) (40.75). Minimum yield was recorded in untreated control (P_0) (35.33).

Fruit set improving chemical treatments had significant influence on yield per tree of mango. Maximum yield was recorded in application of spermidine (F_1) (43.38) which was on par with application of boron (F_3) (42.77) and with spermine (F_2) (38.34).Minimum yield was recorded in untreated control (F_0) (34.32). There is significant difference in yield (kg.tree-1) among the interaction between flower enhancing plant growth regulators and fruit set improving chemicals. Maximum yield was recorded in application of paclobutrazol along with spermidine (P_1F_1) (50.24), which was on par with application of NAA along with boron (P_2F_3) (49.19), NAA along with spermidine spray (P_2F_1) (48.54), application of paclobutrazol alone (P_1F_0) (43.79), spraying of boron alone (P_0F_3) (42.36) and paclobutrazol along with spermine application (P_1F_2) (41.36). Minimum yield was recorded in application of NAA alone (P_2F_0) (28.36) which was on par with control (30.80).

Table 1: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on number of new flushes (number) of mango cv. Banganpalli

Treatment	Oct 15th				Nov 5th				Nov 30th			
	P_1	P_2	P_0	Mean	P_1	P_2	P_0	Mean	P_1	P_2	P_0	Mean
F_1	15.33b	29.33c	32.66c	25.77**b**	8.00 b	8.33 b	17.33c	11.22**b**	3.33a	2.00a	1.66a	2.33
F_2	30.66c	28.66c	21.33b	26.88**b**	11.3 b	5.66 a	10.33b	9.10**b**	2.00a	2.00a	3.66b	2.55
F_3	2.33a	11.66a	9.00a	7.66**a**	0.00 a	8.66 b	4.33a	4.33**a**	2.66a	5.00b	3.33a	3.66
F_0	9.66a	5.66a	19.66b	11.66**a**	1.33 a	1.66 a	3.66a	2.21**a**	3.00a	4.00b	2.00a	3.00
Mean	14.49**a**	18.82**a**	20.66**b**		5.16**a**	6.07**a**	8.91**b**		2.74	3.25	2.66	

	F-Test	S.Em ±	CD at (5%)		F-Test	S.Em ±	CD at (5%)		F-Test	S.Em ±	CD at (5%)
Factor F	*	1.916	5.621	Factor F	*	1.138	3.339	Factor F	*	0.392	NS
Factor P	*	1.659	4.868	Factor P	*	0.985	2.891	Factor P	*	0.339	NS
F×P	*	3.319	9.736	F×P	*	1.971	5.783	F×P	*	0.679	1.992

Figures with same alphabets did not differ significantly.
** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant.
Values were compared with respective C.D values.

Table 2: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on internodal length (cm) of mango cv. Banganpalli

Treatment	Intermodal length			
	P_1 - PBZ 3 ml.m^{-1}	P_2 - NAA 80 ppm	P_0 – Control	Mean
F_1 - Spermidine 0.01mM	7.91a	8.53b	7.99a	8.14
F_2 - Spermine 0.1mM	8.18a	8.35a	7.81a	8.11
F_3 - Boron 1.25g.l^{-1}	8.49a	9.00b	9.06b	8.85
F_0 - Control	7.38a	8.49a	9.85c	8.57
Mean	7.99**a**	8.59**b**	8.67**b**	

	F – Test	S.Em ±	CD at (5%)
Factor F	*	0.222	NS
Factor P	*	0.192	0.565
F × P	*	0.385	1.131

Figures with same alphabets did not differ significantly.
** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant.
Values were compared with respective C.D values

Table 3: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on number of days taken for panicle initiation of mango cv. Banganpalli

Treatment	Days			
	P_1 - PBZ 3 ml.m^{-1}	**P_2 - NAA 80 ppm**	**P_0 – Control**	**Mean**
F_1 - Spermidine 0.01mM	45.00b	44.66b	59.00c	49.55**b**
F_2 - Spermine 0.1mM	40.00a	55.00c	48.33b	47.77**a**
F_3 - Boron 1.25 g.l^{-1}	40.00a	47.00b	44.33a	43.77**a**
F_0 - Control	36.66a	39.66a	56.00c	44.10**a**
Mean	40.41**a**	46.58**b**	51.915**c**	

	F – Test	**S.Em ±**	**CD at (5%)**
Factor F	*	1.535	4.502
Factor P	*	1.329	3.899
F × P	*	2.658	7.798

Figures with same alphabets did not differ significantly.
** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS).
Values were compared with respective C.D values.

Table 4: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on time taken for 50% flowering from panicle initiation of mango cv. Banganpalli

Treatment	Days			
	P_1 - PBZ 3 ml.m^{-1}	**P_2 - NAA 80 ppm**	**P_0 - Control**	**Mean**
F_1 - Spermidine 0.01 mM	29.33c	31.33c	20.00a	26.88
F_2 - Spermine 0.1 mM	30.33c	29.00b	27.66b	28.99
F_3 - Boron 1.25 g.l^{-1}	30.00c	27.33b	25.00b	27.44
F_0 - Control	29.33c	27.66b	21.00a	25.99
Mean	29.74b	28.83b	23.41a	

	F – Test	**S.Em ±**	**CD at (5%)**
Factor F	*	0.836	NS
Factor P	*	0.724	2.124
F × P	*	1.448	4.248

Figures with same alphabets did not differ significantly.
** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant.
Values were compared with respective C.D values.

Table 5: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on time taken for 100% flowering from panicle initiation of mango cv. Banganpalli

Treatment	Days			
	P_1 - PBZ 3 ml.m^{-1}	P_2 - NAA 80 ppm	P_0 - Control	Mean
F_1 - Spermidine 0.01 mM	46.00b	39.33a	45.33b	43.55
F_2 - Spermine 0.1 mM	44.33b	46.00b	34.66a	41.66
F_3 - Boron 1.25 g.l^{-1}	40.66a	39.33a	38.33a	39.44
F_0 - Control	43.33b	43.66b	35.33a	40.77
Mean	43.58**b**	42.08**b**	38.41**a**	

	F - Test	S.Em ±	CD at (5%)
Factor F	*	1.197	NS
Factor P	*	1.036	3.040
F × P	*	2.073	6.081

Figures with same alphabets did not differ significantly.
** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS), NS- Non Significant.
Values were compared with respective C.D values.

Table 6: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on total number of fruits per tree of mango cv. Banganpalli

Treatment	Fruits in number			
	P_1 - PBZ 3 ml.m^{-1}	P_2 - NAA 80 ppm	P_0 - Control	Mean
F_1 - Spermidine 0.01 mM	157.00b	152.66b	131.33a	146.99**b**
F_2 - Spermine 0.1 mM	145.66b	116.00a	137.33b	132.99**a**
F_3 - Boron 1.25 g.l^{-1}	134.33a	148.33b	139.66b	140.77**b**
F_0 - Control	150.33b	118.00a	114.66a	127.66**a**
Mean	146.83**b**	133.74**a**	130.74**a**	

	F - Test	S.Em ±	CD at (5%)
Factor F	*	4.366	12.806
Factor P	*	3.781	11.091
F × P	*	7.562	22.182

Figures with same alphabets did not differ significantly.
** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS).
Values were compared with respective C.D values.

Table 7: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on yield (kg) of mango cv. Banganpalli

Treatment	Yield (kg.tree-1)			
	P_1 - PBZ 3 ml.m^{-1}	P_2 - NAA 80 ppm	P_0 - Control	Mean
F_1 - Spermidine 0.01 mM	50.24b	48.54b	31.38a	43.38**b**
F_2 - Spermine 0.1 mM	41.36b	36.88a	36.80a	38.34**a**
F_3 - Boron 1.25 g.l^{-1}	36.76a	49.19b	42.36b	42.77**b**
F_0 - Control	43.79b	28.36a	30.80a	34.32**a**
Mean	43.03**b**	40.75**b**	35.33**a**	

	F - Test	S.Em ±	CD at (5%)
Factor F	*	1.893	5.552
Factor P	*	1.639	4.808
F × P	*	3.279	9.617

Figures with same alphabets did not differ significantly.
** Significant at (p= 0.01 LOS), *Significant at (p= 0.05 LOS).
Values were compared with respective C.D values.

Paclobutraol and NAA have significantly minimised the number of new flushes compare to control (Table 1). Similar reduction in number of new flushes or vegetative shoots in mango cv. Alphonso was earlier reported when trees were sprayed with paclobutrazol at 3000 ppm [26], and in mango cv. Irwin [21], often induced by a lower activity of GA_3 [32]. Paclobutrazol and NAA has significantly reduced the internodal length compare to control (Table 2). Similar reduction in internodal length was obtained with application of paclobutrazol by Orwintinee *et al*.[21] in mango cv. Irwin, Ram and Tripathi[24] in mango cv. Dashehari and Soloman and Reuveiiodes[31] in mango.

Flowering of mango was associated with reduced vegetative growth and available evidence strongly suggest that flower initiation depends on the presence of an unknown flower promoting factor or factors synthesised in the leaves. At the same time, there are other factors in the shoots which work against the flowering factor or factors[14]. Further evidence suggests that a group of hormones called gibberellins act as inhibitors of flowering[32]. GA3 is a vegetative growth promoting hormone and paclobutrazol displays an anti-gibberellic activity[33]. Hence in the present investigation the observed reduction in vegetative growth in terms of reduction in number of new flushes and reduced intermodal length in paclobutrazol applied trees, were due to anti gibberellic activity of paclobutrazol. NAA found to be significantly reducing the vegetative growth in terms of vegetative flush and internodal length when compared to control (Table 1 and Table 2). As NAA was found to have flowering promoting activity[20], the observed reduction in vegetative growth in present investigation may to due to inhibitory effect of flower promoting factors on vegetative growth in plants, because of NAA is a flowering hormone[4].

Paclobutrazol significantly reduce the number of days taken for panicle initiation compare to control (Table 3). Similar early panicle initiation was earlier reported by Kumar *et al*.[15] in mango cv. Baneshan, Rao *et al*.[26] in mango cv. Alphonso when trees were treated with PBZ @ 3000 ppm. Orwintinee *et al*.[21] Adil *et al*.[1] also found similar earliness in mango flowering in mango cv. Irwin when trees were treated with PBZ @ 1 gm. a.i. per tree, and PBZ @ 2.5 a.i./tree respectively. Paclobutrazol with its anti - gibberellic activity 33, in the present study might have initiated the flowering early when compare to control. Paclobutrazol significantly increased the time taken for 50 % flowering (Table 4) and 100 %

flowering (Table 5) compare to control. Once panicle initiation has taken place, there was no effect of paclobutrazol and NAA on reducing the time taken for 50 % flowering, 100 % flowering and per cent of flowering compare to control. Similar increase in full bloom period was earlier observed by Khader *et al*.[13] with paclobutrazol application in mango. Further, the increase in number of days taken for 50 % and 100 % flowering has prolonged the flowering period which might have ultimately resulted in better pollination and fruit set in paclobutrazol and NAA applied trees (Table 6).

Paclobutrazol application has significantly increased the number of fruits per tree compare to control and NAA spray (Table 6). Similar increase in number of fruits tree-1 was earlier reported by Kumar *et al*.[15] in mango cv. Baneshan, Orwintinee *et al*.[21] in mango cv. Irwin, Kumbhar *et al*.[16] in mango cv. Kesar. Paclobutrazol application significantly increases perfect flower percentage[7] in mango. These may cause for increase in the total number of fruits per tree by PBZ application. The increased in intensity of flowering, better fruit set and fruit weight in paclobutrazol treated trees have ultimately increased the yield of mango by 42.17 %. Burondkar and Gunjate[7] has also found similar correlation between flowering, fruit set, fruit weight and yield of mango in response to paclobutrazol application. Fruit set improving chemical treatments had significant influence on number of fruits per tree of mango. Maximum number of fruits was recorded in application of spermidine, which was on par with application of boron. Minimum number of fruits was recorded in untreated control, which was at par with spermine. Similar increase in number of fruits per tree with spermidine spray was earlier reported by Singh and Singh 30 in mango, Singh and Janes[29] in mango, Aman Ullah Malik and Zora Singh[2] in mango cv. Kensington pride. And similar increase in number of fruits per tree with boron was earlier reported by Sanna *et al*.[27] in mango cv. Fagrikalan and Ramzy *et al*.[25] in mango. The increase in the number of fruits per tree by application of polyamines like spermidine and spermine may be due to improvement in embryo development[23], increased viability of the ovules and a prolonged pollination period[9]. There is substantial evidence to support that ethylene is the main trigger in abscission process 6 and polyamines are considered as anti-ethylene substances[3], being the likely competitors of precursors of ethylene (S-adenosyl methionine). Hence, exogenous application of polyamines has been reported to improve fruit retention in apple[8] and in mango[30], by increase in number of fruit perpanicle. Boron is essential for stigma receptivity, pollen tube germination and growth[19] it may cause for higher number of fruits per tree when trees were sprayed with boron. Flower enhancing plant growth regulators combinations with fruit set improving chemicals significantly increased the number of fruits per tree (Table 6). Paclobutrazol combination with spermidine could able to increase the number of fruits per tree compare to control. Paclobutrazol could helps in getting more number of reproductive shoots to tree[26], Kumbhar *et al*.[16], Muhammad Nefees *et al*.[17], Adil *et al*.[1] and also increase the perfect flowers per panicle[15]. Spermidine (polyamines) as earlier discussed cause for better fruit set by increasing the embryo development [23], by increase the viability of ovules and prolonged pollination period[9] and increased the harvested fruits per tree by increase the fruit retention, possibly by inhibiting endogenous ethylene biosynthesis, which is the known trigger in abscission[6].

Among fruit set improving chemicals spermidine and boron were significantly effective in increasing the yield compare to control and spermine (Table 7). This increase in yield may be due to increase in total number of fruits per tree (Table 6). The similar increase in yield was earlier reported by Sanna *et al*.[27] with boron spray in mango, Ramzy *et al*.[25] with boric acid application in mango, Singh and Singh[30] application with polyamines in mango, Aman Ullah malik and Zora Singh[2] application with polyamines in mango cv.

Kensington pride and Enas *et al*.[12] application with polyamines in cannino apricot.

Paclobutrazol significantly increase the yield compare control and other plant growth regulators (table 7). Paclobutrazol increases the fruit weight in mango cv. Baneshan[15] The increased in intensity of flowering, better fruit set and fruit weight in paclobutrazol treated trees have ultimately increased the yield of mango by 42.17 %. Burondkar and Gunjate[7] has also found similar correlation between flowering, fruit set, fruit weight and yield of mango in response to paclobutrazol application. This increase in yield may be due to increase in total number of fruits per tree (Table 6). Similar increased in yield of mango in response to paclobutrazol application was obtained by various worker like Shinde *et al*.[28] in cv. Alphonso, Kumar Raj *et al*.[15] in Beneshan, Orwintinee *et al*.[21] in cv. Irwin and Kumbhar *et al*.[16] in cv. Kesar.

Paclobutrazol in combination with spermidine could able to increase the yield (kg per tree) compare to control (Table 7). Paclobutrazol helps in getting more number of reproductive shoots[17] and also increases the perfect flowers per panicle[15] in mango. Spermidine could able to help in increasing fruit set and fruit retention[2] in mango and also improves the average fruit weight[12]. In the interaction of paclobutrazol along with spermidine synergistically increase the yield (kg per tree) by flower enhancing nature of paclobutrazol and fruit set, fruit retention and fruit weight increasing behaviour of spermidine could helps synergistically in getting more yield per tree compare to their individual application and control. Similar synergistic effect on increasing the yield was earlier reported by Sanna *et al*.[27] with sucrose along with potassium citrate.

CONCLUSION

Paclobutrazol (@3ml.m-1 of canopy diameter) applied trees significantly reduced the vegetative growth in terms of minimum number of new flushes and internodal length compared to control trees. Trees applied with paclobutrazol alone had significantly promotes early flower initiation by 11 days and 6 days when compares to control and NAA applied trees respectively. Among the plant growth regulators, pacloburazol application alone has increased the yield up to 42.17 % over control. Among the combination, maximum increase in yield over control was recorded in paclobutrazol application along with spermidine (63.11 %), NAA + spermidine (57.59 %) and NAA + boron (60.03 %).

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