



EFFECT OF FLOWER ENHANCING PLANT GROWTH REGULATORS AND FRUIT SET IMPROVING CHEMICALS ON FLOWERING AND FRUIT SET OF MANGO (*Mangifera indica* L.) cv. BANGANPALLI

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ABSTRACT

The present investigation 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 increases percent flowering (25% over control), panicle length and breadth at the time off full bloom stage. Significantly the highest fruits per panicle and yield were recorded in paclobutrazol (42.17 % over control) alone applied trees compare to control. Boron (1.25gr.l⁻¹) could able to significantly increase the fruit per panicle and final retention of fruits and increased the fruit weight reflecting in the overall increase in yield by 37 percent. Among the combination, maximum increase in yield over control was recorded in paclobutrazol application along with spermidine at 0.01mM (63.11 %), NAA at 80 ppm + spermidine at 0.01mM (57.59 %), NAA at 80 ppm + boron at 1.25gr.l⁻¹ (60.03 %). However, based on benefit cost ratio spraying of NAA + Boron has give maximum benefit cost ratio of 3.06. Among the fruit set improving chemical boron either alone or in combination with NAA has recorded highest improvement in the yield.

KEY WORDS: Spermine, Spermidine, Percent flowering, Flower enhancing plant growth regulators, Mango.

INTRODUCTION

Mango (*Mangifera indica*) is the premier fruit among the tropical fruits and has been in cultivation in the Indian subcontinent since several centuries. Mango occupied an area of 2.312 million hectares with a production of 15.026 million tonnes (NHB Database, -2011). The fruit is highly valued because of its excellent flavor, appealing aroma, delicious taste, attractive shades of colour and nutritive value, which has attracted the world market. In India, Andhra Pradesh is the leading mango producing state and occupies an area of 0.48 million hectares with a production of 4.05 million tonnes (NHB Database, -2011). Although, India is the leading mango producing country, the development of mango orchards as an established industry has remained a distant goal and our per hectare yields (2.45 t ha⁻¹) are low inspite of great potential (NHB Database, -2011). 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 climatic changes especially temperature during flowering and fruit set period has been attributed to erratic flowering and poor fruit set in mango cv. Banganpalli (Bhagwan *et al.*, 2011). 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. Various chemicals and plant growth regulators application have been standardized for enhancing and uniform

flowering in mango. Application of paclobutrazol @ 3ml.m⁻¹ canopy diameter was found to improve the flowering about 38% in mango cv. Banganpalli (Bhagwan *et al.*, 2011). The effect of paclobutrazol in improving flowering percent was due to its anti gibberellins activity (Quinlin and Richardson, 1984). Spraying of NAA @ of 50-100ppm has shown the effect in early flowering (Davenport, 2007) in mango. Naphthalene acetic acid (NAA), an auxin group of plant growth regulator was found to have an effect on the flower promoting activity in mango (Beyer, 1976). Polyamines form a class of aliphatic amines that are ubiquitous in living organisms and are known to have role in a wide range of biological processes including plant growth and development (Pandey *et al.*, 2000). Putrescine, spermidine and spermine are the major forms of polyamines which are biosynthesised from arginine or ornithine. Polyamines arise from a common metabolic intermediate pathway as of ethylene and are believed to act antagonistically to ethylene in several physiological process like stress, senescence etc. (Anon., 2004). Recently, polyamines have been attributed to play a role in the fruit set of many crop including mango. (Aman ullah Malik and Zora singh 2006). Among the micronutrients, spraying of Boron at full bloom stage has significantly improved fruit set in mango (Zong Runi and Dong 2000) by enhancing the pollen grain germination and pollen tube elongation which consequently leads to better fruit set (Saleh and El-Monem 2003). However, no work has been carried out on the combination of both

flower enhancing plant growth regulators and fruit set improving chemicals on yield of mango cv. Banganpalli along with cost benefit ratio for successful commercialization of these plant growth regulators and chemicals.

MATERIALS & 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 (Bhagwan *et al.*, 2011). 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 (Davenport, 2003). 1.45mg of spermidine was dissolved in 1litre 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. For recording flowering, fruit set and yield parameters, 40 well distributed healthy shoots were tagged in four directions of plant canopy. Data on percent flowering (%), panicle length and breadth, No. of days taken for fruit set from panicle initiation, fruit set per panicle, fruit weight, yield and cost benefit ratio were recorded. The data were subjected to statistical analysis as per the procedure out lined by Panse and Sukhatme (1985).

RESULTS & DISCUSSION

The changes in percent flowering (%) of mango cv. Banganpalli sprayed with different flower enhancing plant growth regulators and fruit set improving chemicals are presented in the table 1.

TABLE 1: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on per cent flowering (%) of mango cv. Banganpalli.

Treatment Days	Flowering in % Dec 20th				Flowering in % Jan 10th				Flowering in % Feb 1st			
	P ₁	P ₂	P ₀	Mean	P ₁	P ₂	P ₀	Mean	P ₁	P ₂	P ₀	Mean
F ₁	10.4a	12.3b	2.8a	8.5	37.14a	50.47b	29.52a	39.04a	73.32b	79.04b	64.75a	72.37a
F ₂	16.1b	8.9a	12.3b	12.43	49.52b	26.65a	45.71b	40.62a	80.95b	49.49a	71.42b	67.28a
F ₃	15.2b	8.6a	12.3b	12.03	62.84b	42.85a	60.94b	55.54b	86.66b	75.23b	91.42c	84.43b
F ₀	15.2b	17.1b	1.9a	11.4	70.47c	63.18b	38.09a	57.24b	88.56b	87.61b	75.23b	83.8b
Mean	14.22b	11.72b	7.32a		54.99b	45.78a	43.56a		82.37	72.84	75.70	
	F -Test	S. Em ±	CD at (5%)		F -Test	S. Em ±	CD at (5%)		F -Test	S. Em ±	CD at (5%)	
Factor F	*	1.710	NS		*	3.577	10.49		*	3.494	10.25	
Factor P	*	1.481	4.343		*	3.098	9.08		*	3.026	NS	
F×P	*	2.962	8.687		*	6.196	18.17		*	6.052	17.75	

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.

F₁ - Spermidine 0.01mM

F₂ - Spermine 0.1mM

F₃ - Boron 1.25g.l⁻¹

F₀ - Control

P₁ - PBZ 3 ml.m⁻¹

P₂ - NAA 80 ppm

P₀ - Control

At initial stage of flowering (Dec 20th) Maximum flowering percent recorded in application of Paclobutrazol (P₁) (14.22), which was on par with application of NAA (P₂) (11.72). Minimum flowering percent was recorded in untreated control (P₀) (7.32). At 20 days after initial stage of percent flowering (Jan 10th) Maximum flowering percent recorded in application of paclobutrazol (P₁) (54.99). Minimum flowering percent was recorded in untreated control (P₀) (43.56), which were on par with application of NAA (P₂) (45.78). There was no significant difference observed among flower enhancing plant growth regulator application with respect to percent flowering at 40 days after initial stage of percent flowering (Feb 1st). Paclobutrazol was significantly more effective in increasing the flowering percentage. Gibberellins, a group of plant growth hormones were reported to be inhibitory to flowering (Kachru *et al.*, 1971), in mango and the available evidence suggests the flower promotive effect of

paclobutrazol in mango due to its anti - gibberellin activity (Quinlan and Richardson, 1984). Hence, in the present investigation the increase in the percent (%) flowering of mango by paclobutrazol was due to its anti - gibberellin activity. The similar findings of increase in per cent flowering (%) by application of PBZ was earlier reported by Kumar Raj *et al.* (2005) in mango cv. Baneshan, Orwintiner *et al.* (2008) and Muhammad Nafeez *et al.* (2010) in mango cv. Irwin. NAA spray has also significantly increased the flowering in mango cv. Banganpalli in the present investigation when compared with the control. Similar increase in flowering with spraying of NAA was reported in mango cv. Succary Abiad (Wahdan *et al.*, 2011). NAA which is considered as flowering hormones in some crops (Moti-Singh *et al.*, 1987) might have increased the latent flowering factors in the mango and resulted in overall increase in flowering in

mango cv. Banganpalli when compared to control in the present investigation.

The data (Table 2 and Table 3) indicating that there is significant difference among flower enhancing plant growth regulators with respect to panicle length and

breadth. Minimum panicle length was recorded in untreated control (P₀) (14.79), which was on par with spraying of NAA (P₂) (15.86). Maximum panicle length was recorded in application of paclobutrazol (P₁) (16.64).

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

Treatment	Panicle length (cm)			
	P ₁ - PBZ 3 ml.m ⁻¹	P ₂ - NAA 80 ppm	P ₀ - Control	Mean
F ₁ - Spermidine 0.01mM	17.36b	16.16b	13.76a	15.76
F ₂ - Spermine 0.1mM	17.10b	16.00b	16.30b	16.46
F ₃ - Boron 1.25g.l ⁻¹	14.40a	15.33a	16.50b	15.41
F ₀ - Control	17.73b	15.96b	12.63a	15.44
Mean	16.64b	15.86a	14.79a	
	F -Test	S.Em ±	CD at (5%)	
Factor F	*	0.544	NS	
Factor P	*	0.471	1.384	
F×P	*	0.943	2.768	

TABLE 3: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on panicle breadth (cm) of mango cv. Banganpalli

Treatment	Panicle breadth (cm)			
	P ₁ - PBZ 3 ml.m ⁻¹	P ₂ - NAA 80 ppm	P ₀ - Control	Mean
F ₁ - Spermidine 0.01mM	12.06b	9.866a	9.36a	10.42a
F ₂ - Spermine 0.1mM	12.20b	11.16b	12.46b	11.94b
F ₃ - Boron 1.25g.l ⁻¹	11.90b	9.93ba	11.70b	11.17a
F ₀ - Control	13.10c	11.66b	10.23a	11.66b
Mean	12.31b	10.65a	10.93a	
	F - Test	S.Em ±	CD at (5%)	
Factor F	*	0.334	0.981	
Factor P	*	0.289	0.849	
F×P	*	0.579	1.699	

Among interactions minimum panicle length was recorded in control (P₀F₀) (12.63), which was on par with spraying of spermidine alone (P₀F₁) (13.76), paclobutrazol along with boron application (P₁F₃) (14.40) and NAA along with boron application (P₂F₃) (15.33). Maximum length was recorded in Paclobutrazol alone application (P₁F₀) (17.73). Minimum panicle breadth was recorded in application of NAA (P₂) (10.65), which were on par with untreated control (P₀) (10.93). Maximum panicle breadth was recorded in application of paclobutrazol (P₁) (12.31). Among interaction minimum panicle breadth was recorded in spraying of spermidine alone (P₀F₁) (9.36), which was on par with application of NAA along with spermidine (P₂F₁) (9.86), NAA along with boron application (P₂F₃) (9.93) and control (P₀F₀) (10.23). Maximum panicle breadth was recorded in application of paclobutrazol alone (P₁F₀) (13.10). Similar increase in panicle length with the application of paclobutrazol in mango was reported by Vijayalaxmi and Srinivasan (1998) in mango cv. Alphonso when trees treated with PBZ @ 10 ml.tree⁻¹. Paclobutrazol could able to increase the panicle breadth compare to control and NAA (Table 3). However, Winston (1992) in mango cv. Kensington and Orwintinll *et al.* (2008) in mango cv. Irwin reported that the panicles of paclobutrazol treated trees were considerably shorter than those of control trees. The discrepancy in the finding of present investigation to the earlier reports regarding

panicle may be due to varietal change, time of applications and dosage of paclobutrazol. However, increase in panicle length and breadth of paclobutrazol treated trees might be beneficial for increase the number of hermaphrodite flowers per panicle. This may cause for better fruit set over the control. Fruit set improving chemical treatments have been sprayed during flowering and hence, it might not have influenced on the percent flowering, panicle length and breadth which were recorded before flowering or at full bloom stage. However, any significant differences in flowering might have resulted from the factors other than fruit set improving chemical which were sprayed after the data on flowering parameters has been recorded. The results on number of days taken for fruit set after panicle initiation after application of different flower enhancing plant growth regulators and fruit set improving chemicals are presented in the table 4. Among fruit set improving plant growth regulators minimum number of days was recorded in untreated control (P₀) (49.66), followed by NAA (P₂) (54.83). Maximum number of days was recorded in application of paclobutrazol (P₁) (58.83). Paclobutrazol could not able to reduce the time taken for fruit set after panicle initiation compare to control. However, increase in days taken for fruit set from panicle initiation might be beneficial for better fruit set and fruit retention in paclobutrazol treated trees. Fruit set improving chemical treatments did not differ significantly on number

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of days taken for fruit set after panicle initiation of mango. Significant difference was observed in interaction effect between flower enhancing plant growth regulators and fruit set improving chemicals with respect to number of days taken for fruit set after panicle initiation of mango. Minimum number of days was recorded in spraying of spermidine alone (P₀F₁) (45.66), which was on par with

control (P₀F₀) (46.33), NAA along with spermine application (P₂F₂) (48.33). Maximum number of days was recorded in Pacllobutrazol alone application (P₁F₀) (62.00). This increase in days may be due to increase in days taken for full bloom stage. However, these may further cause for better fruit set by providing prolonged pollination period by the effect of polyamines (Crisosto *et al.*, 1988).

TABLE 4: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on number of days taken for fruit set 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	55.66b	56.00b	45.66a	52.44
F ₂ - Spermine 0.1 mM	59.66b	48.33a	53.33b	53.77
F ₃ - Boron 1.25 g.l ⁻¹	58.00b	54.33b	53.33b	55.22
F ₀ - Control	62.00c	60.66c	46.33a	56.22
Mean	58.83c	54.83b	49.66a	
	F - Test	S.Em ±	CD at (5%)	
Factor F	*	1.251	NS	
Factor P	*	1.083	3.179	
F × P	*	2.167	6.358	

TABLE 5: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on number of fruit set per panicle 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	5.80b	5.60b	5.53b	5.64b
F ₂ - Spermine 0.1 mM	5.40b	5.20a	5.20a	5.26a
F ₃ - Boron 1.25 g.l ⁻¹	6.40d	5.86c	5.86c	6.04c
F ₀ - Control	6.20c	5.80b	4.86a	5.62b
Mean	5.95c	5.61b	5.36a	
	F - Test	S.Em ±	CD at (5%)	
Factor F	*	0.085	0.251	
Factor P	*	0.074	0.217	
F × P	*	0.148	0.434	

TABLE 6: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on fruit weight (gm) of mango cv. Banganpalli

Treatment	Fruit weight (g)			
	P ₁ - PBZ 3 ml.m ⁻¹	P ₂ - NAA 80 ppm	P ₀ - Control	Mean
F ₁ - Spermidine 0.01 mM	320.00b	318.00b	239.00a	289.00b
F ₂ - Spermine 0.1 mM	284.00b	318.00b	268.00a	290.00b
F ₃ - Boron 1.25 g.l ⁻¹	273.66a	331.66c	303.33b	302.88b
F ₀ - Control	291.33b	240.66a	268.66a	266.88a
Mean	289.74a	302.08b	269.74a	
	F - Test	S.Em ±	CD at (5%)	
Factor F	*	8.143	23.885	
Factor P	*	7.052	20.685	
F × P	*	14.104	41.370	

The data presented in table 5 indicating that maximum fruit set per panicle was recorded in application of pacllobutrazol (P₁) (5.95), followed by application of NAA (P₂) (5.61). Minimum fruit set per panicle observed in untreated control (P₀) (5.36) Similar increase in fruit set per panicle in response to pacllobutrazol application was recorded by Kumar Raj *et al.* (2005) in cv. Baneshan and Orwintinee *et al.* (2008) in mango cv. Irwin. Among fruit set improving chemical treatments maximum fruit set per panicle was recorded in application of boron (F₃) (6.04), followed by spermidine (F₁) (5.64), which was on par with untreated control (F₀) (5.62). Minimum fruit set per

panicle was recorded in spermine (F₂) (5.26). Similar increase in fruit set was earlier obtained by Sanna *et al.* (2005) in mango cv. Fagri kalan when trees were sprayed with boron and Ramzy *et al.* (2011) in mango. Boron is essential for stigma receptivity and pollen tube extension by formation of boron sorbitol (carbohydrate) complex that promotes absorption, translocation and metabolism of sugar in pollen and synthesis of pectin material for cell wall of growing pollen tube (Nyomora and Brown, 1997). Among interaction effect between flower enhancing plant growth regulators and fruit set improving chemicals maximum fruit set per panicle was recorded in application

of paclobutrazol along with boron (P_1F_3) (6.40). Minimum fruit set per panicle was recorded in control (P_0F_0) (4.86). Paclobutrazol could able to increase fruit set per panicle compared to control and NAA (Table 5). This may be due to increase of number of perfect flowers per panicle. Paclobutrazol combination with spermidine could able to increase fruit set per panicle significantly when compared to control (Table 5). Paclobutrazol could helps in getting more number of perfect flowers and thus further helps in better fruit set in paclobutrazol treated trees compare to control (Kumar Raj *et al.*, 2005). Polyamines like spermidine may increase the fruit set per panicle by improving embryo development (Ponce *et al.*, 2002), increase viability of the ovule and prolonged pollination period (Crisosto *et al.*, 1988) there by increasing the pollen germination and pollen tube growth (Wolukan *et al.*, 2004). Paclobutrazol along with spermidine because of their fruit set improving properties, might have caused increase in number of fruits per panicle synergistically compare to their individual application and control. The similar synergistic effect in increasing the number of fruits per panicle was earlier reported by Kumar Raj *et al.* (2005). Combination of paclobutrazol along with Ca (NO_3)₂ increases number of fruits per panicle compares to their individual application in mango cv. Baneshan.

The changes in fruit weight (gm) of mango cv. Banganpalli sprayed with different flower enhancing plant growth regulators and fruit set improving chemicals are presented in the table 6. Among flower enhancing plant growth regulators maximum weight was recorded in application of NAA (P_2) (302.08). Minimum fruit weight was recorded in untreated control (P_0) (269.74), which were on par with application of paclobutrazol (P_1) (289.74). Similar increase in fruit weight was earlier reported by Wahdan *et al.*, (2011) in mango cv. Succary Abiad treated with NAA @ 60 ppm. Among fruit set improving chemicals maximum fruit weight was recorded in application of Boron (F_3) (302.88). Minimum fruit weight was recorded in untreated control (F_0) (266.88), which were on par with application of spermine (F_2) (290.00) and spermidine (F_1) (289.00). In the early stages of fruit development the polyamines are maintained at a high level, followed by decline with fruit development in mango (Malik and Singh, 2004), Grape (Shiozaki *et al.*, 2000). The high polyamine concentrations may be related to the high growth rate at initial stages of fruit development (Fraga *et al.*, 2004) in prunus persica or active cell division (Galston, 1983). These high growth rate and active cell division at initial stages of fruit development might be cause for in fruit weight. Similar increase in fruit weight in Canino Apricot was earlier obtained by Enas *et al.* (2010) treated with polyamine. Among the interaction effect maximum fruit weight was recorded in application of NAA along with boron (P_2F_3) (331.66). Minimum fruit weight was recorded in spraying of spermidine alone (P_0F_1) (239.00). NAA might have increased the fruit weight by increasing the fruit pulp content and fruit size. The similar increase in fruit weight by Boron application was earlier reported by Ramzy *et al.* (2011) in mango. In the interaction of NAA along with boron because of their both fruit weight improving properties, might have caused for increase in fruit weight synergistically compare to their individual application and

control. The similar synergistic effects in increasing the fruit weight were earlier reported by Sanna *et al.* (2005) with sucrose along with boric acid increase fruit weight synergistically in combination compare to individual application.

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). 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 (1993) has also found similar correlation between flowering, fruit set, fruit weight and yield of mango in response to paclobutrazol application. Similar increased in yield of mango in response to paclobutrazol application was obtained by various worker like Kumbhar *et al.* (2007) in cv. Kesar and Orwintinee *et al.* (2008) in cv. Irwin. 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). This increase in yield may be due to increase in fruit set per panicle and increase in average fruit weight. The similar increase in yield was earlier reported by Sanna *et al.* (2005) with boron spray in mango, Ramzy *et al.* (2011) with boric acid application in mango, Aman Ullah malik and Zora Singh (2006) application with polyamines in mango cv. Kensington pride. Among the interactions 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). Paclobutrazol helps in getting more number of reproductive shoots (Muhamad Nafes *et al.* (2010) and also increases the perfect flowers per panicle (Kumar Raj *et al.*, 2005) in mango. Spermidine could able to help in increasing fruit set and fruit retention (Amanullah Malik and Zora Singh, 2006) in mango and also improves the average fruit weight (Eanas *et al.* (2010). 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.* (2005) with sucrose along with potassium citrate. The data (Table 8) revealed that there is significant difference between flower enhancing plant growth regulators, fruit set improving chemicals with respect to number of days taken from panicle initiation to harvesting. Minimum number of days taken from panicle initiation to harvesting was recorded in paclobutrazol (P_1) (117.58),

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which was on par with application of NAA (P₂) (119.07). Maximum days were recorded in untreated control (P₀) (124.74) among plant growth regulators. Similar findings were obtained by GoGuey (1990), Singh and Dhillon (1992) in mango treated with paclobutrazol. Among fruit set improving chemicals minimum number of days taken from panicle initiation to harvesting was recorded in application of spermidine (F₁) (114.77), which were on par with application of boron (F₃) (117.88).

Maximum days were recorded in untreated control (F₀) (126.10), which was on par with application of spermine (F₂) (120.44). This minimization in number of days taken for harvesting from panicle initiation by boron application is may be due to early fruit set, pollen tube germination and growth (Nyomora and Brown, 1997). Early maturity by polyamines may be due to early fruit set, pollen tube germination and growth cause for early maturity (Amanullah Malik and Zora Singh, 2006).

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	43.38b
F ₂ - Spermine 0.1 mM	41.36b	36.88a	36.80a	38.34a
F ₃ - Boron 1.25 g.l ⁻¹	36.76a	49.19b	42.36b	42.77b
F ₀ - Control	43.79b	28.36a	30.80a	34.32a
Mean	43.03b	40.75b	35.33a	
	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	

TABLE 8 : Effect of flower enhancing plant growth regulators and fruit set improving chemicals on number of days taken from panicle initiation to harvesting of mango cv. Banganpalli

Treatment	Days in number			
	P ₁ - PBZ 3 ml.m ⁻¹	P ₂ - NAA 80 ppm	P ₀ - Control	Mean
F ₁ - Spermidine 0.01 mM	109.00a	113.66a	121.66b	114.77a
F ₂ - Spermine 0.1 mM	117.66b	122.33b	121.33b	120.44b
F ₃ - Boron 1.25 g.l ⁻¹	116.33a	120.66b	116.66a	117.88a
F ₀ - Control	127.33c	119.66b	131.33c	126.10c
Mean	117.58a	119.07a	122.74b	
	F - Test	S.Em ±	CD at (5%)	
Factor F	*	1.573	4.613	
Factor P	*	1.362	3.995	
F × P	*	2.724	7.991	

TABLE 9: Effect of flower enhancing plant growth regulators and fruit set improving chemicals on benefit cost ratio of mango cv. Banganpalli

Treatment	Benefit : Cost			
	P ₁ - PBZ 3 ml.m ⁻¹	P ₂ - NAA 80 ppm	P ₀ - Control	Mean
F ₁ - Spermidine 0.01 mM	1.82	2.71	1.35	1.96
F ₂ - Spermine 0.1 mM	0.28	0.12	0.29	0.23
F ₃ - Boron 1.25 g.l ⁻¹	1.15	3.06	2.80	2.33
F ₀ - Control	1.97	1.33	1.53	1.54
Mean	1.30	1.80	1.53	

Basic cost of cultivation = 30,000 per ha

Market price of fruits = Rs 30 per kg

Basic cost of Chemicals:

Chemical	Rs.
1) P ₁ - Paclobutrazol	5,025/1
2) P ₂ - NAA	6,360/Kg
3) F ₁ - Spermidine	3,018/gm
4) F ₂ - Spermine	5,618/gm
5) F ₃ - Boron	640/Kg

Among interactions minimum number of days taken from panicle initiation to harvesting was recorded in application of paclobutrazol along with spermidine (P₁F₁) (109.00), which was on par with application of NAA along with spermidine (P₂F₁) (113.66), paclobutrazol along with boron (P₁F₃) (116.33) and spraying of boron alone (P₀F₃)

(116.66). Maximum number of days taken from panicle initiation to harvesting was recorded in control (P₀F₀) (131.66). The fruit maturity depends mostly on the available degree days (or) heat units (Shinde *et al.*, 2001) and these early harvesting in paclobutrazol treated trees may be due to delayed fruit set in paclobutrazol treated

trees which might have got better exposed to more heat units than other. Early maturity by polyamines may be due to early fruit set, pollen tube germination and growth cause for early maturity. In the interaction of paclobutrazol along with spermidine synergistically minimise the number of days taken for harvesting from panicle initiation may be due to paclobutrazol providing more heat units for maturity and by polyamine early fruit set might have caused for these synergistic minimisation of number of days taken for harvesting from panicle initiation. Similar synergistic effect on reducing the days taken for harvesting from panicle initiation was earlier reported by Kumar Raj *et al.* (2005) in mango. KH_2PO_4 along with H_3PO_4 application could able to minimise the number of days taken for harvesting from panicle initiation compare to individual application. The Benefit cost ratio of mango cv. Banganpalli sprayed with different flower enhancing plant growth regulators and fruit set improving chemicals are presented in the table 9. Among the flower enhancing plant growth regulator treatments the highest benefit cost ratio was recorded with application of NAA (P_2) (1.80), lowest benefit cost ratio was recorded with application of paclobutrazol (P_1) (1.30). This is due to the low chemical cost per kg (or) lit and further due to less dosage of NAA compared to the paclobutrazol. Among the fruit set improving chemical treatments the highest benefit cost ratio was recorded with application of boron (F_3) (2.33), lowest benefit cost ratio was recorded with application of spermine (F_2) (0.23). This may due to low chemical cost per kg (or) lit of boron compare to spermine and spermidine. Among the interactions highest benefit cost ratio was recorded in application of NAA along with boron (P_2F_3) (3.06), followed by spraying of boron alone (P_0F_3) (2.80), NAA along with spermidine application (P_2F_1) (2.71) and application of paclobutrazol alone (P_1F_0) (1.97). Lowest benefit cost ratio was recorded in application of NAA along with spermine (P_2F_2) (0.12). This may be due to chemical cost of per kg or lit was lesser compare to other chemicals which were used in interactions.

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