INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

www.scienceandnature.org

CROP IMPROVEMENT STUDIES WITH FLOWER ENHANCING AND FRUIT SET IMPROVING CHEMICALS IN MANGO (*Mangifera indica* L.) cv. BANGANPALLI

*Vijay Krishna G., [1]Bhagwan, A., [2]Raj Kumar, M. & [3]Siva Shankar, A.
*****College of Horticulture, Rajendranagar, Hyderabad -500030 (Telangana), India.
[1]Fruit Research Station, Sangareddy, Medak- 502001 (Telangana), India.
[2]Fruit Research Station, Sangareddy, Medak- 502001 (Telangana), India.
[3]Department of crop Physiology, College of Agriculture, Rajendra nagar, Hyderabad -500030 (Telangana), India.

ABSTRACT
An experiment on the effect of flower enhancing chemicals (Ca $(NO_3)_2$ (1%), KH_2PO_4 (1%) and H_3PO_4 (0.5%)) and fruit set improving chemicals (Spermidine @0.01mM, spermine @0.1mM and boron-20% @ 1.25gm.l-1) on percent flowering, fruit set and yield of mango. KH_2PO_4 and H_3PO_4 alone or in combinations with fruit set improving chemical significantly increase in percent of flowering, panicle length and breadth when compare to control trees. Significantly the highest fruits.panicle-1, yield and fruit.tree-1 (16.7 % over control) and was recorded in Ca $(NO_3)_2$ applied trees and spermidine (22.9% over control) applied trees alone compare to control. Spermidine alone could able to significantly increase the fruit.panicle-1 and final retention of fruits and increased the fruit weight reflecting in the overall increase in yield by 48.72 %. Among the combination, maximum increase in yield over control was recorded in Ca $(NO_3)_2$ + spermidine (87.27 %), H_3PO_4 + spermine (76.09 %), KH_2PO_4 + Spermine (74.51 %). However, based on benefit cost ratio spraying of Ca $(NO_3)_2$ + spermidine has give maximum benefit cost ratio of 3.35.

KEY WORD: Flower enhancing chemicals, Fruit set improving chemical, per cent flowering, Polyamines, Mango.

INTRODUCTION
Mango (*Mangifera indica* L.) is a major fruit crop of the tropical regions of the world. India is the largest producer of mango in the world. 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 (NHB Database, - 2012). Of late, the production and productivity of mango cv. Banganpalli has been decreased in the past 4-5 years (Bhagwan *et al*., 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. To mitigate these production problems there is much need to use the flower promoting and fruit set improving chemicals. Various chemicals application has been standardized for enhancing and uniform flowering in mango. Spraying of various chemicals like Ca $(NO_3)_2$ (Kumar raj *et al*., 2005), KH_2PO_4 (1%) (Bhagwan *et al*., 2011)), H_3PO_4 (Kumar raj *et al*., 2007) has been standardized to enhance the flowering in mango cv. Banganpalli. For improving the fruit set, spraying of polyamines like spermidine @ 0.01mM and spermine @ 0.1mM at full Bloom stage were standardized in mango cv. Kensington pride (Aman ullah Malik and Zora singh 2006). Among the micronutrients spraying of boron at full bloom stage has significantly improved fruit set in mango (Saleh and El-Monem 2003).

MATERIALS & METHODS
The experiment was conducted on fifteen years old, well grown, uniform statured trees of mango cv. Banganpali. Trees were spaced with 8 m and planted in square system. The statistical design adopted was Factorial Randomised block design with 12 treatments which were replicated thrice. To prepare 1% of ca $(NO_3)_2$ one gm of Ca $(NO_3)_2$ was dissolved in 1 litre of water. One gm of Potassium di hydrogen orthophosphoric acid (KH_2PO_4) was dissolved in 1 litre of water to get 1% of KH_2PO_4. One ml of phosphoric acid (H_3PO_4) was dissolved in 2 litres of water to get 0.5% of H_3PO_4. Ca $(NO_3)_2$, KH_2PO_4 and H_3PO_4 @ 0.5% were sprayed at the time of panicle initiation was found to improve flowering in mango cv. Banganpalli (Kumar raj *et al*., 2005). 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 (Sanna *et al*., 2005). Data on percent flowering, panicle length and breadth, fruit set per panicle, fruits per tree and yield were recorded. Fifty shoots were randomly tagged (from North, South, East and West directions) and the number of tagged shoots which had flowered was recorded and expressed as percentage of flowering. The panicle length, breath and fruit set of ten randomly selected shoots were recorded and mean was calculated. The total number of fruits harvested per tree was counted after harvest and expressed as number of fruits per tree. The average fruit weight was

computed by dividing the total yield (kg per tree) and number of fruits per tree of the respective treatment.

RESULTS & DISCUSSION

Flowering parameters

Changes in percent flowering (%) of mango cv. Banganpalli sprayed with different flower enhancing chemicals and fruit set improving chemicals are presented in the Table 1. At initial stage of flowering (Dec 20th) There was significant difference in percent flowering (%) among different flower enhancing chemicals application. Maximum percent flowering was recorded in application of Ca $(NO_3)_2$ (C_1) (7.42), which were on par with application of KH_2PO_4 (C_3) (5.92). Minimum percent flowering was recorded in untreated (C_0) (3.23), which were on par with application of H_3PO_4 (C_2) (5.11). At 20 days after initial stage of percent flowering (Jan 10th) maximum percent flowering was recorded in application of KH_2PO_4 (C_3) (39.51), which were on par with application of H_3PO_4 (C_2) (34.75) and Ca $(NO_3)_2$ (C_1) (32.85). Minimum percent flowering was recorded in untreated control (C_0) (22.85).At 40 days after initial stage of percent flowering (Feb 1st) maximum percent flowering was recorded in application of KH_2PO_4 (C_3) (68.01), which were on par with application of H_3PO_4 (C_2) (60.94) and Ca $(NO_3)_2$ (C_1) (59.87).

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

Treatment	Flowering in %					Flowering in %					Flowering in %				
Days	Dec 20th					Jan 10th					Feb 1st				
	C_1	C_2	C_3	C_0	Mean	C_1	C_2	C_3	C_0	Mean	C_1	C_2	C_3	C_0	Mean
F_1	13.33c	5.61b	10.47c	3.80a	8.30b	39.04b	41.90b	51.42c	21.90a	38.56b	65.23b	63.80b	76.18b	44.75a	62.49
F_2	2.85a	5.99b	4.76a	0.95a	3.63a	20.95a	30.47a	49.52b	21.90a	30.71a	51.42a	60.94b	79.99c	44.75a	59.27
F_3	7.80b	5.04a	5.61b	4.38a	5.70a	36.18b	38.09b	35.23b	29.52a	34.75b	58.09a	67.61b	64.75b	62.85b	63.32
F_0	5.71b	3.80a	2.85a	3.80a	4.04a	35.23b	28.57a	21.90a	18.09a	25.94a	64.75b	51.42a	51.14a	41.90a	52.30
Mean	7.42b	5.11a	5.92b	3.23a		32.85b	34.75b	39.51b	22.85a		59.87b	60.94b	68.01b	48.56a	
	F -Test	S. Em±		CD at (5%)		F - Test	S. Em±		CD at (5%)		F - Test	S. Em±		CD at (5%)	
Factor C	*	0.730		2.108		*	2.743		7.922		*	3.062		8.843	
Factor F	*	0.730		2.108		*	2.743		7.922		*	3.062		NS	
C×F	*	1.460		4.216		*	5.486		15.844		*	6.124		17.686	

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.

F_1 - Spermidine 0.01mM — C_1 - Ca$(NO_3)_2$ @ 1%
F_2 - Spermine 0.1mM — C_2 - H_3PO_4 @ 0.5%
F_3 - Boron 1.25g.l-1 — C_3 - KH_2PO_4 @ 1%
F_0 – Control — C_0 - Control

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

Treatment	Panicle length (cm)				
	C_1 - Ca$(NO_3)_2$ 1%	C_2 - H_3PO_4	C_3 - KH_2PO_4	C_0 - Control	Mean
F_1 - Spermidine 0.01mM	16.10b	15.86b	15.76b	12.73a	15.11
F_2 - Spermine 0.1mM	14.66b	12.20a	18.56c	15.33b	15.18
F_3 - Boron 1.25g.l-1	15.93b	13.46a	17.06c	13.26a	14.92
F_0 - Control	16.83b	13.66a	15.96b	13.66a	15.02
Mean	15.88b	13.79a	16.83b	13.74a	
	F - Test	S.Em ±		CD at (5%)	
Factor F	*	0.403		NS	
Factor C	*	0.403		1.164	
F×C	*	0.806		2.328	

Minimum percent flowering was recorded in untreated control (C_0) (43.56). Calcium nitrate applied trees gave significantly more percent flowering and this may be due to calcium has been reported to act as secondary messenger for flower induction (McKenzie, 1994). It might be cause for increase in reproductive shoots in Ca $(NO_3)_2$ treated trees compare to control. The similar increase in per cent of flowering was earlier obtained by Ashok Kumar and Reddy (2007) in mango cv. Baneshan trees treated with Ca $(NO_3)_2$, Kumar raj *et al*. (2005) in mango cv. Baneshan trees treated with KH_2PO_4 and H_3PO_4. The data (Table 2 and Table 3) revealed that there is significant difference among flower enhancing chemicals with respect to panicle length and breadth of mango. Minimum panicle length was recorded in untreated control (C_0) (13.74), which was on par with H_3PO_4 (C_2) (13.79). Maximum panicle length was recorded in application of KH_2PO_4 (C_3) (16.83), followed by application of Ca $(NO_3)_2$ (C_1) (15.88). Minimum panicle breadth was recorded in untreated control (C_0) (10.62), which was on par with application of H_3PO_4 (C_2) (11.41). Maximum panicle breadth was recorded in application of Ca $(NO_3)_2$ (C_1) (13.62), which was on par with application of KH_2PO_4 (C_3) (13.20). KH_2PO_4 and Ca $(NO_3)_2$ significantly increase the panicle length (Table 2), panicle breadth (Table 3) compare to control. Similar increase in panicle length was earlier reported by Kumar raj *et al*. (2005) in mango cv. Baneshan trees treated with KH_2PO_4. However, increase in panicle length and breadth of flower enhancing chemical treated trees might be beneficial for increase the number of perfect flower per panicle. These 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.

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

Treatment	Panicle breadth (cm)				
	C_1 - $Ca(NO_3)_2$ 1%	C_2 - H_3PO_4	C_3 - KH_2PO_4	C_0 - Control	Mean
F_1 - Spermidine 0.01 mM	13.05c	12.30b	12.73b	10.16a	12.06a
F_2 - Spermine 0.1 mM	13.10c	10.60a	14.90d	12.13b	12.68b
F_3 - Boron 1.25 g.l-1	12.63b	11.30b	12.90b	9.33a	11.54a
F_0 - Control	15.73d	11.46b	12.30b	10.86a	12.58b
Mean	13.62b	11.41a	13.20b	10.62a	
	F -Test	S.Em ±		CD at (5%)	
Factor F	*	0.308		0.891	
Factor C	*	0.308		0.891	
F × C	*	0.617		1.783	

TABLE 4: Effect of flower enhancing and fruit set improving chemicals on fruit set per panicle of mango cv. Banganpalli

Treatment	Fruits in number				
	C_1 - $Ca(NO_3)_2$ 1%	C_2 - H_3PO_4	C_3 - KH_2PO_4	C_0 - Control	Mean
F_1 - Spermidine 0.01mM	6.33c	5.60a	5.20a	6.00b	5.78a
F_2 - Spermine 0.1mM	5.73b	5.66a	5.60a	5.53a	5.63a
F_3 - Boron 1.25 g.l-1	6.46c	5.86b	6.00b	5.60a	5.98b
F_0 - Control	6.20b	5.86b	6.00b	5.40a	5.86a
Mean	6.18b	5.74a	5.70a	5.63a	
	F - Test	S.Em ±		CD at (5%)	
Factor F	*	0.084		0.242	
Factor C	*	0.084		0.242	
F×C	*	0.168		0.485	

Fruit set parameters

Data presented in table 4 revealed that there is significant difference among flower enhancing chemicals on fruit set.panicle-1 of mango. Maximum number of fruits per panicle was recorded in application of Ca $(NO_3)_2$ (C_1) (6.18).Minimum number of fruits per panicle was recorded in untreated control (C_0) (5.63), which was on par with application of KH_2PO_4 (C_3) (5.70) and H_3PO_4 (C_2) (5.74). Similar findings were reported by Sanchez *et al*. (1998) in mango trees treated with Ca $(NO_3)_2$. Calcium compound by way of reducing the young fruit let abscission (Ramzy *et al*., 2011) might have increased the number of fruits per panicle in the present investigation. Among fruit set improving chemical treatments maximum number of fruits per panicle was recorded in application of boron (F_3) (5.98). Minimum number of fruits per panicle was recorded in application of spermine (F_2) (5.63), which was on par with spermidine (F_1) (5.78) and untreated control (F_0) (5.86). Similar increase in fruit set was earlier obtained by Sanna *et al*. (2005) in mango cv. Fagri kalan and Ramzy *et al*. (2011) in mango when trees were sprayed with boron. Boron deficiency resulted in low pollen viability, poor pollen germination and pollen tube growth resulted poor fruit set in almond (Nyomora and Brown, 1997). Carbohydrate also plays an essential role in pollen tube growth, deficiency in carbohydrates metabolism in anther leads to abnormal pollen development in many plants (Bhadula and Sawhnev, 1989). 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 maximum number of fruits per panicle was recorded in application of Ca $(NO_3)_2$ along with boron (C_1F_3) (6.46), which was on par with application of Ca $(NO_3)_2$ along with spermidine (C_1F_1) (6.33). Minimum number of fruits per panicle was recorded with application of KH_2PO_4 along with spermidine (C_3F_1) (5.20). Ca $(NO_3)_2$ in combinations with boron could able to increase fruit set per panicle when compares to control. Calcium nitrate might have helped in advanced flowering and maturity. By way of preventing the abscission of fruit lets, calcium increases the harvested fruits per panicle significantly and may cause for better fruit set in Ca $(NO_3)_2$ treated trees compare to control. Similar findings were reported by Sanchez *et al.* (1998) in mango. As earlier discussed, boron could able to increase the stigma receptivity, pollen germination and pollen tube growth (Nyomora and Brown,

1997) might have caused increased fruit set per panicle in the present investigation. In the interaction of Ca $(NO_3)_2$ along with boron because of their both fruit set improving properties, might have caused the increased fruit set per panicle synergistically compared to their individual application and control. The similar synergistic increase in the number of fruit set per panicle was earlier reported by Sanna *et al*. (2005) in the combination spray of boric acid along with sucrose when compared to their individual effects in mango cv. Fagri kalan.

Yield parameters

The data (Table 5) revealed that there is significant difference among flower enhancing chemicals with respect to number of fruits per tree of mango. Maximum number of fruits per tree was recorded in application of Ca $(NO_3)_2$ (C_1) (123.25). Minimum number of fruits per tree was recorded in untreated control (C_0) (103.41), which was on par with application of H_3PO_4 (C_2) (107.83) and application of KH_2PO_4 (C_3) (110.82). Calcium nitrate as earlier discussed might have helped in advancement of flowering and maturity. By way of preventing the abscission of fruit lets, calcium nitrate increases the harvested fruits per tree significantly. It may be due to increase in per cent of flowering and better fruit set by increasing the number of fruits per panicle (Kumar raj *et al*., 2005) and by better fruit retained per panicle (Ramzy *et al*., 2011). Similar increase in number of fruits per tree was earlier reported by Kumar raj *et al*. (2005) and Ramzy *et al*. (2011) in mango cv. Baneshan treated with Ca $(NO_3)_2$. Among fruit set improving chemicals Maximum number of fruits per tree was recorded in application of spermidine (F_1) (125.66), which was on par with application of spermine (F_2) (122.99). Minimum number of fruits per tree was recorded in untreated control (F_0) (95.41), which was on par with application of boron (F_3) (102.24). Similar increase in fruits.tree-1 by polyamines was earlier reported by Aman Ullah Malik and Zora Singh (2006) in mango cv. Kensington pride. The increase in the number of fruits.tree-1 by application of polyamines like spermidine and spermine may be due to improvement in embryo development (Ponce *et al*., 2002), increased viability of the ovules and a prolonged pollination period (Crisosto *et al*., 1988). There is substantial evidence to support that ethylene is the main trigger in abscission process (Brown, 1997) and polyamines are considered as anti-ethylene substances (Apelbaum *et al*., 1981), being the likely competitors of precursors of ethylene (S-adenosyl methionine). Hence, exogenous application of polyamines has been reported to improve fruit retention in mango (Singh and Singh, 1995), by increase in number of fruit.panicle-1.

TABLE 5: Effect of flower enhancing and fruit set improving chemicals on number of fruit per tree of mango cv. Banganpalli

Treatment	Fruits in number				
	C_1 - $Ca(NO_3)_2$ 1%	C_2 - H_3PO_4	C_3 - KH_2PO_4	C_0 - Control	Mean
F_1 - Spermidine 0.01mM	140.67b	128.66b	106.66a	126.66b	125.66b
F_2 - Spermine 0.1mM	113.33b	134.00b	139.66b	101.00a	121.99b
F_3 - Boron 1.25 g.l-1	124.00b	87.00a	108.66a	89.33a	102.24a
F_0 - Control	115.00b	81.67a	88.33a	96.67a	95.41a
Mean	123.25b	107.83a	111.80a	103.41a	

	F - Test	S.Em ±	CD at (5%)
Factor F	*	4.782	13.811
Factor C	*	4.782	13.811
F×C	*	9.565	27.623

In the interaction maximum number of fruits per tree was recorded in application of Ca $(NO_3)_2$ along with spermidine (C_1F_1) (140.67), which was on par with application of KH_2PO_4 along with spermine (C_3F_2) (139.66), H_3PO_4 along with spermine application (C_2F_2) (134.00), H_3PO_4 along with spermidine application (C_2F_1) (128.66), spraying of spermidine alone (C_0F_1) (126.66), $Ca(NO_3)_2$ along with boron application (C_1F_3) (124.00), spraying of Ca $(NO_3)_2$ alone (C_1F_0) (115.00) and Ca $(NO_3)_2$ along with spermine (C_1F_2) (113.33). Minimum number of fruits per tree was recorded with spraying of H_3PO_4 alone (C_2F_0) (81.67). KH_2PO_4 could helps in getting early full bloom stage and higher reproductive shoots per tree and may further cause for better fruit set and improves the number of fruits per tree (Kumar raj *et al*., 2005). Polyamine cause for better fruit set by improves embryo development (Ponce *et al*., 2002), increase viability of ovules (Crisosto *et al*., 1988) and increase in the number of fruits per tree by better fruit retention (Brown, 1997). In the interaction of KH_2PO_4 along with spermine synergistically increases the total number of fruits harvested per tree, by flowers enhancing nature of KH_2PO_4 and fruit set and fruit retention behaviour of spermine, synergistically helps in getting more number of fruit per tree compare to individual application and control. Similar synergistically increase in number of fruits harvested per tree was earlier reported by Sanna *et al*. (2005) sucrose along with potassium citrate reached maximum number of fruits per tree compare to individual application in mango.

Data presented in the table 6 revealed that there is no significant difference among the flower enhancing chemicals application with respect to fruit weight. In fruit set improving chemical treatments maximum fruit weight was recorded in application of spermidine (F_1) (352.83), which were on par with application of spermine (F_2) (350.99) and boron (F_3) (338.74). Minimum fruit weight was recorded in untreated control (F_0) (283.91). 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). 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 interactions maximum fruit weight was recorded in application of Ca $(NO_3)_2$ along with spermidine (C_1F_1) (383.66), which were on par with application of H_3PO_4 along with spermine (C_2F_2) (376.00). Minimum fruit weight was recorded in application of KH_2PO_4 alone (C_3F_0) (256.66). Ca $(NO_3)_2$ might be increase the fruit weight by increasing the fruit size and fruit pulp content. Polyamine as earlier discussed increases the fruit weight by high growth rate and active cell division at initial stages of fruit development might be cause for increase in fruit weight. In the interaction of Ca $(NO_3)_2$ along with spermidine because of their both fruit weight improving properties, might have caused the increase in fruit weight synergistically compare to their individual application and control. Similar synergistically effect in increasing the fruit weight was earlier reported by Sanna *et al.* (2005) with sucrose along with boric acid combination.

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

Treatment	Fruit weight (g)				
	C_1 - $Ca(NO_3)_2$ 1%	C_2 - H_3PO_4	C_3 - KH_2PO_4	C_0 - Control	Mean
F_1 - Spermidine 0.01mM	383.66c	330.33b	361.33b	336.00b	352.83b
F_2 - Spermine 0.1mM	352.66b	376.00c	355.00b	320.33b	350.99b
F_3 - Boron 1.25 g.l-1	320.33b	335.66b	337.66b	361.33b	338.74b
F_0 - Control	323.00b	260.00a	256.66a	296.00a	283.91a
Mean	344.91	325.49	327.66	328.41	
	F - Test	S. Em ±		CD at (5%)	
Factor F	*	8.855		25.574	
Factor C	*	8.855		NS	
F×C	*	17.711		51.149	

The data (Table 7) revealed that there is significant difference among flower enhancing chemicals with respect to yield per tree of mango. Maximum yield per tree was recorded in application of Ca $(NO_3)_2$ (C_1) (42.69). Minimum yield per tree was recorded in untreated control (C_0) (33.94), which was on par with application of H_3PO_4 (C_2) (35.82) and KH_2PO_4 (C_3) (36.86). This may be due to early flowering, better fruit retention (Ramzy *et al.*, 2011) and reducing abscission (Wahedan *et al.*, 2011) in Ca $(NO_3)_2$ treated trees. Similar increase in yield was earlier reported by Ramzy *et al.* (2011) in mango. Among fruit set improving chemicals Maximum yield per tree was recorded in application of spermidine (F_1) (44.38), which was on par with application of spermine (F_2) (43.06), followed by application of boron (F_3) (34.47). Minimum yield per tree was recorded in untreated control (F_0) (27.41). The high polyamine concentrations may be related to the high growth rate at initial stages of fruit development or active cell division (Fraga *et al.*, 2004) in *prunus persica.* These high growth rate and active cell division at initial stages of fruit development might be cause for in fruit weight. Hence, these fruit weight may cause for high yield. Similar increase in fruit weight and yield in Canino Apricot was earlier obtained by Enas *et al.* (2010) treated with polyamine. Among interaction maximum yield per tree was recorded in application of Ca $(NO_3)_2$ along with spermidine (C_1F_1) (53.96), which was on par with application of H_3PO_4 along with spermine (C_2F_2) (50.38) and KH_2PO_4 along with spermine application (C_3F_2) (49.57).

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

Treatment	Yield (kg. tree-1)				
	C_1 - $Ca(NO_3)_2$ 1%	C_2 - H_3PO_4	C_3 - KH_2PO_4	C_0 - Control	Mean
F_1 - Spermidine 0.01mM	53.58c	42.50b	38.53b	42.55b	44.29c
F_2 - Spermine 0.1mM	39.96b	50.38c	49.93c	32.35b	43.15c
F_3 - Boron 1.25 g.l-1	39.72b	29.20a	36.69b	32.27b	34.47a
F_0 - Control	37.14b	21.23a	22.67a	28.61a	27.41a
Mean	42.60b	35.82a	36.95a	33.94a	
	F - Test	S. Em ±		CD at (5%)	
Factor F	*	1.792		5.175	
Factor C	*	1.792		5.175	
F×C	*	3.584		10.35	

Minimum yield per tree was recorded with application of H_3PO_4 alone (C_2F_0) (21.23). In the interaction of $Ca(NO_3)_2$ along with spermidine synergistically increased the yield (kg per tree) by flower enhancing nature of $Ca(NO_3)_2$ and fruit set, fruit retention and fruit weight increasing behaviour of spermidine could helps synergistically in getting more yield per tree (kg) compare to their individual application and control. Similar synergistic increase on yield was earlier reported by Sanna *et al*. (2005) sucrose along with potassium citrate, increases the yield in mango compares to their individual application. The effect on Benefit cost ratio of mango cv. Banganpalli sprayed with different chemicals is presented in the table 8. Among the flower enhancing chemical treatments the highest benefit cost ratio was recorded with application of Ca $(NO_3)_2$ (C_1) (2.30), lowest benefit cost ratio was recorded with application of H_3PO_4 (C_2) (1.13). This is due to low chemical cost per kg (or) lit of Ca (NO3)2 when compare to KH_2PO_4 and H_3PO_4. Among the fruit set improving chemical treatments the highest benefit cost ratio was recorded with application of spermidine (F_1) (2.60), lowest benefit cost ratio was recorded with application of spermine (F_2) (0.69). This may due to higher increment in yield in spermidine treated trees compare to control and other even though the chemical cost was more. Among the interactions highest benefit cost ratio was recorded with application of Ca $(NO_3)_2$ along with spermidine (C_1F_1) (3.35), followed by spermidine alone application (C_0F_1) (3.32). Lowest benefit cost ratio was recorded in application of spermine alone (C_0F_2) (0.43). These may be due to Ca $(NO_3)_2$ along with spermidine treated get more yield (kg per tree) compare to control and other even though chemical cost of spermidine was more.

TABLE 8: Effect of flower enhancing and fruit set improving chemicals on benefit cost ratio of mango cv. Banganpalli

Treatment	B:C ratio				
	C_1 - $Ca(NO_3)_2$ 1%	C_2 - H_3PO_4	C_3 - KH_2PO_4	C_0 - Control	Mean
F_1 - Spermidine 0.01mM	3.35	2.07	1.68	3.32	2.60
F_2 - Spermine 0.1mM	0.59	0.93	0.83	0.43	0.69
F_3 - Boron 1.25 g.l-1	2.50	0.90	1.36	2.36	1.78
F_0 - Control	2.78	0.64	0.69	2.81	1.73
Mean	2.30	1.13	1.14	2.24	

Basic cost of cultivation = 30,000 per ha
Market price of fruits = Rs 30 per Kg

Basic cost of Chemicals:

	Chemical	Rs.
1)	C_1 - $Ca(NO_3)_2$ @ 1%	370/Kg
2)	C_2 - H_3PO_4 @ 0.5%	1,400/l
3)	C_3 - KH_2PO_4 @ 1%	870/Kg
4)	F_1 –Spermidine	3,018/gm
5)	F_2 –Spermine	5,618/gm
6)	F_3–Boron	640/Kg

CONCLUSION

All flower enhancing chemicals (Ca $(NO_3)_2$, KH_2PO_4 and H_3PO_4) used in the experiment were improves the percent of flowering compares to control. Ca $(NO_3)_2$ alone and in combination with polyamine could able to improves the fruit set per panicle and fruit weight which reflecting in the overall increase in yield. Among the flower enhancing chemicals, Ca $(NO_3)_2$ sprays alone have increased the yield up to 29.81 % over control. Among the combination, maximum increase in yield over control was recorded in Ca $(NO_3)_2$ + spermidine (87.27 %), H_3PO_4 + spermine (76.09 %) and KH_2PO_4 + Spermine (74.51 %). However, based on benefit cost ratio, spraying of Ca $(NO_3)_2$ + spermidine has given maximum benefit cost ratio of 3.35.

REFERENCES

Aman ullah malik and Zora singh (2006) Improved fruit retention, yield and fruit quality in mango with exogenous application of polyamines. Scientia Horticulturae, vol.(110):167-174.

Apelbaum, A., Burgoon, A.C., Andrew, J.D., Liberman, M., Ben-Arie, R. and Matto A.K. (1981) Polyamines inhibit biosynthesis of ethylene in higher plant tissue and fruit protoplast. Plant Physiol, vol. (68): 453–456.

Ashok Kumar, M. and Reddy, Y. N. (2007) Effect of calcium nitrate and salicylic acid sprays at flowering on transduction of flowering in mango cv. Baneshan. Crop Research (Hisar), vol. (34) (1/3): 146-148.

Bhagwan, A., Vanajalatha, K., Prabhakar Reddy, I., Sarka,r S.K. and Girwani, A. (2011) Standardization of Dosage and Time of Soil Application of Cultar on Flowering and Yield of Mango cv. Banganpalli. Presented in Global Conference on Augmenting Production and Utilization of Mango: Biotic and Abiotic Stresses held on 21-24th June, 2011 at Lucknow.

Brown, K.M. (1997) Ethylene and abscission. Physiol. Plant vol. (100): 567–576.

Crisosto, C.H. (1988) Putrescine influences ovule senescence, fertilization time, and fruit set in 'Comice' pear. J. Am. Soc. Hort. Sci., vol. (113): 708–712.

Enas, A.M., Ali, S.M., Sarrwy, A. and Hassan H.S.A.

(2010) Improving Canino Apricot Trees Productivity by Foliar Spraying with Polyamines. Journal of Applied Sciences Research, vol. 6(9): 1359-1365.

Fraga, M .F. (2004) Changes in polyamine concentration associated with aging in Pinus radiata and Prunus persica. Tree Physiol., vol. (24): 1221–1226.

Galston, A.W. (1983) Polyamines as modulators of plant development. BioScience, vol. (33): 382–388.

Kumar Raj, M., Reddy, Y.N., Chandrasekhar, R. and Srihari, D. (2005) Effect of foliar application of chemicals and plant growth regulators on flowering of unpruned mango trees of cv. Baneshan. Journal of Research ANGRAU, vol. 33 (2): 6-11.

Kumar Raj, M., Reddy, Y.N., Chandrasekhar, R. and Srihari, D. (2007) Effect of pruning, paclobutrazol and chemicals on the induction of flowering on new laterals in mango (*Mangifera indica* L.) cv. Baneshan. Journal of Research ANGRAU, vol. 35 (1): 22-26.

Malik, A.U. and Singh, Z. (2004) Endogenous free polyamines of mangos in relation to development and ripening. J. Am. Soc. Hort. Sci., vol. (129): 280–286.

McKenzie, C.B. (1994) Preliminary results of calcium and potassium uptake from foliar sprays on Sensation mango. Year Book – South African Mango Growers Association, vol. (14) : 24-25.

NHB, (2012) National Horticulture Board, Guargon, India. *http://www.gov.in/area production. html*.

Nyomora, A.M. S. and Brown, P. H. (1997) Fall foliar-applied boron increases tissue boron concentration and nut set of almond. J. Amer. Soc. Hort. Sci., vol.122(3): 405-410.

Ponce,M.T., Guinazu, M. and Tizio, R. (2002) Effect of putrescine on embryo development in the stenospermocarpic grape cvs Emperatriz and Fantasy. Vitis, vol. (41): 53–54.

Ramzy, G., Stino Habashy, S.A. and Kelani, R.A. (2011) Productivity and fruit quality of three mango cultivars in relation to foliar spray of calcium,zinc, boron and potassium. Journal of Horticultaral Science & Ornamenta plant, vol. 3 (2): 91-98.

Saleh, M.M. and El-Monem, E.A. (2003) Improving the productivity of Fagri Kalan mango trees grown under sandy soil conditions using potassium, boron and sucrose as foliar spray. Ann. Agric. Sci., vol. (48) 747-756.

Sanchez, J., Durand, G. and Crane, J.H. (1998) Evaluation of flowering promoters and plant water status during the off cycle of three mango (Mangifera indica L.) varieties. Processing of the Interamerican Society for Tropical Horticulture, Barquisimeto, Venezuela, 27 September – 2 October 42: 232-235(Abst.)

Sanna Ebeed and Abd El-Migeed M.M.M. (2005) Effect of Spraying Sucrose and Some Nutrient Elements on Fagri Kalan Mango Trees. Journal of Applied Sciencse Research, vol. 1(5): 341-346.

Singh, Z. and Singh, L. (1995) Increased fruit set and retention in mango with exogenous application of polyamines. Journal of Horticultural Sciences, vol. (70): 271-277.

Wahdan, M.T., Habib, S.E., Bassal, M.A. and Qaoud, E.M. (2011) Effect of some chemicals on growth, fruiting, yield and fruit quality of "Succary Abiad" mango cv. Journal of American Science, vol. 7(2): 651-658.