Effect of chemicals, PGRs and pruning on flowering and yield in mango under high density planting

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 Received: 24.1.2019/Accepted: 29.1.2019

ABSTRACT

Investigations were conducted on canopy management in mango (*Mangifera indica* L) cv Alphonso using chemicals, different growth regulators and pruning methods under high density planting during the year 2015-2016. In the present study emphasis was given mainly to understand the physiological basis for canopy management, flowering and yield. The treatments were evaluated in terms of changes in flowering characters, yield and yield parameters and fruit quality characters. Paclobutrazol (2.5 ml/m of canopy diameter)-received trees were the shortest at pre-flowering stage (Dec 2015) followed by chlormequat chloride triple spray 6,000 ppm. Paclobutrazol-treated trees recorded the highest fruit set, number of fruits and yield followed by chlormequat chloride triple spray. The yield was almost double as compared to control.

Keywords: Mango; high density planting; growth; PGRs; pruning

INTRODUCTION

Mango (*Mangifera indica* L) belongs to the family *Anacardiaceae* which is one of the most popular and delicious fruit crops in the tropical and subtropical regions of the world. It is being cultivated for consumption in the Indian subcontinent for the past 4,000 years (de Candolle 1904) and originated from the Indo-Burma region (Mukherjee 1958). Mango is known for its captivating flavour and delicious taste. It is also an excellent source of vitamin A and C. Being a tropical fruit in India mango is seldom pruned or treated with chemical PGRs to regulate the canopy growth and development to achieve better yield and quality of fruits. Overcrowding of branches results in poor penetration of sunlight causing low productivity coupled with inferior quality of fruits (Rathore et al 2009). Hence management of canopy architecture is a critical component to improve crop performance by increasing the magnitude of partitioning of dry matter towards reproductive parts.

Plant growth regulators have been used commercially since the 1950s to modify the growth. In the recent years plant growth regulators and chemical fertilizers have played an important role in improving the growth, yield and quality of several fruit crops. Application of growth regulators, chemicals like paclobutrazol and ethrel in mango has been reported to respond to flower induction (Yadav et al 2005, Yeshitela et al 2004, Nafees et al 2010). Although several physiological approaches to improve yield and quality have been carried out, comparative performance of pruning and chemical application to mango tree crop are limited in Tamil Nadu and India.

In Tamil Nadu paclobutrazol is applied either in last week of September or first week of October to check the vegetative growth in mango. Absorption of the drenched paclobutrazol is critical because the active ingredient may be leached away from the rhisosphere if it coincides with heavy rain which is highly unpredictable. Thereafter in Tamil Nadu the northeast monsoon commences and the rain may extend till first week of December. So reapplication of paclobutrazol is in question and it is a costliest management practice too. Therefore there is need to identify an alternate chemical which is suitable for foliar spray or other canopy management practices such as second and tip pruning to get flowering in mango under high density

planting. Alphonso can be grown both under conventional and high density planting. Trees under high density planting are more vigorous. The growth regulating chemicals such as chlormequat chloride, TIBA, ethephon and daminozide have been studied widely under conventional planting.

MATERIAL and METHODS

This study was undertaken on canopy management in mango cv Alphonso through different growth regulators and pruning methods under high density planting during the year 2015-2016. The present investigations were carried out in a farmer's field located at Petathapuram near Karamadai, Coimbatore, Tamil Nadu. Five-year-old Alphonso mango trees which were uniform in size were used for the study. The experiment was laid out in a randomized block design having eight treatments and five replications. Each replication consisted of five trees. The trial was laid out in trees spaced at 5 x 5 m.

Treatments used were T_1 (Control), T_2 (Soil drenching with paclobutrazol 2.5 ml/m of canopy diameter), T_3 (Foliar spray of chlormequat chloride 6,000 ppm), T_4 (Foliar spray of TIBA 500 ppm), T_5 (Foliar spray of ethephon 2,000 ppm), T_6 (Foliar spray of daminozide 2,500 ppm), T_7 (Second pruning at pre-flowering) and T_8 (T_7 + tip pruning). The soil application of paclobutrazol 2.5 ml/m of canopy diameter was given on 29 Sept 2015.

The required quantity of paclobutrazol was dissolved in water (1 ml/litre) and poured in small holes (10-15 cm depth) around the collar region as suggested by Burondkar and Gunjate (1993). The foliar sprays were given once in thirty days from the last week of Sep 2015. Totally three sprays were given. The sprays were given in the morning hours using hand sprayer. The trees were well irrigated before the application of growth regulators. The trees were also given complete wetting with growth regulators. First pruning, that is total removal of past season's growth was done after the harvest (Jul 2015). Second pruning was done in the middle of Dec 2015. Crowded and inward growing branches were removed to open up the canopy to facilitate the penetration of sunlight as well as aeration. This was done to remove the vegetative flush just prior to flowering. Trees under this treatment received two extra irrigations just before flowering in order to induce vegetative flush and later the young flushes were cut back.

RESULTS and DISCUSSION

The data exhibited statistically more pronounced effects in terms of tree height, canopy diameter, shoot length, number of new shoots and number of intercalary units (Table 1). The lowest values were observed in trees treated with paclobutrazol followed by the treatment T_3 (Foliar spray of chlormequat chloride 6,000 ppm). The application of growth regulators (inhibitors) had a suppressive effect on plant. Soil drenching of paclobutrazol displayed a quicker and stronger inhibition effect compared to other growth regulators or pruning methods as paclobutrazol is a gibberellin biosynthesis inhibitor (Fig 1).

The considerable reduction in vegetative growth in the trees treated with paclobutrazol is in accordance with Lal and Mishra (2008) in mango and Kumar and Rattanpal (2010) and Pilania et al (2010) in guava.

Effect of different growth regulators and pruning methods on flowering

All the chemical treatments in the experiment induced early flowering in mango. Application of paclobutrazol suppressed the vegetative growth and induced early and profuse flowering as compared to control. In other words the flower inductive cycle which is a part of phenological and physiological cycle of mango tree may commence earlier in the season but flowering is prevented by the inhibitor until the buildup of sufficient promoter to counteract the inhibitor. Paclobutrazol thus appears to help in achieving this stage much earlier because of its inhibitory activity.

Flowering is the first set of several events that sets the stage for mango production; the timing and intensity of flowering greatly determines the fruit load capacity of the tree in a given season. From the data gathered on the days taken to flowering and days taken to 50 per cent flowering it was obvious that the application of paclobutrazol could substantially enhance the flowering characters such as number of panicles, percentage of shoots with panicle and length of panicles. Paclobutrazol-treated trees recorded higher percentage of shoots with panicle. The value was almost double as compared to control and it was followed by chlormequat chloride application.

Days to flowering and 50 per cent flowering were advanced by 22 days under paclobutrazol and there were sufficient number of panicles per sqm of

Table 1. Effect of different growth regulators and pruning methods on tree growth of mango

Treatment	Tree height (cm)	Number of intercalary units	Canopy diameter (cm)	Shoot length (cm)	Number of new shoots
T_1: Control	242.0	6.11	242.4	72.55	172.1
T_2: Soil drenching with paclobutrazol 2.5 ml/m of canopy diameter	181.4	3.52	188.8	40.88	168.9
T_3: Foliar spray of chlormequat chloride 6,000 ppm	197.5	4.10	200.4	50.52	173.2
T_4: Foliar spray of TIBA 500 ppm	198.9	4.17	207.2	57.10	169.1
T_5: Foliar spray of ethephon 2,000 ppm	199.6	4.19	210.1	60.69	171.2
T_6: Foliar spray of daminozide 2,500 ppm	201.7	4.20	212.3	60.44	174.4
T_7: Second pruning at pre-flowering	227.1	6.10	240.2	84.42	141.6
T_8: T_7 + tip pruning	218.8	5.29	230.2	81.21	138.1
Mean	212.3	4.56	193.1	63.41	163.25
SEd	2.33	0.05	0.028	4.45	1.69
$CD_{0.05}$	4.78	0.12	0.058	9.08	3.45

Table 2. Effect of different, growth regulators and pruning methods on fruit quality of mango

Treatment	Carotene (mg/100 g)	Ascorbic acid (mg/100 g)	TSS (%)	Reducing sugars (%)	Total sugars (%)
T_1: Control	5.25	28.18	7.99	2.26	11.60
T_2: Soil drenching with paclobutrazol 2.5 ml/m of canopy diameter	12.74	52.54	26.86	4.15	15.12
T_3: Foliar spray of chlormequat chloride 6,000 ppm	9.54	43.34	25.33	3.99	14.10
T_4: Foliar spray of TIBA 500 ppm	8.51	34.95	19.16	3.39	12.45
T_5: Foliar spray of ethephon 2,000 ppm	8.88	41.03	20.08	2.37	14.50
T_6: Foliar spray of daminozide 2,500 ppm	8.76	39.56	19.05	2.21	13.75
T_7: Second pruning at pre-flowering	5.43	23.14	10.73	2.59	11.55
T_8: T_7 + tip pruning	4.68	19.86	8.99	2.33	11.59
Mean	7.97	35.32	17.27	2.89	13.08
SEd	0.11	1.99	0.22	0.04	0.15
$CD_{0.05}$	0.23	4.08	0.47	0.08	0.31

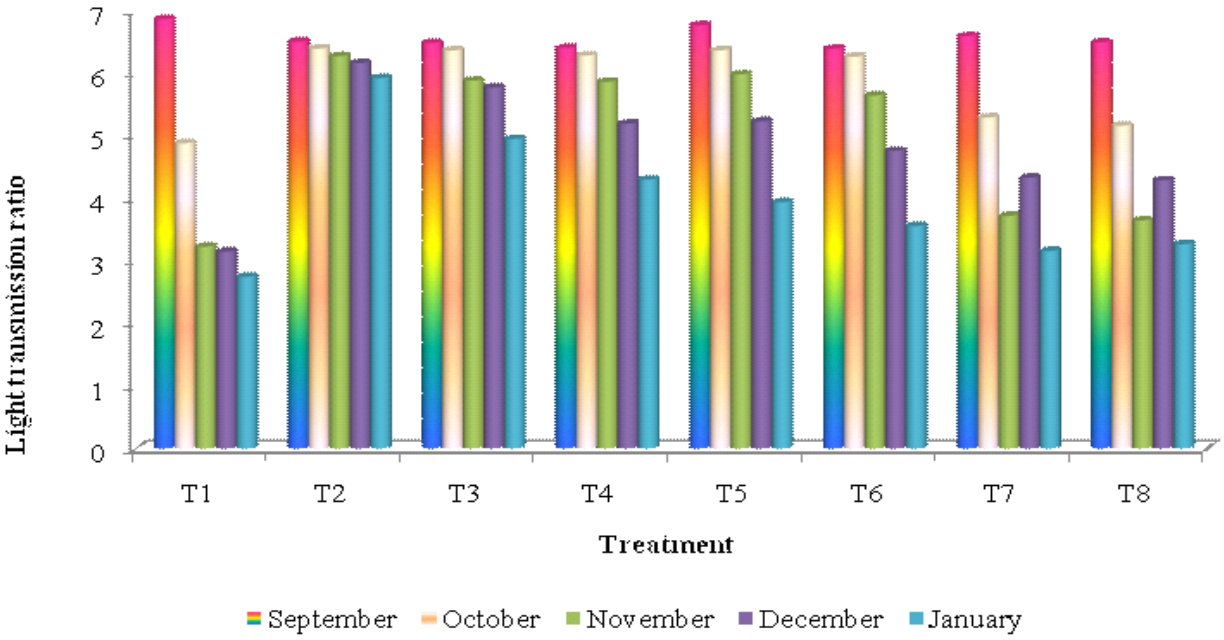
canopy area and number of panicles per tree so that the higher productivity could be achieved. The number of panicles per sqm canopy area and number of panicles per tree were higher in paclobutrazol treatment followed by chlormequat chloride (Fig 2). Similar results were obtained by Ram and Tripathi (1993).

Lower number of panicles per sqm was observed in control. Number of panicles emerged from the new shoots per tree and number of pure and mixed panicles per tree was also significantly influenced by different treatments. The highest number of panicles was observed in T_2 (Soil drenching with paclobutrazol 2.5 ml/m of canopy diameter) followed by T_3 (Foliar spray of chlormequat chloride 6,000 ppm) (Fig 2).

Similar observations were made by Vijayalaxmi and Srinivasan (1998). Pruning resulted in less number of panicles due to exploitation of reserves for shoot growth than the reproductive growth.

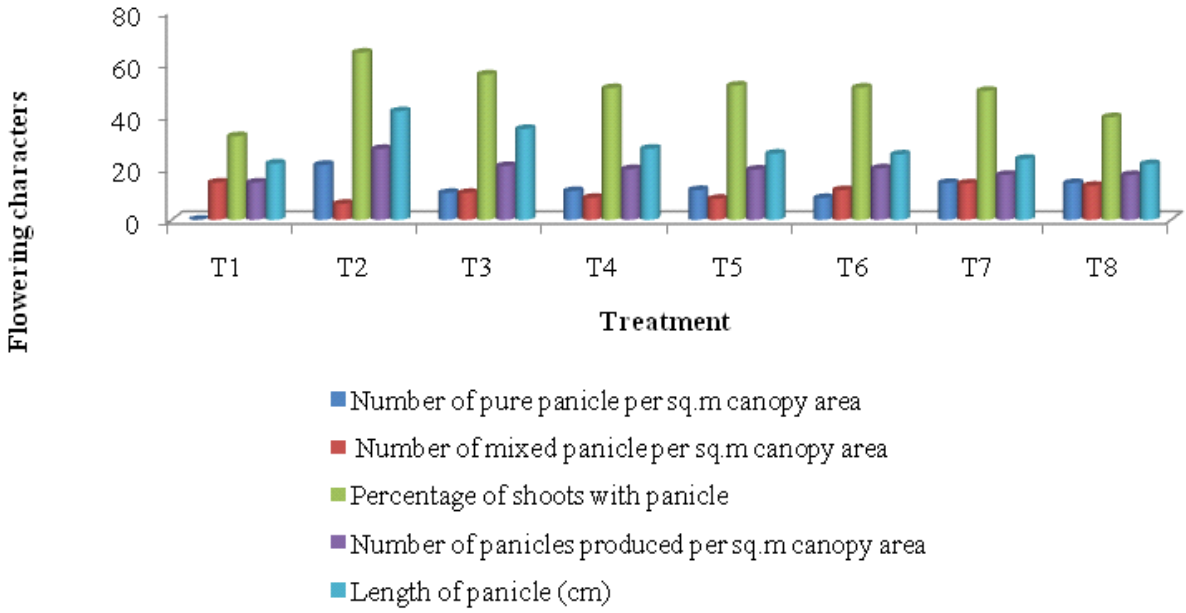
Effect of different growth regulators and pruning methods on fruit characters

The quality of fruits is actually decided by physical and chemical characters. Chemical characters are decided by edible characters like sweetness and the physical characters are decided by fruit circumference and volume. The effect of both chemicals paclobutrazol and CCC was observed in the other characters; they can increase the circumference and fruit volume by recording more length and width over the untreated control. In general much emphasis has been made to increase the productivity of mango. These chemicals namely paclobutrazol and CCC were able to improve physical characters of fruits considerably.



T_1: Control, T_2: Soil drenching with paclobutrazol 2.5 ml/m of canopy diameter, T_3: Foliar spray of chlormequat chloride 6,000 ppm, T_4: Foliar spray of TIBA 500 ppm, T_5: Foliar spray of ethephon 2,000 ppm, T_6: Foliar spray of daminozide 2,500 ppm, T_7: Second pruning at pre-flowering, T_8: T_7 + tip pruning

Fig 1. Effect of different growth regulators and pruning methods on light transmission ratio in mango



T_1: Control, T_2: Soil drenching with paclobutrazol 2.5 ml/m of canopy diameter, T_3: Foliar spray of chlormequat chloride 6,000 ppm, T_4: Foliar spray of TIBA 500 ppm, T_5: Foliar spray of ethephon 2,000 ppm, T_6: Foliar spray of daminozide 2,500 ppm, T_7: Second pruning at pre-flowering, T_8: T_7 + tip pruning

Fig 2. Effect of different growth regulators and pruning methods on flowering characters of mango

Plate 1. Fruits on paclobutazol-treated mango tree

Plate 2. Fruits on chloromequat chloride-sprayed mango tree

Effect of different growth regulators and pruning methods on fruit quality characters

The quality of fruit is a function of efficiency of crop in utilization of nutrients available and their impact on the biosynthesis of other substances which finally get translocated and accumulated in fruit. Hence it is an interaction of nutritional composition of plants specifically with fruit hormones which influence the ripening process.

The improvement in the physico-chemical characters such as ascorbic acid (52.54), carotene (5.25 to 12.74 mg/100 g), TSS (26.86%), reducing sugars (2.26 to 4.15%) and total sugars (15.12%) were observed (Table 2). The beneficial effect of growth regulators might be due to their influence on physiological process. The treatments might have influenced the process of photosynthesis leading to accumulation of carbohydrates.

Yield and yield parameters

Fruit set, the most important yield determining factor was significantly enhanced by the soil application of paclobutrazol (Plate 1). Kurian and Iyer (1993) presented similar observation. Besides paclobutrazol, the fruit set was promoted by foliar spray of chlormequat chloride (Plate 2). This could have been made possible through proper supplementation of nutrition and prevention of formation of abscission layer by inhibiting the enzymatic activities such as pectinase. Thus when paclobutrazol is applied as a soil drenching the yield of mango can be increased. It is one of the best growth regulating chemicals to increase the yield in mango. The growth inhibitor chlormequat chloride was also found to bring about good flowering and yield.

CONCLUSION

Paclobutrazol-treated trees recorded the highest fruit set, number of fruits and yield followed by chlormequat chloride triple spray. The yield was almost double as compared to control. From the data recorded in the present experiment it could be concluded that when paclobutrazol was applied as a soil drenching the yield of mango could be increased. It is the best growth regulating chemical to increase the yield in mango. The growth inhibitor chlormequat chloride was also found to bring about good flowering and yield.

REFERENCES

Burondkar MM and Gunjate RT 1993. Control of vegetative growth and induction of regular and early cropping in Alphonso mango with paclobutrazol. Acta Horticulturae **341:** 206-215.

de Candolle A 1904. Origin of cultivated plants. Kegan Paul, Trench, Trübner and Co, London.

Kumar Y and Rattanpal HS 2010. Effect of pruning in guava planted at different spacings under Punjab conditions. Indian Journal of Horticulture **67(Special Issue):** 115-119.

Kurian RM and Iyer CPA 1993. Chemical regulation of tree size in mango (*Mangifera indica* L) cv Alphonso. I. Effects of growth retardants on vegetative growth and tree vigour. Journal of Horticultural Science **68(3):** 349-354.

Lal B and Mishra D 2008. Studies on pruning in mango for rejuvenation. Indian Journal of Horticulture **64(4):** 405-408.

Mukherjee SK 1958. The origin of mango. Indian Journal of Horticulture **l5:** l29-134.

Nafees M, Faqeer M, Ahmad S, Khan MA, Jamil M and Aslam MN 2010. Paclobutrazol soil drenching suppresses vegetative growth, reduces malformation and increases production in mango. International Journal of Fruit Science **10(4):** 431-440.

Pilania S, Shukla AK, Mahawer LN, Sharma R and Bairwa HL 2010. Standardization of pruning intensity and integrated nutrient management in meadow orcharding of guava (*Psidium guajava* L). Indian Journal of Agricultural Sciences **80(8):** 673-678.

Ram S and Tripathi PC 1993. Effect of cultar on flowering and fruiting in high density Dashehari mango trees. Indian Journal of Horticulture **50(4):** 292-295.

Rathore N, Mishra NK, Lal RL and Mishra DS 2009. Effect of foliar application of nutrients on yield and quality of litchi cv Rose Scented. Indian Journal of Horticulture **66(4):** 524-525.

Vijayalaxmi D and Srinivasan PS 1998. Induction of flowering in 'off' year mango cv Alphonso as influenced by chemicals and growth regulators. Annals of Plant Physiology **12(2):** 93-97.

Yadav RK, Rai N, Yadav DS and Asati BS 2005. Use of paclobutrazol in horticultural crops- a review. Agricultural Review **26:** 124-132.

Yeshitela T, Robbertse PJ and Stassen PJC 2004. Effects of various inductive periods and chemicals on flowering and vegetative growth of Tommy Atkins and Keitt mango (*Mangifera indica*) cultivars. New Zealand Journal of Crop and Horticultural Science **32(2):** 209-215.