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Studies on Effect of Foliar Sprays of Paclobutrazol and Cycocel on Flowering Behaviour of Mango *cv*. Alphonso

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Abstract: *A field experiment was conducted at plot No.28, in the Department of Horticulture, college of Agriculture, DBS Konkan Krishi Vidyapeeth, Dapoli (M.S.), India to visualize the effect of foliar sprays of paclobutrazol and cycocel on enhancing flowering behaviour of mango* cv. *Alphonso. The experiment was laid out in randomize block design having nine treatments viz. T_1-500ppm paclobutrazol, T_2-1000ppm paclobutrazol, T_3-1500ppm paclobutrazol, T_4-2000ppm paclobutrazol, T_5-1000ppm cycocel, T_6-1500ppm cycocel, T_7-2000ppm cycocel, T_8-2500ppm cycocel, T_9-control which were replicated three times. The results revealed that foliar sprays of cycocel 1500ppm applied in the month of October are better for early flower emergence, flowering, highest number of hermaphrodite flowers, total number of flowers, fruit set, fruit retention and higher fruit yield. Hence this can successfully be used for emergence of flowering in mango.*

Keywords: *Alphonso mango, paclobutrazol, cycocel, flowering, fruit setting, yield.*

INTRODUCTION

Alphonso is one of the premium mango (*Mangifera indica* L.) variety in India and has great export potential. Konkan is the major and famous mango producing region on the west coast of Maharashtra accounting for about 10 per cent of the total area under mango in the whole country, out of which almost 90 per cent area is covered by the choicest mango cultivar Alphonso. The warm and humid climate, annual rainfall (3000-4000mm), well drained lateritic soils and rain free season from November to May prevalent in Konkan region are ideal for Alphonso mango cultivar particular. Fundamental understandings of mango flowering and fruiting are essential to efficiently utilize cropping management system, responsible for extending both the flowering and crop production season. Flowering and fruit set are the most critical of all events occurring after establishment of a tree crop. Given favourable growth conditions, the timing and intensity of flowering greatly determine when and how many fruits are produced during a given season. Understanding and controlling this phenomenon has been of a prime importance to the researchers for over a century.

A full grown Alphonso tree in bearing season (on year) produces panicles in thousands, each of which bears about 1000-6000 flowers, but only 11-13 per cent of them are hermaphrodite of which only 0.13 per cent reach maturity (Gunjate, 1985) [3]. However, it is observed that there is heavy fruit drop at various stages of fruit development is a serious problem and has become a limiting factor for optimizing production. Along with that, alternate bearing habit has handicapped the productivity of mango crop. Due to these problems, productivity

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of Alphonso mango in Konkan region is 2-3 times less than average mango production of the country. The induction of early and regular flowering will help in lowering the severity of these problems. Many plant growth regulators like Ethrel have been used for inducing flowering (Suryanarayana, 1985) [12] but were not found effective. In view of these facts, the present study was therefore taken up to study the influence of PGR's on flowering and yield attributes in Alphonso mango.

MATERIAL AND METHODS

A field experiment was conducted at plot No. 28, in the Department of Horticulture, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli during 2009-10 by randomized block design having nine treatments *viz.* T_1-paclobutrazol (500 ppm), T_2-paclobutrazol (1000 ppm), T_3-paclobutrazol (1500 ppm), T_4-paclobutrazol (2000 ppm), T_5-cycocel (1000 ppm), T_6-cycocel (1500 ppm), T_7-cycocel (2000 ppm), T_8-cycocel (2500 ppm), T_9-Control which were replicated three times. In this study, the different doses of cycocel and paclobutrazol were used as foliar sprays in the month of October. Fifty four uniformly grown 30 years old Alphonso mango trees having 10 × 10 m spacing, two plants per treatment and 20 panicles per plant were selected for experiment. The observations to be recorded are as days required for initiation of flowering, number of days required from initiation to maximum flowering, number of male flowers, hermaphrodite flowers, total number of flowers, length of panicle, fruit set per panicle, fruit retention per panicle, number of fruits at harvest per panicle, yield (fruits/tree) and yield (kg/tree).

Physical parameters of fruit after harvest includes number of days required for ripening, physiological loss in weight (PLW) (weight of fruit at harvest (g)-weight of ripe fruit (g)/weight of fruit at harvest (g) × 100), incidence of spongy tissue (no. of fruits exhibiting spongy tissue symptom/total no. of fruits examined × 100) where as chemical parameters of fruit includes total soluble solids and titratable acidity were estimated. The selected trees for study were manured uniformly on 1st July with 1.5 kg N, 0.5 kg P_20_5 and 1.0 kg K_20 and 50 kg FYM per plant. The data were analyzed statistically as per Panse and Sukhatme, 1985 [9] using RBD and valid conclusions were drawn only on significant differences between treatment mean at 0.05% level of significance.

RESULTS AND DISCUSSION

Days Required for Initiation of Flowering

The data presented in the Table 1 in regards to number of days required for initiation of flowering has indicates that the number of days required for initiation of flowering significantly differed

Table 1
Effect of foliar sprays of paclobutrazol and cycocel on days required for initiation of flowering, initiation to maximum flowering and number of male, hermaphrodite and total number of flowers per panicle in mango cv. Alphonso

Treatments	*Days required for initiation of flowering*	*Days required for initiation to maximum flowering*	*Number of male flowers/panicle*	*Number of hermaphrodite flowers/panicle*	*Total number of flowers per panicle*
T_1	138.33	43.67	578.67	84.89	630.23
T_2	137.33	43.67	591.11	83.56	674.67
T_3	137.33	38.67	557.45	89.11	646.56
T_4	136.00	38.67	568.00	109.11	697.00
T_5	129.00	41.00	587.89	105.00	673.01
T_6	109.67	33.00	559.56	154.11	713.67
T_7	139.00	41.33	597.33	120.00	717.34
T_8	138.67	43.67	573.67	112.56	686.22
T_9	162.00	40.00	582.22	77.34	659.56
Mean	136.370	40.407	577.32	103.96	677.58
S.Em. (±)	7.21	2.28	0.02	10.84	42.46
C.D. (P = 0.05)	22.22	7.04	NS	33.40	NS

amongst the treatments. The treatment T_6 (109.67 days) recorded earliest flowering followed by the treatment T_5 (129 days). The remaining other treatments recorded maximum days required for initiation of flowering while the highest numbers of days were required by control (162). The growth retardants especially cycocel and paclobutrazol have major role in breaking biosynthesis pathway of gibberellins, which results in controlling the vegetative growth of the plants. The control plants required more number of days for flowering which might be because of late maturity of shoots due to continued synthesis of gibberellins and absence of hormones required for flowering.

In treated plants, treatment T_6 (cycocel 1500 ppm) showed early flowering which might be due to blocking of GA biosynthesis pathway, thereby checking vegetative growth and giving rest to the plants which might have resulted in accumulation of carbohydrates in the shoots leading to their maturity which made the plants ready to flower after achieving sufficient chilling requirements (Anbu and Romani, 2001) [1]. Similar findings were also reported by Rath and Das (1979) [10] who observed that induction of early flowering in mango with spraying of CCC, MH and CEPA along with ringing. Tongumpai *et al.* (1991) [13] observed that mango cv. Khiew Sawoey responded least to paclobutrazol application but follow up sprays of KNO_3 induced early flowering.

Days Required from Initiation of Flowering to Maximum Flowering

The number of days required from initiation of flowering to maximum flowering further indicates that the lowest number of days (33 days) were required in the treatment T_6 (cycocel 1500ppm) while the highest number of days were required in the treatments T_1 (43.67 days), T_2 (43.67 days), T_8 (43.67 days) [Table 1]. The present findings are in accordance with the results of Tongumpai *et al.* (1991) [13] and Vuillaume (1991) [14] had recorded earlier induction of flowering by application of paclobutrazol to different cultivars of mango. Kulkarni (1988) [6] had noticed that the hormonal concept of flowering in mango implies the cyclic synthesis of floral stimulates in the leaves and the gap between two such cycles would decide the flowering behaviour of a cultivar.

Number of Male Flowers Per Panicle

There was no significant difference among the treatments on number of male flowers [Table 1]. However, maximum number of male flowers were recorded in the treatments T_7 (597.33), T_5 (587.89) and T_2 (591.11). The lowest numbers of male flowers were recorded in the treatment T_3 (557.45).

Number of Hermaphrodite Flowers Per Panicle

There was significant difference amongst the various treatments with regards to hermaphrodite flowers [Table 1]. The treatment T_6 (154.11) recorded the highest number of hermaphrodite flowers and were significantly superior over rest of the treatments. The lowest numbers of hermaphrodite flowers were recorded in control (77.34) which was less than the mean magnitude of hermaphrodite flowers. The present findings are in accordance with Khader (1991) [5] who reported that foliar application of paclobutrazol increased number of perfect flowers in mango cv. Dashehari. Suryanarayana (1985) [12] observed that cycocel 5000 ppm was effective in increasing number of perfect flowers. Mukopadhyay (1976) [8] had observed that CCC and B-9 were effective at 5000 ppm in mango cv. Langra and Baramasi to increase number of perfect flowers.

Total Number of Flowers Per Panicle

There was non-significant difference in respect of total number of flowers per panicle [Table 1]. However, maximum numbers of the total flowers were recorded in the treatment T_7 (717.34) followed by T_6 (713.67), T_4 (697), T_8 (686.22) and minimum numbers of total flowers were recorded in the treatment T_2 (674.67). In general, the foliar sprays of cycocel and paclobutrazol induce early flowering i.e. total number of flowers and higher percentage of hermaphrodite flowers which might be due the anti-gibberellins activity, in which they reduce indigenous GA levels and increase auxin and cytokinins level which might have been resulted in production of higher proportion of total number of flowers. Hence GA activity might have been blocked by application of these chemicals resulting in proliferation of flowering. The present findings are in agreement with Khader (1991) [5], Suryanarayana (1985) [12] and Mukopadhyay (1976) [8].

Length of Panicle (cm)

The length of panicle are indicates that the length of the panicle has significant relationship with application of foliar sprays [Table 2]. The highest length of panicle (34.67) was recorded in control, which was significantly superior over the treatments T_5 (31.67), T_2 (31.33). The shortest length of panicle was recorded in T_8 (26.67) followed by T_7 (28.00), T_4 (28.33), T_3 (28.67), T_1 (31.00) which were at par with each other. It was also observed that with increasing concentration of paclobutrazol and cycocel, panicle length went on decreasing. The present findings are in accordance with Khader (1991) [5] who observed reduction in panicle length by foliar application of paclobutrazol @ 3000 mg/l in mango cv. Dashehari. Suryanarayana (1985) [12] also observed that length of panicle decreased slightly with cycocel (5000 ppm) and Alar (5000 ppm) respectively in mango cv. Mulgoa. This is probably due to blocking of GA biosynthesis which reduced length or growth of panicle.

Fruit Set Per Panicle at Pea Grain Stage (no.)

The highest fruit set per panicle at pea grain stage was recorded in the treatment T_6 (18.30) and was significantly superior over rest of the treatments (Table 2). The treatments T_5 (9.21), T_3 (9.82), T_4 (10.38) recorded the minimum fruit set and were at par with each other. The lowest fruit set (5.62) was recorded in control, which was less than the mean magnitude of fruit set per panicle. The superiority of fruit set might be due to the increase in number of hermaphrodite flowers. Similarly Daulta *et al.* (1981) [2] who observed that Zn and CCC increased the fruit set at pea grain stage in mango. The low fruit set in mango is described due to self incompatibility and numerous problems in the pollination and fertilization and prevailing low temperature during flowering (Singh and Ram 1983) [11].

Fruit Retention at Marble Stage Per Panicle

The highest fruit retention was observed in the treatments T_6 (4.00) while the lowest fruit retention was recorded in treatment T_8, T_7 and T_2 (2.00). The higher fruit retention per panicle might be primarily due to increased number of hermaphrodite flowers [Table 2]. Singh and Ram (1983) [11] observed that cycocel and Alar were effective in increasing the fruit retention in mango by increase in cytokinins like activity in the fruits, since these chemicals were reported beneficial effects.

Number of Fruits at Harvest Per Panicle

There was significant effect of application of chemicals on number of fruits at harvest [Table 2]. The treatment T_6 (1.27) recorded highest number of fruits at harvest and which was at par with the

Table 2
Effect of foliar sprays of paclobutrazol and cycocel on length of panicle, fruit set at pea nut and marble stage, number of fruits at harvest per panicle and yield in mango cv. Alphonso

Treatments	*Length of panicle (cm)*	*Fruit set (no.) at pea grain stage/ panicle*	*Fruit retention at marble stage/ panicle (no.)*	*Number of fruits at harvest/panicle*	*Yield (fruit/tree)*	*Yield (kg/ha)*
T_1	31.00	7.36	2.67	0.70	66.67	1666.6
T_2	31.33	14.62	2.00	0.78	97.33	2433.33
T_3	28.67	9.82	3.00	0.80	125.67	3141.67
T_4	28.33	10.38	2.33	0.91	124.00	3100.00
T_5	31.67	9.21	3.33	0.85	105.00	2625.00
T_6	27.67	18.30	4.00	1.27	211.67	5291.67
T_7	28.00	15.41	2.00	1.15	167.33	4183.33
T_8	26.67	13.94	2.00	0.93	168.33	4208.33
T_9	34.67	5.62	2.33	0.42	60.00	1500.00
Mean	29.778	11.629	2.565	0.862	125.111	3127.78
S.Em. (±)	1.43	2.24	0.37	0.14	19.38	484.42
C.D. (P = 0.05)	4.41	6.91	1.152	0.45	59.71	1492.64

treatments T_7, T_8, T_4 and T_5. The lowest number of fruits was recorded in control (0.42) which was less than the mean magnitude of number of fruits at harvest. The increase in number of fruits may be due to higher percent reproductive shoots, hermaphrodite flowers and more number of fruits retained till the maturity stage. Singh and Ram (1983) [11] observed that cycocel and Alar were effective in increasing the fruit set in mango.

Yield (Fruits/Tree)

The yield (fruits/tree) has indicates that the highest number of fruits per tree recorded in treatment T_6 (211.67), which was at par the treatments T_8 (168.33), T_7 (167.33) while the lowest number of fruits was recorded in control (60.00) and was less than the mean magnitude of yield (fruits/tree) [Table 2].

The increase in number of fruits may be due to higher percent reproductive shoots, hermaphrodite flowers and more number of fruits retained till to maturity stage. The results are analogous to the findings reported by Maiti *et al.* (1972) [7] who observed an increase in number of fruits per limb by spraying cycocel 2000 ppm.

Yield (kg/hectare)

The yield (kg/ha) has indicated that there was significant difference amongst the various treatments [Table 2]. The highest fruit yield (kg/ha) was recorded in treatment T_6 (5291.67) and was at par with the treatments T_8 (4208.33) and T_7 (4183.33) whereas it was significantly superior over rest of the treatments. The lowest fruit yield (kg/ha) was recorded in control (1500).

The growth retardants paclobutrazol and cycocel are also known to alter the source-sink relation in the plant and directly or indirectly relocate carbohydrate resource, suppressing the vegetative growth and increasing yield. The increased yield might be due to the higher percentage shoots, hermaphrodite flowers and more number of fruits retained per panicle till maturity. Similar results were reported by Maiti *et al.* (1972) [7] in mango.

Days Required for Ripening After Harvest

There was no significant difference in various treatments with respect to the days required for ripening [Table 3]. However, the treatments T_6, T_9, T_3, T_2 and T_1 recorded maximum days required for

Table 3
Effect of foliar sprays of paclobutrazol and cycocel on days required for ripening, TSS (°Brix), percentage of acidity, spongy tissue, physiological loss in weight and organoleptic evaluation of ripe mango cv. Alphonso

						Organoleptic score			
Treatments	*Days required for ripening*	*TSS (°Brix)*	*Acidity (%)*	*Spongy tissue (%)*	*Physiological Loss in Weight (%)*	*colour*	*flavour*	*Texture*	*Average*
T_1	14.85	18.77	0.23	10.00	13.03	5.83	6.33	5.67	5.94
T_2	13.49	21.33	0.24	15.00	12.65	6.17	6.00	6.00	6.05
T_3	13.33	20.90	0.28	10.00	12.74	7.33	6.53	6.5	6.78
T_4	11.22	19.50	0.25	18.33	11.89	6.33	6.17	6.33	6.27
T_5	11.92	18.73	0.22	15.00	12.80	5.83	6.5	6.17	6.16
T_6	13.12	20.40	0.25	10.00	12.51	8.17	8.00	8.17	8.11
T_7	12.95	20.40	0.24	10.00	12.48	7.50	6.67	7.5	7.22
T_8	12.14	20.77	0.24	13.33	11.56	8.00	6.33	8.00	7.44
T_9	13.23	19.90	0.24	20.00	12.74	5.83	5.00	6.00	5.61
Mean	12.917	20.078	0.246	13.52	12.488	6.70	6.393	6.778	6.624
S.Em. (±)	0.96	0.85	0.26	2.71	0.57	0.51	0.42	0.47	0.29
C.D. (P = 0.05)	NS	NS	NS	NS	NS	1.57	1.3	1.46	0.9

ripening. The remaining other treatments $T_{7,}$ T_8, T_5 and T_4 recorded minimum number of days required for ripening. However, all treatments were at par with each other.

Chemical Parameters of Fruits

TSS (°Brix)

The presented data has indicates that there was no significant difference in application of these chemicals on TSS (°Brix) content of fruits. However, maximum TSS (°Brix) was recorded in the treatments T_2 (21.33), T_3 (20.90), T_8 (20.77), T_7 (20.40) and T_6 (20.40) whereas the lowest TSS (°Brix) was recorded in T_5 (18.73) [Table 3]. The increase in TSS during ripening process of mango fruits could be attributed due to hydrolysis of starch into sugars. The similar results were reported by Joshi and Roy (1985) [4].

Acidity (%)

There was no significant difference amongst various treatments with respect to the acidity of ripe fruit [Table 3]. The maximum acidity (%) was recorded in the treatments T_3 (0.28), T_4, T_6 (0.25), T_7, T_8 and T_9 (0.24). The minimum acidity was recorded in the treatments T_5 (0.22) and T_1 (0.23). The increase or decrease in acidity during ripe stage could be attributed to the degeneration of organic acids. Findings analogous to these observations have been reported by Joshi and Roy (1985) [4].

Occurrence of spongy tissue (%)

There was no significant difference among various treatments with spongy tissue [Table 3]. The treatments T_9 (20.00) and T_4 (18.33) recorded maximum percentage spongy tissue whereas the treatments T_2 (15.00), T_5 (15.00), T_1 (10.00), T_6 (10.00) and T_7 (10.00) recorded comparative percentage of spongy tissue.

Physiological loss in weight (%)

The percent physiological loss in weight has further indicates that there was no significant difference among the treatments [Table 3]. However, maximum physiological loss in weight was recorded in the treatments T_3 (12.74), T_5 (12.80) and T_1 (13.03), while all other treatments recorded minimum physiological loss in weight. Findings analogous to these observations have been reported by Joshi and Roy (1985) [4].

Sensory Evaluation

The maximum organoleptic score for colour, flavour and texture was recorded by treatment T_6 (cycocel 1500 ppm) followed by T_8, and T_7. According to Hedonic scale all treatments recorded higher acceptance than that of control [Table 3].

CONCLUSION

The results of present investigation concluded that among various concentration treatments of growth retardants, the foliar sprays of cycocel 1500 ppm applied in the month of October are better for early flower emergence, flowering, highest number of hermaphrodite flowers, total number of flowers, fruit set, fruit retention and higher fruit yield. Hence this can successfully be used for emergence of flowering in mango. Also yield is influenced by other internal as well as external factors.

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References

Anbu, E. and Romani, F., (2001), Effects of paclobutrazol on growth and yield of mango cv. Neelum. *Acta Hort.*, 239:171-175.

Daulta, B.S., Singh, H.K., and Chauhan, K.S., (1981), Effect of Zinc and CCC sprays on flowering, fruiting and physico-chemical composition of fruit in mango (*Mangifera indica* L.) cv. Dashehari. *Haryana J. Hort. Sci.,* 10(3/4): 161-165.

Gunjate, R.T., (1985), Floral biology of Alphonso, Goamankur and Kesar varieties of mango. *J. Maharashtra agric. Univ.* 10(2): 193-195.

Joshi, G.D. and Roy, S.K., (1985), Effect of existing method of harvesting on chemical composition and palatability on mango (*Mangifera indica* L.) cv. Alphonso fruits. *Indian Food Packer,* 39(4): 26-31.

Khader, S.E., (1991), Control of tree height, trunk girth, shoot growth and total assimilation in young grafted mango trees by paclobutrazol. *Indian J. Hort.,* 48(2): 112-115.

Kulkarni, V.J., (1988), Chemical control of tree vigour and promotion of flowering and fruiting in mango using paclobutrazol. *J. Hort. Sci*., 63(3): 557-566.

Maiti, S.C., Basu, R.N. and Sen, P.K., (1972), Chemical control of growth and flowering in mango (*Mangifera indica* L.). *Acta Hort*., 24: 192-195.

Mukopadhyay, A.K., (1976), A note on effect of growth retardants and L-methionine on flowering of mango (*Mangifera indica* L.). *Haryana J. Hort. Sci*., 5(3/4): 169-171.

Panse, V.G. and Sukhatme, P.V., (1985), Statistical methods for Agricultural Workers, ICAR, New Delhi.

Rath, S. and Das, G.C., (1979), Effects of ringing and growth retardants on growth and flowering of mango. *Scientia Horticulturae*, 10(1):101-104.

Singh, R.S. and Ram, S. (1983), Studies on use of plant growth substances for mango cv. Dushehri. *Indian J. Hort*., 40(3/4): 188-194.

Suryanarayana, V., (1985), Influence of growth retardants on flowering and inflorescence characters in mango. *Andhra Agric. J.,* 32(3): 208-209.

Tongumpai, P., Jutamance, K. and Subhadrabandhu, S., (1991), Effect of paclobutrazol on flowering of mango cv. Khiew sawoey. *Acta Hort*., 291: 67-70.

Vuillaume, C., (1991), Towards control of flowering in mango in Cameroon. Use of a growth regulator- paclobutrazol. *Fruits (Paris),* 46(2): 187-198.