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Effect of growth regulators, nutrients, seaweed extract and pruning on induction of early flowering in mango (*Mangifera indica*) cv. Kesar

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ABSTRACT

The research work was carried out in two successive seasons from 2010 to 2012 on 16 years old mango (*Mangifera indica* L.) trees cv. Kesar in Gujarat under rainfed condition. For induction of early flowering, 13 treatments were given. The chemicals (4 and 6% KNO_3, 4 and 6% $CaNO_3$), growth regulator (100 and 200 ppm of 6-BA), seaweed extract (3 and 5 %) and soil application of paclobutrazol (5 and 7.5 g a.i. 1 tree) were used. The selected shoots of mango were pruned and sprayed with 2 % urea during last week of May. Application of 200 ppm 6-BA on postharvest vegetative flush and old shoots resulted profound effect on early panicle emergence with maximum (41.83 cm) length of panicle without cool inductive temperature for flower bud differentiation. The study revealed that 200 ppm 6-BA is effective in induction of early flowering in mango.

Key words: 6–BA, Early flowering, Mango, Paclobutrazol, Pruning, Seaweed extract

Mango (*Mangifera indica* L.) exhibits a wide variation in flowering and fruiting period due to diversity in agro-climatic conditions. In India, flower bud differentiation takes place during the month of October-December (Palanichamy *et al*. 2012). Low night temperature and dry atmosphere are probably favourable for fruit-bud differentiation in mango. In the sub-tropics, day temperature of 15°C and night temperature of 10°C induce mango floral morphogenesis (Davenport and Nunez-Elisea 1997), whereas temperature of about 20°C or higher promote vegetative growth. In the tropics, where temperature may remain too high, cool night and dry period preceding flowering are generally believed to be necessary for induction of flowering. After withdrawal of rainfall and dry spell, commencement of winter triggers flowering in mango. Flowering occurs on new vegetative flush when matures. Flowering usually occurs in three flushes in the season.

In recent times, due to global warming, an unusual phenomenon of temperature rise induced the flowering in mango cv. Kesar during the month of February-March 2011 in Saurashtra region of Gujarat. It is clear that climatic changes triggered by green house gas pollution globally is affecting the flowering pattern of mango. The duration of flowering is usually of short 2 to 3 weeks (Mukherjee 1953). Flowering period in mango is governed by climatic conditions, variety and cultural practices (Thomas *et al.* 2000). Pre-blossom temperature affects the fruit set and yield (Rodrigo and Herrero 2002). When winter temperature is satisfying the chilling requirement, tree shows delayed flowering and poor fruit set (Byrne and Bacon 1992). Combination of temperature changes and low intensity of winter causes poor flower induction, delayed flower set and late harvesting of fruits in May-June. Fruiting period for more than one month results in poor and staggered production of fruits and coincides with unpredictable rain during fruit development which causes a great loss to the growers. The manipulation of flowering in order to get the fruit maturity for early harvesting would be of great value to the benefit of growers.

MATERIALS AND METHODS

The research work was conducted for over two years from 2010 to 2012 on randomly selected 78 mango trees cv. Kesar in the age group of 16 years, having uniform size, flowering time and intensity, maintained with normal cultural practices in sub block with 190 trees at Sabalpur region of Junagadh. The field experiment was laid in randomized block design (RBD) with 3 replications. In each replication, two mango trees were selected and imposed with 13 treatments to induce early flowering. The treatments include 6-benzyl amino purine (Plant growth regulator), seaweed (*Sargassum wightii)* extract, chemical nutrients (KNO_3, $CaNO_3$ and urea) soil application of paclobutrazol (Anti-gibberellins compound) and pruning immediately after harvesting of fruits.

As per the treatment details, one spray of each treatment

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Table 1 Effect of growth regulators, nutrients, seaweed extract and pruning on inflorescence emergence in old and new shoots in mango cv. Kesar

Treatment	Days taken for inflorescence emergence from the date of experiment started					
	Old shoot			New shoot		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
T_1- 100 ppm BA	98.19	102.15	100.17	97.14	100.31	98.73
T_2- 200 ppm BA	88.36	93.72	91.04	103.86	110.24	107.05
T_3 - 4% $CaNO_3$	153.99	161.23	157.61	162.10	167.98	165.04
T_4 - 6% $CaNO_3$	149.65	158.50	154.08	158.55	162.55	160.55
T_5 - 4% KNO_3	151.25	150.68	150.97	156.60	158.72	157.66
T_6 - 6% KNO_3	142.02	140.12	141.07	146.12	142.18	144.15
T_7 - Unpruned + 2% Urea	152.04	160.72	156.38	155.35	167.12	161.23
T_8 - Moderate pruning (10 cm) + 2% Urea	156.50	166.05	160.13	160.65	170.40	165.53
T_9 - 3% seaweed	132.15	141.12	136.64	136.60	147.10	141.85
T_{10}-5% seaweed	124.04	127.55	126.80	130.56	132.80	131.68
T_{11} - Paclobutrazol @ 5g.a.i./tree	138.98	152.23	145.61	144.20	158.52	151.36
T_{12} - Paclobutrazol @ 7.5g.a.i./tree	120.12	130.04	125.08	129.55	135.76	132.66
T_{13} - Control	158.05	168.50	161.78	160.60	175.79	168.20
Mean	135.80	142.51	139.03	141.68	148.42	145.05
SEm±	6.64	7.59	5.19	12.27	12.31	5.29
CD (P=0.05)	19.38	22.14	14.76	35.82	35.94	15.07
CV (%)	8.47	9.22	9.14	15.00	14.37	8.94

was given with power sprayer on the whole crown of the tree. The required concentration of 100 and 200 ppm of 6-benzyl amino purine (6-BA), seaweed (3 and 5 %) extract collected from Okha to Dwarka and Vumani reef coastal line and seaweed liquid fertilizer extracted by following the Challen and Hemingway (1966) method in Central Salt and Marine Chemicals Research Institute, Bhavnagar, Gujarat, chemical nutrients KNO_3 (4 and 6 %), $CaNO_3$ (4 and 6 %), urea (2 %) of 20 litres were sprayed per tree in each treatment. The chemical spray was given twice, first immediately after harvesting to study the influence of treatments on vegetative growth and second on new vegetative flush during second week of August.

Soil application of paclobutrazol (5 and 7.5 g a.i./tree) was done in 15 cm deep trench and 1 m from tree trunk after harvesting in last week of May with assured irrigation and second application on 10 August 2010 and 2011. Moderate pruning of 10 cm was done immediately after harvesting by using pruner.

The data on experimental tree were recorded from 40 selected, healthy shoots covering all sides to study flowering behavior on newly emerged as well as old (Pre harvest vegetative flush) shoots. Observations were recorded on number of days taken for inflorescence emergence from date of application and from the date of summer vegetative flush (May-June), percentage of flowering, types of panicles and length of panicles on old as well as new shoots. The data were statistically analyzed for consecutive years and pooled analysis was done by following the method of Panse and Sukhatme (1989) for randomized block design.

RESULTS AND DISCUSSION

The findings related to days taken for inflorescence emergence from the date of operation affected significantly by various chemical treatments. The pooled data of two years (2010-11 and 2011-12) pertaining to the number of days taken for inflorescence emergence from the date of application (Table 1) was minimum (91.04 days) in trees treated of 200 ppm 6-BA on old shoots which is at par with 100 ppm 6-BA (98.73 days) when applied on new shoots and 200 ppm 6-BA (107.05 days) applied on new shoots compared to control (168.20 days). Irrespective of the treatments, old shoots required minimum number (139.03 days) of days to get stimulus to initiate flowering than new shoots (145.05 days).

Application of 100 ppm 6-BA required significantly minimum number of days (135.78 days) which was at par with 200 ppm 6-BA (143.45 days) for the emergence of inflorescence from the date of summer vegetative flush (Table 2) compared to control (207.53 days). The findings are in conformity with the results of Chen (1987). Early induction of flowering due to elevated cytokinin levels have implicated in breaking dormancy in adventitious and auxillary buds (Stafstrom 1995) and stimulation of bud break (Faust *et al*. 1997).

Data regarding the proportion of pure panicle (Fig 1), mixed panicles leafy panicles on old and new shoots revealed that application of paclobutrazol @ 7.5 g a.i. 1 tree produced the maximum proportion of pure panicles (68.45 %) but at par with 200 ppm 6-BA (65.79 %) on old shoots. Paclobutrazol translocates through xylem and acts as a growth retardant to suppress the vegetative growth by

Table 2 Effect of growth regulators, nutrients, seaweed extract and pruning on inflorescence emergence from date of summer vegetative flush in mango cv. Kesar

Treatment	Days taken for inflorescence from the date of summer vegetative flush		
	2010-11	2011-12	Pooled
T_1- 100 ppm BA	131.90	139.65	135.78
T_2- 200 ppm BA	136.77	150.12	143.45
T_3 - 4% $CaNO_3$	193.44	210.40	197.42
T_4 - 6% $CaNO_3$	133.77	198.50	166.13
T_5 - 4% KNO_3	190.67	197.20	193.94
T_6 - 6% KNO_3	181.92	187.82	184.87
T_7 - Unpruned + 2% Urea	200.50	207.14	203.82
T_8 - Moderate pruning (10 cm)+2% Urea	194.15	199.02	196.59
T_9 - 3% Seaweed	176.85	181.54	179.20
T_{10}-5% Seaweed	167.92	172.56	170.24
T_{11} - Paclobutrazol @ 5g.a.i./tree	183.20	191.60	187.40
T_{12} - Paclobutrazol @ 7.5g.a.i./tree	164.02	177.50	170.76
T_{13} - Control	204.08	210.99	207.53
Mean	173.78	185.77	179.78
SEm±	16.52	10.34	9.75
CD (P=0.05)	48.22	30.19	27.74
CV (%)	16.46	9.64	13.28

interrupting the biosynthesis of gibberellins. It evidenced by the involvement of gibberellins on suppression of floral process (Davenport 2009, Murti and Upreti 2000) and

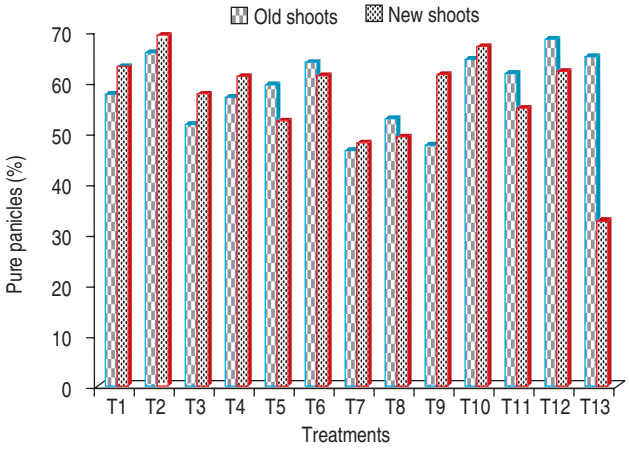

Fig 1 Effect of growth regulators, nutrients, seaweed extract and pruning on induction of pure panicles on old and new shoots of mango cv. Kesar. T_1- 100 ppm BA , T_2- 200 ppm BA, T_3 - 4% $CaNO_3$, T_4 - 6% $CaNO_3$, T_5 - 4% KNO_3, T_6 - 6% KNO_3, T_7 - Unpruned + 2% Urea, T_8 - Moderate pruning (10 cm) + 2% Urea, T_9 - 3% Seaweed (*Sargassum wightii*), T_{10}-5% Seaweed (*Sargassum wightii*) , T_{11} - Paclobutrazol @ 5g.a.i. / tree, T_{12} - Paclobutrazol @ 7.5g.a.i. / tree, T_{13} - Control.

inhibition of gibberellins synthesis by paclobutrazol in mango buds concomitant with profuse induction of flowering (Abdel Rahim *et al*. 2011, Upreti *et al*. 2013). Application of 200 ppm 6-BA produced the maximum proportion of pure panicles (69.23 %) on new shoots compared to control. Maximum proportion of leafy panicles (9.04 %) are produced with 100 ppm 6-BA on old shoots.

Table 3 Effect of growth regulators, nutrients, seaweed extract and pruning on length of panicle in old and new shoots of mango cv. Kesar

Treatment	Length of panicle (cm)					
	Old shoot			New shoot		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
T_1- 100 ppm BA	40.63	37.34	38.99	45.42	39.45	42.44
T_2- 200 ppm BA	42.91	40.75	41.83	46.78	35.89	41.33
T_3 - 4% $CaNO_3$	20.14	18.14	19.14	18.63	16.12	17.37
T_4 - 6% $CaNO_3$	24.55	22.83	23.69	22.73	19.55	21.14
T_5 - 4% KNO_3	26.11	24.89	25.50	24.73	22.45	23.59
T_6 - 6% KNO_3	30.12	28.12	29.12	28.75	26.17	27.46
T_7 - Unpruned + 2% Urea	21.56	18.76	20.16	17.05	18.66	17.86
T_8 - Moderate pruning (10 cm) + 2% Urea	16.98	14.12	15.55	15.13	15.00	15.06
T_9 - 3% seaweed	26.45	24.29	25.37	30.75	28.67	29.71
T_{10}-5% seaweed	28.88	26.14	27.51	33.75	31.58	32.68
T_{11} - Paclobutrazol @ 5g.a.i./tree	22.12	19.34	20.73	20.60	18.94	19.77
T_{12} - Paclobutrazol @ 7.5g.a.i./tree	20.11	18.17	19.14	17.00	15.21	16.11
T_{13} - Control	31.76	27.55	29.66	30.53	28.11	29.32
Mean	27.10	24.65	25.88	27.07	24.29	25.68
SEm±	1.69	1.83	1.25	1.73	1.40	1.11
CD (P=0.05)	4.94	5.33	3.54	5.06	4.08	3.17
CV (%)	10.82	12.83	11.79	11.09	9.96	10.62
Interaction Y × T		5.78			5.13	

Application of 200 ppm 6-BA had profound effect (Table 3) on panicle length (41.83 cm) on old shoots which was at par with 100 ppm 6-BA (38.99 cm). It is further revealed that moderate pruning (10 cm) + 2% urea recorded lowest length (15.06 cm) of flowering panicles on new shoots compared to other treatments and control (29.32 cm).

For induction of early flowering, KNO_3, $CaNO_3$, 6-BA, seaweed extract and paclobutrazol were used. It is clear that use of 200 ppm 6-BA on postharvest vegetative flush and old shoots resulted in early panicle emergence with maximum length of panicle without cool inductive temperature. The results clearly indicate that 200 ppm 6-BA could be effective in successful induction of early flowering.

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