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Response of paclobutrazol treatment on flowering, fruit maturity, yield and quality of mango (*Mangifera indica*) cv Totapuri

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ABSTRACT

A field trial was conducted at Indian Institute of Horticultural Research Bangalore during 2007-2011 to study the effect of different doses and time of application of paclobutrazol on flowering, fruiting behavior and quality of 22 years old mango (*Mangifera indica* L.) cv Totapuri under South Indian Condition. There were nine treatments involving two doses of paclobutrazol 2.5g and 5.0g a.i/plant with four times of application (last week of July, August, September and October) along with control. All the paclobutrazol applied treatments induced early flowering to an extent by 20-25 days with increased percentage of flowering of 30-65% compared to control. The harvest maturity was also influenced by paclobutrazol application with an advancement of 3-4 weeks compared to control. The fruit yield was also affected and most pronounced effect was with T_5-treatment (2.5g a.i. applied during last week of September) which recorded mean cumulative fruit yield of 141.1 kg/ Plant, which is 55% higher compared to control (91.1 kg/ plant). However, fruit quality attributes such as TSS and acidity were not affected by different dose and time of application of paclobutrazol. Cost benefit ratio was maximum (1:3.02) with the treatment 2.5g a.i. paclobutrazol applied during the last week of September month.

Key words: Flowering, Fruit yield, Fruit quality, Mango, Paclobutrazol, Totapuri

Mango (*Mangifera indica* L.) is one of most important fruit crop of India. It is grown over an area of 2.30 million hectares with a total production of 15.19 million tonnes (Anonymous 2011). National productivity of mango is 6.6 MT/ha and a wide range of variation from 0.7 MT/ha to 13.6 MT/ha has been recorded in different parts of mango growing regions of India. Such wide range of variation indicates the need of region specific technology development for sustainable crop husbandry. In recent years, mango has been found highly vulnerable to weather dynamics threatening sustainability. The crux of mango productivity is the inconsistent annual flowering cycle irrespective of varieties. Flowering in mango occurs only in shoots of stems that have attained sufficient age since the previous vegetative flush positively modified by cool temperatures (Davenport 2009). In mango, although Indian varietal wealth is quite rich, only about 30 varieties are commercially grown with varied production dynamics. However, present Indian scenario the Indian scenario is grim with only about 10% of 'A' grade fruits. In general, there are many constraints prevailing in the Indian mango industry. Control of vegetative vigor and canopy size with simultaneous promotion of flowering is important for enhancing the production efficiency of mango orchards (Iyer and Kurian 2002).

The physiological effect of growth retardants that are antagonistic to gibberellins such as paclobutrazol are the most promising for increasing the productivity (Kurian and Iyer 1993). Although, direct effects of paclobutrazol (PBZ) on growth and flowering of mango have been well documented (Kulkarni 1988, Kurian and Iyer 1993, Abc, Burondakar and Gunjate 1991). Many mango orchards in western and southern parts of India have adopted its application for mango production especially in alternate bearing cultivars. However, there is no information available on flowering and harvesting time with the use of paclobutrazol. Such information is important in varieties like Totapuri to avoid market glut leading to reduced prices and hence, the present study was undertaken in Totapuri mango, which is one of commercially important mango variety mainly used for processing.

MATERIALS AND METHODS

The trial was conducted at Indian Institute of Horticultural Research, Bangalore, during 2007-2011, on Totapuri cultivar of mango employing randomised block design replicated three times. The trees were 22 years old at the start of the study and were growing on unspecified rootstock under uniform cultural management practices

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and raised with rainfed conditions. The trees were given paclobutrazol as soil drench along the drip line of the trees 2.5 or 5.0g a.i/tree in 10L of water in the month of July, August, September and October months. There were 9 treatments including control (2 doses×4 months of treatments). Flowering characters were recorded from ten tagged shoots/plant during the flowering season. Fruit yield was recorded from each plant during the fruiting season (May-June). Fruit quality parameters such as average fruit weight, total soluble solids (TSS) and acidity were noted as per the standard procedures from a random sample of twenty five fruits from each tree. The cost benefit ratio was worked out based on the prevailing market rates and for the mean cumulative fruit yield. Analysis of variance and F-test were employed for the interpretation of the results.

RESULTS AND DISCUSSION

Flowering parameters

The data on flowering parameters (Table 1) such as flowering percentage, indicated that flowering percentage was found to be significant among the treatments during the years 2008, 2009 and 2010. All the paclobutrazol applied treatments increased the flowering percentage compared to control during the different years. The mean flowering percentage was more with paclobutrazol treatments compared to control. Similar results of enhanced flowering by paclobutrazol application was reported by Tongumpai *et al*. (1991), Nartvaranat *et al*. (2000), Burondakar and Gunjate (1991), Kulkarni (1988), and Reddy and Kurian (2008). With respect to number of days for 50% flowering, significant differences among the treatments were recorded during different years except in 2009. All the paclobutrazol treatments advanced flowering to an extent by 13-18 days compared to control. The most pronounced effect of mean advancement by 18 days was with paclobutrazol 5.0g a.i./ plant applied during the last week of September months. Similar results of early and profuse flowering in mango was reported by Kurian *et al.* 1993b. Regarding the days to maturity from flowering, significant differences among the treatments were recorded during different years. The paclobutrazol treatments advanced harvesting of Totapuri mango by 16.25 days compared to control. Early harvesting in paclobutrazol applied treatments was mainly attributed to advanced flowering and fruit set. Early harvest in varieties like Totapuri mango is very much important to avoid market glut since major portion of produce goes for processing of mango pulp.

Fruit yield

Table 1 Effect of paclobutrazol on flowering and harvesting time of Totapuri mango

Treatment	Flowering percentage						No of days for 50% flowering						Days to maturity					
	2007	2008	2009	2010	2011	Mean	2007	2008	2009	2010	2011	Mean	2007	2008	2009	2010	2011	Mean
T_1- 2.5g a.i/ plant Last week of July	95.0	80.5	75.5	70.0	81.5	80.5	145.4	147.8	156.8	149.4	151.2	150.1	131.8	129	139.9	135.4	133.1	133.8
T_2- 5.0g a.i/ plant Last week of July	100.0	82.5	85.0	86.7	89.7	88.7	149.2	150.9	157.3	147.1	148.6	150.6	131.4	130	140	140.3	134.9	135.3
T_3- 2.5g a.i/ plant Last week of Aug	95.0	80.0	80.0	83.3	86.4	84.9	152	152.4	160.1	150.2	153.7	153.6	134.8	131	138.4	144.1	137	137.0
T_4- 5.0g a.i/ plant Last week of Aug	95.0	79.0	95.0	80.0	90.5	87.9	153.5	150	150.4	153.1	152.1	151.8	130.6	134.6	149.5	145	138.4	139.6
T_5- 2.5g a.i/ plant Last week of Sept	95.0	86.0	90.0	33.3	78.9	86.6	153.4	150.8	162.7	155	155.5	155.4	134.7	134.7	150	139.6	137.6	139.3
T_6- 5.0g a.i/ plant Last week of Sept	100.0	92.0	80.0	46.7	82.3	86.2	142.9	144.3	155.6	151.4	147.2	148.2	141.8	136.1	144.1	135.4	138.9	139.2
T_7- 2.5g a.i/ plant Last week of Oct	100.0	100.0	85.0	78.3	90.7	90.8	147.7	146.7	159.5	150	151	150.9	142.2	140.3	146.8	139.5	141.8	142.1
T_8- 5.0g a.i/ plant Last week of Oct	100.0	100.0	80.0	93.3	93.4	93.3	150.2	149.8	160.6	152.3	153.9	153.3	141.3	139	149.7	141	141.7	142.5
T_9- Control	85.0	72.5	70.0	35.0	69.1	66.3	163.9	162.5	170.9	168.1	167.5	166.5	156.7	154.9	164.2	158.6	159.3	158.7
F-test	NS	*	*	*	NS		*	*	NS	*	*		*	**	*	*	*	
Sem(±)	4.2	6.1	5.5	14.5	10.3		0.8	1.2	5.3	2.1	3.4		0.7	1.3	2.5	2.8	3.1	
CD (P=0.05)		19.1	16.5	43.9			2.4	3.7		6.3	10.2		2.3	4	7.6	8.1	9.4	

Table 2 Fruit yield of Totapuri as influenced by paclobutrazol application

Treatment	No of fruit/plant						Fruit yield/plant (kg/plant)					
	2007	2008	2009	2010	2011	Mean	2007	2008	2009	2010	2011	Mean
T_1- 2.5g a.i/plant Last week of July	607.3	404.6	428.7	308.3	271.0	403.9	134.5	130.5	116.3	67.6	80.0	105.7
T_2- 5.0g a.i/plant Last week of July	809.6	558.0	641.7	340.0	350.4	539.8	172.5	134.6	153.0	73.3	81.5	122.9
T_3- 2.5g a.i/plant Last week of Aug	625.6	456.3	573.3	405.0	426.0	497.2	156.9	125.9	132.8	85.0	121.3	124.3
T_4- 5.0g a.i/plant Last week of Aug	579.6	277.1	648.3	311.6	280.3	419.4	147.0	100.9	162.0	68.9	68.7	109.5
T_5- 2.5g a.i/plant Last week of Aug	850.0	605.7	575.0	295.0	494.7	564.1	229.5	128.6	156.6	61.6	130.6	141.3
T_6- 5.0g a.i/plant Last week of Sept	601.6	710.0	541.7	200.0	380.0	486.7	147.4	169.3	134.5	47.2	98.6	119.4
T_7- 2.5g a.i/plant Last week of Oct	612.3	813.0	608.6	220.0	254.7	501.7	156.0	193.6	150.3	50.3	67.6	123.5
T_8- 5.0g a.i/plant Last week of Oct	725.6	920.3	432.0	277.6	339.1	538.9	213.0	207.6	107.6	57.7	92.3	135.6
T_9- Control	500.3	574.8	491.6	117.3	236.7	408.2	118.7	127.8	118.2	31.7	60.6	91.4
F-test	**	**	NS	*	*		*	**	NS	*	*	
Sem(±)	16.1	48.1	124.6	40.2	29.4		3.9	8.9	33.1	12.0	15.8	
CD (P=0.05)	48.4	144.1		120.6	90.5		11.8	28.6		36.7	45.9	

Table 3 Fruit quality of Totapuri as influenced by paclobutrazol treatment

Treatment	Average fruit weight (g/plant)						T.S.S (^{o}Brix)						Acidity (%)					
	2007	2008	2009	2010	2011	Mean	2007	2008	2009	2010	2011	Mean	2007	2008	2009	2010	2011	Mean
T_1- 2.5g a.i/ plant Last week of July	221.1	321.8	348.3	220.1	295.4	281.3	11.9	11.8	15.6	14.2	12.5	13.2	0.18	0.17	0.24	0.19	0.2	0.19
T_2- 5.0g a.i/ plant Last week of July	214.2	243.5	311.8	219.2	238.6	245.4	11.8	12.1	14	15.1	13.9	13.3	0.17	0.17	0.26	0.18	0.19	0.19
T_3- 2.5g a.i/ plant Last week of Aug	254.3	275.0	318.8	210.6	285.1	268.7	11.9	11.9	15.3	14.8	14.1	13.6	0.17	0.17	0.25	0.17	0.18	0.18
T_4- 5.0g a.i/ plant Last week of Aug	225.0	330.9	317	226.3	246.5	269.1	12.0	11.8	15.3	14.5	14	13.5	0.18	0.17	0.28	0.18	0.21	0.20
T_5- 2.5g a.i/ plant Last week of Sept	273.0	213.9	383.8	210.8	264.7	269.2	12.0	11.6	15.3	15.1	13.5	13.5	0.18	0.17	0.27	0.19	0.2	0.20
T_6- 5.0g a.i/ plant Last week of Sept	250.6	225.5	310.8	242.6	261.3	258.1	12.1	11.6	16.3	15	14.2	13.8	0.17	0.17	0.29	0.18	0.18	0.19
T_7- 2.5g a.i/ plant Last week of Oct	257.2	240.8	270.4	230.7	267.9	253.4	12.1	11.6	13.7	14.6	14	13.2	0.18	0.18	0.28	0.19	0.19	0.20
T_8- 5.0g a.i/ plant Last week of Oct	319.2	230.4	233.6	208.8	274.9	253.3	11.9	11.5	15.7	14	13.8	13.3	0.18	0.18	0.24	0.2	0.2	0.2
T_9- Control	257.4	223.8	271.8	270.5	258.1	256.3	11.8	11.7	15	14.5	14.7	13.5	0.19	0.17	0.25	0.2	0.2	0.20
F-test	**	**	NS	*	*		NS	NS	NS	NS	NS		NS	NS	NS	NS	NS	
Sem(±)	2.5	7.7	36.9	8.4	5.3		0.2	0.3	0.6	0.4	0.3		0.06	0.009	0.08	0.1	0.2	
CD (P=0.05)	7.71	23.1		25.3	15.9													

Table 4 Cost benefit ratio of paclobutrazol application in Totapuri

Treatment	Cost of cultivation/ ha (₹)	Gross returns/ ha (₹)	Net returns/ ha (₹)	Cost: Benefit ratio
T_1- 2.5g a.i/plant Last week of July	17 560	52 530	34 970	1:2.00
T_2- 5.0g a.i/plant Last week of July	17 620	61 500	43 880	1:2.49
T_3- 2.5g a.i/plant Last week of Aug	17 560	62 150	44 590	1:2.53
T_4- 5.0g a.i/plant Last week of Aug	17 620	54 750	37 130	1:215
T_5- 2.5g a.i/plant Last week of Sept	17 560	70 650	53 090	1:3.02
T_6- 5.0g a.i/plant Last week of Sept	17 620	59 700	42 080	1:2.38
T_7- 2.5g a.i/plant Last week of Oct	17 560	61 750	44 190	1:2.51
T_8- 5.0g a.i/plant Last week of Oct	17 620	67 800	50 180	1:2.84
T_9- Control	17 560	45 700	28 140	1:1.60

The fruit yield in terms of number of fruits and fruit yield/plant as influenced by paclobutrazol treatments are presented in Table 2. Significant differences were recorded in fruit yield during different years except in 2009. All the paclobutrazol treatments increased fruit yield compared to control and the most pronounced effect was with T_5, i.e. paclobutrazol applied at the rate of 2.5g a.i/plant during the last week of September. Maximum mean cumulative fruit yield of 141.3 kg/plant were recorded with T_5 treatment whereas, control recorded a minimum mean cumulative fruit yield of 91.4 kg/plant. The beneficial effects of paclobutrazol in enhancing the fruit yield of Alphonso mango have earlier been documented by Kurian and Iyer (1993c), Burondakar and Gunjate (1991) and Reddy and Kurian (2008). Increased fruit yield by paclobutrazol application was due to enhanced flowering, fruit yield increase due to paclobutrazol application was to an extent of 20-50 percent in different treatments compared to control treatments.

Fruit quality attributes

The fruit quality attributes such as average fruit weight, TSS and acidity have been presented in Table 3. Average fruit weight was found to be significant during different years except during 2009. Maximum mean fruit weight of 281.3g was with treatment T_1 (2.5g a.i/plant) applied during last week of July) whereas, treatments T_2 (5.0g a.i/plant applied last week of July) recorded the lowest mean fruit yield of 245.4 g/fruit. On contrary, Reddy and Kurian (2008), Kurian and Iyer (1993c) indicated reduced average fruit size in Alphonso mango by paclobutrazol application. The differences may be due to varietal response to paclobutrazol application. The other fruit quality parameters such as TSS and acidity were found to be nonsignificant among different treatments during different years. Similar results of nonsignificant results were reported by Reddy and Kurian (2008) and Kurian and Iyer (1993c) in Alphonso mango.

Cost benefit ratio

The cost benefit ratio worked out for the mean cumulative fruit yields as presented in Table 4 showed that maximum cost benefit ratio of 1:3.02 was obtained with the treatment of 2.5 g a.i. per plant paclobutrazol during the last week of September month, whereas least cost benefit ratio of 1:1.60 was obtained with treatment control indicating the superiority of application of paclobutrazol for Totapuri mango. All the paclobutrazol treatment increased the cost benefit ratio compared to control. The increase in cost benefit ratio was mainly attributed to the increased fruit yield compared to control. The Totapuri is a late variety mainly used for processing. The cost benefit ratio was worked out based on the prevailing rates for inputs and day to day cultural operations. The cost of Totapuri mango were taken @ ₹ 5/kg which was the farm price of freshly harvested fruits at the Institute. The cost of paclobutrazol were taken as @ ₹ 5 850/ L.

Paclobutrazol application induced more and early flowering to an extent of 2-3 weeks with advanced harvesting time of 3-4 weeks compared to control in Totapuri mango. Fruit yield was also enhanced to an extent of 20-55% with pacolbutrazol and also increased cost benefit ratio as compared to control.

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