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Effect of dose and time of paclobutrazol application on the flowering, fruit yield and quality of mango cv. Alphonso

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ABSTRACT

A field trial was conducted for eight years at Indian Institute of Horticulture Research, Bengaluru to find out the effect of dose and time of application of paclobutrazol (PBZ) on flowering, fruit yield and quality of 'Alphonso' mango. The percentages of flowering, vegetative and dormant shoots were affected by paclobutrazol application. Different dose and time of application of paclobutrazol increased the percentage of flowering shoots significantly and most pronounced effect was with treatment D_1T_2 (3ml/m canopy PBZ applied 90 days before bud break) which recorded 89.9% flowering shoots as compared to 73.8% in control treatment. Regarding fruit yield, maximum mean fruit yield of 22.0kg/plant was recorded with treatment D_1T_2 (3ml/m canopy PBZ applied 90 days before bud break) and least was with control (13.1kg/plant) which accounts for fruit yield increase of 67.9%. No particular trend was observed in respect of shoot length in different treatments. However in general, paclobutrazol application reduced the shoot length compared to control. With respect of fruit quality attributes, acidity and TSS were found to be non-significant among different treatments during different years. Average fruit weight was found to be significant during different years and paclobutrazol application reduced the average fruit size compared to control. Cost benefit ratio was maximum of 1:2.52 was with treatment 3ml/m canopy PBZ applied 90 days before bud break and least cost benefit ratio of 1:1.06 was with control.

Key words: mango, fruit yield, fruit quality, paclobutrazol, flowering.

INTRODUCTION

Mango is one of the most important fruit crops of India. It is grown in area of 2.297 million ha with a production of 15.188 million tonnes according productivity of 6.6 t/ha (NHB, 2011) which is very low compared to countries like Israel, Mexico, Brazil and Philippines. One of the reasons for low productivity is due to alternate bearing tendency in most of the commercial varieties of mango. Control of vegetative vigour and canopy size with simultaneous promotion of flowering are important for enhancing the production efficiency of mango orchards (Iyer and Kurian, 2002). The use of vigour regulating rootstocks and growth retardants that are antagonistic to gibberellins such as paclobutrazol (Kurian and Iyer, 1993a and Kurian *et al*, 1996) are the most promising approaches in this regard. Although, the direct effects of paclobutrazol on the growth and flowering of mango have been well documented (Kulkarni, 1988, Kurian and Iyer, 1993a, b, c, and Burondkar and Gunjate, 1991). However, there is little information on the long term effects of continuous application of PBZ on flowering, fruit yield and quality of mango especially in varieties like Alphonso one of the important commercial varieties of mongo having tendency of alternate bearing. Such information is important for sustained production of mango hence, the study was taken up in Alphonso variety of mango.

MATERIAL AND METHODS

The experiment was conducted at Indian Institute of Horticulture Research, Bengaluru for eight years on Alphonso cultivar of mango employing randomized block design replicated four times. The trees were nine years old at the start of study and were growing on unspecified rootstock under rainfed conditions with uniform cultural management practices. The plants were given two doses of paclobutrazol 3ml/m canopy, (0.75g a.i/m canopy) 5 l/m canopy (1.25g a.i/m canopy) with 3 times of application namely 60, 90, 120 days before bud break, totaling seven treatments including control. The paclobutrazol applied as soil drench along the drip line of trees. Percentage of shoots producing flower panicles or vegetative shoots or remaining dormant shoots were recorded during January-February months along with panicle length and length of shoots from

the tagged shoots following the imposition of the growth retardant treatments. Fruit yield was recorded in May-June months during the year 1999 to 2006. Fruit quality parameters such as average fruit weight, total soluble solids and acidity were recorded as per standard procedures from a random sample of 25 fruits from each tree. Cost benefit ratio was worked out from the mean cumulative fruit yields based on prevailing market rates. Analysis of variance and F.test were employed for the interpretation of the results.

RESULTS AND DISCUSSION

Shoot length

The shoot lengths as influenced by paclobutrazol application are presented in Table-2. Most of the years shoot length was found to be non-significant among the different treatments. Only during the years 2001, 2005 and 2006, significant differences were observed among the treatments. However, in general paclobutrazol application reduced the shoot length compared to control. This observation is in agreement with the earlier findings of paclobutrazol influence on shoot growth of mango (Kurian and Iyer, 1993a, Burondkar and Gunjate, 1991 and Reddy and Kurian, 2008). Paclobutrazol is a known inhibitor of gibberellin biosynthesis (Anon., 1984) and lower gibberellin levels resulting from its application might have retarded the shoot elongation. The reduction in shoot elongation serves to control excess vegetative vigour and thereby to restrict the canopy size of mango trees, which would facilitate easier orchard management practices as well as planting mango trees at higher densities than the conventional spacing.

Flowering

The percentage of flowering, dormant and vegetative shoots as influenced by different treatments are presented in Tables 1 and 2. Enhancement in the proportion of flowering shoots through a reduction in the proportion of vegetative and dormant shoots was a striking response to paclobutrazol application. All the paclobutrazol treatments increased the percentage of flowering shoots with reduced percentage of vegetative and dormant shoots compared to control. The increased flowering percentage with different paclobutrazol treatments ranged from 11-14% more compared to control with concurrent reduction of vegetative and dormant shoots in the paclobutrazol treatments. Enhanced flowering of mango trees following paclobutrazol treatments has earlier been reported (Kurian and Iyer, 1993b, Burondkar and Gunjate, 1991, Kulkarni, 1988 and Reddy and Kurian, 2008.) Maximum mean percentage of flowering shoots (89.9%) were recorded with treatment D_1T_2 3ml PBZ/m canopy applied 90 days before bud break and least mean percentage of shoots as in control treatment (73.9%).

Fruit yield

Fruit yield in terms of fruit number and weight of fruits/tree increased with the application of paclobutrazol (Table 3). All the treatments increased the fruit yield compared to control and the most pronounced effect was with treatments D_1T_2 (3ml/m canopy PBZ applied 90 days before bud break) which increased the mean fruit yield to an extent of 64.9% compared to control treatment. Such beneficial effects of paclobutrazol in enhancing fruit yield of 'Alphonso' mango have been documented by earner workers (Kurian and Iyer, 1993c, and Burondkar and Gunjate 1991, Reddy and Kurian 2008). Fruit yield increase was mainly attributed to enhanced percentage of flowering shoots and reduced percentage of vegetative and dormant

Table 1. Effect of time and dose of application of paclobutrazol on vegetative and flowering shoots of mango cv. Alphonso

Treatment	Vegetative shoots (%)									Flowering shoots (%)								
	1999	2000	2001	2002	2003	2004	2005	2006	Mean	1999	2000	2001	2002	2003	2004	2005	2006	Mean
D_0T_0	25.0	5.0	6.2	14.5	9.5	14.0	12.5	16.5	12.9	67.5	53.5	93.8	85.5	70.5	71.0	80.0	69.0	73.8
D_1T_1	12.5	3.3	7.5	10.5	3.5	1.7	13.8	17.5	8.8	87.5	88.2	92.5	89.5	86.5	97.3	83.7	74.0	87.4
D_1T_2	10.0	4.3	16.2	12.0	4.5	1.0	2.5	17.8	8.5	90.0	93.2	83.8	88.0	89.0	98.5	96.3	81.0	89.9
D_1T_3	18.5	4.5	7.5	13.0	4.0	2.3	11.5	15.5	9.6	81.5	93.0	92.5	87.0	86.9	97.4	87.3	83.0	88.6
D_2T_1	45.0	2.5	10.0	9.5	3.2	1.2	12.0	4.5	11.0	63.7	90.5	90.0	90.5	89.9	98.8	86.5	94.0	87.9
D_2T_2	20.0	1.8	2.5	7.5	3.5	1.7	10.0	10.0	7.1	78.8	75.7	97.5	92.5	90.0	95.8	90.0	83.5	87.8
D_2T_3	25.0	8.0	6.2	9.0	3.8	4.3	11.0	16.5	10.5	75.0	70.5	93.8	91.0	88.4	92.4	87.0	82.0	85.0
F.test	NS	NS	**	*	*	*	*	*		NS	NS	**	*	*	*	*	*	
S.Em±	9.8	1.4	1.3	1.2	1.6	1.1	1.5	2.1		11.2	9.9	1.3	1.2	3.4	3.5	3.8	1.5	
CD at 5%	-	-	3.9	3.6	4.8	3.4	4.5	6.3		-	-	3.9	3.8	9.3	10.8	11.5	4.5	
CV%	2.7	1.9	3.2	5.4	1.5	2.8	3.7	4.2		2.1	3.4	3.0	2.0	1.5	4.8	5.1	4.1	

D_0T_0 - Control
D_1T_1 - 3ml/m canopy PBZ applied 60 days before bud break
D_1T_2 - 3ml/m canopy PBZ applied 90 days before bud break
D_1T_3 - 3ml/m canopy PBZ applied 120 days before bud break
D_2T_1 - 5ml/m canopy PBZ applied 60 days before bud break
D_2T_2 - 5ml/m canopy PBZ applied 90 days before bud break
D_2T_3 - 5ml/m canopy PBZ applied 120 days before bud break

Table 2. Effect of paclobutrazol on dormant shoots and shoot length of 'Alphonso' mango

Treatment	Dormant shoots (%)									Shoot length (cm)								
	1999	2000	2001	2002	2003	2004	2005	2006	Mean	1999	2000	2001	2002	2003	2004	2005	2006	Mean
D_0T_0	7.5	41.5	0	0	17.0	15.0	7.5	20.5	13.6	13.5	12.3	12.1	13.1	14.5	15.0	16.5	13.5	13.8
D_1T_1	0	8.5	0	0	10.0	1.0	2.5	8.5	3.8	12.0	10.4	10.2	15.4	13.5	14.1	14.2	12.5	12.7
D_1T_2	0	2.5	0	0	6.5	0.5	1.2	1.2	1.5	12.3	10.9	10.5	14.0	13.0	13.9	13.8	12.3	12.5
D_1T_3	0	2.5	0	0	9.1	1.3	1.2	1.5	2.0	11.9	9.3	10.0	12.0	13.2	14.0	13.5	11.2	11.8
D_2T_1	21.3	7.0	0	0	6.9	0	1.5	1.5	4.8	10.5	7.6	9.8	13.0	13.8	14.5	15.9	12.0	12.1
D_2T_2	1.2	22.5	0	0	6.5	2.5	0	6.5	4.9	11.5	11.1	10.9	13.1	13.4	13.1	14.0	11.9	12.3
D_2T_3	0	21.5	0	0	7.8	3.3	2.0	1.5	4.5	11.0	10.1	11.0	13.5	12.9	12.4	13.4	11.6	11.9
F.test	**	NS	NS	NS	*	*	*	*		NS	NS	*	NS	NS	NS	*	*	
S.Em+	3.7	9.6	0	0	2.5	2.1	1.1	3.9		1.2	1.08	0.42	1.05	1.5	1.9	0.6	0.2	
CD at 5%	10.9	-	0	0	7.5	4.3	3.3	11.7		-	-	1.7	-	-	-	1.8	0.4	
CV%	5.1	2.3	0	0	1.9	2.5	1.0	2.2		2.3	1.7	2.9	2.1	1.0	3.5	4.8	1.2	

D_0T_0 - Control
D_1T_1 - 3ml/m canopy PBZ applied 60 days before bud break
D_1T_2 - 3ml/m canopy PBZ applied 90 days before bud break
D_1T_3 - 3ml/m canopy PBZ applied 120 days before bud break
D_2T_1 - 5ml/m canopy PBZ applied 60 days before bud break
D_2T_2 - 5ml/m canopy PBZ applied 90 days before bud break
D_2T_3 - 5ml/m canopy PBZ applied 120 days before bud break

Table 3. Fruit yield of 'Alphonso' mango as influenced by paclobutrazol application

Treatment	No. of fruits/plant									Fruit yield (Kg\plant)								
	1999	2000	2001	2002	2003	2004	2005	2006	Pooled Mean	1999	2000	2001	2002	2003	2004	2005	2006	Pooled mean
D_0T_0	29.7	53.7	94.7	60.5	55.0	69.71	96.5	69.7	66.2	5.7	11.7	16.1	14.1	12.5	12.0	20.1	14.9	13.4
D_1T_1	35.2	65.0	106.5	99.1	71.5	108.2	183.2	115.5	98.0	8.7	14.6	17.3	20.5	16.5	20.2	37.3	21.4	19.6
D_1T_2	22.5	72.5	77.5	90.0	156.0	94.0	194.7	109.4	102.1	5.5	20.7	16.0	18.1	35.6	18.9	39.8	25.8	22.6
D_1T_3	31.0	62.0	94.0	81.9	96.5	80.7	176.0	92.6	89.3	7.7	14.0	16.5	20.4	21.8	16.1	37.2	21.1	19.4
D_2T_1	31.7	66.0	98.5	90.9	124.8	90.2	156.7	96.8	94.5	7.9	15.2	16.9	18.9	27.0	18.1	32.8	23.3	20.0
D_2T_2	31.5	57.7	69.4	85.0	96.2	100.7	189.5	91.7	90.2	7.6	13.7	14.8	17.5	21.8	20.5	38.9	24.9	20.0
D_2T_3	41.5	72.5	99.5	80.1	112.0	95.5	151.7	85.6	93.6	10.2	16.6	17.9	16.0	23.2	19.4	28.5	21.0	19.1
F.test	NS	*	NS	NS	*	*	*	*	*	NS	*	NS	*	*	*	*	*	*
S.Em+	9.4	4.3	16.7	14.1	7.1	6.4	9.9	7.2	4.4	2.3	2.1	2.9	1.4	3.2	1.6	2.5	2.0	3.5
CD at 5%	-	13.1	-	-	21.3	19.4	30.1	21.8	14.3	-	6.2	-	4.3	9.8	4.7	7.6	6.3	10.8
CV%	2.9	3.8	4.6	4.1	5.5	3.2	2.1	2.0	1.9	2.4	1.1	3.7	4.5	3.0	1.5	3.0	4.2	5.0

D_0T_0 - Control
D_1T_1 - 3ml/m canopy PBZ applied 60 days before bud break
D_1T_2 - 3ml/m canopy PBZ applied 90 days before bud break
D_1T_3 - 3ml/m canopy PBZ applied 120 days before bud break
D_2T_1 - 5ml/m canopy PBZ applied 60 days before bud break
D_2T_2 - 5ml/m canopy PBZ applied 90 days before bud break
D_2T_3 - 5ml/m canopy PBZ applied 120 days before bud break

shoots by the application of paclobutrazol. Paclobutrazol alters the source-sink relationships in mango to support the fruit growth with fewer leaves and lesser leaf area (Kurian *et al*, 2001) which explains the enhanced fruit yield with lesser vegetative growth.

Fruit quality

There was no appreciable influence of different treatments on fruit quality parameters such as total soluble solids and acidity but average fruit weight reduced as a result of paclobutrazol treatment (Table 4). All the paclobutrazol treatments affected the average fruit weight compared to control. This may be due to more number of fruits by the paclobutrazol application. Almost similar trend was observed in mango by Kurian and Iyer (1993c) and Reddy and Kurian (2008) as a direct response to paclobutrazol application.

Cost benefit ratio

The cost benefit ratio worked out in terms of mean fruit yield, gross and net returns are presented in Table 5. Maximum cost benefit ratio of 1:2.52 was recorded with the treatment 3ml paclobutrazol/m canopy applied 90 days before bud break treatment whereas, control treatment recorded the least cost benefit ratio of 1:1.06. All the paclobutrazol treatments increased the cost benefit ratio and the best treatment was found to be 3ml/m canopy PBZ applied 90 days before bud break. Paclobutrazol application affected the percentage of flowering shoots in turn increased the fruit yield of Alphonso mango. Paclobutrazol application

Table 4. Fruit quality attributes of Alphonso mango as influenced by paclobutrazol application

Treatment	Average fruit weight (g/fruit)								TSS (°Brix)							
	1999	2000	2001	2002	2003	2004	2005	2006	1999	2000	2001	2002	2003	2004	2005	2006
D_0T_0	243.0	246.2	179.7	230.5	229.1	176.3	205.6	215.0	15.5	15.9	16.9	17.2	17.1	17.5	16.8	16.7
D_1T_1	231.0	232.5	182.6	212.1	230.5	186.1	202.5	191.5	16.0	15.7	17.4	16.4	17.6	17.8	16.7	16.9
D_1T_2	240.0	243.7	158.2	177.8	235.6	199.4	205.1	235.6	15.8	14.1	16.4	17.0	18.0	17.6	17.0	17.2
D_1T_3	247.0	248.7	176.6	243.0	225.5	197.8	212.2	228.1	15.0	15.6	17.3	16.9	17.5	18.0	17.1	17.5
D_2T_1	200.0	197.5	179.8	209.5	290.1	200.7	210.5	238.8	15.2	15.5	17.1	17.3	16.9	17.1	17.5	17.4
D_2T_2	219.5	221.2	194.7	208.2	260.4	203.6	205.9	240.5	15.3	14.9	16.6	16.0	16.7	16.9	17.3	16.9
D_2T_3	240.0	241.2	179.2	203.0	210.9	200.5	199.8	220.6	15.5	15.0	16.5	17.5	17.1	16.8	16.9	16.6
F.test	*	*	NS	NS	*	*	*	*	NS	NS	NS	NS	NS	NS	NS	NS
S.Em+	8.5	10.8	18.1	19.5	2.1	3.9	1.5	2.8	0.5	0.4	0.35	0.41	0.39	0.45	0.40	0.30
CD at 5%	27.5	32.1	-	-	6.3	11.7	4.5	8.4	-	-	-	-	-	-	-	-
CV%	2.0	1.8	2.7	3.2	2.3	1.4	1.9	2.9	4.1	4.0	2.1	1.8	3.6	2.5	1.0	1.6

D_0T_0 - Control
D_1T_1 - 3ml/m canopy PBZ applied 60 days before bud break
D_1T_2 - 3ml/m canopy PBZ applied 90 days before bud break
D_1T_3 - 3ml/m canopy PBZ applied 120 days before bud break
D_2T_1 - 5ml/m canopy PBZ applied 60 days before bud break
D_2T_2 - 5ml/m canopy PBZ applied 90 days before bud break
D_2T_3 - 5ml/m canopy PBZ applied 120 days before bud break

Table 5. Cost benefit ratio of 'Alphonso' mango as influenced by paclobutrazol

Treatment	Gross returns	Net returns	Cost Benefit ratio
D_0T_0 - Control	45850	23650	1:1.06
D_1T_1 - 3ml/m canopy PBZ applied 60 days before bud break	45850	45050	1:2.12
D_1T_2 - 3ml/m canopy PBZ applied 90 days before bud break	67550	54500	1:2.52
D_1T_3 - 3ml/m canopy PBZ applied 120 days before bud break	77000	44350	1:1.99
D_2T_1 - 5ml/m canopy PBZ applied 60 days before bud break	66850	45750	1:2.08
D_2T_2 - 5ml/m canopy PBZ applied 90 days before bud break	68250	44700	1:1.98
D_2T_3 - 5ml/m canopy PBZ applied 120 days before bud break	67200	43300	1:1.95

reduced the shoot length and average fruit weight. TSS and acidity were not affected by the different treatments. Cost benefit ratio was maximum with 3ml PBZ/m canopy applied 90 days before bud break.

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