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Cumulative and residual effects of paclobutrazol on growth, yield and fruit quality of 'Alphonso' mango

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ABSTRACT

A field experiment was conducted during 1996 to 2002 at Indian Institute of Horticultural Research, Bangalore, to study the cumulative and residual effects of paclobutrazol (PBZ) application on shoot vigour, flowering and fruit yield of seventeen years old 'Alphonso' mango trees. Foliar sprays of the chemical at 500, 1000 or 2000 ppm or soil drench at 5 or 10 g a. i. per tree was given during September for three consecutive years and the residual effects were observed for three more subsequent years. Application of PBZ as soil drench was more effective than its foliar spray and doubled fruit yield during the six years. Chemical parameters of fruits such as TSS and acidity were not affected by the treatments but average weight of a fruit was less in the case of PBZ treatments. Residual influence of this chemical, when applied as soil drench, persisted in the three years following the discontinuation of application for three consecutive years, indicating the scope for skipping the application of PBZ or tapering down its dose after three years of its continuous application. From the results of this study, application of paclobutrazol at 5 g a.i. per tree as soil drench for three consecutive years and then its discontinuation for the subsequent three years appears to be most appropriate for 'Alphonso' mango trees in the age group of about 15 to 25 years.

Key words: Mango, *Mangifera indica*, paclobutrazol, shoot vigour, fruit yield, fruit quality

INTRODUCTION

Control of vegetative vigour with simultaneous promotion of flowering is important for enhancing the production efficiency of mango orchards (Iyer and Kurian, 2002). Use of vigour regulating rootstocks such as Vellaikulumban and Olour (Kurian *et al*, 1996) and growth retardants that are antagonistic to gibberellins such as paclobutrazol (Kurian and Iyer, 1993) are the most promising approaches in this regard. Although the direct effects of paclobutrazol (PBZ), on the growth and flowering of mango have been well documented (Kulkarni, 1988; Kurian and Iyer, 1993 a, b, c; Burondkar and Gunjate, 1991) and many mango orchardists in western and southern parts of India have adopted application of PBZ for higher mango production, there is little published information on long term effects of its continuous application as well as residual influence of the chemical on growth, yield and fruit quality of mango in the years following the discontinuation of its application. Such information is very important for sustained production of perennial fruit trees; hence this study was taken up to bridge the above gap in knowledge concerning enduring use of PBZ for enhanced mango productivity.

MATERIAL AND METHODS

The experiment was conducted at Indian Institute of Horticultural Research, Bangalore, during 1996-2002, on mango cultivar 'Alphonso' in randomized block design with four replications. The trees grafted on unspecified rootstocks were seventeen years old at the start of study and were maintained with uniform cultural practices. PBZ was applied either as foliar spray of 500, 1000 or 2000 ppm or as soil drench along the drip line of the trees at 5 or 10 g a.i. / tree in 10 liters of water, during September in 1996, 1997 and 1998. Percentage of shoots producing panicles or vegetative shoots or remaining dormant as well as the length of new shoots was recorded during January – February following imposition of PBZ. Fruit yield per tree was recorded in May - June from 1997 to 2002. Fruit quality parameters such as average fruit weight, total soluble solids (TSS), acidity, number of days taken by mature fruits to

ripen and incidence of spongy tissue disorder were recorded from a random sample of fifty fruits from each tree. Analysis of variance and F- test were employed for the interpretation of the results.

RESULTS AND DISCUSSION

Shoot growth

There was significant reduction in length of new shoots produced following PBZ application, the effect being more marked with soil application than foliar spray and increasing with the dose of the chemical within each method of application as per the earlier findings (Burondkar and Gunjate, 1991; Kurian and Iyer, 1993a). PBZ is a known inhibitor of gibberellin biosynthesis (Anon, 1984) and therefore lower gibberellin levels resulting from its application might have retarded the shoot elongation. The inhibitory effect of PBZ on shoot elongation slowly dissipated once its application was discontinued and differences in shoot length were not statistically significant during 2000 to 2002, though the shoots on treated trees remained shorter than those on control trees (Table 1). This 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 one.

Table 1. Effect of PBZ on shoot length of 'Alphonso' mango

Sl. No.	Treatment	Shoot length (cm)					
		1997	1998	1999	2000	2001	2002
1	PBZ 500 ppm	13.2	14.9	15.2	16.3	17.8	16.2
2	PBZ 1000 ppm	11.6	14.3	14.6	13.9	18.3	16.1
3	PBZ 2000 ppm	11.1	12.2	12.5	11.8	17.3	16.0
4	PBZ 5 g a.i.	10.5	11.7	12.1	12.8	18.8	15.9
5	PBZ 10g a.i.	10.1	11.4	11.7	12.2	18.0	15.5
6	Control	16.6	18.2	19.7	17.3	19.6	16.6
	S. Emt ±	1.4	2.0	1.9	2.5	2.1	1.8
	LSD *P=0.05*	4.4	5.9	5.7	NS	NS	NS

NS- Not significant

Flowering

Enhanced proportion of flowering shoots through a reduction in proportion of vegetative and dormant shoots, was a striking response to PBZ treatments, which was more pronounced with soil application rather than foliar spray (Table 2). This effect was quite discernible in all the years of study except during the year 1999 when the natural flowering was high with even the control plants putting forth panicles in 91% of their shoots and continued in years after the treatment was stopped, though statistically not significant, particularly in the case of soil treatments. Thus PBZ, especially as soil drench, was especially effective in enhancing flowering during years of sparse natural flowering and the residual effect of the chemical in this regard may persist for two to three years after application is stopped. Such enhanced flowering of mango trees following PBZ treatments has earlier been reported by

Table 2. Effect of PBZ on proportion of vegetative, dormant and flowering shoots of 'Alphonso' mango during flowering

Sl.No	Treatment	Vegetative shoots (%)						Dormant shoots (%)						Flowering shoots (%)					
		1997	1998	1999	2000	2001	2002	1997	1998	1999	2000	2001	2002	1997	1998	1999	2000	2001	2002
1	PBZ 500 ppm	20.7	6.2	12.5	10.5	2.0	6.5	15.0	51.3	1.25	2.5	3.0	8.0	64.3	42.5	86.2	87.0	89.0	85.5
2	PBZ 1000 ppm	2.5	5.0	15.0	8.0	3.5	10.1	28.0	20.0	0.0	2.0	4.0	9.5	69.5	75.0	85.0	90.0	92.5	80.4
3	PBZ 2000 ppm	6.0	2.5	8.7	7.5	3.0	6.2	3.5	57.5	0.0	2.9	2.0	6.9	90.5	90.0	91.2	89.6	95.0	86.9
4	PBZ 5g a.i.	5.5	11.3	32.5	6.0	4.0	3.5	6.8	1.2	8.7	1.5	3.0	3.4	87.7	87.5	58.7	92.5	93.0	93.1
5	PBZ 10g a.i.	1.3	1.2	31.2	5.0	1.5	2.5	11.2	3.8	2.5	1.0	2.0	3.0	95.0	95.0	66.2	94.0	96.5	94.5
6	Control	8.7	15.0	8.7	12.0	5.0	7.2	4.0	30.0	0	2.0	6.0	6.9	55.0	55.0	91.2	86.0	89.0	85.9
	S. Em.±	5.8	4.1	6.7	4.3	3.4	3.5	9.9	13.4	2.6	2.9	2.1	2.9	12.5	12.5	8.0	13.6	10.5	8.1
	LSD *P=0.05*	NS	NS	20.0	NS	NS	NS	NS	39.8	NS	NS	NS	NS	37.2*	37.2*	24.0*	NS	NS	NS

* Significant at P = 0.01; NS = Not significant

Table 3. Effect of PBZ on fruit yield of 'Alphonso' mango

Sl. No	Treatment	Number of fruits per tree								Weight of fruits per tree (Kg / Plant)							
		1997	1998	1999	2000	2001	2002	Cumu-lative	Mean	1997	1998	1999	2000	2001	2002	Cumu-lative	Mean
1	PBZ 500 ppm	85.0	49.0	212.5	166.2	150.5	145.5	808.2	134.7	17.4	10.0	43.6	34.1	30.9	32.1	168.1	28.9
2	PBZ 1000 ppm	96.2	56.0	188.7	155.0	178.0	162.5	836.4	139.4	20.7	12.0	40.6	33.3	38.3	35.6	180.5	30.0
3	PBZ 2000 ppm	147.2	104.7	227.7	119.7	161.2	160.0	921.4	153.5	30.2	21.5	46.7	24.5	33.0	33.6	189.5	31.8
4	PBZ 5g a.i.	163.7	463.7	277.5	253.0	159.0	172.1	1489.0	248.1	31.9	90.4	54.1	49.3	31.0	35.8	292.6	49.5
5	PBZ 10g a.i.	242.5	389.5	231.2	271.2	259.0	209.4	1609.8	267.1	43.7	70.1	41.6	48.8	46.6	40.7	291.5	48.6
6	Control	78.7	35.0	164.0	122.5	162.2	120.1	682.5	113.7	16.9	7.5	35.3	26.3	34.9	26.4	147.3	24.5
	S. Em.±	67.4	98.1	37.9	14.51	86.7	13.3	79.8	30.3	17.2	0.6	5.5	2.7	3.4	3.5	29.9	7.3
	LSD *P=0.05*	NS	291.5	NS	43.1*	57.3*	39.7	239.5	90.9	NS	1.7*	12.9	8.0*	9.9*	10.5	90.1	21.7*

* Significant at P = 0.01; NS = Not significant

Table 4. Effect of PBZ on fruit quality of 'Alphonso' mango

Sl. No	Treatment	TSS (°Brix)						Acidity (%)						Average fruit weight (g)					
		1997	1998	1999	2000	2001	2002	1997	1998	1999	2000	2001	2002	1997	1998	1999	2000	2001	2002
1	PBZ 500 ppm	18.4	21.0	19.5	18.6	19.6	19.0	0.167	0.217	0.167	0.202	0.202	0.202	200.5	213.2	205.0	210.6	206.3	208.9
2	PBZ 1000 ppm	18.6	21.5	19.2	19.2	19.4	19.2	0.184	0.167	0.184	0.218	0.218	0.202	212.2	204.2	215.1	215.8	204.9	215.0
3	PBZ 2000 ppm	19.2	20.6	20.0	19.8	18.9	18.5	0.184	0.184	0.184	0.168	0.202	0.218	205.1	201.3	205.0	219.4	204.7	210.0
4	PBZ 5g a.i.	19.2	19.2	19.0	18.6	19.9	19.4	0.217	0.184	0.217	0.168	0.218	0.202	195.6	189.9	213.8	210.9	195.9	200.9
5	PBZ 10g a.i.	19.0	19.5	20.5	18.0	18.5	19.0	0.184	0.217	0.167	0.235	0.202	0.225	179.5	171.1	179.9	201.7	180.4	196.4
6	Control	19.5	21.3	21.0	18.2	20.5	20.6	0.167	0.134	0.167	0.168	0.202	0.202	210.5	229.0	215.2	220.5	215.4	220.1
	S. Em.±	0.5	0.8	0.9	0.3	0.7	0.4	0.02	0.016	0.01	0.03	0.02	0.03	7.4	6.2	5.2	5.3	6.1	4.9
	LSD *P=0.05*	NS	NS	NS	NS	NS	NS	NS	0.048	NS	NS	NS	NS	22.2	18.4*	15.6	16.1	18.3	14.9

* Significant at P = 0.01; NS = Not significant

Kurian and Iyer (1993b), Burondkar and Gunjate (1991) and Kulkarni (1988). The present study indicates the scope for skipping the application of the chemical after a few years of its continuous application or tapering down its dose, especially during the years when good flowering is expected, while continuing to get the beneficial influence on flowering.

Fruit yield

Fruit yield in terms of number and weight of fruits per tree increased with application of PBZ and this was more striking in the case of soil application than foliar spray (Table 3). This effect dissipated in the year following withdrawal of PBZ treatment in the case of foliar spray and in the second year following withdrawal of PBZ treatment in the case of soil application at lower dose while the effect continued to manifest in the case of soil application at higher dose. Though beneficial effects of PBZ in enhancing fruit yield of 'Alphonso' mango have earlier been documented by Kurian and Iyer (1993c) and Burondkar and Gunjate (1991), the present study reveals that the soil application of PBZ can be temporarily withdrawn for three

Table 5. Effect of PBZ on incidence of spongy tissue and ripening of 'Alphonso' mango

Sl. No	Treatment	Incidence of spongy tissue (%)						Days for 50% fruit ripening					
		1997	1998	1999	2000	2001	2002	1997	1998	1999	2000	2001	2002
1	PBZ 500 ppm	2.0	2.5	2.4	2.0	2.9	2.4	9.0	9.8	9.1	9.0	10.1	9.9
2	PBZ 1000 ppm	8.0	10.0	2.6	2.5	3.1	3.0	9.1	9.3	9.6	9.2	9.5	9.4
3	PBZ 2000 ppm	8.0	10.0	2.0	2.8	3.0	2.8	9.0	8.8	9.8	9.0	9.9	9.0
4	PBZ 5g a.i.	7.5	10.0	2.1	3.9	1.9	2.0	8.5	8.8	9.0	8.7	10.5	9.2
5	PBZ 10g a.i.	6.5	17.5	2.0	4.2	2.5	2.6	8.7	9.5	10.0	9.1	9.8	9.5
6	Control	4.0	5.0	3.2	2.8	4.0	3.8	6.5	6.0	8.5	8.9	8.1	8.4
	S. Em.±	4.05	5.03	2.1	3.10	1.5	1.9	0.41	0.59	1.8	0.48	1.7	1.4
	LSD *P=0.05*	NS	NS	NS	NS	NS	NS	1.21	1.75*	NS	NS	NS	NS

* Significant at P = 0.01; NS = Not significant

years or so after three years of continuous application without a reduction in fruit yield. PBZ alters the source-sink relationships in mango to support 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 the treatments on chemical parameters of fruit quality such as total soluble solids and acidity, but average weight of a fruit reduced as a result of PBZ treatment, more so with the soil application (Table 4). Almost similar trend was observed by Kurian and Iyer (1993c) as a direct response to PBZ application. The influence of PBZ on fruit size continued even during three years following withdrawal of its application in the present study. Incidence of spongy tissue disorder in fruits of 'Alphonso' mango was unaffected by different PBZ treatments, but ripening of fruits harvested at full maturity was delayed by PBZ as indicated by number of days taken for ripening of 50% of the harvested fruits (Table 5). This effect was however not statistically significant in the years after application of the chemical was stopped.

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