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Effect of Paclobutrazol on Inducing Off-Season Flowering and Fruit Products of Wax Apple (*Eugenia javanica*) cv. Taiwan

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Abstract

Three-year-old wax apple trees cv. Taiwan were treated with paclobutrazol by drenching at the rate of 0, 1, 2 and 4 g.ai/tree or by spraying at 0, 500, 1,000 and 2,000 mg/L 40 and 90 days after pruning. The experiment was conducted at a private orchard in Varincharam district, Ubon Ratchathani province during the period from July 2002 to October 2003. The results showed that all the treated trees flowered, while the control trees did not flower at that time. Drenching gave better results than spraying in the first flower flush and the response increased with the concentration of paclobutrazol in both drench and spray treatments. The quality of harvested fruits such as fruit size, fruit weight, total soluble solid, titratable acidity, and the ratio of TSS : TA did not differ significantly among the treatments.

Keywords : Drenching, foliar spray, growth retardant, inflorescence, total soluble solids

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Introduction

Wax apple is one of the most common tropical fruits grown in Thailand. This species, belonging to the Myrtaceae family, presumably originated in South-East Asia. Currently the distribution ranges from India through South-East Asia to the Pacific Islands (Panggabean, 1992). In Thailand, many varieties are grown commercially in the central part of the country such as Phetchaburi, Nakhon Pathom and Samut Sakhon Provinces.

The wax apple tree flowers and sets fruit readily. Under natural conditions, the trees flower twice a year. The first flower flush appears from late December to January, and fruits are harvested in February and March. The second flush occurs around late February and harvest is in April-May. At present, growers cultivate the easy-to-flower cultivars, such as Petch Sairung, Petch Khiew and Petch Toon Klao. On season wax apple fruit yield most but prices are low. Growers have tried to produce off-season crops to gain high income, and many methods have been used to change in phenology of reproductive development, such as pruning, water stress and application of chemical and growth regulators. Paclobutrazol, a growth retarding chemical, reduces vegetative growth and promotes flowering in many kinds of fruit crops including mango (Leal *et al.,* 1999), durian (Subhadrabandhu and Kaiviparkbunyay, 1998), apple (Quinlan and Richardson, 1984), peach (Erez, 1986), lemon (Bunjungsiri, 1990), lychee (Chaitrakulsub et al., 1992) and mango (Chacko *et al.,* 1988).

The objective of this study was to investigate the effect of applying paclobutrazol to induce flowering for off-season production of wax apple as there is no data available for wax apple.

Materials and Methods

The experiment was conducted at a private orchard in Varincharam district, Ubon Ratchathani province, North-Eastern Thailand during the period from July 2002 to October 2003. Sixty-four, uniform, three-year-old, wax apple trees of cv. Taiwan with canopy diameter of 3 m were selected for the study. The experiment was laid out in a factorial in completely randomized design with four replications (trees). There were twelve treatment combinations (See Table 1), testing the effect of application method, concentration of paclobutrazol and leaf age at time of treatment.

Parameters observed consisted of

1. Percentage of shoots flowering (10 shoots were tagged in each tree.)

2. Number of inflorescences per shoot and number of flowers per inflorescence

3. Time of first blooming and time taken to 50% flowering after paclobutrazol application

4. Time of harvest, percentage fruit set and number of fruit per tree

5. Fruit quality

The data on fruit size, fruit weight and number of fruit per tree were recorded and percentage of fruit set was determined. The time of harvest was recorded as the time after paclobutrazol application.

The quality of fruits was also evaluated

1. Total soluble solids (TSS) were evaluated according to the technique of the A.O.A.C (1984). a drop of juice from the central part of the mesocarp was placed on an infrared focus refract meter and the result was expressed in degrees Brix (° B).

2. Titratable acidity (TA) was determined using the method described by Hulme (1971). The results were expressed as percentage of citric acid. This method was calculated according to following formula

$$\% \text{ citric acid} = \frac{\text{N.base x mL. Base x meq. Wt.of citric acid x } 100}{\text{mL. of juice}}$$

The data collected were analysed and statistically difference were determined by using the Duncan's new multiple range test.

Results

Percentage flowering

All the paclobutrazol treated trees produced off-season flowers, while the control trees did not flower at that time. Percentage flowering was significantly different among the treatments. Paclobutrazol application induced up to 100% flowering (Table 1).

Number of inflorescences per shoot and number of flowers per inflorescences

The highest number of inflorescences per shoot (5.1, 60 days after the treatment) was seen at the concentration of 4 g.ai/tree, as soil drench, at 40 days leaf age, while the sprayed application at 500 mg/L, 90 days leaf age produce the lowest number of inflorescence per shoot. Number of flowers in the inflorescence did not differ significantly among the treatments (Table 1).

Time taken to 50% flowering and time of first blooming

The treated trees flowered earlier. In 4 g.ai paclobutraxzol as soil drench at 90 days leaf age, the trees took 68 days after application to produce flowers 50% and time of first blooming was 78 days after the application. For the 500 mg/L treatment 40 days leaf age, the time taken for 50% flowering gave the longest 75 days after application paclobutrazol and the first blooming flowers was 86 days after application (Table 1). In this experiment, no flowers were seen in the control tree, i.e. trees that did not receive paclobutrazol treatment.

Time of harvest

Paclobutrazol applied at the rate of 4 g.ai/tree as soil drench, at 90 days leaf age, gave the earliest harvest at 115 days after treatment while the foliar spray at 500 mg/L, at 40 days leaf age took the longest time of (123 days) (Table 1).

Percentage fruit set

No significant difference was found in the percentage fruit set among the paclobutrazol treatments. All treated trees, whether drenched or sprayed, possessed the fruit set 100 percent.

Fruit weight and fruit size

Fruit weight and size (length and diameter) were not significantly different among the treatments. The maximum fruit weight (86.6g) was recorded from the trees receiving paclobutazol at 1 g.ai/tree as soil drench, applied at 90 days leaf age and the lowest fruit weight (84.5 g) was found at the rate of 1 g.ai/tree as soil drench, at 40 days leaf age. The 1,000 ml/L foliar spray at 90 days leaf age resulted in the highest fruit length (5.5 cm) while the concentration of paclobutrazol at 2 g.ai/trees as soil drench, at 90 days leaf age gave the maximum fruit diameter (8.1 cm) (Table 2).

Total soluble solid (TSS), Titratable acidity (TA) and TSS : TA

Total soluble solid content did not differ significantly among the treatments (Table 3). The highest total soluble solid (19.97 ° Brix) was found in the paclobutrazol treatment at the rate of 2 g.ai/trees as soil drench, at 90 days leaf age and the lowest (18.90° Brix) was found at the rate of 2,000 mg/L as foliar spray, at 40 days leaf age. The same trend was seen in the titratable acidity and TSS : TA.

Discussion

Flowering and off-season production in wax apple trees can be induced by paclobutrazol. Similar results were also reported for mango (Tongumpai et al., 1991), lemon (Banjungsiri, 1990), durian (Subhadrabandhu et al., 1998), apple (Quialan and Richardson, 1984), peach (Erez, 1986) and cherry (Ogata et al., 1986). This chemical is known to inhibit gibberellin biosynthesis, and when the level of gibberellin in the plant is reduced, flowering is stimulated (Pal and Ram, 1978). So, the effect of paclobutrazol in wax apple may be similar to these paclobutrazol-treated trees.

At 68 days after the paclobutrazol application the 50% flowering in the trees receiving the high concentration was greater than those in trees receiving the low concentration in soil drench application methods but the time to first blooming were 78 days after application

Table 1 Number of inflorescence per shoots, number flower per inflorescence, time of first blooming, time taken to 50% flowering and time of harvest after paclobutrazol application

Treatment	Number of Inflorescence Per shoots	Number flowers per shoots	Time to first Blooming (day)	Time taken to 50% flowering (day)	Time of harvest (day)
1. PBZ 1g/tree, soil drench, 40 day leaf age	4.05bc*	4.82	85ab	73b	119bcd
2. PBZ 2g/tree, soil drench, 40 day leaf age	4.60b	4.99	85ab	72bc	120abcd
3. PBZ 4g/tree, soil drench, 40 day leaf age	5.15a	4.87	84bc	70cd	118bcde
4. PBZ 1g/tree, soil drench, 90 day leaf age	3.75cd	4.9	81c	69dc	119bcd
5. PBZ g/tree, soil drench, 90 day leaf age	3.70cd	5.1	80cd	74a	123a
6. PBZ 4g/tree, soil drench, 90 day leaf age	4.20bc	4.83	78d	68e	115f
7. PBZ 500 ppm, foliar spray, 40 day leaf age	3.20de	4.67	86a	75a	123a
8. PBZ 1,000 ppm, foliar spray, 40 day leaf age	3.25de	4.92	85ab	72bc	121ab
9. PBZ 2,000 ppm, foliar spray, 40 day leaf age	4.47b	4.88	84bc	73b	121ab
10. PBZ 500 ppm, foliar spray, 90 day leaf age	2.88e	4.72	82c	72bc	119bcd
11. PBZ 1,000 ppm, foliar spray, 90 day leaf age	3.22de	5.01	80cd	70cd	118bcde
12. PBZ 2,000 ppm, foliar spray, 90 day leaf age	3.60cd	5.24	79d	69de	117ef
F-test	* *	**NS**	* *	* *	* *
C.V (%)	**9.98**	**5.11**	**1.02**	**2.21**	**1.38**

* Means followed by different letter are significantly different at 0.05 level as determined by DMRT.

NS = not significant

CV = coefficient of variation

Table 2 Fruit weight, length and diameter of off-season wax apple after receiving paclobutrazol

Treatment	Weight/ Fruit (g)	Length (cm)	Diameter (cm)
1. PBZ 1 g/tree, soil drench, 40 day leaf age	84.55	5.36	7.91
2. PBZ 2 g/tree, soil drench, 40 day leaf age	86.52	5.4	8.02
3. PBZ 4 g/tree, soil drench, 40 day leaf age	84.67	5.39	7.97
4. PBZ 1 g/tree, soil drench, 90 day leaf age	86.64	5.34	8.02
5. PBZ 2 g/tree, soil drench, 90 day leaf age	58.38	5.28	8.12
6. PBZ 4 g/tree, soil drench, 90 day leaf age	85.99	5.35	8.02
7. PBZ 500 mg/L, foliar spray, 40 day leaf age	83.83	5.32	7.97
8. PBZ 1,000 mg/L, foliar spray, 40 day leaf age	85.34	5.34	7.98
9. PBZ 2,000 mg/L, foliar spray, 40 day leaf age	85.65	5.33	8.04
10. PBZ 500 mg/L, foliar spray, 90 day leaf age	86.2	5.33	8.02
11. PBZ 1,000 mg/L, foliar spray, 90 day leaf age	84.86	5.51	7.98
12. PBZ 2,000 mg/L, foliar spray, 90 day leaf age	85.84	5.3	7.99
F-test	**NS**	**NS**	**NS**
C.V.(%)	**3.34**	**3.42**	**4.41**

NS = not significant

Table 3 Total soluble solid (TSS), titratable acidity (%TA), vitamin C and TSS : TA ratio of wax apple after paclobutazol application

Treatment	TSS (brix)	% TA	TSS : TA
1. PBZ 1 g/tree, soil drench, 40 day leaf age	18.97	0.223	40.1
2. PBZ 2 g/tree, soil drench, 40 day leaf age	19.1	0.228	39.2
3. PBZ 4 g/tree, soil drench, 40 day leaf age	19.05	0.223	40.6
4. PBZ 1 g/tree, soil drench, 90 day leaf age	19.05	0.223	38.4
5. PBZ 2 g/tree, soil drench, 90 day leaf age	19.97	0.224	40.6
6. PBZ 4 g/tree, soil drench, 90 day leaf age	19	0.234	38.6
7. PBZ 500 mg/L, foliar spray, 40 day leaf age	18.95	0.226	40
8. PBZ 1,000 mg/L, foliar spray, 40 day leaf age	19.05	0.233	38.9
9. PBZ 2,000 mg/L, foliar spray, 40 day leaf age	18.9	0.223	38.6
10. PBZ 500 mg/L, foliar spray, 90 day leaf age	19.05	0.224	40.4
11. PBZ 1,000 mg/L, foliar spray, 90 day leaf age	19	0.233	39.7
12. PBZ 2,000 mg/L, foliar spray, 90 day leaf age	19.02	0.233	39
F-test	**NS**	**NS**	**NS**
C.V.(%)	**2.43**	**7.31**	**8.83**

NS = not significant NS = not significant

(Table 1). Paclobutrazol at the rate of 4 g.ai/ trees as soil drench was more effective in hasten flowering than the low concentration while the foliar spray at 500 mg/L was more effective than the high concentration.

Comparing the application methods, the soil drench was more effective in flower initiation than foliar spray in wax apple, as paclobutrazol is extremely transported via xylem than phloem (Pal and Ram, 1978). Besides it was uptaked together with nutrient through the trunk and the top. Whereas few paclobutrazol was absorbed by leaves. This is also reported in mango (Subhadrabandhu et al., 1999). All treated trees, either drenched or sprayed, possessed the fruit set of 100 percent. As the wax apple flower is complete type and easily fertilized, flowers were thinned at 80 days after the application for increase fruit quality. Thus, fruit size, fruit weight and number of fruit per trees did not differ significantly among the treatments.

Conclusion

The 3-year-old wax apple tree were sprayed or soil drenched with various concentrations of paclobutrazol and a different stages of leaf development i.e. at fully mature (40 days) and at old leaf (90 days) after pruning. The results can be concluded as follows.

1. All the treated trees flowered and set fruit, whereas no flowers were found in the control trees.

2. The higher concentration of paclobutrazol and soil drench application gave the best results on flowering.

3. TSS content, TA content and ratio of TSS:TA were not significantly different among the treatments.

5. Fruit weight and fruit size (length and diameter) among the treatments were not significantly different.

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