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Effect of Paclobutrazol on Flowering, Fruit Setting and Fruit Quality of Durian (*Durio zibethinus* Murr.) CV. Chanee.

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ABSTRACT

The effect of paclobutrazol on durian cv. Chanee was studied at a private orchard in Klaeng district, Rayong province for two consecutive years in 1988 and 1989. The results showed that the use of paclobutrazol together with surfactant did not enhance the time of flowering regarding to the application times, the positions in the trees where the chemical was applied and the ages of the treated trees as compared with the control treatment. The chemical applied at any time at various ages of the trees increased the percentage of branch bearing flowers, but the percentage of branch bearing fruits and the number of fruits per tree were not different among the treatments. Paclobutrazol applied with surfactant did not cause any difference in the mean fruit weight between the treated and untreated trees. However, the treated young trees appeared to have smaller fruits than those of the treated old trees. The length of fruit stalk of the paclobutrazol-treated trees was shorter than that of the untreated trees. The positions in the trees where the chemical was applied did not affect on the length of fruit stalk. The duration and frequency of the harvest were longer in the treated trees than in the control ones, but the position of the trees where the chemical was applied did not have any effect on the duration and the number of harvest. Paclobutrazol did not cause any differences in the percentage of flesh recovery, as well as quality of the harvested fruits.

Key words : paclobutrazol, flowering, fruit quality, durian cv. Chanee, *Durio zibethinus*

INTRODUCTION

Durian is the leading economic fruit of Thailand. The fruit is popularly consumed locally as well as exporting. The production of durian in Thailand increased from 426,245 metric tons in 1987 to 746,642 metric tons in 1993, with the increase in harvesting area from 55,095 hectares in 1987 to 70,893 hectares in 1993 (Anon., 1996). 'Chanee' is among the leading durian cultivar in the country and is popularly grown in the eastern provinces. The data in 1993 showed the harvesting area of Chanee was 35.7% with the production of 38.8% of the country figure (Anon., 1996). In 1990, Thailand exported about 7,000 tons of fresh durian worth 4.75 million U.S. dollars (Trade Statistics Center, 1990), and about 80% of this export was sent to Hong Kong. As durian has high trade potential, so researches on increasing the productivity and quality of the fruits are urgently required.

In Thailand, durian trees started to flower in November to December and the peak harvest is in April-May where growers are faced with low price. If the trees are made to flower earlier and can be harvested at 3-4 weeks ahead of the normal harvest,

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growers can benefit higher income 5-6 times of the normal one. Paclobutrazol was introduced to Thailand for a trial on mango in 1987 and was shown to have the ability of producing early crop (Voon *et al*., 1991; Tongumpai *et al*., 1991). In durian, there was no definite evidence of paclobutrazol in inducing 'off-season' flowers nor increasing quality of the fruits. Therefore, this study was designed to investigate the response of the durian tree to the use of paclobutrazol at different times, positions of the tree and ages of the trees on flowering, yield and fruit quality of 'Chanee' durian.

MATERIALS AND METHODS

The study was divided into 3 experiments, and paclobutrazol was applied as foliar spray in all experiments. As durian trees are rather sensitive to paclobutrazol comparing to other tropical fruits like mango, and the application of paclobutrazol as a soil drench is not commonly practised among durian growers as the trees would either take a long time to recover or gradually decline due to high concentration of paclobutrazol applied as soil drench.

Experiment 1. Study on the suitable time in applying paclobutrazol as foliar spray.

Thirty-six 'Chanee' durian trees of about 10 years old having similar canopy size and growth were selected in this study. Factorial in completely randomized design with 2 factors was used.

Factor 1, consisted of paclobutrazol concentration at 0, 500 and 1000 ppm.

Factor 2, consisted of time of paclobutrazol application, at the last week of July, August and September.

The experiment consisted of 9 treatment combinations with 4 replications having one durian tree as one replicate. In all treatments, the chemical was thoroughly sprayed to run off covering whole tree canopy.

Experiment 2. Study on applying paclobutrazol at specific sites.

Twenty-four 'Chanee' durian trees of about 10 years old of similar canopy size and growth were selected in this study. Factorial in randomized complete block design was employed in this study.

Factor 1, consisted of paclobutrazol concentration at 0, 500 and 1000 ppm.

Factor 2, consisted of specific sites in the trees where paclobutrazol was applied viz. a) applying to only lateral branches where flowers are borne and b) applying to both lateral branches and leaves at the terminal end.

The experiment consisted of 6 treatment combinations with 4 blocks having one branches represented one replication.

Experiment 3. Effect of paclobutrazol on flowering of durian trees at different ages.

Twenty four durian trees cv. Chanee at 5, 10 and 20 years old were used in this study. Factorial in completely randomized design with 2 factors was employed, with factor 1 consisted of three levels of age viz. 5, 10 and 20 years old tree. Factor 2 consisted of 2 concentrations of applied paclobutrazol, viz. at 0 and 500 ppm. The paclobutrazol solution was applied as foliar spray until run-off to the whole tree canopy in July. There were 6 treatment combinations with 4 replicates having one durian tree represented one replication.

The parameters measured were as follows.

1. Time taken from paclobutrazol application to flower emergence, (recorded in all experiments).

2. Percent of branches bearing flowers, by counting all branches of each tree and expressed as flowering percentage (recorded in Expt. 1 and 3).

3. Percent of branches bearing fruits, by counting all branches of each tree and expressed as

fruiting percentage (recorded in Expt. 1 and 3).

4. The number of harvest and time taken from the first to the last harvest of each tree (recorded in Expt. 2).

5. Average fruit weight from 50 random fruits of each tree (recorded in Expt. 1 and 3). In Expt. 2 all fruits in the tree were weight and averaged.

6. Number of fruits per tree (recorded in Expt. 1 and 3). In Expt. 2 the number of fruits per branch were recorded.

7. Average length of fruit stalk from 50 random fruits of each tree (recorded in Expt. 1 and 3). In Expt. 2 all fruits in the tree were measured and averaged.

8. Fruit quality which comprised of flesh firmness, measured by using Effegi fruit firmness tester with diameter of the plunger of 0.8 cm., total soluble solids (TSS) of flesh, measured by using hand refractometer and flesh color by comparing with color chart of the Royal Horticultural Society, London.

Durian trees used in this study were grown in the private orchard at Klaeng district, Rayong province during the period from July 1988 to May 1990. Quality analyses were conducted at the Physiology Laboratory, Dept. of Horticulture, Kasetsart University, Bangkhen Campus.

RESULT

Experiment 1. Study on the suitable time in applying paclobutrazol as foliar spray.

The application of 500 and 1000 ppm paclobutrazol to 'Chanee' durian at three different times, i.e. end of July, end of August and end of September, gave the following results.

1.1 Time taken from applying chemical to flower emergence.

There was no difference on the time of flower emergence in trees receiving paclobutrazol at different months and the control tree (Table 1). This indicated that paclobutrazol at the concentrations studied and applying at three different months did not give any effect on flower induction of durian tree cv. Chanee.

1.2 Intensity of flowers.

Taking the application of paclobutrazol in July, August and September into account on percent of flowering branches, the results did not show any significant difference. The trees receiving paclobutrazol at 500 and 1000 ppm had more flower intensity expressed as percent of flowering branches than that of the control tree. Trees receiving 500 ppm paclobutrazol in August and those receiving 1000 ppm in July, August and September had the highest percent of flowering branches of 97%, whereas those control trees showed the lowest flowering percentage of 91% (Table 1).

1.3 Percent of fruit set, number of fruits per tree and average fruit weight.

The trees receiving paclobutrazol at different times and concentrations did not have any statistically significant difference on percent of fruit setting branches, number of fruits per tree and average fruit weight. The paclobutrazol treated trees at 500 and 1000 ppm did not show any significant difference on all parameters mentioned compared with those of the control trees (Tables 1 and 2).

1.4 Length of fruit stalk.

The trees receiving paclobutrazol in July, August and September produced fruits with lengths of the stalks not significantly different from the control tree. However, the higher concentration of paclobutrazol gave shorter fruit stalk. Fruits from the control tree had the longest fruit stalk of 6.2 cm, whereas those fruits from the trees receiving 500 and 1000 ppm paclobutrazol in July and August had the shortest fruit stalk of 4.9 cm (Table 2).

1.5 Flesh quality.

The quality of flesh represented by total

Table 1 Application time of paclobutrazol on the time taken to flower emergence, flowering and fruiting percentage of 'Chanee' durian.

Month of Application	Paclobutrazol conc. (ppm)	Time of flower emergence (%)	Flowering branch (%)	Fruiting branch (%)
July	0	100[1/]	92 cd[2/]	80.00
	500	99	95 ab	81.70
	1000	99	97 a	82.30
August	0	100	93 bcd	79.30
	500	99	97 a	81.50
	1000	99	97 a	82.00
September	0	100	91 d	80.50
	500	99	94 bc	72.30
	1000	99	97 a	81.70
cv. (%)		2.63	1.70 5.74	

[1/] Time to flowering of the control tree expressed as 100 percent.
[2/] Means within the same parameter followed by similar letter are not significantly different at the 5% level by DMRT.

Table 2 Application time of paclobutrazol on the number of fruits per tree, average fruit weight and length of fruit stalk of 'Chanee' durian.

Month of application	Paclobutrazol conc. (ppm)	Number of fruits per tree	Average fruit weight (kg)	Length of fruit stalk (cm)
July	0	82	2.23	5.4 ab[1/]
	500	76	2.19	4.9 B
	1000	79	2.20	4.9 b
August	0	81	2.28	5.3 ab
	500	71	2.29	4.9 b
	1000	66	2.16	4.9 b
September	0	77	2.43	6.2 a
	500	73	2.23	5.2 b
	1000	68	2.31	5.1 b
cv. (%)		26.02	11.71	11.57

[1/] Means within the same parameter followed by similar letter are not significantly different at the 5% level by DMRT.

soluble solids, flesh firmness and color of flesh were not significantly different in fruits of the paclobutrazol treated trees compared to those of the control ones. This was seen in all treatments including those receiving paclobutrazol in different months. (Table 3).

Experiment 2. Study on applying paclobutrazol at specific sites.

This experiment was designed with the aim of testing the receptive site of paclobutrazol in durian tree. In general, durian flowers are borne on the old lateral branches which have the supporting leaves at the terminal end. Therefore, paclobutrazol was applied either to only the branches where flower buds are located or to the branches plus the leaves at the terminal end. The results showed that there was not significantly different of all parameters studied in all treatments. Paclobutrazol at 500 and 1000 ppm did not give any significant difference in time of flower emergence, number of fruits per branch, average fruit weight, average length of fruit stalk, number and duration of harvest and flesh quality of the harvested fruits (Tables 4, 5 and 6).

Experiment 3. Effect of paclobutrazol on flowering of durian trees at different ages.

The study on the response to 500 ppm paclobutrazol of durian trees at various ages viz. 5, 10 and 20 years old gave the following results.

3.1 Time taken from chemical application to flower emergence.

There was not significantly different on the time taken from paclobutrazol application to the emergence of flower among trees of various ages and the control tree (Table 7).

3.2 Percent of flowering branch.

The percent of flowering branch was highly significantly different among the trees of different ages. Ten years old tree receiving 500 ppm paclobutrazol had the highest percent of flowering branch at 96%, whereas the twenty years old tree that did not receive paclobutrazol produced the lowest percent of flowering branch at 83% (Table7).

Table 3 Application time of paclobutrazol on total soluble solids (TSS), flesh firmness and flesh color of 'Chanee' durian.

Month of application	Paclobutrazol conc. (ppm)	TSS (%)	Flesh firmness (kg/cm^2)	Flesh color
July	0	10.5	7.2	Hcc 403/1
	500	10.8	8.9	Hcc 403/1
	1000	13.5	8.4	Hcc 403/1
August	0	10.4	8.7	Hcc 403/1
	500	14.0	7.4	Hcc 403/1
	1000	12.9	8.0	Hcc 403/1
September	0	11.5	8.8	Hcc 403/1
	500	9.9	8.6	Hcc 403/1
	1000	9.6	8.6	Hcc 403/1
cv. (%)	18.99	12.92		

Table 4 Site of paclobutrazol application on the time taken to flower emergence, number of fruit per branch, average fruit weight of 'Chanee' durian.

Site of application	Paclobutrazol conc. (ppm)	Time to flower emergence[1/] (day)	Number of fruit/branch	Fruit wt. (kg)
Branch	0	110	2.3	2.15
	500	109	2.3	2.13
	1000	109	2.0	2.00
Branch + terminal shoot	0	110	2.0	2.25
	500	109	2.0	2.08
	1000	110	2.0	1.98
cv. (%)		0.46	35.36	14.29

[1/] Time taken from paclobutrazol application to flower emergence.

Table 5 Site of paclobutrazol application on length of fruit stalk, number of harvest and harvesting time of 'Chanee' durian.

Site of application	Paclobutrazol conc. (ppm)	Length of fruit stalk (cm)	Number of harvest	Harvesting time[1/] (day)
Branch	0	5.5	2.0	14
	500	5.4	2.0	13
	1000	5.0	2.0	15
Branch + terminal shoot	0	5.0	1.0	13
	500	5.2	1.0	14
	1000	5.0	1.0	14
cv. (%)		11.27	35.77	91.45

[1/] Time taken from the first harvest to the last harvest of the same tree.

3.3 Percent of fruiting branch.

There was not significantly different on the percent of fruiting branch among the paclobutrazol treated trees of various ages and the control trees (Table 7).

3.4 Number of harvested fruits per tree.

The number of fruits harvested per tree was highly significant among the ages of trees. The older the trees, the higher the number of fruits harvested. This is also found in this study in which the 20 years old tree treated with paclobutrazol produced the highest fruit number of 130 fruits

Table 6 Site of paclobutrazol application on total soluble solids (TSS), flesh firmness and flesh color of 'Chanee' durian.

Site of application	Paclobutrazol conc. (ppm)	TSS (%)	Flesh firmness (kg/cm^2)	Flesh color
Branch	0	16.8	6.8	Hcc 403/1
	500	12.7	9.3	Hcc 403/1
	1000	13.1	8.9	Hcc 403/1
Branch + terminal shoot	0	13.6	6.3	Hcc 403/1
	500	17.6	6.7	Hcc 403/1
	1000	16.2	7.5	Hcc 403/1
cv. (%)		28.43	39.51	

Table 7 Effect of paclobutrazol (PBZ) on time taken to flower emergence, percent of flowering and fruiting branches of 'Chanee' durian at different ages.

Treatment	Time flowering (days)	Flowering branch (%)	Fruiting branch (%)
5 yr. old tree with no PBZ	109	90.5 b[1/]	62.0
10 yr. old tree with no PBZ	110	90.7 b	76.5
20 yr. old tree with no PBZ	110	83.0 c	71.7
5 yr. old tree with 500 ppm PBZ	109	94.5 ab	65.5
10 yr. old tree with 500 ppm PBZ	109	96.0 a	74.2
20 yr. old tree with 500 ppm. PBZ	110	90.7 b	86.0
cv. (%)	0.47	3.27	17.55

[1/] Means within the same parameter followed by similar letter are not significantly different at the 5% level by DMRT.

whereas the 5 years old untreated trees gave the lowest fruit number of 55 fruits (Table 8). However, there was not significantly different on the number of fruit harvested between the paclobutrazol treated and the control trees of the same age (Table 8).

3.5 Average fruit weight.

The average fruit weight was significantly different between the paclobutrazol treated and the control trees. In general the control trees seemed to produce big fruits. In this study, the control, 20 years old trees produced the highest fruit weight of 2.8 kg whereas the paclobutrazol treated, 5 years old trees gave the lowest fruit weight of 2.0 kg (Table 8).

3.6 Length of fruit stalk.

The average length of fruit stalk was highly

significantly different between the paclobutrazol treated and the control trees. The control trees produced longer fruit stalk, and there was no significantly different in fruit stalk among trees of different ages. The control, 20 years old tree had the longest fruit stalk of 6.2 cm, whereas the paclobutrazol treated, 5 years old trees gave the shortest fruit stalk of 5.2 cm (Table 8).

3.7 Flesh quality.

There was not significantly different on the TSS, flesh firmness and flesh color of fruits from the paclobutrazol treated and the control trees. However, there was a trend indicating that fruits from the paclobutrazol treated trees produced higher %TSS and lower flesh firmness at harvest. The color of the flesh was the same in all treatment. There was no difference in these characters among the trees of different ages (Table 9).

DISCUSSION

The study on applying paclobutrazol as foliar spray to durian tree cv. Chanee was investigated for the responses on flower emergence, flower intensity and final fruit retention on the trees, to a) time of applying the chemical and specific sites on the tree where the chemical was applied, and b) ages of the trees where the chemical was applied. The results showed that both concentrations of paclobutrazol viz. 500 and 1000 ppm applied only to the old branches where flower buds are located as well as applying to leaves at the terminal end of that branch did not give any significant differences in the parameters studied when compare with the control trees. Trees receiving paclobutrazol at 1000 ppm produced higher flower intensity than those in the other treatments, but they also produced higher fruit drops so that the final fruit retention was not different from the control trees. This phenomenon was also reported in tangerine (Kitinunprakon and Subhadrabandhu, 1988) and lychee (Chaitrakulsub *et al*., 1992).

Paclobutrazol applied in July, August and September did not significantly effect on the time of flower emergence of durian trees as comparing to that of the control ones. It could be possible that the times in applying paclobutrazol were not appropriated for the induction effect of this

Table 8 Effect of paclobutrazol (PBZ) on number of fruit per tree, average fruit weight and length of fruit stalk of 'Chanee' durian.

Treatment	Number of fruit /tree	Average fruit weight (kg)	Length of fruit stalk (cm)
5 yr. old tree with no PBZ	55 b[1/]	2.65 x	6.2 p
10 yr. old tree with no PBZ	67 b	2.68 x	6.1 p
20 yr. old tree with no PBZ	125 a	2.80 x	6.2 p
5 yr. old tree with 500 ppm PBZ	61 b	2.05 y	5.2 q
10 yr. old tree with 500 ppm PBZ	70 b	2.40 xy	5.3 q
20 yr. old tree with 500 ppm PBZ	130 a	2.60 x	5.4 q
cv. (%)	26.42	11.86	6.53

[1/] Means within the same parameter followed by similar letter are not significantly different at the 5% level by DMRT.

Table 9 Effect of paclobutrazol (PBZ) on total soluble solids (TSS), flesh firmness and flesh color of 'Chanee' durian trees of different ages.

Treatment	TSS (%)	Flesh firmness (kg./cm^2)	Flesh color
5 yr. old tree with no PBZ	14.5	6.0	Hcc 403/1
10 yr. old tree with no PBZ	14.8	9.1	Hcc 403/1
20 yr. old tree with no PBZ	15.6	6.6	Hcc 403/1
5 yr. old tree with 500 ppm PBZ	19.7	5.5	Hcc 403/1
10 yr. old tree with 500 ppm PBZ	20.0	4.2	Hcc 403/1
20 yr. old tree with 500 ppm. PBZ	16.5	5.0	Hcc 403/1
cv. (%)	41.25	58.85	

chemical. As there was no anatomical evidence of floral bud differentiation of durian trees, so it is difficult to pinpoint the exact time that paclobutrazol should be applied. If the influence of paclobutrazol is on the induction of flowering, then the chemical should be applied well ahead of the differentiation time. However the results in this study tended to indicate the effect of paclobutrazol on stimulating flower intensity, thus the role of paclobutrazol on flowering of durian tree should be further investigated.

No significant differences were observed in flowering of the trees receiving paclobutrazol only at the old branches bearing flower bud and those receiving the chemical to the whole branch i.e. to the branch bearing flower bud together with the terminal shoot of that branch (Table 4, 5 and 6). This may be due to the translocating ability of paclobutrazol in the tree. Paclobutrazol was reported to move well in the xylem (Voon *et al*., 1991) and the effective application was reported as soil drench through the roots (Subhadrabandhu *et al*., 1998). Therefore in this study, paclobutrazol was applied to the branch and leaves in which the already low absorption would result in low amount of chemical into the phloem, and the translocation of paclobutrazol in the phloem was very little (Voon *et al*., 1991). This may be the reason of no response to paclobutrazol on flowering when the chemical was applied as described in this study.

The effect of paclobutrazol can be clearly seen in the reduction of fruit stalk and the smaller size of harvested fruits. The first effect was a disadvantage as short fruit stalk can cause the growing fruits in the same cluster too close together and resulted in an unshapely fruits and not properly growth of some fruits. Mark and scar were oftenly seen at the fruit skin. This effect can be counteracted with the spray of gibberellic acid at the early stage of fruit development, as gibberellic acid can increase the length of fruit stalk. The second effect of paclobutrazol on causing small sized fruits was welcomed by growers who produced fruits for export. International as well as most local markets welcomed medium sized fruits of about 0.5-1.0 kg per fruit. This size of fruit is in more demand by consumers as it can be consumed at one time. As the price of durian fruits sold in the market based on the weight, thus the price of small and medium sized fruits are not so high and can be afforded by average income persons. Then growers can sell medium sized fruits easier than larger ones. In

future, more growers tend to produce uniform fruits of medium size and good shape and this may be the advantage side of using paclobutrazol on durian production.

The study on the response to applied paclobutrazol of durian trees at different ages viz. 5, 10 and 20 years old showed that younger trees responded better in flowering intensity than the older trees (Table 7, 8 and 9). This could be due to the older trees are larger in canopy size which cause the trees to receive the applied chemical less thoroughly. The older trees may have more endogenous hormonal level such as gibberellin which can counteract the effect of paclobutrazol. In general, older trees seem to response to environmental changes in a lesser degree than younger trees.

Paclobutrazol was shown to have no effect on flesh quality of durian in this study (Table 9). This confirms earlier reports of using paclobutrazol on other fruit crops such as lychee (Chaitrakulsub *et al*., 1992) and mango (Tongumpai *et al*., 1989).

Flowering induction and fruit setting of durian cv. Chanee depend strongly on environments such as temperature, relative humidity, soil moisture, endogenous hormonal levels as well as the physiological status of the trees. These factors need further study, an understanding of the relation between exogenous and endogenous factors in relation to flowering would be beneficial in adapting the practical work in the orchard for better production of this 'Chanee' durian in the future.

CONCLUSION

The study of using paclobutrazol applying as foliar spray to durian trees cv. Chanee can be concluded as follows :

1. Paclobutrazol did not have any influence on flower emergence.
2. Paclobutrazol treated trees had higher flowering intensity than those of the control one.
3. Paclobutrazol did not have any effect on the yield and number of fruits retained in the tree at harvest.
4. Fruits from the paclobutrazol treated tree were smaller and had shorter fruit stalk than those of the control one.
5. Paclobutrazol did not have any effect either on the number of harvest or the duration of harvest.
6. Paclobutrazol did not have any influence on total soluble solids, flesh firmness and flesh color of the fruits at harvest.

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LITERATURE CITED

Anonymous. 1996. Statistics of Fruit Crop Production in 1993. Division of Planning, Department of Agricultural Extension, Thailand. 367 p.

Chaitrakulsub, T., S. Subhadrabandhu, T. Powsung, R. Ogata, and H. Gemma. 1992. Effect of paclobutrazol on vegetative growth, flowering, fruit set, fruit drop, fruit quality and yield of lychee cv. Hong Huay. Acta Horticulturae 321 : 291-299.

Kitinunprakorn, P. and S. Subhadrabandhu. 1988. Effect of daminozide on total nonstructural carbohydrates, total nitrogen contents in leaves and stem apexes in relation to flowering ability of tangerine (*Citrus reticulata* Blanco) cv. Khiew-Waan, Kasetsart J. (Nat Sci.) 22 : 152-156.

Subhadrabandhu, S., K. Iamsub, and I. Kataoka.

1998. Methods of paclobutrazol application to mango and its residual effect in leaf and orchard soil. Submitted to Japan J. Trop. Agr.

Tongumpai, P., K. Jutamanee, and S. Subhadrabandhu. 1991. Effect of paclobutrazol on flowering of mango cv. Khiew Sawoey. Acta Horticulturae 291 : 67-70.

Tongumpai, P., N. Hongsbhanich, and C.H. Voon. 1989. Cultar for flowering regulation of mango in Thailand. Acta Horticulturae 239 : 375-378.

Trade Statistics Center. 1990. Exporting Goods Based on Commodities. Department of Business Economics. Bangkok. 294 p.

Voon, C.H., C. Pitakpaivan, and S.J. Tan. 1991. Mango cropping manipulation with Cultar. Acta Horticulturae 291 : 219-228.

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