ROOTING OF *CLERODENDRUM THOMSONIAE* CUTTINGS AS AFFECTED BY PACLOBUTRAZOL AND ROOTING HORMONES

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Abstract. The positive effect of a five min immersion in an IBA-containing solution on the number of roots formed on *Clerodendrum thomsoniae* Balf cuttings was greatly enhanced by paclobutrazol (PP333). Little was gained from the addition of IAA to an immersion solution containing both PP333 and IBA PP333 alone did not significantly promote root formation, but caused a decrease in mean root length and an increase in root diameter

REVIEW OF LITERATURE

Paclobutrazol (PP333, active ingredient ([2RS, 3RS] -1- [4-chlorophenyl] -4- 4-dimethyl-2-1, 4-triazol-yl-pentan-3-ol]) is an anti-gibberellin-like growth retardant which has been used successfully for height control on a wide range of ornamentals (5,9). It can be applied either as a foliar spray or as a soil drench. Substrate drenches with growth retardants are often preferred to foliar sprays since the former are more precise and their effectiveness is less influenced by environmental factors (13). Lack of uniform coverage, phytotoxicity, and the need for multiple applications are generally regarded as the major shortcomings of foliar sprays. Nevertheless, foliar applications are still widely used commercially because of their relative ease of application and the reduced labour required (12,13).

Attempts have been made to achieve sufficient growth inhibition by pre-plant treatments with growth retardants other than PP333 (8,10). Large numbers of rooted or unrooted cuttings could be quickly and conveniently treated prior to planting by immersing or soaking them in a solution of growth retardant, thereby eliminating the need for post-plant sprays or drenches. Preliminary experiments (unpublished) demonstrated the potential of pre-plant treatment of *C. thomsoniae* with PP333 as an alternative to conventional application methods. The results of these experiments also indicated a positive effect of the growth retardant on subsequent rooting.

These results are similar to those obtained by other workers. In hypocotyl cuttings of *Phaseolus vulgaris*, PP333 greatly increased the number of roots formed (14). This growth retardant also promoted root formation on cuttings of *Coleus blumei*, *Plectranthus australis*, *Prunus laurocerasus*, *Salix discolor*, and *Vitis labrusca* (3,4). In these experiments relatively low concentrations of growth retardant were used compared to those required to induce residual effects on subsequent vegetative and generative development. Rooting may be further improved by higher concentrations of growth retardent alone or in combination with rooting hormones.

The use of auxins in vegetative propagation is well established. Van Bragt, *et al.* (15) obtained a higher percentage of rooted cuttings of several ornamental species after immersion of the cuttings in an auxin-containing solution than after dipping the basal part of the cuttings in a powder mixture containing auxin.

Since positive effects on rooting would be an important added value of pre-plant treatments of ornamentals with growth retardants, it is necessary to quantify the effects of PP333 on root formation of cuttings and to test the hypothesis that further improvement of rooting can be obtained by applying the growth retardant in combination with one or more rooting hormones.

In previous experiments (unpublished) *C. thomsoniae* has been shown to respond greatly to post-plant treatments with PP333. Because of these clear responses, involving both height reduction and an increase in flowering, *C. thomsoniae* was used as a test plant in the present study.

MATERIALS AND METHODS

On December 20, 1989, internodal cuttings, each consisting of one leaf pair, attached to a stem piece (approximately 7cm) were harvested from *C. thomsoniae* stock plants. Upon harvest the cuttings were immersed in one of 26 solutions, containing 0 or 1.2 mmol/l PP333; 0, 0.4, 1.0, 2.0 or 4.0 mmol/l IBA; and 0, 0.4, 1.0, 2.0, or 4.0 mmol/l IAA. Only equimolar combinations of IBA and IAA were included. Both auxins were applied in the form of their water soluble ammonium salts. Application of PP333 was as an aqueous suspension of Cultar (7). The control treatment consisted of an immersion in distilled water Tween 20 (1.5 ml/l) was added to all solutions.

The experiment was set up according to a randomised complete block design, with eighteen cuttings per treatment and three blocks. Six cuttings at a time were immersed for 5 min. in 500ml of the appropriate treatment solution. After immersion the cuttings were left to dry on tissue paper before planting them into individual pots using a pumice. peat mix (2:1 v/v) and placing them under a closed misting system.

After three weeks the number of roots, their length, and root dry weight were recorded for each cutting. Mean root lengths were calculated by dividing the total root length by the number of roots. Means were separated using the least significant difference test with $p = 0.05$ after analysis of variance.

RESULTS

Rooting was significantly improved by prior treatment of unrooted cuttings with a solution containing 1.0, 2.0, or 4.0 mmol/l IBA (Table 1). Further increase in the number of roots was obtained with the addition of 1.2 mmol/l PP333 to an IBA-containing solution. The growth retardant alone did not significantly promote root initiation.

Table 1. Effects of PP333 and IBA on rooting of *C thomsoniae* cuttings Different letters within columns are comparable across all three tables and designate significant differences Data are means with standard deviations in brackets

Immersion solution mmol/l		Number of roots per cutting	Root length (mm)	Root dry weight (mg/mm)
PP333	IBA			
0	0	6 0 k (2 5)	42 1 bc (13 8)	7 4 fghi (1 3)
1 2	0	10 3 jk (8 3)	30 6 fghi (5 6)	8 8 j (2 4)
0	0 4	11 9 ijk (4 5)	52 0 a (9 9)	7 1 cdefgh (0 7)
1 2	0 4	30 5 cd (10 8)	28 4 ghi (8 8)	7 5 fghi (1 2)
0	1 0	17 4 gh (5 5)	46 3 ab (10 3)	8 0 ghij (0 9)
1 2	1 0	34 4 bc (12 1)	34 3 defg (8 3)	6 0 abcde (0 9)
0	2 0	20 3 fgh (7 7)	51 1 a (9 3)	7 2 defgh (1 0)
1 2	2 0	40 4 b (15 3)	28 2 hi (6 0)	5 1 a (1 0)
0	4 0	34 1 bc (15 6)	51 7 a (9 7)	5 9 abc (1 1)
1 2	4 0	47 0 a (21 8)	24 7 i (5 2)	5 8 abc (0 6)

Immersion in a solution containing 0.4, 2.0, or 4.0 mmol/l IBA caused a significant increase in the average root length PP333 alone, or in combination with IBA, reduced the average root length.

Root dry weight/mm was relatively unaffected by IBA PP333 by itself increased root dry weight/mm, reflecting a larger root diameter. Application of both IBA and PP333 generally resulted in decreased root dry weights/mm compared to the control

Immersion of *C. thomsoniae* cuttings in a solution of IAA prior to planting had little effect on rooting (Table 2). When applied in combination with PP333 a higher number of roots per cutting than for the controls was obtained only with 4 0 mmol/l IAA The effect of PP333 on the average length per root was not altered by the addition of IAA The increase in root dry weight/mm caused by PP333 was counteracted by simultaneous treatment with IAA.

Table 2. Effects of PP333 and IAA on rooting of *C thomsoniae* cuttings Different letters within columns are comparable across all three tables and designate significant differences Data are means with standard deviations in brackets

Immersion solution mmol l		Number of roots per cutting	Root length (mm)	Root dry weight (mg/mm)
PP333	IAA			
0	0	6 0 k (2 5)	42 1 bc (13 8)	7 4 fghi (1 3)
1 2	0	10 3 jk (8 3)	30 6 fghi (5 6)	8 8 j (2 4)
0	0 4	8 4 jk (2 7)	42 7 bc (9 7)	7 4 fghi (1 1)
1 2	0 4	9 6 jk (7 4)	30 7 fghi (8 8)	8 5 ij (1 6)
0	1 0	5 6 k (3 2)	38 0 cde (15 0)	7 4 fghi (1 6)
1 2	1 0	9 5 jk (6 1)	25 7 i (6 1)	7 2 efgh (4 4)
0	2 0	7 9 jk (3 7)	47 6 ab (15 6)	7 3 fghi (1 1)
1 2	2 0	11 4 ijk (13 3)	29 0 fghi (8 3)	8 3 hij (6 4)
0	4 0	13 7 ij (8 2)	45 0 b (13 6)	7.7 ghij (1 0)
1 2	4 0	21 9 fg (13 6)	30 4 fghi (6 8)	6 2 abcdef (1 2)

The positive effect of PP333 in combination with IBA on the number of roots was enhanced with 1.0 or 2.0 mmol/l IAA (Table 1 and 3)

Table 3. Effects of PP333, IAA, and IBA on rooting of *C thomsoniae* cuttings Different letters within columns are comparable across all three tables and designate significant differences Data are means with standard deviations in brackets

Immersion solution mmol/l			Number of roots per cutting	Root length (mm)	Root dry weight (mg/mm)
PP333	IBA	IAA			
0	0	0	6 0 k (2 5)	42 1 bc (13 8)	7 4 fghi (1 3)
1 2	0	0	10 3 jk (8 3)	30 6 fghi (5 6)	8 8 j (2 4)
0	0 4	0 4	13 9 hij (5 5)	51 4 a (11 2)	8 0 ghij (1 2)
1 2	0 4	0 4	36 2 bc (11 7)	38 5 cd (7 4)	5 9 abcd (1 0)
0	1 0	1 0	22 3 fg (12 0)	51 3 a (7 7)	7 5 ghij (1 4)
1 2	1 0	1 0	47 2 a (13 9)	34 7 def (8 0)	6 2 abcdef (1 4)
0	2 0	2 0	23 7 ef (9 1)	51 1 a (9 9)	7 1 cdefgh (1 5)
1 2	2 0	2 0	48 0 a (17 1)	32 4 efgh (11 5)	5 4 a (1 2)
0	4 0	4 0	29 5 de (13 7)	47 9 ab (8 9)	6 8 bcdefg (1 5)
1 2	4 0	4 0	50 7 a (17 6)	26 2 i (7 9)	5 6 ab (1 4)

Few significant differences were found between cuttings which had been immersed in a solution containing IBA and PP333 and those which had been treated with both auxins as well as PP333. An immersion solution containing both IBA and IAA had no significant effect on root dry weight per mm, but addition of PP333 caused a reduction of root dry weight/mm compared to the control.

DISCUSSION

The growth retardant PP333 and IBA synergistically increased the number of roots formed on *C. thomsoniae* cuttings. Further increase was obtained with the addition of IAA, but only when applied in a concentration of 1.0 or 2.0 mmol/l.

PP333 by itself did not significantly promote rooting. Davis, *et al.* (3,4) demonstrated a positive effect of PP333 on rooting depending upon the species. They suggested that the lack of response of cuttings from some species may be due to insufficient uptake. In the case of *C. thomsoniae* this is not likely since PP333 did significantly affect other rooting parameters.

The roots on PP333-treated cuttings were shorter and thicker than those on controls. Similar effects were reported for other species (1,3,4,11). The advantage a sturdier root system may have in facilitating transplanting of rooted cuttings was lost when cuttings were treated with IBA as well as PP333.

The mode by which PP333 influences root initiation and development is not known, but may be related to its anti-gibberellin activity (3,4,14). The application of gibberellins to cuttings generally inhibits rooting (2,6) In the present study PP333 may have altered the root system by reducing the endogenous gibberellin levels, which were apparently low enough not to inhibit adventitious root initiation.

Further research will be necessary to investigate the interaction between PP333 and IBA. Results of the present study show similarities with those resulting from work done by Kefford (6), who obtained a higher number of roots after treatment with both auxin and the gibberellin antagonist, EL 531, than after treatment with only EL 531 or auxin by itself.

The obvious potential of PP333 in combination with IBA in enhancing root initiation holds promise not only with respect to pre-plant treatment of plants which require height control but also for species which are difficult to propagate vegetatively.

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