Use of Low Concentration NAA Sprays to Suppress Sprouting on Rootstocks

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Scions of both a variegated cultivar of *Agonis flexuosa* [Willd.] Sweet 'Pied Piper' on seedling rootstocks and *Hakea francisiana* F. Muell. on seedling *Hakea salicifolia* (Vent.) B.L. Burtt rootstocks are rapidly overgrown by rootstock sprouts if no control measures are taken. Naphthaleneacetic acid (NAA) sprays have been used to impose sprout control in rootstocks. Due to phytotoxicity on the scion of single, high-concentration NAA sprays, the time of application, frequency and concentration of multiple low concentration NAA sprays have been investigated. For grafted *A. flexuosa* weekly 100 mg litre-1 NAA sprays to rootstock tissue only reduced sprouting without significant reduction in scion growth. Repeated pre-graft sprays of 200 mg litre-1 NAA three times per week for 2 weeks initially reduced stock sprouting but this effect was lost by 7 weeks. Post-graft NAA sprays (100 mg litre-1) significantly reduced sprout length for the duration of the experiment. There was large variability in scion growth and budburst. NAA sprays at the above pre- and post-graft concentrations and frequencies could not be recommended due to the high level of bud dormancy or death in these scions compared with control scions which all sprouted. *Hakea salicifolia* stocks, treated with the same pre-graft and post-graft spray regimes as *A. flexuosa,* showed total stock sprout control without stock phytotoxicity if post-graft sprays were applied. Pre-graft sprays, either separately or in combination with post-graft sprays, gave phytotoxic stock responses of callusing and leaf necrosis. The combined sprays controlled all stock sprouting but the pre-graft sprays only reduced sprout growth to half of that of the control. Dormant hardwood scions of *H. francisiana* did not burst during this 9-week experiment.

INTRODUCTION

Rootstock sprouting is a major problem with grafted plants in commercial nurseries necessitating costly hand removal of sprouts. Sprouting is thought to be caused by loss of inhibitory effects of auxins which originate in the apex (Yang et al., 1992). Sprout control strategies have aimed to replace this through application of synthetic auxin analogues such as NAA as a single high-concentration (0.5% to 8%) spray (Boswell and Nauer, 1979; Morris and Cawthon, 1981). These treatments have caused inhibition or death of scions when sprayed on a number of species (Boswell et al., 1979; Nauer and Boswell, 1978; Nauer et al., 1978). Investigations of low-concentration NAA spray applications aimed to achieve rootstock sprout control with *A. flexuosa* grafted with the variegated cultivar *A. flexuosa* 'Pied Piper'. This attractive weeping cultivar is difficult to propagate from cuttings. *Hakea francisiana* F. Muell., a small tree with spectacular flowers, is difficult to grow in eastern Australia due to its intolerance of heavy soils. McKenzie

(1994) reported that this species was propagated commercially using seedling scions grafted onto seedling *H. salicifolia* at the cotyledon stage to minimise rootstock sprouts. I have also tested low-concentration NAA sprays for suppression of rootstock sprouts in this *Hakea* combination. Grant and Loveys (1996) showed that CO_2 enrichment of the fog environment improved scion growth of *A. flexuosa* 'Pied Piper' compared with ambient fog conditions but the expected reduction in transpiration or improved carbohydrate status (Grant et al., 1992) did not lead to superior grafting success. For this environment they showed that weekly rootstock sprays of 50 to 100 mg litre^{-1} NAA controlled sprouting without adversely affecting the scion. Clonal cutting-derived stocks eliminated the problem of lignotuber tissue which was prone to epicormic bud sprouting. It was thus possible to select clonal stocks for reduced sprouting in combination with NAA sprays (Grant and Loveys, unpublished). The effect of rootstock pre-graft and post-graft NAA sprays needs further investigation. These experiments investigate the timing and frequency of NAA sprays for both *Agonis* and *Hakea* sprout control.

MATERIALS AND METHODS

Plant materials and methods used are described by Grant and Loveys (1996). Briefly, seedling and cutting *A. flexuosa* and seedling *H. salicifolia* stocks were grafted with 1- to 2-mm or 2- to 3-mm diameter micro-wedge grafts, respectively. Both scions were two nodes with leaf blades trimmed in half. All 10 to 20 nodes below the graft were disbudded, leaving intact green leaves. *Agonis flexuosa* stocks and scions were soft to semi-hardwood and actively growing. *Hakea salicifolia* stocks were similar but *H. fancisiana* scions were semi-hardwood and dormant. All grafts were placed in a fog igloo maintained at 95% relative humidity. In the first *Agonis* experiment NAA was sprayed basipetally from below the graft with either 0 or 100 mg litre^{-1} NAA in 5% ethanol. In the second and third experiment with *A. flexuosa* and *H. salicifolia,* half the stocks were initially pruned of all lateral shoots/buds prior to spraying with NAA. After grafting half of these pre-graft NAA plants were not sprayed again while the other half pre- and post-graft NAA plants were sprayed with 100 mg litre^{-1} NAA. The unpruned and unsprayed stocks were grafted having removed lateral shoots and buds, then half were left as unsprayed controls while the rest were sprayed with NAA (post-graft). Scion and/or sprout lengths, including all lateral shoot lengths, were measured and records were made of scion death, bud dormancy, and sprouting. Data was analysed by analysis of variance, Welch's test, or the Mann Whitney test.

RESULTS

Weekly applications of 100 mg litre^{-1} NAA to *A. flexuosa* rootstock tissue, from the time of grafting reduced mean sprout lengths to 11% of control plants by Day 57, whereas treated scion lengths were not significantly different to the control during this period (Table 1).

TABLE 1. The effect of 100 mg litre^{-1} NAA sprays on scion and sprout lengths of grafted variegated *Agonis flexuosa*. 'Pied Piper'.

Treatment	Scion length	Sprout length
Control	1275.7 a	447.0 b
NAA	227.0 a	50.7 c

Note: Plants were measured after 57 days in fog propagation conditions. NAA sprays commenced within 24 h of grafting and were repeated weekly. Data represent the mean of 10 replicates. Values within each column followed by the same letter were not significantly different at $P<0.05$ measured by students t test.

Further treatments tested an increased frequency of NAA application prior to and/or after grafting, in combination with pre-graft pruning of all stock lateral shoots and buds just prior to initial spray application (Table 2). At Day 22 scion lengths were the same for all treatments but both post-graft NAA treatments were controlling sprout growth to less than 3 mm and were significantly less than both the pre-graft NAA treatment and the control. Controls showed no sprout inhibition and were greater than the pre-graft NAA which retained some residual sprout inhibition. Day 48 was similar except that the residual sprout inhibition for the NAA pre-treated control was declining from 24% of control sprout length at Day 22 to 54% of control at Day 48 (Table 2).

TABLE 2. The effect of repeated rootstock 200 mg litre^{-1} pre-graft and/or 100 mg litre^{-1} post-graft NAA sprays on scion and sprout lengths and percent scion sprouting, dormancy, or death of grafted *Agorlis flexuosa* 'Pied Piper'.

	Day 22		Day 48		Day 48		Scion
Treatment	Scion length (mm)	Sprout length (mm)	Scion length (mm)	Sprout length (mm)	Sprout (%)	Dormant (%)	Dead (%)
Control	2.6 a	387.0 a	49.3 a	781.0 a	100	0.0	0.0
Pre-graft NAA	3.9 a	91.0 b	69.6 a	424.0 a	56	22	22
Post-graft NAA	1.1 a	2.9 c	13.6 a	7.1 b	29	71	0.0
Pre-/post-graft NAA	0.4 a	1.8 c	20.3 a	2.9 b	22	56	22

Note: Plants were measured after 22 and 48 days in fog propagation conditions. Pre-graft sprays (six) commenced 13 days prior to grafting and post-graft sprays within 24 hours of grafting and were repeated 10 times in 25 days, then weekly. Data represent the mean of seven or nine replicates. Values within each column followed by the same letter were not significantly different at $P<0.05$ measured by analysis of variance and the Mann-Whitney test.

Control *H. salicifolia* rootstocks sprouted within 2 weeks of grafting (Table 3). If six 200 mg litre^{-1} NAA spray treatments were given only prior to grafting the upper stock leaves showed some necrosis and stock sprouting was largely inhibited over 38 days. When 100 mg litre^{-1} NAA post-graft sprays were continued in conjunction with pre-graft sprays then sprouts were controlled but necrosis was more extensive and callusing occurred at each leaf axil. If post-graft sprays were used alone then necrosis was avoided but stock sprouts were still fully controlled (Table 3). Scions remained dormant during the course of the experiment.

TABLE 3. The effect of repeated 200 mg litre^{-1} pre-graft and/or 100 mg litre^{-1} post-graft NAA sprays on sprout lengths of *Hakea salicifolia* seedling rootstocks grafted with *H. francisiana* scions.

Sprout length (mm)	Day 16	Day 24	Day 38	Day 64
Control	6.8 a	97.8 a	470.0 a	626 a
Pre-graft	0.0 b	6.0 b	70.0 b#	288 b
Post-graft	0.0 b	0.0 c	0.0 c	0 c
Pre-/post-graft NAA	0.0 b	0.0 c+	0.0 c+#	0 c

Note: + = callus, # = necrosis. Plants were measured after 16, 24, 38 and 64 days in fog propagation conditions. Pre-graft sprays (six) commenced 13 days prior to grafting and post-graft sprays within 24 h of grafting and were repeated 10 times in 25 days, then weekly. Data represent the mean of four replicates. Values within each column followed by the same letter were not significantly different at $P<0.05$ measured by Welch's test and analysis of variance.

DISCUSSION

In the second experiment both post-graft and pre- and post-graft NAA applications were very effective for sprout control but could not be recommended due to the high level of inhibition and death of scions. It would appear that 10 post-graft 100 mg litre^{-1} NAA spray treatments in 25 days were most likely responsible for the high level of scion bud dormancy and death (Table 2). All repeated NAA treatments caused some scion death and/or bud dormancy in Experiment 2, probably due to translocated NAA. The cumulative effect of these repeated sprays was similar in damage to the sum of the active ingredient sprayed only once such as for avocado (Boswell et al., 1979) and valencia orange (Nauer and Boswell, 1978) where scion death or bud dormancy resulted. Further testing should either reduce the NAA concentration (e.g. 50 to 100 mg litre^{-1} NAA) or the frequency of application. The optimum concentration and frequency should aim to simulate the lost endogenous auxin production until scion growth achieves sprout suppression via apical dominance. Actively growing semi-hardwood *H. francisiana* scionwood was not available so dormant hardwood scions were used instead. This was probably the reason for lack of scion growth in both treated and control plants which is similar to observations by Grant and Loveys (1996) for dormant *A. flexuosa* scions. Despite this lack of scion growth and the consequent reduction in endogenous auxin production (Yang et al., 1992), NAA sprays maintained control of sprouts for the

9-week duration of the experiment. This result should allow *H. francisiana* cultivars, rather than seedlings as described by McKenzie (1994), to be grafted onto *H. salicifolia* seedling rootstocks without uncontrollable sprouting. An obvious benefit would be that superior forms could be propagated readily and they would flower years before the seedling scion material. Beardsell et al. (1993) described the need for effective means of vegetative propagation as a major obstacle to the availability of superior selections of Australian native trees. The above methods can be used to rapidly propagate such clones.

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