Effect of imidacloprid on the growth of *Eucalyptus nitens* seedlings

Marina Hurley[1,2] and Vin Patel[3]

[1]School of Agricultural Science, Box 252–254, University of Tasmania, Hobart, Tasmania 7001, Australia
[2]Current address: School of Resource Management, Institute of Land and Food Resources,
University of Melbourne, Victoria 3010, Australia
Email: mhurley@unimelb.edu.au
[3]Co-operative Research Centre for Sustainable Production Forestry, Box 252–12, University of Tasmania, Hobart, Tasmania 7001, Australia

Revised manuscript received 12 August 2002

Summary

Imidacloprid is currently being investigated as a control mechanism to prevent seedling defoliation by endemic Melolonthine scarab beetles in Tasmania. A trial to test any phytotoxic effects found a significant reduction in growth of *Eucalyptus nitens* seedlings following the application of imidacloprid as a root drench at medium and high concentrations. Compared to untreated seedlings, those treated with 50 mL L^{-1} suffered a 13% reduction in growth and at 15 mL L^{-1} the reduction was 8%. As eucalypt seedlings are particularly vulnerable to damage by insects and mammals within 12 months of planting, the cost of reducing their growth by use of imidacloprid should be considered when developing a strategy for pest control.

Keywords: insecticides; imidacloprid; seedling growth; *Eucalyptus nitens*

Introduction

Newly-established eucalypt plantations in northern Tasmania are prone to attack by the Melolonthine scarab beetles *Heteronyx crinitus* Blackburn and *Heteronyx dimidiata* (Erichson). The forestry industry is estimated to lose up to $1 million per annum due to these beetles (D. de Little, *pers. comm.*). Damage can occur at any time from late spring to early winter. However, as seedlings are often decimated within days of being planted, control is necessary as soon as the seedlings are planted. *Eucalyptus nitens* are especially susceptible to *Heteronyx* damage within the first year of planting; seedlings that escape damage during this period are likely to withstand future damage from insects or browsing mammals (Simmul *et al.* 2000; C. McArthur *pers. comm.*).

Imidacloprid has been investigated as a suitable insecticide to protect *E. nitens* seedlings from attack by *Heteronyx* spp. (Blaesing and Gee 1998; Brown 1999). Advantages of imidacloprid are low toxicity to vertebrates, low application rates, long systemic persistence in plants and rapid degradation in the soil (Koppenhofer and Kaya 1998), and it is effective in reducing damage from both *H. dimidiata* and *H. crinitus* (Blaesing and Gee 1998). Imidacloprid affects insects through contact and ingestion, and it kills by disrupting the nervous system (Lagadic *et al*. 1993). With imidacloprid applied as a root drench to potted seedlings, in glasshouse conditions, the LD_{50} of *Heteronyx dimidiata* feeding on *E. nitens* was 0.84 mL L^{-1} (Brown 1999). In the field, however, higher concentrations are necessary to withstand vagaries of weather and to protect seedlings for the duration of the growing season. Application of imidacloprid (Confidor®) at 15 mL L^{-1} to planted seedlings was recommended to effectively control African black beetle (*Heteronychus arator*) feeding on *E. globulus* (J. Matthiessen, CSIRO, *pers. comm.*). Application of 1000 mL Confidor® at 13.4 mL L^{-1} to 100 *E. nitens* potted seedlings gave better protection from *Heteronyx* damage than 6.7 mL L^{-1}, during a three-month field trial. As most chemicals have toxic effects on biological systems, and it is important that insecticides have minimal phytotoxic properties, the aim of this study was to investigate the effect of medium (15 mL L^{-1}) and high (50 mL L^{-1}) concentrations of imidacloprid (Confidor 350C®) on the growth of *E. nitens* seedlings.

Methods

One hundred and twenty *Eucalyptus nitens* nursery-reared seedlings were used to test the effect of imidacloprid on growth rate. The seedlings were eight weeks old with an average height of 28.6 cm (se = ±0.4). To simulate field exposure, the experiment was conducted on potted plants in an open shadehouse at the CRC for Sustainable Production Forestry research station, University of Tasmania, Hobart. Initially the seedlings were left unwatered for two days to improve absorption of the drench. It was established that 10 mL of solution was necessary to saturate the dry rootball. Therefore 10 mL of Confidor 350C® insecticide solution was applied to the rootball of each seedling using a pipette. The plants were then left unwatered for 24 h to facilitate uptake of the solution. Forty seedlings were treated with 15 mL L^{-1} imidacloprid, 40 seedlings with 50 mL L^{-1} imidacloprid and 40 seedlings were left untreated as control. Seedling heights were measured before application of insecticide on 1 December 1998 and on completion of the experiment on 7 May 1999. Growth increments (increase in height) were $\log_{10}$ transformed to ensure homogeneity of variances, and analysed by one-way analysis of variance.

Table 1. Growth of *Eucalyptus nitens* seedlings following imidacloprid treatment (*n* is number of seedlings per treatment)

	Imidacloprid treatment (n = 40)		
	50 mL L^{-1}	15 mL L^{-1}	Control
Initial height (cm) ± se, 12 January 1998	30.3 ±0.7	27.7 ±0.6	28.0 ±0.6
Final height (cm) ± se, 5 July 1998	67.9 ±1.8	67.7 ±1.8	73.9 ±1.5
Net growth (cm) ± se	37.6 ±1.7	40.0 ±1.9	45.9 ±1.4
Growth as a fraction of original height (%)	124	145	164
Loss in potential growth (%)	18	13	

Results

Damage by feeding insects was minimal during the experiment. Very small amounts of weevil damage were recorded on three individual plants in the high treatment and none on the medium or control seedlings. There were no visible signs of necrosis or stunted development. Growth increments differed significantly between treatments ($F_{3.70}$ = 3.70; P = 0.028). Seedlings treated at 50 mL L^{-1} grew an average of 37.6 cm (se = 1.7), that is 124% of their original height; seedlings treated at 15 mL L^{-1} grew an average of 40.0 cm (se = 1.9) or 144% of their original height; and untreated seedlings grew an average of 45.9 cm (se = 1.4) or 164% of their original height (Table 1). Root drenching with imidacloprid at concentrations of 50 mL L^{-1} and 15 mL L^{-1} caused an average reduction in height growth of 18% (8.3 cm) and 13% (5.9 cm), respectively, compared to untreated seedlings.

Discussion

Seedlings are most susceptible to damage by *Heteronyx* spp. within 12 months of transplanting, and small seedlings are also particularly vulnerable to browsing by mammals during this time. An earlier field trial evaluating the efficacy of insecticides in controlling *Heteronyx* sp. feeding on *E. nitens* found that unprotected seedlings grew an average of 5.8 cm (a 35% increase in height); seedlings treated with 6.7 mL L^{-1} of imidacloprid (Confidor 350C®) (average 10 mL application of solution per plant) grew an average of 9.1 cm (55% increase in height); while seedlings treated with 13.4 mL grew an average of 15.0 cm (91% increase in height) (Blaesing and Gee 1998). While the higher concentration of imidacloprid clearly gives better protection against damage from feeding by *Heteronyx*, the current study shows that seedlings will also suffer phytotoxicity at these concentrations. If conditions for seedling growth are not optimal, treatment with high concentrations of imidacloprid may further retard seedling development during the initial establishment phase and maintain seedling vulnerability to pest damage into a second growing season. The likelihood or risk of significant insect damage occurring in a particular area needs to be weighed against the economic and environmental costs of using imidacloprid to protect *E. nitens* seedlings against that damage. The reduction in seedling growth needs to be included in the overall economic costs, as well as the cost (risk) of increasing the time that seedlings are at smaller sizes.

References

Blaesing, D. and Gee, C. (1998) Control of *Heteronyx* sp. foraging on *Eucalyptus nitens* seedlings. Serve-Ag Research report for North Eucalypt Technologies, 3 September 1998, 29 pp.

Brown, G. (1999) Preliminary investigations into *Heteronyx* spp. Honours thesis, School of Agricultural Science, University of Tasmania, Hobart.

Koppenhofer, A.M. and Kaya, H.K. (1998) Synergism of imidacloprid and an entomopathogenic nematode: a novel approach to white grub (Coleoptera: Scarabaeidae) control in turfgrass. *Journal of Economic Entomology* **91,** 618–623.

Lagadic, L., Ludovic, B. and Leicht, W. (1993) Topical and oral activities of imidacloprid and cyfluthrin against susceptible laboratory strains of *Heliothis virescens* and *Spodoptera littoralis*. *Pesticide Science* **38,** 29–34.

Simmul, T., Mathiessen, J. and Hurley, M. (2000) *Initiating Systematic Investigation of the Biology and Management of Establishment Insect Pests in Eucalyptus Plantations — Linking Western Australia and Tasmania*. CRC for Sustainable Production Forestry. Technical Report No. 35.