The use of a systemic insecticide to control defoliating insects on *Eucalyptus nitens* (Deane and Maiden) Maiden

F.C. Hand[1], N.G. Ramsden[1,2] and M.W. Moncur[1]
[1] CSIRO, Division of Forestry
Locked Bag No. 2,
Post Office Sandy Bay, Tasmania 7005
[2] Present address: Forestry Tasmania, Hobart
[3] CSIRO, Division of Forestry
PO Box 4008
Canberra, ACT

Abstract

A trial was undertaken to investigate the effectiveness of a systemic insecticide in limiting the impact of defoliating insects on floral development in Eucalyptus nitens *plantations. Stem injection treatment with monocrotophos resulted in more than three times as many flower buds on treated trees as on untreated control trees at some sites. However, defoliation scores across all sites before and after treatment were the same for treated and untreated trees. Spectacular reduction in defoliation from the large green sawfly* (Perga affinis insularis) *occurred at one site.*

Introduction

Eucalypts in Tasmania may be directly defoliated by a range of specialised leaf-eating insects including chrysomelid beetles, sawflies, weevils, scarabs, caterpillars and leaf miners (Elliott and de Little 1984). These insects can affect wood production, limiting the quality and quantity of wood harvested from intensively managed plantations, and repeated heavy foliage losses can lead to tree death. These insects can also affect other aspects of forest biology. For example, reproductive failure in eucalypts has paralleled observations of large leaf beetle (*Chrysophtharta* spp.) and scarab (*Heteronyx* sp.) populations (D. de Little, pers. comm.).

Insect attack is often highly irregular between years and between sites, but damage to eucalypts from leaf beetles is common and often severe. An integrated pest management system has been developed by Elliott *et al.* (1992) to reduce damage from the eucalypt leaf beetle, *Chrysophtharta bimaculata*, in eucalypt plantations. Weekly monitoring of egg and larval levels in *C. bimaculata* populations through late spring and summer provides information on the activity of this pest's major natural enemies, and determines whether spraying with specific insecticides should follow.

In some situations, such as high-value eucalypt seed orchards or experimental plantings monitored for floral development, even low levels of defoliation may be unacceptable. In these situations, the use of systemic insecticides injected into tree stems has the potential to provide some protection against damaging insects.

In a Tasmania-wide survey of seed production sites for *Eucalyptus nitens* (Moncur *et al.* 1994), protecting flower buds from random attack was seen as worth attempting. This paper reports on the use of a systemic insecticide introduced into xylem tissues of planted eucalypts in spring 1991. Flowering, fruiting and foliation were assessed before and after this treatment to determine its effectiveness.

Methods

Eighteen sites used for studies of floral development in *E. nitens* were available for treatment with the systemic insecticide. Edge-trees had been selected, starting with a co-dominant and continuing with selection of these or larger trees. Site details are presented in Table 1.

Thirty trees were used at most sites. The treated trees included five with the largest flower-bud crops which had been selected in autumn 1991 for detailed floral development studies. Five untreated control trees were randomly selected from other trees at the site, after which the balance of 'treated' trees were chosen. Stems were injected with insecticide between late September and early November 1991. Sites were treated sequentially with increasing altitude. Ten were treated between 10.45 and 14.50 hours in an attempt to ensure maximum transpiration rates for insecticide uptake. Logistics caused treatment times, averaging nearly two hours, to start on other sites as early as 09.35 hours and finish as late as 17.30 hours.

The insecticide used was Nuvacron 400 (CIBA-GEIGY Australia Ltd), containing 400 g/l monocrotophos as the active ingredient dissolved in 200 g/l dipropylene glycol monomethyl ether. It was deposited in the secondary xylem of treated trees, at breast height, using a punch technique adapted from Campbell (1990) and shown in Photo 1. A pilot trial indicated the spike holes would retain an average of only 0.88 ml of liquid each, so undiluted product was used. Dosage was adjusted to differing tree circumferences by spacing holes 4 cm apart; this resulted in 0.7 ml of Nuvacron being deposited for each centimetre of tree diameter. After injection of each tree, all damage was sealed to exclude disease, using a bitumen-based wound sealant (Loctite) from an aerosol canister.

Photo 1. Stem-injection method, showing the punch ready to be extracted (left), insecticide being delivered (right), and the sealed hole (centre).

Table 1. Locations, altitudes and tree ages for 18 sites receiving systemic insecticide treatment in 1991.

Site	Latitude	Longitude	Altitude (m)	Year planted	No. treated trees	No. control trees
Hastings	43°25'	146°54'	40	1980	25	5
Wesley Vale	41°11'	146°27'	42	1986	25	5
Woolnorth	40°49'	144°54'	55	1984	25	5
Esperance I	43°18'	146°55'	75	1983	20	5
Forth	41°11'	146°16'	80	1985	25	5
Kingston	42°58'	147°17'	100	1981	10	3
Creekton	43°24'	146°53'	120	1987	25	5
M-Greene	41°05'	145°54'	150	1986	25	5
Goulds	41°06'	148°07'	200	1984	25	5
Ross	41°59'	147°30'	220	1986/87	25	5
Mahnkens	41°12'	147°14'	235	1985	25	5
Esperance II	43°17'	146°52'	240	1983	25	5
Pecks	41°19'	147°19'	410	1981	25	5
Esperance III	43°15'	146°50'	430	1983	25	5
Hampshire	41°15'	145°47'	460	1984	25	5
Talbots	41°26'	145°43'	645	1984	25	5
Arve IV	43°11'	146°50'	650	1983	23	5
Camden	41°20'	147°24'	680	1984	25	5

Heights and stem diameters of all trees were measured before treatment in autumn 1991 and after treatment in spring 1992. Flower-bud numbers were counted in autumn and spring in 1991 and 1992. Levels of crown browsing were scored each autumn, using the system described by Raymond (1991) where defoliation scores 4, 3, 2 and 1 applied respectively to no defoliation, light defoliation, young leaves lost from the tip of the tree, and current leaves lost and twigs thickening. Two people took part in each scoring.

Flower-bud numbers were estimated on half of the tree crown, after examining the whole crown. A few groups of a suitable number of umbels (e.g. 1, 10, 100) were counted to establish the area covered by this quantity (which depended on the regularity of the umbels along the branch) and the average number of buds/umbel. From this information and from scanning the tree, an estimate was made of the size of half the crop. This figure was then multiplied by an estimated number of mean buds/umbel and doubled. Fruit sampling was for the main study only (Moncur *et al.* 1994).

Results

Stem injection with the systemic insecticide Nuvacron had no effect on mean heights, diameters or levels of tree defoliation when compared with untreated trees (Table 2). Some individual untreated trees were heavily defoliated (Photo 2) despite there being less overall defoliation damage on all sites but one in the year after treatment.

Total flower-bud production over all sites in 1992 was 17% greater than in 1991. It was at least twice that of 1991 among treated trees at five widely distributed plantations growing at altitudes of 55, 80, 120, 220 and 460 m (Figure 1). While untreated control trees also had more flower buds in 1992, the numbers on treated trees at these sites were 3.25 times greater than on untreated trees.

Table 2. Effect of insecticide treatment on tree height, diameter and level of defoliation at 18 locations in Tasmania. Ht = height (m); DBH = diameter at breast height (cm); Def = level of defoliation (see method of Raymond 1991). Superscripts indicate sampling times: 1 = autumn 1991; 2 = autumn 1992; 3 = spring 1992 (treated). Treated trees received insecticide in spring 1991. Figures in the body of the table are shown with standard errors.

Site	Treated						Untreated					
alt.(m)	Ht^1	Ht^3	DBH^1	DBH^3	Def^1	Def^2	Ht^1	Ht^3	DBH^1	DBH^3	Def^1	Def^2
40	6.5±0	6.5±0	14.7±1	18.8±1.1	2.5±0.1	3.3±0.1	6.5±0	6.5±0	14.4±2	18.6±2.4	3±0	4±0.3
42	6.5±0.2	8.2±0.3	7.8±0.4	13±0.7	2.8±0.1	3.6±0.1	6.3±0.3	8.2±0.7	7±0.4	11.9±0.8	2.8±0.4	3.6±0.3
55	9.4±0.2	11.9±0.2	14.1±0.4	20.1±0.6	3±0	3.9±0.1	10.2±0.4	12.7±0.5	14.2±0.7	20.7±1.1	2.8±0.2	4±0.3
75	9.8±0.4	11.6±0.4	13.2±0.6	16.6±0.9	2.5±0.1	2.4±0.1	10.4±0.7	11.2±0.4	14±1.2	16.6±2	2.2±0.2	2.4±0.3
80	9.9±0.2	12.7±0.3	13.9±0.5	23.4±0.8	3.1±0.1	3.6±0.1	9±0.7	10.9±1.4	11.4±1	20.4±1.8	3.2±0.4	3.8±0.3
100	9.4±0.5	10.3±0.5	18.7±1.2	29.1±1.9	3.2±0.1	3.8±0.1	10.3±0.2	11.2±0.4	19±2	26.5±1.7	3±0	3.3±0.4
120	6.7±0.2	10.4±0.2	9±0.4	13.6±0.5	2.9±0.1	3.5±0.1	6.2±0.6	9.4±0.5	7.8±1	12.6±1.3	3±0	3.4±0.3
150	8.6±0.3	10.6±0.4	16.4±0.6	24.4±0.9	2.2±0.1	2.8±0.1	9.1±0.5	10.9±0.8	16.2±1.1	23.7±1.7	2.2±0.4	2.8±0.3
200	11.1±0.7	14.4±0.6	14.6±1	21.7±1.1	3.1±0.1	3.7±0.1	11.6±1	14.7±1.4	18±2.3	24.3±2.4	3±0	3.4±0.3
220	5.8±0.2	7.8±0.2	8.6±0.6	14.5±0.5	3±0	3.9±0.1	5.9±0.2	7.9±0.5	7.6±0.7	14.6±1.1	3±0	4±0.3
235	10±0.3	13.2±0.4	11.4±0.6	16.7±0.8	2.6±0.1	3.1±0.1	9.8±0.7	12.8±0.8	10.8±1.7	15.8±2	2.6±0.2	2.6±0.3
240	10.5±0.4	12.5±0.5	14.4±0.6	17.8±0.8	2.9±0.1	3±0.1	10.8±1.3	13±1.5	14.4±2.9	17.5±2.2	2.8±0.2	2.8±0.3
410	10.7±0.4	13.1±0.5	15.6±0.7	19.7±0.8	2.3±0.1	3.9±0.1	11.6±1.3	14.2±1.9	16.2±3.4	20.6±4.3	2±0.4	3.6±0.3
430	7.5±0.5	9.6±0.6	11.5±0.7	13.4±1.1	2.7±0.1	2.8±0.1	6.7±0.6	9.2±1.3	10.6±1.7	11.7±2.5	2.4±0.2	2.6±0.2
460	7.3±0.2	10.2±0.7	13.8±0.6	20.7±1	1.6±0.1	3.8±0.1	7.8±0.5	11.8±1.3	16±1.2	24.7±2.9	2±0.4	3.6±0.2
645	7.2±0.3	9.9±0.5	9.6±0.6	14.7±0.8	2.6±0.1	3.8±0.1	7.2±0.5	9.6±0.8	10±1.6	14.3±2	2.8±0.2	4±0.2
650	9.8±0.4	12.5±0.5	17.1±0.8	19.5±0.9	3±0.1	3.1±0.1	10.2±0.9	13.4±1.2	17.2±2.2	22.1±2.7	3±0.3	3.2±0.2
680	11.8±0.3	14.7±0.4	17±0.8	21.3±0.8	1±0	3.6±0.1	11.6±0.8	14.5±1	15.6±1.5	19.8±1.8	1±0	3.6±0.2
Mean	8.8±0.12	11.1±0.15	13.1±0.21	18.4±0.28	2.6±0.03	3.4±0.03	8.9±0.27	11.2±0.34	13.2±0.52	18.5±0.67	2.6±0.08	3.4±0.08

Photo 2. Defoliation one year after a 1991 insecticide injection of most edge-trees at Wesley Vale, Tasmania. All within-stand crowns (untreated) and that of one edge-tree control fourth to the observer's right are leafless. The second edge-tree from the observer was also a control but suffered relatively little damage from insect attack.

Larval swarms of the large green sawfly (*Perga affinis insularis*) were observed at Wesley Vale in spring 1992 (42 m altitude) and all within-stand trees in this three-hectare planting had been severely defoliated (Photo 2). The 25 insecticide-treated trees were scored again on 6 January 1993, as were the next 25 untreated trees along the same border row; mean defoliation scores were 3.68 $\pm$ 0.56 and 1.92 $\pm$ 0.76 for treated and untreated trees respectively.

Discussion

Removal of new shoot growth can parallel losses of floral buds and thus potential seed yield, with long-term implications. Flowers of *E. nitens* open one year after they are first visible as buds in the axils of new leaves. Following pollination, a further year is required before seed is sufficiently mature for harvest. Given longer times to flowering in other commercial species, cessation of damage to new growth protects potential yield for the minimum of two years needed for any cycle of seed production. The increased number of flower buds on treated trees compared with untreated trees at some sites in this trial following stem injection with monocrotophos indicates that this technique can provide some protection against insect damage.

Spraying large trees evenly from the ground is difficult. Seed orchards are often isolated to avoid contamination from unwanted pollen sources and may be close to towns and power lines. In these instances, methods of spraying such as aerial or ground application pose problems which may be successfully overcome by stem-injection techniques.

Although the injection method described here was used to limit potential defoliation from chrysomelid attack, the damage conclusively controlled was browsing by larvae of the large green sawfly.

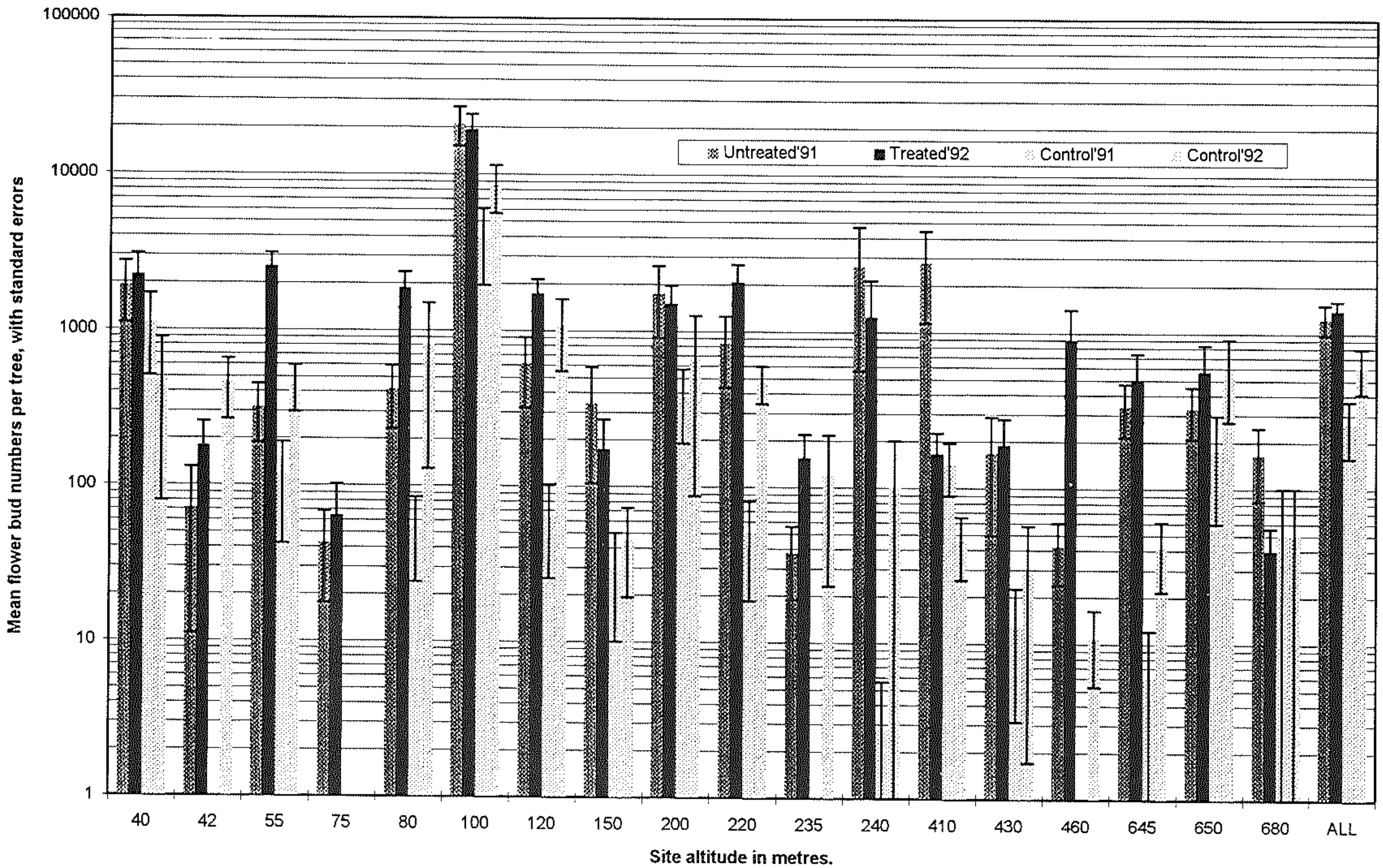

Figure 1. Flower-bud production at 18 sites before and after tree stem injections

Acknowledgements

This work was supported by funding from the Tasmanian Forest Research Council for a project on flowering and seed production. It was proposed and supervised by A.R. Griffin who is currently leader of Shell Forestry and based in London, while employed with CSIRO.

References

Campbell, K. (1990). Tree injection for insect control. *IFA Newletter* 31: 22–23.

Elliott, H.J. and de Little, D.W. (1984). *Insect Pests of Trees and Timber in Tasmania.* Forestry Commission, Tasmania.

Elliott, H.J., Bashford, R., Greener, A. and Candy, S.G. (1992). Integrated pest management of the Tasmanian *Eucalyptus* leaf beetle, *Chrysophtharta bimaculata* (Olivier) (Coleoptera: Chrysomelidae). *Forest Ecology and Management* 53: 29–38.

Moncur, M.W., Hand, F.C. and Ramsden, N.G. (1994). Environmental and cultural effects on flowering and seed production of plantation grown *Eucalyptus nitens.* Report for the Tasmanian Forest Research Council, Inc. from CSIRO Division of Forestry.

Raymond, C.A. (1991). Genetic variation in resistance to insect defoliation. In: Proceedings of the 11th ARWG1 (Forest Genetics) meeting, pp. 56–58. Coonawarra, South Australia.

Tasforests