



Phytotoxicity of Insecticides used to Control Aphids on Sitka Spruce

INFORMATION NOTE

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SUMMARY

Information on the phytotoxicity of insecticides used to control aphids on Sitka spruce has been obtained from trials conducted to support experiments on the impact of aphids on tree growth. Dimethoate, malathion, pirimicarb, Pynosect® and Savona® were tested as foliar sprays and chlorpyrifos and malathion were tested as soil drenches. None of the insecticides showed any phytotoxic effects when applied to transplants at standard (recommended) rates, and dimethoate and malathion were even slightly growth promoting. Applications at twice the standard rate resulted in a range of phytotoxic effects. Pirimicarb, which is widely used for spruce aphid control, had only a limited effect on root dry weight and was otherwise non-phytotoxic.

BACKGROUND

1. Current research on the impact of green spruce aphid (*Elatobium abietinum*) and spruce root aphids (*Pachypappa* and *Pachypappella* spp.) on the growth of Sitka spruce has involved the use of insecticides to maintain experimental plots of trees free of infestation. The performance of uninfested trees is then compared with that of untreated and infested trees to estimate the effect of aphids on a range of growth parameters (Straw and Fielding, 1997).
2. It is essential in these experiments that the insecticides used have minimal phytotoxic or growth promoting properties which might otherwise confound the effects of aphid exclusion. However, published information on the direct effects of insecticides on Sitka spruce is scarce and to select appropriate insecticides a series of trials has been conducted to screen various products for phytotoxicity (Straw, Fielding and Waters, 1996).
3. The insecticides screened in these trials are often used to control *E. abietinum* and root aphids in forest nurseries. *E. abietinum* is a frequent cause of defoliation of Sitka and Norway spruce transplants, and heavy infestation by root aphids can cause yellowing and even death of young plants. The data on phytotoxicity from our trials may have a wider interest, therefore, and are summarised in this Note.

4. The only condition applied to the selection of insecticides for testing was that they should be non-systemic, at least between the shoot and root. Even with this criterion, the tests included some of the main, readily available insecticides recommended for aphid control.

INSECTICIDES TESTED

5. Five insecticides, dimethoate, malathion, pirimicarb, Pynosect® and Savona® were tested as foliar sprays against *E. abietinum*, and chlorpyrifos and malathion were tested as soil drenches against root aphids (Table 1).
6. Chlorpyrifos, dimethoate and malathion are contact organophosphorus insecticides available as emulsifiable concentrates (Whitehead, 1997), although dimethoate also has some systemic properties, at least within the shoot. Pirimicarb is a carbamate insecticide recommended particularly for aphid control and is available as Pirimor® (ICI), a wettable powder, whereas Pynosect 30 WM (Mitchell Cotts Ltd) is a fast acting, contact pyrethroid containing a mixture of natural pyrethrins and resmethrin. Savona (Koppert Ltd) is an insecticidal soap containing 50% w/w potassium salts of fatty acids.

EXPERIMENTS ON POT-GROWN TRANSPLANTS

7. The effect of single applications of these insecticides, except Savona, on height growth, dry weight (DW), needle size and needle density of standard nursery transplants by the end of the growing season was tested in trials at the Entomology field station at Ludlow, Shropshire. Plants used were 1U1 Queen Charlotte Islands provenance (seed identity no. QSS 83(20 17)) obtained in the autumn prior to each trial and potted into 15 cm pots with standard compost. This material was maintained on outdoor nursery beds under automatic watering regimes and inspected regularly for insect infestation. However, few aphids occurred on the plants during the trials.

Foliar sprays

8. Dimethoate, malathion, pirimicarb and Pynosect were tested at the standard field rate (x1) and twice the standard rate (x2) (Table 1), and were compared with controls that involved spraying plants to runoff with an equivalent volume of water. Insecticides were applied with knapsack sprayers in April using approximately 0.5 litres of insecticide per treatment. During spraying the compost was protected by wrapping each pot in a plastic bag. Two control groups of plants were used, giving 10 treatments in total, and each treatment contained 30 plants.

Insecticides were applied without wetting agents or other additives.

9. Application of the insecticides at recommended rates generally had none or only minor phytotoxic effects, and in some instances appeared growth promoting, whereas most applications at twice the recommended rate had some detrimental effect on growth (Figure 1).
10. Dimethoate and malathion at the standard rate increased total shoot and total plant DW, although not root DW. At twice the normal rate, dimethoate still increased shoot DW, but root DW was depressed. Malathion at the x2 rate reduced both shoot and root DW (Figure 1).
11. Pynosect reduced plant DW, although the x2 application had a more severe effect than the x1 application. Pirimicarb appeared to reduce root DW at the x1 rate, but otherwise was not phytotoxic. Despite effects on plant DWs, none of the insecticides, at the standard or higher rate, affected transplant height growth (leader length).
12. Effects on root DW were generally more severe than on shoot DW, leading to negative effects on root:shoot ratios. Plant survival was good in most treatments, but five trees died following x1 application of dimethoate and 14 trees died in the two Pynosect treatments, which was significant ($P < 0.001$).

Table 1

Standard application rates of insecticides used in trials

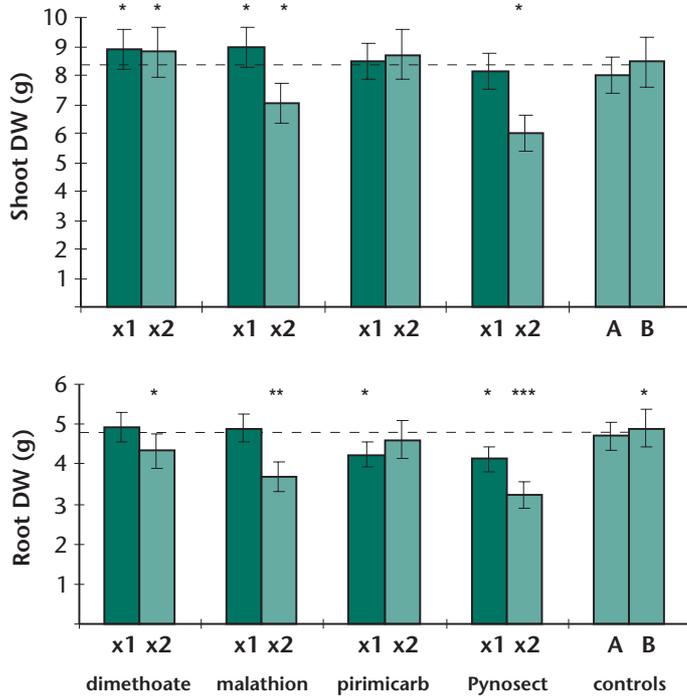
Insecticide	Application rates		
	Product rate (ml l ⁻¹)	a.i. rate (g l ⁻¹) (%)	Recommended field rate
Foliar sprays			
Dimethoate	0.8	0.32 (0.03%)	320 g a.i. 1000 l ⁻¹ , HV
Malathion	4.2	2.52 (0.25%)	1.26 kg a.i. ha ⁻¹ , MV
Pirimicarb	(0.5)*	0.25 (0.025%)	500g product 1000 l ⁻¹
Pynosect	2.4	0.03:0.2 (0.03%)	120 ml 50 l ⁻¹ , HV
Savona	10.0 (1%)	-	1:99 dilution of product
Root drenches			
Chlorpyrifos	1.5	0.72 (0.07%)	2 ml product l ⁻¹
Malathion	1.68	1.01 (0.1%)	200 g a.i. 100 m ⁻² , in 200 l [†]

* g l⁻¹

† for control of sciarid larvae on mushrooms

Figure 1

Effect of single foliar applications of insecticides on shoot and root growth of pot-grown Sitka spruce transplants



13. Needle density was largely unaffected by treatment, except that the x2 Pynosect treatment reduced the total number of needles on the new leader by 13% and needle density by 11–15%. Individual needle DW on the new leader was reduced by 14% in the x1 malathion treatment, by 22% in the x2 malathion treatment and by 18% in the x2 Pynosect treatment. Malathion at normal field rate had a significant, positive effect on the DW of older needles.

Root drench of chlorpyrifos

14. In a separate trial, three treatments, (1) a root drench of chlorpyrifos at standard rate (Table 1), (2) a root drench of chlorpyrifos at twice the standard rate and (3) a water control, were each applied to 30 transplants. Treatments were applied in early May using 150 ml of drench or water per plant. Height growth, needle densities and weights, and shoot and root DWs were determined in the autumn.

15. The x1 and x2 drenches had no significant effect on shoot and root DW, although a small (non-significant) reduction in shoot DW following the x2 application caused a significant ($P < 0.05$) increase in the shoot:root ratio.

16. Total needle numbers and needle density on the new leader were reduced by both chlorpyrifos treatments, by 5% and 7%, respectively, following the x1 drench, and by 19% and 21%, respectively, following the x2 drench. Needle retention on the previous year's leader was also reduced, by 12% in the x1 treatment and by 27% in the x2 treatment.

FIELD TRIALS

17. Longer-term effects of the insecticides used in the pot-plant trials were investigated under experimental approval in trials on 2–4 year old Sitka spruce established in the field. These trials also included Savona as a foliar spray and malathion as a root drench. Insecticides were applied on three dates over 2 years (in April and October) at standard (x1) field rates, the foliar sprays being applied to runoff and the root drenches at a rate of 0.7–1.4 l per tree. Control trees were sprayed or drenched with an equivalent volume of water. Each treatment was applied to 5 replicate plots of 15 trees.

18. The foliar insecticides had no adverse effect on height growth, needle density or survival, although after 2 years trees treated with Savona grew less well and trees treated with malathion grew slightly better, but these trends were not significant ($P = 0.09$).

19. Foliage colour was generally unaffected by spraying except that trees sprayed with Savona showed distinct browning of the needles after the second winter. Similar discoloration has been noted elsewhere (Musau and Parry, 1989) and may be related to degradation of the wax cuticle of the needles by the soap concentrate, rendering them more susceptible to damage on exposed sites.

20. Malathion applied as a root drench had no significant effects on tree growth or appearance, but drenching with chlorpyrifos increased mean leader length and side shoot growth by 25% and 13%, respectively, by the end of the second year. Root aphids were not present on the site and even though an outbreak of *E. abietinum* occurred in this particular trial in the second year (not in the other trials), the differences in tree growth could not be explained by differences in infestation. The results suggest a long-term positive effect of chlorpyrifos on Sitka growth, but the effect needs confirmation.

CONCLUSION

21. Results from all trials indicated that amongst the foliage insecticides, pirimicarb, had the least effect on Sitka spruce and appeared to cause only a slight reduction in root DW of transplants at the x1 rate. This was not apparent in plants sprayed at the higher rate. Applications of dimethoate and malathion at normal field rates also had no adverse effect, and appeared to be growth promoting.
22. Pynosect was the most phytotoxic insecticide to transplants under nursery conditions, with a clear dose-dependent effect, although it had no effect on established plants in the field. In the nursery it reduced shoot, root and individual needle DW, and transplant survival.
23. Neither of the root drenches were phytotoxic, except that chlorpyrifos reduced needle densities, particularly at the higher application rate. However, applications of chlorpyrifos over two years appeared to increase shoot growth of plants established in the field.
24. The results obtained from these trials should not be taken as specific recommendations for the use or non-use of particular insecticides for controlling aphids on spruce. Application of insecticides must always be in accordance with the uses approved by the Pesticide Safety Directorate (PSD) of the Ministry of Agriculture, Fisheries and Food.

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