Forestry Commission

Research Information Note 271

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THE USE OF PERMETHRIN 12ED THROUGH THE ELECTRODYN SPRAYER CONVEYOR TO PROTECT FOREST PLANTS FROM *HYLOBIUS* DAMAGE, by Stuart Heritage, David Johnson and Terry Jennings

Abstract

This Note describes safe and judicious use of Permethrin 12ED through the Electrodyn Sprayer Conveyor (ESC) to protect plants from damage from *Hylobius abietis* and species of *Hylastes* beetles. The mode of action of the system is described and the properties and limitations of the active ingredient and formulation are discussed. The results of one of the experiments which form the basis for the current recommendations for the use of Permethrin 12ED through the ESC are summarised. Damage may still occur on sites which have very high populations of these insects.

Background

1. The Electrodyn Sprayer Conveyor is being developed by the Forestry Commission to treat young forest trees with permethrin. Its use has been approved for this purpose by the Pesticide Safety Directorate (PSD) of the Ministry of Agriculture, Fisheries and Food. This approval for experimental use restricts it to use by the Forestry Commission. An application has been made for full approval which, if granted, would allow this system to be made commercially available.

2. All species of plants used for restocking ex-conifer plantations are at risk of damage from the large pine weevil *(Hylobius abietis)* and species of black pine beetle *Hylastes*. Treatment with insecticides before planting is currently the most reliable way of ensuring that plants are protected. Only the main stem and upper part of the root system of conifers requires protection because both *Hylobius* and *Hylastes* start their feeding at the root collar. Predicting damage levels is unreliable at present and, therefore, all plants destined for restocking sites should be treated. Dipping or spraying plants at the nursery, or other central facility is the current recommended method to provide safe and cost-effective plant protection. Permethrin applied using the Electrodyn Sprayer Conveyor (ESC) may provide an effective alternative to conventional aqueous spray or dipping systems.

3. The Electrodyn application principle was patented in 1976 by ICI plc (now Zeneca Agrochemicals) and developed commercially as a hand-held system to treat crops such as cotton in the tropics. The insecticide is formulated in a special oil-based carrier that does not readily conduct electricity. This is gravity fed through a plastic nozzle that has been impregnated with carbon and to which is applied a high voltage electric field of around 20,000 volts. Highly charged ligaments of spray liquid are generated as it emerges from the nozzle and these quickly break up into droplets of very even size. The size of the droplets is determined by the voltage applied and the flow rate. Because the droplets are very small (less than 100 microns in diameter) and carry a high electric charge, the attractive force to earthed surfaces is about 50 times stronger than gravity. When an earthed surface passes through an Electrodyn spray cloud, the lower surface of the target receives the same treatment as the upper surface.

Electrodyn Sprayer Conveyor (ESC)

4. The conveyor treatment system was developed, by the Forestry Commission's Technical Development Branch in conjunction with ICI, to reduce operator exposure to chemicals and improve plant handling. Plants pass through a spray booth fitted with two Electrodyn spray heads placed to treat a narrow (150 mm) band of plant stem from just below the root collar.

5. The system has two major advantages over dipping for treating bare rooted stock.

   - The insecticide is supplied at the working concentration, so that no measuring of concentrates or mixing is required.
   - The product is formulated using oil and organic solvents and most of the highly volatile solvent (cyclohexanone) in the formulation evaporates before the plants reach the end of the spray booth. They are ready for immediate packing and dispatch when they reach the end of the conveyor. Because it is not necessary to heel in the plants to allow the deposit to dry, this not only reduces treatment times, but lessens the risk to plants from handling and desiccation.

6. The product is supplied in 5 litre containers which are emptied mechanically into a bulk holding tank. From here it is pumped to header columns above each nozzle. These columns prevent pulses in flow rate caused by the pump from reaching the nozzles. Also, as the temperature drops and the product becomes more viscous, the liquid builds up in the columns thus increasing the head of pressure and automatically maintaining the correct flow rate. Once correctly installed and calibrated, the ESC should maintain an even and repeatable application applying 200 ml product per 1000 tree seedlings.

7. The use of any insecticide to treat conifer transplants prior to planting in restocking areas may reduce plant vigour. This may be either from direct toxic effects, and/or due to the additional plant handling associated with the treatment process. The effects may be seen as a reduced root growth potential (RGP), reduced first year increment or even plant death. The effect of the Permethrin 12ED (ESC) on plant vigour has been examined in several experiments which showed that the carrier oils in this formulation are particularly phytotoxic and that this effect is exacerbated by cold storage. To reduce the risk of phytotoxicity, trees should be planted out within 14 days of treatment and should not be cold-stored.

8. Foresters are mainly concerned with damage from *Hylobius,* but *Hylastes* can occasionally cause severe damage which sometimes occurs in the absence of *Hylobius. Hylastes* are beetles which, like *Hylobius,* develop in the roots and stumps of felled conifers. The adult *Hylastes* are considerably smaller than those of *Hylobius,* being approximately 1/30th the body weight. They feed under the bark of the roots of young forest plants which is a part of the plant not directly treated by the ESC. Because *Hylastes* attack plants starting just below the root collar and within the band of insecticide, this treatment will also protect plants from *Hylastes.* In addition, given the small size of *Hylastes* relative to *Hylobius,* it is reasonable to expect *Hylastes* to be at least as susceptible to control by permethrin as *Hylobius.* Experience over a number of years, using permethrin both as a conventional dip treatment and as Permethrin 12ED (ESC), has shown this to be the case. Treatments targeted at *Hylobius* also protected plants from damage by *Hylastes,* in some cases, even where protection from *Hylobius* was inadequate.

Safety and protective clothing

9. It is essential that plant treatment and the planting of treated plants is carried out by personnel who are fully trained and equipped with the appropriate protective clothing. There are different specifications of protective clothing required for handling the liquid formulation, for treating plants and during planting (see Figures 1 & 2).

10. Clean gloves must be used at the start of each work period and replaced during use if damaged. Before removal, the outside of the gloves must be washed and surplus moisture wiped off. All protective clothing must be carefully washed down at the end of each period of use and planting suits changed daily in accordance with manufacturers' instructions. Personal clothing must be kept separate from protective clothing which should be stored in ventilated accommodation.

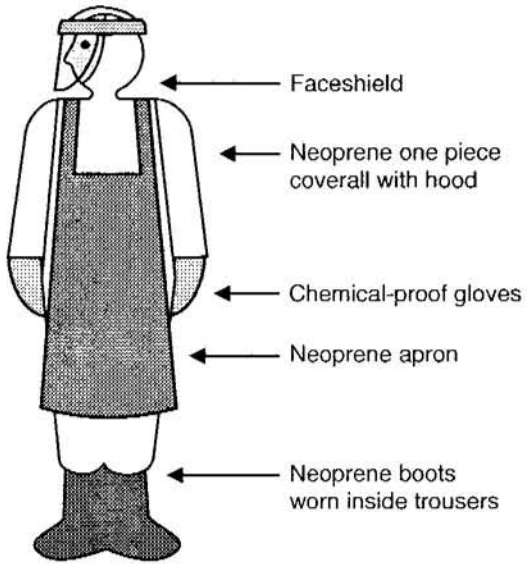

Figure 1. The protective clothing for treating plants using the ESC and handling the formulation.

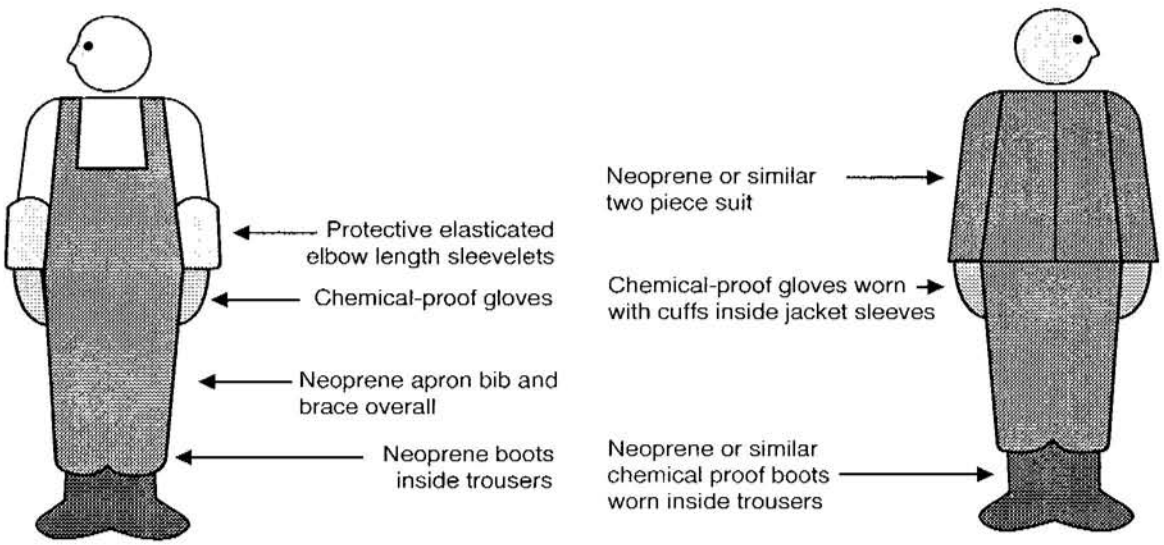

Figure 2. Protective clothing for planting treated plants.

11. Although the plants are ready for packing and dispatch as they reach the end of the conveyor and the deposit is fully rainfast, plants must be handled wearing the protective clothing necessary for handling wet plants. The volatile solvents are toxic and the bags should be opened and allowed to ventilate for several minutes in open air before plants are removed for planting. The routines for monitoring the flow-rates of spray liquid and ensuring adequate air-flow from the spray booth should be followed precisely.

12. Engineering controls may replace personal protective equipment if a COSHH assessment shows that they provide an equal or higher standard of protection. In addition to these requirements, it is necessary to establish a system of operator monitoring throughout the work.

Care of the environment

13. This insecticide is non-specific and is dangerous to non-target organisms such as fish, birds, and animals. Great care should be taken to ensure that the risk from accidental loss during the treatment process is minimised by containing any spillage. Authorised waste contractors should be used to dispose of used containers and washing water. Care should be taken to ensure that treated plants or used containers do not contaminate surface water and ditches.

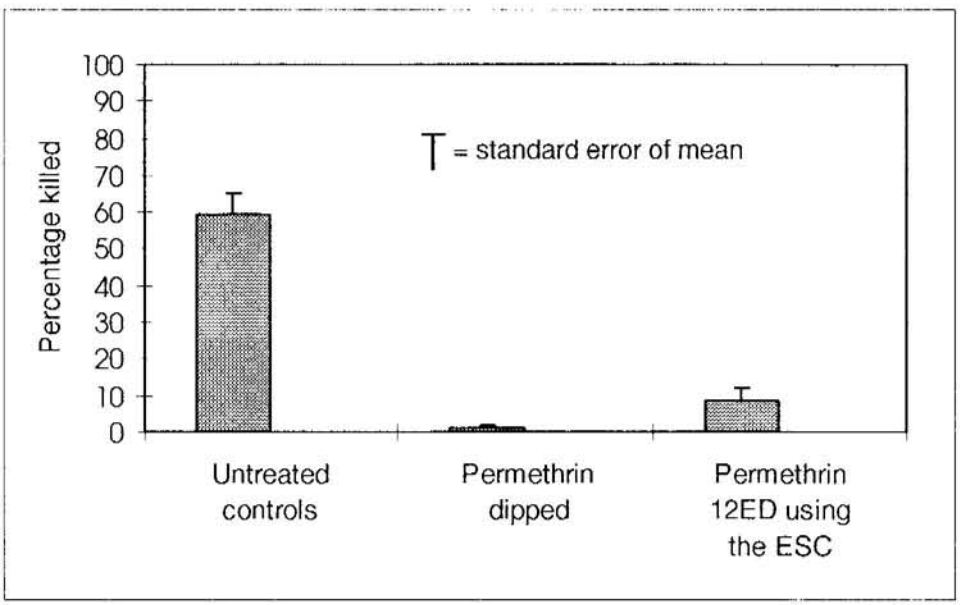

Figure 3. The protection of transplants using Permethrin 12ED applied using the ESC.

Experimental evidence for the recommendations

14. Many experiments have demonstrated that treatment of plants using the ESC should provide an adequate level of protection. Except for sites with very high damage pressures, the protection should be as good as that from dipping in permethrin (Figure 3). Because the insecticide is applied as a relatively narrow band, care should be taken during planting that the plants are planted to the correct depth and that the treated zone is not buried.

15. Unlike its damage to conifers, *Hylobius* attacks broadleaves starting just below the top buds and works down the stem. For this reason, these plants will receive little protection from the ESC if treated in the usual way. No experimental work has been undertaken on the use of the ESC to protect broadleaves.

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