USE OF CONTROLLED-RELEASE PESTICIDES IN POTTING MIXES

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INTRODUCTION

Controlled-release (CR) formulations of insecticides have been investigated in Australia since 1979 for control of soil insect pests such as sugar cane grub, or more recently, cockchafer beetle in turfgrass. Since some of the pesticides formulated in this fashion have been systemic chemicals, the potential exists for their use in containerised nursery stock to control sucking pests such as aphids or scale. In addition, there are several root-inhabiting pests (e.g., root mealy bug and weevil larvae) common in nursery stock that require fairly toxic, persistent chemicals for control. A product providing a safer formulation of such chemicals as well as the potential for once-only application, could have significant potential in the nursery industry.

In 1986-87, the Nursery Industry Association of South Australia (SA) and the Australian Special Rural Research Fund sponsored trialwork by our department to look at the potential application within the nursery industry of the controlled-release (CR) products currently available in Australia. Similar research was being conducted in the NSW Dept. of Agriculture on the potential use of certain CR products for controlling two-spotted mite in nursery stock.

In Australia the technology for formulation of CR products has been led by the Incitec company, Brisbane. They have cooperated with research by providing formulations developed for other agricultural industries to be assessed for nursery production. The scope of our study included testing efficacy of the chemicals in controlling targeted pests, assessing potential phytotoxicity to common nursery plant materials, and assessing the response of nursery workers to their use.

The nursery industry is a very intensive form of horticulture where the end product is of high value. The use of moderately expensive, targeted agricultural chemicals is justified as the cost of such chemicals is low relative to total production costs. With labour being the major cost component of production, slow-release fertilisers are widely accepted in the nursery industry as a labour saving practice. The potential of a protectorant treatment of insecticide granules incorporated at potting up and targeted against specific pests, has good potential for acceptance in the nursery industry.

The following points summarise the potential benefits of using controlled-release formulations in nurseries:

- Labour saving—single application applied at potting-on stage.
- Safer to use than conventional formulations of the same active ingredient. Dust, spray drift and application problems minimised.
- Has potential to be used in integrated pest management programs as targeted pests are controlled without adverse affects to beneficial insects.
- Residual protection from pests for a desired time period.

MATERIALS AND METHODS

The first active ingredient formulated as a controlled-release product and available for evaluation was phorate (Thimet®), which has registration on field flower crops but is not generally used in pots. Rates for pot trials were extrapolated from kg/ha rates recommended for control of aphids on field-grown chrysanthemums. Chlorpyrifos (Suscon blue®) gained registration in 1985 on sugar cane and the experimental chemical, carbosulfan, was released for trialwork in 1987.

Trials were conducted at Northfield Research Labs and at four commercial production nurseries in SA. Potting media consisted of 4:1 coarse pine bark:sand at Northfield, with variations used by each nursery incorporating small percentages of peat or organic compost to pinebark/sand media. CR granules were incorporated into measured volumes of media to fill trial pots (varied from 130mm to 180mm) and young tube-stock were planted immediately in treated pots. Controls consisted of traditional formulations of the same active ingredient, and untreated pots. Trials were sited outside in open beds or shadehouses in the case of woody nursery stock, or in greenhouses for flower and foliage plants.

Growth data was collected at monthly intervals for 6 month and 9 month formulations and at two monthly intervals for 2 year formulations. Release-rate of chemicals from granules was assessed by Incitec laboratories by collection of samples from controls placed in experimental plots under the same conditions as treatment pots. Insect levels were determined by a visual rating system of infestation or, in the case of aphids, by leaf disc analysis in the laboratory. Leaf discs were collected from treatment plants, placed on petri dishes, then 20 live aphids were introduced onto the discs. Counts of aphids were made at 3 and 5 days and assessments were made by means of a rating index. Table 1 summarizes the trials at all sites.

Table 1. Summary of CR insecticide trials in South Australia

Trial plant	Chemical	Target pest	Phytotoxicity*
Outdoor			
Azalea	Phorate	Lace fly/mites	yes
Camellia	Chlorpyrifos	Weevil larvae	no
Olearia	Carbosulfan	Mealybugs	no
Eucalyptus	Carbosulfan	Psyllids	no
Greenhouse			
Gerbera	Phorate	Aphids	yes
Hibiscus	Carbosulfan	Aphids	no
Epiphyllum	Carbosulfan/	Mealybug/Scale	no
''	Chlorpyrifos	Mealybug	no
Pisonia	Carbosulfan/	Aphids	no
''	Chlorpyrifos	Mealybug	yes
Fittonia	Chlorpyrifos	Mealybug	yes
Syngonium	Chlorpyrifos	Mealybug	no

* Phytotoxicity to insecticides observed on some rates used in experiment

RESULTS AND DISCUSSION

PHORATE — In trialwork to control two-spotted mites, CR phorate has proved effective at rates of 200 to 400g a.i./m^3 of potting mix (1). These rates are relatively high in comparison to that needed to control mealybug (25 to 100g a.i./m^3) or aphids (80 to 160g a.i./m^3). In trialwork throughout Australia on a total of 37 species, phytotoxicity symptoms have been apparent on half of these species at rates above 100g a.i./m^3. These problems limit the use of phorate at the high rates necessary to control mites but show potential for control of sucking pests.

In trial work with azaleas the following results were obtained, as shown in Table 2.

Table 2. Effect of CR phorate on growth and aphid control of two azalea cultivars 4 months from treatment

Azalea	Phorate rate g a.i./m^3	Mean sum lateral length (mm)	Mean aphid ratings*
'Elsa Karga'	0	51.0 a**	3.9 a
5 in. pots	40	55.5 a	1.1 b
	80	48.7 a	0.9 b
	160	49.7 a	0.4 bc
	240	35.2 b	0.1 c
'Paul Schame'	0	45.3 a	4.0 a
7 in. pots	40	44.3 a	2.6 ab
	80	44.3 a	0.7 cd
	160	42.0 a	0.2 d
	320	36.5 a	0.0 d

* Rating index of total aphid infestation 5 = high, 0 = nil, using leaf disc analysis
** Within columns, values not followed by the same letter differ significantly ($P<0.05$)

Suppression of azalea growth occurs only at rates of 240g a.i./m^3. Azalea would be considered to be a sensitive crop in terms of pesticide phytotoxicity problems and potential root damage with potting mix additives. Efficacy of phorate treatments was assessed in the laboratory by means of leaf disc analysis at monthly intervals utilising aphids. These results would recommend rates of 100 to 150 g a.i./m^3 to control aphids on azaleas.

A major problem when dealing with this chemical is the strong odour associated with it, and apprehension on the part of nurserymen in our study to put a hazardous chemical into potting machines. Although the toxicity of phorate is reduced by controlled release encapsulating (Oral LD50-2 mg/kg reduced to LD50-319 mg/kg) the strong odour associated with it remained. The chemical also appeared to be releasing faster than anticipated in potting mixes in comparison to soil which means the formulation would have to be adjusted for nursery use.

CHLORPYRIFOS — This broad spectrum insecticide is formulated into CR granules for suppressing soil insects. In nursery stock it would be used against pests that inhabit the root-zone during some stages of their life cycle, as there is little systemic activity

Chlorpyrifos has become a low toxicity (Oral LD50 > 1000mg/kg) alternative to the use of aldrin (a persistent organo-chlorine insecticide) for control of weevil larvae in nursery stock. Larvae of several weevil species are responsible for damage to the crown and roots of woody nursery plants. This is reported as a serious problem overseas and becoming more prevalent in Australia. In the U.K., controlled-release granules of chlorpyrifos gave excellent preventative control against vine weevil (2) for 3 to 4 months after treatment. Rates of 75 to 300 g a.i./m^3 were utilised on *Cotoneaster* and *Thuja* without damage, the higher rates recommended if persistent control is desired. In trialwork in SA, no suppression of growth occurred in *Camellia japonica* at rates of up to 800g a.i./m^3 used for control of garden weevil during nursery production.

Trials in SA assessing rates of chlorpyrifos CR granules in controlling root mealy bug on greenhouse crops showed little phytotoxicity on treatment plants up to a rate of 500g a.i./m^3 The exception was *Pisonia umbellifera* 'Variegata', a New Zealand native grown as an indoor foliage plant, which was also stunted by Chlorpyrifos sprays used as a control.

CARBOSULFAN — This is a systemic insecticide formulated in controlled release granules under the trade name Marshal/Suscon® for use in control of pests of forest trees and pastures. Two-year formulations are generally used to control weevil pests in young pine plantations. Trialwork in SA was designed to test rates and efficacy of one-year release formulations of carbosulfan granules in woody ornamental plants during the nursery production phase. Carbosulfan significantly reduced aphid populations on *Hibiscus rosa-sinensis* at rates of 1.0 to 2.0 kg a.i./m^3 with no reduction in plant growth (Table 3).

Table 3. Results of the use of carbosulfan on *Hibiscus rosa-sinensis* for the control of aphids

Rate kg/m^3	Number leaves (6 months)	Plant height (6 months)	Aphid rating* (3 months)	Aphid rating* (6 months)
0	22 5 a**	22 5 b	4 0 a	4 7 a
0 5	21.0 a	30 6 ab	1 2 b	4 2 a
1 0	24 5 a	32.4 a	2 0 b	2 5 b
2 0	21.8 a	29.1 ab	1 2 b	2.5 b
4 0	24 5 a	28.8 ab	1.0 b	4 2 a
2 0[2]	20 5 a	35 3 a	1.3 b	5 0 a

* Rating index of total aphid infestation 5 = high, 0 = nil
[2] Dibbled
** Within columns, values not followed by the same letter differ significantly ($P<0\ 05$)

A lower rate of 0.5 g controlled aphids for 3 months but was ineffective at 6 months. The dibbled treatment involved placing the CR granules in a hole formed by a dibble inserted in the potting medium after planting, which was viewed as a labour saving application method. The clustered granules were clearly less effective at providing control than those incorporated throughout the mix. No phytotoxicity was apparent at all rates tested, the poorer growth of control plants is a reflection of heavy aphid infestation.

Carbosulfan proved to be effective when used at a native plant nursery in controlling sucking pests on advanced plants grown for landscape use. On *Olearia racemosa,* after a period of 7 months, carbosulfan at rates of 0.5 to 4.0 kg/m^3 controlled a mealy bug infestation that occurred on control and dibbled treatment plants. There was no phytotoxicity apparent at any rate tested. On *Eucalyptus globulus,* rates up to 10 kg/m^3 carbosulfan safely controlled a psyllid infestation that occurred at 4 months. By 6 months, as seen in Table 4, psyllids had established on all plants.

Table 4. The effect of Carbosulfan on control of psyllids on nursery plants of *Eucalyptus globulus*

Treatment kg/m³	Psyllid infestation rating (0 to 5) (0 = low, 5 = high)		
	1 Mo.	4 Mo	6 Mo
0	0.0 a	3.3 a	4 5 a
1 25	0 0 a	1.7 bc	4.0 a
2.5	0.0 a	0 8 cd	4 7 a
5 0	0 0 a	0.3 d	3.8 a
10 0	0 0 a	0 8 cd	3 8 a
5.0 (dibbled)	0.0 a	2.0 b	3.8 a

* Within columns, values not followed by the same letter differ significantly ($P<0.05$)

It appears that the active ingredient in this case was releasing at a faster rate than expected for a one year formulation, or higher rates are necessary for control under heavy insect pressure.

CR carbosulfan and chlorpyrifos were also tested on greenhouse-grown epiphyllum which were heavily infested with scale and mealybug. Over a four month period after treatment, CR carbosulfan at rates of 2.5 to 5.0 kg/m^3 significantly controlled scale over controls but had no effect on mealybug. Chlorpyrifos CR was effective in controlling mealybug at rates of 2.5 to 5.0 kg/m^3 for four months; however, sprays of the same active ingredient had no effect. Chlorpyrifos, which does not have systemic activity, had no effect in controlling scale.

RELEASE RATES

Release rates of CR granules used in nursery pots can be expected to differ from the same formulations used in soil. In organic-based potting media with high air-filled porosity, granules are more exposed to air and thus to chemical changes than those incorporated in soil. Fluctuations in temperatures are also greater in pots, particularly for woody nursery plants grown outdoors. Average temperatures in pots grown in greenhouses can be expected to be elevated over average soil temperatures, which should accelerate release rates of active ingredients. High levels of leaching also can occur through normal irrigation practices in pots with high porosity mixes. However, the organic components of a potting mix may bind active ingredients more effectively than a sandy soil.

RECOMMENDATIONS

Insecticides formulated as controlled release granules appear to have good potential for controlling common pests in nursery crops. Nurseries participating in this study were very supportive of a product which would reduce spraying for safety and labour considerations. Many were also looking for a broad spectrum protectorant insecticide similar to Temik®, which has recently been withdrawn from the nursery trade. Those that had a specific problem pest such as weevils, were willing to use targeted treatments even if an extra step such as pre-mixing in potting mix is necessary.

Chemicals need to be of lower toxicity and without noticeable odour to be acceptable for general use in potting-on. Phorate CR appears to be limited in nursery use due to phytotoxicity and safety problems. Chlorpyrifos CR looks particularly promising in control of root weevil and mealybug, and further trialwork is recommended to establish rates on species particularly susceptible to weevil damage (e.g. *Rhododendron*, conifers).

As a broad-spectrum systemic insecticide, CR Carbosulfan appears to have many characteristics suited to use in ornamental nurseries. No phytotoxicity has been observed on a wide range of treatment plants, held both in greenhouses and outdoors. A range of sucking pests are controlled effectively to at least 6 months after application of a one-year release product. Rates as low as 0.5 kg/m^3 were effective in controlling aphids.

Further work with CR formulations of Chlorpyrifos and Carbosulfan is recommended to understand release characteristics of granules in potting media and to better define rates and periods of efficacy. It is important that the active ingredients are depleted from the nursery pot before being sold to consumers, unless the treated plants are marketed as products containing an insecticide. It is also recommended that further CR formulations of lower toxicity insecticides and fungicides should be explored for nursery applications.

LITERATURE CITED

1 Goodwin, S 1985 Evaluation of controlled-release granular formulation of phorate against two-spotted mite, *Tetranychus urticae*, on ornamental plants (Unpublished report) N S W. Department of Agriculture.

2 Cross, J V and D V. Alford 1990 Hardy ornamental nursery stock vine weevil, chemical control CSG Commissioned R&D - Experiment Report 30/03/90 Ref No L/L3/FN05/001