A SURVEY OF SLUGS AND SNAILS IN ORNAMENTAL PLANT PRODUCTION NURSERIES

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SUMMARY

An assessment was made of the pest status and control of terrestrial gastropods in plant production nurseries in the Auckland and Hamilton areas. Thirteen gastropods were encountered in the survey but the composition of the gastropod fauna and the level of infestation varied considerably between nurseries. Nursery facility construction and sanitation were important determinants of damage levels. The nature of gastropod damage to plants is briefly described. All nurseries employed pesticides for gastropod control, viz. metaldehyde baits and methiocarb baits and sprays.

INTRODUCTION

Terrestrial gastropod (slugs and snails) are important pests of horticultural plants (ornamental and productive) in many parts of the world (Godan 1983). Infestations of plant production nurseries can be derived from indigenous gastropod species or from the establishment of foreign species. Through commerce, including trade in plant material, many gastropod pest species have become established over a wide geographic area outside their natural range. Twenty five terrestrial gastropods of northern hemisphere origins have become established in New Zealand (Barker 1982, and unpubl.) and are responsible for most of the gastropod damage to cultivated plants in this country. This paper describes an assessment of the pest status of these introduced gastropods in plant production nurseries in the Auckland and Hamilton areas.

METHODS

Nurseries in Auckland (11) and Hamilton (7) were visited to ascertain the incidence and pest status of terrestrial gastropods in plant production units. Nursery managers were interviewed to determine their perception of losses due to slugs and snails, and approaches to control. Outdoor (open air and shade houses) and indoor (greenhouse) facilities at each nursery were searched to determine the level of gastropod infestation, the species present and the source of infestation. A list of plants damaged and the nature of the damage was compiled by inspection of nursery stock and from information provided by nursery staff. Each nursery was visited in spring, with return visits made to some (12/18) of the nurseries the following summer and autumn.

RESULTS

Incidence of gastropods

Thirteen gastropod species were recorded during the survey (Table 1). The brown field slug (*Deroceras panormitanum*) was the most prevalent species, being equally abundant in both indoor and outdoor propagation and growing-on areas. Numbers of this slug were highest in humid, temperature controlled greenhouses (20-25 °C). The grey field slug (*Deroceras reticulatum*) was common in outdoor facilities but was recorded only occasionally in low numbers in greenhouses. The spotted garden slug (*Limax maximus*) occurred both outdoors and indoors, but always in low numbers. Tawny garden slugs (*Lehmannia flava*), jet slugs (*Milax gagates*) and the veined slug (*Athoracophorus bittentaculatus*) were occasionally found in outdoor growing-on areas. Bourguignat's garden slug (*Lehmannia nyctelia*), garden slugs (*Arion hortensis*), brown garden snails (*Helix aspersa*), and glass snails (*Oxychilus cellarius*, *O. draparnaldi* and

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TABLE 1: The gastropod species associated with indoor (I) and outdoor (O) plant production facilities of various nurseries in Auckland and Hamilton

		<i>Deroceras panormitanum</i>	<i>D. reticulatum</i>	<i>Limax maximus</i>	<i>Lehmannia flava</i>	<i>L. nycetelia</i>	<i>Arion hortensis</i>	<i>Milax gagates</i>	<i>Helix aspersa</i>	<i>Oxyechilus alliarius</i>	<i>O. cellarius</i>	<i>O. draparnaldi</i>	<i>Zonitoides arboreus</i>	<i>Athoracophorus bientaculatus</i>
AUCKLAND														
Nursery	A	I	+											
		O	+	+	+									
	B	I	+				+							
		O	+	+		+	+	+	+					
	C	I	+		+		+			+	+		+	
		O	+	+										
	D	I	+						+					
		O	+	+					+					
	E	I	+	+										
		O	+	+										
	F	I	+	+										
		O	+	+										
	G	I	+											
		O	+											
HAMILTON	Nursery	A	I	+		+				+				
			O	+	+				+			+		+
		B	I	+							+			
			O	+	+			+			+		+	
		C	I	+				+						
			O	+	+	+	+		+			+		
		D	I	+										
			O	+										
		E	I	+										
			O											
		F	I											
			O	+	+					+				
		G	I	+										
			O	+										
% Incidence		I	94	11	6	0	6	22	0	6	6	11	6	17
		O	94	78	22	11	17	28	22	28	17	11	11	0

O. alliarius) were associated with plants both indoors and outdoors. Although these species occurred in low frequency, they tended to be abundant when present. The orchid snail (*Zonitoides arboreus*) was found only in three greenhouses, where it was abundant.

Pest status

Growers faced very low economic injury levels in response to customer expectations of high quality, unblemished plants.

With vegetable, bedding plant and pot plant seedlings, losses were often high and affected a large number of plant species. Seedlings in trays or punnets were destroyed or severely retarded at an early stage by damage to stems, cotyledons and early true leaves. Seedling losses resulted in increased labour input for transplanting replacements, wastage of labour and potting medium through discard of punnets or trays, and/or a failure to meet customer orders. In nurseries where gastropods were a persistent pest, seed sowing rates were scaled up to compensate for projected seedling losses. The principal pest species of vegetable, bedding and pot plant seedlings were the brown field slug, the grey field slug and the garden slug.

Gastropods were also a significant cause of seedling losses with woody ornamentals. The plants in this category which were most frequently cited by growers as being subject to slug and snail damage are listed in Table 2. Seedlings were destroyed or severely stunted at an early stage by damage to stems, cotyledons, early true leaves and/or apical tissue. Greatest losses occurred in the trays in which seed was sown or early post-transplant. Economic losses resulted from shortfalls of seedling material for growing-on and subsequent sale. For some plant species, losses of rare or high cost seed was also of economic consequence. In outdoor propagation units the brown field slug, the grey field slug and the garden slug were the main pest species of woody ornamental seedlings, while indoors the brown field slug and Bourguignat's slug were most troublesome.

TABLE 2: Woody ornamental plant seedlings frequently damaged by gastropods.

<i>Boronia</i> spp.	<i>Hymenosporum flavum</i>
<i>Clematis</i> spp.	<i>Lapageria rosea</i>
<i>Dodonea viscosa</i>	<i>Pittosporum</i> spp.
<i>Eucalyptus</i> spp.	<i>Salvia splendens</i>
<i>Hoheria populnea</i>	<i>Sophora</i> spp.

TABLE 3: Woody ornamental and perennial plants frequently damaged during growing-on stages or as pot plants by gastropods.

<i>Actinidia chinensis</i>	<i>Coleus blumei</i>	<i>Magnolia</i> spp.
<i>Adiantum</i> spp.	<i>Cordyline</i> spp.	<i>Maranta leuconeura</i>
<i>Anemone</i> spp.	<i>Cyclamen persicum</i>	<i>Myosotidium hortensia</i>
<i>Anigozanthos manglesii</i>	<i>Cymbidium</i> spp.	<i>Nerium oleander</i>
<i>Anthurium scherzianum</i>	<i>Dahlia</i> spp.	<i>Petunia</i> spp.
<i>Arthropodium cirrhatum</i>	<i>Datura</i> spp.	<i>Phalaenopsis</i> spp.
<i>Asplenium nidus-avis</i>	<i>Delphinium</i> spp.	<i>Phormium</i> spp.
<i>Asparagus</i> spp.	<i>Dianthus</i> spp.	<i>Pittosporum</i> spp.
<i>Aster</i> spp.	<i>Dracaena</i> spp.	<i>Poncirus trifoliata</i>
<i>Aucuba japonica</i>	<i>Eucalyptus</i> spp.	<i>Primula vulgaris</i>
<i>Begonia tuberosa</i>	<i>Geranium</i> spp.	<i>Rhapis</i> spp.
<i>Calathea makoyana</i>	<i>Gladiolus</i> spp.	<i>Rhopalostylus</i> spp.
<i>Cattleya</i> and allied genera	<i>Hemerocallis</i> spp.	<i>Senecio cruentus</i>
<i>Chamaedorea elegans</i>	<i>Hosta</i> spp.	<i>Sophora</i> spp.
<i>Cheiranthus cheiri</i>	<i>Howea</i> spp.	<i>Stromanthe amabilis</i>
<i>Chlorophytum capense</i>	<i>Hymenosporum flavum</i>	<i>Tagetes erecta</i>
<i>Chrysaliidocarpus cabadae</i>	<i>Iris</i> spp.	<i>Viola</i> spp.
<i>Chrysanthemum</i> spp.	<i>Kentia forsteriana</i>	<i>Vitis</i> spp.

Numerous plant species were subject to damage from gastropods during the growing-on stages from seedling/cutting transplants to sale. The plants most frequently cited as being damaged are listed in Table 3. The nature of the damage was dependent on the type and stage of development of the plants. Five broad categories of damage were recognised:

(i) Damage to green stems: Soft and semi-mature stems of various wood ornamentals and fruit trees were damaged by rasping the green tissue from the trunk or main leader branches. The gastropods most responsible for this damage were evidently the brown field slug, the grey field slug, the garden slug and the brown garden snail. With ferns, the garlic snail (*Oxychilus alliarius*) and the orchid snail were also involved.

(ii) Leaf damage: The extent of foliar damage varied greatly between plant species. Leaves of some plants were nearly destroyed, while others were only holed or eaten around the leaf margin. Thicker leaves were mostly rasped on the lower surface. The gastropods responsible for this form of damage were variously the brown field slug, grey field slug, spotted garden slug, Bourguignat's garden slug, garden slug, brown garden snail, orchid snail and the glass snails.

(iii) Tuber/bulb damage: Mine-like indentations, holes and tunnels were bored into tubes, bulbs, rhizomes and fleshy roots, often leading to secondary rots. Members of the Orchidaceae in greenhouses were subject to root damage by bark snails and the brown field slug. Underground parts of Amaryllidaceae, Iridaceae and Liliaceae when growing in soil in open ground or in containers were damaged by garden slugs, jet slugs, grey field slugs and brown field slugs.

(iv) Bud damage: Various woody ornamentals (particularly *Magnolia*), fruit trees (citrus) and vines (*Vitis*) were damaged during winter and spring by chewing out the vegetative buds. The grey field slug and the brown garden snail were primarily responsible for this damage.

(v) Inflorescence damage: Flower buds and open flowers of various shrubs, perennials and pot plants were damaged by various slugs, the brown garden snail and the bark snail.

The effect of gastropod grazing was to reduce the quality of plants. Some plants were damaged to the extent that they were discarded by the growers but more frequently the plants required pruning and/or withholding from sale until the quality was restored. Economic loss was greatest when damage occurred on high value plants. These were generally the slower growing plants and/or those requiring special cultural conditions which are costly to maintain.

Factors contributing to pest status

The severity of slug, and occasionally snail damage, was often closely linked to the state of the surrounding ground. Where outdoor growing areas were surrounded with grass or weedy headlands, marginal damage was quite severe. Most infestations in greenhouses were caused by introductions in potting media, on the bottoms of boxes or pots, or active movement through side ventilations or cracks in the structure. Accumulation of debris such as boards, pots, cardboard, and weed growth within some nurseries provided an excellent habitat for gastropods and an important source of reinfestation.

Recessed bottoms of pots and trays, while necessary for adequate drainage, provided an excellent day-time hiding place for gastropods. Spaces between and underneath plants in planter bags were also favourable. Moss on pots, benches and on the ground was a habitat for slugs and small snails.

Materials used to cover the ground had an important influence on gastropod numbers. Nurseries established on concrete or tarmac generally had low infestations unless debris was allowed to accumulate. Ground cover with black polythene film was apparently effective initially but once torn or holed provided a refuge for slugs. Loose gravel, both directly on the soil or on polythene, supported numerous slugs and snails. Loose scoria was apparently less favourable as it supported fewer gastropods.

Most nurseries employed overhead sprinkler irrigation which provided a humid environment ideal for gastropods. In greenhouses and most outdoor growing areas, irrigation minimised any seasonality of gastropod attack on plants. Where irrigation

was less frequently applied, as in open ground, damage occurred mainly in spring, but also in autumn and winter.

Controls used and perceived effectiveness

Chemicals were employed against gastropods in all nurseries surveyed. The majority of growers broadcast proprietary bait formulations at frequent intervals (every 10-14 days) throughout the year or during seasons of damage. Baits containing metaldehyde (2-3% ai) were found to be effective by some growers and not by others. Where the gastropod infestation was severe these baits were perceived to give inadequate levels of control but a distinction between inadequate kill and a continual reinfestation from headlands could not be made. Some growers expressed a reluctance to broadcast metaldehyde baits over potted plants as the subsequently mouldy pellets were repugnant to plant buyers and were perceived as sources of plant pathogens. Some growers with persistent gastropod infestations had switched to using bait and spray formulations containing methiocarb. Broadcast 2% methiocarb baits have given satisfactory levels of control. Other growers have achieved similar levels of control with methiocarb sprays applied at 56 g ai/100 litres water. Phytotoxicity had been observed with spray application rates of 112 g ai/100 litres water.

Several growers used copper sprays in open ground growing areas, primarily for disease control. A low incidence of slug and snail damage in these nurseries may in part be due to toxic and repellent effects on gastropods of these copper sprays.

None of the growers interviewed knew that gastropod species and age classes differed in acceptability of baits and in susceptibility to active ingredients and formulations. Only a few growers were aware that slugs poisoned with baits containing 2-3% metaldehyde had a high recovery rate under humid conditions.

Growers with limited gastropod damage in their nurseries have generally not sought improvements in sanitation or management. Where gastropods have been a significant and persistent problem, growers had responded by evaluating alternative molluscicides and/or improved nursery sanitation through removal of weeds and debris within and around the nursery. Some growers had an established (breeding) gastropod population within the nursery beds. Limitations of growing area often prevented the use of a fallow and disinfestation period between consecutive crops.

CONCLUSIONS AND RECOMMENDATIONS

Considerable variation exists between nurseries in gastropod faunas and levels of infestation. In some nurseries gastropods are of considerable economic importance but costs of control and lost sales opportunities are poorly documented.

Gastropod infestations could be kept to a minimum if nursery facilities and surrounds were constructed and maintained to eliminate slug and snail habitats (i.e. weedy surrounds, wood and cardboard debris, etc). Propagation equipment and potting media should be stored away from possible gastropod contamination and/or be disinfested prior to use.

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