Snails and slugs in ornamentals

Michael P. Parrella □ Karen L. Robb □ Pat Morishita

Routine controls aren't adequate to meet quarantine requirements of other states

Control of snails and slugs on ornamental plants in the field, nursery, or greenhouse has been a perennial problem. Feeding by these molluscs on the flowers and foliage of many different plant species, together with their unsightly slime trials, can greatly reduce marketability of plants. Therefore, growers of ornamental plants commonly apply a molluscicide during periods of high snail and slug activity.

Quarantine problem

Routine control procedures, such as application of a molluscicide, removal of hiding places, weed control in and around the nursery or greenhouse, and good sanitation, can usually be relied upon to prevent or reduce snail and slug damage to plants. However, in the face of regulatory action by other states, these control practices are no longer satisfactory. On February 21, 1984, Alabama, Arkansas, Louisiana, Mississippi, Oregon, Tennessee, and Virginia imposed quarantines on the brown garden snail, *Helix aspersa* Müller. Florida established a more comprehensive quarantine covering all phytophagous molluscs (that is, all snails and slugs).

If plant material shipped from California into one of these states is found to be infested with brown garden snail (or any snails or slugs in the case of Florida), the offending grower/shipper may be prohibited from shipping into that state for at least six months. In some states, violation of the quarantine results in an automatic six-month suspension. This represents immediate serious economic consequences for the grower/shipper and often results in the loss of regular customers. As of March 5, 1984, 31 California grower/shippers had been suspended from shipping into Florida.

Specific quarantine requirements vary from state to state, but in general, grower/shippers must have a snail- or molusc-free holding area, nursery, or greenhouse to obtain certification to ship into the state. Regular treatment of these snail- or mollusc-free areas is important to maintain certification. We therefore evaluated old and new molluscicides in lathhouse and field-nursery situations. We also tested the ability of selected materials to irritate and dislodge snails from plant material before storage for shipment.

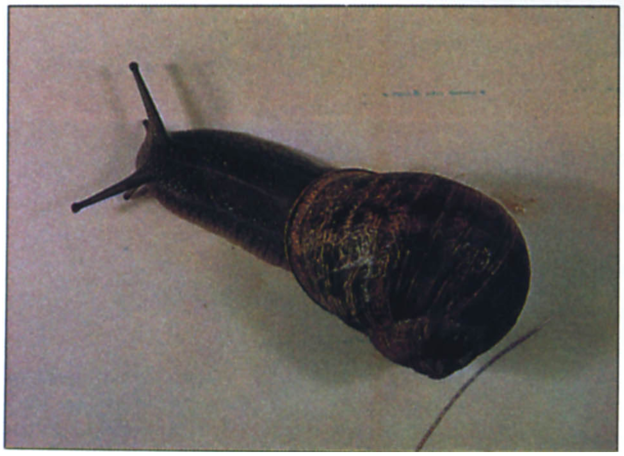
Molluscicide evaluation

Standard bedding plant flats, 18 inches square, were planted with a ground cover such as *Ostiospermum* or with chrysanthemum cuttings about one month before testing began. Wooden arenas (12 by 12 by 12 inches) were then placed in the center of each flat and forced about 1 inch deep into the soil; plants on the outside border of the arena were removed. A 1-inch-wide band of rock salt was glued around the top of the area as a barrier to the snails, keeping them in the arena.

Selected materials were applied to the foliage in the arenas at rates proportional to those recommended per acre. After application, 20 mature snails (1-inch diameter), collected from a nearby citrus grove where molluscicides had not been used, were added to each arena. Several different trials were conducted comparing specific formulations. Each dosage/formulation was applied to four arenas; in untreated controls, water was sprayed on foliage in arenas containing snails. Arenas were placed on raised benches within a lathhouse at the University of California, Riverside. Mortality of snails was recorded 1 day after application and thereafter every 3 days for 15 days, so that any snail recovery would be known and absolute mortality readings made.

A similar procedure was followed in the field-nursery trial except that larger arenas were used (9 square feet) and 20 chrysanthemum cuttings were planted in a 1-square-foot area in the center of the arena. Molluscicides were applied only to the 1-square-foot area containing plants; the rest of the arena remained untreated.

To approximate a field situation, we provided snails a place within the arena where they could hide during the day.



The brown garden snail, *Helix aspersa*, is difficult to eliminate from nursery plants such as Marguerite daisy with only bait or granular molluscicides, yet all must be dislodged before plants can be shipped.

Only while foraging for food at night would they contact the pesticide. Also, the arenas received overhead sprinkler irrigation twice a day, which is typical of southern California nurseries. The number of replications and mortality readings were the same as in the lathhouse trial. In addition, after 15 days, we removed the original snails and added new mature snails to determine the duration of the pesticides' effectiveness.

In a test of the ability of selected pesticides to dislodge snails, bunches of cut myrtle (*Myrtus* sp.) artificially infested with brown garden snails were dipped for five seconds into specific insecticide solutions. Bunches were then suspended about 1 foot above flats and the number of snails dropping off was recorded. There were 10 bunches of *Myrtus* per treatment with 20 snails per bunch.

Results

Materials found to have little or no molluscicidal activity included methomyl 1.8L, bendiocarb 76W, 10G, carbosulfan 2.5E, 10G, and carbaryl 20 percent bait. Mortality assessments after five days showed that methiocarb, mexacarbate, and metaldehyde (as Deadline) provided the best control (table 1). Combining metaldehyde or thiodicarb with methiocarb gave good control, although not better than methiocarb alone.

Only five-day mortality readings are given; snail recovery was minimal after this period. Snail mortality with some materials did increase in later readings as a result of constant exposure to the molluscicides. However, this was not considered, because continual exposure to molluscicide in a field-nursery situation is unlikely to occur.

Results at a cooperating nursery were similar to those in the lathhouse trials. However, under the irrigation system at the nursery, materials rapidly lost their ability to kill snails. Only the metaldehyde 4 percent (Deadline) provided any appreciable kill after 14 days.

Of the materials tested, insecticidal soap was the most effective at dislodging snails (table 2). This material not only dislodged 88 percent of the snails, but did so after the first 15-minute period of observation. While dipping bunches of cut greens in insecticidal soap immediately after harvest may seem to be an effective means of dislodging snails, in a quarantine situation, dislodging 100 percent of the snails is the only acceptable result. More research is needed — dipping for longer periods, increasing the soap concentration, and the like. In addition, an important aspect that we did not test was the possible effect of the soap on the dipped plant, such as removal of the distinct coloration of eucalyptus leaves or vase life of eucalyptus after dipping.

Maximizing control

Slug and snail species differ in their sensitivity to pesticides, host plant preferences, activity periods, favorite resting places, and the like. Therefore, knowledge of the species and their habits can greatly increase chances for control. For example, brown garden snail, which normally spends a good deal of its time off the ground on plants, is difficult to eliminate with only bait or granular formulations of molluscicides.

In general, snails are more sensitive than slugs are to pesticides. However, sensitivity depends on the species, size and maturity of the individuals, and the manner in which the mollusc comes into contact with the pesticide. For example, the grey garden slug, *Agriolimax reticulatus* (Müller) is very sensitive to physical contact with metaldehyde, but mortality from ingestion is minimal. The opposite is true of the brown garden snail.

Application of molluscicides to unprotected, exposed areas is unlikely to be effective, because snails and slugs do not frequent such areas. Placing the material close to plant flats, fences, and walls should maximize contact of mollusc with pesticide. Also, placement of effective baits repeatedly in the same areas maximizes control, because molluscs tend to "learn" the location of food sources and will return to the same areas to feed.

Feeding by slugs on Pepperomia (above) and orchids reduces the marketability of these and other flowers and nursery plants.

TABLE 1. Efficacy of selected materials and formulations for control of brown garden snail in lathhouse trials, UC Riverside

Treatment*	Mean no. dead snails after 5 days†	Percent mortality
Metaldehyde		
25% liquid (That's It), 2 lb ai/acre	8.8 d	43.8
4% bait (Deadline), 1-sq-in drop/sq ft	16.0 b	80.0
2% bait (Soil Serv), 4 lb ai/acre	3.2 e	16.0
Methiocarb		
2% bait (Mesurol), 4 lb ai/acre	19.4 a	97.0
75W liquid (Mesurol), 2 lb ai/acre	15.4 b	77.0
Mexacarbate		
2E liquid (Zectran), 2 lb ai/acre	16.4 b	82.0
2E liquid (Zectran), 4 lb ai/acre	19.2 a	96.0
50W liquid (Zectran), 2 lb ai/acre	18.8 ab	94.0
50W liquid (Zectran), 4 lb ai/acre	18.6 ab	93.0
Thiodicarb		
3.2E liquid (Larvin), 2 lb ai/acre	10.0 c	50.0
Metaldehyde + methiocarb, 2% + 2% bait (Soil Serv), 4 lb ai/acre	17.2 b	86.0
Thiodicarb + methiocarb, 1.75% + 2% bait (Soil Serv), 4 lb ai/acre	18.4 ab	92.0

* Deadline applied to one location within each arena; other materials placed uniformly throughout the arenas.
† Means followed by the same letter do not differ significantly (P=0.05), Duncan's new multiple range test. Control mortality was always less than 5%.

TABLE 2. Efficacy of dip treatments to remove brown garden snail from myrtle *(Myrtus)* bunches

Treatment*	Count 60 minutes posttreatment†
Insecticidal soap, 50.5%, 300 oz form material	3.3 a
Methomyl, 1.8L, 0.5 lb ai	6.2 b
Permethrin 3.2E, 0.25 lb ai	9.7 c
Bendiocarb 76W, 0.5 lb ai	9.8 c
Control (water)	16.0 d

* Rates are per 100 gallons water.
† Mean number of snails per bunch. Pretreatment count was a mean of 20 snails per bunch in each case. Means followed by the same letter do not differ significantly (P=0.05), DMRT.

The habituation and development of resistance to a particular material may occur as a result of the recovery of snails or slugs from sublethal molluscicide doses. This is quite common and depends on environmental conditions and the material used. For example, metaldehyde is relatively ineffective in cool weather (68°F or lower), is rapidly inactivated by sunlight, and declines in effectiveness at high humidities (75 percent RH or greater) after application. These characteristics appear not to be the case with Deadline, which is a special formulation of metaldehyde. Carbamate materials, such as mexacarbate and methiocarb, on the other hand, are less effective (more snails and slugs recover) if dry conditions prevail after application. In fact, the toxicity of these materials increases in humid surroundings. Alternating the use of metaldehyde with carbamates should improve mollusc control while reducing problems associated with resistance or habituation to a specific material.

Maximum control of snails and slugs can only be obtained through knowledge of the biological and physical requirements of the particular target species together with consideration for the influence of environment on the molluscicide.

Michael P. Parrella is Assistant Professor, Karen L. Robb is Staff Research Associate, and Pat Morishita (retired) was Staff Research Associate, Department of Entomology, University of California, Riverside. *This research was supported by the California Association of Nurserymen and the Northern California Flower Growers and Shippers Association. The technical assistance of Alan Urena and Drs. Judy Johnson and Adrian Mayr is gratefully acknowledged.*