Environmental Horticulture Program Research Summaries

# IR-4 Environmental Horticulture Program
# Mollusc Efficacy

## Brown Garden Snail (*Cryptomphalus aspersus*)

**Author: Cristi L. Palmer**
**Date: April 16, 2024**

**Acknowledgements**
**Ely Vea**
**Susan Bierbrunner**

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award numbers 2015-34383-23710, 2017-34383-27100, 2019-34383-29973, 2020-34383-32455 and 2021-343830-34848 with substantial cooperation and support from the State Agricultural Experiment Stations and USDA-ARS.

## Table of Contents

## Table of Tables

## Abstract

Molluscs (slugs and snails) can cause significant feeding damage of environmental horticulture plants in production. Baits containg metaldehyde or iron phosphate are the primary means to manage molluscs. This project was initiated to examine the potential for active ingredients with less risky environmental and mammalian toxicity profiles to be effective molluscicides. To study options for managing snails, eleven (11) products with eight (8) different active ingredients were screened against the brown garden snail (*Cyptomphalus apersus*). Of these, two baits with metaldehyde (Deadline T&O and Metarex) provided generally good management of the brown garden snail, although not strictly by causing mortality; in experiments where mortality was limited, plant damage was reduced to commercially acceptable levels. TC Powder provided variable efficacy, but further studies are warranted to determine how efficacy could be improved. SpinOut also provided inconsistent efficacy, but later studies demonstrated better plant protection than earlier experiments.

## Introduction

Molluscs (slugs and snails) can cause significant feeding damage of environmental horticulture plants in production. Baits containg metaldehyde or iron phosphate are the primary means to manage molluscs. This project was initiated to examine the potential for active ingredients with less risky environmental and mammalian toxicity profiles to be effective molluscicides. Research was conducted in 2009 through 2012, 2018 and 2019.

## Materials and Methods

Generally, plants potted in containers were placed in test arenas where treatments were applied. A set number of adult snails were introduced to the arenas. Mortality was assessed every few days up to a week and then weekly with each experiment ending between 14 and 28 days after initial treatment. Metarex, a metaldehyde containing bait, was the standard product in most experiments. Most experiments tested additional bait formulations, but some experiments included treatments to plants and containers. The protocols used were 09-010, 10-022, 11-030, 18-016, and 20-023. For more detailed materials and methods, including application rates for various products, please visit https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-researcher-resources/#Protocols to view and download these protocols.

Commercial and numbered compound formulations were supplied to researchers (See list of researchers in Appendix 1) by their respective manufacturers.

## Results and Summary

### *Efficacy*

To study options for managing snails, eleven (11) products with eight (8) different active ingredients were screened against the brown garden snail (*Cyptomphalus apersus*). Of these, two baits with metaldehyde (Deadline T&O and Metarex) provided generally good management of the brown garden snail, although not strictly by causing mortality (Table 1). In experiments where mortality was limited, plant damage was reduced to commercially acceptable levels. TC Powder provided variable efficacy, but further studies are warranted to determine how efficacy could be improved. SpinOut also provided inconsistent efficacy, but later studies demonstrated better plant protection than earlier experiments. Of the iron based products, Sluggo 3 reduced snail populations and feeding damage at levels similar to Metarex in 2 experiments. The other products generally provided limited impact on snail mortality or feeding damage, but V-10433 at 40 oz in one experiment did exhibit 87.5% mortality. All experiments were conducted with a single application of all treatments, so further studies with some products reapplied at 7 or 14 days might provide better performance.

Please see below for outcomes from individual experiments.

**Table 1. Average efficacy rating for Brown Garden Snail.**

| Product (Active Ingredients) | MOA | Snail, Brown Garden (*Cryptomphalus aspersus*) |
|---|---|---|
| BW133 (BW133) | FRAC NC | 1.0 (1 - 1) n1 |
| Deadline T&O (Metaldehyde) | unknown | 2.7 (1 - 5) n6 |
| Elector (Spinosad) | IRAC 5 | 1.0 (1 - 1) n1 |
| Metarex (Metaldehyde) | unknown | 3.8 (3 - 5) n5 |
| Sluggo (Iron Phosphate) | unknown | 1.5 (1 - 2) n2 |
| Sluggo 3 (Iron Phosphate) | unknown | 2.5 (2 - 3) n2 |
| Slugkill 5 (FeEDTA-iron chelate) | unknown | 1.0 (1 - 1) n2 |
| Spinosad (Bran) (Spinosad) | IRAC 5 | 1.0 (1 - 1) n2 |
| SpinOut LF 100 (Copper hydroxide) | FRAC M1 | 1.7 (1 - 3) n3 |
| TC Powder (saponin) | unknown | 2.5 (1 - 5) n4 |
| V-10433 (V-10433) | unknown | 1.7 (1 - 3) n3 |

Average rating on a scale of 1 – 5 with 1 = 0 to about 70% efficacy and 5 = 100 efficacy or equivalent to non-inoculated control; minimum to maximum rating; number of trials. A rating of 2 or lower is considered unacceptable. A rating of 3 or higher is considered commercially acceptable.

In 2009, Wilen conducted two experiments in a greenhouse examining prospective molluscicides for managing Brown Garden Snail (*Cryptomphalus aspersus/Cornus aspersum/Helix aspersa*). Snails were collected from a citrus orchard where no molluscicides had been applied for at least one year. Ten adult snails were placed in arenas (2.6 sq ft plastic boxes with 3 inches of potting mix) opposite plants with treatments applied to the surface of the potting mix. Dead and moribund snails were counted and plant feeding damage was assessed up to 14 days after treatment. Deadline and Metarex (both containing metaldehyde) provided effective mortality by 7 DAT and both significantly reduced feeding damage even 1 DAT (Table 2, Table 3). TCPowder, was ineffective broadcast at 218 lb per acre. Thus, a second experiment was conducted increasing the TCPowder rate to 435 lb per acre. By 3 DAT, TCPowder exhibited 100% mortality and reduced feeding damage, equivalent to Metarex (Table 4).

**Table 2. Efficacy of Deadline, Metarex, and TCPowder for Brown Garden Snail, Wilen, 2009a.**

| Treatment | Rate per acre | Cumulative number dead snails | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 DAT | | 3 DAT | | 5 DAT | | 7 DAT | | 14 DAT | |
| Deadline T&O | 20 lb | 2.83 | b | 5.33 | b | 6.33 | b | 8.33 | b | 8.83 | b |
| Metarex | 87.1 lb | 3.00 | b | 4.50 | b | 6.17 | b | 8.17 | b | 9.00 | b |
| TCPowder | 218 lb | 0.00 | a | 0.00 | a | 0.00 | a | 0.00 | a | 0.50 | a |
| Nontreated | | 0.00 | a | 0.00 | a | 0.00 | a | 0.00 | a | 0.00 | a |
| | | p=.0000 | | p=.0000 | | p=.0000 | | p=.0000 | | p=.0000 | |

*Means in a column followed by the same letter are not significantly different at the P=0.05 level. Mean separation was done using Duncan's Mean Separation

**Table 3. Marigold Feeding Injury after application of Deadline, Metarex, and TCPowder for Brown Garden Snail, Wilen, 2009a.**

| Treatment | Rate per acre | Plant injury (0=no injury, 10=no aboveground plant) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 DAT | | 3 DAT | | 5 DAT | | 7 DAT | | 14 DAT | |
| Deadline T&O | 20 lb | 2.50 | a | 2.83 | a | 1.83 | b | 2.67 | b | 2.67 | b |
| Metarex | 87.1 lb | 1.67 | a | 1.50 | a | 0.67 | a | 1.17 | a | 1.52 | a |
| TCPowder | 218 lb | 6.67 | b | 8.50 | b | 9.00 | c | 9.92 | c | 9.17 | c |
| Nontreated | | 7.50 | b | 9.50 | b | 9.00 | c | 10.00 | c | 9.42 | c |
| | | p=.0000 | | p=.0000 | | p=.0000 | | p=.0000 | | p=.0000 | |

*Means in a column followed by the same letter are not significantly different at the P=0.05 level. Mean separation was done using Duncan's Mean Separation

**Table 4. Efficacy of and Marigold Feeding Injury after application of Deadline, Metarex, and TCPowder for Brown Garden Sail, Wilen, 2009b.**

| Treatment | Rate per Acre | Cumulative number dead snails | | | | Plant injury | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2 DAT | | 3 DAT | | 2 DAT | | 3 DAT | |
| Metarex | 87.1 lb | 4.25 | b | 8.50 | b | 1.5 | a | 1.5 | a |
| TCPowder | 435 lb | 5.50 | c | 10.00 | c | 2.5 | a | 2.5 | a |
| Nontreated | | 0.00 | a | 0.00 | a | 7.75 | b | 7.75 | b |
| | | p=.0000 | | p=.0000 | | p=.0037 | | p=.0037 | |

Plant injury (0=no injury, 10=no aboveground plant)

*Means in a column followed by the same letter are not significantly different at the P=0.05 level. Mean separation was done using Duncan's Mean Separation

In 2010, Wilen conducted a greenhouse experiment examining prospective molluscicides for managing Brown Garden Snail (*Cryptomphalus aspersus/Cornus aspersum/Helix aspersa*). Snails were collected from a citrus orchard where no molluscicides had been applied for at least one year. Ten adult snails were placed in arenas (2.6 sq ft plastic boxes with 3 inches of potting mix) opposite plants with treatments applied to the surface of the potting mix. Dead and moribund snails were counted and plant feeding damage was assessed up to 28 days after treatment. It was observed that uniform coverage was not achievable with Elector and Conserve, and it is possible snails did not consume these treatments.

Less mortality was observed in this experiment than in the 2009 experiments. Deadline, Metarex, and Sluggo provided between 20 and 58% mortality (Table 5). However, significant feeding damage still occurred with Deadline and Sluggo (Table 6). Metarex reduced feeding damage as did both rates of TCPowder. TCPowder appeared to have a very strong repellent effect, and snails withdrew or sealed themselves off as a behavorial response.

**Table 5. Efficacy of Molluscicides for Brown Garden Snail, Wilen, 2010.**

| Treatment | Rate per Acre | Cumulative Percent Dead | | | | |
|---|---|---|---|---|---|---|
| | | 1DAT | 3DAT | DAT | 14DAT | 28DAT |
| Deadline | 15 lb | 0.00 | 3.333 b | 6.667 bcd | 23.333 ab | 25.000 abc |
| Sluggo | 15 lb | 0.00 | 1.667 b | 1.667 cd | 8.333 cd | 10.000 cd |
| Sluggo 3 | 15 lb | 0.00 | 1.667 b | 11.667 ab | 25.000 a | 33.333 ab |
| Slugkil | 15 lb | 0.00 | 10.000 a | 16.667 a | 20.000 abc | 20.000 bc |
| TCPowder | 436 lb | 1.67 | 3.333 b | 3.333 cd | 10.000 bcd | 10.000 cd |
| Elector | 3.75 lb | 0.00 | 0.000 b | 0.000 d | 0.000 d | 0.000 d |
| Elector | 5 lb | 0.00 | 0.000 b | 0.000 d | 0.000 d | 0.000 d |
| Conserve | 11g ai* | 0.00 | 0.000 b | 0.000 d | 0.000 d | 0.000 d |
| Metarex | 43.6 lb | 0.00 | 1.667 b | 8.333 bc | 28.333 a | 36.667 a |
| Untreated | | 0.00 | 0.000 b | 0.000 d | 0.000 d | 0.000 d |
| TCPowder | 174 lb | 0.00 | 0.000 b | 0.000 d | 0.000 d | 1.667 d |

Means followed by same letter do not significantly differ (P=.05, LSD)

**Table 6. Salvia Feeding Injury after application of Molluscicides for Brown Garden Snail, Wilen, 2010.**

| Treatment | Rate per Acre | Plant Feeding Damage | | | | |
|---|---|---|---|---|---|---|
| | | 1DAT | 3DAT | DAT | 14DAT | 28DAT |
| Deadline | 15 lb | 1.67 c | 2.17 d | 2.50 d | 4.00 bc | 3.67 cd |
| Sluggo | 15 lb | 4.33 ab | 6.83 abc | 6.50 ab | 5.83 ab | 8.50 a |
| Sluggo 3 | 15 lb | 4.67 ab | 6.50 bc | 4.00 cd | 3.67 bc | 6.33 ab |
| Slugkil | 15 lb | 4.50 ab | 6.17 c | 5.50 bc | 6.00 ab | 6.50 ab |
| TCPowder | 436 lb | 0.17 d | 0.00 f | 0.00 e | 0.33 d | 2.50 d |
| Elector | 3.75 lb | 5.17 a | 7.83 ab | 7.00 ab | 5.50 ab | 8.83 a |
| Elector | 5 lb | 3.33 b | 7.83 ab | 7.33 a | 6.17 ab | 8.17 a |
| Conserve | 11g ai* | 4.83 a | 8.17 a | 6.83 ab | 5.83 ab | 8.83 a |
| Metarex | 43.6 lb | 0.83 cd | 1.67 de | 2.67 d | 2.50 cd | 1.67 d |
| Untreated | | 5.00 a | 8.00 a | 7.00 ab | 7.17 a | 8.67 a |
| TCPowder | 174 lb | 0.17 d | 0.33 ef | 0.00 e | 0.17 d | 5.50 bc |

Means followed by same letter do not significantly differ (P=.05, LSD)

In 2011, Wilen conducted two greenhouse experiments examining prospective molluscicides for managing Brown Garden Snail (*Cryptomphalus aspersus/Cornus aspersum/Helix aspersa*). Snails were collected from a citrus orchard where no molluscicides had been applied for at least one year. Ten adult snails were placed in arenas (2.6 sq ft plastic boxes with 3 inches of potting mix) opposite plants with treatments applied to the surface of the potting mix. Dead and moribund snails were counted and plant feeding damage was assessed up to 19 days after treatment.

Similar to the 2010 experiments, less mortality was observed in this experiment than in the 2009 experiments. In the first experiment, Deadline, Metarex, and Sluggo 3 provided between 28 and 30% mortality (Table 7). However, significant feeding damage still occurred with Deadline and Sluggo (Table 6). By 14 DAT, Deadline, Sluggo 3, and Metarex reduced feeding damage. In the second experiment, Metarex caused 27% mortality (Table 9). While TCPower did not significant

impact snail mortality, it exhibited repellency where snails withdrew their foot or sealed themselves off as a behavorial response, reducing feeding damage through 7 DAT (Table 10).

**Table 7. Efficacy of molluscicides for Brown Garden Snail, Wilen, 2011a.**

| Treatment | Rate per acre | Cumulative number dead snails | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 DAT | | 3 DAT | | 5 DAT | | 7 DAT | | 14 DAT | | 19 DAT | |
| Deadline T&O | 15 lb | 1.7 | a | 2.3 | a | 2.5 | a | 2.7 | a | 2.8 | a | 3 | a |
| Sluggo | 15 lb | 0 | b | 0.2 | b | 0.5 | c | 0.8 | b | 0.7 | b | 0.8 | b |
| Sluggo 3 | 15 lb | 0 | b | 0.2 | b | 1.7 | b | 2.5 | a | 2.2 | a | 2.8 | a |
| Slugkil 5 | 15 lb | 0 | b | 0 | b | 0.3 | c | 0.5 | b | 0.8 | b | 0.8 | b |
| Conserve 15 | 15 lb | 0 | b | 0 | b | 0 | c | 0 | b | 0 | b | 0 | b |
| Conserve 20 | 20 lb | 0 | b | 0 | b | 0 | c | 0 | b | 0 | b | 0 | b |
| Metarex | 21.8 lb | 1.7 | a | 1.8 | a | 2 | ab | 2.5 | a | 3 | a | 3 | a |
| UTC | | 0 | b | 0 | b | 0 | c | 0 | b | 0 | b | 0 | b |
| | | p=.0001 | | p=.0001 | | p=.0001 | | p=.0001 | | p=.0001 | | p=.0001 | |

* Means followed by same letter do not significantly differ (P=.05, LSD)

**Table 8. Marigold Feeding Injury after application of molluscicides for Brown Garden Snail, Wilen, 2011a.**

| Treatment | Rate per acre | Plant injury (0=no injury, 10=no aboveground plant) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 DAT | | 3 DAT | | 5 DAT | | 9 DAT | | 14 DAT | |
| Deadline T&O | 15 lb | 2.3 | | 3.2 | abc | 4.3 | abc | 3.8 | de | 2.8 | cd |
| Sluggo | 15 lb | 4.8 | | 2.3 | c | 3 | bcd | 5.5 | cd | 5 | bc |
| Sluggo 3 | 15 lb | 4.3 | | 2.5 | c | 2.3 | cd | 2.5 | e | 2.5 | d |
| Slugkil 5 | 15 lb | 3.8 | | 2.8 | bc | 3.5 | abcd | 6 | bcd | 5.8 | b |
| Conserve 15 | 15 lb | 5.3 | | 5.7 | ab | 5.3 | ab | 9 | a | 9.7 | a |
| Conserve 20 | 20 lb | 4.8 | | 4 | abc | 5.8 | a | 7.3 | abc | 8.8 | a |
| Metarex | 21.8 lb | 1 | | 1.2 | c | 1.2 | d | 1.7 | e | 1.7 | d |
| UTC | | 5.7 | | 6 | a | 3.7 | abc | 8.3 | ab | 9.5 | a |
| | | p=.0512 | | p=.0318 | | p=.0063 | | p=.0001 | | p=.0001 | |

* Means followed by same letter do not significantly differ (P=.05, LSD)

**Table 9. Efficacy of Deadline, Metarex, and TCPowder for Brown Garden Snail, Wilen, 2011b.**

| Treatment | Rate per acre | Cumulative number dead snails | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 DAT | | 3 DAT | | 6 DAT | | 7 DAT | | 14 DAT | |
| Metarex | 87.1 lb | 0.7 | | 1.3 | a | 1.2 | | 2.0 | a | 2.7 | a |
| TC Powder | 10 lb | 0.2 | | 0.2 | b | 0.2 | | 0.2 | b | 0.2 | b |
| Nontreated | | 0.0 | | 0.0 | b | 0.0 | | 0.0 | b | 0.0 | b |
| | | p=.2948 | | p=.0050 | | p=.1056 | | p=.0016 | | p=.0002 | |

* Means followed by same letter do not significantly differ (P=.05, LSD)

**Table 10. Marigold Feeding Injury after application of Metarex and TCPowder for Brown Garden Snail, Wilen, 2011b.**

| Treatment | Rate per acre | Plant injury (0=no injury, 10=no aboveground plant) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 DAT | | 3 DAT | | 6 DAT | | 7 DAT | | 14 DAT | |
| Metarex | 87.1 lb | 0.3 | b | 0.3 | b | 1.8 | b | 0.7 | b | 1.2 | b |
| TCPowder | 10 lb | 0.3 | b | 1.7 | b | 1.5 | b | 0.0 | b | 5.0 | a |
| Nontreated | | 3.7 | a | 7.0 | a | 7.3 | a | 9.0 | a | 8.3 | a |
| | | p=.0063 | | p=.0018 | | p=.0180 | | p=.0001 | | p=.0022 | |

* Means followed by same letter do not significantly differ (P=.05, LSD)

In 2018, McDonnell conducted a greenhouse experiment examining prospective molluscicides for managing Brown Garden Snail (*Cryptomphalus aspersus/Cornus aspersum/Helix aspersa*). Four adult snails were placed in arenas (plastic boxes) containing two pots with 'Bonanza Yellow' marigolds. Treatments were applied as prescribed for each product. Deadline was broadcast to the soil surface of the pots. Spinout was applied to the outside of pots with a spray bottle and then spread evenly with paper towels dampen with 5 ml of solution. V-10433 was applied as a foliar spray to run off. Location (in or out of a pot containing the marigold) and mortality of snails were assessed. If snails were found on the potting mixed, they were moved to near the bottom of the pot containing the marigold. Plant health was assessed at the beginning and end of the experiment.
Deadline caused 93.8% mortality, fewer snails (although not statistically significant) were found "in" the pot/plant (Table 11), and plants were healthy at the end of the experiment (data not shown). Spinout did not provide an effective barrior in this experiment and caused no mortality. V-10433 applied at 40 oz per 100 gal exhibited 87.5% mortality, fewer snails (although not statistically significant) were found "in" the pot/plant, and plants were healthy at the end of the experiment (data not shown).

**Table 11. Efficacy of Deadline, Spinout, and V-10433 for Brown Garden Snail, McDonnall, 2018.**

| Treatment | Application Method | Mortality 28 DAT (%) | Out (Not in soil or on plant) | In (On soil or plant) |
|---|---|---|---|---|
| Deadline 40 lb per acre | Broadcast | 93.75a* | 2 | 57 |
| V-10433 40 oz per 100 gal | Foliar spray | 87.5a | 7 | 61 |
| V-10433 8 oz per 100 gal | Foliar spray | 12.5b | 9 | 127 |
| Spinout No dilution | Application to pot | 0c | 13 | 131 |
| Spinout 1 quart per 1 gal | Application to pot | 0c | 7 | 137 |
| Inoculated, Non-treated | -- | 0c | 6 | 138 |
| Non-treated, Non-inoculated | -- | NA | NA | NA |

*Means separated with Tukey-Kramer multiple comparison adjustment, $\alpha = 0.05$.

In 2019, Uber conducted an outdoor experiment examining prospective molluscicides for managing Brown Garden Snail (*Cryptomphalus aspersus/Cornus aspersum/Helix aspersa*). Ten adult snails were placed in arenas (3' x 3' x 1' open to the clay/loam soil below) containing one 6" pot with 'Durango Orange' marigolds. Each arena was at the base of a citrus tree. Treatments were applied as prescribed for each product. Deadline was broadcast to the soil surface of the

pots. Spinout was applied to the outside of pots with a spray bottle and then spread evenly with paper towels dampen with 5 ml of solution. V-10433 was applied as a foliar spray to run off. Snails were collected from a commercial citrus grove. Mortality of snails was assessed with moribund larvae not included as 'dead'. If snails were found on sides or top of the arena, they were moved to the arena floor. Feeding damage was assessed on a scale of 0 to 10.
Deadline caused 65% mortality, and plant feeding damage was reduced at the end of the experiment (Table 12). Spinout did not impact snail mortality, but feeding damage was reduced due to repellency with the high rate demonstrated significantly less plant damage through 28 DAT. Neither rate of V-10433 impacted snail mortality, and feeding damage was the same as the nontreated controls.

**Table 12. Efficacy of Deadline, Spinout, and V-10433 for Brown Garden Snail, Uber, 2019.**

| Treatment | Application Method | Live Snails 28 DAT | | Plant Damage 28 DAT | |
|---|---|---|---|---|---|
| Deadline 40 lb per acre | Broadcast | 3.5 | b | 4.9 | b |
| V-10433 40 oz per 100 gal | Foliar spray | 10.0 | a | 10.0 | a |
| V-10433 8 oz per 100 gal | Foliar spray | 9.0 | a | 10.0 | a |
| Spinout No dilution | Dip | 8.5 | a | 5.4 | b |
| Spinout 1 quart per 1 gal | Dip | 9.5 | a | 9.5 | a |
| Inoculated, Non-treated | -- | 10.0 | a | 10.0 | a |

In 2020, Uber conducted an outdoor experiment examining prospective molluscicides for managing Brown Garden Snail (*Cryptomphalus aspersus/Cornus aspersum/Helix aspersa*). Ten adult snails were placed in arenas (3' x 3' x 1' open to the sandy/loam soil below) containing one 6" pot with 'Bonanza Yellow' marigolds. Each arena was at the base of a citrus tree. Treatments were applied as prescribed for each product. Deadline was broadcast to the soil surface of the pots. Spinout was applied to the outside of pots with a spray bottle and then spread evenly with paper towels dampen with 5 ml of solution. BW-133 and V-10433 were applied as foliar sprays to run off. Snails were collected from a commercial citrus grove. Mortality of snails was assessed with moribund larvae not included as 'dead'. If snails were found on sides or top of the arena, they were moved to the arena floor. Feeding damage was assessed on a scale of 0 to 10.
Deadline caused 21% mortality through 14 DAT, but plant feeding damage was reducedcompared to the non-treated arena (Table 12). Spinout did not impact snail mortality, but less feeding damage occurred than another other treatment through 33 DAT. Neither rate of B-133 or V-10433 impacted snail mortality, and feeding damage was consistent with the nontreated controls.

**Table 13. Efficacy of Molluscicides for Brown Garden Snail, Uber, 2020.**

| Treatment | Application Method | Live Snails 14 DAT | | Plant Damage 19 DAT | | Plant Damage 33 DAT | |
|---|---|---|---|---|---|---|---|
| BW133 5 lb per 100 gal | Foliar spray | 9.8 | a | 4.8 | bc | 7.8 | bc |
| BW133 3 lb per 100 gal | Foliar spray | 9.5 | a | 5.0 | abc | 9.8 | a |
| Deadline 40 lb per acre | Broadcast | 7.8 | b | 3.8 | cd | 6.8 | c |
| Spinout 1 quart per 1 gal | Dip | 9.5 | a | 1.5 | de | 2.3 | d |
| Spinout No dilution | Dip | 9.3 | a | 0.3 | e | 2.0 | d |
| V-10433 8 oz per 100 gal | Foliar spray | 9.8 | a | 7.3 | ab | 10.0 | a |
| V-10433 40 oz per 100 gal | Foliar spray | 10.0 | a | 7.5 | a | 9.8 | a |
| Inoculated, Non-treated | -- | 9.3 | a | 6.3 | abc | 9.3 | ab |
| Non-Inoculated, Non-treated | | 0.0 | c | 0.0 | e | 0.0 | e |

## Table 14. Detailed Summary of Efficacy Screening for Brown Garden Snail

Note: Table entries are sorted by crop Latin name. Only those trials with research reports received by 4/11/2024 are listed below.

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | State | Year | Application Type | Results |
|---|---|---|---|---|---|---|---|---|---|
| 34456 | BW133 (BW133) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Field Container | Uber | CA | 2020 | Surface of potting media | No reduction in live snail populations with 3 or 5 lb per 100 gal and feeding damage comparable to inoculated controls. |
| 30214 | Deadline T&O (Metaldehyde) | Snail, Brown Garden (Cryptomphalus aspersus) | Scarlet Sage (Salvia splendens) | Greenhouse | Wilen | CA | 2010 | Broadcast | 25.0 % snail mortality and significant, but insufficient, reduction of feeding damage at 15 lb per acre. |
| 29360 | Deadline T&O (Metaldehyde) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) 'Bonanza Yellow' | Greenhouse | McDonnell | OR | 2018 | Broadcast | Great control with 40 lb per acre applied as bait on soil; best treatment. |
| 33903 | Deadline T&O (Metaldehyde) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) 'Durango Orange' | Field Container | Uber | CA | 2019 | Broadcast | Up to 65% mortality with 20 lb per acre; good reduction of feeding damage. |
| 33903 | Deadline T&O (Metaldehyde) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) 'Bonanza Yellow' | Field Container | Uber | CA | 2020 | Broadcast | Some reduction in live snail populations with 25 lb per acre and feeding damage was comparable to inoculated controls. |
| 29360 | Deadline T&O (Metaldehyde) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2009 | Broadcast | Excellent control at 20 lb per acre; comparable to Metarex. |
| 29360 | Deadline T&O (Metaldehyde) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2011 | Broadcast | 30% snail mortality and acceptable reduction of feeding damage at 15 lb per acre. |
| 30215 | Elector (Spinosad) | Snail, Brown Garden (Cryptomphalus aspersus) | Scarlet Sage (Salvia splendens) | Greenhouse | Wilen | CA | 2010 | Broadcast | 0 % snail mortality and no reduction of plant feeding damage at 3.75 and 5 lb per acre. |
| 30216 | Metarex (Metaldehyde) | Snail, Brown Garden (Cryptomphalus aspersus) | Scarlet Sage (Salvia splendens) | Greenhouse | Wilen | CA | 2010 | Broadcast | 36.7 % snail mortality and acceptable reduction of feeding damage at 43.6 lb per acre. |
| 29693 | Metarex (Metaldehyde) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2009 | Broadcast | Experiment 1: Excellent control at 87.1 lb per acre. |
| 29693 | Metarex (Metaldehyde) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2009 | Broadcast | Experiment 2: Excellent control at 87.1 lb per acre. |
| 29693 | Metarex (Metaldehyde) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2011 | Broadcast | Experiment 1: 30% snail mortality and acceptable reduction of feeding damage at 21.8 lb per acre. |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | State | Year | Application Type | Results |
|---|---|---|---|---|---|---|---|---|---|
| 29693 | Metarex (Metaldehyde) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2011 | Broadcast | Experiment 2: 27% snail mortality but great reduction of feeding damage. |
| 30217 | Sluggo (Iron Phosphate) | Snail, Brown Garden (Cryptomphalus aspersus) | Scarlet Sage (Salvia splendens) | Greenhouse | Wilen | CA | 2010 | Broadcast | 10.0 % snail mortality and no significant reduction of feeding damage at 15 lb per acre. |
| 29796 | Sluggo (Iron Phosphate) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2011 | Broadcast | Did not significantly reduce snail mortality at 15 lb per acre; significant, but insufficient, reduction of feeding damage. |
| 30218 | Sluggo 3 (Iron Phosphate) | Snail, Brown Garden (Cryptomphalus aspersus) | Scarlet Sage (Salvia splendens) | Greenhouse | Wilen | CA | 2010 | Broadcast | 33.3 % snail mortality and significant, but insufficient, reduction of feeding damage at 15 lb per acre. |
| 29798 | Sluggo 3 (Iron Phosphate) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2011 | Broadcast | Up to 56 % snail mortality and acceptable reduction of feeding damage at 15 lb per acre. |
| 30219 | Slugkill 5 (Sodium ferric EDTA (FeEDTA-iron chelate)) | Snail, Brown Garden (Cryptomphalus aspersus) | Scarlet Sage (Salvia splendens) | Greenhouse | Wilen | CA | 2010 | Broadcast | 20.0 % snail mortality and no significant reduction of feeding damage at 15 lb per acre. |
| 29964 | Slugkill 5 (Sodium ferric EDTA (FeEDTA-iron chelate)) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2011 | Broadcast | Did not significantly reduce snail mortality at 15 lb per acre; significant, but insufficient, reduction of feeding damage. |
| 30220 | Spinosad (Bran) (Spinosad) | Snail, Brown Garden (Cryptomphalus aspersus) | Scarlet Sage (Salvia splendens) | Greenhouse | Wilen | CA | 2010 | Broadcast | 0 % snail mortality and no significant reduction of feeding damage at 5 lb per acre. |
| 29966 | Spinosad (Bran) (Spinosad) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2011 | Broadcast | No efficacy. |
| 33793 | SpinOut LF 100 (Copper hydroxide) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Field Container | McDonnell | OR | 2018 | Spray on container | No control with 1 qt per gal applied as barrier outside of pots. |
| 33793 | SpinOut LF 100 (Copper hydroxide) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) 'Durango Orange' | Field Container | Uber | CA | 2019 | Spray on container | No mortality with 25 and 100% v/v, but good reduction of feeding damage with 100% v/v. |
| 33793 | SpinOut LF 100 (Copper hydroxide) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Field Container | Uber | CA | 2020 | Spray on container | No reduction in live snail populations with 0.25% or 100% v/v but by 7 and 9 days after treatment feeding damage was low and comparable to the non- inoculated controls. |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | State | Year | Application Type | Results |
|---|---|---|---|---|---|---|---|---|---|
| 30221 | TC Powder (TSP (ai saponin)) | Snail, Brown Garden (Cryptomphalus aspersus) | Scarlet Sage (Salvia splendens) | Greenhouse | Wilen | CA | 2010 | Over the top | 1.7 and 10 % snail mortality at 174 and 436 lb per acre; acceptable reduction of feeding damage at the higher rate. |
| 29361 | TC Powder (TSP (ai saponin)) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2009 | Broadcast | Experiment 1: No control at 218 lb per acre. |
| 29361 | TC Powder (TSP (ai saponin)) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2009 | Broadcast | Experiment 2: Excellent control at 436 lb per acre; better than Metarex. |
| 29361 | TC Powder (TSP (ai saponin)) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Greenhouse | Wilen | CA | 2011 | Broadcast | Did not significantly reduce snail mortality at 10 lb per 1000 sq ft; acceptable reduction of feeding damage only for 7 days. |
| 33794 | V-10433 (V-10433) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Field Container | McDonnell | OR | 2018 | Surface of potting media | Good control with 40 oz per 100 gal sprayed to runoff; comparable to Deadline. Lower rate inefective. |
| 33794 | V-10433 (V-10433) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) 'Durango Orange' | Field Container | Uber | CA | 2019 | Surface of potting media | No mortality or reduction of feeding damage with 8 and 40 fl oz per acre. |
| 33794 | V-10433 (V-10433) | Snail, Brown Garden (Cryptomphalus aspersus) | Marigold, French (Tagetes patula) | Field Container | Uber | CA | 2020 | Surface of potting media | No reduction in live snail populations with 8 or 40 oz per 100 gal and feeding damage comparable to inoculated controls. |

## Appendix 1: Contributing Researchers


| | |
|---|---|
| Dr. Rory McDonnell | Oregon State University<br>Corvalis, OR 97331 |
| Dr. Buzz Uber | Crop Inspection Service<br>Valley Center, CA 92082 |
| Dr. Cheryl Wilen<br>(retired) | University of California, San Diego<br>Sandiego, CA 92123 |