INVITED ARTICLE

SEEKING SNAIL SOLUTIONS: ASSESSING SNAIL BAITS AND NOVEL SNAIL MANAGEMENT APPROACHES

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TAKE HOME MESSAGES

- Juvenile snails can be killed with bait (mortality 18-80%), but efficacy is highly variable due to numerous factors.
- Preliminary studies indicate that bait density is more important than bait size.
- GRDC is funding a new round of snail/slug research to expand on some of these scoping studies.

BACKGROUND

Snails in broadacre crops pose a very real threat to grain export through contamination at harvest. In south-eastern Australia, round and conical snails cause frustration and harvest delays due to clogged machinery. They also cause considerable damage to germinating crops. Year round snail management should involve an integrated approach of various cultural, mechanical and chemical controls. Baiting is a major tool that, when used at the right time, can offer good control. Poor success of baiting programs may be a result of several variables, including timing, species and age of snails, environmental conditions, and properties of commercial baits. Juvenile snails (<7mm) are considered especially hard to control (SARDI 2003).

Over the years, numerous novel products other than commercial snail baits have been rumoured to be toxic to snails. Occasionally, farmers have conducted their own small scale trials in a desperate search for more snail management tools. Caffeine (dissolved in solution) to repel and/or kill snails on canola windrows has been tested on a small scale by several groups, with varying success. A horticultural fertiliser Perlka® (granulated calcium cyanamide) with herbicidal and other properties was also suggested to be toxic to snails in all life stages.

AIM

Investigate the efficacy of several commercial snail baits on juveniles of the four pest snail species, and assess the effect of bait size and density on mortality.

Conduct preliminary trials to investigate the usefulness of caffeine and Perlka® as additional snail management tools.

METHOD

TRIAL 1: EFFICACY OF COMMERCIAL BAITS AGAINST JUVENILE SNAILS

Location:	Roseworthy Campus, SA
Replicates:	5
Plot size:	Arena 0.2m^2 (circular sheet metal enclosure (15cm high) partly buried into soil with fly screen mesh fitted over top)
Treatments:	Seven commercially available baits (three active ingredients) + controls (nil)

Juvenile snails were collected from Warooka (SA). The snail species were: *Theba pisana* (Italian white snail), *Cernuella virgata* (common white snail), *Cochlicella acuta* (pointed snail) and *Cochlicella barbara* (small pointed snail). Arenas were prepared in field and each contained germinating canola seedlings and stinging nettle weed seedlings.

On 21 August 2012, 30 snails (150 snails/m^2) were placed in the centre of each arena and bait pellets distributed in an even circle around them. All baits were applied at label rates. After 7 days, snails were retrieved and assessed for mortality. The average snail retrieval rate per cage was 85 ± 1%. Data were corrected for background mortality (obtained from control cages) using Abbott's Correction.

TRIAL 2: EFFECT OF SIZE AND DENSITY OF BAIT PELLETS ON SNAIL MORTALITY

Location:	Roseworthy Campus, SA
Replicates:	5
Plot size:	Arena 0.2m^2 (circular sheet metal enclosure (15cm high) partly buried into soil with fly screen mesh fitted over top)
Treatments:	Metaldehyde 15g/kg bait applied as two pellet sizes (whole, half), at three rates (20, 40, 80 baits/m^2) to arenas containing two densities (150, 300 snails/m^2) of two species of juvenile snails, plus controls (nil).

Juvenile snails were collected from Warooka (SA). The snail species were: *Theba pisana* (Italian white snail) and Cochlicella acuta (pointed snail). Arenas were prepared in field as described above.

On 19 September 2012, snails (30, 60) were placed in the centre of each arena and bait pellets distributed in an even circle around them. After 13 days, snails were retrieved and assessed for mortality. The average snail retrieval rate per cage was 94 ± 1%.

TRIAL 3: EFFECT OF CAFFEINE ON SNAILS IN CANOLA WINDROWS

Location:	Corny Point (Yorke Peninsula, SA)
Replicates:	5
Plot size:	20 x 2m (windrows approx. 2m wide)
Spray equipment:	Small powered portable unit with four nozzle boom
Treatments:	Caffeine (dissolved in water with sodium benzoate) at two concentrations (5 and 10% w/v) at two water rates (200 and 400L/ha) and control (nil).

On 8 November 2012, caffeine was sprayed onto the dried canola windrows. Post treatment snail counts were conducted the next day (1 DAT – day/s after treatment) using 50cm x 50cm quadrats laid on the windrows and a visual count of round snails (approx. 99% *T. pisana*) recorded. Six quadrat assessments were made per plot. Assessment was repeated at 5 DAT.

TRIAL 4: EFFECT OF PERLKA® ON SNAIL EGGS

Location:	Laboratory pilot trial (Waite Campus, SA)
Replicates:	4
Treatments:	Control (nil), Perlka® at 200kg/ha, 400kg/ha, 600kg/ha, 800kg/ha

Eggs from round snails (predominantly *T. pisana*) were collected with soil from Warooka. Plastic food takeaway containers were prepared with soil and 45 eggs and the treatment applied to the surface of the soil. Containers were incubated at 15-20°C (12L:12D) for 34 days and 3-5mm simulated rainfall was applied by mist spray every two to three days to maintain soil moisture. Numbers of hatched snails were recorded.

RESULTS AND INTERPRETATION

TRIAL 1: EFFICACY OF COMMERCIAL BAITS AGAINST JUVENILE SNAILS

Overall juvenile snail mortality was 47 per cent and ranged from 18 to 80 per cent. *Theba pisana* juveniles appeared the least affected by the baits compared with other species (Table 1). This may have merely reflected lower activity levels by this species, but there were some statistically significant differences in *T. pisana* mortality between several of the tested baits.

Among the other three species, although the mortality caused by the different baits ranged between 30 and 80 per cent, the observed differences in mortality between the bait products were not statistically significant. We suspect that higher replication may reveal significant differences. We know that some products are more or less effective under different environmental conditions (Godan, 1983). This trial was conducted in late winter; better results might have been achieved in autumn. It should be noted that this trial was assessed after only seven days: these results do not take into account potential differences in the persistence of different bait products beyond this period.

Table 1. Per cent mortality of juvenile snails contained in field arenas with label rates of commercial snail/slug baits and alternative food. Values are adjusted using Abbott's Correction to recognise natural mortality. Product names are withheld due to the preliminary nature of these results.

Bait product	*T. pisana*	*C. virgata*	*C. acuta*	*C. barbara*
Product 1	18.3^{c}	53.4^{a}	56.3^{a}	44.3^{a}
Product 2	32.0^{abc}	47.8^{a}	44.4^{a}	40.5^{a}
Product 3	22.7^{abc}	51.6^{a}	30.7^{a}	49.7^{a}
Product 4	20.6^{bc}	67.9^{a}	39.0^{a}	40.0^{a}
Product 5	42.8^{a}	80.4^{a}	65.8^{a}	33.1^{a}
Product 6	40.3^{ab}	63.8^{a}	65.1^{a}	57.6^{a}
Product 7	34.9^{abc}	52.4^{a}	61.4^{a}	68.6^{a}
All baits	30.2	59.6	51.8	47.7
Sig. diff.	P=0.005	NS (P=0.119)	NS (P=0.157)	NS (P=0.191)
Tukey HSD (P=0.05)	21.6	–	–	–

*Values followed by different letters are significantly different within the same column.

TRIAL 2: EFFECT OF SIZE AND DENSITY OF BAIT PELLETS ON SNAIL MORTALITY

Size of bait pellet does not significantly influence the likelihood of a snail encountering a bait. Table 2 reveals no change in juvenile snail mortality, with whole and half sized pellets for both species tested at 20 and 80 baits/m^2 rates. This suggests that doubling the total amount of active ingredient on the ground does not significantly improve snail mortality if the bait density (baits/m^2) remains the same. The total number of baits on the ground (not total a.i.) is the factor which determines the likelihood of snails encountering baits. Doubling the bait density is likely to significantly increase snail mortality. This is made clear in Figure 1, in which an increase in *T. pisana* mortality reflects the increasing density of whole bait pellets. This trend occurred for both moderate and high snail densities and occurred similarly for *C. acuta* (graph not shown).

Table 2. Per cent mortality of juvenile snails contained in field arenas with Metaldehyde (15g/kg) bait applied at different rates and pellet size along with alternative food. *Closest to label rate. Recommended rate is 16-24 baits/m² (5-7.5kg/ha).

Baits per m²	Bait size	*T. pisana*	*C. acuta*
80	whole	70.4[a]	69.9[a]
80	half	65.2[a]	65.0[ab]
40	whole	62.0[ab]	65.4[a]
20*	whole	43.3[bc]	47.0[bc]
20	half	35.8[c]	33.5[c]
Control (0)	–	3.4[d]	3.6[d]
Sig. diff.	–	P<0.001	P<0.001
Tukey HSD (0.05)		19.0	18.2

*Values followed by different letters are significantly different within the same column.

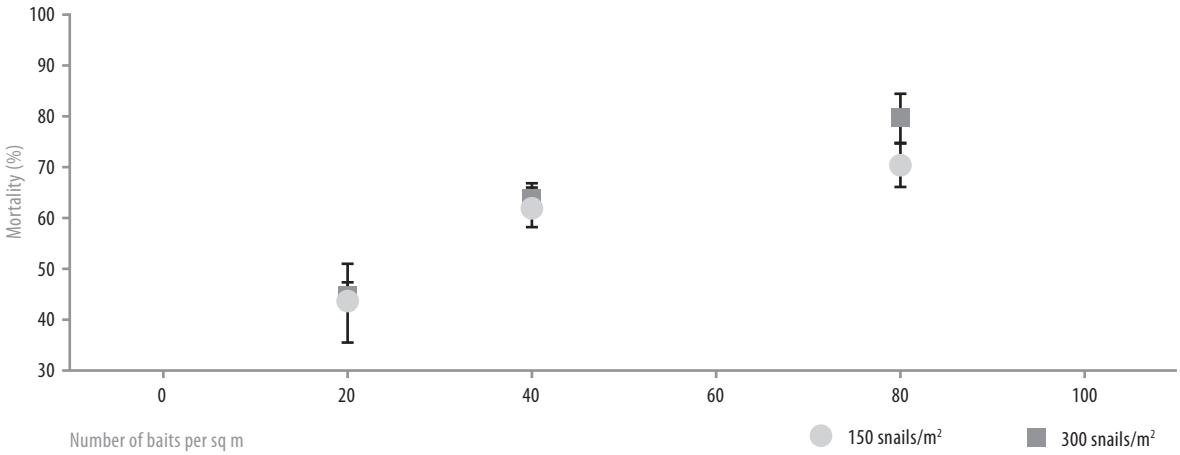

Figure 1. Per cent mortality (± SE) of juvenile *T. pisana* snails showing increased mortality with increased number of baits per m² at two snail densities.

TRIAL 3: EFFECT OF CAFFEINE ON SNAILS IN CANOLA WINDROWS

Analysis of this trial is still under way. However, initial observations and preliminary analyses suggest that the caffeine did not have a significant impact on snail presence in the windrows. One reason for this may be the limited penetration of spray into the dense layered windrow. Additionally we noted that when snails did drop off the surface of the windrows (either from caffeine or disturbance) often they got caught up in the next layer of pods and stems and would still potentially be picked up by machinery at harvest time. A similar trial was conducted in desiccated field peas with potentially more promising results.

TRIAL 4: EFFECT OF PERLKA® ON SNAIL EGGS

The results of this small trial clearly indicate that Perlka® has a significant effect on egg hatching success under laboratory conditions (Table 3). What remains to be known is how long the applied Perlka® would continue to be effective in preventing or limiting egg hatch and how environmental conditions could influence this effect. The product, applied at the label rate of 250kg/ha, tends to cause plant phytotoxicity through its herbicidal effects. In canola, it is recommended that Perlka® be applied either pre-sowing or after the 6-leaf stage; this could have a limiting effect on the time of application relative to snail activity and crop vulnerability.

We also conducted large-scale field trials of Perlka® in canola and fallow to observe the impact upon snail populations. This trial was conducted in mid-July 2012 and the treatment impacts were assessed nine weeks after application. The results were inconclusive, but may have revealed effects if the treatment had occurred earlier in the season. Having observed significant egg mortality effects in the laboratory, we are anticipating further field trials.

Table 3. Percentage (and actual number) of snail eggs (45 eggs/dish) that hatched from dishes containing different rates of Perlka® applied to soil surface. n=4. Recommended rate is 250kg/ha.

Treatment	Percent eggs hatched ± SE (Actual)
Control (nil)	25.0 ± 7.7 (11.3 ± 3.5)
Perlka® 200kg/ha	0
Perlka® 400kg/ha	0
Perlka® 600kg/ha	0
Perlka® 800kg/ha	0

COMMERCIAL PRACTICE

Ideally, a snail baiting program should focus on the brief (about two weeks) window of early season snail activity prior to the beginning of egg-laying and appearance of juveniles, and should be used as a mop-up operation for those snails that survived summer burning/ rolling/cabling management activities.

Juveniles can be killed with bait, but snail species, bait product and environmental factors will influence bait efficacy. Preliminary scoping trials suggest that bait density is more important than bait size for effective snail uptake: some products that offer smaller pellet sizes may achieve greater frequency of encounters between snails and bait.

This project is ongoing: extensive baiting trials are planned in order to validate some observations in relation to bait properties, including the effects of environment (temperature, UV, etc.). Additional novel approaches to snail management will also be investigated.

REFERENCES

Godan D (1983) Pest slugs and snails. Springer Verlag, Berlin.

SARDI (2003) 'Bash'em Burn'em Bait'em: Integrated snail management in crops and pastures'.

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