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Refining snail chemical control

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Take home messages

- Baits do kill juvenile snails.
- Stubble and/or green plant material reduce uptake of snail bait by juvenile snails.
- A baiting program that is integrated with appropriate stubble and weed management at pre-sowing is likely to optimise snail control.
- Calibrate your bait spreader to optimise the effectiveness of your baiting program.
- Perlka® did not have a significant effect on reducing snail populations in caged field trials.
- The effectiveness of bait product and bait size differs between the pest snail species; once fully researched, future bait program recommendations will be tailored to the species being targeted.

Background

Four exotic snail species have become established in Australia as major pests of grain crops. They cause significant economic losses through yield loss as a result of feeding damage and through contamination and grain loss at harvest. Market access is continually threatened by these exotic snails: two round species, the vineyard snail *Cernuella virgata* (Da Costa) and the white Italian snail *Theba pisana* (Müller), and two conical species, the pointed snail *Cochlicella acuta* (Müller) and the small pointed snail *Prietocella barbara* (L.).

These snails are widespread across southern Australia and require a year-round integrated management approach including cultural, mechanical and chemical controls. Baiting is a major tool, but the control achieved is often mediocre. Several variables influence the effectiveness of baiting programs and these include timing, species and age of snails; properties of commercial baits; and environmental conditions, including weather, soil moisture, stubble load and the supply of alternative food. Factors such as stubble and alternative foods can interfere with bait programs.

An effective snail baiting program relies on an even distribution of baits at appropriate rates over affected areas. A collaborative YPASG/SARDI GRDC fast track project was funded to investigate the effectiveness of commercial spreader machinery, designed for fertiliser application but used for bait, in achieving even distribution of baits at effective rates.

Alternate products have been suggested to provide control of snails in field crops. The horticultural fertiliser Perlka® (granulated calcium cyanamide) was previously tested for effects on snail eggs by SARDI in laboratory trials before current field testing.

This paper reports on the effects of stubble residues, crop plants and bait fragmentation on the efficacy of baiting programs. General outcomes of bait spreader machinery tests are discussed and the outcomes of Perlka® field tests are presented.

Methods

Influence of crop and stubble on bait efficacy to control juvenile snails

Location:	Laboratory trial, Waite Campus, SA
Replicates:	6
Plot size:	Plastic 4L Decor containers containing soil from Warooka, SA to depth of 4cm, and enclosed with wire frame and stocking material
Treatments:	(i) bare soil, (ii) canola seedlings (30 plants at cotyledon/first leaf stage), (iii) stubble (fine chickpea stubble 18 months old from Urania, SA), (iv) canola + stubble (30 plants + chickpea stubble)

In August 2013, arenas were prepared with treatments and 30 *T. pisana* juveniles (10 to 20 days old; 2 to 3mm diameter). Two Mesurol (2 per cent methiocarb) snail baits (10mm long) were placed centrally within each arena. Snail mortality was assessed after one week. This experiment was repeated in September with *C. acuta* juveniles (2mm diameter). Transformed mortality values were analysed by ANOVA and posterior pairwise comparisons by Tukey HSD.

Effectiveness of spreader machinery in distributing snail/slug baits

Location: Urania, SA

Treatments: Spreader machines – Amazone, Bogballe, Vicon, Kuhn (Lehner and C-Dax)
Bait products – Meta, Metarex, Slugger (4mm diameter), Slugout

This was a YPASG-led trial (YPA00002) funded by GRDCs fast track program intended to investigate the effectiveness of common fertiliser spreaders to evenly distribute snail/slug bait products to achieve recommended numbers of baits per metre squared. Machines were tested with manufacturer representatives onsite and a qualified calibrator prepared the machinery settings and made modifications as appropriate. Multiple runs over 50 catch-trays were made with each machine and bait product combination. Bait weight and number (and in some instances bait size) in each tray were recorded and distribution patterns constructed from these data. General observations and outcomes are presented.

Smaller bait fragments: are they effective?

Location: Laboratory trial, Waite Campus, SA

Replicates: 5
Plot size: Transparent plastic 4L Decor containers containing soil from Warooka, SA to depth of 4cm, and enclosed with wire frame and stocking material
Treatments: Snail species: *T. pisana*, *C. virgata* and *C. acuta*.
Meta and Multiguard baits (2.5mm, 5mm, 7.5mm, and 10mm long)

Arenas were prepared with 30 mature snails and eight bait pieces (Meta or Multiguard). Only one snail species was tested at a time. After three days, any remaining baits were removed and weighed to determine amount consumed and snail mortality was assessed after another five days. Indicative conditions for *C. virgata* were 20°C (min19°C, max 23°C), and a relative humidity (rH) of 89 per cent (min 50 per cent, max 100 per cent). An ANOVA was performed on individual species data sets with the covariate of amount of bait consumed.

Effect of Perlka® on recruitment of snails

Location: Warooka, SA (medic and volunteer barley)

Replicates: 10

Plot size: Arena 0.2m^2 (circular sheet metal enclosure (15cm high) partly buried into soil with fly screen mesh fitted over top)
Treatments: Control (nil) and Perlka® (200 kg/ha) with snails added to cages at 0, 13 and 28 days after application.

On 22 May 2013, 60 cages were prepared and treated with Perlka®. Twenty adult snails *(>12mm)* each of *C. acuta* and *T. pisana* were placed in each cage to lay eggs. After 13 days, the snails were removed, mortality recorded and the cages resealed to contain any resulting juvenile snails. This was repeated in separate cages to expose snails for two weeks to Perlka® that was either freshly applied, 13 days or 28 days old on the ground. On 4 Oct 2013, all cages were assessed for juvenile recruitment and data analysed by paired t-tests. Prior to the final assessment, sheep gained access into the trial site and destroyed some arenas, thereby reducing the final replication, hence this data was not analysed.

Results and interpretation

Influence of crop and stubble on bait efficacy to control juvenile snails

The presence of stubble and/or canola significantly reduced mortality of *T. pisana* juveniles relative to the bare soil treatment ($F_{3,20}$ = 25.12, $P<0.001$) (Figure 1). In the bare soil treatment *T. pisana* mortality was 85.8 per cent, whereas in the stubble, canola plus stubble and canola alone treatments the mortality was 56.7, 44.6 and 41.1 per cent respectively. Stubble also significantly lowered the mortality from the bait treatment in the *C. acuta* experiment ($F_{3,20}$ = 6.64, $P<0.01$). In the bare soil treatment *C. acuta* mortality was 67.5 per cent, and in the stubble, canola plus stubble and canola alone treatments the mortality was 32.0, 46.5 and 52.8 per cent respectively. Clearly these results demonstrate baits do kill juvenile snails.

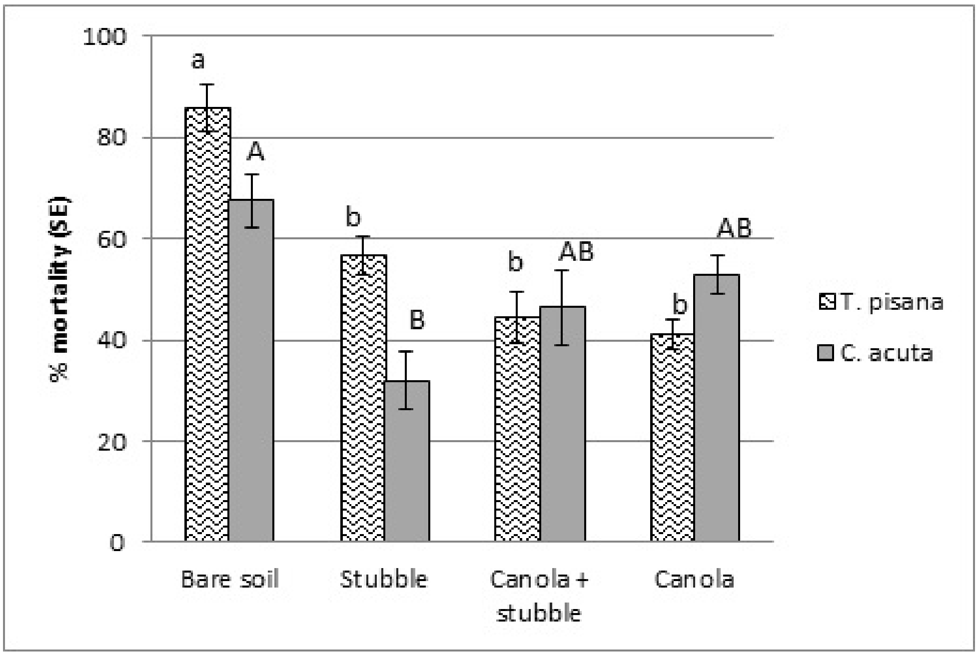

Figure 1. Mean (±SE) mortality of juvenile (2 to 3mm) T. pisana and C. acuta snails exposed to Mesurol bait in laboratory arenas containing soil with stubble and/or canola seedlings for 1 week. (Different letters of same format indicate significant differences within species, Tukey HSD test).

Canola and stubble can act as alternative food and the stubble additionally could present obstructions to these very small juveniles locating bait. While larger snails may not be so hindered by the stubble, it may still act to conceal baits and hence lessen the efficacy of the bait. Retention of stubble residues favours snails due to the more suitable habitat (G. H. Baker, 1998) and based on the results of this trial it could also reduce the effectiveness of chemical control.

Limiting alternative foods by applying baits after controlling weeds and before crop emergence are recognised methods to improve bait uptake. Additionally, the reduction of stubble prior to baiting is worth considering to increase the number of bait/snail encounters. This will be tested in 2014 field trials.

Effectiveness of spreader machinery in distributing snail/slug baits

The primary finding was that effective spread (bout) width of snail/slug bait was less than would be achieved when spreading fertiliser and differences were evident between bait products (Figure 2). Even with the best operational settings for each spreader, the spread width was consistently less than anticipated. Therefore, current bait spreader practices based on fertiliser spread widths are unlikely to be achieving the uniform spread needed for effective baiting.

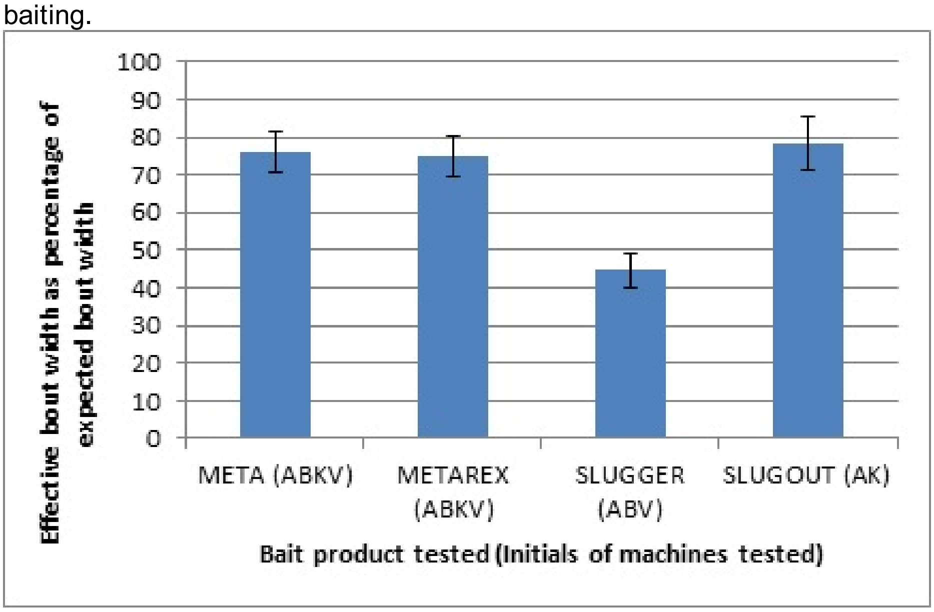

Figure 2. Effective bout width as a percentage of expected bout width (±SE) for different bait products averaged over four spreader machines (Amazone, Bogballe, Kuhn and Vicon; n=1 to 6 per machine).

Snails may not be attracted to bait and therefore consumption of bait is a numbers game, which relies on active snails encountering baits. To improve the chance of snails encountering bait, the baits must be placed uniformly and at correct rates. Based on previous work, calculations of probability of encounter as a function of number of baits, attractiveness and snail activity indicate an increased number of baits per square metre are needed. To get the most out of your baiting program, your spreader should be calibrated for bait product. A tabulated comparison of some bait products and their properties is provided at the end of this paper (Table 1).

A secondary outcome from this trial was during the spreading process where a proportion of bait was crushed into smaller fragments, dependent on product. While this increases the number of bait points on the ground, the minimum effective bait size and the degradation properties of smaller pieces means that fine crushing of baits may be detrimental to a baiting program and increase operator exposure. Further comparative results of bait size and bait density across the bout width with the tested spreaders and bait products will be presented at the 2014 GRDC Grains Research Update for Advisers in Adelaide.

Smaller bait fragments: are they effective?

Bait product and size had significant effects on mortality of round snails but not for the conical snail and consumption values indicated a deterrent effect of Meta bait (Figure 3).

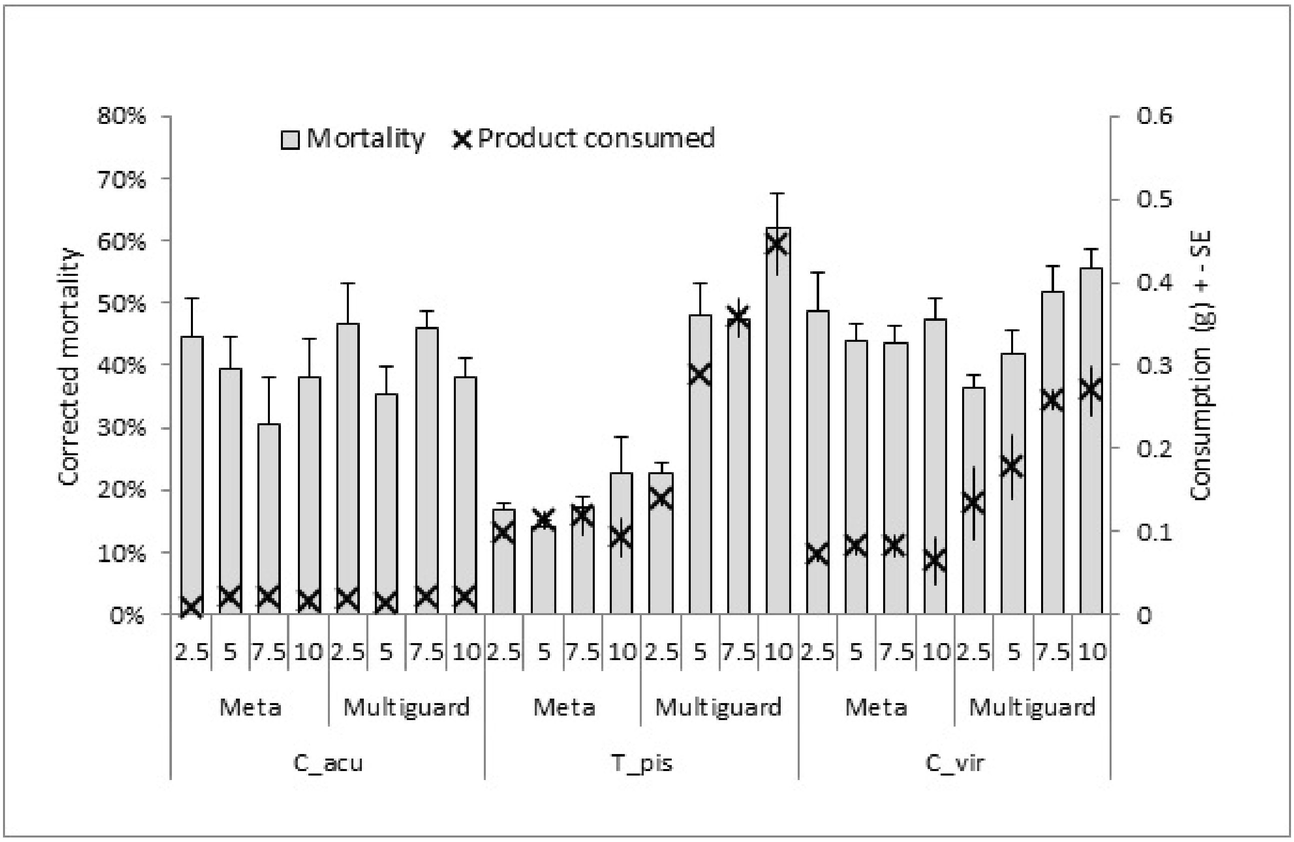

Figure 3. Average (±SE) mortality (bars) and consumption (g) of baits (X) by C. acuta, T. pisana and C. virgata adult snails exposed to Meta (1.5 per cent metaldehyde) or Multiguard (6.0 per cent Fe EDTA complex) bait pellets 2.5, 5, 7.5 or 10mm long in laboratory arenas.

The round snail, *T. pisana,* demonstrated significant differences in mortality between the two bait products (*P<0.001*) and between the bait sizes (*P<0.001*) (pooled for both products). Amount of bait eaten had a significant effect ($F_{1,31}$ *=11.20, P<0.01*) on mortality, and a significant interaction between product and size ($F_{3,31}$ *=3.47, P<0.05*) was evident. The Multiguard treatments exhibited a pattern which indicated that mortality in these treatments was limited by the amount of product available (i.e. bigger bait pieces = more to eat = higher mortality). The snails readily consumed all available bait and the mortality values reflected the amount of product offered. Meta bait of all sizes caused relatively low mortality, not all the bait was consumed and the amount consumed did not differ with bait size.

Cernuella virgata snails responded similarly to *T. pisana* with the exception that higher mortality occurred in the Meta treatments, however similar feeding patterns (i.e. same amount consumed independent of amount available). There were significant differences in mortality between the two bait products (*P<0.001*) and between the bait sizes (*P<0.001*) (pooled for both products). Consumption had a significant effect ($F_{1,31}$ *=10.71, P<0.01*) on mortality and a significant interaction existed between product and size ($F_{3,31}$ *=8.62,P<0.001*). This leads to the question: does the Meta product have some feeding deterrent properties towards round snails?

For *C. acuta*, no significant differences in mortality or consumption occurred between the treatments of bait product and bait size. Since *C. acuta* snails are smaller than round snails, it is unlikely that their mortality would have been limited by the amount of bait product available.

Earlier trials in 2012 indicated that bait density is more important than bait size for effective control. If bait is applied such that there is sufficient product on the ground to ensure a lethal consumption, this trial has shown that mortality will not be affected by having smaller or larger baits within the range of 2.5 to 10mm. However, different bait products or target snail species will determine the minimum lethal consumption. It is anticipated that baits smaller than 2.5mm would degrade faster and possibly be harder for snails to find especially if applied to fields with abundant stubble loads.

Effect of Perlka® on recruitment of snails

Adult snails retrieved from arenas were in very good condition with very low mortality (0.5 to 7.0 per cent) within both species. There were no significant differences in mortality between the control and Perlka™ treatments within species and time group (adult data not presented). At all dates and irrespective of the treatment, both species were observed mating and laying eggs within arenas.

Analysis of the data for the remaining arenas showed no significant difference between treatments for both species in the first two time groups (Table 2).

Table 2. Mean juvenile snail recruitment (snails/arena) in arenas treated with or without Perlka™, where mature snails were placed in the arenas for a two week period beginning at 0 days (immediately after application), 13 days or 28 days after the chemical treatment application. Paired t-tests within species and column indicated no significant difference

	Chemical treatment	0 days	13 days	28 days*
T. pisana	Control	58.6[a]	85.0[a]	52.5
	Perlka™	55.4[a]	97.0[a]	50.3
C. acuta	Control	22.8[a]	37.6[a]	32.5
	Perlka™	35.3[a]	57.6[a]	57.6

*Not analysed due to missing cages following damage.

Earlier laboratory trials had shown that Perlka™ was 100 per cent effective in preventing *T. pisana* egg hatch at rates of 200 to 800 kg/ha (Baker & DeGraaf, 2013). Additional laboratory trials demonstrated this same effect at the lower rates of 50 to 200 kg/ha, but no effect on snail hatchling (1 to 5mm) survival exposed to 200 kg/ha Perlka™ in identical conditions. In the caged field conditions over an extended period, Perlka™ did not have a significant effect on juvenile recruitment of *C. acuta* or *T. pisana* snails, probably because the Perlka™ effect on eggs is short-term and requires eggs to be present at or very soon after the Perlka™ treatment is applied. Therefore, the usefulness of Perlka™ as a snail management tool appears very limited.

Commercial practice

'The chief obstacle to improving chemical control of slugs (and snails) is not the lack of molluscicidal materials but the difficulty of getting them into the animal' (Briggs & Henderson, 1987).
To optimise baiting programs, consider:

- modifying the ground environment to increase the likelihood of snails finding bait (i.e. reducing stubble);
- modifying the ground environment to increase the likelihood of snails eating bait (i.e. limit the alternative food options);
- applying baits at appropriate rates and even distribution (i.e. calibrate your spreader to ensure it is spreading the bait as effectively as you believe it is.); and
- taking advantage of best conditions (i.e. after rainfall when snails are active).

References

Baker G & DeGraaf H (2013) GRDC Updates, Adelaide, pg. 61-67.

Briggs & Henderson (1987) *Crop Protection* 6: 341-346.
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0 Responses to Refining snail chemical control