Slugs, Snails and Iron based Baits: An Increasing Problem and a Low Toxic Specific Action Solution

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Abstract

Slugs and snails are growing as a significant problem around the world. The problems extend to damage to vegetation and crops, contamination,?quarantine problems, disease carriers host such as flukes and poisonings of both micro and macro non-target species by baits. This paper traces the history of slug and snail controls in the world.? It addresses the latest developments in low toxic specific and highly effective molluscicides.? It looks at the action of the various molluscicides and the importance of natural predators and farming practices.? Why the problem is becoming more significant world wide with current practises of minimum tillage and high organic matter build up in the soil is also briefly discussed.? Best practice monitoring technique and bait application?are mentioned. Of particular importance are studies involving the application of an Australian developed bait based on an iron chelate FeEDTA complex in the mid?1990's.? The history, toxicity, mode of action, efficacy?and future work and development are discussed.

Keywords:

Slug, snail bait, molluscicide, iron chelate

Introduction

History

During the last forty years the major chemical controls used against slugs and snails have been baits based on either metaldehyde or methiocarb as the active ingredients. Metaldehyde initially was used as a fire lighter and it properties as a slug killer became know in the 1930's. Methiocarb based baits were developed in the sixties. Simple metal salts have been known to be toxic but generally repulsive to molluscs since the 1890's. Recently the development of a mollusc specific iron chelate based bait has proven to give significant control without any appreciable toxicity concerns.

Recent significant developments in bait

Major efforts have been applied to find new methods of controlling slugs in agriculture. Various novel methods and approaches have been explored with some success including work on nematodes, (Glen *et al*. 1996) predators such a beetles and repellents (Dawson *et al*. 1996). Nevertheless, the most popular and effective method of slug control in today's agriculture is still baiting. Over the last 25 years the use of baits has grown rapidly around the world. Concerns about toxicity of current baits on beneficial non-target species, mammals and effects on the environment continue to grow. Despite the quest by companies and researchers for a more acceptable and viable method of tackling the problem there has been few significant developments. Some work with a group of chelates being evaluated as contact poisons and stomach poisons (Henderson *et al.* 1989) was undertaken in the late eighties-early nineties. It wasn't until major formulation developments of various metal chelates incorporated into a bait (Young, 1998) that a new generation of molluscicide became a commercialised product and was registered in Australia with an active ingredient Iron EDTA complex under the brand name Multiguard[?].

Increase in slugs as a major agricultural pest

During the last 25 years there has been significant growth in slugs as a pest. Some of this is likely to be attributed to the wider distribution of the pest through more extensive transportation of produce etc. The grey field slug (*Deroceras reticulatum)* is the most widely distributed pest slug species and has readily adapted to the environments in many countries. The importance of slugs as pests increased almost simultaneously with the growth in minimal/zero tillage, direct drilling of cereal and other crops. The significant benefits to agriculture systems of minimal tillage and retaining high levels of organic material in the soil have also brought with them challenges in controlling a number of pests. Some of these problems appear to stabilize but slugs are listed as one of the major pests that benefit from this farming practice. Some knowledge of how tillage, crop rotations and the effect of beneficial predators can be helpful in the control of slugs. In the north of Europe and the United Kingdom slugs cause significant damage to wheat, barley and rape and other vegetable crops (Garthwaite and Thomas 1996). Similar the USA has many of the same problems including corn/maize as a significant target (Hammond 1996). In New Zealand establishment of pasture (Barker 1990) has been reported to have significant problems with slugs. In the right conditions their ability to build up rapidly must not be underestimated. Slugs feed vigorously above and below the surface on seeds, shoots and roots along with other organic matter they can find.

Slugs in Australia

The problems of slugs damage in Australia as elsewhere in the world appears to be growing. In about the only published work undertaken in slug field trials in this area in Australia (Horne and Horne, 1992) it is stated that farmers underestimate losses caused by slugs. As slugs do most of their damage at night, or even below the surface they often go unidentified, or the damage is passed off as the results of something else such as poor germination or cut worms. In Australia slugs are a problem in the higher rainfall climates stretching from southern Western Australia, South Australia, NSW, Victoria and Tasmania. The value of some crops, such as lettuce, strawberries and certain vegetables and herbs is dramatically reduced by slug damage. Other crops, such as poppies, wheat, barley, onions, lentils, pyrethrum, pasture, canola, may be damaged by slugs as seeds or seedlings just after they begin to shoot below or above the ground and protection is required until they become established.

Monitoring, application control techniques

The initial step in determining the need to apply a bait involves looking for and identifying the likelihood and size of a slug problem before they have a chance to attack, damage or destroy the plants seeds or shoots above or below the ground. A piece of hardwood or masonite placed on the ground and held in place firmly against flat soil surface with a weight or peg is an ideal slug trap for assessing the slug problem.(Young *et al* 1996). Traps should be placed in a number of varied locations throughout the crop. Counts of slugs under these should be taken around dawn. Some attempts have been made to predict the counts to gauge the level of the problem, but as a rough rule of thumb if an average of more that one slug per 300mm x 300mm trap is found the slug problem is significant. If more than eight slugs are found under such a trap the problem is severe.

Iron chelate baits as a chemical control

Iron chelate baits are relatively new in commercial applications although they are well established in the home garden market here and in New Zealand. Before considering details of the mode of action of such baits it is useful to consider a comparison of the toxicity, effectiveness and current rating of iron chelate baits with the two older type baits, methiocarb and metaldehyde. In Australia the baits are easily distinguished by their colour.

Table 1. Comparison of baits.

Baits	Colour	Toxicity	Effectiveness	Poison Rating

Iron EDTA complex	**Red-brown / Yellow**	Low. Targets Slugs, Snails and Slaters	Excellent: Provides fast reliable Protection in tested conditions.	Not Scheduled
Methiocarb	**Blue**	High	Very Good	Sched. 5
Metaldehyde	**Green**	Highly toxic to mammals eg: Dogs, birds etc	Poor at Low Temperatures and in wet conditions. Good at higher temperatures	Sched. 5

Iron chelate baits are specific to snails, slugs and slaters (molluscs and crustacea) whereas both methiocarb and metaldehyde are non-specific and are toxic to a wide range of organisms including mammals.

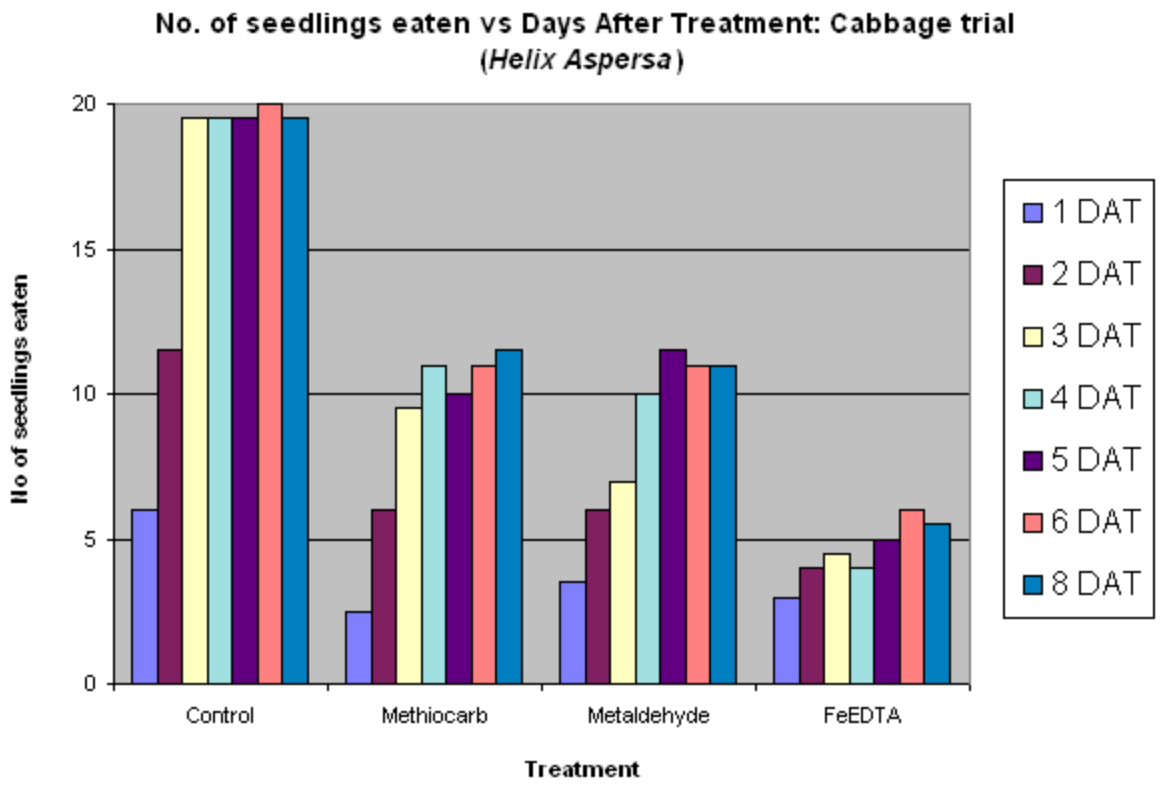
Iron chelate baits have been extensively trialed on virtually all Australian pest snails and slugs. Typical results of comparison between the types of snail and slug killer are given in figure 1 and table 2.

Table 2. Percentage kill rate in various trials.

CROP/FOOD Alterative (SPECIES)	Peas (Theba pisana)	Corn (*Helix aspersa*)	Pasture *(Deroceras reticulatum)*	Cabbage (*Helix aspersa*)	Grapes * (*Theba pisana*)	Carrot *(Deroceras reticulatum)*	Carrot *(Cochlicella babara)*	Carrot *(Mirco. vestita)*	*Carrot* ***(Cochlicella acuta)***
Days after Treatment	11	7	7	8	7	10	6	7	8
FeEDTA Complex	86	97	91	90	83	88	70	97	100
METHIOCARB	65	75	-	65	84	79	46	63	70
METALDEHYDE	60	85	-	68	93	53	-	53	75

Not only have the trials shown the Iron Chelate baits can produce higher mortality rates but they can also provide superior crop protection by reducing the feeding of the pest. *The grape trial was carried out when the daily maximum was about 30°C.

Figure 1: Comparison of crop damage for various treatments



Mode of action

It has been known for many years that simple iron compounds are toxic to molluscs as contact poisons by absorption through the foot but incorporation into palatable bait poses major problems. Iron chelates can be incorporated into bait, which is palatable to the mollusc and it appears that at an appropriate location in the mollusc's gut the iron is released as Fe^{3+}, and is toxic causing death if the concentration is sufficiently high. A number of chelates are efficacious, particularly those belonging to the group of compounds referred to as complexones, but to date the iron EDTA complex formed by the reaction of ferric EDTA with hydroxide ions is the most effective on the basis of the total iron concentration. A number of iron complexones have been shown to be effective. A complexone is a chelate that has at least one iminodiacetic group $-N(CH_2CO_2H)_2$ or two aminoacetic groups $-NHCH_2CO_2H$ or a derivative of either of these where the $-CH_2-$ group is substituted (Anderegg, 1987).

Since iron based baits do not work by paralysis the snails move away from the bait back to their shelter before dying.

Future directions in slug control:

It is predicted that the low toxic specific iron based baits will become established for control of snail and slugs. A better understanding of the ecology of snails and slugs will hopefully lead to maximising the effect of farming procedures, natural biological control and chemical control to minimise crop damage by these pests. The use of nematodes and other parasites in biological control is currently not very effective but may be developed into more successful products in the long-term future.

Current molluscicides are effective for up to a maximum of about 4 weeks. Iron chelates, in general, degrade but unlike metaldehyde, do not degrade to substances that are repellent to snails. Therefore, there is a potential to make a long lasting iron based bait which does not become repellent. Perhaps it will

be possible, in the fairly near future, to design an iron based bait that is effective for up to three months at a cost which is similar to that of the current metaldehyde baits.

References

1. Anderegg, G. 1987. in Wilkinson, G., Comprehensive Coordination Chemistry, Volume 2, Chapter 20.3 Complexones, (*Pergamon, Oxford*). pp 777-792.

2. Barker, G.M. Addison, P. J. Robertson, L.N. and Willoughley, B.E. 1990. *N. Zealand J. Ag. Res*. **33**, 595-605.

3. Dawson, G.W., Henderson, I.F. Martin, A.P. and Pye, B.J. 1996. *Proc. BCPC Symp. No. 66:* Slug and Snail pests in Agriculture, pp. 439-444.

4. Garthwaite, G.D. and Thomas, M.R., 1996. *Proc. BCPC Symp.No.66:* Slug and Snail Pests In Agriculture, pp. 39 - 46.

5. Glen, D.M. Wilson, M.J., Hughes, L. Cargeeg, P. and Hagjos, A. 1996. *Proc. BCPC Symp.No.66:* Slug and Snail Pests In Agriculture, pp. 271-280.

6. Hammond, R.B. 1996. *Proc. BCPC Symp.No.66*: Slug and Snail Pests In Agriculture, pp. 31-38.

7. Henderson, I. F. Briggs, G.G. Coward, N.P. Dawson, G.W. Pickett, J.A., 1989, Proc. BCPC Symp.No.41 Slugs and Snails in World Agriculture. p289-294.

8. Henderson, I.F. and Martin, A.P. 1990. *Ann. Appl. Biol*. **116**, 273-278.

9. Horne, J.A and Horne, P.A., 1992. Control of slugs in direct drilled pasture. Dept. of Agri. Vic Final Report, Project Number DAV 160.

10. Young, A.G. Port, G.R. Craig, A.D. James, D.A. and Green, T, 1996. *Proc. of BCPC Symposium No.66:* Slug and Snail Pests In Agriculture, pp. 133-140.

11. Young, C.L. 1998, Stomach-action molluscicides, *Aust. Patent*: AU-B-77420/98.