

## Evaluation of active ingredients and nematodes against slugs and snails on organic lettuce

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### Abstract

*Three years trials were carried out to evaluate the efficacy of some molluscicides for the control of slugs (Arion sp.) and snails (Cepaea nemoralis and Helix aspersa) on organic lettuce in Emilia-Romagna (Italy). Iron phosphate has proven to be as effective as those based on metaldehyde. The nematodes Phasmarabditis hermaphrodita did not work against individuals as big as those employed in the trials.*

### Introduction

Terrestrial gastropods, mostly slugs (*Arion* spp., *Deroceras* spp., ecc.) and snails, may cause severe damages to a vast number of horticultural crops such as lettuce, cabbage, strawberry and fennel during wet periods in spring or in autumn. The problem is higher in organic farms where these organisms find a favourable environment thanks to the presence of organic infrastructures and the prohibition to use chemicals of synthesis such as herbicides and insecticides.

Agronomical preventive techniques are very important to reduce the amount of gastropods in cultivated fields, but they are not sufficient to avoid the presence of damages on sensitive crops such as lettuce or other vegetables. For this reason, in some crucial periods, it is necessary to use specific molluscicides such as metaldehyde. This active ingredient, even if not natural, is allowed in organic agriculture only in traps so with limited efficacy. The aim of the trials is the evaluation of the effectiveness of some alternative molluscicides that could be applied directly on fields or crops such like is done for iron phosphate or *Phasmarabditis hermaphrodita*.

### Materials and methods

In the years 2003-2007 four randomized block trials have been conducted in an organic farm located in Sala di Cesenatico (FC), in Emilia-Romagna region, Italy. The aim was the evaluation of the effectiveness of some molluscicides allowed in organic agriculture against slugs and snails on lettuce. Table 1 shows the most important features of the trials. Every plot was made by a wooden cage of 1 m<sup>2</sup> base and 0,5 m high as described by Maurin and Lavanceau (1988). To avoid the escape of gastropods the cages have been protected by an anti-insect net. In every plot 9-10 plants were transplanted on a soil layer 5 cm deep. Molluscicides applications and gastropods disposal in the cages was made 1-3 weeks after transplanting. The slugs and snails used in the trial were collected in the surrounding fields, immediately before

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the beginning of the trials. The trials focused on *Arion* sp., *Cepaea nemoralis* and *Helix aspersa*. The products and active ingredients or biocontrol agents tested are listed in table 2. The metaldehyde based products used in trials 1-3 and 4 were different: dry formulated (Gastrotox E) or wet formulated (Mesuroil M plus).

To evaluate gastropods mortality 7-10 slugs and snails per plot have been employed. Crop assessments were done on 60-200 leaves of lettuce estimating the eroded leaf surface.

The statistical analysis has been made, after the transformation of percentage data in angular values, by variance analysis (Anova) and mean comparison test (LSD con  $P \leq 0,05$ ).

**Tab. 1: main features of the trials**

	Trial 1	Trial 2	Trial 3	Trial 4
Year	2003	2004	2004	2007
Place	Sala di Cesenatico (FC)			
Cultivar of lettuce	Diabless		Mafalda	
Transplanting date	24-Sep	12-May	18-Sep	3-Sep
Experimental layout	randomized block - 4 replications			
Plot size (m <sup>2</sup> )	1	1	1	1
Number of applications	1	1	2	1
Applications date	30- Sep	18-May	11-Oct, 20-Oct	5-Sep
Number of plants/plot	9	10	10	10
Number of slugs/plot	4	-	10	10
Number of snails/plot	3	10	-	-

**Tab. 2: products details**

Product	Active ingredient or organism	A.i. content (% or unit/g)	Dose		Trial
			product (g/ha)	a.i. (g/ha or unit/m <sup>2</sup> )	
Nemaslug	<i>P. hermaphrodita</i>	$6 \times 10^5$	6.300	300.000	1, 2, 3
Ferramol	iron phosphate	1	50.000	500	1, 2, 3, 4
Gastrotox E	metaldehyde	5	10.000	500	1, 2, 3
Mesuroil M plus	metaldehyde	5	10.000	500	4

## Results

The results of the trials are shown in tables 3 and 4.

### *Trial 1 (autumn 2003)*

The trial period has been very dry. The product containing iron phosphate (Ferramol) was as effective as that containing metaldehyde (Gastrotox E) on both slugs and on snails. In our experimental conditions the use of nematodes of species *P. hermaphrodita* (Nemaslug) couldn't permit to obtain any differences in comparison with the untreated check.

*Trial 2 (spring 2004)*

The trial period has been rather dry. Both iron phosphate (Ferramol) and metaldehyde (Gastrotox E) have been effective against snails even if the second one was slightly more performing than the first one. No dead snails have been found among those treated with *P. hermaphrodita* (Nemaslug), but a significative decrease of leaves damages, compared to the untreated check, has been reported.

**Tab. 3: average results**

Treatment		Trial 1 (20-Oct-03) 19 DAT					Trial 2 (10-Jun-04) 23 DAT				
		dead slugs (%)		dead snails (%)		leaf eroded surface (%)	dead snails (%)		leaf eroded surface (%)		
1	untreated	23.1	b	0	b	48.7	a	2.5	c	59.4	a
2	metaldehyde	100	a	91.7	a	0.9	b	82.5	a	0.3	c
3	iron phosphate	100	a	66.7	a	0.3	b	62.5	b	1.3	c
4	<i>P. hermaphrodita</i>	25	b	18.2	b	52.3	a	0	c	23.2	b

Means marked by different letters on the same column are statistically different according to LSD test ( $P \leq 0.05$ ).

*Trial 3 (autumn 2004)*

The trial period has been very wet and rainy. In our trial conditions iron phosphate (Ferramol) caused a higher slugs mortality than metaldehyde (Gastrotox E) even if leaves damages were comparable.

*Trial 4 (autumn 2007)*

The trial period has been quite wet. Both metaldehyde (Mesuro M plus) and iron phosphate (Ferramol) caused a high slugs mortality. As lettuce damages are concerned, the first molluscicide performed better than the second one.

**Tab. 4: average results**

Treatment		Trial 3 (25-Oct-04) 5 DAT <sub>2</sub>				Trial 4 (21-Sep-07) 16 DAT			
		dead slugs (%)		leaf eroded surface (%)		dead slugs (%)		leaf eroded surface (%)	
1	untreated	12.9	c	20.6	a	17.2	a	24.2	a
2	metaldehyde	32.5	b	2.1	b	100	b	0.3	c
3	iron phosphate	86.8	a	0.6	b	89.7	b	6.3	b

Means marked by different letters on the same column are statistically different according to LSD test ( $P \leq 0.05$ ).

## Discussion

In our experimental conditions the product based on *P. hermaphrodita* showed a very low molluscicidal activity. This may be caused, among other reasons, by the use of species of slugs and snails of big size.

Both iron phosphate and metaldehyde based molluscicides have shown an interesting activity even if it has to be noticed that the first one has been used at a product rate five times higher than the second one. In dry or very dry conditions (respectively trials 2 and 1) metaldehyde has performed better than iron phosphate. In wet or very wet conditions (trials 4 and 3) iron phosphate performed better than dry formulated metaldehyde but slightly worse than wet formulated metaldehyde. The product based on iron phosphate could be an interesting tool to fight gastropods in organic farming as it can be spread directly on the crop, differently than metaldehyde.

## Conclusions

According to the results of the trials it is possible to state that:

the product based on nematodes *P. hermaphrodita* may be fit to be used in infestation conditions where little sized species of gastropods are prevalent but not against big sized individuals (Speiser *et al.*, 2001; Grimm, 2002);

the effectiveness of metaldehyde based products can vary upon formulation type. Wet formulated products have to be preferred to dry formulated ones (Henderson and Triebkorn, 2002);

the product based on iron phosphate has proven to be as effective as those based on metaldehyde but easier to be used in organic agriculture thanks to the possibility of spreading directly on crops (Arndt *et al.*, 2004).

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