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Assessment of methods of chemical control against slug damage on Brussels sprouts

Undertaken for the Horticultural Development Council

CONTRACT REPORT

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ADAS

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AUTHENTICATION

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

.....M J Savage.....
Signature

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Date 17 March 1989

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CONTENTS

SUMMARY

At Freiston, Nr Boston, Lincolnshire, and Ebrington, Gloucestershire, two trials were conducted in the 1988 Brussels sprout crop to compare different molluscicides, timings and their efficacy in controlling slug grazing damage to the buttons. The molluscicides were a copper sulphate/aluminium sulphate/sodium tetraborate mixture (as Nobble), metaldehyde (as PP mini slug pellets), and methiocarb (as Draza). The timings were designed to coincide with periods of peak slug activity and critical stages of crop growth.

At the Lincolnshire site, reduction of slug damage to the buttons was obtained using the pellet formulations. However, at the Gloucestershire site populations of slugs remained very low throughout the growing period, and damage to sprout buttons at harvest was minimal.

An additional trial was conducted at Marlow, Buckinghamshire to investigate the control of slug damage in autumn broccoli. Details are given in Appendix 2. Once again, slug numbers were low and there were no significant differences in final yield or numbers of marketable broccoli heads.

INTRODUCTION

Approximately 11,000 ha of Brussels sprouts are grown in the UK, of which 2,800 ha are grown in Lincolnshire and 1,200 in the Vale of Evesham/Gloucestershire area. Forty per cent of the Lincolnshire crop is for the processing trade whilst the Evesham/Glos crop is mainly for the fresh market with an increasing proportion going to the supermarket trade. Among other qualities, all of these markets require freedom from surface blemishes and discolourations.

In some years (eg 1985 and 1987), considerable quantities of Brussels sprouts fail to attain the required standard due to the surface of the buttons being grazed by slugs, mainly during September and October. At that time of year many sprout crops are relatively advanced in growth. The sprout plants are grown close together in order to ensure acceptable, uniform button size, and this produces good conditions for slugs if the weather is wet. Crop debris in the form of fallen lower leaves provides food and shelter for the slugs, whilst autumn rainfall ensures that the relative humidity in the crop remains high, which also favours the pest.

It has always been assumed the most important species of slug involved, in arable fields, is the grey field slug (Deroceras reticulatum). However, other species may be present in some horticultural situations and their role in damage to the buttons merits investigation.

Currently, most growers use bran-based pellets to control the slugs, application usually being when damage is first seen. This strategy appears ineffective, probably because there is much alternative food for the slugs within the sprout crop. Slug pellets generally have a short period of activity in the field and only tend to kill a relatively small proportion of the slug population.

This experiment was designed to discover whether the application of molluscicide treatments earlier in the life of the crop, before damage has occurred, leads to improved slug control and reduced button damage.

Monitoring of slug activity during this study would provide information concerning conditions when damage is most likely.

MATERIALS AND METHODS

Site 1

Ebrington, Chipping Cambden, Gloucestershire. This site was on the holding of an established business at the tip of Gloucestershire within about two miles of the border with Warwickshire. A wide range of vegetables are grown for both the fresh market and the pre-packed trade, mainly on clay loam soils.

The experiment was of a randomised block design with four replicates. Each plot consisted of a 15 metre length of a standard twelve-row bed of Brussels sprouts planted at spacings of approximately one metre between rows and within rows.

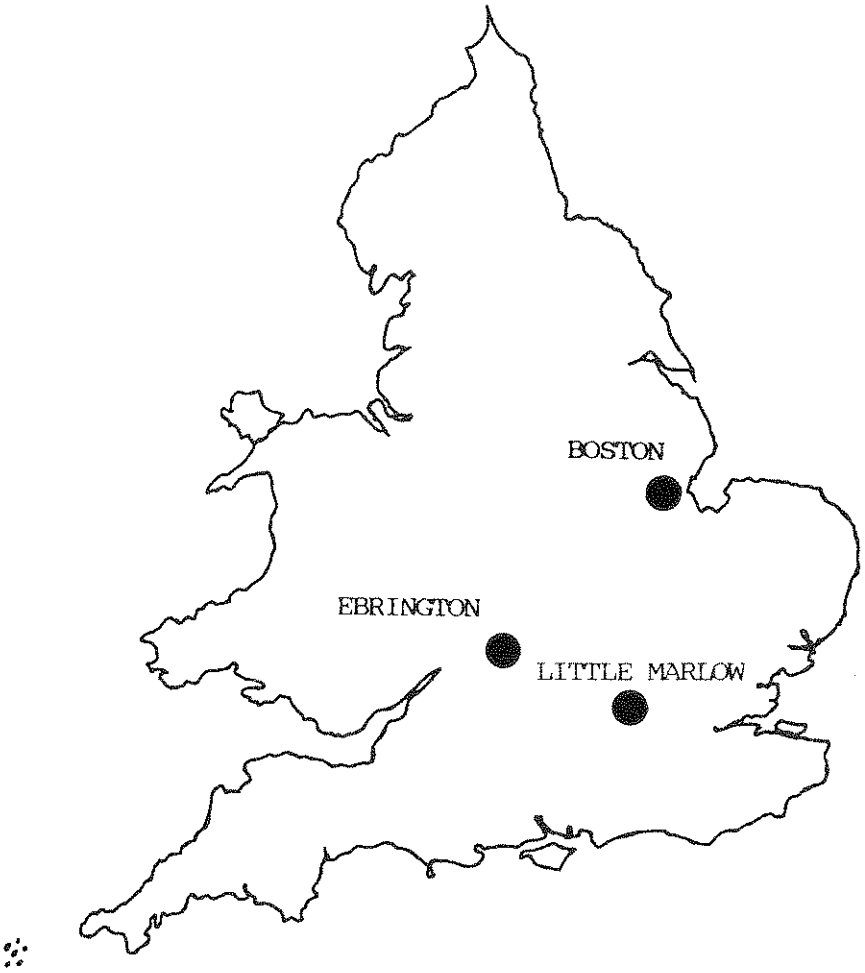
Site 2

Coupledyke Hall, Freiston, Boston, Lincolnshire. This site was on the holding of an established business growing Brussels for processing, mainly on silt soils.

The trial was of a randomised block design with four replicates. Each plot was twelve metres by fifteen metres, with the Brussels sprouts planted at spacings of 66 cm between rows and 51 cm within rows.

See Appendix 2

Fig 1: Location of sites



Treatments

Three commercially available molluscicides were used in the treatments, each at the standard rate. These were:-

1) 6% metaldehyde (PBI mini slug pellets) @ 15 kg/ha
2) 4% methiocarb (Draza) @ 5.6 kg/ha
3) Aluminium ammonium sulphate + sodium tetraborate + copper sulphate (Nobble) @ 2.24 kg/ha in 400 litres water.

The treatments were

	Chemical	Timing
A	Untreated control	-
B	Inorganic salts	First peak of activity and just before canopy closes
C	Metaldehyde pellets	At each peak of activity (separated by 2 weeks minimum)
D	Metaldehyde pellets	At first sign of damage plus 1 week later
E	Methiocarb pellets	Monthly, planting to harvest
F	Methiocarb pellets	as B
G	Methiocarb pellets	as C
H	Methiocarb pellets	as D

The actual dates in practice that these treatments were applied were as follows:-

Site 1

B, F 1 September
C, G 1 September and 13 September
D, H Not applied as no damage recorded
E 25 May, 21 June, 19 July, 23 August, 20 September

Site 2

B & F 18 July only (1st activity and canopy closing coincided)
C & G 18 July and 6 September
D & H 18 July, 27 July
E 6 July, 5 August, 6 September, 4 October

Husbandry

The trials were located in commercial crops that were planted in fields where severe slug damage had occurred on sprouts in 1987. In order to provide a sequence of picking dates across the field, different cultivars with different maturity dates had been planted.

At Site 1 sufficient areas of the cv Robert had been planted. However, at Site 2 the size of plot required for the experiment (12 m x 15 m) dictated that the trial would spread over more than one variety; in the event, two replicates were in cv Merlon and two in cv Igor.

The sprouts were raised in cellular trays and planted by the growers in mid-May (Site 1) and mid-June (Site 2).

The plots were marked out on 25 May (Site 1) and 1 July (Site 2) and traps consisting of a small quantity of wheat bran covered by an upturned plant pot saucer were placed within the rows. The traps were examined for slugs at weekly intervals and were then moved within the plot to avoid constant recapture of the same individuals.

The various treatments were applied to the plots on the dates described. The spray treatment (Nobble) was applied using a hand-held gas-powered boom sprayer, the pellets by hand.

Assessments

The weekly catches of slugs were recorded and some treatments were applied when slug activity increased markedly; other treatments were applied at predetermined crop growth stages or by calendar dates.

At harvest a random sample of 100 buttons was picked from each plot and the amount of damage on each button assessed. At Site 1, because of low levels of damage only the control plots were initially assessed and damage levels recorded.

At Site 2, where damage was greater all plots were assessed and each button was given a damage score using the following system:

No damage	= nil
1 or 2 grazed areas	= low damage level
3 or 4 grazed areas	= moderate damage level
More than 4 grazed areas	= high damage level

Statistical Analysis

At Site 1 slug numbers and damage were too low for analysis.

At Site 2 the total percentage of undamaged buttons per treatment was analysed. This was done by Analysis of Variance and Duncan's multiple range test was used to separate different treatments. Angular transformation was used during the analysis to transform skewed data.

RESULTS

Table 1: Slug damage

Site 1

	Treatment	% buttons in damage category			
		Nil	Low	Moderate	High
A	Untreated	91	9	0	0
B	Inorganic salts)				
C	Metaldehyde, at peaks of activity (2 wk apart min))				
D	Metaldehyde at first damage + 1 wk later)				
E	Methiocarb monthly planting to harvest)	Not assessed due to low levels of slug damage.			
F	Methiocarb as B)				
G	Methiocarb as C)				
H	Methiocarb as D)				

Site 2

	Treatment	% buttons in damage category			
		Nil	Low	Moderate	High
A	Untreated	50(a)	14(a)	21(b)	15(c)
B	Inorganic salts	51(a)	14(a)	23(b)	14(c)
C	Metaldehyde, at peaks of activity (2 wk apart min)	79(b)	8.5(a)	9(a)	3.5(ab)
D	Metaldehyde at first damage + 1 wk later	73(b)	11(a)	10(a)	5(ab)
E	Methiocarb monthly, planting to harvest	79(b)	15(a)	5(a)	1(a)
F	Methiocarb as B	70(b)	11.5(a)	11.5(a)	7(b)
G	Methiocarb as C	71(b)	14.5(a)	10.5(a)	4(ab)
H	Methiocarb as D	75(b)	12(a)	9(a)	4(ab)

Treatments followed by the same letter (in brackets) are not significantly different (P = 0.05) by Duncan's Multiple Range Test.

Trap catches of slugs are recorded on graphs 1 and 2.

At Site 1, only 33 slugs were caught throughout the entire trapping period; of these 73% were Arion subfuscus, 24% were Deroceras reticulatum and all others were Arion silvaticus.

The majority of the slugs caught at Site 2 were Deroceras sp, probably D. caruanae. Species of the Arion hortensis complex (possibly A. distinctus) were also caught.

Table 2: Total slugs caught - Site 1

Date	Treatment A	B	C	D	E	F	G	H	Total	
01 June	1	0	0	0	0	0	0	0	1	A. subfuscus 1
08 June	0	0	0	0	0	0	0	0	0	
14 June	0	0	0	0	0	0	0	0	0	
21 June	0	0	0	0	0	0	0	0	0	
28 June	0	0	0	0	0	0	0	0	0	
05 July	0	0	0	0	0	0	0	0	0	
12 July	0	0	0	0	0	0	0	0	0	
19 July	1	2	0	0	1	0	2	3	9	A. subfuscus 6 A. silvaticus 1 D. reticulatum 2
26 July	2	1	4	3	0	0	1	3	14	A. subfuscus 12 D. reticulatum 2
02 Aug	0	1	0	0	0	0	0	3	4	A. subfuscus 3 D. reticulatum 1
09 Aug	0	1	0	0	0	0	0	2	3	A. subfuscus 2 D. reticulatum 1
16 Aug	0	0	0	0	0	0	0	0	0	
23 Aug	0	0	0	0	0	0	0	0	0	
01 Sept	0	0	0	1	0	0	0	0	1	D. reticulatum 1
06 Sept	0	0	0	1	0	0	0	0	1	D. reticulatum 1
13 Sept	0	0	0	0	0	0	0	0	0	
20 Sept	0	0	0	0	0	0	0	0	0	
27 Sept	0	0	0	0	0	0	0	0	0	
04 Oct	0	0	0	0	0	0	0	0	0	
TOTAL	4	5	4	5	1	0	3	11	33	

Table 3: Total slugs caught - Site 2

Date	Treatment A	B	C	D	E	F	G	H	Total	
05 July		1							1	D. caruanae
08 July					2	1			3	D. caruanae
11 July	2		1		1	1	1		6	D. caruanae
14 July	2	4	7	2	4	4	2		25	D. caruanae
18 July	5	4	5	2	3		5	9	33	D. caruanae
22 July	11	11	5	5	8	12	4	10	66	D. caruanae
26 July	3	7			1		4	1	16	A. distinctus 2 D. caruanae 14
01 Aug	6	12	5		3				26	A. distinctus 10 D. caruanae 16
05 Aug									0	
08 Aug	1	4							5	D. caruanae
12 Aug		5					2	2	9	D. caruanae
16 Aug									0	
19 Aug									0	
22 Aug	1								1	D. caruanae
25 Aug									0	
02 Sept	20	19	4	10		4	3	14	74	A. distinctus 19 D. caruanae 55
09 Sept									0	
15 Sept	5	2		8	1	1	3		20	A. distinctus 16 D. caruanae 3 Milax budapestensis 1
28 Sept		4		1					5	A. distinctus 3 D. caruanae 2
13 Oct				14		1			15	A. distinctus
27 Oct						1		1	2	D. caruanae
TOTAL	56	73	27	42	23	25	24	37	307	

Fig 2 Slug activity and treatment timings - Site 1

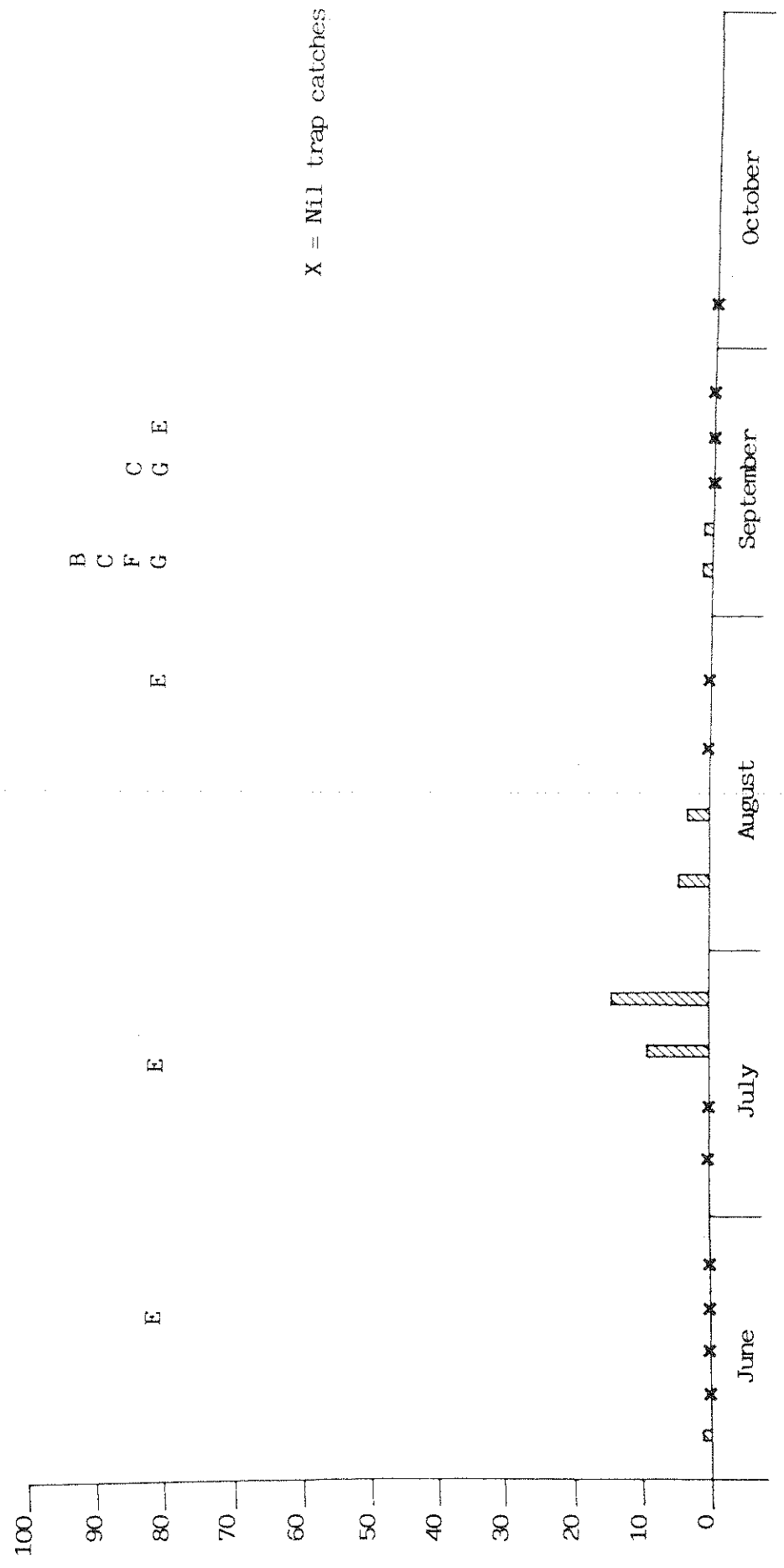
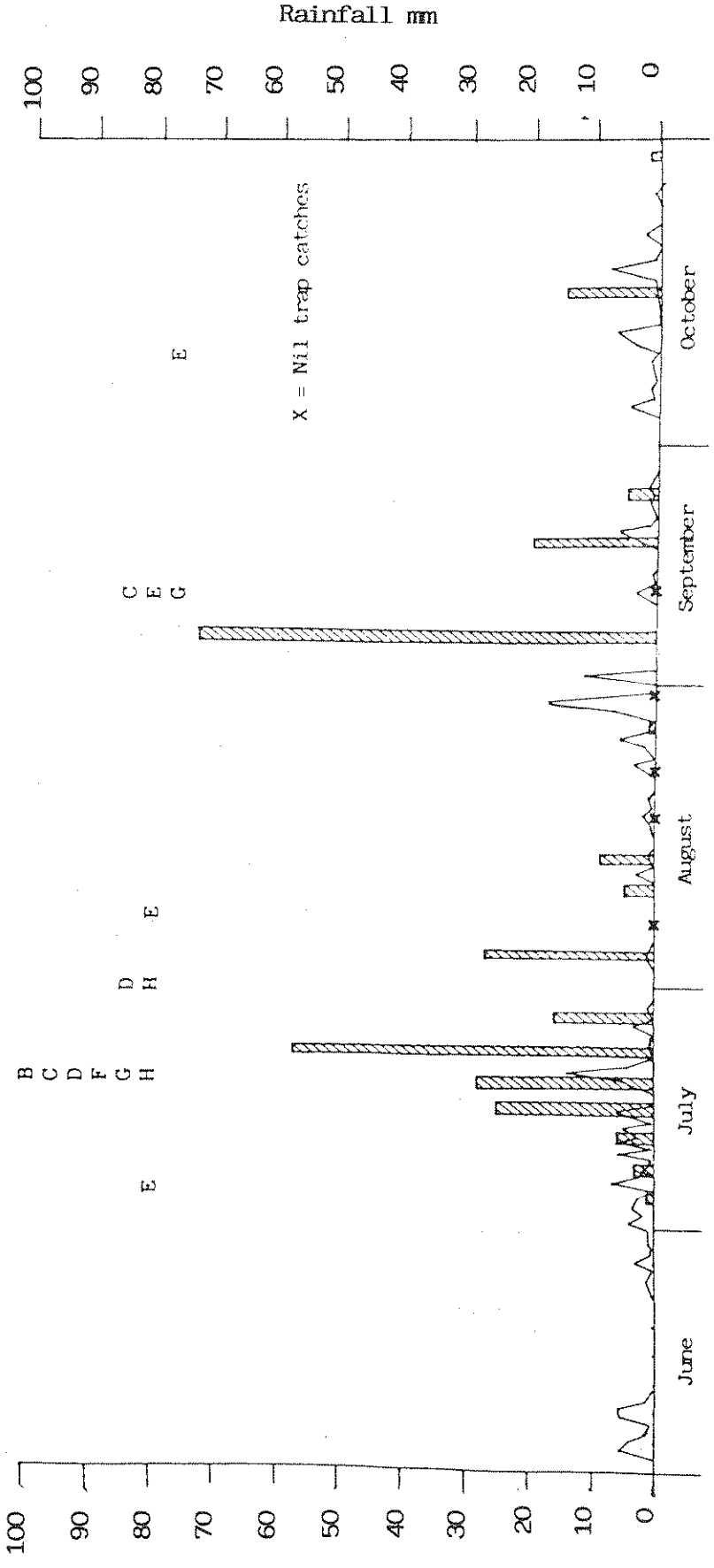


FIG 3 SLUG ACTIVITY AND TREATMENT - SITE 2



DISCUSSION

Adviser experience and the MAFF Pesticide Usage Survey 1981 (Survey Report 29) confirm that a large proportion of the Brussels sprout crop is treated with molluscicide baits. On the soils which are prone to slug damage growers may make repeated applications, often at reduced rates. The major problem remains in predicting when increased slug activity will occur and the optimum strategy for control. Currently most growers make their first application at the growth stage they regard as having the greatest damage risk. Follow-up treatments would usually be made 2-6 weeks later.

An important part of this study is the investigation of optimum treatment times relative to slug activity. When this study was designed it was decided to use three sets of criteria to act as triggers for application of treatments. These triggers were slug activity, crop growth stage, and calendar date. In the event, slug activity as monitored by the bran traps was minimal.

At the Lincolnshire site, the treatments applied at the first peak of slug activity coincided with that applied at the closing of the crop canopy, since these occurred at the same time. This raises doubts about the feasibility of using slug traps as triggers for treatments; crop growth stages or calendar date may be more reliable. Superimposing a graph of rainfall at the Freiston site upon the graph of slug catches in traps clearly indicates a correlation between rainfall and slug activity (see Figure 3). Applying pellets just after reasonably heavy showers (say more than 5 mm rain) may well be an effective method of timing such treatments.

The results table for site 2 clearly shows that pellet baits are effective in reducing slug damage to sprout buttons. The level of damage in the untreated control was such that only 50% of buttons were blemish-free; in the best treatments nearly 80% of the buttons were unblemished and the levels of moderate and severe damage were also significantly lower. The level of damage in the plots treated with aluminium ammonium sulphate/copper sulphate/sodium tetraborate mixture (Nobble) was almost identical to those found in the untreated controls.

There was no evidence from this site which indicates that one active ingredient of pellet baits was better than the other, when used at recommended rates. Evidence from slug control on other crops suggests that differences between methiocarb and metaldehyde baits are often minimal. In trials, differences in efficacy between formulations of metaldehyde are often greater than the difference between metaldehyde and methiocarb-based pellets. There is also no evidence that multiple applications of pellets showed any advantage over single or double applications properly timed, or that any of the timings used in this study showed a significant advantage. However this is perhaps not surprising for, at site 2, the first peak of slug activity, the canopy closing and the first signs of slug damage all coincided (18 July) and most plots were treated on the same day.

CONCLUSIONS

To draw meaningful conclusions from two trials where only one produced significant results is difficult. Care should be exercised in the interpretation of these trials but several valid inferences may be possible:-

1. The use of methiocarb or metaldehyde pellets in a Brussels sprout crop will reduce the level of damage by slug grazing and may also reduce the severity. The copper sulphate mixture used was not effective.

2. Optimum control appears to result from one or two applications at the time when the crop canopy closes. Further applications may not improve control.

3. There was no differences between methiocarb and metaldehyde pellets.

4. The use of slug traps may not be a practical, accurate or reliable method of timing treatments applied against slugs.

5. The efficiency of pellet baits may increase after periods of moderate or heavy rainfall when slugs are most active.

6. Routine slug pellet applications to Brussels sprouts may be difficult to justify. For example, at the Ebrington site, which was identified as high risk, damage from slugs was minimal.

RECOMMENDATIONS

This work should be continued for a further year in order to obtain additional results in different field conditions and higher levels of slug damage. The role of different slug species in damage to sprouts and the importance of rainfall in timing slug pellet applications are of particular interest.

ACKNOWLEDGEMENTS

The co-operation of Mr Drinkwater of Ebrington, Chipping Campden, and Mr Grant of Freiston, Boston, is gratefully acknowledged.

STORAGE OF DATA

The raw data will be stored by the ADAS Regional Entomologist, Block A, Government Offices, Coley Park, Reading, RG1 6DT for a period of 10 years. HDC will be consulted before disposal.

APPENDIX I

Details of Crop - Site 1

Location:	Ebrington, Chipping Cambden, Gloucestershire	
Soil type:	Clay loam (Banbury Association series)	
Cultivar:	Robert (mid-season)	
Planting date:	10 May 1988 (after raising in cellular trays)	
Trial plots marked out:	25 May 1988	
Farm applied treatments:	April 88	Trifluralin
		Propachlor
	May 88	Chlorpyrifos + disulfoton
	July 88	Chlorfenvinphos
		Iprodione
		Demeton-S-methyl
	August 88	Iprodione
		Demeton-S-methyl
		Cypermethrin
	September 88	Chlorothalonil
		Benomyl
	All at recommended rates	
Harvested:	27 September 1988	

Details of Crop - Site 2

Location:	Coupledyke Hall, Freiston Boston, Lincs	
Soil type:	Course silty marine alluvial Silt (Wisbech Association series)	
Cultivars:	Merlon (mid-season) Igor (late mid-season)	
Planted:	16 June 88 (after raising in cellular trays)	
Trial plots marked out:	1 July 88	
Farm applied treatments:	May 88	Propachlor
	July 88	Demeton-S-methyl
		Cypermethrin
	August 88	Demeton-S-methyl
		Cypermethrin
		Triadimenol
		Chlorothalonil
	early Sept 88	Demeton-S-methyl
		Cypermethrin
		Triadimenol
		Iprodione
	mid Sept 88	Demeton-S-methyl
		Cypermethrin
		Triadimenol
		Iprodione
	All at recommended rates	
Harvested:	1 + 4 November 1988	

APPENDIX II

AUTUMN BROCCOLI: CHEMICAL CONTROL OF SLUGS

Officer in charge of Site: D Richardson, ADAS Regional Office Reading

Location of site: Little Marlow, Bucks

SUMMARY

Nobble, metaldehyde or methiocarb, at the timings in the table below, were applied to a crop of autumn broccoli cv Violet Queen planted on 28 July 1988. Plots were of three beds, each bed 15 m x 1.8 m and there were three replicates. An area of 5 m x 1.8 m was harvested from the middle bed of each plot on 26 October 1988. Slug numbers, monitored by trapping, were low and although there were slight but significant differences in leaf damage, there were no significant differences in the final yield or numbers of marketable heads cut. Club root damage badly affected some plots.

Treatments

Chemical	Rate	Date(s) applied
1. Untreated		
2. 'Nobble' (at planting)	2.24 kg/ha	1 August
3. Metaldehyde (at each peak of slug activity)	15.0 kg/ha	29 July + 16 August
4. Metaldehyde (at planting and 2 weeks later)	"	1 August + 16 August
5. Methiocarb (applied monthly)	5.5 kg/ha	29 July + 5 September
6. Methiocarb (as 2)	"	29 July
7. Methiocarb (as 3)	"	29 July + 16 August
8. Methiocarb (as 4)	"	1 August + 16 August

RESULTS

Table 1: Mean number of damaged leaves

	(10 plants per plot)							
Treatment	1/8	8/8	15/8	22/8	5/9	12/9	19/9	26/9
1	3.3	9.0	16.0	6.7	4.3	3.0	6.0	2.3
2	2.3	13.7	23.3	17.0	8.7	1.3	4.3	2.0
3	1.7	3.0	1.7	5.7	4.7	1.3	0.3	0.7
4	1.3	3.0	5.3	5.7	2.0	0.3	2.3	1.0
5	2.0	3.0	6.0	9.0	2.0	6.0	1.0	0.3
6	2.3	2.7	9.0	9.0	1.7	0.3	1.0	1.0
7	0.7	4.0	4.3	8.7	4.0	3.7	2.3	0.7
8	2.3	4.0	6.7	6.7	2.7	0.3	0.7	0.7
LSD (5%)	3.2	4.6	7.8	8.3	7.5	6.2	3.6	2.4
CV (%)	88.1	49.7	49.1	55.7	113.6	173.6	92.1	125.7

Table 2: Yield and mean number heads cut (range)

Treatment	Yield (kg)	No. heads cut Mean (range)
1	6.6	22.3 (14-32)
2	7.3	21.3 (20-23)
3	3.5	11.3 (1-20)
4	3.8	11.3 (2-26)
5	11.2	31.0 (28-36)
6	4.3	17.3 (15-20)
7	o.0	24.0 (20-31)
8	7.8	23.3 (13-35)
LSD (5%)	5.9	15.0
CV (%)	50.7	42.3

Table 3: Mean no. of slugs per trap

Treatment	1/8	8/8	15/8	22/8	5/9	12/9	19/9	26/9
1	0	0	0	0	0	0	0	3.0
2	0	0.5	1.0	0	1.0	0	0.5	5.0
3	0	1.0	2.0	0	0	0	0.5	2.0
4	0	0	1.0	0.5	0.5	0	0	2.5
5	0	1.0	1.0	0	0	0	1.0	3.5
6	0	0.5	0	0	0	0	0.5	2.5
7	0	0	0.5	0	0	0	1.0	5.0
8	0	0	0.5	2.5	0	0	0.5	2.5

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