SLUG FEEDING ON SEEDS AND SEEDLINGS OF RYEGRASS AND WHITE CLOVER

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SUMMARY

Feeding by the grey field slug (*Deroceras reticulatum*) on seeds and seedlings of white clover (*Trifolium repens*) and ryegrass (*Lolium perenne*) was observed under controlled conditions. Clover seeds and seedlings were destroyed more rapidly than ryegrass as a result of slug feeding. The destruction rate of seeds and seedlings was constant during the first 14 days following sowing. The ryegrass seed coat provided initial protection to the seed but the clover seed coat did not. It was shown that water soluble substances present in the seeds of both ryegrass and white clover attracted slugs to feed but there was some evidence to suggest that these were more easily released by clover seed.

INTRODUCTION

The grey field slug is common on New Zealand farms and is often the cause of damage in newly sown crops or pastures (Pottinger 1979) especially following direct drilling (Barker and Pottinger 1980). Several workers (e.g. Byers and Bierlein 1982, Charlton 1978, Ferguson and Barratt 1983) have shown that this slug species has its greatest impact on agriculturally important plant species in the first few weeks following sowing. Despite this, the amount of quantitative information available concerning the damage potential of slugs in New Zealand agriculture remains small.

This research was encompassed within the MAF Agricultural Research Division direct drilling programme based at Invermay, where broad aspects of minimum tillage on Southern South Island soils were under investigation. These experiments aimed to investigate some aspects of grey field slug feeding activity when provided with seeds and newly germinated seedlings of ryegrass and white clover. The effect of the period of exposure to slugs of these pasture species after sowing was also investigated.

METHODS

Pot trial

This trial was conducted outdoors during April 1984. Forty-eight boxes constructed of untreated *Pinus radiata* measuring 500 x 400 x 100 mm deep were each lined with a nylon gauze (mesh = 1 mm²) bag of 500 x 400 x 500 mm filled to a depth of 50 mm with sieved topsoil. The soil was thoroughly wetted and allowed to settle for 4 days. Three 20 mm deep grooves were made in the soil, 150 mm apart running the length of the box to represent drill slits into which 132 untreated ryegrass and 132 untreated white clover seeds were sprinkled. These seed densities were equivalent to sowing rates of 15 kg/ha ryegrass and 4 kg/ha white clover. One of four treatments was assigned to each box in a randomised block design. In the slug free control treatment the gauze bags were sealed. The other boxes received five slugs, collected from pasture nearby and ranging in size from 0.34 g to 0.81 g wet weight. This represents a density of 25 slugs/m². The bags were sealed to prevent the slugs from escaping. Slugs were removed after four, nine and fourteen nights to provide the other three treatments. After 25 days the bags were opened and the seedlings within each box counted.

Laboratory experiments

Four experiments were carried out in constant temperature cabinets at 18°C in continuous darkness. Slugs ranging in size from 0.14 g to 0.92 g wet weight were collected from pasture and weedy areas and stored at 8°C until needed.

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- (i) Feeding preferences of slugs given a choice of ungerminated ryegrass and clover seeds were assessed by placing 10 seeds of each species on moist filter paper within each of twenty nine 150 mm diameter glass petri dishes. One slug was introduced to each dish. Slug feeding on the seeds was observed daily for 6 days and the number of seeds damaged and destroyed recorded.
- (ii) In a similar experiment with 26 replicates, each slug was offered 5 germinated ryegrass seeds (with the radicle but not plumule emerging) and 5 ungerminated clover seeds. Observations were made at 2 and 8 days and numbers of damaged and destroyed seeds recorded.
- (iii) Germinated 8 day old seedlings of each species were offered to slugs as above with 15 replicates and the assessments were made after 24 h.
- (iv) To test the possibility that the seeds contained water soluble substances which could influence slug feeding, approximately 2 cm³ of ryegrass and clover seeds were each soaked for 3 h in 15 ml of water which was initially at 50 °C. Pieces of filter paper 1 cm² were dipped into the decanted extracts and distilled water used as a control treatment. One slug was placed in each of 22 glass petri dishes 150 mm in diameter and presented with five pieces of filter paper from each treatment. The number of pieces of filter paper showing feeding signs were recorded after 24 h.

RESULTS AND DISCUSSION

Pot trial

Germination was higher for clover than for ryegrass (92% and 72% respectively; SED = 1.4%). This compares with germination of 98% and 81% for clover and ryegrass seed respectively held on moist filter paper at 18°C in the laboratory. Seedling survival (Table 1) for both pasture species was proportional to the length of time for which the slugs were present although clover was more severely affected with approximately six seeds or seedlings lost per day compared to two per day for ryegrass. Percent destruction of clover seeds and seedlings was higher ($P < 0.01$) than for ryegrass for all slug treatments. This supports the findings of Ferguson and Barratt (1983) which showed clover to be more susceptible to slug damage than ryegrass.

TABLE 1: Seedling survival at day 25 after exposure to slugs for 0, 4, 9 and 14 nights after sowing 132 seeds of each pasture species.

Number of nights with slugs present	Average seedling numbers				Average % seedlings destroyed by slugs			
	Ryegrass	SEM*	Clover	SEM*	Ryegrass	Clover	Difference	SED**
0	95	5.5	122	6.0	0	0	0	
4	82	12.4	93	18.1	14	25	11	3.5
9	82	14.4	67	28.3	14	45	31	7.8
14	69	20.0	39	31.5	27	68	41	8.8

*Based on between box variability.

**Based on variability within boxes.

Laboratory experiments

In the comparison of ungerminated ryegrass and clover seeds (Table 2(i)), damage to clover seeds started within 24 h and by the third day 90% of the clover seeds had been destroyed while the ryegrass seeds showed no signs of damage. On day four minor damage to the emerging radicles of a few ryegrass seeds had occurred, but this was not repeated and had no apparent effect on subsequent development. The experiment was terminated after 6 days when 100% of the clover seeds had been destroyed; none of the ryegrass seeds showed serious damage. Considerable amounts of filter paper had been consumed by the slugs in this experiment despite the availability of ryegrass seeds.

TABLE 2: Slug damage to ryegrass and white clover seeds and seedlings in laboratory experiments.

(i) Time (days)	Percent ryegrass seeds			Percent clover seeds		
	*Germinating	Damaged	Destroyed	*Germinating	Damaged	Destroyed
1	0	0	0	93	1	14
2	0	0	0	99	5	64
3	0	0	0	100	5	90
4	12	0.7	0	100	3	96
5	30	0.7	0	100		99
6	71	0.7	0	100		100

(ii) Time (days)	percent germinated ryegrass seeds		percent ungerminated clover seeds	
	Damaged	Destroyed	Damaged	Destroyed
2	96	0	0	84
8	50	50	0	98

(iii) Time (days)	Percent 8 day old ryegrass seedlings		Percent 8 day old clover seedlings	
	Damaged	Destroyed	Damaged	Destroyed
1	85	9	0	98

(iv) Time (days)	Percent feeding on seed extracts			
	Ryegrass	Clover	Control	SED
1	66	52	8	8

*Theoretical germination determined from seeds kept at 18°C in the absence of slugs.

In order to determine whether the slugs were deterred from feeding on ryegrass seeds by the physical nature of the seed coat the comparison of germinated ryegrass seeds with ungerminated clover seeds was carried out. After two days 84% of the clover seeds but none of the ryegrass seeds had been destroyed (Table 2(ii)). However 96% of the ryegrass seeds showed signs of radicle grazing. After 8 days 98% of the clover seeds were consumed with only hard seed remaining. By this time 36% of the ryegrass seeds had been destroyed by partial or complete seed hollowing, and a further 14% had been destroyed by severe radicle and plumule grazing. All the surviving ryegrass seedlings showed signs of slug feeding on both the plumule and radicle.

Observations during this experiment revealed that in the instances of ryegrass seed hollowing access to the endosperm was via the radicle or plumule, but never through the seed coat. This was in contrast to clover where the slugs frequently penetrated the seed coat and often consumed this in addition to the endosperm. The consumption of the ryegrass seed coat was very rare suggesting that slugs may be deterred by the texture of the ryegrass seed coat.

The comparison of slug damage to 8 day old ryegrass and clover seedlings was initiated to determine if apparent instances of selective feeding on clover seedlings rather than ryegrass seedlings was a result of the nature of the ryegrass seed coat or other factors. The experiment showed that the slugs fed as readily on ryegrass seedlings (94%) as on clover seedlings (98%) (Table 2 (iii)). However the clover seedlings were completely consumed within this period while only 9% of the ryegrass seedlings were so badly damaged as to be unviable. Of the surviving ryegrass seedlings, 69% showed root damage, and 93% had shoot damage. The nature of feeding damage on ryegrass seedlings supports the observation of Duthoit (1964) that slug feeding on the radical of ryegrass seeds was incidental and that most feeding initially concentrated on the plumule.

During the course of laboratory experiments (i) and (ii) it was recorded that significantly more instances of feeding on filter paper had occurred where soluble substances from the clover seed had stained the filter paper yellow, than in the vicinity of ryegrass seeds. In Experiment (i) the mean number of feeding signs per dish after 2 days near clover seeds was 6.5 while near ryegrass seeds it was 0.6 (SED = 0.8). In Experiment (ii) after 2 days the corresponding values were 4.0 and 2.0 (SED = 0.4).

The results of Experiment (iv) showed that the number of pieces of filter paper per petri dish showing signs of slug feeding was significantly higher for both ryegrass and clover than for plain filter paper. There was no significant difference between the ryegrass and clover seed extracts.

It appears that both ryegrass and clover seeds contain water soluble substances that can stimulate slug feeding. At 18°C (as in experiments (i) and (ii)) the clover seed solute may be released more easily than that from ryegrass seed. This may explain the greater attraction of slugs to the filter paper in the vicinity of clover as opposed to ryegrass seeds.

CONCLUSIONS

These experiments suggest that slugs attack and destroy clover seeds as soon as the seeds imbibe water whereas ryegrass seeds as not attacked until the radicle emerges, perhaps because of the protection provided by the seed coat. The clover seed coat does not deter slug feeding. Seeds of both species contain water soluble substances which encourage slug feeding but clover seeds apparently release this exudate more readily.

ACKNOWLEDGEMENT

S. Crosbie for assistance with statistical analysis, and B. Barratt for assistance in preparing the manuscript.

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