LEAF MINER DAMAGE ASSESSMENT EXPERIMENTS IN LABORATORY AND FIELD WITH *SCAPTOMYZA FLAVA*

ALI A. SERAJ and P.G. FENEMORE

Department of Plant Science, Massey University, Palmerston North

SUMMARY

In order to assess the ability of *Scaptomyza flava* (Diptera: Drosophilidae) to affect the growth and yield of two cruciferous vegetables (Chinese cabbage and turnip), experiments were conducted in the laboratory and field over two seasons during 1991-1993. In the laboratory, reduced growth of Chinese cabbage and turnip occurred when four or more pairs of flies were caged with plants for 24 hours. In the field experiments turnip tolerated low levels of leaf mining without reduction in weight of bulb but the net yield of Chinese cabbage was significantly reduced.

Keywords: brassica leaf miner, *Scaptomyza flava*, damage assessment, turnip, Chinese cabbage.

INTRODUCTION

Insect damage in cabbage crops can be the result of injury to the leaves during the preheading stages, or of injury to the head. The first type of injury can cause the formation of a smaller head, thus a lower weight of yield (quantitative yield reduction); the second type generally gives cosmetic damage (qualitative yield reduction) (Wit 1985). Criteria to estimate the damage thresholds for qualitative yield reduction are generally very subjective and dependent on long and short term market situations. Whether quantitative damage occurs or not depends on the type of crop, the growing stage, the amount of insect injury, and growing factors (Wit 1982). Straka (1979) found economic damage (above 3%) when 8.9-10.4% of the leaf area was destroyed in early cabbage, and 10.7-13.7% in late cabbage.

Scaptomyza flava is a dipterous leaf miner that commonly infests many cruciferous vegetables especially in the young plant or seedling stages. It is common throughout New Zealand but no damage assessment experiments have previously been reported. It has multiple generations per year (about 13) with no distinct dormancy. In order to assess the ability of *Scaptomyza flava* leaf miner to affect the growth and yield of two cruciferous vegetables (Chinese cabbage and turnip), several experiments were conducted in the laboratory and field. This paper reports the results of these experiments.

MATERIALS AND METHODS

Laboratory experiment

Turnip seed *Brassica rapa* L. and chinese cabbage *Brassica rapa chinensis* group (*Brassica campestris* spp. *pekinensis*) seeds were sown in seed boxes in a glasshouse. Ten days after sowing, the seedlings were transplanted individually into plastic flower-pots (10 cm diam.) which were kept in a growth room at $20 \pm 1^\circ \text{C}$ during the day (about 16 hours of light) and $15 \pm 2^\circ \text{C}$ during the night (about 8 hours darkness). After 20 days in the growth room (one month old plants), 1-2 day old adult *Scaptomyza flava* obtained from a rearing colony were caged onto the plants and at this stage the average number of leaves per plant for turnip was 5 and for Chinese cabbage 4.5. There were six treatments, each replicated four times in a completely randomized design: 1 - plants without any insects (control plants). 2-6 - plants with one, two, three, four and six pairs of adult insects per cage. After 1 day, the plants were removed from the cages and larvae of *S. flava* allowed to develop. When larvae were fully fed and had pupated, plants were harvested by cutting off at ground level (16 days after infestation).

Proc. 46th N.Z. Plant Protection Conf. 1993: 45-48

Measurements of fresh weight of tops (whole plant cut off at ground level), total leaf area, leaf area mined for each leaf and fresh weight of the bulb root (for turnip only after lifting, washing and drying), were made for each plant.

Field experiments

The dates of sowing, sampling, spraying and harvesting are given in Table 1.

Experiment 1 1991/92: Chinese cabbage, variety "Chi-Hi- Li", and turnip variety "Snow ball", were sown in field plots with 40 cm spacing between rows on 5/12/91. Plots were four 3 m rows. The seedlings were thinned to about 15 cm spacing between plants. Insecticide was applied with treatments designed to provide different levels of leaf miner suppression. Each treatment was replicated four times in a randomized complete block design. The treatments were as follows:

- 1 - Control, no insecticide applied.
- 2 - Permethrin (Ambush 50 EC, a contact insecticide) applied at full label rate of 50 g/ha as a dilute spray.
- 3 - Permethrin applied at 25 g/ha.
- 4 - Pirimicarb (Pirimicarb 50 a contact/systemic insecticide) applied at full label rate of 125 g/ha for the first application plus acephate (Orthene 75) 750 g/ha. for the second application.

Prior to each spray application ten plants were selected at random from the centre rows of each plot and total leaf area and leaf area mined measured by an Area Meter MK2 (Webb 1989) (Areas of different tone on the same object can be measured independently by adjustment of the threshold control of this machine).

At maturity the effects of leaf miner attack were determined by taking random samples of 10 plants from the centre rows of each plot and recording gross fresh weight of plants after cutting at ground level, and net weights after damaged leaves were removed. In addition for turnip, the fresh weight of washed bulb roots was recorded.

Experiment 2 1992/93: A similar experiment was established with the same varieties of Chinese cabbage and turnip. The treatments were as follows: 1 - Control, no insecticide applied; 2,3,4 - Permethrin applied at full label rate, 1/2 label rate, 1/4 label rate respectively as in 1991/92. At harvest five plants were taken from the middle row of each plot and fresh weight of leaves (and bulb roots of turnip) recorded as in 1991/92.

TABLE 1: Summary of time of sowing, sampling and spraying for field Experiments 1 and 2.

	Exp.1: 1991/92	Exp.2: 1992/93
Sowing date	05.12.91	24.11.92
Seedlings thinned	16.12.91	15.12.92
First spraying	24.12.91	28.12.92
First sampling	24.12.91	06.01.93
Second spraying	07.01.92	08.01.93
Third spraying		14.01.93
Second sampling	07.01.92	18.01.93
Third sampling (Turnip only)	10.2.92	
Fourth spraying		20.01.93
Fifth spraying		28.01.93
Sixth spraying (Turnip only)		04.02.93
Harvest : Chinese cabbage	29.1.92	02.02.93
Turnip	10.2.92	17.02.93

RESULTS

Laboratory experiment

The degree of injury to the plant was closely related to the density of the leaf miners. The area of leaf mined for Chinese cabbage (Table 2) increased with increasing

number of adult insects but not in direct proportion. For example one pair of adults resulted in 18.25 cm² (3.9%) of leaf mined but four pairs of adults produced only 30 cm² (6.6%) of leaf mined rather than an expected 73 cm². This could be due to interference during oviposition between adults with increasing numbers confined to relatively small plants. Even 6 pairs of adults per plant resulted in only 82 cm² of leaf area mined or approximately 16.4% of total leaf area at termination of the experiment. Nevertheless, all treatments, with the exception of one pair of adults per plant, significantly reduced total leaf weight. Total leaf area, including that mined, showed no significant differences between treatments except for an anomalous reduction associated with two pairs of adults per plant.

The area of leaf mined for turnip (Table 2), except for an anomalous figure with four pairs of adults, increased in about direct proportion to numbers of adults ($r^2=0.69$). There was a significant difference in the fresh weight of leaves and bulb roots, between the control plants and treatments with 4 and 6 pairs of adults. A single pair of adult insects per plant gave a bulb root weight little more than half that of the control, but the difference was not significant due to high variability.

TABLE 2: The effects of *Scaptomyza flava* on leaf area mined and fresh weight of leaves of turnip and Chinese cabbage and weight of turnip bulb root.

Number of adult pairs/plant	Total leaf area		Leaf area mined		Fresh weight		
	Turnip	Cabbage	Turnip	Cabbage	Leaves	Bulb root	
	(cm ² /plant)		(cm ² /plant)		Turnip	Cabbage	Turnip
					(g /plant)		(g)
0	532 a	587 a	0 a	0 a	26.8 a	40 a	7.25 a
1	450 ab	466 ab	8 bc	18 ab	25 abc	29 ab	3.72 ab
2	429 b	362 b	10 cd	15 ab	26.1 ab	22 b	4.30 ab
3	442 b	414 ab	12 cd	20 b	23 abc	26 b	2.82 ab
4	390 b	454 ab	3 ab	30 b	17.7 c	28 b	1.40 b
6	463 ab	503 ab	16 d	82 c	18.2 bc	25 b	2.02 b

Figures in each column accompanied by the same letter are not significantly different at $P \geq 0.05$ (ANOVA followed by LSD test for separation of means).

Field experiments

In Experiment 1 the percentage leaf area mined on turnips reached a peak of 24% on untreated control plants in January 1992 (Table 3) but this had declined to 4% by harvest. Permethrin at full label rate gave the most effective suppression of leaf miner and percentage area mined on sprayed plants at no time exceeded 2%.

The gross weights of leaves and of bulb roots of untreated control plants were significantly less than at the full rate of permethrin.

In 1992/93 (Experiment 2) leaf miner infestation was at a low level and did not exceed 5% leaf area mined on unsprayed plants. There were no significant differences at harvest between treatments in gross weight of leaves or of bulbs.

The leaf area of Chinese cabbage mined on untreated control plants was less than on turnip in both seasons, reaching a maximum of 13% in January 1992. As with turnip, permethrin at full label rate gave the most effective suppression of leaf miner (Table 3).

Leaf miner had no effect on gross weights of heads in either season but in 1992/93 net weight of heads, after removal of leaf miner damaged outer leaves, was significantly lower for untreated control plants compared to the full permethrin treatment. This difference was not significant in 1991/92.

TABLE 3: Percentage leaf area mined (Expt. 1- 7.1.92, Expt. 2- 15.1.93) and mean weights (g) of leaves and bulb roots of turnip and head of Chinese cabbage at harvest in two field experiments.

Treatment	Rate g ai/ha	Turnip % leaf area mined	Cabbage Gross weight of leaves	Turnip Weight of bulb root	Weight of cabbage head		
					Gross	Net ¹	
Expt. 1 1991/92							
Untreated		24	13	81.9 b	132.3 bc	150 a	118 a
Permethrin 50		2	2	131.8 a	230.3 a	146 a	135 a
Permethrin 25		3	0.7	115.1 a	193.8 ab	135 a	116 a
Pirimicarb 125 + Acephate 750		11	7	81.3 b	118.4 c	134 a	112 a
Expt. 2 1992/93							
Untreated		4	3	112 a	225 a	218 a	152 b
Permethrin 50		2.5	0	124 a	242 a	381 a	300 a
Permethrin 25		0.3	1.5	124 a	268 a	348 a	238 ab
Pirimicarb 125 + Acephate 750		1	0.2	113 a	231 a	367 a	221 ab

Values with the same letter do not differ significantly $P=0.05$.

¹After removal of outer leaf miner damaged leaves.

CONCLUSION

It may be concluded that *Scaptomyza* has the potential to reduce the yield of both turnip and Chinese cabbage. In the case of the former by reducing effective leaf area and thus indirectly affecting yield and with the latter by directly damaging outer leaves of the head, which then require removal at harvest. In the Manawatu such effects are unlikely to occur every year based on two seasons' experience.

ACKNOWLEDGEMENTS

The authors wish to thank Mrs. Lorrain Davis for assistance in the field and laboratory. We would also like to thank staff of Plant Growth Unit who permitted us to have access to their greenhouses and field areas.

REFERENCES

- Straka, F., 1979. The level of economic damage caused by leaf-gnawing insects during the first half of the vegetation period of cabbage and cauliflower (Bg, En, Ru, 10 ref). *Gradinarska I Lozarska Nauka* 16: 84-92.
- Webb, N., 1989. User Manual Delta-T Devices Ltd. Cambridge, England 139pp.
- Wit, A.K.H., 1985. The relation between partial defoliation and yield of spring cabbage. *Zeitschrift Angewandte Entomologie* 100: 96-99.
- Wit, A.K.H., 1982. The relation between artificial defoliation and yield in Brussels sprouts as a method of assess the quantitative damage induced by leaf-eating insects. *Zeitschrift Angewandte Entomologie* 94: 425-31