SEED PREDATION IN NODDING AND SLENDER WINGED THISTLES BY NODDING THISTLE RECEPTACLE WEEVIL

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SUMMARY

The extent of seed predation by *Rhinocyllus conicus* (nodding thistle receptacle weevil) on nodding thistle (*Carduus nutans*) and slender winged thistle (*C. pycnocephalus*) was recorded at Argyll in Hawkes Bay in 1984-85 and 1985-86, and for nodding thistle in Canterbury in 1988-89. In nodding thistle at Argyll 34% and 49% of the seed crop was destroyed by *Rhinocyllus* in 1984-85 and 1985-86 respectively. At Argyll, levels of seed predation increased over the period 1982-1986. In Canterbury in 1988-89, only 3% of seed was lost to *Rhinocyllus*, possibly due to later flowering in Canterbury. In slender winged thistle seed losses were estimated at 24% in both 1984-85 and 1985-86, but actual losses may be higher (up to 65%) because of the mode of feeding of *Rhinocyllus*.

INTRODUCTION

Nodding thistle (*Carduus nutans*) is a major weed of pastures from the Bay of Plenty to Otago. *Rhinocyllus conicus* (nodding thistle receptacle weevil), which destroys the seed of nodding thistle, was introduced as a biological control agent (Jessep 1981) and is now established throughout most of the range of the plant (Jessep 1989). Overseas studies have shown seed losses to *Rhinocyllus* ranging from 35% (Surles and Kok 1978) to 78% (McCarty and Lamp 1982). In New Zealand, Popay *et al* (1984) studied seed losses at Argyll in Hawkes Bay in 1982-83 and 1983-84; they reported 38% seed destruction in the second year. *Rhinocyllus* had been released in the area for the first time in 1981-82. In this study we examine data on loss of nodding thistle seed to *Rhinocyllus* at Argyll from 1982-83 to 1985-86, and for one season (1988-89) from Canterbury.

Although nodding thistle is the preferred host for *Rhinocyllus*, slender winged thistle (*Carduus pycnocephalus*) is also attacked early in the season (Jessep 1981; Popay *et al* 1984). At Argyll, 22% and 40% of inflorescences were infested with *Rhinocyllus* in 1982-83 and 1983-84 respectively (Popay *et al* 1984). We present data for slender winged thistle for the following 2 years from that site.

METHODS

Data were collected at two sites: Argyll Road, near Waipawa in Hawkes Bay, and at Fereday Island by the Rakaia River in Canterbury. Methods followed those used by Popay *et al* (1984). At 2-4 week intervals, nodding thistle inflorescences were collected and the receptacle inside diameter, and the number of *Rhinocyllus* larvae, were recorded for each. For both sites, the estimated number of seeds which each inflorescence would have produced in the absence of *Rhinocyllus* was calculated from the receptacle area, using an equation derived from counts of 2974 seeds in 34 unattacked inflorescences collected on 14 February 1985 at Argyll. The number of seeds destroyed per larva was calculated by comparing the actual and estimated seed outputs of 64 inflorescences with *Rhinocyllus* present. The estimated seed outputs for each inflorescence, with and without the effects of *Rhinocyllus*, were summed for all inflorescences dissected at each date.

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The timing of seed production was determined by recording inflorescence numbers ripened in permanent quadrats between each visit. These numbers were weighted by the mean seed output per inflorescence (calculated from diameter) at that date to estimate the percentage of the seed crop produced over each interval. The percentages were combined with the fraction of seeds lost to *Rhinocyllus* at each date, to calculate an overall value for the losses of seed caused by *Rhinocyllus*.

Popay *et al* (1984) presented data on the fraction of seeds lost to *Rhinocyllus* at various dates through the 1982-83 season, but had no data on the timing of seed production. To estimate the overall losses in that summer, the timing of seed production was set equal to the average of the following three years.

For slender winged thistle, inflorescences were collected from flowering plants on three dates in November/December 1984, and on two dates in 1985. The presence of weevils was recorded. On 13 December 1984, inflorescences were also collected from the ground underneath flowering plants.

RESULTS

At Argyll the regression relating seeds per inflorescence to receptacle area (in mm²), in the absence of weevils was $y = 1.093 \cdot \text{area} + 5.945$ ($r^2 = 0.38$; $P < 0.05$). The number of seeds destroyed per larva was 27.7 ± 6.4 (mean $\pm$ 95% C.I.).

The percentage of seeds destroyed by *Rhinocyllus* at each Argyll census was always low in midsummer but higher early and late in the season (Fig. 1). The same pattern was observed at Canterbury.

Over the four years at Argyll, *Rhinocyllus* destroyed between 22 and 49% of the potential seed crop (Table 1). There was a general increase in the levels of loss. The rest of the seed crop ripened successfully; between 23 and 51% of all seeds were in inflorescences not attacked by *Rhinocyllus*, and from 15 to 38% in inflorescences containing weevils.

In contrast, in Canterbury in 1988-89 only 3% of seeds were destroyed by *Rhinocyllus* (Table 1).

In 1984-85, 24% of the 177 slender winged thistle inflorescences collected from plants were infested with *Rhinocyllus* larvae. In 1985-86, 204 inflorescences were examined and again 24% contained larvae. However, in 1984 65% of the 62 inflorescences collected from the ground were attacked.

Fig. 1: Percentage of nodding thistle seeds destroyed by *Rhinocyllus conicus* at various dates through four consecutive seasons, 1982-83 to 1985-86, at Argyll Road, Hawkes Bay.

TABLE 1: Seed losses to *Rhinocyllus conicus* in nodding thistle at Argyll, Hawkes Bay, from 1982-83 to 1985-86; and at Fereday Island, Canterbury, in 1988-89.

		% seed destroyed	% set in attacked infl.	% set in unattacked infl.	Infl./m ² over season	Potential seeds/m ²	Actual seeds/m ²
Argyll	1982-83 ⁺	22.2	33.1	44.7	n.d.	n.d.	n.d.
	1983-84 [*]	38.1	37.8	24.1	29.0	8622	5353
	1984-85	33.6	15.6	50.8	26.4	4779	3173
	1985-86	48.9	28.4	22.7	21.3	5273	2694
Canterbury	1988-89	2.8	5.1	92.1	28.3	6427	6245

n.d. no data; * data from Popay *et al* 1984; + calculated from data in Popay *et al* 1984, using mean timing of seed production for subsequent three years.

DISCUSSION

The results of the regression from Argyll, relating seeds per inflorescence to receptacle area, only differed by about 5% from the regression of Popay *et al* (1984), but both were higher by 35% than the equation of Jessep (1990) from Canterbury in 1974-75. The reason for this is not known. The estimate of the number of seeds destroyed per larva (27.7) was very similar to Popay's estimate (29.6).

Although *Rhinocyllus* attacks many of the inflorescences produced early in the season, most thistle seeds are produced in January and February (Popay *et al* 1984) when the majority of inflorescences escape attack.

At Argyll, although there was some fluctuation from year to year, there was a general increase over the period 1982-86 in the levels of seed destruction by *Rhinocyllus*. This may reflect the fact that *Rhinocyllus* was first released in the area in 1981-82, and populations of the insect may have been still increasing. This suggestion is supported by the increase in the level of seed destruction in November/December in successive years (Fig 1).

However, the 49% seed loss in 1985-86 is still less than the maximum levels reported overseas (e.g. 78% by McCarty and Lamp 1982). Despite the attentions of *Rhinocyllus*, many seeds still survived to maintain the population, as Popay *et al* (1984) pointed out. The recent release of a second seed-destroying insect, *Europhora solstitialis*, may help (R.L. Hill, pers. comm.).

A sizeable fraction of the seeds actually set at Argyll were ripened in inflorescences attacked by *Rhinocyllus*. There is some debate over whether such seeds have a different germination rate from seeds in unattacked inflorescences. Popay *et al* (1984) found no difference for seed collected at Argyll. Surles and Kok (1978) found a significant change only in axillary heads (seeds from infested heads gave higher germination). McCarty and Lamp (1982) reported higher germination from infested sites, but in only one year of two; while Rees (1977) showed a clear decrease in germination with increasing number of larvae per inflorescence.

The very low levels of seed predation in Canterbury (compared to the North Island site) was unexpected. *Rhinocyllus* was released at this site on 18 November 1976 (C.T. Jessep, pers. comm.) so the populations should have reached equilibrium. The problem seemed to be that flowering was some 4 weeks later in Canterbury than was typical for Argyll. Therefore, a much smaller proportion of the seed crop was set during December when *Rhinocyllus* was commonest. It is not known if the time of flowering was unusual in 1988-89 in Canterbury. The region was suffering a serious drought at the time; although the thistles seemed unaffected by the drought, it is possible that flowering was delayed. Further work is planned to document the seed losses in other years.

About 24% of slender winged thistle inflorescences were attacked by *Rhinocyllus*, in 1984-85 and 1985-86. This was similar to the 22% for 1982-83 (Popay *et al* 1984). However, the mode of feeding of *Rhinocyllus* may mean that all these figures are underestimates. Inflorescences of slender winged thistle are much smaller than those of

nodding thistle (3-5 mm diameter vs 15-25 mm), and once all the receptacle has been eaten, the larvae often burrow down the stem. This weakens the stem, causing the inflorescence to fall off. The much higher incidence of *Rhinocyllus* in inflorescences collected from the ground under plants (65%) suggests that the inflorescences still attached to plants may be disproportionately the unattacked ones. Hence, *Rhinocyllus* seed predation may be having a useful effect on slender winged thistle, which is an important weed in some areas (Kelly and Popay 1985). Unfortunately, we know of no data on changes in density of slender winged thistle since the introduction of *Rhinocyllus*.

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