INCIDENCE OF THE NODDING THISTLE RECEPTACLE WEEVIL ON NODDING AND SLENDER WINGED THISTLES

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SUMMARY

In nodding thistle (*Carduus nutans*) flower heads collected during the 1982-83 and 1983-84 seasons from a Hawkes Bay farm, receptacle diameter and the number of nodding thistle receptacle weevil (*Rhinocyllus conicus*) larvae were recorded. In some heads mature seeds were counted. In November, over 90% of the heads contained an average of 19-30 larvae. Later in the season fewer heads contained larvae and there were fewer larvae per head. In the 1983-84 season, the maximum possible effect of the weevil was to reduce seed production by 76%. Only 22-40% of slender winged thistle (*C. pyconcephalus*) heads collected in November contained larvae.

INTRODUCTION

Nodding thistle has become a major pasture weed in several areas of New Zealand. In the early 1970's the nodding thistle receptacle weevil was released at several sites (Jessep 1975) and since then it has been spread to many other areas by farmers and Noxious Plant Officers. Jessep (1975) described the life cycle of the weevil in New Zealand. The same weevil has been introduced into North America to help control *Carduus* spp. Rees (1977), Surlles and Kok (1978) and McCarty and Lamp (1982) have assessed its impact on seed production by *C. nutans* (= *C. thoermeri*). In all three cases, weevil larvae infestations were heavy at the beginning of the flowering season, but later flowers were less affected.

In November 1983, at a site in Hawkes Bay, where nodding thistles had been studied for several years, it was noticed that flower heads contained large numbers of weevil larvae. Adult weevils had been released on a neighbouring farm about 1 km away in 1981-82 and the occasional weevil-affected head had been observed in the study area in that season.

The opportunity was therefore taken to measure the levels of weevil infestation during the 1982-83 and 1983-84 seasons and to try to estimate the effects of the infestations on seed production.

According to Jessep (1981), slender winged thistle is also affected by the same weevil. Slender winged thistles were present on the same site in November 1982 and 1983 and levels of weevil infestation were also assessed for this species.

MATERIALS AND METHODS

On five dates in 1982-83 and on six dates in 1983-84 (Table 2) flower heads were collected from a dense stand of nodding thistles near Argyll Road, Hawkes Bay. On each occasion heads were collected at or after full bloom, but before seeds had started to shed. Heads were collected from different positions on the plants. The number of heads collected on each date is shown in Table 2. For each collected head the receptacle diameter was measured and the number of weevil larvae (or pupae) recorded.

In 228 of the heads not affected by weevils, the seed was in an advanced state of maturity, i.e. the seeds were dark brown in colour and capable of germination. In these heads the numbers of mature and aborted seeds were counted and the relationship between receptacle area (calculated from the diameter) and mature seed number calculated.

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TABLE 1: Number of mature seeds per nodding thistle head in relation to receptacle diameter and weevil numbers.

Receptacle diameter (mm)	larvae per head					
	0	2	4	6	8	10
15	(1) 211	152	93	33	0	0
21	(1) 338	279	220	160	101	42
	(2) 347	273	213	120	60	33
	(3) 170	113	50	27	3	20
25	(1) 448	389	330	270	211	152
	(2) 467	453	350	293	273	130
	(3) 257	203	240	110	70	53
29	(1) 576	517	458	398	339	280
	(2) 590	627	497	467	500	223
	(3) 347	297	233	193	137	90

(1) = Hawkes Bay data

(2) = Surles and Kok (1978) 1973 data

(3) = Surles and Kok (1978) 1974 data

TABLE 2: Numbers of heads collected and effect of weevil infestation on seed production in those heads

Date of collection	No. of heads collected	Estimated Av. No. mature seeds per head	Estimated % of seed surviving weevil damage	Estimated % of seed surviving in best case*
19.11.82	130	536	54	3
15.12.82	196	320	68	15
31.12.82	269	352	81	47
14.01.83	315	296	93	78
4.02.83	111	245	99	97
4.11.83	133	327	34	2
18.11.83	159	377	15	1
12.12.83	208	350	47	5
10.01.84	296	270	73	36
10.02.84	226	237	94	75
15.03.84	42	187	45	7

* Assuming that a single weevil in a head destroyed all seed in that head.

In 168 heads with mature seeds, weevil larvae were present, and the number of unaffected mature seeds was counted. For each of these heads the number of mature seeds which would have formed if no weevils were present was calculated from the receptacle diameter and the relationship between this and mature seed production. The difference between the actual and theoretical number of mature seeds was divided by the number of larvae present, to obtain an estimate of the number of seeds destroyed by each larva.

Germination of mature seeds from weevil-affected heads was compared with that of mature seeds from unaffected heads.

In the 1983-84 season, numbers of flower heads were counted at intervals in two 144 m² plots in the paddock from which seed heads were collected. This allowed estimates to be made of potential seed production per unit area.

TABLE 3: Flower numbers in a nodding thistle stand, the extent of weevil infestation and the effect on seed production.

Date	Flower heads/m ²	Seed/m ² in absence of weevils	Seed/m ² after weevil damage	Seed/m ² best case*	Weevil larvae /m ²
4.11.83	0.17	56	19	1	3.2
18.11.83	0.72	271	42	1	19.4
12.12.83	9.01	3154	1470	164	61.7
10.01.84	18.40	4968	3647	1788	30.1
10.02.84	0.69	164	153	123	0.4
15.03.84	0.05	9	4	1	0.2
Total	29.04	8622	5335	2078	

* See Table 2

On 19 November 1982, 27 slender winged thistle flower heads were collected and on 4 November 1983, 98 heads were collected. The number of weevils per head was counted.

RESULTS AND DISCUSSION

The percentage of nodding thistle heads collected at each date which contained larvae or pupae, and the mean number of larvae and pupae per affected head are shown in Fig. 1. Only larvae were found in November: later in the season pupae were also found. In November 1982 and November 1983 almost all the heads collected contained larvae and the number of larvae per head averaged 19 to 27. As the flowering season progressed, both the proportion of the heads containing larvae and the number of larvae in affected heads declined. On the last collection date in 1984, a high proportion of heads contained larvae, although the number of weevils per head remained low.

There was a good correlation ($r=0.83$) between receptacle area and mature seed number. The regression equation was:

$$Y = 0.76 X + 76.8$$

where Y is the number of seeds per head and X the receptacle area in mm². On average, 88% of the florets in a head formed mature seeds.

The number of mature seeds destroyed by each weevil larva was not influenced by the size of flower head and although there was a trend for the number of seeds destroyed by each larva to decline with increasing weevil number per head, this was not statistically significant. The date on which seed heads were collected did, however, have a marked effect. In November of both years, the larvae found in flower heads were small in size and very numerous and the average number of seeds destroyed by each larva was 13.8. At later collection dates, the number of seeds destroyed by each larva was 29.6, averaged over collection dates.

Based on these data, the calculated number of mature seeds per head, for heads of selected receptacle diameter, resulting from infestation with different numbers of larvae are shown in Table 1, along with estimates of numbers derived from the data of Surles and Kok (1978). Our data are reasonably comparable with the 1973 data of Surles and Kok. Their seed production per head was much lower in 1974 than in 1973, but seed destroyed by each weevil larva was still comparable with our data.

Germination of mature nodding thistle seed from weevil-infested heads was the same (65%) as that from weevil-free heads. Surles and Kok (1978) also found that the presence of weevil larvae did not reduce germination of mature seed.

Fig. 1: Percentage of collected nodding thistle heads affected by weevil larvae (solid line) and the number of larvae per affected head (broken line) at different dates in 1982-83 and 1983-84. Vertical bars and 95% confidence limits.

Potential mature seed production per head from collected heads and the percentage of seeds surviving weevil attack were calculated for each date of collection (Table 2). In these calculations the seed loss of 13.8 per larva was used for November collections and 29.6 for other dates. Seed production was also calculated for the best possible case, where a single weevil in a head was assumed to destroy all the seed in that head.

In the two large plots in which flower heads were counted in the 1983-84 season, there was an average of 3.8 flowering stems/m². The number of flowers/m² is shown in Table 3. Although counts were not made often enough for all flowers to be counted, the figures indicate the pattern of flower production, which reached a peak in early January. Estimates of seed production, based on flower numbers and on the data in Table 2, are also shown in Table 3. Using our data on weevil damage to seeds, the weevils reduced seed production by 38.1%. In the best possible case, seed production was reduced by 75.9%. Even in this case, over 2000 mature seeds per m² could still have been produced.

The estimated weevil larva population/m² is also shown in Table 3. Highest larval numbers were present in December, about a month before peak flowering. Maximum egg laying by adults did not appear to coincide with maximum flower production. Even if egg laying and maximum seed production coincided there would still have been relatively few larvae per head. At the end of the 1983-84 season, when flower head numbers were again low, weevil infestation rates rose.

Whether the reduction in seed production caused by the weevils is likely to seriously affect the size of future populations of nodding thistles depends on how the factors which influence seed survival in the soil and the survival of young thistle seedlings operate. If both seed and seedling mortality is greater at higher seed and seedling densities, then it is possible that even the highest possible reduction in seed numbers, to 2000/m², will not have as big an effect on future thistle populations as this potential 76% reduction in seed production suggests. Certainly, 2000 seeds/m² is still theoretically high enough to maintain a large seed bank in the soil and to allow a high number of autumn-germinated seedlings.

Of the slender winged thistle heads collected, 22% contained weevil larvae in November 1982 and 40% in November 1983. Average number of larvae per affected head was 1.7 in both years. Nodding thistle heads collected at the same dates were much more heavily infested. Nodding thistle would appear to be the preferred host for the weevil rather than slender winged thistle, as suggested by Jessep (1981).

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