THE EFFECT OF NODDING THISTLE *(CARDUUS NUTANS)* ON PASTURE PRODUCTION

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SUMMARY

Rosette stage nodding thistles had little effect on pasture production. Bolting and flowering plants affected pasture growth in a circle up to twice the diameter of the flowering plants. Infestations of 1000 plants per hectare were calculated to reduce pasture herbage production by approximately 8% between October and May. Pasture weakened by thistle competition became heavily infested with seedling thistles and other weeds.

INTRODUCTION

Where nodding thistle densities are high there can be little doubt that herbage production and composition of associated pasture must be seriously affected. However, the losses and compositional changes caused by scattered populations of widely separated plants are less obvious and more difficult to quantify.

Kelly and Popay (1985) in calculating losses due to thistle infestation assumed that no herbage was produced within the shadowline of nodding thistle plants and that production outside of this line was normal, so that percent thistle cover and percent herbage loss were the same figure. In contrast, Hartley (1983) found that the removal of rushes from pasture increased the stock carrying capacity by a proportion almost twice that of the gain in grazeable area, suggesting that the adverse influence of the rush clumps on pasture growth extended well beyond the plant's aerial boundaries.

At two sites in the Waikato the production of permanent pasture surrounding individual nodding thistle plants was measured from spring through into the following winter. The effect of thistle competition on pasture composition was also measured.

METHOD

Trial 1 was conducted on pasture rotationally grazed by cattle on a Tirau sandy loam soil near Hinuera. The pasture in Trial 2 was on a Horotiu sandy loam soil at Rukuhia and was rotationally grazed by sheep. Both trials were sampled seven times; Trial 1 between September 1983 and August 1984, and Trial 2 between September 1984 and July 1985. In Trial 1 the sample thistles were selected from a naturally occurring population. Those used in Trial 2 were transplanted as seedling rosettes into the trial site in September 1983.

After each grazing pasture was trimmed to sampling height under and around 14-20 nodding thistle plants, typical of the population for size and growth stage. Immediately before the next grazing the selected thistles were cut at ground level, their diameter, height and weight recorded, and the patch of bare ground under each plant measured. Pasture herbage was harvested from the circle (which varied in size according to rosette diameter) covered by each thistle rosette and from a series of concentric rings extending out from the edge of the rosette. The two rings nearest the rosette were each 125 mm wide and the two or three succeeding rings each 250 mm wide, so that the pasture was sampled to either 750 mm or 1000 mm from the edge of the thistle rosette. All herbage was harvested from the central circle and from the two 125 mm wide inner rings. Herbage on five 250 mm x 250 mm sample areas was harvested and bulked from each of the two or three outer rings. All thistle and pasture samples were dried to determine DM content.

When the thistles matured and rosette leaves disappeared, the diameter of the inner circle in Trial 1 was arbitrarily set at 500 mm for all thistles sampled, and in Trial 2 was determined by the previously recorded maximum rosette size achieved by each plant. For the last two harvests at both sites the positions of sample plants were marked prior to their disintegration. Herbage from the final harvest of both trials was dissected to determine the proportions of pasture, nodding thistle seedlings and other weeds.

In analysing herbage production data for each harvest, yield from the outer sample ring around each thistle we assumed to represent the normal productive potential of the pasture and these were treated as controls in assessing the effects of thistle competition.

RESULTS

Table 1 gives sampling dates for both trials and the means of the range of thistle diameters on which sampling at each harvest was based. Growth stages of thistles at sampling, their overall canopy diameter as they bolted and branched and the mean diameter of bare ground patches under thistles are also given. Tables 2 and 3 give actual pasture herbage DM/ha yields from the outer control rings, and the production relative to these control rings from the other sample areas under and around thistles. The tables also indicate the percent herbage losses calculated to result from infestations of 1000 thistles/ha. The relative amounts of pasture species (grass and clover), nodding thistle seedlings and other weeds in herbage samples from the final harvest of Trial 1 in August 1984, and from Trial 2 in July 1985, are given in Table 4. Variations in the height, canopy diameter or weight of bolting and flowering plants did not significantly correlate with the pasture loss due to the presence of individual thistles.

TABLE 1: Nodding thistle rosette diameter, flowering thistle canopy diameter, bare ground (B.G.) diameter, and thistle growth stage at sampling dates.

	Trial 1					Trial 2			
Sampling dates	Mean rosette diam. (mm)	Mean canopy diam. (mm)	Mean B.G. diam. (mm)	Thistle growth stage *	Sampling dates	Mean rosette diam. (mm)	Mean canopy diam. (mm)	Mean B.G. diam. (mm)	Thistle growth stage *
28. 9.83	550	550	200	R	17. 9.84	730	730	360	R
27.10.83	770	770	200	R-B	29.10.84	820	820	360	R-B
8.12.83	770	1270	220	F	19.12.84	830	830	350	B-F
1. 2.84	690	1500	180	F-D	22. 1.85	800	1170	280	F
14. 3.84	540	1400	180	D	27. 2.85	810	970	440†	F-D
11. 5.84	500	0	0	A	4. 4.85	790	970	180	A
16. 8.84	500	0	0	A	9. 7.85	790	0	0	A

* Thistle growth stage: R = rosette, B = flowering, D = dying or dead, A = absent
† Stock damage

In Trial 1, rosette to early bolting stage thistles, sampled in September and October, had little effect on pasture growth (Table 2). At the same growth stage in Trial 2, only production under or within 125 mm of thistles was significantly ($P<0.05$) reduced (Table 3). The large patches of bare ground under thistles in Trial 2 (more than three times the area of those in Trial 1) (Table 1) caused a considerable part of this reduction. By December thistles in both trials had reached the early to full flowering stage and were having a marked effect on pasture growth, with herbage yields progressively reducing at each step across the sampling profile towards the thistle centre. In both trials thistles depressed pasture production most severely in February, even though by this time flowering was almost finished and the plants were sensescing. Reduced pasture growth was still apparent in April (Trial 2) and May (Trial 1) around the sites of thistle plants which, by then, had broken down and disappeared. At the final sampling of Trial 1 in August, herbage production differences across the sampling profile had disappeared, partly due to invasion by seedling nodding thistles and other weeds (Tables 2 and 4). By July, in Trial 2, the vigorous growth of invading thistles and

TABLE 2: Trial 1: Relative pasture DM yields from under and around nodding thistles, actual control yields and percent herbage loss/1000 thistles/ha. (Mean of 20 thistles/harvest)

Harvest date	Under rosette	Distance from rosette edge (mm) 0-125	125-250	250-500	500-700	750-1000 control kg/ha	(SEM) *	% herbage loss/1000 thistles /ha*
28. 9.83	100	100	100	100	—	1400	(3.0)	—
27.10.83	97	97	99	102	100	1440	(3.1)	0.3
8.12.83	30	62	75	84	96	1790	(3.0)	8.3
1. 2.84	18	27	40	64	88	2140	(2.6)	13.8
14. 3.84	30	46	61	74	90	2090	(2.8)	8.5
11. 5.84	45	51	61	65	84	1600	(4.4)	9.3
16. 8.84	104	85	96	98	101	1950	(3.2)	—

*% herbage loss = -³ = A^i - RY100
where A^i is the are of the ith region
RY is the relative yield
i = 1

TABLE 3: Trial 2: Relative pasture DM yields from under and around nodding thistles, actual control yields and percent herbage loss/1000 thistles/ha. (Mean of 14-20 thistles/harvest)

Harvest date	Under rosette	Distance from rosette edge (mm) 0-125	125-250	250-500	500-750	750-1000 control kg/ha	(SEM)	% herbage loss/1000 thistles /ha*
17. 9.84	61	86	98	98	100	1940	(3.2)	2.4
29.10.84	39	75	88	97	100	2100	(3.3)	5.1
19.12.84	38	56	73	84	96	2770	(3.3)	8.9
22. 1.85	34	50	63	73	92	2190	(4.2)	11.4
27. 2.85	25	48	54	70	89	1460	(7.1)	13.3
4. 4.85	53	69	73	85	97	2630	(3.8)	6.8
9. 7.85	132	123	119	112	104	1370	(4.1)	—

see Table 2.

TABLE 4: Percent pasture, nodding thistle seedlings and other weeds at the final sampling dates for both trials.

	Rosette centre	Distance from rosette edge (mm) 0-125	125-250	250-500	500-750	750-1000
	Trial 1 (sampled 16.8.83)					
Pasture	88	95	96	97	98	99
Nodding thistle	7	2	3	2	1	1
Other weeds	5	3	1	1	1	—
	Trial 2 (sampled 9.7.85)					
Pasture	34	44	55	73	79	78
Nodding thistle	5	5	4	2	1	1
Other weeds	61	50	40	24	21	21

flatweeds around the sites of dead thistles had replaced much of the original grass/clover pasture cover and reversed the earlier pattern of herbage yields (Tables 3 and 4).

Herbage dissections (Table 4) showed that in both trials the control rings furtherest from the previous season's thistle plants contained similar small numbers of nodding thistle seedlings. Trial 2 pasture contained a much higher proportion of other weeds, mainly flatweeds, than pasture in Trial 1. In both trials, but particularly in Trial 2, the proportion of pasture species (grass and clover) progressively decreased and the amounts of nodding thistle and other weeds correspondingly increased as sampling moved from the outer control circles towards the centre where thistle plants had flowered and died during the previous summer.

DISCUSSION

Prior to the bolting stage, mid to late October in these trials, nodding thistle plants had little effect on pasture growth beyond the perimeter of the rosette. Even within the rosette boundaries substantial amounts of herbage were produced, although most of this would have been denied to stock except under fairly heavy grazing pressure. However, as they developed through the late spring and summer, thistles became extremely effective competitors with grazed pasture. Comparison of the data in Tables 1, 2 and 3 shows that individual thistles affected pasture growth for considerable distances beyond the area covered by the rosette base or shaded by the canopy of the bolting and flowering plants.

In Trials 1 and 2 respectively the circle of reduced pasture growth around thistles was approximately 50% and 100% greater in diameter than the mean canopy diameter of the flowering plants. These results indicate that, in assuming pasture production losses caused by nodding thistle to be proportionally equal to the area covered by the thistles, Kelly and Popay (1985) considerably underestimated the impact of scattered thistle populations.

The calculations of pasture herbage loss for infestations of 1000 thistles/ha in Tables 2 and 3 indicate that the onset of significant pasture production reductions coincided with a rapid increase in thistle biomass from late October, and reached a maximum of 13%-14% for both trials in mid summer. Autumn pasture recovery was slow around dead thistles and production losses of approximately 7% and 9% were calculated in April and May. Herbage production losses of approximately 8% were calculated for both trials over the period from October to April or May.

Pasture composition was seriously affected in the vicinity of thistle plants allowed to complete their life cycle. At the two sites the numbers of thistle seedlings established in the most seriously weakened pasture (that within the canopy shadow line of dead thistle plants), were 5-7 times greater than numbers in the outer control areas. Flatweeds were also much more numerous where thistle plants had flowered and died.

CONCLUSION

Nodding thistles affect pasture growth well beyond the canopy of the bolting and flowering plants. Therefore, relatively minor populations of scattered plants, allowed to survive through the summer, can significantly reduce herbage production from pasture and cause its rapid deterioration, facilitating the establishment of seedling thistles and other weeds.

ACKNOWLEDGEMENTS

Thanks to Dr J. Waller for statistical analyses and to Mr J. Pearce for providing a trial site.

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