WIND DISPERSAL OF NODDING THISTLE SEEDS AND PAPPI

DAVE KELLY¹, HEATHER CAMERON¹, and JACK ALEX²¹Botany Department, University of Canterbury, Christchurch 1²Department of Environmental Biology, University of Guelph,
Ontario, Canada N1G 2W1

SUMMARY

Dispersal of nodding thistle (*Carduus nutans*) pappi and seeds was examined in 1986 and 1987 at Rakaia, Canterbury, using nets at three heights (1, 3 and 5 m) and three distances (10, 33 and 100 m) from an isolated patch of plants. In 1986, only a small proportion of pappi were caught above 1 m height or more than 10 m downwind; the percentage of pappi with a seed decreased with height and distance in both 1986 and 1987. Overall, 15.1% of pappi carried a seed in 1986, and 8.7% in 1987. Wind dispersal is inefficient for nodding thistle because the seed detaches readily from the pappus.

INTRODUCTION

The dispersal abilities of nodding thistle (*Carduus nutans*) seeds are of concern to many people because the plant is perceived as a serious weed where it occurs at high densities (Kelly and Popay 1985), because it has probably not colonized all of its potential range in New Zealand, and because of its status as a legally declared noxious plant. Dispersal of nodding thistle seed is assisted by a large pappus. Pappi are readily observed blowing around in large numbers over summer, heightening the concern of landowners. Some experimental studies have measured dispersal of nodding thistle using sticky traps placed on the ground (Delahunty 1962; Smith and Kok 1984). The aim of this study was to measure the vertical and horizontal pattern of dispersal in nodding thistle, by trapping pappi in the air with nets at different heights and distances from the source of seed.

METHODS

The study site was in mid-Canterbury on the north bank of the Rakaia river, 8 km north-east of Rakaia township. A paddock of permanent pasture was used which was generally clear of nodding thistle (which is widespread in this area) except for a dense patch of about 50 large flowering plants covering 8 m by 5 m in the centre of the paddock in 1986. In 1987 this patch contained only about half the number of thistles. Three metal towers were erected at distances of 10 m, 33 m and 100 m from the edge of the thistle patch. Each tower held six nets: two replicates each at heights of 1 m, 3 m and 5 m from the ground. The nets had a throat diameter of 38 cm and were constructed of fine plastic mesh which did not allow thistle seeds (technically achenes) to escape. At weekly intervals the nets were emptied and the seeds and pappi inside identified to species level and counted.

The experiment was conducted in two consecutive summers: January to March 1986, and January to March 1987. In 1987 and for the first part of 1986 the nets were aligned south-east of the thistles to catch during north-west winds, which are the most common strong winds in the area. For the later part of the 1986 period the towers were moved to catch from gentler north-east winds. Wind speed and direction were measured by a recording anemometer throughout the study. In 1987 three anemometers were run at 1, 3 and 5 m heights on the 10 m tower to record the vertical wind profile.

RESULTS

As well as large, plump, well-filled nodding thistle seeds, a number of small withered seed were found. These were much lighter (0.33 ± 0.034 mg, mean $\pm$ 95% C.I.) than the filled seeds (2.13 ± 0.11 mg), and very few germinated (0.4% vs 63.8% Proc. 41st N.Z. Weed and Pest Control Conf.

for filled seeds), so they were not included in the seed totals given here.

In 1986 nearly half (49%) of all pappi caught were taken from the closest nets (10 m distance/1 m height; Fig. 1a). There was a rapid decrease in the number of pappi caught both with distance downwind, and with height above ground. Only 11.5% of the pappi were caught in the 5 m nets in 1986.

The percentage of pappi attached to a filled seed was low. The closest nets had the highest percentage (22.5% at 10m/1m), while at the 5 m height only 10.4% of pappi had a seed, and at 100 m distance only 7.1% of all pappi caught through the season carried a seed. Overall, for all nets combined, 15.1% of pappi had a seed aboard in 1986.

The absolute number of seeds found was therefore even more heavily biased towards the 10m/1m nets than the pappi; 73% of seeds were in these closest nets, only 7.9% were caught in the 5 m nets, and only 7.7% at 100 m distance.

In 1987 the total number of pappi caught was down by 66% (828 vs 2415 in 1986). The predominance of the lowest and closest nets was less marked in 1987: only 15% of all pappi were caught in the 10m/1m nets (Fig. 1b). At all heights more pappi were caught at 33 m distance than at 10 m distance.

However, the distribution of seeds was similar to 1987 to that in 1986, with most seeds (51%) being caught in the 10m/1m nets, where 29% of pappi had a seed. The equivalent figure for all 5 m nets was 1.9% of pappi with a seed, and for all 100 m nets it was 0.6%. Overall throughout the season in all the nets 8.7% of pappi carried a seed. Only 5.6% of the seeds caught were in the 5 m nets, and only one seed (1.4%) made it to the 100 m nets.

The anemometers showed that, in 1987, total wind run was lower near the ground. The wind run through the 1 m and 3 m nets was only 59% and 89% respectively of the wind run at 5 m.

Fig. 1: The total number of pappi and seeds of nodding thistle (*Carduus nutans*) caught in nets at different heights off the ground and different distances downwind from an isolated patch of thistles. Seeds are shown as black. (a) 1986 season; (b) 1987 season.

DISCUSSION

Since nets were used in the present study, the distances measured are minimum dispersal distances; this difficulty also applies, though less severely, to results from sticky traps at ground level. Pappi which have reached a height of 5 m from the ground are likely to travel a long way (perhaps measured in kilometres) in the stronger winds at that height, but 10% or less were found to have a seed attached. Of all the 5 m nets, those at the closest distance caught the fewest pappi, perhaps because few pappi from the source plants were lifted 5 m vertically in 10 m horizontally. The data from these 10m/5m nets probably represent background levels of airborne nodding thistle pappi dispersing across the study area from plants growing further upwind.

These results on the distribution of pappi agree with the studies of Delahunty (1962) and Smith and Kok (1984), which showed that most pappi remain near the parent plants. Most pappi were caught low down and near in, even though the volume of air filtered through the 1 m nets was only 59% of the volume passing through the 5 m nets. Also, it is noteworthy that so few of the netted pappi carried a filled seed: less than 16% overall in both years, and less than 8% for the nets at 100 m from the seed source. Again this result confirms the findings of Delahunty (1962). Several reports have stressed that the seeds are readily detached from the pappus (Doing *et al* 1969, Matthews 1971, Stuckey and Forsyth 1971). It seems that once the seed has been detached from the pappus, for example while bumping along the ground, the pappus has a much better chance of being picked up by wind gusts and carried away.

In both 1986 and 1987, more than half the seeds were caught in the closest nets. The proportion of pappi captured in these nets in 1986 was similarly large but was much smaller in 1987. This may be because the number of flowering plants in the source area was lower in 1987, reducing the number of pappi caught, hence reducing the signal-to-noise ratio (between local and distant thistles) and making stochastic effects more important. The percentage of pappi with filled seeds was also lower in 1987. Observations at the time suggested that high levels of seed predation by *Rhinocyllus conicus* (Popay *et al* 1984) in 1987 may have been responsible. Many *Rhinocyllus*-damaged inflorescences were noted in 1987.

Overall, these data confirm the impression from other studies that wind dispersal of nodding thistle is not very efficient, because the seed is heavy (so a pappus with a seed is unlikely to travel far), and easily detached from the pappus (so most dispersing pappi are empty of seed). That conclusion may be reassuring to a farmer who is standing at her or his boundary fence, watching thistle pappi float onto the property.

ACKNOWLEDGEMENTS

We thank DSIR Entomology Division for the loan of towers and an anemometer, and Mr L. Smith of Northbank Station for making the study site available. One of us (H.B.C.) was supported by a grant from Entomology Division.

REFERENCES

- Delahunty, E., 1962. Nodding thistle. *Proc 15th NZ Weed and Pest Control Conf.*: 24-28.
- Doing, E.F., Biddiscombe, E.F., and Knedlhans, S., 1969. Ecology and distribution of the *Carduus nutans* group in Australia. *Vegetatio* 17: 313-351.
- Kelly, D. and Popay, A.I., 1985. Pasture production lost to unsprayed thistles at two sites. *Proc. 38th NZ Weed and Pest Control Conf.*: 115-118.
- Matthews, L.J., 1971. Nodding thistle. *N.Z. J. Agric.* 122: 72-73.
- Popay, A.I., Lyttle, L.A., Edmonds, D.K., and Phung, H.T., 1984. Incidence of nodding thistle receptacle weevil on nodding thistle and slender winged thistle. *Proc. 37th NZ Weed and Pest Control Conf.*: 28-32.
- Smith, L.M. and Kok, L.T., 1984. Dispersal of musk thistle (*Carduus nutans*) seed. *Weed Science* 32: 120-125.
- Stuckey, R.L. and Forsyth, J.L., 1971. Distribution of naturalised *Carduus nutans* (Compositae) mapped in relation to geology in northwestern Ohio. *Ohio J. Sci.* 71: 1-15.