INCREASING TEMPERATURES MAY ENHANCE EMERGENCE AND SEEDLING GROWTH OF NODDING THISTLE, SUMMER GRASS AND SPINY EMEX

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SUMMARY

The influence of temperature on growth habits of three weed species, viz. nodding thistle (*Carduus nutans*), summer grass (*Digitaria sanguinalis*) and spiny emex (*Emex australis*) were investigated. Seeds of each species were planted in trays with and without pre-established ryegrass/white clover swards, under four constant temperature regimes: 10°C, 15°C, 20°C and 25°C, and two fluctuating temperature regimes. Seedling emergence and shoot growth of nodding thistle and spiny emex were stimulated by higher temperatures. Summer grass seedlings emerged only at temperatures of 20°C or more. Global warming may enhance establishment of summer grass. Success of nodding thistle and spiny emex is likely to be inversely related to effect of temperature on pasture growth.

Keywords: climate change, global warming, pasture weeds, temperature

INTRODUCTION

In recent years there has been considerable interest in the impact of global warming on New Zealand agriculture. It has been predicted that New Zealand may experience an increase in mean temperature of 1-3°C (Salinger *et al* 1989) and such a temperature rise would probably exert important effects on the weed spectrum in New Zealand cropping and pasture systems (Rahman and Wardle 1990; Wardle and Rahman 1990). Global warming is also expected to influence growth rates of New Zealand pasture species (Baars 1990), and since the success of pasture weeds is inversely related to pasture vigour, global warming may also exert indirect influences on the success of various pasture weeds (Wardle and Rahman 1990).

Relatively little information is available as to how the biology of important pasture weed species may be influenced by small differences in temperature. The purpose of this study was to determine the influence of temperature on seedling emergence and growth of three weed species, selected because of their differing climatic distributions, viz. nodding thistle (widespread throughout New Zealand and not severely restricted by temperature), summer grass (restricted to the warmer areas of New Zealand), and spiny emex (abundant in Australia but restricted to only a handful of locations in New Zealand (Panetta and Mitchell 1991)). These weed species were selected because they can occur in pasture although spiny emex and summer grass are also frequently found in crops.

MATERIALS AND METHOD

Ryegrass-white clover swards were established in polystyrene trays (50 x 30 x 11 cm deep) by planting 60 perennial ryegrass (*Lolium perenne* cv. Yatsyn) and 40 white clover (*Trifolium repens* cv. Pitau) seeds per tray. The soil used was a Horotiu sandy loam (pH 5.7; organic C 9.1%; total N 0.81%; total P 0.18%). After 2 months these swards were placed in four constant temperature regimes: 10°C, 15°C, 20°C and 25°C (with 16/8 hours light/dark) and two fluctuating temperature regimes (outdoor: 10°C to 25°C, and glasshouse: 20°C to 30°C). These swards were then left for another month, after which four swards per temperature were planted with seeds of each of the following three species: nodding thistle (50 seeds/tray), summer grass (100 seeds/tray) and spiny emex (50 seeds/tray). Seeds were planted by pushing them 3 mm into the soil surface.

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All weed seed had been collected within the previous 18 months. Shortly after planting the weed seeds, pasture cover was estimated in each sward by point quadrat analysis, by measuring the total number of pasture hits per 100 points. Swards were maintained at 3-5 cm height throughout the experimental period.

Weed seeds were also planted in pots in the absence of pasture species. For each temperature x weed species combination, four replicate pots (15 cm diameter) were filled with soil (Horotiu sandy loam) and planted with fifteen weed seeds.

Following set-up, all trays and pots were watered regularly to keep the soil near field capacity. Every 3-5 days over a 6 week period, the total number of weed seedlings which had emerged in each tray or pot were counted. This was used to determine total percent emergence, and calculate the speed of emergence index "S" of Khandakar and Bradbeer (1983) as modified by Wardle *et al* (1991). Briefly the index S ranges from 100 (if all seedlings emerge within 1 day of planting) to 0 (if no seedlings ever emerge). Six weeks after weed seed planting, weed seedlings were thinned to three per tray or pot and left for a further 6 weeks. At this time the shoot dry weight of each seedling was determined by oven-drying (80 °C; 24 h).

RESULTS AND DISCUSSION

Results of the various treatments with and without pre-established swards are summarised in Tables 1 and 2 respectively.

Temperature had little effect on total emergence of nodding thistle but higher or fluctuating temperatures tended to accelerate emergence. Total emergence was independent of pasture cover, although the pots without swards had slower emergence rates. Nodding thistle seedling emergence was very low in all treatments, for unknown reasons. Optimal growth of nodding thistle occurred at around 20 °C, consistent with the observations of Medd and Lovett (1978). Seedling emergence and growth occurred at around 10 °C in the pots without pasture species. These results reflect the ability of nodding thistle to germinate and grow over a wide range of temperatures. Temperature is not a major factor restricting distribution of nodding thistle in New Zealand at present, and a predicted temperature rise of 1.5-3 °C (global warming theory: Salinger *et al* 1989) is more likely to influence nodding thistle by indirect rather than direct means e.g. by influencing the competitiveness of pasture cover (Wardle and Rahman 1990).

TABLE 1: Influence of temperature on seedling emergence and growth of three weed species in pre-established swards.

Weed	Assessments ²	10 °C	15 °C	20 °C	25 °C	F ¹	GH ¹
nodding thistle	% G	4.0b ³	8.5ab	5.5ab	6.5ab	10.5a	6.5ab
	SoG	0.16b	0.83a	0.50ab	0.73a	0.87a	0.53a
	D.W.	0.003b	0.062ab	0.013a	0.049ab	0.005b	0.039b
	P.D.	59.5c	56.8c	16.3c	13.5c	134.2b	199.2a
summer grass	% G	0.0d	0.0d	3.0c	15.3b	42.0a	35.3a
	SoG	0.00c	0.00c	0.46b	4.41a	6.51a	5.94a
	D.W.	-	-	0.016b	0.018b	0.014b	0.410a
	P.D.	51.8cd	53.5c	8.8e	22.8de	87.3b	191.5a
spiny emex	% G	53.5a	54.5a	50.0a	44.0a	42.5a	47.5a
	SoG	2.3d	5.3bc	8.0a	6.7ab	4.4cd	4.8bc
	D.W.	0.016b	0.197b	0.214b	0.088b	0.088b	0.048b
	P.D.	50.3c	37.3c	4.8d	9.5d	120.7b	164.5a

¹ F, GH = field (outdoor) and glasshouse conditions.

² % G, SoG, D.W. and P.D. indicate percent emergence, speed of emergence, dry shoot weight per plant (g) and pasture density (total number of hits per 100 points).

³ Within each row numbers followed by different letters are significantly different at P=0.05 (Tukey's test).

TABLE 2: Influence of temperature on seedling emergence and growth of three weed species in pots without pasture species.

Weed	Assessments	10 °C	15 °C	20 °C	25 °C	F	GH
nodding thistle	% G	0.0b	4.0b	2.0b	4.0b	8.0a	2.0b
	SoG	0.000b	0.054b	0.056b	0.096	0.162a	0.036b
	D.W.	-	-	-	-	0.092	-
summer grass	% G	0.0b	0.0b	0.0b	4.0b	62.0a	30.0a
	SoG	0.000b	0.000b	0.000b	0.090b	0.956a	0.626a
	D.W.	-	-	-	-	0.285b	5.718a
spiny emex	% G	40.0bc	58.0b	32.0c	34.0c	84.0a	62.0ab
	SoG	0.31c	1.09ab	0.84bc	0.91b	1.48a	1.37ab
	D.W.	0.021b	0.177b	0.174b	0.110b	0.219b	1.568a

Symbols as for Table 1; blank spaces indicate insufficient seedlings for dry weight determination.

Limited emergence of summer grass occurred at 20 °C in the pre-established swards, otherwise emergence was restricted to the 25 °C or fluctuating temperature treatments. This species appears to have a threshold temperature (between 20-25 °C) below which emergence will not occur. At present this weed is restricted to the warmer areas of the North Island, but considering the requirement of summer grass for high temperatures, it is likely that a 1.5-3 °C temperature rise could increase its distribution and abundance in the future.

Spiny emex seedlings were capable of emerging at all temperatures. Emergence was relatively high (>40%) in all treatments, but was highest in the absence of pasture swards in the fluctuating temperature treatments. Emergence and growth of spiny emex over a wide temperature range is consistent with the observations of Weiss and Simmons (1977). In general seedling growth of spiny emex was much lower in the presence than in the absence of swards, indicating that it does not compete well with pasture species. Temperatures throughout New Zealand at present are suitable for spiny emex to establish, and a 1-3 °C increase is unlikely to exert a major direct influence on its occurrence in perennial pastures. However, spiny emex seedling emergence and growth appears to be strongly influenced by the competitive effects of pasture species, and success of this weed is likely to depend on the response of pasture species to these temperature changes. In Australia spiny emex occurs mostly in annual pastures, which are unlikely to survive in New Zealand following a temperature increase of 1-3 °C. Spiny emex is also an important weed in cereal crops and since higher temperatures increase crop growth rates (Salinger *et al* 1989), interactions between weeds, cereal crops and temperature merits investigation.

Of the three weed species tested, summer grass is the most likely to spread further as a direct result of a 1-3 °C temperature increase. All three species demonstrated generally negative interaction with pasture. Thus any predicted effect of elevated temperature (global warming theory) on these weeds will almost certainly be influenced by temperature effects on pasture productivity, and in the case of summer grass and spiny emex, also crop productivity. Other factors could also influence success of these species in pasture and cropping situations, including rainfall and soil moisture-temperature interactions.

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