COMPETITION BETWEEN FIREWEED, *SENECIO MADAGASCARIENSIS* AND OATS, *AVENA STRIGOSA*

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Summary. Glasshouse and field trials were conducted to measure the effect of increasing density of fireweed, *Senecio madagascariensis* Poir., on the growth and yield of grazing oats, *Avena strigosa* cv. Saia. A significant reduction in yield was detected at one plant m^{-2} while a moderate infestation of 5 plants m^{-2} caused a 25% loss in productivity. The competitiveness of fireweed with oats was not reduced as a result of increased soil fertility.

INTRODUCTION

A recent mail survey of fireweed in coastal areas of N.S.W. showed that 57% of all respondents believed that the weed reduced crop or pasture productivity on their properties. The experiments reported here were undertaken to determine the nature and size of these losses at both low and high fertility, and to assess the practical importance of fireweed as a competitive weed.

The effect of increasing fireweed density on the growth and yield of Saia oats was investigated at Camden, N.S.W. under glasshouse conditions and in the field. Saia oats is a grazing and forage species often grown in fireweed-infested areas of eastern Australia.

METHODS

Glasshouse experiment. Seed of Saia oats was purchased locally and fireweed seed collected in the field at The Oaks, N.S.W., immediately prior to the experiment in May 1985. Fireweed seeds were germinated on moist filter paper in petri dishes at 25°C and the oats in large trays at room temperature. Seedlings of fireweed were then transplanted at the cotyledon stage to 18 cm diameter black plastic bags filled to a depth of 18 cm with surface soil obtained from an unfertilised area under native pasture at Camden. Oat seedlings (6 days old) were transplanted 18 days after the fireweed. Pots of soil were maintained close to field capacity by regular watering. Glasshouse conditions ranged from 29±3/10±2°C day/night temperature at the start of the experiment to 32±3/13±2°C day/night temperature at the end of the experiment.

A basal dressing of nitrogen (as urea) and phosphorus (as superphosphate) was mixed into the soil of each pot at rates of 20 and 10 kg ha^{-1} respectively. In addition high fertility treatment pots received six 400 ml applications of Aquasol® complete nutrient solution (23% N, 4% P, 18% K and trace elements) at fortnightly intervals, being equivalent to a total application of 216 kg N, 38 kg P, and 170 kg K ha^{-1}.

The experiment began on 17 June 1985 and plants were harvested on 8 October 1985 and dried at 70°C. Among the indices of growth of oats measured were tiller number and total dry weight.

The experimental design was a randomised complete block factorial in which there were five replicates of each of the 10 treatments (2 levels of soil fertility x 5 levels of fireweed density). In each pot there were two oat plants, 7.5 cm apart and fireweed at 0, 1, 2, 4 and 8 plants per pot, or 0, 40, 80, 160 and 320 plants m^{-2}.

Field experiment. Preparation of the area involved spraying with the herbicide glyphosate at 2.16 kg a.i. ha^{-1} in early February 1986, forage harvesting to remove the plant residue and cultivating to produce a good seed bed. The soil was very similar to that used in the glasshouse. On 4 June Saia oats was drilled at 90 kg ha^{-1} in 15 cm rows at a depth of 2.5 cm. Immediately after sowing, Starter 18 fertilizer was broadcast at a low rate (30 kg N/14 kg P ha^{-1}) and a high rate (120 kg N/55 kg P ha^{-1}). Fireweed seedlings were planted out some 12 days later after the oat seedlings had emerged and been counted to check for uniform establishment.

Fireweed seed collected near Dapto, N.S.W. in November 1985 had been germinated in Cellupak Planter speedling trays in a 50% peat, 50% vermiculite media mix with added nutrients and watered fortnightly with Aquasol[R]. Seedlings were transplanted to the field at the 10 leaf stage and the area irrigated as required.

The first harvest of oats, simulating grazing to 2.5 cm above ground level, was at 11 weeks after sowing when the oats was 15 and 30 cm high in the low and high fertility plots respectively, and fireweed was in the early stages of flowering. The second harvest occurred at 15 weeks during profuse flowering and a third made seven weeks later as fireweed began to senesce. Only the latter included both oats and fireweed. Measurements made were total fresh and dry weights, and fireweed plant diameter. All plant material was dried at 70°C.

The experimental design was a split plot factorial in which there were four replicates of each of the 16 treatments: two levels of soil fertility (main plots) x eight levels of fireweed density (sub-plots). Sub-plots were 2 m^2 in area and had an average oat density of 280 plants m^{-2}. The fireweed densities were 0, 1, 2, 4, 10, 20, 40 and 80 plants per plot or 0, 0.5, 1, 2, 5, 10, 20 and 40 plants m^{-2}. Data was subject to log_e transformation before analysis.

RESULTS AND DISCUSSION

Increasing fireweed density caused a significant decrease in the number of tillers and total dry weight of oats (see Figs. 1 and 2). Under glasshouse conditions with comparatively high fireweed densities the data approximate an asymptotic relationship. However, even in the field trial where much lower densities were included there was still no indication of the sigmoidal relationship often cited for weed competition (3). Curves relating yield of oats to fireweed density generally showed a rapid initial decline followed by a longer levelling out stage.

In the field, losses in productivity were more marked at the third harvest than at the first and second simulated grazings (see Figs. 2 a, b, c). At least two factors contributed to this result. Firstly, at the seedling and early developmental stages of growth, plant resources are likely to have been non-limiting and competition between plants, small. Secondly, simulation based on the knowledge that cattle avoid grazing fireweed meant that only oats was cut at the first two harvests. This allowed the weed to grow above the pasture canopy, and because of its much branched habit, gain a competitive advantage for light.

If pasture growing beneath fireweed is also avoided by stock, as has been suggested (1), the effective grazing area may be reduced considerably. At the highest density in the present study, as much as 60% of ground area was covered by fireweed at the third harvest.

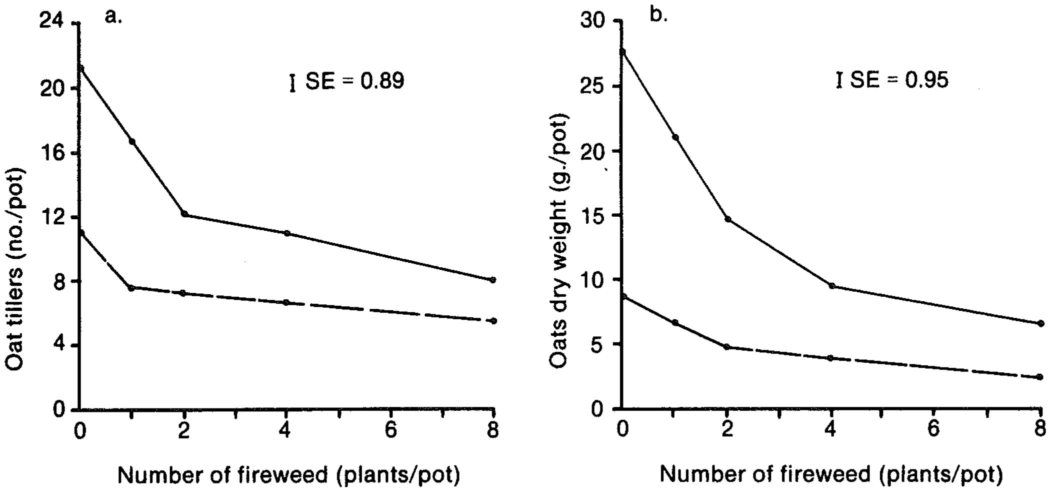

Figure 1. The effect of fireweed density on (a) the number of tillers, and (b) the dry weight yield of oats in the glasshouse at high (—•—) and low (-—•—) soil fertility.

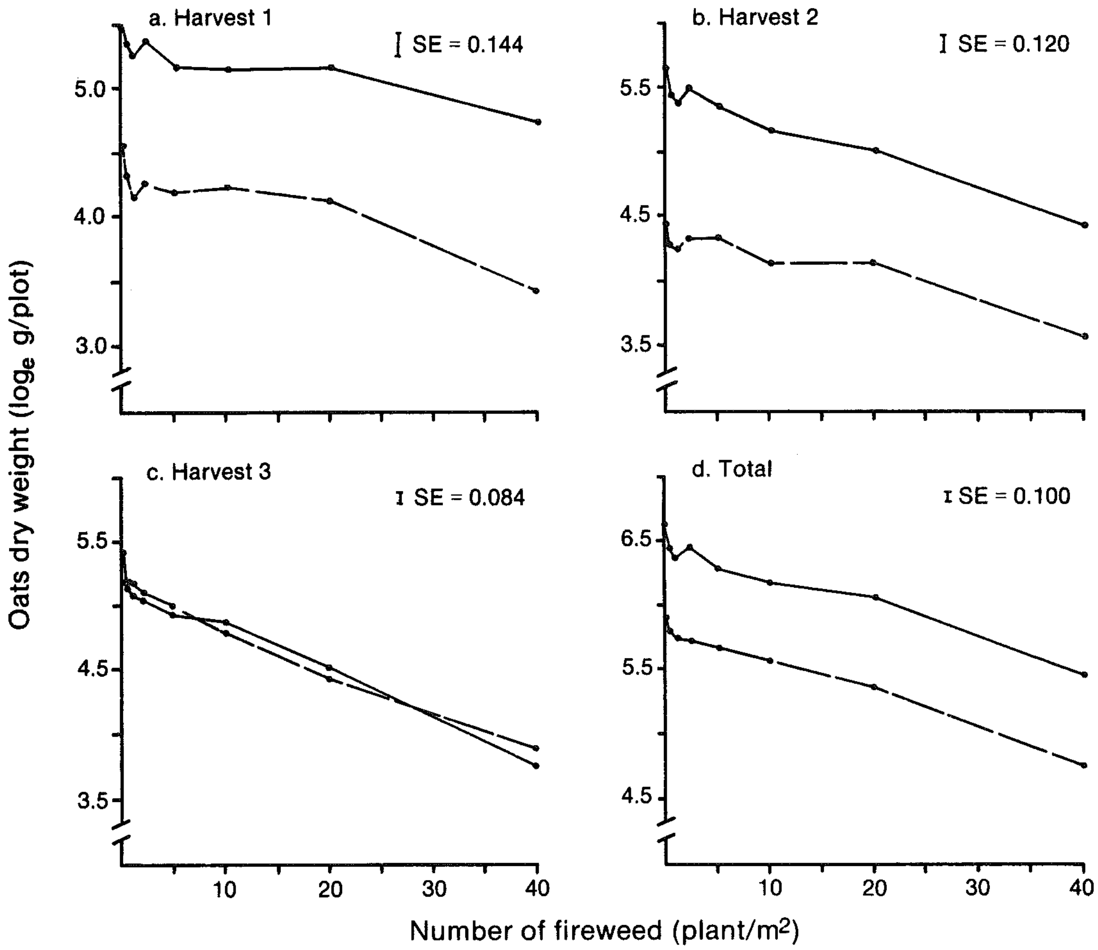

Figure 2. The effect of fireweed density on the dry weight yield of oats in the field under high (—•—) and low (—•—) soil fertility.

In the glasshouse experiment when the number of fireweed plants was equal to that of oats (two per pot), tiller production in the latter was reduced to 60% and total yield to 54% of the control over the two soil fertility levels. In other glasshouse work in which a number of annual and perennial pasture grasses and clovers were subjected to fireweed competition, the growth of nearly all species was suppressed more than Saia oats. Thus, the strong competition with oats in the present study is evidence of the ability of fireweed to substantially reduce the productivity of a range of forage crops and pastures.

Fireweed reduced tiller production and yield of oats in absolute terms more under high soil fertility than low soil fertility. On a percentage basis, however, the reductions obtained for soil fertility treatments were not significantly different at the 5% level. This result suggests that the competitiveness of fireweed with Saia oats and other pastures is not suppressed as a result of improved soil fertility conditions alone, and that as a weed it competes strongly for soil nutrients.

In Fig. 2 a, b, c the results of the three field harvests are presented. The low and high fertility graphs for harvest 3 are almost identical, whereas those for harvests 1 and 2 are widely separate. It is assumed that between the second and third harvests, the fertilizer differential had disappeared through crop and weed uptake and leaching.

Practically, the field data show a significant reduction in total forage yield (5% level) with a fireweed infestation of only one plant m^{-2} over both fertility levels. At 5 fireweed plants m^{-2} a 25% loss in productivity occurred. Oats grown alone yielded 1.84 and 3.74 t ha^{-1} DM for low and high fertility treatments respectively.

Previously, Martin and Colman (2) considered that fireweed had little influence on pasture production, at least in warm climate grass pastures, and that competition with pasture species was small. Their conclusion was based on the fact that at the highest density in their study (4.79 plants m^{-2}) total fireweed yield (106 kg ha^{-1}) was not a significant part of the total herbage on offer. In this experiment a similar density of fireweed yielded between 500 and 800 kg ha^{-1} DM.

Undoubtedly, factors such as the condition of the pasture, whether it is annual or perennial, time of fireweed establishment, and duration of growth will alter the competition process. However, the results of this present study with forage oats highlight the importance of fireweed as a competitive weed and show its potential to reduce pasture productivity, particularly species less competitive than oats. The extent to which growth is suppressed depends on the level of infestation.

REFERENCES

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