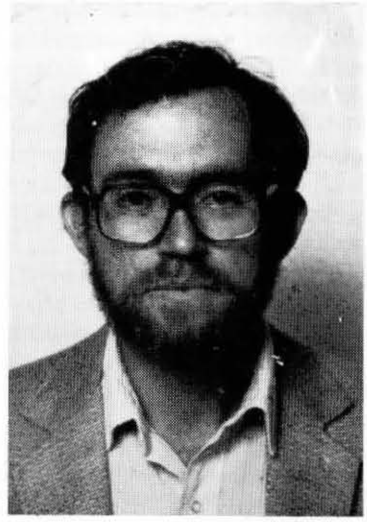
RESEARCH REPORTS



Size structure of silvergrass *(Vulpia* spp.*)* populations in direct drilled wheat

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Summary

Silvergrass (*Vulpia* spp.) occurs in direct drilled wheat fields but not in conventionally tilled crops. In the former, the size structure of silvergrass populations was highly and positively skewed if establishment of seedlings occurred early in crop growth, but approaches normality if established late. Similarly, in early established populations, the upper quartile (25%) of the population accounts for more than 60% of total population weight, whereas with late establishment this percentage drops to about 40%. These anomalously large plants (that is, those in the upper quartile) may account for a disproportionate amount of the competitive effect on the crop. Experiments concerning the effect of removal of anomalously large individuals on subsequent growth of remaining plants may be profitable in formulating methods of weed control.

Introduction

The silvergrasses or squirrel tail and rat's tail fescues (*Vulpia bromoides* (L.) S.F.Gray and *V. myuros* (L.) C.C.Gmel.) are common weed components of pastures in southern Australia. Although they contribute to early season livestock forage, they are more widely known for livestock carcase irritation and as vegetable fault in clipped wool. Silvergrass survival is very susceptible to cultivation and, therefore, the taxon has not been known hitherto as a problem in crops. Silvergrass tolerance to a broad range of post-emergent herbicides is becoming increasingly apparent, and this has allowed the species to flourish in direct drilled wheat crops where such herbicides are necessary. No practical method of post-emergent silvergrass control is known, and the extent or intensity of silvergrass infestation in crops has not been investigated.

Size of individual annual plants is partly a function of time of establishment (Black and Wilkinson, 1963; Ross and Harper, 1972). Early established individuals pre-empt ecological space and resources, resulting in a population of individuals whose weights are skewed positively. Thus, a few individuals within the population account for a disproportionate amount of the total population mass and, presumably, have a disproportionate effect on competing plant species. In a crop situation perhaps only a few large individuals of a weed per unit area significantly affect the crop rather than the entire population of individuals. In this presentation I report the effect of establishment date on the size structure of silvergrass populations in a direct drilled wheat crop. Results from a tillage experiment and a limited survey of wheat crops in the Southern Tablelands of New South Wales are also presented to document the effect of cultivation on silvergrass.

Methods

Size structure

A field planted with oats (*Avena sativa* L.) in 1980 was direct drilled with wheat (*Triticum aestivum* cv. Egret) at 75 kg ha^{-1} on 15 June 1981 at Ginninderra Experiment Station, Canberra. Neither pre- or post-emergent herbicides nor fertilizers were applied so that weed–crop interactions might be enhanced. The field was divided into 3 m × 3 m plots. Weed seedlings of all species within groups of three randomly distributed plots were removed continuously until the following dates: 31 July, 5, 10, 20 and 30 August, 9, 19 and 29 September, 9 and 29 October and 18 November, after which the weeds were allowed to establish and grow. Three plots were left unweeded as controls. Abundant rainfall in winter and spring assured adequate conditions for germination and establishment of silvergrass seeds. Silvergrass is capable of year round germination and establishment once a 2- to 3-month dormancy period is satisfied (Dillon and Forcella, 1984). Although several weed species other than silvergrass occurred in these plots, only annual ryegrass (*Lolium rigidum* Gaudin) and sorrel (*Rumex acetosella* L.) were abundant.

On 30 November all silvergrass individuals within the plots were harvested separately, placed in bags, and air dried. Plants were identified as to species (based on relative glume lengths), separated into vegetative and reproductive components, and weighed to the nearest 0.01 g.

On 10 December wheat plants in the central 4 m^2 of each plot were harvested. Grain heads were threshed, and the grain cleaned, air dried and weighed.

Susceptibility to cultivation

A wheat experiment involving 10 treatments (Table 1), each with four replicates, was conducted at Murrumbateman, New South Wales in 1981 and 1982. Treatments compared direct drilled with conventional cultivation practices, narrow with wide row spacing, and early with late planting.

Table 1 Abundance of silvergrass in plots of wheat given one of 10 treatment combinations. Application of any one treatment is indicated by 'x'.

Treatment combinations	Treatments[1]								Silvergrass[2]		
	DD	CT	EP	LP	WR	NR	SF	CF	a	b	c
1	x	.	.	x	.	x	.	.	25	5	14.4
2	x	.	x	.	.	x	.	.	100	28	4.3
3	x	.	.	x	.	x	.	.	25	5	13.7
4	x	.	.	x	x	.	.	.	50	15	9.8
5	x	.	.	x	x	.	.	.	75	40	107.0
6	x	.	.	x	.	x	.	x	0	0	0.2
7	x	.	.	x	.	x	.	x	0	0	0.1
8	.	x	.	x	.	x	x	.	0	0	2.4[3]
9	.	x	.	x	.	x	x	.	0	0	0.7
10	.	x	x	.	.	x	x	.	0	0	0.2

[1] Treatment specifications were as follows: **DD** direct drill; **CT** conventional tillage; **EP** mid-April planting date; **LP** mid-May planting date; **WR** 36 cm wide drill rows; **NR** 18 cm wide drill rows; **SF** short fallow using cultivator as needed beginning mid-March; **CF** chemical fallow using broad-spectrum herbicides as needed beginning mid-March.
[2] Abundance of silvergrass: **a** percentage of replicates per treatment in which silvergrass was estimated to be problematic (as observed by R. A. Fischer) in December 1981; **b** averages of visually estimated mass of silvergrass in grams per square metre in 1981 (R. A. Fischer); **c** geometric averages of number of individuals per square metre in November 1982.
[3] Plots of treatment 8 were cultivated conventionally in 1982, but were direct-drilled in three previous years. The relatively high number of silvergrass in 1982 may have resulted from previous treatments.

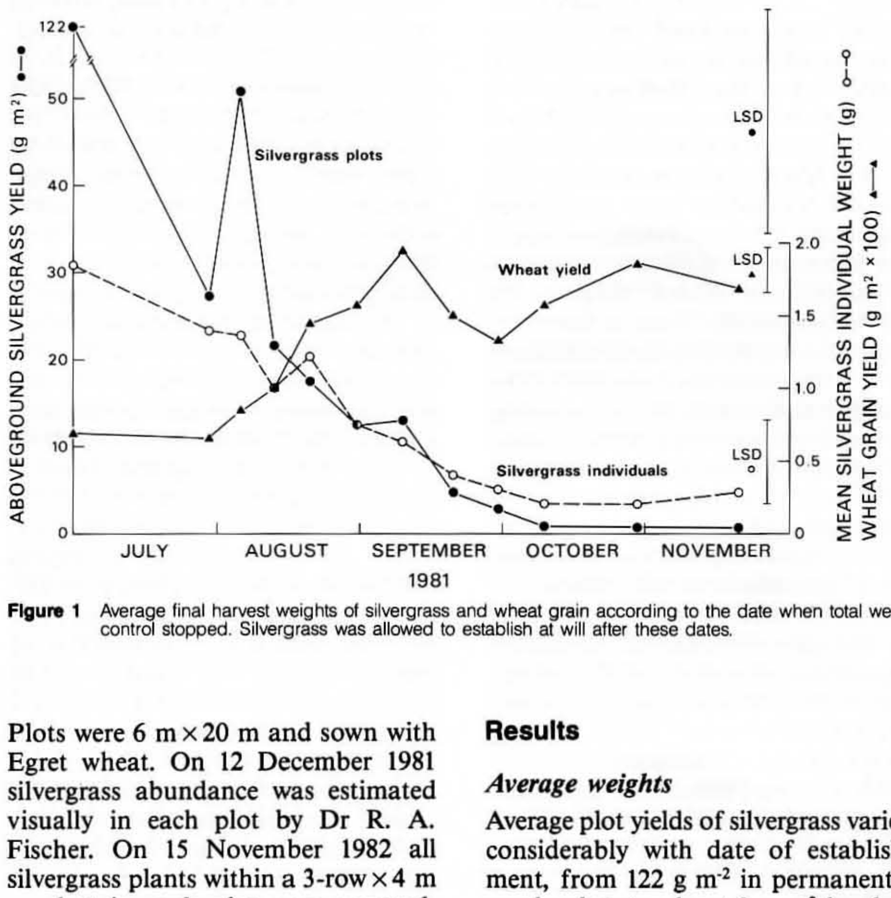

Figure 1 Average final harvest weights of silvergrass and wheat grain according to the date when total weed control stopped. Silvergrass was allowed to establish at will after these dates.

Plots were 6 m × 20 m and sown with Egret wheat. On 12 December 1981 silvergrass abundance was estimated visually in each plot by Dr R. A. Fischer. On 15 November 1982 all silvergrass plants within a 3-row × 4 m quadrat in each plot were counted, harvested, dried and weighed collectively.

On 12 November 1982, 20 commercial wheat fields between Canberra and Boorowa, New South Wales were examined for type of cultivation (direct drill or conventional) and presence of silvergrass. The number of silvergrass individuals within two 2-row × 8 m arbitrarily positioned quadrats were counted.

Results

Average weights

Average plot yields of silvergrass varied considerably with date of establishment, from 122 g m^{-2} in permanently weedy plots to about 2 g m^{-2} in plots kept weed free until October or November (Figure 1). Silvergrass yields were significantly reduced in plots allowed to establish weed populations in mid- to late August and thereafter. This period was also the time when the presence of weeds led to the greatest change in yield of the wheat crop (Figure 1). Reduction in silvergrass yield of 100 g m^{-2} was associated with a similar yield increase in wheat grain.

Average weights for individual plants varied in a manner similar to that of plot yields, but were less erratic (Figure 1). Shoots of plants in continuously weedy plots averaged 1.8 g in weight. As plants established at later dates average shoot weights gradually declined to about 0.2 g. Weights of reproductive components of the plant consistently averaged about 50% of total shoot weights.

Species differences

The number of individuals of the two silvergrass species was approximately equal in all sets of plots except the continuously weedy and 31 July treatments, where *V. bromoides* was 1.5 to 2.5 times as common as *V. myuros*. However, the mean dry weights of *V. bromoides* were only about half those of *V. myuros* in the same two treatments, the differences being significant (t-tests, $P < 0.05$). There were no significant differences between mean dry weights or numbers of individuals of the two species in the remaining treatments.

Size structure

Variability (expressed as coefficients of variation) of individual weights within establishment dates was considerable although it decreased from >120 in early establishment plots to <80 in late establishment plots. Figure 2 depicts 'box plots' (*sensu* Tukey, 1977), which summarize the distribution of individual plant weights. These box plots show that the major difference between early and late establishment plots was the degree of positive skewness, that is, the number and size of anomalously large plants. Early establishment plots were highly positively skewed while late establishment plots supported plant populations whose weight distributions approached normality.

The few anomalously large plants in each set of plots accounted for a very high proportion of total weight of silvergrass. For example, the upper octile (12.5%) of individuals represented nearly 50% of the total mass in early establishment plots, but only 20% to 30% in late establishment plots. The weights accounted for by each quartile (25%) of the individuals in each population varied in a similar manner: the upper quartile decreased from more than 60% of total weight in early establishment plots to about 40% in plots established after mid-September.

Susceptibility to cultivation

Conventional tillage greatly restricted the abundance of silvergrass, whereas

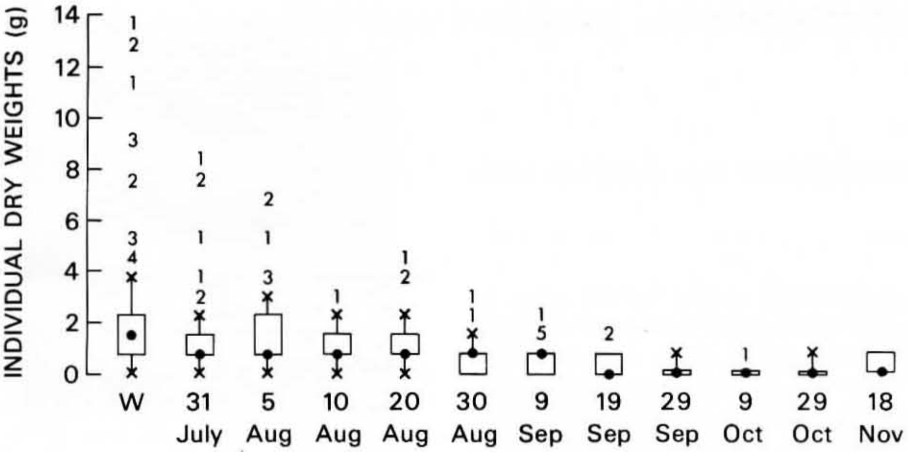

Figure 2 'Box plots', that is, summaries of frequency histograms of individual silvergrass dry weights (pooled within treatments) according to the date at which establishment was allowed to proceed. Boxes represent interquartile weights, that is, range of weights of the mid-50% of the population. Distances between Xs are interoctile weights, that is, range of weights of the mid-75% of population. Extreme weights and their number are represented by Arabic numerals. Solid circles are median weights.

silvergrass was abundant in direct drilled treatments (Table 1). Wide row spacing of direct drilled seed was particularly conducive to the establishment and growth of silvergrass. However, chemical fallowing prior to drilling of seed appeared to control silvergrass (Table 1).

Of the 20 wheat fields examined for the presence and abundance of silvergrass, 16 had been conventionally tilled and the remaining four direct drilled. Silvergrass was present in all four direct drilled fields with an average ($\pm$ standard deviation) of 50.5 ± 78.8 plants per square metre. Only two of the conventionally tilled fields supported silvergrass populations (abundance was 0.05 and 15.0 plants per square metre). Chi-square analysis of presence-absence data of silvergrass in the two tillage systems indicated that the species occurred significantly ($P < 0.05$) less often than expected in conventionally tilled fields and more often than expected in direct drilled fields.

Discussion and conclusions

The positively skewed distribution of weights of individuals within a plant population is well known (Koyama and Kira, 1965; Obeid *et al.*, 1967; Ogden, 1970; Ross and Harper, 1972). It seems not to have been documented explicitly that a very large proportion of total population mass is accounted for by the weights of a very small proportion of the population. During the interspecific competition that occurs in weedy crops, it is probably this small proportion of anomalously large individuals that exerts a disproportionately large competitive effect on the crop. Direct evidence for this is scant, but it is suggested by the response of wheat yield to both timing of weed control (Figure 1) and the presence of anomalously large weed plants (Figure 2). In the present experiment anomalously large plants were common if weed populations were established before mid-August, and in such cases associated wheat yields remained low. With weed establishment occurring after this date, wheat yields were consistently high despite the presence of weeds, most of which were uniformly small.

The effect on the remainder of the population after the removal of anomalously large individuals in their early stages of growth is unknown. Perhaps the positions held by the removed individuals would be usurped by others, resulting in a final size distribution as positively skewed as would be the case if no plants were removed. Alternatively, if early growth and final size (which are related: Ross and Harper, 1972), are determined genetically (Burdon and Harper, 1980), then removal of initially large seedlings might affect a final size distribution that approaches normality with more uniformly small individuals. If this alternative was the case, then competing crop plants would not be affected as severely as they would in competition with a weed population that attained a highly skewed size distribution. Experiments along these lines may be profitable, especially in view of future herbicide applicators that may sense photoelectrically the presence of plants above some minimum size.

Silvergrass essentially is not present in conventionally tilled wheat crops in the Southern Tablelands of New South Wales, perhaps because of its germination-emergence intolerance to darkness and burial (Dillon and Forcella, 1984). Its tolerance to post emergent herbicides such as diclofop methyl probably explains its proliferation in direct drilled wheat crops. If and when herbicides are found that affect silvergrass, it is suggested that their methodology of application take into consideration that only a small but active proportion of the population may require control. The size of this active group of individuals varies with the time of their establishment.

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