Integrated weed management for the control of herbicide resistant annual ryegrass

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Summary. A series of experiments to evaluate suppression of herbicide resistant annual ryegrass infestations with sustainable management activities was conducted. Ryegrass seed bank densities and crop yields for various treatments are reported. Reducing the density of ryegrass prior to sowing by a 3 week delay in sowing date was an effective treatment in reducing the seed bank and improving crop yields. Pre-emergent herbicide application reduced the seed bank and improved crop yields in pea crops as did crop topping. Seed catching reduced the ryegrass seed bank but not always below the crop damage threshold and crop yield responses were not consistent . Crop rotations containing legumes had higher weed seed densities than cereal only rotations in the absence of herbicide treatments.

INTRODUCTION

Many populations of annual ryegrass across southern Australia have developed herbicide resistance due the persistent use of selective herbicides in both cereal and legume crops (1). Recent surveys indicate that 40% of cropped paddocks contain populations of ryegrass with serious levels of resistance (2,3). The continued emphasis on herbicide application for weed control will increase this proportion. Herbicide resistant ryegrass has developed multiple resistance to many selective herbicides such that many populations have limited herbicide options for suppressing infestations and reducing weed competition. With widespread and difficult weeds, an appreciation of integrating cultural control methods and herbicides to provide sustainable weed management is required. The following series of experiments evaluated the effect of integrated management on a ryegrass seed bank over 2 years.

MATERIALS AND METHODS

Field experiments were established to evaluate the effect of delayed sowing, burning stubble residues and catching ryegrass seed at harvest (4) on the continuing ryegrass seed bank. These cultural methods were evaluated in a wheat, barley and pea rotation (Experiment 1, Roseworthy SA, mean annual rainfall 441 mm) and in a wheat, barley and faba bean rotation (Experiment 2, Auburn SA, mean annual rainfall 596 mm). The use of trifluralin pre-emergent herbicide (0.7 L/ha) with crop topping at late ryegrass anthesis (paraquat, 100 g a.i./ha) at weed anthesis with seed catching at harvest were examined in a wheat and pea rotation at Roseworthy (Experiment 3). The efficacy of reducing the soil seed bank in a pasture prior to cropping were examined at Roseworthy with one year of spraytopping, chemical fallowing and ploughing and two years of spraytopping (Experiment 4). Experiments 1, 2 and 3 were split plots (3 levels) and experiment 4 was a split plot (2 levels). Preliminary results of the ryegrass seed bank are presented, three 110mm diam. cores per plot were taken in autumn prior to rainfall. Crop sowing rates were standard for each area. Data was analysed by Anova on Genstat 5.0.

RESULTS AND DISCUSSION

There were many treatments and interactions from four experiments, the results are presented in table form showing treatments and interactions effects on ryegrass seed bank density and crop yields. The important observations are summarized below.

1. Seed catching reduced the ryegrass seed bank by approximately 55% across all experiments, see Tables 1, 2 and 3. Crop yields did not immediately reflect this reduction as seed densities were not reduced to below a damage threshold, (Tables 5,6 and 7).

2. Delayed sowing time; Tables 1, 2 and 3 show that a delay of 3 weeks was effective in reducing seed numbers in the soil. Crop yields were improved by delayed sowing, (Tables 5, 6 and 7) except when crops were competitive, barley, Table 5 and wheat, Table 7.

3. Legume crops in the cropping sequence increased weed seedbank numbers, (Tables 1, 2 and 3) in the absence of herbicides. Where effective pre-emergent and crop topping herbicides were available, ryegrass numbers were reduced (Table 3). Crop yields reflected the improved weed control, expt.3. Table 7.

4. Burning stubble did not significantly reduce seed numbers (data not shown) in the drier, more variable Roseworthy environment. At Auburn burning resulted in a significant reduction as sufficient stubble was present to fuel a destructive fire on ryegrass seed. The burning of stubble across all treatments resulted in 58% less ryegrass seed in the 1995 seedbank (P<0.001)(data not shown). Crop yields were inconsistent under burning treatments and showed no sig difference from unburnt treatments (data not shown).

5. There were significant interactions between crop species and seed catching as weed seed output was higher in some crops. Tables 1 and 2 show this and Table 3 shows the usefulness of seedcatching in conjunction with other treatments.

6. Pasture treatments; spraytopping, chemical fallowing and cultivated fallow as single treatments and spraytopping twice as followed by wheat and pea crops are described in Table 4. Each pasture treatment was differentially effective. The wheat crops and the pea crop on the ploughed treatment effectively suppressed the ryegrass seed bank as much as the second year of spraytopping, and to a greater extent with seed catching than without.

Table 1. Means of the ryegrass seed bank after 2 years of a wheat, barley and pea rotation at Roseworthy, (ryegrass seed/sq m). The initial ryegrass seedbank was 5300 seeds/sq?m.

	Time of sowing			
	Early		Late	
Crop sequence	Catching seed	Seed not caught	Catching seed	Seed not caught
Barley - peas	2247	5972	1372	4459
Peas - wheat	842	2008	412	573
Wheat - barley	495	929	197	224

Crop sequence and time of sowing were significant (P<0.05), with a significant interaction between crop spp. and seed catching (P<0.05).

Table 2. Means of the ryegrass seed bank after 2 years of a wheat, barley and bean rotation at Auburn, (ryegrass seed/sq m). The initial ryegrass seedbank was 3127 seeds/sq m.

	Time of sowing			
	Early		Late	

Crop sequence	Catching seed	Seed not caught	Catching seed	Seed not caught
Barley - beans	2153	3867	1488	2560
Beans - wheat	4358	8817	2867	5752
Wheat - barley	1175	2210	767	2784

All treatments and crop sequences.were significant (P<0.05), there were no significant interactions.

Table 3. Treament means of pre-emergence herbicide application, crop topping and seed catching in a wheat-peas rotation at Roseworthy (ryegrass seed/ sq m). The initial seed bank was 76 ryegrass seeds/sq m.

	Herbicide treatment							
	Pre-emergent				None			
	Crop topping		No crop topping		Crop topping		No crop topping	
Crop sequence	Seed caught	Un-caught	Seed caught	Un-caught	Seed caught	Un-caught	Seed caught	Un-caught
Wheat-peas	0	26	254	395	219	623	754	2131
Peas-wheat	26	26	202	237	140	254	886	1736

Crop topping was significant (P<0.001), with a pre-emergent herbicide*seed catching interaction (P<0.01).

Table 4. Treatment means of ryegrass seed density following pasture treatments in the year prior to a wheat-peas rotation at Roseworthy (ryegrass seed/sq m). The initial ryegrass seedbank was 1644 seeds/sq m.

Year	Pasture treatment in year prior to planting											
1993	Spraytopped				Chemical fallow				Ploughed fallow			
1994 Spraytopped	Wheat		Peas		Wheat		Peas		Wheat		Peas	
	Catch	U/C	Catch	U/C	Catch	U/C	Catch	U/C	Catch	U/C	Catch	U/C

1995	362	167	377	1561	2657	202	228	570	1894	88	263	368	1350

All pasture treatments were significantly different (P<0.05), 1994 crop spp. was significant (P<0.001), seed catching was significant(P<0.01).

Table 5. Crop yields (t/ha) from Experiment 1 at Roseworthy.

	Time of sowing			
	Early		Late	
Crop	Catching seed	Seed not caught	Catching seed	Seed not caught
1993-4 Barley		2.64		2.36
1993-4 Peas		1.17		0.93
1993-4 Wheat		1.43		1.60
1994-5 Barley	1.20	1.11	1.02	1.10
1994-5 Peas	0.12	0.16	0.36	0.34
1994-5 Wheat	0.85	0.88	1.23	1.13

Time of sowing was significant for wheat and peas only (P<0.001).

Table 6. Means of crop yields (t/ha) from Experiment 2, Auburn.

	Early		Late	
Crop	Catching seed	Seed not caught	Catching seed	Seed not caught
1993-4 Barley		1.54		3.25
1993-4 Beans		-		2.13
1993-4 Wheat		1.9		2.41
1994-5 Barley	1.53	1.77	1.83	1.74

1994-5 Beans	0.37	0.46	0.66	0.83
1994-5 Wheat	2.40	2.59	2.32	2.03

Sig. crop*time of sowing interaction (P<0.001).

Table 7. Means of crop yields (t/ha) from Experiment 3, Roseworthy.

	Herbicide treatment							
	Pre-emergent				None			
	Crop topping		No crop topping		Crop topping		No crop topping	
Crop sequence	Seed caught	Un-caught	Seed caught	Un-caught	Seed caught	Un-caught	Seed caught	Un-caught
1993-4 Wheat	-	2.59	-	3.59	-	2.58	-	3.30
1993-4 Peas	-	0.73	-	0.99	-	0.70	-	0.83
1994-5 Wheat	1.04	1.13	1.05	1.14	0.80	0.77	0.62	0.52
1994-5 Peas	0.55	0.53	0.28	0.35	0.31	0.32	0.09	0.05

Crop topping treatments and pre-emergent herbicide sig. (P<0.001) and sig. crop * pre-emergent herbicide interaction (P<0.001)

Annual ryegrass is a fecund grass weed with a high proportion emerging from the seedbank in any season, therefore, the greatest influence on the seed bank and on crop yields (in the absence of effective herbicides) is the size of the seed set from the previous year. Integrating the low herbicide resistance risk management options of pre-emergence trifluralin application and crop topping with competitive crop species, delayed sowing and seed catching shows good prospects for long term management of annual ryegrass populations.

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