1989

Brome grass population dynamics in relation to control systems

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WESTERN AUSTRALIA

EXPERIMENTAL SUMMARY 1989

BROME GRASS POPULATION DYNAMICS IN RELATION TO CONTROL SYSTEMS

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Introduction

The background to the brome grass problem has been well documented in previous Experimental Summaries. This report summarizes the key findings over the last 4 years, and also indicates the direction in which further research should go. Our current emphasis on developing a whole farm management approach for controlling brome grass is consistent with the expectations from farmers in the northern wheatbelt where most of the brome grass problems exist. The project has also provided answers to questions directed to us at the start of the investigation. For example, farmers wanted to know why despite the use of the lupin-wheat rotation sequence, regeneration of brome grass in the wheat crop is quite common. They wanted to know whether the persistence of brome grass is related more to survivors shedding seeds or to the persistence of seeds in the soil. A knowledge of this is important since the annual rate of population change will be determined by the balance between the addition of new seeds and the losses of existing seeds from the system. It is in relation to such questions that the study has taken the demographic approach. This approach has proved to be particularly useful in understanding how demographic processes produce population changes and in identifying the stages and the processes that are most critical for the regulation of the brome grass population. Overall, this approach has provided a practical compromise between the simplicity of long-term descriptive studies and the complexity of purely mechanistic studies. The data have a considerable value for analytical work and have some use for predictive purposes.

Project Objectives

(i) To identify the level of control of brome grass under various rotation systems so that farmers can be advised on the degree of infestation likely to be encountered when using a particular system.

(ii) To design the best control system to reduce quickly the anticipated large seed population of brome grass in the soil.

(iii) To identify the stages and the processes that are most critical for the regulation of the brome grass population so that better weed control strategies can be developed.

(iv) To predict brome grass population based upon the rates of change of the seedbanks, the effective seedling recruitment and the adult fecundity under different crops, herbicides and management systems.

(v) To note whether there is a shift in weed species resulting from the long-term weed control programme.

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Trial Number: 86C1

Treatments: The 16 treatments are summarized in Table 1. For further details, see 1988 Experimental Summaries.

Table 1. Treatments evaluated

Rotation system 1986-87-88-89	Herbicide programme
(R 1) P-P-P-P	No herbicide
(R 2) P-P-P-P	Spraytopping with Roundup/Sprayseed
(R 3) P-P-P-P	Fusilade*
(R 5) P-W-P-W	Pasture spraytopping; one kill of Bromus in wheat
(R 6) W-P-W-P	As in R5, but phase shifted one year
(R 7) P-W-P-W	Fusilade in pasture; one kill of Bromus in wheat
(R 8) W-P-W-P	As in R7, but phase shifted one year
(R 9) L-W-L-W	Simazine in lupins; one kill of Bromus in wheat
(R10) W-L-W-L	As in R9, but phase shifted one year
(R11) L-W-L-W	Sim, Fus in lupins; one kill of Bromus in wheat
(R12) W-L-W-L	As in R11, but phase shifted one year
(R13) L-W-L-W	Rdup, Sim, Fus in lupins; one kill of Bromus in wheat
(R14) W-L-W-L	As in R13, but phase shifted one year
(R15) L-W-L-W	Rdup, Sim, Fus in lupins; no Bromus control in early wheat
(R16) W-L-W-L	As in R15, but phase shifted one year
(R 4) W-W-W-W	Late-sown wheat to allow 2 kills of Bromus

* All Fusilade treatments were applied approximately 2 weeks after first score. P = Pasture, W = Wheat, L = Lupins, Sim = Simazine, Fus = Fusilade, Rdup = Roundup.

Assessments

Seed reserves

At the commencement of each growing season all plots were sampled to obtain a base level for the brome grass seed population in the soil. Thereafter, the change in brome grass seed population was monitored at (i) 4 weeks after seeding, (ii) the time of crop anthesis before the shedding of brome grass seed, and (iii) immediately after crop harvest after seed shed. Soil samples were taken to a depth of 10 cm using a steel pipe with a 10 cm diameter core. A total of 20 soil cores were taken randomly within each plot after dividing the plot into four quarters and taking five samples from each quarter. The cores within each quarter plot were composited and the seeds extracted from the soil by dry sieving and the numbers of viable seeds determined by the tetrazolium chloride method.

Emerged populations and fate

Counts of emerging brome grass were obtained approximately 4 weeks after crop seeding. The brome grass counts were based on 12, 25 x 25 cm random quadrats within each plot and the totals expressed as numbers/m^2. Out of the 12 quadrats, four were retained as fixed quadrats within which all new seedlings were counted and colour coded as they emerged at monthly intervals to monitor their fate and seed production.

At the time of crop anthesis, another count was made to determine the brome grass density.

Crop yield

Both the wheat and lupin crops were harvested at the end of the season to determine the grain yield. Medic seed production was also determined.

Summary of Findings

A.

(i) Lupin-wheat rotation

The lupin-wheat rotation is the best option for brome grass control. In the first rotation cycle, the brome grass density was reduced to 5 plants/m^2 from an initial density of 148 plants/m^2 when simazine and fusilade were used sequentially in lupins, compared with 75 plants/m^2 when simazine alone was used (Table 2).

Table 2. Brome grass density (plants/m^2) at time of crop anthesis

Rotation to 1989	Herbicide(s) used in lupin phase	Cropping phase			
		Lupin 1986	Wheat 1987	Lupin 1988	Wheat 1989
L W L W	Simazine	75	107	5	24
L W L W	Simazine, fusilade	5	27	2	7

However, despite the excellent control of brome grass with simazine followed by fusilade, the surviving 5 plants/m^2 produced on average 50 viable seeds. These new seeds together with the existing seeds (30 seeds/m^2) in the soil, contributed to the brome grass infestation in the following wheat crop. As there is no selective herbicide for its control in the cereal phase, this led to increases in the size of the seed bank. However, the lupin-wheat rotation provided the best opportunity for breaking the life cycle of the existing brome grass population. This is due to the complete exhaustion of the brome grass soil seed reserves by the time of crop anthesis during the wheat phase following lupins (Table 3). This suggests that the key to the long-term control of brome grass lies in the prevention of seed production in the wheat year after lupins.

By the second rotation cycle, there was a further reduction in the brome grass seed reserves despite the lack of control of the small brome grass population in the wheat crop (Table 3). It is anticipated that probably a point can be reached to achieve complete exhaustion of the seed reserves if control pressure is maintained, leading to long-term control of brome grass.

Table 3. Brome grass soil seed reserves under lupin-wheat rotation cropping over a period of four consecutive years. Results are expressed as percentages of the original population assessed at the start of the experiment in 1986

Rotation system	Start of season				At crop anthesis				After crop harvest			
1986-87-88-89	1986	87	88	89	1986	87	88	89	1986	87	88	89
(R 9) LWLW	100	22.2	13.4	9.1	1.4	0	0.1	0.1	40.3	150.7	11.8	-
(R11) LWLW	100	3.9	12.2	1.4	2.5	0	0.2	0	8.9	110.8	2.3	-
(R13) LWLW	100	0.9	2.6	0.1	1.5	0	0	0	3.1	45.1	0.4	-
(R15) LWLW	100	1.4	4.2	0.4	1.9	0	0.4	0	3.9	64.8	0.4	-

Overall, the results show the importance of lupins acting as the cleaning crop where effective control measures are available to reduce the soil populations of brome grass seed to levels which will make the growing of cereal crops feasible. The levels obtained however, were clearly determined by the brome grass control levels during the lupin year. In all cases, the use of fusilade dramatically reduced the brome grass population. It removed most of the brome grass that escaped the simazine treatment. Simazine does not give consistent results because its activity depends very much on the soil moisture content. The addition of Roundup or Spray-Seed to simazine for the initial kill of brome grass, followed by the fusilade sprays, had proven to be the most effective treatment when confronted with a high brome grass challenge of around 1000 plants/m^2. At this high density, this treatment outyielded the simazine only treatment by 44% when the grain yield of wheat following lupins were compared. At moderate brome grass density of about 150 plants/m^2 however, the use of Roundup or Spray. Seed with simazine is not worthwhile because only a small increase in wheat grain yield over the simazine-fusilade treatment was noted. At this moderate density, the simazine-fusilade treated lupins outyielded the simazine-treated by 22%, and by 30% at high density (Table 4).

Table 4. The grain yield of wheat (kg/ha) following lupins with moderate or high infestations of brome grass

	Infestation level	
Treatment	Moderate[1]	High[2]
9	640	555
11	780	719
13	793	800

1. Yield data obtained in 1987.
2. Yield data obtained in 1988.

The simazine-only treatment also resulted in a build-up of the ryegrass population in subsequent wheat crop, if ryegrass control is ignored. This is mainly due to the staggered germination of ryegrass which managed to escape the simazine activity.

The results also showed that early seeding of wheat following lupins without any prior cultivation or any means of weed control, on the assumption that the brome grass control was adequate in the lupin year, resulted in a larger proportion of brome grass emerging within the crop instead of before seeding when the seedlings could be more easily destroyed. This led to a 32% reduction in grain yield compared to a wheat crop sown at standard seeding time with one kill of brome grass before seeding. At this stage it is not known whether a point can be reached which allows early seeding of wheat without sacrificing yield if control pressure is maintained on brome grass.

(ii) Pasture-wheat rotation

This system failed to give better brome grass control or higher grain yield of wheat than the lupin-wheat sequence despite the use of fusilade or the adoption of seed-set control techniques (pasture-topping) during the pasture phase.

(iii) Continuous pasture

Continuous pasture receiving yearly applications of fusilade resulted in a rapid decline in the brome grass infestation level and seed reserves. However, this resulted in a shift in weed species, favouring doublegee and capeweed.

With the spray-topping treatment, brome grass control was inadequate despite the introduction of sheep to evenly graze the paddock before treatment to allow even head emergence of brome grass.

(iv) Delayed crop sowing

Crop yield declined markedly with delayed sowing despite the lower infestation level of brome grass. Hence, this treatment is unacceptable.

B. <u>Demographic Studies and Prediction of Brome Grass Population</u>

With the four-year demographic data, we can calculate the rate of change of the seedbanks, the effective seedling recruitment and the adult fecundity of brome grass for the nine basic treatments, with some confidence (Table 5). Combining the values of the various treatments, we can predict the brome grass population.

For example, with the gradual depletion of the seed bank our calculations showed that by combining basic treatments 6 and 7 (Table 4), it takes at least 5 years to completely exhaust the brome grass seedbank. The rotation must include three lupin crops (<u>L</u> W <u>L</u> W <u>L</u> W).

Table 5. Influence of cropping and herbicide treatments on annual rate of change of brome grass (i) seed banks (λ), (ii) effective seedling recruitment (ke) and (iii) adult fecundity (F). The calculations were based on data collected from May 1986 till September 1989

Basic treatments	λ	ke	F
1. Pasture (no spray)	1.78	0.18	18
2. Pasture (spraytopped)	0.65	0.20	17
3. Pasture (fusilade)	0.25	0.05	19
4. Lupins (simazine)	0.31	0.08	19
5. Lupins (simazine, fusilade)	0.06	0.006	12
6. Lupins (Roundup, simazine, fusilade)	0.02	0.007	9
7. Std wheat (1 kill of Bromus)	2.70	0.22	45
8. Early wheat (no control of Bromus)	6.59	0.30	40
9. Late wheat (2 kills of Bromus)	0.69	0.17	29

C. <u>Direction of Future Research</u>

(i) The opportunity to achieve long-term control of brome grass should not be missed in view of the virtual exhaustion of its seed reserves by the time of crop anthesis during the wheat cropping phase after lupins. However, because of the lack of a suitable selective herbicide for use in cereals to remove brome grass, the brome grass problem is likely to persist if no attempts were made to control it in the wheat cropping phase. With the availability of the wheat cv. blade that is fairly tolerant to metribuzin, a herbicide reported to give good control of brome grass, we have tried using this approach to eliminate the small population of brome grass. However, metribuzin has to be incorporated by sowing to be effective. This in turn is dependent on the degree of incorporation and the availability of soil moisture. Hence, the results obtained so far were inconsistent. A more versatile herbicide, an analog of metribuzin, commercially known as Tycor, has been released in the U.S. and Europe for post-emergence selective control of <u>Bromus</u> species in cereals. This product may be the key to the chemical control of brome grass in Australia. Hence testing Tycor for the selective control of brome grass in cereal under Australian conditions is worth pursuing.

(ii) Combining the values of the rates of change of the brome grass seed bank of various basic treatments it is possible to evaluate different cropping sequences and to select the one that appears as the most useful with regard to brome grass control. In this regard, planting lupins for two consecutive seasons or the rotation of lupins with a pasture legume are worthy of consideration. Planting two years of lupins however is not recommended because of disease problems.