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Population dynamics of brome grass in relation to control systems

A H. Cheam

Stephen Lee
University of Adelaide

C. M. Ralph

P Nelson

POPULATION DYNAMICS OF BROME GRASS IN RELATION TO CONTROL SYSTEMS

INTRODUCTION

A 4-year study was initiated in 1986 to determine the effects of crop rotations and herbicides on the population dynamics of brome grass. The brome grass population at the experimental site was initially thought to consist of only *Bromus diandrus* but later observations confirmed the presence of *Bromus rigidus*. In the northern wheatbelt of Western Australia where most of the brome grass problems exist, *B. rigidus* appears to be quite widespread. Both *B. rigidus* and *B. diandrus* commonly co-exist in the field, in pastures and in wheat and lupin crops. Because of this co-existence and the morphological similarity between the two species during the vegetative phase, we found it impossible to study the response of the individual species in the present situation. Hence the brome grass populations, both the emerged and seed populations, referred to in this project do not belong to a single species.

AIMS

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

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

OFFICERS: A. Cheam, S. Lee.

CO-OPERATORS: C. Ralph, P. Nelson

LOCATION: East Chapman Research Station (86C1/5153EX)

TREATMENTS

The treatments will be as follows in any particular year.

1. Continuous pasture

No herbicide will be used so that the build up of the brome grass population can be monitored.

2. Continuous pasture

Seed set will be controlled by spraytopping with either Roundup® or Gramoxone®. This treatment is one of the cheapest means of control, and will determine how long it takes to exhaust the seed bank.

3. Continuous pasture

Total grass control by Fusilade®. This is much more expensive than 2 but it will determine how long seed remains viable in the field.

4. Continuous wheat

This treatment is liable to give poor brome grass control, but we will attempt to control brome grass by tickling dry, allowing weeds to germinate, killing the grass, allowing a second germination, killing the grass and planting.

Planting will be delayed approximately 3 weeks from the break of the season. This treatment gives 2 kills pre-planting . As no further in-crop control is possible it is likely that this system may crash and we are having to delay seeding considerably to obtain a measure of weed control.

5. Pasture/wheat

Brome grass seed set will be controlled in the pasture phase with Roundup CT or Gramoxone W. In the wheat phase, the area will be tickled dry and the grass killed after 10 days and the crop seeded. This treatment gives one weed kill pre-cereal planting and seed set control in the pasture phase.

6. Wheat/pasture

Treatments the same as in 5, but one year phase shifted.

7. Pasture/wheat

Brome grass will be totally controlled in the pasture phase with Fusilade. In the wheat phase the area will be tickled dry and the grass killed after 10 days and the crop seeded. This treatment gives one weed kill pre-cereal planting and total control in the pasture phase.

8. Wheat/pasture

Treatments the same as in 7, but one year phase shifted.

9. Lupins/wheat

The lupins to be sown dry with 1.5 L/ha Simazine applied pre-planting. This is the cheap option. The wheat to be sown using the one kill pre-planting system used in 5 above. This system relies on the Simazine giving adequate control in the lupin year and on one kill being sufficient in the wheat year to give adequate control of brome grass.

10. Wheat/lupins

Treatments the same as in 9, but phase shifted one year.

11. Lupins/wheat

The lupins to be sown dry with 1.5 L/ha Simazine applied pre-planting and a follow up of Fusilade for improved brome grass control. The wheat to be sown using the one kill pre-planting system used in 5 above. This system gives more certain brome grass control in the lupin phase.

12. Wheat/lupins

Treatments the same as in 11, but phase shifted one year.

13. Lupins/wheat

The lupins to be sown 7 days after the break with 1 L/ha Sprayseed and 1.5 L/ha Simazine applied pre-planting and a follow up of Fusilade. This system should give maximum brome grass control in the lupin phase, but is the most costly in terms of both chemicals and in terms of delayed seeding on

lupin yields, but should give the best brome grass control in the lupin phase. The wheat to be sown using the one kill pre-planting system used in 5 above.

14. Wheat/lupins

Treatments as in 13 but phase shifted one year.

15. Lupins/wheat

Lupin treatment as in 13 above. The wheat to be drilled in on the break. This is a high risk treatment for the wheat as it assumes that the brome grass control is adequate in the lupin year to allow no control in the wheat phase. However if it works it will allow maximum growing time for the wheat and this should lead to higher yields.

16. Wheat/lupins

Treatments as in 15 but phase shifted one year.

ASSESSMENTS

To measure changes in population, counts of emerging brome grass will be obtained at 4-6 weeks after seeding of the respective crop. At 15-18 weeks after seeding, coinciding with the time of crop anthesis, another count will be made to determine the brome grass density. In lupins and wheat, brome grass seedlings will be counted and colour-coded as they emerge to monitor their fate and seed production. Seed reserves will be monitored by sampling soil to 10 cm depth. At the end of each season, wheat and lupins will be harvested to determine grain yield. Medic seed production will also be determined.

RESULTS AND COMMENTS

Presented below are the results obtained for the 1987 season. Where appropriate, we have included the 1986 results for comparison.

Seedling Populations and Fate

The levels of brome grass infestation in the second year of the rotation were significantly affected by the weed management levels during the first year. As brome grass control methods improve and annual seed production is greatly reduced, the decline of the seedbank becomes an important parameter. This was clearly evident in plots sown to lupins last year. The relatively few brome grass plants counted in the wheat crop during 1987 in treatments R11, R13 and R15 (Table 1) indicated that applications of Fusilade in 1986 were successful in controlling brome grass during the lupin phase. In contrast, the use of Simazine alone (R9) gave poorer control. Fusilade is a very effective herbicide for removing brome grass that escaped Simazine. Although Fusilade was highly effective against brome grass, some seed return (34-62 seeds/m^2) did occur because herbicides are rarely completely effective. It is these new seeds and the carryover of some old viable seeds (20-40 seeds/m^2) that contributed to the 1987 infestation in the wheat crop. This infestation ranged from 6-17 seedlings/m^2 when assessed 4-5 weeks after crop seeding. Consequently, brome grass was not competitive enough in the 1987 wheat crop and there was an increase in grain yield. Nevertheless, there is still a need to control the brome grass population if long-term control is the target, because brome grass has the potential to increase rapidly through seed

production and reinfest a field once there is a failure in the weed control programme. The patterns of emergence of brome grass, the fate of the seedlings and the reproductive capacity of the survivors in the wheat cropping phase in 1987, following one lupin crop in 1986, are shown in Table 2. The results confirm that in the wheat crop, once the crop is sown, the newly emerged brome grass has a high survivorship value because of the lack of a suitable in-crop weed control programme. Of the survivors, the early cohorts were the most productive showing higher seed production if the brome grass density is low. In addition, the contributions of early cohorts are of greatest significance to cereal yield loss. Hence, extra efforts should be taken to control them.

As expected, in plots (R6, R8, R10, R12, R14 and R16) sown to wheat last year where there was a build-up of the brome grass population due to the lack of an in-crop herbicide, a high level of brome grass infestation was noted in the second year of the rotation (Table 1). The fate of this high weed burden depended upon the crop and the herbicide(s) used in the 1987 rotation. Sowing lupins with Simazine and a follow-up spray of Fusilade gave excellent control of the brome grass (R12, R14, R16). Similar results were obtained in 1986. The brome grass population was so low in the 1987 season that no plant could be obtained for plant counts when quadrats were randomly placed in the Fusilade-treated plots.

When pasture followed wheat as in rotations R6 and R8, the use of Fusilade in R8 again gave excellent control of the brome grass population (Table 1).

Under continuous wheat (R4) conditions, however, because of the two kills of brome grass undertaken before seeding, the brome grass density was reduced to around 40 plants/m^2. The later crop sowing allowed a higher proportion of brome grass seeds to germinate which were subsequently destroyed before the crop was sown.

The population trends of brome grass in plots sown to pasture in 1986 again depended upon the crop and the herbicide(s) used in the 1987 rotation. Under continuous pasture conditions, the best treatment was R3 (Table 1) when control pressure was maintained on brome grass in both years with the use of Fusilade. Under pasture-wheat rotation (R5 and R7), however, the regeneration of brome grass during the wheat cropping phase in 1987 was disappointing.

<u>Seed reserves</u>

Seed counts taken at various time intervals during the second year of the cropping sequence are shown in Table 3. A comparison of the seedbank immediately after crop harvest in November 1986 and the seedbank in early May 1987 (before crop sowing), revealed a substantial reduction in the brome grass seedbank in soils under all rotations. The average reduction was 46% and the mode of seed decline was mainly germination, thus indicating that the relatively short innate dormancy of brome grass is one of the vulnerable stages in the life cycle of the weed.

The other critical phase of rapid seed decline was during the 4-5 weeks after crop seeding, resulting in 71-99% reduction in the soil seed population (Table 3). For example, in plots sown to lupins in 1986 (R9, R11, R13 and R15), the brome grass seed reserves were virtually exhausted by early September of 1987. However, the surviving brome grass population rapidly replenished the seedbank in the soil. This demonstrates the potentially rapid build-up of brome grass if control measures are relaxed. Thus adequate brome grass management must be maintained in excess of two years if the seed

population is to be held in an acceptable level. It is our intention to test this hypothesis in the coming season. Also, plant counts for treatment R3 in the 1988 season will give us a good indication.

The seedbank is a critical feature in determining whether a population increases or declines. With brome grass it is therefore clear that the key to the long term control of this weed must be the prevention of seed production for at least two years. The use of Fusilade during the lupin or pasture phase is the most effective means as shown in treatments R12, R14, R16, R3 and R8 (Table 3).

Crop yield

On the whole, poor season limited yields in 1987. The total rainfall was only 236 mm in 1987 compared with 288 mm in 1986. Rapid drying conditions completely killed the emerged pasture seedlings. Thus only the lupin and wheat yields are presented here (Table 4). Yields obtained in 1986 have been included for comparison.

Despite the poor season, preceding crop, management and chemical treatments have shown a significant effect on the 1987 crop yield. For example, wheat planted in the 1986 lupin plots that received Simazine and Fusilade applications in 1986, yielded an extra 240 kg/ha over the 1986 harvest following the standard practice of one weed kill before sowing. The yield was in fact almost twice as much on the lupin plots that received Simazine and Fusilade in 1986 as it did in the 1986 pasture plots. The lowest yields occurred on plots under continuous wheat. The late sowing inevitably depressed yield. The early-sown wheat on the other hand also failed to give high yield and this could be attributed to the inadequate control of the volunteer lupins during the early stages of the wheat crop.

Lupin yields in 1987 were also markedly lower. In particular, the wet-sown lupins were out-yielded by the dry-sown lupins despite the better weed control in the wet-sown plots. The unfavourable weather at the time of seedling establishment in the wet-sown plots resulted in a poor stand of lupins which in turn accounted for the poor yield.

Overall, it was found that the lupin-wheat sequence is undoubtedly a better system than the pasture-wheat sequence in terms of weed control and crop yield.

Table 1. Effect of crop-herbicide rotation on the number and the rate of decline/increase of brome grass seedlings or plants in the following year when assessed at about 4 weeks after seeding (4 WAS) and at the time of crop anthesis (CA)

Rotation treatment 1986/1987		Seedlings or plants/m^2		Annual rate (%) of seedlings or plants decline		/ increase	
		4 WAS	CA	4 WAS	CA	4 WAS	CA
Continuous pasture (P)							
P- P (R1)	1986	596	271				
	1987	571	501	4.2	-	-	84.9
P-P (R2)	1986	793	277				
	1987	81	43	89.8	84.5	-	-
P-P (R3)	1986	958	35				
	1987	13	0	98.6	100	-	-
Wheat before pasture							
W-P (R6)	1986	172	142				
	1987	427	344	-	-	148.3	142.3
W-P (R8)	1986	147	104				
	1987	505	1	-	99	243.5	-
Wheat (W) after pasture							
P-W (R5)	1986	465	261				
	1987	296	105	36.3	59.8	-	-
P-W (R7)	1986	695	40				
	1987	118	83	83.0	-	-	107.5
Continuous wheat							
W-W (R4)	1986	37	20				
	1987	40	41	-	-	8.1	105
Wheat before lupins (L)							
W-L (R10)	1986	225	191				
	1987	1,062	164	-	14.1	372	-
W-L (R12)	1986	174	189				
	1987	945	0	-	100	443.1	-
W-L (R14)	1986	155	94				
	1987	406	0	-	100	161.9	-
W-L (R16)	1986	875	395				
	1987	867	0	0.9	100	-	-
Wheat after lupins							
L-W (R9)	1986	184	75				
	1987	126	107	31.5	-	-	42.7
L-W (R11)	1986	148	5				
	1987	17	27	88.5	-	-	440
L-W (R13)	1986	292	3				
	1987	10	8	96.6	-	-	166.7
L-W (R15)	1986	299	4				
	1987	6	45	98	-	-	1,025

Table 2. The pattern of brome grass emergence and the survivorship and reproductive capacity of each cohort in the lupin-wheat rotations

Emergence group (cohort)		1986 (Lupins) Emergence (m^{-2})	Survivors (m^{-2})	Seeds/ plant	1987 (Wheat) Emergence (m^{-2})	Survivors (m^{-2})	Seeds/ plant[A]
Treatment 9							
1		184 (79)[B]	37	24	120 (88)	117	12
2		43 (18)	20	4	15 (11)	15	2
3		8 (3)	3	0	1 (1)	1	0
	TAE	235 (TS)	60 (26)[C]		136	133 (98)	
Treatment 11							
1		148 (64)	0	0	17 (85)	16	9
2		68 (29)	0	0	3 (15)	1	0
3		16 (7)	0	0	0 (0)	0	0
		232	0		20	17 (85)	
Treatment 13							
1		292 (61)	0	0	9 (90)	9	55
2		168 (35)	0	0	1 (10)	0	0
3		16 (4)	0	0	0	0	0
		476	0		10	9 (90)	
Treatment 15							
1		299 (52)	0	0	7 (54)	7	59
2		261 (46)	0	0	5 (38)	5	9
3		11 (2)	0	0	1 (8)	1	0
		571	0		13	13 (100)	

A Filled seeds at time of assessment
B Emergence as % of total emergence
C Survivors as % of total emergence

TAE Total annual emergence
TS Total survivors

Cohorts 1, 2 and 3 represented assessments during the first, second and third month, respectively, after crop seeding.

Table 3. Effect of herbicide-crop rotation on the number of brome grass seed in the soil at the end of the first year (1986) and during the second year (1987) of the cropping sequence. Values shown in brackets are percentage reductions in relation to seed counts taken on May 5, 1987 which served as a baseline reference for subsequent samples

Rotation 1986-87-88-89	Viable seeds/m^2 to 10 cm depth: After crop harvest Nov 26 '86	1987 initial nos (May 5)	4-5 weeks after seeding (Jun 10 - July 21)	Before seed shed (Sept 1 - Sept 22)	After crop harvest Nov 13 '87: New	Old	Total
Pasture in 1987							
P-P-P-P (R1)	6,616	4,707	773(83.6)	331(93)	5,744	496	6,240
P-P-P-P (R2)	3,853	1,953	129(93.4)	76(96.1)	256	61	317
P-P-P-P (R3)	767	125	2(98.4)	6(95.2)	10	4	14
W-P-W-P (R6)	4,715	3,534	582(83.5)	451(87.2)	1,833	420	2,253
W-P-W-P (R8)	4,276	3,570	745(79.1)	528(85.2)	6	367	373
Lupins in 1987							
W-L-W-L (R10)	5,559	3,546	604(83)	261(92.6)	1,095	183	1,278
W-L-W-L (R12)	4,628	3,227	541(83.2)	294(90.9)	21	113	134
W-L-W-L (R14)	3,866	2,823	438(84.5)	257(90.9)	4	159	163
W-L-W-L (R16)	13,539	8,145	2,382(70.8)	1,131(86.1)	40	738	778
Wheat in 1987							
W-W-W-W (R4)	929	499	23(95.4)	0(100)	1,332	28	1,360
P-W-P-W (R5)	3,137	1,590	21(98.7)	17 (98.9)	4,349	219	4,568
P-W-P-W (R7)	742	244	5(98)	0(100)	3,307	28	3,335
L-W-L-W (R9)	724	398	21(94.7)	0(100)	2,705	2	2,707
L-W-L-W (R11)	82	36	6(83.3)	0(100)	1,018	6	1,024
L-W-L-W (R13)	59	17	2(88.2)	0(100)	855	0	855
L-W-L-W (R15)	97	34	9(73.5)	0(100)	1,618	13	1,631

Table 4. The grain yields of wheat and lupin in 1986 and 1987 following the various treatments for controlling brome grass

Treatment 1987-1987	Wheat yield (kg/ha) 1986	1987	Lupin yield (kg/ha) 1986	1987
Wheat before pasture				
W-P (R6)	491	-	-	-
W-P (R8)	719	-	-	-
Wheat after pasture				
P-W (R5)	-	487	-	-
P-W (R7)	-	567	-	-
Continuous wheat				
W-W (R4)	581	333	-	-
Wheat before lupins				
W-L (R10)	452	-	-	747
W-L (R12)	507	-	-	740
W-L (R14)	557	-	-	573
W-L (R16)	295	-	-	540
Wheat after lupins				
L-W (R9)	-	640	997	-
L-W (R11)	-	780	1,015	-
L-W (R13)	-	793	1,192	-
L-W (R15)	-	533	1,210	-