ADVANCES IN WEED MANAGEMENT FOR ORGANIC CEREAL PRODUCTION IN SOUTHEAST AUSTRALIA

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Abstract

Organic cereal production in southeast Australia is challenging for producers due to a range of influences such as weeds and low soil available phosphorus. Two experiments were conducted on a certified organic property at Berrigan NSW during 2001-2003 to investigate 'within crop' weed management and forage crop management for weed control. Sowing later using a short season wheat cultivar did not affect yield and reduced ($P<0.05$) levels of annual ryegrass (*Lolium rigidum* Gaud.). Incorporating a forage crop into the rotation prior to sowing a cereal resulted in improved ($P<0.05$) weed management for the cereal crop, in comparison to retaining annual pasture. There were no differences between forage treatments in weed management in the following wheat crop. Where forage was cut for silage and then grazed, grain yield was higher ($P<0.05$) than where forage was only grazed or cut for silage, or where annual pasture was retained.

Introduction

Organic crop and pasture production in southeast Australia is constrained by the presence of many exotic plant species, a result of pastoral occupation, over-grazing by sheep, and extensive soil cultivation (Moore 1957). Cereal crops are further constrained by low levels of available phosphorus (P) (Penfold 2000), making profitable organic production challenging for the majority of producers. Recent research into the non-chemical management of annual ryegrass (*Lolium rigidum* Gaud.) in certified organic farming systems has provided options to manage this weed in these farming systems (Burnett *et al*. 2004). Sowing cereal crops later using a short season cultivar can provide an opportunity to manage ryegrass before the crop is sown. Managing ryegrass in the year prior to growing cereals, by growing and managing a forage crop, has also demonstrated significant weed reduction. This paper reports results from two experiments that investigated the management of annual ryegrass in cereal crops and forage phases.

Methodology

Two experiments were conducted at a certified organic property at Berrigan in NSW (35º 40' S, 145º 9' E) from 2001 to 2003. In experiment A the effect of establishment system and sowing rate on the density of annual ryegrass in wheat was investigated over three years. Establishment systems consisted of sowing wheat (*Triticum aestivum* cv. Chara) at a standard sowing time compared with a late-sown system using a short season cultivar (H45). Different cultivars were selected. as the focus of the experiment was the production system; consequently, cultivars were chosen on their suitability for that system. Standard sowing times were 5 June 2001, 22 May 2002 and 6 May 2003, and late sowing times were 27 June 2001, 25 June 2002 and 6 June 2003. Three sowing rates (60, 100 and 150 kg/ha) were used and treatments were replicated three times. The seed was sown into prepared soil and P (20

kg/ha) was applied as Guano™ with the seed. Annual ryegrass density and wheat yield were measured.

In experiment B the effect of forage (field pea and oats) management on the subsequent weed burden and grain yield in wheat crops was measured. A control treatment of annual pasture was grazed with sheep as per current producer practice. Forage was sown in 0.22 ha plots in 2002. Forage was managed by grazing with sheep, cutting for silage, green manuring, or a combination of silage and grazing. Wheat (cv. Chara) was established in the year after forage production (2003), with weed burden and wheat yield assessed. The soil was classified as a eutrophic red chromosol (silty clay loam) (Isbell 1996). Site soil characteristics (0-10 cm) and available nutrients for both experiments based on autumn tests are presented in Table 1 with growing season rainfall data in Table 2.

Table 1. Soil characteristics (0-10 cm) for experiments A and B.

Experiment and year Experiment A	pH ($CaCl_2$)	Available N (kg/ha)	Olsen P (mg/kg)	Total C (%)
2001	5.1	56	3	1.2
2002	5.1	31	8	1.1
2003	5.0	20	7	1.3
Experiment B				
Forage, 2002	5.4	41	4	1.2
Wheat, 2003	5.3	65	3	1.2

Table 2. Growing season rainfall (mm) (GSR) (April-November), total GSR and long term average (LTA, 120 years) rainfall.

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	GSR total	LTA
Berrigan 2001	26.5	3.5	19.0	37.0	29.0	24.5	69.5	6.0	215.0	322
Berrigan 2002	38.0	13.5	22.5	11.0	22.5	26.5	8.5	4.0	146.5	321
Berrigan 2003	42.5	86.5	47.5	70.5	96.5	29.5	67.0	48.5	484.0	322

Results and brief discussion

Experiment A

In 2002 and 2003, there was less ryegrass ($P<0.05$) at crop emergence and at crop tillering with the late-sown system (Table 3). Similarly, at crop anthesis, there was less ($P<0.05$) weed DM yield with the late-sown system in 2001 and 2003 (Table 4) whilst only in 2002 was there a yield penalty ($P<0.05$) with the late-sown system (Table 5).

At crop anthesis, weed DM yield was reduced ($P<0.05$) by sowing rate increases in 2002 and 2003 (Table 4) but sowing rate had no effect on grain yield in any year (Table 5).

Table 3. Effect of establishment system on annual ryegrass density (plants/m^2) at crop emergence and crop tillering.

Year/ Establishment system	Ryegrass density at crop emergence			Ryegrass density at crop tillering		
	Standard	Late	l.s.d.	Standard	Late	l.s.d.
2001	60	238	51.8	228	168	69.6
2002	67	38	21.9	85	45	34.0
2003	331	80	42.5	187	97	28.1

Table 4. Effect of establishment system and sowing rate on weed DM yield (t/ha) at crop anthesis.

Year/ Establishment system	Establishment system			Sowing rate (kg/ha)			
	Standard	Late	l.s.d.	60	100	150	l.s.d.
2001	1.3	0.8	0.21	1.1	1.1	1.0	0.25
2002	0.6	0.5	0.12	0.7	0.5	0.4	0.14
2003	2.4	1.3	0.60	2.4	1.5	1.6	0.74

Table 5. Effect of establishment system and sowing rate on wheat grain yield (t/ha).

Year/ Establishment system	Establishment system			Sowing rate (kg/ha)			
	Standard	Late	l.s.d.	60	100	150	l.s.d.
2001	0.4	0.4	0.12	0.4	0.4	0.4	0.10
2002	1.0	0.8	0.12	0.8	0.9	0.9	0.15
2003	1.5	1.4	0.30	1.4	1.4	1.5	0.37

Sowing later using a short-season cultivar provides an opportunity for producers to better manage a competitive species such as annual ryegrass. However, sowing later does carry the risk of reduced grain yield, particularly if the spring period is drier than usual, as yield is highly dependent on available moisture during this period. In northeast Victoria, Coventry *et al.* (1993) found losses up to 250 kg/ha of grain for each week's delay in sowing after the beginning of May. Gomez-Macpherson and Richards (1995) also showed a 1.3% decline in grain yield if sowing was delayed after late May at Wagga Wagga in southern New South Wales.

Increased sowing rates are used widely by organic producers to increase competition against weeds and to allow for losses with post-sowing cultivation (Patriquin 1988). However, there was no effect of increased sowing rate on wheat grain yield. It is likely that this was due to insufficient soil moisture in the critical spring period and low available soil nitrogen.

Experiment B

Where forage was cut for silage and then grazed, grain yield was higher ($P<0.05$) than where forage was only grazed or cut for silage, or where annual pasture was retained (Table 6). Green manuring resulted in the second highest wheat grain yield (Table 6). There was more weed DM ($P<0.05$) in the wheat following annual pasture (Table 6). There was more wheat DM yield ($P<0.05$) after forage had been green manured compared to grazed annual pasture and grazed forage (Table 6).

Table 6. Forage composition and DM yield, weed biomass, and grain yield of wheat during the 2002-2003 phase.

Treatment in 2002	2003 Wheat		
	Wheat DM yield (t/ha)	Weed biomass (t/ha)	Grain yield (t/ha)
Forage green manured	14.5	0.5	4.5
Forage grazed	11.9	0.4	4.0
Forage cut for silage	12.2	0.5	3.7
Forage cut for silage and grazed	12.1	0.5	4.8
Annual pasture grazed	8.9	2.0	3.1
l.s.d.	**2.31**	**0.50**	**0.68**

Gross margin returns were calculated on the 2002-2003 phase. The silage and grazing treatment provided the highest returns per hectare, followed by green manuring (Table 7). Whole farm analysis based on the particular system used is required to more accurately gauge the relative profitability of forage treatments.

Table 7. Gross margins ($/ha) for the forage/wheat cropping sequence at Berrigan in 2002/2003.

Forage treatment /Gross margin 2002-2003	Green Manure	Grazing	Silage	Silage & Grazing	Annual Pasture
Cost of forage treatment in 2002	298	283	384	384	133
Income from forage in 2002	0	59	124	133	88
Cost of wheat crop in 2003	313	313	313	313	328
Income from wheat in 2003	1125	1000	925	1200	785
Total for 2002 - 2003	**515**	**464**	**353**	**637**	**412**

Conclusions

Sowing later using a short-season wheat cultivar can provide organic producers with an option to manage annual ryegrass prior to crop sowing. However, producers should be aware that sowing later in the southeast Australian grain production zone does carry increased risk of reduced grain yield, especially if the spring is dry. Using a forage crop to manage weeds prior to sowing a cereal crop provides producers with an economical way of reducing the influence of weeds in the cereal crop. Given the limitations to managing many weed species within the pasture phase, incorporating a forage crop that can be utilised by either cutting silage or grazing or a combination of both to reduce weed seed banks prior to the cropping phase is a valuable tool for organic cereal producers.

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