Evaluation of within crop weed management for organic and conventional grain production in south-east Australia

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Abstract

Field experiments investigating delayed sowing of wheat and increased sowing rate, as two potential within-crop weed management strategies, were conducted on an organic farm in southern New South Wales and on a conventional farm in north east Victoria from 2001 to 2003. The effect of sowing time and sowing rate on the density and yield of annual ryegrass, wheat biomass and grain yield was measured. The late sowing time allowed for an additional weed management event at both sites. A late sowing time using a short season cultivar reduced ryegrass density at crop emergence and at crop tillering by at least 43%, and ryegrass DM yield at crop anthesis. Ryegrass density was not affected by sowing rate at these times. Increasing the sowing rate also reduced ryegrass DM yield in three of five experiments. Wheat DM yields at anthesis increased with sowing rate in all five experiments. Sowing later reduced wheat grain yield in one experiment whilst higher sowing rates increased wheat grain yield only on the conventional site. Results suggest that there were lower ryegrass densities and no grain yield penalties with later sowing. Yield benefits from increased sowing rate could have been affected by dry conditions in some years. Producers should consider that additional weed management associated with later sowing will impose extra costs but that this might be cost effective if less weed contamination and higher yields are achieved.

Key Words

Weed management, annual ryegrass, wheat, organic

Introduction

The south-east Australian grain production zone is characterized by highly disturbed plant communities following pastoral occupation, soil cultivation and over-grazing by sheep (Moore, 1957). In conventional grain production systems, herbicide resistance has become common such that Australia is ranked second in the world in terms of the number of weed species that have become resistant to various herbicide groups (Heap *et al.,* 2004). In organic grain production systems, the management of weeds is cited by the majority of producers as being a significant management issue (Wynen, 1992). The development of practical non-chemical weed management methods is critical if farming systems are to continue to produce cereal grain that is not compromised by excessive competition from weeds or is contaminated with weed seed.

Delayed sowing of grain crops can provide both organic and conventional producers with an opportunity to manage weeds prior to crop sowing (Powles and Matthews, 1996). However, delayed sowing can result in reduced grain yield as crops form grain later when evapo-transpiration rates are higher and the potential for early crop senescence is greater (Kohn and Storrier, 1970). Higher sowing rates of cereals can provide weed management benefits (Lemerle *et al.* 1996) but there is limited data on the effectiveness of this approach in organic production systems. This paper reports weed management and grain production results in which delayed time of sowing and increased sowing rate were investigated over three years in south-east Australia.

Methods

Studies were conducted at two sites from 2001 to 2003 at Berrigan NSW (Certified organic site, 35?40? S, 145?9? E) and Rutherglen Victoria (Conventional site, 36?6? S, 146?30? E). At Berrigan soil pH ($CaCl_2$) was 5.0 and available phosphorus (Olsen) (P) 6.0, and at Rutherglen soil pH ($CaCl_2$) was 4.6 and Olsen P 7.5.

A randomised block design consisting of a factorial combination of two sowing times (standard and late) and three sowing rates (60, 100, 150 kg/ha) of wheat was used at both sites and replicated three times. Results from each site were analysed separately using ANOVA. At Berrigan the wheat cultivars were Chara (standard) and H45 (late) and at Rutherglen, Chara (standard) and Diamondbird (late). Prior weed management at Berrigan consisted of a spring fallow (disc plough) with cultivation prior to sowing wheat the following year and at Rutherglen, mowing or spraying with glyphosate at 2 L/ha to reduce grass seed set in spring and spraying at the same rate prior to crop sowing. The late sowing time treatment at both sites received additional weed management with cultivation at Berrigan and spraying at Rutherglen. Annual ryegrass emergence, weed dry matter (DM) production and grain yield were measured.

Results

Late sowing using a short season cultivar significantly reduced ryegrass density ($P<0.05$) at crop emergence and at crop tillering in all experiments except Berrigan in 2001 (Table 1). Annual ryegrass DM production at crop anthesis was significantly reduced in three of five experiments (Table 1). Annual ryegrass density was not affected by sowing rate at these times but increasing the sowing rate significantly reduced annual ryegrass DM production in three of five experiments (data not shown). Wheat DM production at anthesis increased with sowing rate in all five experiments (data not shown). Sowing later significantly reduced wheat grain yield at Berrigan in 2002 only, whilst higher sowing rates resulted in increased wheat grain yield only on the conventional site (Table 2).

Table 1. Effect of sowing time on annual ryegrass density (plants/m^2) at crop emergence and crop tillering, and weed DM production (t/ha) at crop anthesis at Berrigan and Rutherglen

Site	Annual ryegrass at crop emergence			Annual ryegrass at crop tillering			Annual ryegrass DM production at crop anthesis		
	Standard	Late	l.s.d.	Standard	Late	l.s.d.	Standard	Late	l.s.d.
Berrigan 2001	60	238	51.8	228	168	ns	1.3	0.8	0.21
Berrigan 2002	67	38	21.9	85	45	34.0	0.6	0.5	ns
Berrigan 2003	331	80	42.5	187	97	28.1	2.4	1.3	0.60
Rutherglen 2002	237	50	64.3	290	59	72.0	1.8	0.7	0.17
Rutherglen	188	52	63.1	24	3	16.7	0.8	0.7	ns

2003

Table 2. Effect of sowing time and sowing rate on wheat grain yield (t/ha) at Berrigan and Rutherglen

	Sowing time (standard and late)			Sowing rate (kg/ha)			
	Standard	Late	l.s.d.	60	100	150	l.s.d.
Berrigan 2001	0.4	0.4	ns	0.4	0.4	0.4	ns
Berrigan 2002	1.0	0.8	0.12	0.8	0.9	0.9	ns
Berrigan 2003	1.5	1.4	ns	1.4	1.4	1.5	ns
Rutherglen 2002	0.8	0.9	ns	0.7	0.7	1.1	0.27
Rutherglen 2003	3.6	3.7	ns	3.0	3.9	4.1	0.60

Conclusion

The results suggest that there were lower ryegrass densities and no grain yield penalties with later sowing and an increased sowing rate. Although other studies have suggested that sowing later could result in yield penalties (Coventry *et al.,* 1993), our results could have been due to appropriate cultivar selection. Yield benefits from increased sowing rate could have been affected by dry conditions in some years. Producers should consider the advantages and disadvantages of later sowing; additional weed management for later sowing will impose extra costs and there may still be later weed germination after sowing that affects grain yield, but this may be cost effective if higher yields and less weed contamination is achieved.

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