Broadcast sowing, crop row spacing and crop density for the suppression of ryegrass in wheat rotations

John Matthews
CRC for Weed Management Systems, Roseworthy Campus, Adelaide University, Roseworthy, South Australia 5371, Australia. Email: john.matthews@adelaide.edu.au

Summary The interaction of the distance between seeding rows and the seeding density of durum wheat, wheat and field peas on crop yield and weed competition was investigated in a series of field experiments at Roseworthy in South Australia. Sowing densities in rows were compared and wheat in rows was compared to broadcast seeding of wheat at comparable densities. Wheat and pea yields were reduced by increasing row width and increased by higher sowing densities. Wheat yield was increased by broadcast seeding and weed fecundity was reduced at the high crop densities.

Keywords Weeds, row spacings, wheat, durum wheat, field peas.

INTRODUCTION

The trend towards wide row spacing of sowing equipment to accommodate stubble retention planting systems has the potential to increase weed population density because of the higher fecundity of surviving weeds. The requirement for herbicide protection in wide row systems may also lead to more rapid onset of herbicide resistance. This study examines the interaction between various row spacings including broadcast sowing and densities of wheat, durum wheat and field peas in southern Australian rainfed conditions. The competitiveness of various crop density and sowing arrangements was studied by Medd *et al*. (1985) and the associated wheat yields were reported by Auld *et al*. (1983). Broadcast seeding has been positively evaluated for crop yield effects but not weed suppressive effects in low rainfall wheat growing regions of South Australia (Holloway *et al*. 2000). Cereal herbicides were also included in the current to evaluate the effect of row spacing and crop density on herbicide efficacy.

MATERIALS AND METHODS

Field plots of Frame wheat, Tamaroi durum wheat and Parafield field peas were established at Roseworthy Campus near Adelaide. Plots were established at row spacings of 120, 180, 240 and 360 mm with seeding rates of 60, 120, 180 and 240 kg ha^{-1} (D1–D4) of all crop species. Wheat crops were also established by broadcast spreading and incorporated by a prickle chain. Cereal crops were sown with fertiliser containing 24 kg of urea and 19.2 kg of phosphorous per ha. Legume crops were fertilised with 28 kg per ha of phosphorous both with 5% zinc. Row sowing was done with a 10 tyne combine.

Herbicide susceptible annual ryegrass (*Lolium rigidum* Gaud.) was surface applied to the plots at 400 seeds per square metre and incorporated by harrowing. All row sown treatments had trifluralin applied post-planting at 1 L ha^{-1} and incorporated by prickle chain immediately post-sowing, Hoegrass® was applied at the weed 3–4 leaf stage at 1.5 L ha^{-1}. The broadcast wheat treatments had similar herbicide treatments plus trifluralin applied one week post-sowing pre-crop emergence and not incorporated. Plots were sampled for weed density and weed seed yield and were machine harvested to assess crop yields. Trial design was a randomised block design with three replicates with herbicides and broadcast seeding trial comparisons analysed as split plot treatments.

RESULTS

Crops planted in rows Crop yields of peas and wheat were significantly reduced by increasing row width (Table 1), but durum was not affected.

All crops yields were significantly improved by herbicide use (Table 2), however the maximum yield

Table 1. Row spacing effects on crop yields (t ha^{-1}).

	120 mm	180 mm	240 mm	360 mm
Wheat	2.439	2.497	2.228	2.098
Durum	1.715	1.849	1.679	1.845
Peas	1.297	1.220	0.840	0.966

Yields of wheat and peas were significantly different within crop species ($P<0.05$), LSD of wheat and peas were 0.019 and 0.034 t ha^{-1} respectively.

Table 2. Crop yields (t ha^{-1}) and herbicide use.

	Hoegrass®	Trifluralin	None
Wheat	2.308	2.158	2.323
Durum	1.901	1.746	1.668
Peas	1.292	1.221	0.729

All yields were significantly different within crop species ($P<0.05$) LSD of wheat, durum and peas were 0.012, 0.016 and 0.011 t ha^{-1} respectively.

of wheat was obtained with no herbicide when data was averaged across all density and row spacing treatments.

The ryegrass seed yield was reduced by 65% and ryegrass head number by 73% in the highest density durum plots compared to the lowest (P<0.01). There were significant reductions in ryegrass seed output within pea treatments with increasing crop density and decreasing row spacing as well as an effect of herbicide, but the best treatments did not suppress ryegrass seed output below three times the planting density, (data not shown).

Crops planted by broadcasting Broadcast Frame wheat was compared to row planted Frame wheat with similar herbicides applied to each treatment. There was a significant density × planting treatment × herbicide interaction with the highest density broadcast treatment out yielding all other planting arrangements at the same density, Table 3.

The amount of ryegrass seed produced under each sowing arrangement was measured and the results shown in Table 4. The sowing arrangement × density × herbicide interaction was significant but the herbicide effects were very pronounced because of the introduced susceptible ryegrass.

The wheat yields and ryegrass seed output from various planting arrangements averaged across all density and herbicide treatments are presented in Table 5.

Table 3. Effect of sowing patterns, crop density and herbicide on wheat yield (t ha^{-1}).

Row spacing	Sowing density	Hoegrass®	Trifluralin	No herbicide
Broadcast	D1	2.797	3.137	2.550
	D2	2.773	2.460	2.657
	D3	2.690	2.563	2.283
	D4	2.907	3.430	3.520
120 mm	D1	2.245	2.396	2.423
	D2	2.593	2.322	1.845
	D3	2.553	2.310	2.312
	D4	2.403	2.349	2.166
180 mm	D1	2.816	2.630	2.246
	D2	2.643	2.432	2.472
	D3	2.458	2.852	2.567
	D4	2.544	2.902	2.616
240 mm	D1	2.148	2.027	2.000
	D2	2.029	2.390	2.067
	D3	2.233	2.136	2.043
	D4	2.410	2.702	2.471
360 mm	D1	2.255	2.401	2.185
	D2	2.286	2.263	2.171
	D3	2.169	2.228	2.221
	D4	2.001	1.762	1.765

There was a significant interaction (P<0.05) with crop density × row spacing × herbicide, LSD 0.524.

Table 4. Effect of sowing density and herbicides on ryegrass seed yield (seeds m^{-2}) at various sowing patterns.

Row spacing	Sowing density	Hoegrass®	Trifluralin	No herbicide
Broadcast	D1	197	288	725
	D2	235	404	899
	D3	102	170	216
	D4	85	108	132
120 mm	D1	75	305	961
	D2	45	256	481
	D3	31	190	584
	D4	24	98	85
180 mm	D1	83	162	552
	D2	42	177	803
	D3	1	204	121
	D4	0	27	6
240 mm	D1	63	389	982
	D2	51	389	306
	D3	34	230	575
	D4	0	80	399
360 mm	D1	167	310	571
	D2	39	336	457
	D3	29	140	279
	D4	13	69	416

There was a significant interaction (P<0.05) with crop density × row spacing × herbicide LSD 366.

Table 5. Wheat and ryegrass yields from row sown and broadcast treatments.

Sowing arrangement	Wheat yield t ha^{-1}	Ryegrass yield seeds m^{-2}
Broadcast	2.814	282
120 mm	2.326	291
180 mm	2.598	181
240 mm	2.221	277
360 mm	2.142	294

Yields were significantly different. (P<0.05) LSD wheat 0.39, ryegrass 82.

Crop yields were improved by broadcast seeding with the higher yields obtained from the broadcast seeding plots and the narrow row spacings. The lowest ryegrass seed output was obtained at 120 mm row spacings with no difference between the other arrangements. Without the influence of the herbicide effect the data is more informative.

There were interesting interactions between crop sowing density and planting arrangements. At higher densities (D3 and D4) the broadcast sowing arrangements had less than half the ryegrass seed output than the wider row spacings and similar to the narrow rows, Table 6.

The broadcast sown treatments also had trifluralin applied one week post-sowing and pre-crop emergence and not incorporated. A comparison of the efficacy of herbicide treatments was made by assessing final ryegrass seed number.

There was no difference in the seed number per square metre of the Hoegrass®, trifluralin not incorporated and no herbicide treatment all of which were significantly different to trifluralin incorporated immediately post-sowing, Table 7.

Table 6. Ryegrass seed output from various crop density and row spacing arrangements (seeds m^{-2}).

Sowing width	Crop sowing density			
	D1	D2	D3	D4
Broadcast	403	512	108	106
120 mm	447	260	268	202
180 mm	265	341	109	101
240 mm	478	249	279	159
360 mm	350	277	249	332

The interactions at this level were not significant.

Table 7. Effect of herbicides on ryegrass seed numbers in broadcast wheat (ryegrass seeds m^{-1}).

	Incorp. post-sowing	Not incorp.	Hoegrass®	None
Ryegrass	710	227	299	275

There were significant differences between ryegrass seed output ($P<0.05$) LSD 251.

DISCUSSION

Wide sowing row spacings did not suppress weed seed numbers as much as traditional row widths in this study. The effect was greater for uncompetitive crops such as legumes and Durum wheat. The competitive ability of all crops against annual ryegrass was improved in row spacings less than 180 mm or by random broadcasting of seed. The competitive ability of bread wheat (*Triticum aestivum*) was also enhanced by increasing crop density. Crop competitiveness against ryegrass and wheat crop yields were not reduced by broadcast spreading of seed and this method of sowing seed has potential as an alternative in stubble retention systems. Part of the improved efficiency of broadcast seeding at high sowing rates is the greater and more even plant populations as the high densities of crop seeds per row length in wider row spacings often mitigate against optimum plant densities. Of interest is the excellent competitiveness of wheat at traditional row spacings, (180 mm), there may be genotypic constraints for wheat plants to efficiently occupy wider row spacings.

There is good potential for broadcast sowing of wheat and other crops in southern Australia as a method for rapid, timely and low cost crop establishment in winter growing rainfall dependent cropping systems. Competitive wheat crops can be established easily and cheaply and the results suggest that broadcast seeding is a method worthy of further investigation in other environments and with other crop species.

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