TIMING OF BROADLEAF WEED REMOVAL IN WHEAT AND BARLEY IN SOUTHERN QUEENSLAND

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Summary Research in southern Australia has shown that the removal of broadleaf weeds prior to tillering in wheat resulted in greater yield increases compared to when weeds were removed post-tillering. The objective of this study was to determine the timing of broadleaf weed removal in winter cereals in southern Queensland which has different growing conditions to the grain regions of southern Australia. Five field trials were located at three sites over three seasons. Treatments were a factorial combination of two crop species (wheat and barley) × three types of weed infestation (weed free, and sown with either climbing buckwheat (*Fallopia convolvulus* (L.) A. Love) or turnip weed (*Rapistrum rugosum* (L.) All.) × three herbicides treatments (nil herbicide, herbicide applied at two-leaf or tillering stage of the crop). The herbicides were either bromoxynil or chlorsulfuron at the crop two-leaf stage, and either MCPA, picloram + MCPA or picloram + 2,4-D at the crop tillering stage. The weed densities were 13–86 turnip weed m^{-2} and 25–363 climbing buckwheat m^{-2}.

Uncontrolled turnip weed reduced wheat grain yield by 24% and barley yield by 10%; uncontrolled climbing buckwheat reduced grain yield of wheat by 14% and barley by 11%. Grain yield of both crops was unaffected by the timing of weed removal irrespective of weed species. When either of the weeds were removed at crop two-leaf or tillering stages, grain yield was 3–6% less than the weed free control. This small grain yield reduction was largely attributed to crop phytotoxicity caused by the herbicides. These data indicated that the timing of removal for climbing buckwheat and turnip weed extends until mid-tillering in winter cereals in southern Queensland. This provides a wider application window for herbicides than in the southern grain regions of Australia.

INTRODUCTION

Research in southern Australian (Lumb 1968, Pearce 1967, Reeves and Lumb 1972) has shown that chemical removal of broadleaf weeds before tillering in wheat resulted in greater grain yield increases compared to when weeds were removed post-tillering to the start of jointing.

Chemical control of broadleaf weeds in winter cereals in Queensland had, until the release of the sulfonylurea herbicides, been delayed until the tillering stage of the crop. This delay was due to crop tolerance problems associated with pre-tillering applications of 2,4-D, MCPA, picloram and dicamba. These herbicides were widely used to control broadleaf weeds such as turnip weed and climbing buckwheat. The recent widespread use of sulfonylureas, which can be applied preplanting or pre-tillering of the crop, has greatly widened the potential in-crop application window for broadleaf weed control. However, it was not known in southern Queensland how long broadleaf weeds could be left to grow in wheat and barley before grain yields were reduced. The aim of these experiments was to determine the effect of timing of removal of turnip weed and climbing buckwheat on the yield of wheat and barley.

Table 1. Details of experiment locations, weed densities, and herbicides used (application rates in brackets) according to time of application (crop two-leaf or tillering).

Site	Location	Weed density (plants m^{-2})		Herbicide (g a.i. ha^{-1})	
		Turnip weed	Climbing buckwheat	Crop at two-leaf	Crop at tillering
1	Hermitage	86	361	bromoxynil (300)	picloram + MCPA (26 + 420)
2	Hermitage	75	25	chlorsulfuron (15)	picloram + MCPA (26 + 420)
3	Inglewood	31	–	chlorsulfuron (15)	MCPA (350)
4	Hermitage	13[A]	363 [A]	chlorsulfuron (15)	metsulfuron (3) + picloram + 2,4-D (24 + 96)
5	Roma	15[B]	25 [B]	chlorsulfuron (15)	picloram + MCPA (26 + 420)

[A] Plus dead nettle (*Lamium amplexicaule* L.) at 29 plants m^{-2}.
[B] Plus burr medic (*Medicago polymorpha* L.) at 19 plants m^{-2}.

MATERIALS AND METHODS

Five field trials were established at three locations between 1986 and 1988 (Table 1). Soil types were a black earth at Hermitage Research Station, grey clay at Inglewood and a red brown earth at Roma Research Station. The design was a factorial randomized block with three (site 5) or four (sites 1–4) replicates. Treatments were two crop species (wheat and barley) × three types of weed infestation (weed-free, and sown with either climbing buckwheat or turnip weed) × three herbicide treatments (nil herbicide, and herbicide applied at either crop two-leaf or tillering stage). Barley cv. Grimmett and wheat cv. Vasco were sown at approximately 45 kg ha^{-1}. The two weed species were hand-broadcast then harrowed before the sowing rains. The tillering timing of herbicide application at each site was close to mid-tillering i.e. wheat Zadocks 23–26 and barley Zadocks 25–29 (Zadocks *et al.* 1974).

Rainfall received at all sites during the growing period ensured adequate to good growing conditions. Sufficient rainfall to germinate weeds occurred within six days of crop sowing at sites 1 and 2; within four days at sites 3 and 5, and within 11 days at site 4. Weed densities (number of plants m^{-2}) were measured when the crop

Table 2. Effect of timing of broadleaf weed control on wheat grain yield (t ha^{-1}) at each site and overall percentage yield reduction (mean of all sites).

Crop stage at herbicide application	Site 1	Site 2	Site 3	Site 4	Site 5	% Yield reduction
Weed-free						
nil treatment	3.56	3.63	2.28	4.46	3.09	0
two-leaf stage	-	3.54	2.24	4.42	2.83	3
tillering	3.37	3.44	2.21	4.39	2.79	5
Turnip weed						
nil treatment	2.09	2.30	1.71	4.60	2.63	24
two-leaf stage	3.53	3.52	2.33	4.47	2.82	3
tillering	3.32	3.65	2.08	4.62	2.81	5
Climbing buckwheat						
nil treatment	2.01	3.64	–	4.26	2.84	14
two-leaf stage	3.55	3.64	–	4.33	2.89	2
tillering	3.19	3.49	–	4.58	2.67	7
LSD (P=0.05)	0.22	0.26	0.28	0.28	0.21	

Table 3. Effect of timing of broadleaf weed control on barley grain yield (t ha^{-1}) at each site and overall percentage yield reduction (mean of all sites).

Crop stage at herbicide application	Site 1	Site 2	Site 3	Site 4	Site 5	% Yield reduction
Weed-free						
nil treatment	3.87	3.31	3.33	4.01	3.07	0
two-leaf stage	–	3.34	3.22	4.25	3.06	1
tillering	3.73	3.07	3.29	3.91	2.67	5
Turnip weed						
nil treatment	3.24	3.01	2.90	3.86	2.88	10
two-leaf stage	3.69	3.40	3.19	3.94	3.02	3
tillering	3.63	3.03	3.14	4.05	3.04	4
Climbing buckwheat						
nil treatment	2.82	3.04	–	3.99	2.82	11
two-leaf stage	3.82	3.28	–	3.87	3.04	2
tillering	3.60	3.08	–	3.90	2.88	6
LSD (P=0.05)	0.22	0.26	0.28	0.28	0.21	

tillering timing of removal treatments were applied. Crop populations were, on average, 96 wheat plants m^{-2} and 99 barley plants m^{-2}.

Herbicides used at the two-leaf stage of the crop were either bromoxynil or chlorsulfuron (Table 1). The herbicides used at tillering were either picloram + MCPA, MCPA, or metsulfuron + picloram + 2,4-D. The volunteer weeds in all weed free treatments at sites 4 and 5 were removed with chlorsulfuron at the crop two-leaf stage.

RESULTS

Uncontrolled turnip weed reduced, on average, yield of wheat by 24% (Table 2) and barley by 10% (Table 3). Uncontrolled climbing buckwheat reduced yield of wheat by 14% and barley by 11%. Weed densities for turnip weed varied from 13 to 86 plants m^{-2} and climbing buckwheat from 25 to 363 plants m^{-2} (Table 1).

Wheat and barley yields were similar or slightly greater when weeds were removed at the crop two-leaf stage compared with the tillering stage. Yield reductions were significant in the weedy tillering treatments compared with the two-leaf treatment for climbing buckwheat at sites 1 and 5 in wheat, and site 1 in barley, and for turnip weed at site 2 in barley.

Some of the herbicide treatments were phytotoxic to the crops. Herbicide application to the weed-free plots resulted in a yield reduction of 1–3% at two-leaf and 5% at tillering (Tables 2 and 3).

DISCUSSION

In southern Queensland, turnip weed or climbing buckwheat may cohabit wheat and barley until mid-tillering without reducing grain yields. This is based on the weed densities observed in these experiments. The 6% mean grain yield loss across all sites when chemical weed control was delayed until crop mid-tillering was associated mainly with the phytotoxic effect of the herbicides on the crops rather than from weed competition. The significant reduction in wheat and barley yields between the two-leaf and crop tillering treatments could also be attributed to this crop phytotoxic response. It was only when weeds were left uncontrolled, that significant grain yield losses occurred due to weed competition.

The emergence of weeds early in a crop increases the potential for grain yield reductions due to weed competition (Aldrich 1987). As a result, the probability of the crop responding to early versus later herbicide application is also enhanced. The timing of rainfall at each site ensured early weed establishment, and hence, offered good potential for crop grain yield responses to early herbicide treatments. The density of each weed species established in these trials was considered average to heavy compared with commercial populations. It can be assumed that the weed pressure was sufficient to test the effect of timing of weed removal at the crop two-leaf and tillering stages.

A complexity of interacting variables influence the degree of weed competition in crops (Aldrich 1987). Differences in weed species encountered in southern Australia, their often much higher densities; differences in relative growth rates of crops and weeds in the different environments may all contribute to the variation in the results obtained in these trials to those in southern Australia.

In conclusion, provided crop safety of the herbicide is similar, there is little grain yield advantage in applying herbicides at pre-tillering compared to mid-tillering when controlling climbing buckwheat or turnip weed in wheat or barley in southern Queensland. This allows farmers flexibility in both herbicide selection as well as timing of herbicide applications for the control of these weeds. Applications can be delayed until mid-tillering in situations where earlier application is not desired or is not possible. Such situations may include: prolonged periods of wet or windy weather, which prevent earlier applications; where there is a likelihood of late weed germinations; or where applications of chlorsulfuron are not desired because of the risk of residue carryover to subsequent crops.

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