Non-chemical options for managing the seed bank of glyphosate resistant weeds

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Summary Glyphosate resistance is becoming a common problem in farming systems of the subtropical cropping region of Australia. Glyphosate-resistance has been confirmed in awnless barnyard grass (*Echinochloa colona* L. (Link)), liverseed grass (*Urochloa panicoides* P.Beauv.), flaxleaf fleabane (*Conyza bonariensis* (L.) Cronquist), windmill grass (*Chloris truncata* R.Br.) and annual ryegrass (*Lolium rigidum* (Gaud.)) (Preston 2012). As well, common sowthistle (*Sonchus oleraceus* L.) was identified at high risk of developing glyphosate resistance.

To prevent further glyphosate resistance and to improve management of existing glyphosate resistant populations, alternative management tactics for these key weeds are required.

This paper reports on the impact of different tillage and stubble treatments on emergence and persistence of awnless barnyard grass and common sowthistle in two experiments located in southern Darling Downs, Queensland.

Keywords Common sowthistle, awnless barnyard grass, tillage, emergence, seed bank.

Experiment one Established March 2009, a long-term field experiment has evaluated impact of tillage and stubble cover on emergence and seed bank persistence of target weed species. The starting seed bank averaged 24 750 for awnless barnyard grass. The starting seed bank for common sowthistle was not assessed due to small seed size. Emergences have been counted after each new flush and soil coring has taken place to a depth of 10 cm in selected treatments every 6 months. Persistence data have not been collected for common sowthistle. Tickle treatments were applied using a harrow, repeated tillage with a chisel plough and deep burial with a one-way disc plough.

Experiment two A field experiment established November 2011 is examining more closely the impact of different forms of tillage (zero, harrow, gyral, offset discs, and one-way disc) on subsequent emergence and burial of weed seeds. A treatment of glass beads, mimicking weed seeds, was included to provide additional information on vertical movement. Weed seeds and beads were sown in separate (1 m × 1 m) fixed quadrats prior to tillage. There have been four flushes of emergence and soil coring has taken place to recover beads from a depth of 0–10 cm in all treatments and 10–20 cm in the one-way disc treatment to account for deeper burial.

RESULTS

Different forms of tillage greatly affected burial depth of glass beads in Experiment two (Figure 1). Harrow and gyral treatments caused the least burial, with a negligible number of beads buried below 5 cm. In contrast, offset and one-way disc treatments buried 27% and 66% of beads below 5 cm respectively.

Emergence of awnless barnyard grass was reduced by deep burial and repeated tillage (57 and 52% respectively) in Experiment one (Table 1). There was a trend for reduced emergence with autumn and spring tickle treatments causing an average 24% reduction in emergence. A similar result was found from Experiment two, where an increasing intensity of tillage resulted in an increased reduction of emergence (Table 2).

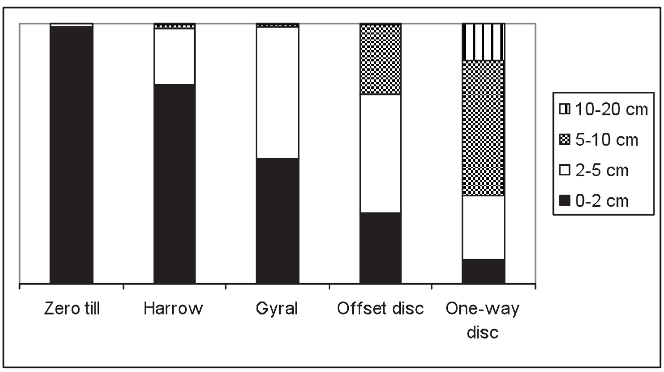

Figure 1. Proportion of glass beads buried to different depths through different forms of tillage.

Table 1. Common sowthistle (ST) and awnless barnyard grass (ABG) cumulative emergence (m^{-2}) and remaining ABG viable seed (% of initial seed-bank) after 3 years in Experiment one. ($P \leq 0.05$).

Treatment	Emergence		ABG persistence (%)
	ST	ABG	
Zero till fallow	19	1912	1.0
Autumn tickle	22	1479	0.5
Spring tickle	17	1436	0.8
Deep burial	13	829	2.8
Repeated tillage	10	924	0.9
Wheat stubble	20	1523	4.0
Barley stubble	19	1990	4.8
Sorghum stubble	27	1727	1.3
LSD	ns	679	0.87

Emergence of common sowthistle was not different across treatments in Experiment one (Table 1). However, there was a trend for reduced emergence in deep burial and repeated tillage treatments. A similar result was found in Experiment two, where tillage with harrows only reduced emergence by 27% while other, more intense tillage treatments reduced emergence by at least 80% (Table 2).

Sowthistle emergence is favoured from a depth of 0–1 cm (Widderick *et al.* 2010) and awnless barnyard grass at a depth of 0–2 cm (Walker *et al.* 2010). The reduced emergence by different forms of tillage is likely to be the result of seed burial below these depths.

The addition of crop stubble did not significantly alter emergence of awnless barnyard grass or common sowthistle (Table 1). However, there was a trend for reduced emergence of awnless barnyard grass under wheat and sorghum stubble and a trend for an increase in common sowthistle emergence under sorghum stubble.

Tillage and stubble treatments altered persistence of awnless barnyard grass seed after 3 years (Table 1).

Table 2. Cumulative emergence from the original fixed quadrat (1 m^2) as % of emergence in zero till in Experiment two.

Tillage type	BYG	ST
Harrow	42.8	73.0
Gyral	34.2	14.7
Offset disc	28.3	19.6
One-way disc	15.5	2.7

In zero till 99% of the original seed sown was depleted. Deep burial increased seed persistence. Walker *et al.* (2010) showed that burial of awnless barnyard grass to 5 cm resulted in an increase in persistence. Wheat and barley stubble treatments also increased seed bank persistence while sorghum stubble had no impact.

Our experimental findings will be incorporated into management strategies for improved control of glyphosate resistant weed species and provide useful data to help understand seed banks of these weeds.

ACKNOWLEDGMENTS

The authors thank the Grains Research and Development Corporation for funding this research.

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