Weeds seed bank changes for annual ryegrass (*Lolium rigidum* Gaudin) and other species under a range of farm management practices on the Liverpool Plains of northern New South Wales

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**Summary** The soil weed seed bank is recognised as the primary source of weed infestations on arable land. Knowledge of the weed seed bank dynamics for individual species would therefore be helpful in designing an integrated weed management program. Farm management practices will govern the size and composition of the weed seed bank. This paper reports two years data of a three year trial to characterise the seed banks of glyphosate resistant annual ryegrass (*Lolium rigidum* Gaudin) and other potentially resistant weeds in paddocks on farms on the Liverpool Plains in northern New South Wales where glyphosate resistant annual ryegrass occurred. Samples were taken from zero tilled and cultivated fields. Soil cores (10 cm depth and 2.5 cm diameter) were used to sample the fields. Soil samples were germinated under polyhouse conditions and the emerged weed seedlings were counted and identified. Knowledge of the cropping history and other chemical and cultural practices used by collaborator farmers are used to help to interpret the results. A total of seven weed species and a few unidentified broad leaf and grass weeds were found. *L. rigidum*, *Polygonum aviculare* L., *Lamium amplexicaule* L., *Crassula colorata* (Nees) Ostenf. and *Poa* spp. were the dominant weeds in most of the paddocks. Several other weeds with lower populations viz. *Fumaria parviflora* Lam., *Cyclospermum leptophyllum* (Pers.) Sprague ex Britt. & P.Wilson, *Sonchus oleraceus* L., *Gamochaeta pensylvanica* (Willd.) Cabrera, *Veronica arvensis* L., *Anagallis arvensis* L. and *Meliolotus indica* All. are not reported in this paper. The combination of rotations and tillage practices appeared to play a significant role in the subsequent increase or decrease of populations of different weed species over time. A third year’s data from 2006 should help to clarify the patterns.

**Keywords** Seed banks, weeds, resistant, Liverpool Plains.

**INTRODUCTION**

The soil weed seed bank is the primary source of weed infestations on arable land and is a good indicator of future weed infestations. It is important therefore to try to reduce the size of weed seed banks and an understanding of weed seed bank dynamics is essential for designing effective weed management strategies (Cardina and Sparrow 1996).

Farm management practices and seed biology of individual species will largely govern the size and composition of the weed seed bank (Cavers and Benoit 1989). Measuring seed bank levels of specific weeds in a paddock over a period of time can provide us with an understanding of the effects of farm management practices on future seed bank changes.

In Australia competition from herbicide resistant annual ryegrass (*Lolium rigidum* Gaudin) is a major constraint in cereal production areas. Confirmation of a sudden build up of glyphosate resistant annual ryegrass populations in wheat cropping systems is posing a serious threat to the grain industry. The aim of this study was to characterise and monitor annual ryegrass and other weed species in the Liverpool Plains area of northern New South Wales to provide insight into changing seed bank patterns over time with different crop rotations and tillage practices.

**MATERIALS AND METHODS**

To date, soil sampling has occurred in June 2004 and April 2005. Sites with a history of glyphosate resistance in annual ryegrass were selected on the Liverpool Plains, which had a range of farm management practices including different tillage practices, crop rotations and spraying regimes. Samples were taken from zero tilled and cultivated fields.

**Sampling** In 2004, samples were collected from the paddocks in the first week of June after most of the annual ryegrass and other weed seedlings had already emerged. In 2005, the samples were taken earlier in the first week of May before most germinations of winter weeds had occurred and before winter crops had been sown. Four properties (sites) were selected for sampling and either three or four paddocks were sampled from each site where annual ryegrass was known to occur. The properties were:

1. Betoota (BT): Premer, four paddocks;
2. Wheel Barrow Back (WB): Spring Ridge, three paddocks;
3. Tamarang (TAM): The Point, three paddocks; and

In each paddock, soil samples were taken along four 50 m replicate transects at 1 m intervals giving a total of 50 cores per replicate, which were bulked, and a total of 200 cores from each paddock. Transects were located 10 m apart and started 15 m in from the edge of the field (Figure 1). Individual soil cores were 2.5 cm in diameter and 10 cm depth. The samples were placed in plastic bags and kept in large ice boxes in the field and then transferred to a cool room at 4°C until germinated.

Global Positioning System (GPS) was used to mark the exact location of the four corners of the sampling area to ensure that soil samples were taken from the same place each year. This allowed an assessment of the changes in the seed bank patterns over time.

Germination Soil samples were germinated in 36 × 20 cm plastic trays on wire mesh tables inside a polyhouse. Paper towel folded twice was placed at the base of the trays and then the soil filled in each tray to a depth of approximately 5 cm. Trays were watered as and when required. Temperatures inside the polyhouse ranged from 2°C–12°C (min.) to 13°C–42°C (max.). Seedlings were identified and counted as and when the weeds emerged and then uprooted. After three months of time given for germination, the samples were dried for one week. Thereafter the samples were inverted, mixed and again settled in the trays and watered to allow for further germination as per Forcella et al. (2003). The total weed emergence in each tray was converted to a m^2 basis.

Cropping and farm management histories for the paddocks being sampled were obtained from farmers through face to face interviews and written responses.

RESULTS
There were large variations between sites and between paddocks within sites in the number of seedlings that emerged for different weed species. There were 17 weed species recorded in total but four of these had negligible counts and hence were discarded. In both years the emerging weed species were similar. Out of the 13 remaining species *Fumaria parviflora* Lam., *Cyclospermum leptophyllum* (Pers.) Sprague ex Britt. & P.Wilson, *Sonchus oleraceus* L., *Gamochaeta pensylvanica* (Willd.) Cabrera, *Veronica arvensis* L.,...

![Figure 1](image-url). Diagrammatic representation of sampling procedures.
Anagallis arvensis L. and Melilotus indica All. had low emergence counts and so are not presented here. Results have been presented for *L. rigidum*, Polygonum aviculare L., Lamium amplexicaule L., Crassula colorata (Nees) Ostenf. and Poa spp. (Table 1). Results for other grass spp. and *Crassula colorata* are discussed but data are not presented due to space limitations. Management practices, specifically the crop rotations performed by the farmers, varied considerably between paddocks and sites. Cropping histories provided by farmers indicated that glyphosate was being sprayed 3–4 times when the field was being kept fallow and once before sowing the crop in both winter and summer. Various other selective herbicides were also being sprayed for weeds other than annual ryegrass.

The persistent seed banks of ryegrass may indicate the presence of herbicide resistance. The results presented are on the basis of seed banks of various weeds present in the soil regardless of the control provided by individual herbicides. Due to the late sampling in 2004 many of the paddocks had low or zero emergence counts. Sampling will again be undertaken in 2006 and results obtained thereafter will help to provide a clearer picture of the effect of rotations and tillage practices on weed seed banks of the different species over time.

**Table 1.** Numbers of individual weeds m⁻² in 2004 and 2005 at different sites on the Liverpool Plains in northern NSW.

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higher counts in 2004 in two of the three paddocks and no counts in 2005 (Table 1).

**Bundella (BUN)** Annual ryegrass at BUN 2 had higher counts in 2004 and reduced germination in 2005. *P. aviculare* and *L. amplexicaule* had little or no germination in both the years. *Poa* spp., grass spp., and *C. colorata* had nil emergence counts except at one paddock for two of the three weed groups.

**DISCUSSION**
Weed numbers varied between properties and between paddocks within properties. Generally, there were low seed banks of annual ryegrass in most areas where glyphosate resistance had been detected, possibly because of low dormancy of annual ryegrass. The two exceptions were sites BT2 and BUN2, which had high levels. Both the paddocks had medium term cereal crop histories and could promote annual ryegrass seed build-up if annual ryegrass was not controlled. Moss and Cussans (1982) found that *A. myosuroides* was encouraged by the increase in the growing of winter cereals, earlier sowing and adoption of minimum tillage techniques. These two paddocks also had other weed populations, which could build up to serious levels. The results could be clearer and it may be interesting knowing long term cropping histories of these paddocks along with the herbicide use pattern.

Seed banks of some species varied greatly between years e.g. paddocks 1 and 2 in WB had a lot of *Poa* spp. in 2004 but none in 2005. WB sites had low annual ryegrass, but WB1 and WB2 had high *Poa* spp. and *C. colorata* possibly because the legume crops could not provide sufficient competition to suppress these weeds.

Across all other sites, *Poa* spp., other grasses and *C. colorata* were more prominent in 2004 rather than 2005, opposite the trend that might be expected due to late sampling. This would suggest that these species were possibly seasonally dominant species i.e. vary with year. On the other hand the presence of annual ryegrass, *L. amplexicaule* and *P. aviculare* varied between years depending on the paddock, suggesting that their occurrence was more determined by farm management practices. Similar results for different weeds were reported by Felix and Owen (2001).

The TAM site had the tillage history of both cultivation and no tillage and lower annual ryegrass levels were reported suggesting that active measures were taken by the grower to control this weed. However, high populations of *L. amplexicaule* were common on all the three paddocks suggesting that a weed shift was occurring under present weed control systems. Mayor and Dessaint (1998) reported an increase in the seed banks of *Capsella bursa-pastoris* due to its advantage against poorly competitive crops in the absence of herbicide pressure. The third year of data should help to clarify the reasons for these differences and suggest helpful practices that lead to control of these weed species.

**ACKNOWLEDGMENTS**
We gratefully acknowledge the technical help of David Edmonds and Mick Faint and the cooperation of Andrew Storrie and Tony Cook from NSW DPI and farmers on the Liverpool Plains. Financial support was provided by the University of New England and CRC for Australian Weed Management.

**REFERENCES**