

ON FARM MONITORING OF WEED OCCURRENCE AND DENSITY IN THE NORTHERN GRAIN REGION

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Abstract Weed management is one of the most important issues, both economically and agronomically, facing farmers in Australia's grain regions. This paper reports the preliminary outcomes of a project investigating the effectiveness of weed management on commercial farms within the Northern Grain Region. Weed management practices and the resultant species occurrence and density have been monitored in winter wheat crops, on 15 farms in since 1997. While a large weed spectrum has been found (77 species), the number of species per paddock is limited (median of 4 in 1997 and 14 in 1998). However, weed densities were low in both years, demonstrating that farmers are managing weed populations effectively in both dry and wet seasons. Tillage practices had an impact on weed density, but this varied with weed species classes. Despite the increase in opportunity cropping, *Avena* spp. and *Sonchus oleraceus* remain the dominant weeds, showing that continued vigilance is required. Suggested changes to weed management techniques could reduce the reliance on herbicides and increase economic effectiveness.

INTRODUCTION

The Northern Grain Region (NGR) covers the cropping areas of northern NSW and Queensland. It has summer dominant but variable rainfall, a hot climate and naturally fertile soils. This provides the opportunity for both summer and winter crops to be grown within the cropping rotations (Webb *et al.* 1997). This environment also favours an extensive weed flora with over 50 species listed as being a problem by farmers (Martin *et al.* 1988), while Felton *et al.* (1994) recorded over 100 species in summer fallows.

Historically, growers in the region use a wheat-sorghum rotation, producing two crops in three years. While this approach provides excellent disease and weed control, it can result in wasteful water management (Hayman *et al.* 1996). Opportunity cropping, which involves sowing a crop whenever water reserves are adequate, has been suggested as a better alternative (Hayman *et al.* 1996). Advantages are increased profits, reduced risk of soil erosion, and the

opportunity to better target specific weeds such as *Avena* spp. or summer grasses. However, in order to ensure that cropping choices are not restricted by herbicide carry-over, herbicides have to be chosen carefully.

There is a perception by farmers that the increased adoption of conservation tillage practices has led to an associated change in weed spectrum. Felton *et al.* (1994) found an increase in *Sonchus oleraceus* L. in the NGR. Packer (1986) found a number of species became more prominent on selected sites in the central west of NSW. However, the Canadian experience has shown that weed spectrum changes can not be related to tillage practices alone (Derksen *et al.* 1993). Other, more site-specific factors need to be considered before changes in the weed spectrum can be fully explained.

This project was established to assess the occurrence and density of weeds throughout cropping cycles and to monitor the overall effectiveness of weed management under different tillage systems. Herein, we concentrate on the weed occurrence and density found in the winter wheat crops of 1997 and 1998.

METHODS

Fifteen farms were monitored for this project, eight on the Liverpool Plains, three south of Moree and four north of Goondiwindi. Three to four paddocks were sampled at each farm, with one paddock in each part of the notional wheat / sorghum / long fallow rotation. Paddocks sown to wheat were sampled during 1997 (below average rainfall) and 1998 (above average rainfall). Paddocks were managed by the growers, with no interaction/advice from us.

In each paddock, four parallel transects, 100 m long and 20 m apart, were established. Along each transect four 10 by 1 m (totalling 16) permanent quadrats were established. Three transects with 12 permanent quadrats were used at the Goondiwindi sites. To ensure easy re-positioning, transects were geo-referenced, using Differential Global Positioning System with an accuracy of 2 to 5 m.

Table 1. Wheat sowing details and resultant crop densities for 1997 and 1998 wheat crops.

Year	Wheat	No. paddocks	Sowing time	Sowing rate (kg ha ⁻¹)	Plant density (m ²)
1997	Bread	14	May - June	27 - 50	68 - 92
	Durum	4	June - July	36 - 47	61 - 125
1998	Bread	14	May - August	30 - 50	23 - 124
	Durum	5	June - July	36 - 50	65 - 91

Weeds were identified and species' density assessed within the 10 × 1 m quadrats, using a ranking system. One to six plants per species = rank of 1; 7 to 20 = 1.5; 21 to 60 = 2; 61 to 190 = 2.5; 191 to 600 = 3; 601 to 6000 = 4; >6000 = rank of 5. The accuracy and time saving aspect of the sampling technique has been quantified and validated (Rew, unpublished data). Weed assessments were made pre-sowing, post-sowing, pre-harvest and post-harvest. Only post-sowing and pre-harvest data are presented. Details of sowing times, rates and subsequent plant numbers are given in Table 1.

Weed data was collated in Microsoft Excel and Splus to obtain percentage occurrence and average density data. Due to the low densities and occurrences, species were grouped into six classes for further analysis. The six classes consisted of: autumn/winter germinating broadleaves, autumn/ winter germinating grasses, spring/summer germinating broadleaves, spring/summer germinating grasses, year-round germinating broadleaves and biennials/perennials. Data were also separated into two regions: Goondiwindi and the Liverpool Plains. Due to the small number of paddocks and similarities in species composition and management, the Moree paddocks were grouped with those of the Liverpool Plains. Too few growers used conventional tillage practices for this tillage class to be included in the analysis. The data were then subjected to REML analysis using Genstat to quantify the effect of tillage strategy, herbicide regime, sampling time and region on the class densities.

RESULTS

Weed occurrence and density 1997 There were 18 wheat paddocks sampled at 12 farms in 1997. Between two and 19 species were found at each paddock with a median of four. Overall, 47 species were recorded, with 31 found at sowing and 30 at harvest. Fourteen species were common to both sampling times.

No species occurred in all the paddocks, but *S. oleraceus* occurred at 16 paddocks and *Avena* spp. (including *Avena fatua* L. and *Avena ludoviciana* Durieu) at 13 paddocks. Weed density was low, with an average of less than seven plants per 10 m², when

averaged over both sampling times and all paddocks where the species was found. *S. oleraceus* was the only exception (Table 2). Some species occurred at higher densities in individual paddocks, e.g. *Avena* spp., *Fallopia convolvulus* L. A.Love., *Echinochloa crus-galli* (L.) Beauv. (data not shown).

Table 2. Average density (ranking) per paddock, of weed species recorded in winter wheat crops (1997) in the Goondiwindi and Liverpool Plains regions in 1997. (Only species occurring on more than 40% of paddocks are listed).

Species	Goondiwindi	Liverpool Plains
<i>S. oleraceus</i>	1.4	0.4
<i>E. crus-galli</i>	0.8	-
<i>Avena</i> spp.	0.7	0.4
<i>Sisymbrium thellungii</i> O.Schulz.	0.7	-
<i>Euphorbia drummondii</i> Bois.	0.4	-
<i>Cirsium vulgare</i> (Savi) Ten.	0.3	-
<i>Lamium amplexicaule</i> L.	-	0.7
<i>Polygonum</i> spp.	-	0.4

- None recorded.

Weed occurrence and density 1998 Eighteen wheat paddocks were sampled at 12 farms in 1998. It was a wetter season than 1997, resulting in a greater median number of species, 14 compared with four in 1997, although the range was similar (six to 19). Overall, 63 species were recorded with 43 at sowing and 52 at harvest. Thirty-one species were common to both sampling times, again an increase on 1997 results.

In 1998, eight species were common to all regions. *S. oleraceus* was found at all paddocks, while *Avena* spp. and *Conyza* spp. were found at all but one paddock, *Gnaphalium* spp. were found at 16 paddocks and *Phalaris paradoxa* L. at 12 paddocks. Average weed densities were generally higher in 1998 than 1997 although, when averaged across all paddocks where

the species were recorded, most species still had densities of less than seven plants per 10 m² (Table 3). The exceptions were *S. oleraceus*, *Sida cordifolia* L. and *Wahlenbergia* spp., which had densities of less than 21 plants per m². Within individual paddocks *E. crus-galli* and *Cyperus* spp. occurred at higher densities (data not shown).

Table 3. Average density (ranking) per paddock, of weed species when present in wheat crops 91998) in the Goondiwindi and Liverpool Plains regions. (Only species occurring on more than 40% of paddocks are listed).

Species	Goondiwindi	Moree	Liverpool Plains
<i>S. oleraceus</i>	1.5	1.0	0.6
<i>Avena</i> spp.	1.0	0.4	0.4
<i>P. paradoxa</i>	0.8	0.1	0.4
<i>Gnaphalium</i> spp.	0.7	0.7	0.6
<i>S. thellungii</i>	0.7	-	-
<i>Centaurium</i> spp.	0.4	-	-
<i>Conyza</i> spp.	0.4	0.5	0.3
<i>C. vulgare</i>	0.2	-	-
<i>Tetragonia tetragonioides</i> (Pallas) Kuntze.	0.2	-	-
<i>Solanum. nigrum</i> L.	0.1	-	-
<i>Lepidium</i> spp.	0.1	-	-
<i>Medicago</i> spp.	0.1	0.1	-
<i>Rapistrum rugosum</i> L. All.	-	0.5	-
<i>Polygonum</i> spp.	-	0.4	1.2
<i>Datura</i> spp.	-	0.2	-
<i>Centipeda thespidioides</i> F. Muell	-	0.1	-
<i>Lactuca serriola</i> L.	-	0.1	0.1
<i>E. crus-galli</i>	-	-	0.8
<i>F. convolvulus</i>	-	-	0.6
<i>L. amplexicaule</i>	-	-	0.6
<i>Urochloa panicoides</i> P. Beauv.	-	-	0.2
<i>Ciclospermum leptophyllum</i> (Pers.) Sprague	-	-	0.2

- None recorded.

Effect of tillage, herbicide, sample time and region on plant density Tillage strategy significantly affected the density of all species classes in both years. The autumn/winter grasses and broadleaves, and spring/summer grasses (in 1997) were recorded at higher

densities in minimum tillage paddocks. In contrast, the biennials/perennials and year-round germinating broadleaves were recorded at higher densities in the no-tillage paddocks. Only spring/summer broadleaves were inconsistent between years, recording higher densities in minimum tillage paddocks in 1997 and no-tillage paddocks in 1998.

Not surprisingly, herbicide regime (none, pre-emergent, post-emergent, pre- and post-emergent) had a significant impact on weed density. There was an interaction between herbicide strategy and time, because the different herbicide strategies controlled the weeds at different times. Only the biennials/perennials were unaffected by time in both years.

The Goondiwindi region generally recorded significantly higher weed densities than the Liverpool Plains. Exceptions were autumn/winter broadleaves in 1997, spring/summer broadleaves in 1998 and biennials/perennials in 1998. The higher densities correlated with the herbicide regime chosen by the Goondiwindi growers. They chose either no herbicide or post-emergence control, whereas the Liverpool Plains group used none, pre or pre-and post but never post-emergence herbicide alone. This meant that the Goondiwindi paddocks recorded higher weed densities at the post-sowing sample time.

DISCUSSION

Cooperating farmers, judged to be among the top 10% of managers, were chosen for this study on the pretext of evaluating weed problems which exist under competent management. This was designed to provide indicators of what future efforts may be required to improve weed management.

The diversity of the weed flora in the NGR, previously indicated in surveys (Martin *et al.* 1988, Felton *et al.* 1994), has been borne out in this study. In all, 77 species were observed across the sites spread from near the southern most areas of the NGR to southern Queensland. No doubt if the survey had taken in the grain growing areas in the northern parts of the NGR (Central Queensland), the spectra would be even broader. However, less than 19 species were observed at any one paddock, with a median of four in 1997 and 14 in 1998. The dramatic increase in median number per paddock corresponded with hugely contrasting seasons; 1997 was drier than average and 1998 wetter. Temporal and spatial effects such as these are inevitable in a region where management factors interact with the environment. This demonstrates how important it is to scout crops regularly and be prepared to modify weed management accordingly.

Higher densities of winter and summer grasses, and winter broadleaves were recorded in the minimum tillage compared with no-tillage paddocks. Whereas, no-tillage paddocks had higher densities of biennial/perennial species and multi-seasonal broadleaves. Much of the multi-seasonal broadleaf group consisted of wind-dispersed species e.g. *S. oleraceus*, *Conyza* spp. and volunteer crops. Perhaps the most notable shift over the past decade has been the ingress of *S. oleraceus*; which has risen from occurring on about one third of farms (Martin *et al.* 1988) to almost ubiquitous occurrence in the present study. It was also perceived as one of the main weed problems by farmers in the region (Alemseged *et al.* 1999). It is presumed the increase in *S. oleraceus* has been promulgated by the combined adoption of reduced tillage practices and sulfonylurea herbicides.

The lability of the flora calls for further vigilance in planning crop sequences. Uncertainty associated with climate and commodity prices has encouraged many growers towards opportunity cropping. This allows them greater crop choice, but only if herbicides are chosen wisely within each cropping phase. The low weed densities recorded throughout this project indicate that competent growers are able to effectively manage weeds, irrespective of seasons. However, given the wide spectrum of weeds persisting at many paddocks under most management systems, albeit that these are at densities insufficient to compete with crops, perturbations could easily arise leading to a rapid escalation of weeds. This leaves little room for complacency, poor planning or poor decisions. The increase in problems of herbicide resistance is an additional compelling reason for planning, monitoring and the keeping of accurate weed management records.

Although the growers participating in this project are abreast of their weed problems, we see further opportunities for refinement. The heavy dependence on herbicide is not only a cost burden on producers (Medd 1997), but increases the chance of residue and resistance problems. It is evident from our results that wheat sowing densities have changed little over the past decade, and are mostly still lower than the optimum advised by Martin *et al.* (1987, 1988). As shown by Walker *et al.* (1998), increased crop competition, achieved by increasing crop density to above 100 plants m⁻², can be substituted in part for herbicide without detrimental effects on crop yield or quality, or loss in weed control. The development of selective spray-topping (Medd *et al.* 1992), for reducing seed production of residual populations, could also be deployed to combat *Avena* spp, one of region's most recalcitrant weeds.

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