The effect of summer weed management strategies on subsequent germinations and seed bank numbers

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Summary Where seed set was stopped over several years the number of innocent weed (*Cenchrus longispinus* (Hackel) Fern.) and caltrop (*Tribulus terrestris* L.) plants that emerged declined and the seed banks of innocent weed declined. However, a reduction in innocent weed plant numbers of between 39 and 65% reduced the amount of seed entering the seed bank by less than 10% suggesting that to obtain a long term reduction in seed bank numbers it is necessary to stop all plants from setting seed. If these trends continue a reduction in the number of operations required to control summer weeds may be possible.

Keywords Summer weeds, plant numbers, seed bank.

INTRODUCTION
There are many reasons for controlling summer weeds including soil moisture and nutrient conservation, reducing pest and disease carryover, reducing wool contamination, avoiding the toxicity of some plants, and reducing the build up on fence lines. With the increased movement to no-till farming systems one of the foremost issues is the passage of seeding equipment.

It is important to identify the main reasons for controlling summer weeds as this can influence the timing of control.

The effects of summer weed control on grain yield and quality have been demonstrated in four years of trials (Fromm and Grieger 2002, 2004).

In the past there has been very little data available on the effects of summer weed management on subsequent germinations and seed banks. This paper reports the results of trials over the last four years that target innocent weed (*Cenchrus longispinus* (Hackel) Fern.) (Site 07) and caltrop (*Tribulus terrestris* L.) (Site 18).

MATERIALS AND METHODS
Field trials commenced in October 1999 with the establishment of long term monitoring sites in the Murray Mallee and upper Yorke Peninsula of South Australia.

Treatments The treatments applied at each of the monitoring sites depended on the farming system being used by the cooperator. The timing of the treatments was dependant on rainfall events. If possible the early treatments were applied prior to the end of December and the late treatments in either February or March.

The experimental design was a randomised complete block with four replicates. The plot sizes were 8 × 35 m (Site 07) and 8 × 40 m (Site 18).

Site 07 – Innocent weed This site was established on a yellow brown sand grading to a loamy sand and a clayey sand.

Treatments:
- Treatment 1: Untreated control.
- Treatment 2: Herbicides applied as necessary.
- Treatment 3: Late herbicide application.
- Treatment 4: Early herbicide application.
- Treatment 5: Untreated + trifluralin in crop.
- Treatment 6: Herbicide as necessary + trifluralin in crop.

Treatments applied during the four summers are summarised in Table 1. The herbicide used for all treatments was glyphosate at 900 to 980 g a.i. ha⁻¹. Broadleaf weeds were controlled over the whole site as required.

In the cropping phase trifluralin was applied to Treatments 5 and 6 at 400 g a.i. ha⁻¹ and incorporated by the seeding operation within four hours of application.

This site was sown to triticale in 2000, wheat in 2002 and wheat in 2003 and regenerated naturally as pasture in 2001.

<table>
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<th>Treatment</th>
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<td>6</td>
<td>T1, T2</td>
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Date herbicides applied
- T1 1/12/99 8/12/00 14/11/01 13/12/02
- T2 29/2/00 5/4/01 13/1/03
- T3 7/3/03
**Site 18 – Caltrop**  This site was established on a deep yellowish brown sand over a yellowish red sandy clay loam.

Treatments applied during the four summers are summarised in Table 2. The herbicides used were glyphosate (450 to 540 g a.i. ha⁻¹) and 2,4-D as the ethyl or iso-octyl ester (400 to 800 g a.i. ha⁻¹).

Treatments:
- Treatment 1: Untreated control.
- Treatment 2: Herbicide as necessary.
- Treatment 3: Late herbicide application.
- Treatment 4: Early herbicide application.

This site was regenerated pasture in 2000, sown to triticale in 2001, regenerated pasture in 2002 and sown to triticale in 2003.

**Assessments**  Seedling populations of the weeds were assessed after each germination and emergence using eight quadrats per plot. Quadrat size was 0.2, 0.25, 0.75 or 1.0 m⁻² (Site 07) and 0.5, 0.75 or 1.0 m⁻² (Site 18).

Seed banks (Site 07) were measured, using 10 cores per plot, at the end of each summer after plants had matured and seed set was complete. Core size was 10 cm in diameter and depth. Seeds were visually assessed for age. They were classed as either new if they had been set in the summer just passed or old if they were had been set prior to that summer.

**RESULTS**

**Plant numbers, Site 07 – Innocent weed**  In 1999/2000 there were three germinations. The total number of plants that emerged in the untreated plots was 211.2 m⁻².

In all years, in Treatments 2 and 6, no innocent weed plants were allowed to set seed.

The number of innocent weed plants that emerged in subsequent years at Site 07 is shown in Table 3. In 2000/01 and 2002/03 the number of plants that emerged in the comparable Treatments 1 and 2 respectively. In 2001/02, following the regenerated pasture, there was a significant reduction in the number of plants that emerged in Treatments 2 and 6 which had no plants set seed in the previous two years. In 2003/04 there was insufficient rainfall to stimulate a complete germination at this site.

**Plant numbers, Site 18 – Caltrop**  In 1999/2000 the initial caltrop population at this site was 21.1 plants m⁻². After the treatment at T1 a second germination occurred. In Treatment 1, 20.7 plants m⁻² and in Treatment 2, 65.9 plants m⁻² emerged.
In addition in Treatment 3 (late herbicide application) in 2001/2002 and 2002/2003 there were also significantly less plants than in Treatment 1.

In 2003/2004, at Site 18 there was insufficient rainfall to stimulate a complete germination. However, the trend in the number of plants that emerged was consistent with the previous two summers.

Seed bank, Site 07 – Innocent weed At the end of the summer of 1999/2000 the seed bank in Treatment 1 (untreated plots) consisted of 3707 seeds m$^{-2}$ comprising 1932 old and 1775 new seeds.

The seed banks for all treatments at the end of subsequent summers are shown in Table 5.

The seed bank in Treatments 2 and 6, which had all emerged plants controlled before they set seed, had declined significantly when compared to Treatments 1 and 5 which had no post-emergent control measures applied.

DISCUSSION

Innocent weed The application of trifluralin in the cropping year significantly reduced the number of plants emerging in Treatment 5 when compared to Treatment 1 by 62%, 39% and 65% in 2000/2001, 2001/2002 and 2002/2003 respectively. However, the number of new seeds entering the seed bank was reduced by 4%, 10% and 8% in 2000/2001, 2001/2002 and 2002/2003 respectively. This suggests that the plants which did emerge and establish in Treatment 5 were able to compensate and set more seed per individual plant than the plants in Treatment 1.

The amount of seed entering the seed bank in Treatment 1 has not increased the total number of seeds in the seed bank over the four year period of this study. The data indicates that a large number of seeds are lost annually which cannot be explained by plant emergence numbers alone. The existence of the seed bank of Treatments 2 and 6 at the end of the 2002/2003 summer, which have not had seed entering the seed bank since the summer of 1998/1999, indicates that some innocent weed seeds can survive in the soil for at least four years.

Caltrop The results suggest that preventing seed set can reduce the number of plants emerging in subsequent summers. However if some plants are allowed to set seed the long term benefits will not be obtained. Early control (Treatment 4) with no follow-up control allowed a second germination to set seed. Late control (Treatment 5) allowed limited seed set from older plants.

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REFERENCES
