

## UTILISING CROP RESIDUES TO CONTROL WEEDS

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**Abstract** Some crop residues are known to have a chemical (allelopathic) as well as physical effect on the growth of subsequent crops and weeds. Preliminary trials in 1997 at the University of New England, Armidale, consisted of plots planted to barley, canola, chickpea, field pea, mungbean, sorghum and a fallowed control. Four target weed species were planted following these crops. Target weed survival was assessed as well as overall weed dry matter production. Generally, with the exception of field pea, all residues were found to reduce weed growth. Barley was found to be the most inhibitory (64% and 47% of the fallow treatment for incorporated residue and surface residue treatments respectively). Field pea was found to have a significant stimulatory effect on overall weed dry matter production (127%), on incorporated plots, yet did not affect the survival rate of target weeds. A trend towards reduced weed growth was observed where residue was retained on the soil surface. In the pot trial chickpea extract inhibited germination and growth of the weed species under investigation.

The range of crops has been extended in 1999 to include navy bean, soybean, sunflower, azuki bean, and cowpea to give wider options for cropping rotations.

### INTRODUCTION

Changes from conventional to conservation tillage practices can cause shifts in weed species and densities (Wilson and Foy 1990). Similarly, changes in crop rotation sequences can also affect weed populations (Hume *et al.* 1991). Any agricultural practice may create changes in the weed flora on a given site (Holt and LeBaron 1990).

Retention of crop residues in conservation tillage systems is recognised as providing several benefits including improved soil conservation and soil structure, as well as increased water infiltration and reduced costs for fuel and labour. Crop rotation has the added potential advantages of providing a disease break, contributing biologically fixed nitrogen from pulse species, and providing a greater flexibility in weed control management. However, there are also several potential negative effects associated with rotational cropping. One important effect can be a decrease in growth and yield of subsequent crops, especially when there are large amounts of fresh

residues in contact with crop seedlings (Kimber 1973, Rice 1984, Mason-Sedun *et al.* 1986). With heavy reliance on herbicides to control weeds, there is the possibility of deleterious effects on human health and the environment through contamination of air, soil and water.

An alternative approach to weed control, in crops, is to utilise allelopathic capacity of individual crops to suppress weed growth. Allelopathy, recognised since the third century BC, has a potential role in weed management strategies used in minimum and no-till systems. The trend towards conservation tillage and a widening range of crop rotation options in Australia has highlighted the potential influence of allelopathy in cropping systems.

Crop residues are known to have a chemical (allelopathic) as well as a physical effect on the growth of subsequent crops and weeds (Lovett and Jessop 1982, Purvis *et al.* 1985, Mason-Sedun *et al.* 1986). Many authors have discussed reductions in germination and growth of weeds and/or crops following crops with retained residues. However, few of these discuss allelopathy as a possible explanation of this phenomenon. A recent example of this is found in Crocker (1998) who discusses the difference in wheat yields following a series of rotations, which included legume species, continuous wheat and long fallow. It was found that although chickpea contributed some nitrogen to the system, and provided a disease break, yields of wheat following chickpea were lower than for the other pulse species and the long fallow treatment. Allelopathy was not discussed as a possible explanation for the reduced yields. Utilising allelopathy for weed management is likely to be most beneficial where other options are reduced due to herbicide resistance and high control costs.

This paper aims to provide a general overview of work currently being undertaken to screen a range of crop species for allelopathic activity. The purpose of this on-going study is to determine the effects of a range of crops on target weed species, general weed growth, and their influence on following crops.

### MATERIALS AND METHODS

**Field trial** Seedbeds were prepared using conventional tillage practices at the University of New England, Armidale. The experiments used a

randomised split plot design with four blocks. Plots measuring 11.4 x 1.5 m were sown to wheat (*Triticum aestivum* L. cv. Sunstate), barley (*Hordeum vulgare* L. cv. Skiff), canola (*Brassica napus* L. cv. Oscar), chickpea (*Cicer arietinum* L. cv. Narayan) and field pea (*Pisum sativum* L. cv. Dundale) in August 1997. Sorghum (*Sorghum bicolor* L. Moe. cv. Patriot), and mungbean (*Vigna radiata* L. cv. Emerald) were sown at the field research facilities at the in November 1997. Plots were sown with a row spacing of 25 cm and at rates recommended for the area. Control plots were cultivated in the same manner as the treatment plots and kept weed free, but were not sown to a crop.

At crop maturity, the plots were mechanically harvested, the residue collected and kept. The plots were then chipped for weeds and the residues replaced on the plot from which they were harvested. The plots were split into two sections measuring 1.5 x 5.7 m. On one half, residues were maintained on the soil surface, and on the other half, residues were incorporated using a rotary hoe. These split plots were further divided into four sub-plots measuring 1.5 x 1 m. Seeds of each of the four target weed species, i.e. wild oats, (*Avena ludoviciana* L. Dur), turnip weed (*Rapistrum rugosum* L. All), paradoxa grass (*Phalaris paradoxa* L.) and sowthistle (*Sonchus oleraceus* L.), were sown into these sub-plots in April 1998 at a rate of 200 seeds per m<sup>2</sup>.

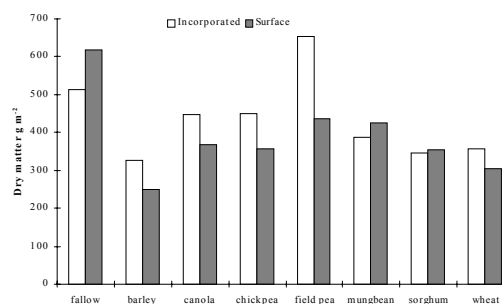
Measurements were taken of sown weed numbers in December 1998. All aboveground plant material was harvested from 50 cm quadrants in each treatment in January 1999, before being dried at 80°C for 48 hrs and weighed.

**Pot trial** Residues of wheat, barley, canola, sorghum, chickpea, and field pea were collected from farms within the northeastern region of NSW in the 1997-98 harvest period. The residues were stored under cool dry conditions at the University of New England, prior to being cut into 2-5 cm lengths. A total of 35 g of chopped residues for each crop were soaked in 3 L of water for 24 hours, strained and vacuum filtered through unbleached calico cloth. Pots with a diameter of 20 cm were filled to 2 cm from the rim with sieved soil composed of loam and sand in a ratio of 1:1. Pots were placed in a polyhouse in a completely randomised design with four replicates of each treatment. Each pot was sown with 100 seeds of one of the four individual target weed species. Wild oats, turnip weed and paradoxa grass were planted at a depth of 1 cm whilst sowthistle was sown onto the surface of the soil. Seeds were sown just prior to application of 250 ml of leachate onto the soil surface. Pots were watered as required to prevent

drying out and to allow sufficient moisture on the soil surface for germination of sowthistle.

## RESULTS AND DISCUSSION

**Field trial** Compared with the fallow incorporated treatment, the field pea incorporated treatment was found to have a stimulatory effect (127%) on overall weed dry matter production on the residue-incorporated plots (Figure 1), yet it did not affect the counts of all target weeds (Table 1). The large difference in weed dry matter (Figure 1) between the residue-incorporated and surface-retained field pea residue may indicate that there is a nutrient effect in conjunction with allelopathic activity from the residue. This explanation was supported somewhat by results from pot trials which confirmed a stimulatory effect on weed growth in field pea treatments, particularly on turnip weed (data not presented).



**Figure 1.** Aboveground dry matter production of background weeds following the harvest of different crops where residues either remained on the soil surface or were incorporated.

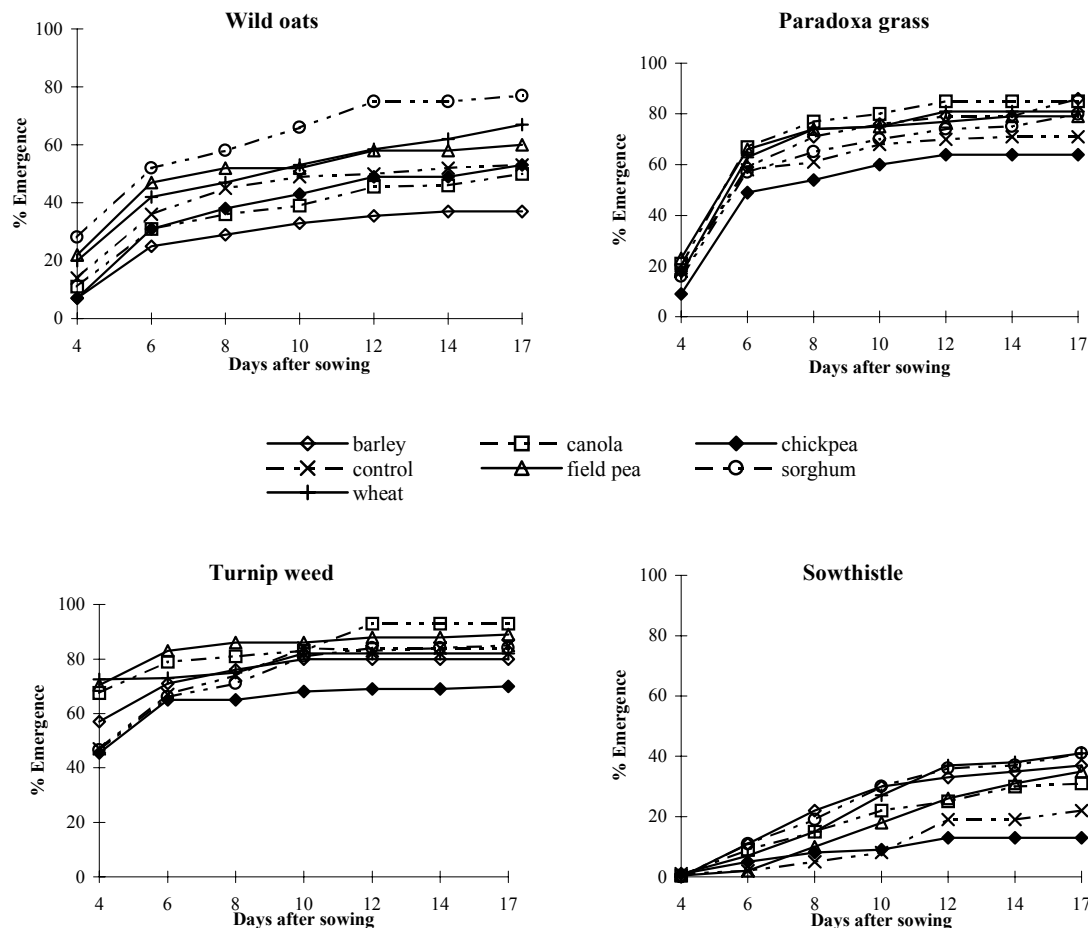
Barley was found to be the most inhibitory residue to overall weed dry matter production, with only 64% and 47% of the fallow in the incorporated residue and the surface residue treatments respectively (Figure 1). However, in target weed counts, barley only suppressed paradoxa grass more than other crops (Table 1).

Residue may play a role in affecting weed growth by reducing light and modifying soil temperature. However, in cases where residue was of a similar physical consistency, differences in weed dry matter production are more likely to be attributed to allelopathic activity. Although not statistically significant, a trend towards reduced weed biomass was observed where residue was retained on the soil surface, possibly due to the physical effects of the residue (Figure 1).

Numbers of target weeds did not indicate a consistent crop treatment effect (Table 1).

**Table 1.** Mean number of target weeds surviving to flowering stage from seeds sown in each treatment.

	Fallow	Barley	Canola	Chickpea	Field pea	Mungbean	Sorghum	Wheat	5% lsd
Sowthistle	1.75	4.75	1.75	0.75	0.25	2.00	3.00	1.00	1.30
Paradoxa grass	10.75	2.75	13.00	7.50	15.00	6.75	5.00	8.75	3.39
Turnip weed	11.75	6.00	1.00	0.50	2.50	6.00	5.00	1.00	2.42
Wild oats	4.75	2.25	1.50	1.50	3.50	6.00	7.25	2.00	1.51
Total	29.00	15.75	17.25	10.25	21.25	20.75	20.25	12.75	



**Figure 2.** Percentage germination of target weed species treated with crop residue extracts. Data presented are the means of four replicates.

**Pot trial** The pot trial indicated that the extracts of crop residues could suppress germination of selected weed species. Barley extract had an inhibitory effect on the germination of wild oats, whilst germination of wild oats was stimulated most by sorghum extract (Figure 2). Extracts of chickpea had a tendency to reduce germination of turnip weed, sowthistle and paradoxa grass. Field pea extract stimulated turnip weed growth noticeably (data not presented), but did not appreciably affect percent germination (Figure 2). A wheat test crop will follow new trials planted this year to determine if allelopathic effects follow through to the next crop. The range of crops has been extended in 1999 to include summer and winter species. Summer crops include navy bean, soybean, sunflower, azuki bean, sorghum, sunflower and cowpea to give wider options for cropping rotations. The winter trials will include barley, canola, field pea, chickpea, wheat, rye and triticale.

From these preliminary findings, there are indications that residues may be utilised to control selected weed species. The reduction of the number of target weeds under chickpea residues, in the field and in pot trials, indicates that its inclusion in a rotation may also reduce the incidence of the target weed species. However, detrimental effects on subsequent crops will need to be examined, as phytotoxic effects of these residues do not appear to be species specific.

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