# Allelopathic potential of *Amaranthus viridis* L. against annual ryegrass

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**Summary** Allelopathic effects of extracts from *Amaranthus viridis* on annual ryegrass have been observed in petri-dish bioassays. The result showed that germination percentage, plus root and shoot growth were significantly decreased compared to controls especially by extracts from dried samples. Extracts at 50% and 100% from dried samples and 100% from fresh plant samples were more toxic to ryegrass. Ryegrass was mostly inhibited by 100% followed by 50% dried and 50% fresh plant extract. The result also suggests that phytotoxicity of *Amaranthus viridis* depends on the extract's preparation procedures.

**Keywords** Allelopathy, *Amaranthus viridis* L. annual ryegrass, extracts.

## INTRODUCTION

In Australia, weeds cost over $4 billion per annum to agricultural production. Weeds are not seen as of economic benefit except for recognition that some can have grazing benefits (Sinden *et al.* 2004). Their ultimate value to natural- and agro-ecosystems have not been completely identified: but many of their negative and positive impacts on both systems are very similar. Their negative impacts are often associated with repetitive use of herbicides which has produced resistant weed biotypes; resistance is continuing to spread, often developing within several years of the first herbicide application (Qasem and Foy 2008). As a result, there is considerable interest in utilising non-chemical control methods including allelopathy phenomena as a management tool.

In allelopathy, plants provide themselves with a competitive advantage by releasing phytotoxins into the nearby environment (Pratley 1996). The concept of allelopathy interaction between weeds is interesting and there is evidence that certain weeds species, have the potential to be used in solving problems of other weed species, in that they represent an excellent source of natural chemicals that may be involved in developing natural herbicides (Qasem and Foy 2008).

*Amaranthus viridis* L. is a common weed of cropping situations. It is distributed in the warmer parts of the world including Australia. Records indicate that leaves, roots, pollen, flowers and stems of pigweed have detrimental effects on germination and growth of different crop species (Hussain *et al.* 2003, Tabriz and Yarnia 2011). However, no such information exists of any *Amaranths viridis* L. allelopathy effect on annual ryegrass (*Lolium rigidum* L.). The present study reports germination and initial growth performance of ryegrass under different conditions and different *Amaranthus viridis* extract concentrations. The results of this study may provide a basis for a suitable non-chemical ryegrass control option.

## MATERIALS AND METHODS

**Extract preparation** Above ground mature plants were collected from the Wagga Wagga campus of Charles Sturt University. Collected samples were chopped into 3 cm pieces. Half of the samples were kept at oven temperature (60°C) for 48 hours and half of the samples were soaked in de-ionized distilled water for 24 hours in a ratio of 1:10 (10 g fresh samples in 100 mL $dH_2O$). Some were kept at 100% (F 100%); some diluted to 50% (F 50%). Oven dried samples were milled to prepare the second extract using the same ratio as for the fresh plant extracts.

**Extract allelopathy assessment** Annual ryegrass was used as the receiver. Twenty seeds (surface sterilised) of ryegrass were sown onto 9 cm petri-dishes lined with one layer of Whatman No. 1 filter paper. 5 ml of each extract from different concentrations were delivered to each petri-dish and distilled water (5 ml) was used as control. Each petri-dish with its cover was sealed with a piece of parafilm to reduce evaporation. All dishes were maintained in a control growth room at 21/19°C with day/night for 12 h/12 h. For the first two days a black polythene sheet was used to cover all the petri-dishes; then the cover was opened. Germinated seeds (with a radical of >1 mm) were recorded and root and shoot lengths were measured after 5 days of incubation.

**Experimental design and statistical analysis** A randomised block design with three replications was used for the experiment. The experiment was repeated twice to confirm the consistency of results. All experimental data were subjected to analysis using Genstat 5 (version 13) and treatment means were tested separately with least significant difference (lsd) at the 5% level of probability. Percent of germination was calculated as (germinated seeds/total given seeds) × 100.

## RESULTS AND DISCUSSION

**Germination percentages** The type of *Amaranthus viridis* L extract had significant effects on the germination of ryegrass at 3 and 5 days after sowing (Figure 1). The water extracts (50% and 100%) from dried shoots retarded germination at 3 and 5 days. Whereas 100% extract from fresh stem was more inhibitory than for the 0% (control) as well as the 50% fresh stem water extracts. A comparison of interactions indicates that at the initial stage of germination, ryegrass was totally restricted by (100% fresh and 50% and 100% dried) plant extracts. Although later on, a minimum percentage of seeds germinated but were at a significantly lower percentage than the control (i.e. seeds treated only with distilled water). The maximum germination percentages were calculated by comparison with the control at 5 days. The lowest germination percentages were the result of treatment with 100% dried extract and it may be that dry extracts contain more allelopathic substances (which inhibit or delay the imbibition process in ryegrass seed germination). A similar result was also reported by Tabriz and Yarnia (2011) with corn, where they reported dry stem extract of pigweed was more phytotoxic (than fresh stem extract) to corn seed germination.

**Root length** The growth of the radical of annual ryegrass was demonstrably inhibited by both fresh and dried plant extracts in all concentrations (Figure 2).

However, under the 50% extracts from fresh plant material, root lengths were longer than under other concentrations, although significantly shorter than the control. Statistically significant shorter root lengths were recorded at 100% and 50% extracts from dried as well as 50% fresh plant samples. This result suggests that high concentrations of extracts of *Amaranthus viridis* contain more dry matter—and so provided more phytotoxic substances per petri-dish. Our findings are supported by Tabrizi and Yarnia (2011) and Hussain *et al*. (2003), who reported inhibitory effects of pigweed to corn, in which shoot extracts were more toxic than root extracts.

**Shoot length** Aqueous extracts from both fresh and dried samples significantly reduced the shoot length of ryegrass compared to the control (Figure 3). Dried extract was more toxic to shoots of ryegrass than fresh plant extract. Suppression of ryegrass shoot growth may be related to slow germination and slow root growth; these were affected by hydrolysis products from the *Amaranthus viridis* tissues. These results are in close agreement to the findings of Inam *et al.* (1989) and Tabrizi and Yarnia (2011).

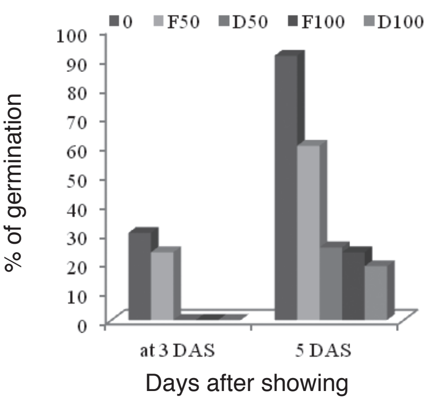


**Figure 1.** Effect of different extract concentrations and times on ryegrass germination (LSD = 6.3, P <0.05).

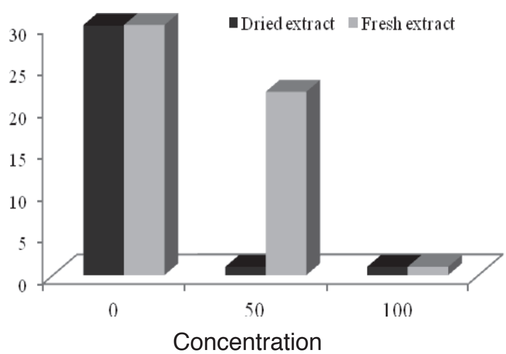


**Figure 2.** Root length of ryegrass is inhibited by extracts of *Amaranthus viridis* L. (LSD = 6.0, P <0.05).

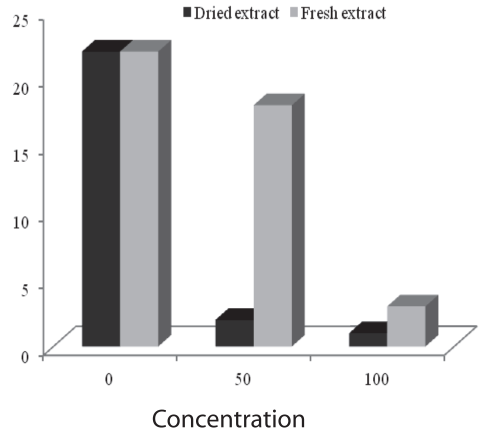


**Figure 3.** Shoot length of ryegrass is inhibited by extracts of *Amaranthus viridis* L (LSD = 4.0, P <0.05).

CONCLUSION

The present study strongly suggests that the common weed *Amaranthus viridis* L. in Australia has allelopathic potential. This needs to be checked in detail.

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