Wheat allelopathic potential against a herbicide-resistant biotype of annual ryegrass

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ABSTRACT

Allelopathy has been receiving world-wide attention for its potential in integrated weed management. The present study showed that aqueous extracts of wheat shoot residues significantly inhibited the germination and root growth of a biotype of annual ryegrass resistant to A, B, C, and D herbicide groups. Wheat cultivars differed significantly in their allelopathic activity against this weed. The results suggest that wheat residue allelopathy may be exploited in managing herbicide-resistant weed species.

KEY WORDS

Allelopathy, wheat (*Triticum aestivum* L.), annual ryegrass (*Lolium rigidum* Gaud.), resistant biotypes.

INTRODUCTION

Annual ryegrass (*Lolium rigidum* Gaud.) has become an important agricultural weed in Australia. Biotypes of this weed have developed resistance to the majority of herbicides currently used (1, 2, 3). The level of resistance to glyphosate, a 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) inhibitor, has also been quantitatively evaluated for ryegrass (4). The development of cross- and/or multiple-resistance has been documented in this weed. As a result, rotation of chemically distinct herbicides will not be effective (5). Non-herbicidal innovations to manage this problematic weed are therefore urgently needed.

Evidence has accumulated that allelopathy holds potential for weed management (6, 7, 8). The aim of this present research is to evaluate 39 wheat cultivars for their residue allelopathy in the suppression of a biotype of annual ryegrass resistant to A, B, C, and D herbicide groups.

MATERIALS AND METHODS

Collection of wheat material and seeds of ryegrass

Shoots of 39 wheat cultivars were collected at mature stage from the field. Leaves and stems were combined. Seeds of resistant annual ryegrass were obtained from Mr Peter Baines of the Farrer Centre for Conservation Farming, Charles Sturt University, Wagga Wagga.

Bioassay with aqueous extracts from 39 wheat cultivars

The bioassay procedure was identical to that previously described in detail in Wu *et al*. (9). Ten grams of ground residue powder from each cultivar were extracted with 100 mL of distilled water in a glass jar for 48 hours at 20?C. The pulpy mixture was filtered, and the resulting filtrate was centrifuged. The supernatant was then vacuum-filtered through one layer of microfilter paper (Whatman, 0.25 ?m). The sterilised filtrate was collected and designated as full strength (100%). On the basis of previous experiments (9), the extract was diluted to a concentration of 33.33% strength for bioassays. Five mL of each diluted extract from 39 wheat cultivars were delivered to each petri dish lined with one layer of Whatman #1 filter paper. Thirty seeds of ryegrass were placed on the petri dishes. Distilled water (5 mL) was included as a control. All dishes were maintained in a tissue culture room at 23?C with fluorescent lights for 24 hours, and were arranged in a randomised complete block design with 3 replicates. Germinated seeds and radicle lengths were recorded after 7 days of incubation. Data were statistically analysed and treatment means were tested separately with least significant difference (lsd) at a 5% level of probability.

RESULTS AND DISCUSSION

The data showed that the phytotoxicity of wheat extracts differed significantly among cultivars. Of the 39 wheat cultivars tested, 16 wheat cultivars significantly reduced ryegrass root growth by more than 80%. However, two cultivars, Angus and Jing Hong, stimulated the root growth, with a length of 47.7 and 49.0 mm, respectively, compared to a water control of 43.7 mm (Fig. 1). Seed germination was also inhibited by the aqueous extracts, giving a germination rate of ryegrass ranging from 0 to 80%, with the control at 83% (data not shown). The average inhibition of wheat extracts on annual ryegrass was 67.9% for root growth and 25.7% for seed germination.

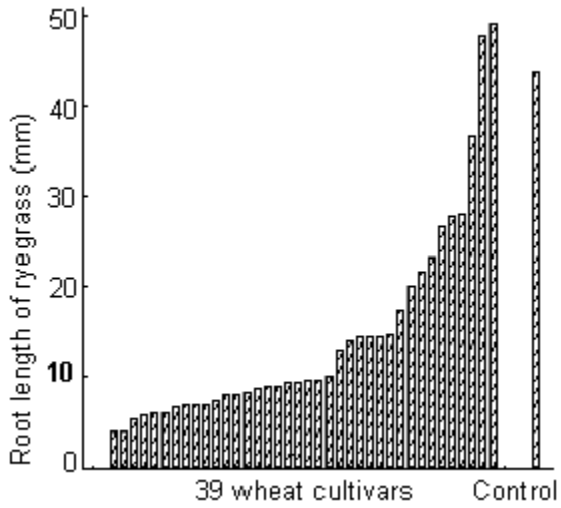

Figure 1. Effect of aqueous extracts of wheat cultivars on root growth of a resistant biotype of annual ryegrass.

The present study showed that wheat residues have allelopathic potential against the germination and growth of a resistant biotype of annual ryegrass. Our previous study also found that wheat residues are allelopathic to a susceptible biotype of this weed, and that inhibition varied with cultivar (9). Similarly, Przepiorkowski and Gorski (10) demonstrated that shoot extracts and root residues of rye (*Secale ceceale*) inhibited not only the germination and growth of three triazine susceptible weeds, but also those of resistant biotypes. Therefore, residues of certain crop cultivars with strong allelopathic potential could be exploited in managing resistant weeds, thereby reducing the dependence on synthetic herbicides. The application of allelopathy is preferred under conservation farming systems where retained crop stubbles could be used to suppress weeds. However, more research is still needed prior to the implementation of crop allelopathy for weed suppression under field conditions.

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