ALLELOPATHY: HOPE OF HYPE?

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<u>Abstract</u>

Rye has been regularly used as a cover crop/mulch in a number of crop production systems. Rye mulch has been shown to simultaneously increase soil organic matter and reduce erosion. When sufficient biomass is achieved, rye mulch suppresses weeds by serving as a physical barrier to emergence and by inhibiting germination through reduced light transmittance and, purportedly, allelopathy.

Many of the studies conducted to assess the alleopathic potential of rye against weeds have used young, green, living, greenhouse-grown tissue as a source of chemical extracts. Few studies have quantified the suppressive potential of rye tissue grown under natural conditions and at a number of development stages; this includes rye that has naturally senesced or has been chemically killed in the field prior to spring crop planting. Results from studies that do exist at highly variable and often difficult to compare because of differences in: initial extract concentration, individual seed dose, seed size, rye developmental stage, etc. The usefulness of rye as a 'natural herbicide' would be supported if its allelopathic activity is maintained during the peak germination period of spring and/or summer annuals, like Palmer amaranth. The objective of this study is to evaluate the inhibitory effects of field grown rye, collected throughout the growing season on Palmer amaranth and cotton seed germination.

Experiment 1: Senescent rye (Wrens Abruzzi) was harvested from The Jones Farm in Tifton, GA in spring of 2010. Samples were dried in an oven for 3 days at 60 C. 10 g of tissue was extracted for 24 hr in 300 ml of dH2O (1:30 wt:vol), ground in a blender, filtered and diluted to create 0.5 and 0.25 X strength solutions. A control (0% extract, dH2O) was also included for comparison. Five replications of 20 palmer amaranth seeds, each, were placed between 2 layers of Anchor brand filter paper in 90 mm diameter Petri dishes. 10 ml of extract was added to each plate and the dishes were held at a 90 degree angle (at 30 C and in the dark) to promote geotropism. Germination, as well as hypocotyl and radicle extension, was measured after 3 d. The study was replicated twice in time. Although the 25% and 50% extracts reduced Palmer seed germination 7 and 24%, respectively, relative to the non-treated control (0%) (Fig. 1a), radicle and hypocotyl growth of the germinated seedlings actually increased when extracts were applied (Fig. 1b). These results are in disagreement with several other studies which showed that root and shoot growth were more sensitive to the activity of inhibitory secondary plant products, whereas germination was not

Experiment 2: Rye (Wrens Abruzzi) was grown in Ty Ty, GA, in 2010-2011, and harvested at 3 growth stages (tillering, stem elongation, and heading). Samples were harvested at 50 C for 4 day in an oven. 10 g of tissue was extracted for 24 hr in 100 ml of dH2O (1:10 wt:vol), ground in a blender, filtered and diluted to create 1, 0.5, 0.25, 0.125 and 0.0625 X strength solutions. A control (0% extract, dH2O) was also included for comparison. Five replications of 25 Palmer amaranth seeds (in 2 ml of extract, in 47 mm diameter Petri dishes on cellulose pads) and 10 cotton seeds (in 4 ml of extract, in 90 mm diameter Petri dishes on Whatman filter paper) The dishes were incubated at 25 (cotton) and 30 C (Palmer) and germination evaluated for 7 days. The study was replicated twice. In general: 1) cumulative germination of both species decreased with increased extract concentration, relative to the non-treated control; 2) younger rye tissue (V3-V5) was more inhibitory than more mature tissue (V 10.5); and 3) large-seeded cotton was less affected by rye extracts than small-seeded palmer amaranth (Fig. 2a and 2b). Similar results have been reported by other authors in the literature, such as Burgos and Talbert (2000) Weed Sci.48:302-310 and Reberg-Horton et al. (2005) J. Chem.Ecol. 31: 179-193.

Our initial results suggest that rye can be inhibitory, but when extract concentrations are extremely high and when fresh, young tissues are used, (under laboratory conditions) – instances which may not occur in real world settings. Allelopathy is notoriously difficult to study. Bioassays may be limited in their abilities to accurately estimate the toxicity of plant residues. Greenhouse studies, while easy to initiate, don't account for the effects of

microorganisms, plant stress, weather, and other environmental conditions that influence the production, uptake, metabolism, and degradation of allelochemicals. Conversely, it can be difficult to evaluate the activity of complex secondary plant products in field studies. Although rye is useful for managing weeds, it has not been proven, conclusively, that allelopathy, independent of physical suppression, has played a substantial role.



Figure 1a. Palmer amaranth seed germination in response to varying concentrations of rye extract.



Figure 1b. Palmer amaranth root and shoot extension in response to varying concentrations of rye extract.



Figure 2a. Palmer amaranth germination in response to varying concentrations of rye extract harvested from plants of increasing age and phonological development.



Figure 2b. Cotton germination in response to varying concentrations of rye extract harvested from plants of increasing age and phonological development.