GIANT RAGWEED RESPONSE TO TILLAGE AND MANAGEMENT

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Introduction

Giant ragweed is a challenging weed species to manage in many cropping systems due to its extended period of emergence, rapid growth rate, and high degree of competitiveness with crop species. Giant ragweed has become increasingly prevalent in glyphosate-resistant cropping systems, possibly due to later-emerging plants which avoid exposure to glyphosate. A study conducted in the late 1960's found that nearly all giant ragweed emerged before May 1 in central Illinois (Stoller and Wax 1973). This early emergence suggested that giant ragweed populations could be effectively managed by preplant tillage or other preplant weed management practices. However, recent research has found relatively late emergence of giant ragweed, with emergence of some biotypes occurring throughout June (Hartzler et al., 2002), potentially later than the timing of post-emergence herbicide applications.

Research has been underway at the University of Wisconsin since 1998 to determine the long-term effects of crop rotation, primary tillage system, and glyphosate use intensity on weed population dynamics in glyphosate-resistant corn and soybean cropping systems (Stoltenberg 2002). Assessment of weed community composition after 6 yr indicated that giant ragweed had become the dominant weed species in several treatments and had increased in abundance in several other treatments (Jeschke and Stoltenberg 2003). The objective of this analysis was to characterize long-term giant ragweed population dynamics in glyphosate-resistant corn and soybean as affected by crop rotation, tillage system, and glyphosate-use intensity.

Methods

Research was conducted at the University of Wisconsin Arlington Agricultural Research Station from 1998 through 2004. Six weed management treatments were compared in continuous corn and a corn-soybean annual rotation, and in three primary tillage systems, moldboard plow, chisel plow, and no-tillage:

GLY:	Glyphosate applied post-emergence (POST) at 0.75 lb ae/A
GLY + GLY:	Glyphosate applied POST at 0.75 lb ae/A and late post-emergence (LPOST) at 0.75 lb ae/A
GLY + CULT:	Glyphosate applied POST at 0.75 lb ae/A plus inter-row cultivation (CULT) in corn only
GLY // NON-GLY:	Glyphosate applied POST at 0.75 lb ae/A rotated annually with a non-glyphosate herbicide program
NON-GLY:	Non-glyphosate herbicide program
NON-GLY PRE + GLY:	Non-glyphosate grass herbicide applied pre-emergence (PRE) plus glyphosate applied POST at 0.75 lb ae/A

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The experimental design was a randomized complete block in a split-split-block arrangement with three replications. The main plots were factorial combinations of tillage and crop rotation treatments, and the subplot factors were weed management treatments.

Soil type was Plano silt loam with pH 5.8 and 4.1% organic matter. Primary tillage was conducted during the Fall of each year. The seedbed was prepared shortly before planting with a field cultivator/straight-tooth harrow in moldboard plow and chisel plow systems. Corn and soybean were planted in 1998, 2000, 2002 and 2004, whereas corn only was planted in 1999, 2001, and 2003. Glyphosate-resistant soybean was drilled in early May at 250,000 seeds/A in rows spaced 7.5-inches apart. Glyphosate-resistant corn was planted in late April or early May at 32,000 seeds/A in rows spaced 30-inches apart. For corn, 150 lb/A N were applied pre-plant and 150 lb/A 6-24-24 was applied as starter fertilizer at planting. Corn and soybean were harvested by machine for grain yield.

Plots were maintained in the same location and received consistent treatments over the duration of the experiment. Plot size was 20-ft wide by 40-ft long. The soil weed seedbank was sampled each spring. Giant ragweed seeds were quantified from 30 soil cores taken from the upper 4 inches of the soil profile in each plot. Sixteen micro-plots (each 10 inches by 10 inches) were established within each plot for measuring weed plant density. Giant ragweed plant density was measured immediately before POST herbicide application, after LPOST herbicide applications, after crop pollination, and before crop harvest.

Results

Giant ragweed occurrence was rare in sampled areas when this experiment was established in 1998 (Figures 1 and 2). However, by 2001, giant ragweed was abundant in several treatments, with the highest plant densities measured in non-glyphosate based treatments in the chisel plow system, more so in continuous corn than corn-soybean rotation. In subsequent years, giant ragweed density increased in some glyphosate-based treatments as well, but was limited mostly to the chisel plow system. Systems with high giant ragweed plant densities showed corresponding increases in giant ragweed seedbank density (Figures 3 and 4). By 2004, average giant ragweed seedbank density in the continuous corn, chisel plow system was nearly 1000 seeds/m^2 (93 seeds/ft^2), whereas seedbank densities in all other systems were less than 250 seeds/m^2 (23 seeds/ft^2), including some weed management treatments in which giant ragweed seedbank density was near zero.

Giant ragweed plant densities were low for all weed management treatments in the corn-soybean rotation in both moldboard plow and no-tillage systems (Figure 2). Across crop rotation and tillage systems, giant ragweed densities were lowest for glyphosate applied POST/LPOST among weed management treatments. This was attributed to the high degree of efficacy of the glyphosate POST/LPOST treatment on late-emerging giant ragweed, including both plants in and between crop rows, relative to other treatments. In the chisel plow, continuous corn system, giant ragweed densities increased over the last 3 yr of the experiment in weed management treatments with a single POST application of glyphosate (Figure 1). Reduced efficacy of glyphosate on giant ragweed was not apparent (data not shown), therefore, it is likely that plants that survived in these treatments emerged following the POST application. The contrast in giant ragweed densities between the glyphosate POST treatment and glyphosate POST/LPOST treatment illustrates the importance of an extended period of effective management of this species. The rapid increase in giant ragweed densities between 1998 and 2001 in non-glyphosate based treatments was attributed to lower efficacy of herbicides included in this treatment compared to the efficacy of glyphosate in other treatments. Beginning in 2002, the non-glyphosate treatment

included herbicides with greater efficacy on giant ragweed. By 2004, late-season giant ragweed density was relatively low for this treatment.

Summary

Giant ragweed established relatively rapidly, and become the dominant weed species in some crop-weed communities. Lower densities of giant ragweed in the corn-soybean rotation relative to the continuous corn system were likely due to greater early-season competition in narrow-row soybean (Burnside and Colville, 1964) than in corn. The greater apparent affinity of giant ragweed for the chisel plow system relative to moldboard plow and no-tillage systems was attributed to a greater proportion of giant ragweed seeds at optimal soil depths for germination, emergence, and early growth (Cousens and Moss, 1990). Giant ragweed emergence rates have been found to be greatest at a seed burial depth of about 1 inch, although emergence can occur from as deep as 6 inches (Abul-Fatih and Bazzaz, 1979). Emergence rates are typically very low within the upper 0.5-inch of the soil profile (Abul-Fatih and Bazzaz, 1979), where a large proportion of the weed seedbank is found in no-tillage systems (Mulugeta and Stoltenberg, 1997). In contrast, the weed seedbank tends to be concentrated near the bottom of the plow layer in moldboard plow systems, below the depth for optimal emergence. Consequently, weed management risks for giant ragweed were lowest for the moldboard plow and no-tillage systems in corn-soybean rotation.

Giant ragweed emergence over extended periods of time was likely a critical factor affecting its population dynamics and management in the chisel plow system. Late emerging plants have the potential to be competitive with crops due to their rapid growth and high photosynthetic rate (Harrison et al. 2001). The lowest giant ragweed densities over time in the chisel plow system were associated with weed management treatments that provided effective management of late-emerging plants.

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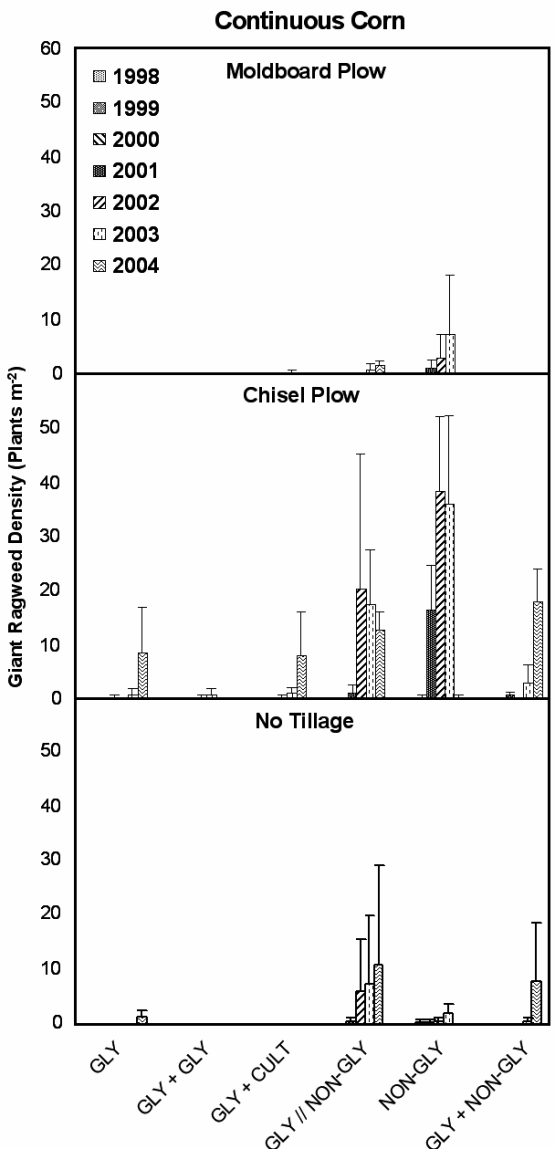

Figure 1. Late-season giant ragweed plant density in continuous corn.

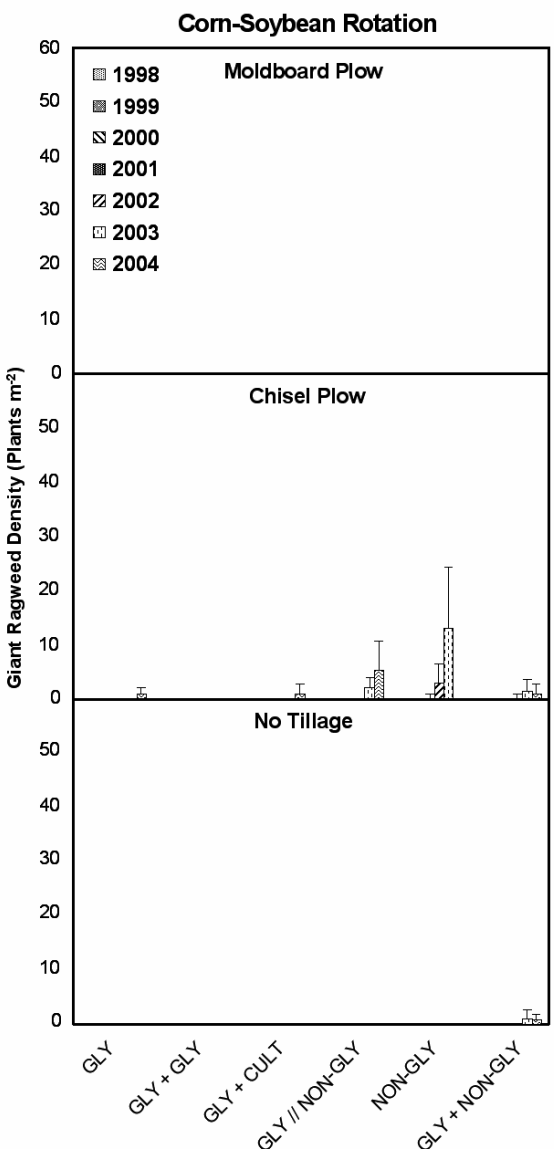

Figure 2. Late-season giant ragweed plant density in corn-soybean rotation.

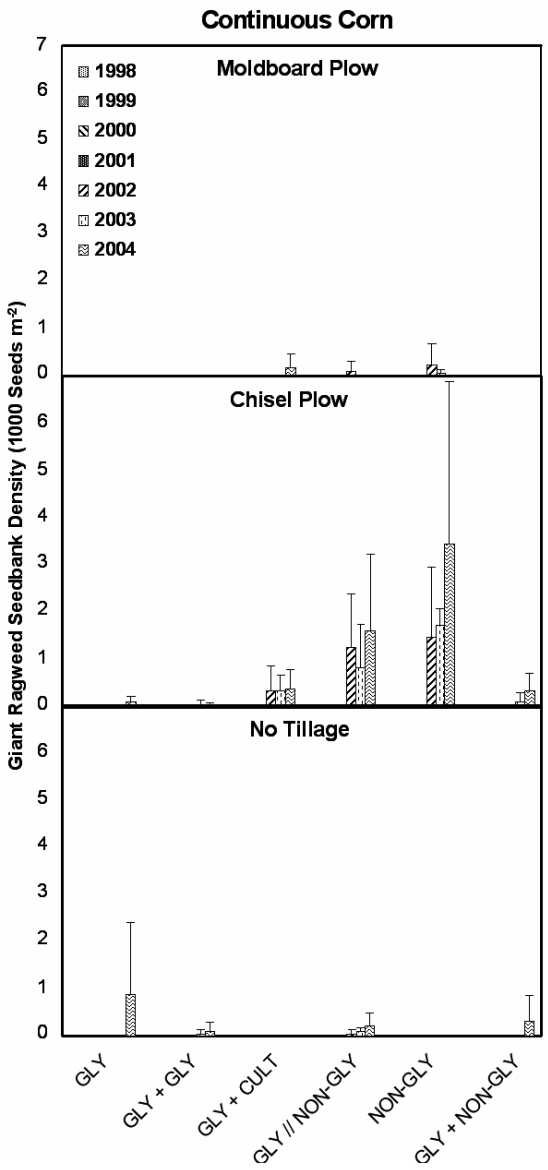

Figure 3. Giant ragweed seedbank density in continuous corn.

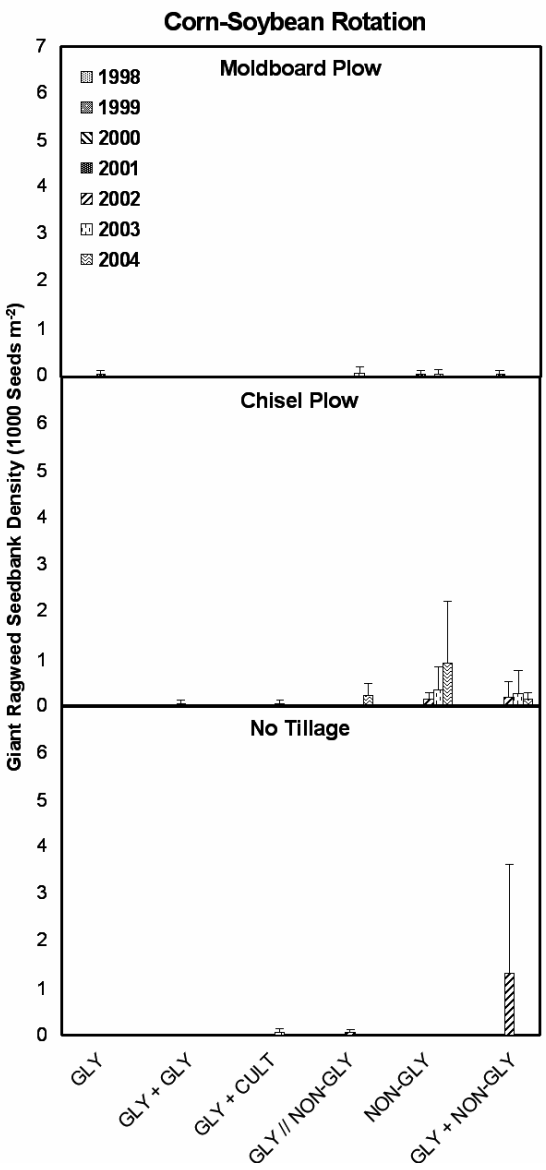

Figure 4. Giant ragweed seedbank density in corn-soybean rotation.