Emergence Patterns of Giant Ragweed (*Ambrosia trifida*) in Various Crops and Crop Rotations

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Introduction

In the Midwest, biotypes of giant ragweed (*Ambrosia trifida*) resistant to multiple herbicide sites of action have been identified. Weeds with multiple herbicide resistance reduce the efficacy of existing herbicides and necessitate the development of alternative weed control strategies. With the increasing prevalence of herbicide-resistant giant ragweed, integrated methods of weed control are needed. From 2012-2014 in southern Minnesota, we determined the effect of six crop rotations containing corn, soybean, alfalfa, and wheat on the level and patterns of giant ragweed emergence to determine the effect these crops have on managing herbicide resistant giant ragweed.

Materials and Methods

- This research took place in 2012-2014 near Rochester, MN, on a site with giant ragweed resistant to ALS and glyphosate herbicide chemistries.
- Experiment had 6 crop rotation sequences (Table 1) applied in a randomized complete block design with four replications. Crops were managed using University of Minnesota recommendations and ensured that no giant ragweed seed production occurred during the course of the study.
- Giant ragweed seed-bank density was sampled from 3 quadrats 0.081 m^2 per plot 15cm deep at the beginning and end of the study. Samples were wet sieved and seeds were sorted by potential viability and counted.
- Giant ragweed emergence was monitored on a weekly basis by pulling emerged seedlings. Counts started at the onset of emergence and continued for 10 weeks. Emergence was monitored in 6 0.23m^2 quadrats in each plot.
- Although this data has yet to be included in analysis, soil moisture and temperature was monitored using soil temperature probes on an hourly basis and by soil sampling weekly to determine gravimetric water content.

Year	Crop Rotation					
	1	2	3	4	5	6
2012	Corn	Soybean	Corn	Soybean	Soybean	Alfalfa
2013	Corn	Corn	Soybean	Wheat	Alfalfa	Alfalfa
2014	Corn	Corn	Corn	Corn	Corn	Corn

* Corn is SmartStax ** Soybean is Liberty Link *** Alfalfa is Roundup Ready

Table 1: Crop rotation treatments each year of the study.

Results and Discussion

Seed-Bank

- Initial giant ragweed seed-bank density was highly variable across the study site, with densities ranging from 4 to 128 seeds m^{-2} (Figure 1A).
- Between 2012 and 2014, 95.6% ± 1.6% of the giant ragweed seed-bank was depleted, with final densities ranging from 0 to 8.6 seeds m^{-2} (Figure 1B).
- There were no differences in the level of seed-bank depletion among the 6 crop rotation treatments.
- Treatments 4-6, which contained wheat and alfalfa in the rotation, generally had lower levels of giant ragweed emergence (Figures 2A&B) while experiencing the same level of depletion, indicating increased seed degradation in these treatments.

Total Emergence

- Giant ragweed emergence differed significantly between years ($p<0.0001$), with an average of 58.39 and 3.86 seedlings m^{-2} emerging in 2013 and 2014, respectively.
- Due to the high level of seed-bank variability, emergence among treatments was evaluated as a proportion of the initial seed-bank estimate (Figure 1A). In 2013, the greatest level of emergence was in treatment 2, where corn was planted following soybean. In treatments 1 and 3, which are corn on corn, and soybean following corn, respectively, there was an intermediate level of emergence. Treatments 4-6, which are wheat following soybean, alfalfa following soybean, and second year alfalfa, had a low level of emergence (Figure 2A). This low level of emergence was likely due to the earlier establishment of these crops, which affected the soil environment in a way that prevented germination. The lack of tillage in the wheat and alfalfa treatments in the previous fall or the spring of 2013 likely prevented seedlings from emerging deeper within the soil, thus reducing the total number of seedlings emerged.
- In 2014, treatment 3, which was corn following soybean, had the largest level of emergence. This was the same crop combination as treatment 2 in 2013, which experienced the largest level of emergence in 2013 (Figure 2A&B). This is likely due to a soil environment more conducive for germination in soybean stubble.

Results and Discussion (continued)

Emergence Patterns

- Emergence patterns differed between 2012 and 2013 (Figure 2), with emergence occurring slightly earlier in 2013 (Figure 3). Fifty percent of total giant ragweed emergence occurred at the 141 and 146 DOY in 2013 and 2014, respectively (Table 2).
- In 2013, the emergence patterns in each of the crop rotation treatments differed slightly (Figure 4). Treatment 6, which was established alfalfa, showed a more gradual emergence pattern, with a larger percentage of seedlings emerging earlier and extending longer in the spring in comparison with other treatments (Figure 4).
- Differences in emergence patterns are likely due to differences in the soil environment, which differed in soil temperature and moisture in each of the treatments, but have yet to be further analyzed (Figure 4).

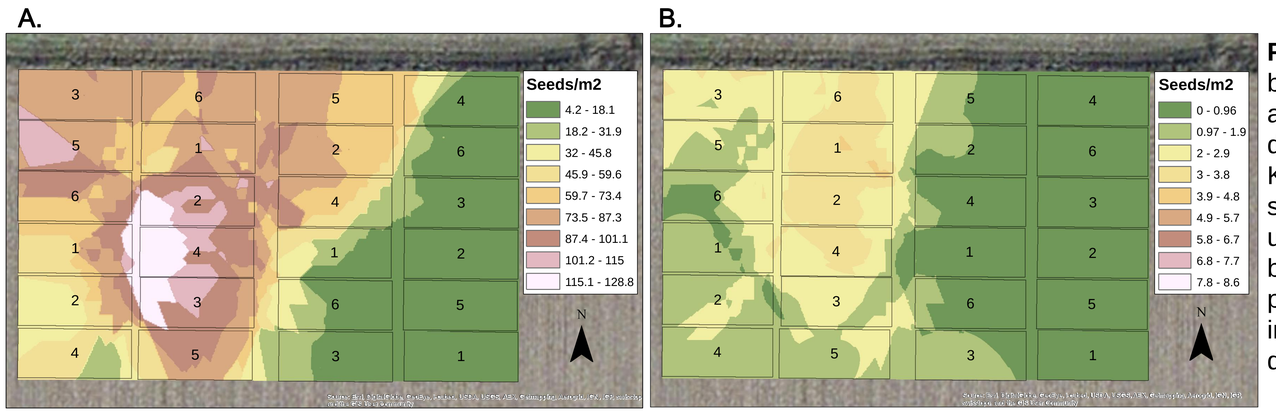

Figure 1: Starting seed-bank density in 2012 (A) and final seed-bank density in 2014 (B). Kriging method of spatial interpolation was used to interpolate between sampling points. Numbers on map indicate treatment (Note differences in scale)

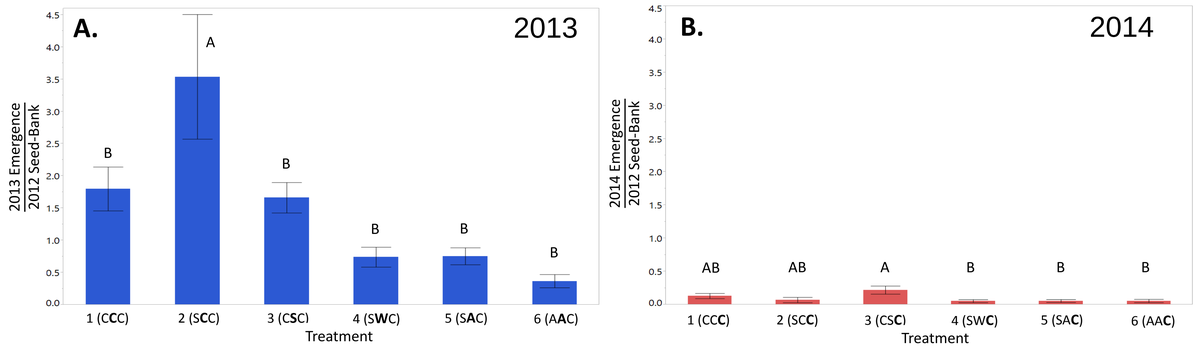

Figure 2: Relative giant ragweed emergence in 2013 (A) and 2014 (B). Emergence is expressed as a proportion of the initial seed-bank density estimate taken in 2012. Different letters signify statistical significance at the 0.05 level using Tukey's HSD test. Shown with standard error bars.

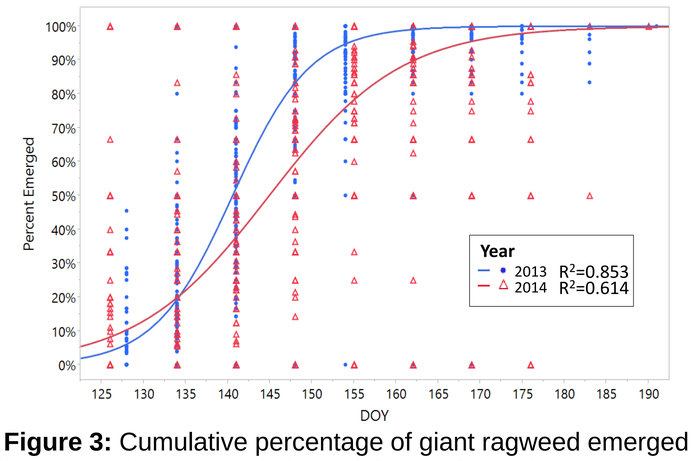

Figure 3: Cumulative percentage of giant ragweed emerged in 2013 and 2014. Logistic models are shown for each year.

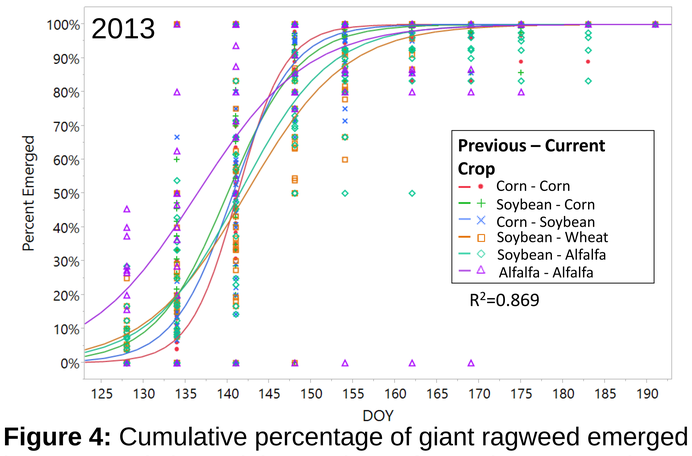

Figure 4: Cumulative percentage of giant ragweed emerged in 2013. Logistic models are shown for each treatment in 2013, the second year of each crop rotation treatment.

Table 2: Day of year (DOY) when 50% and 95% emergence occurred in each treatment in 2013 and 2014. Asterisks represent DOY of treatments within each year that differ significantly at a 0.05 level.

	Days to 50% Emergence		Days to 95% Emergence	
Treatment	2013	2014	2013	2014
1 (CCC)	141 May 21	146 May 26	150* May 28	165 Jun 14
2 (SCC)	140 May 20	145 May 25	153 Jun 3	169 Jun 19
3 (CSC)	141 May 21	148 May 28	151 May 29	166 Jun 15
4 (SWC)	142* May 22	146 May 26	160* Jun 9	160 Jun 9
5 (SAC)	141 May 21	141* May 21	158* May 28	165 Jun 14
6 (AAC)	136* May 16	148 May 28	156 May 28	172 Jun 21
Average	141* May 21	146* May 26	154* Jun 3	166* Jun 15

Conclusions

- Emergence is highly variable among years and crop rotation treatments. Lower levels of emergence occurred in wheat, seedling alfalfa, and established alfalfa, and emergence was prolonged in established alfalfa. These differences are likely due to less conducive soil conditions for emergence in wheat and alfalfa than in corn or soybean systems.
- Herbicide-resistant giant ragweed infested fields can be managed by utilizing various crop rotations in addition to strategic timings of mechanical and chemical weed control options. These can be included as part of an integrated weed management plan directly targeting early emerging weeds.

Acknowledgements

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