Common ragweed (*Ambrosia artemisiifolia*) confirmed ALS inhibitor-resistant in Brown County, Wisconsin

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Introduction:

Common ragweed (*Ambrosia artemisiifolia* L.) is a summer annual broadleaf weed species native to North America. It has become commonplace in agricultural production fields due to several competitive advantages over crops such as its ability to reach heights of 1.5 m (5 ft) and an early germination preference (Bryson and DeFelice, 2010). Due to these competitive advantages, yield reductions of 70% and 62% were observed in corn and soybean, respectively (Coble et al., 1981; Weaver, 2001). Furthermore, common ragweed can produce over 32,000 seeds plant^{-1} increasing the likelihood of seed transfer and survival (Dickerson and Sweet, 1971). Additionally, common ragweed has led to human health concerns such as allergic reactions and hay fever due to the high-volume pollen production (Ziska and Caulfield, 2000).

Common ragweed control presents several challenges. It has an inherent tolerance to defoliation (Gard et al., 2013; MacDonald and Kotanen, 2010) and has developed herbicide resistance to four sites-of-action across 19 states (Heap, 2014). Until now, Wisconsin had no confirmed occurrence of herbicide-resistant common ragweed; however, herbicide-resistant populations have been identified in neighboring states of Illinois, Michigan, and Minnesota (Heap, 2014; Patzoldt et al., 2001). In 2012, the *Late-Season Weed Escape Survey in Wisconsin Corn and Soybean Fields* was initiated. One of the main objectives of this research was to identify herbicide-resistant weed species in Wisconsin and begin proactively educating growers about herbicide resistance management.

Materials and Methods:

The survey identified fields containing potential herbicide-resistant weeds through grower communication, field history, and in-field sampling. To confirm herbicide resistance, seed from 25 mature plants was collected in situ for use in whole-plant herbicide-dose response bioassays.

Materials and Methods continued:

The Brown County common ragweed population was screened for acetolactate synthase (ALS) inhibitor resistance. Seedlings were established and grown under greenhouse conditions. Eight plants per herbicide rate plus labeled adjuvants were sprayed when plants were four inches tall. An ALS-inhibiting herbicide, cloransulam-methyl (FirstRate®), was sprayed at rates of 0, 0.0018 (0.03), 0.018 (0.3), 0.18 (3.0), 1.8 (30), and 9.0 (150) kg ai ha^{-1} (oz ac^{-1}). Plant dry biomass data were collected 28 days after application. Data were converted to percent reduction, and nontreated plants were standardized to 100%. Analysis was conducted using the dose-response model package in R statistical software. Comparisons between our putative resistant and susceptible biotypes were determined by the effective herbicide dose that reduced plant dry biomass by 75% (ED_{75}) at $\alpha=0.1$ (Knezevic et al., 2007).

Results and Discussion:

The Brown County common ragweed population exhibited resistance to cloransulam-methyl. Ninety-four percent of plants treated with 0.018 kg ai ha^{-1} (0.3 oz. ac^{-1}) survived and grew four-fold in height by 28 days after treatment (Figure 1). At the 0.18 kg ai ha^{-1} (3 oz. ac^{-1}) rate, 78% survived and grew three-fold in height. Cloransulam-methyl ED_{75} values for the Brown County and susceptible populations were 1.194 and 0.003 kg ai ha^{-1}, respectively (Figure 2). This indicated a 416-fold level of ALS-inhibitor resistance ($P=0.083$) in the Brown County population. Additionally, dry shoot biomass was greater for the Brown County than susceptible populations at all cloransulam-methyl rates except the nontreated control (Table 1).

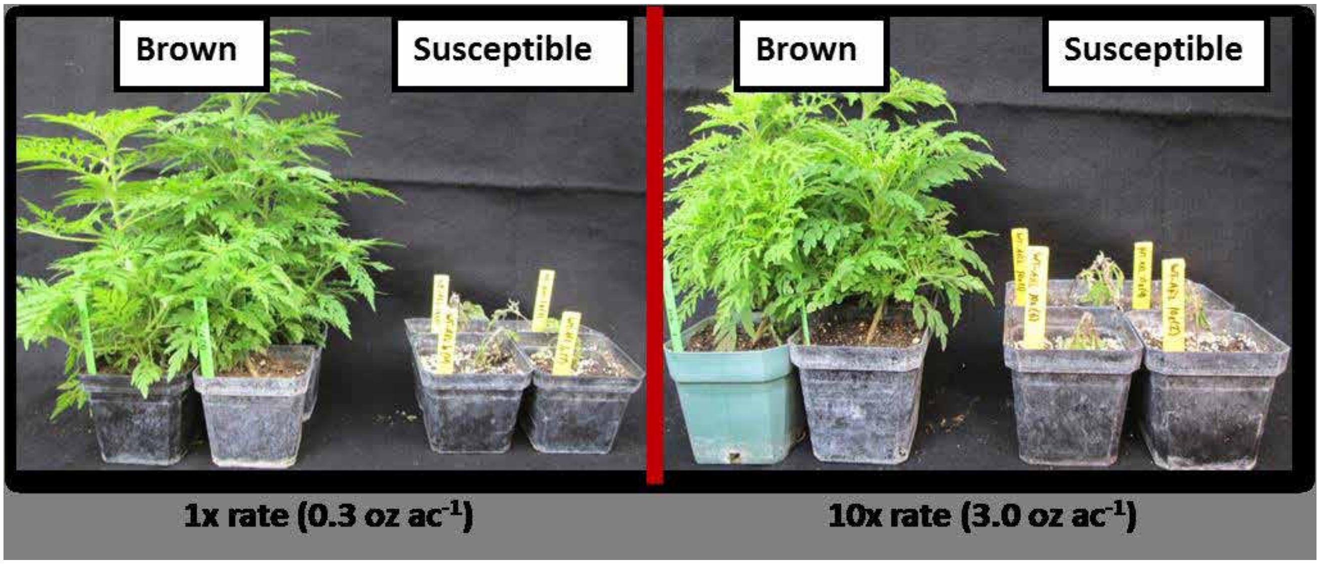

Figure 1. Comparison of four Brown County common ragweed and susceptible plants at the 1x (left) and 10x (right) rate of cloransulam-methyl 23 days after application.

Table 1. Mean comparison of plant shoot dry biomass between the Brown County (putative resistant) and susceptible common ragweed populations at each cloransulam-methyl rate 28 days after treatment. Means are shown in Figure 1.

Significance of mean comparison between populations					
	Cloransulam-methyl rate (kg ai ha^{-1})				
	0	**0.0018**	**0.018**	**1.8**	**9.0**
Significance	**NS**	****	****	*	**

NS, not significant., *Significant at the P=0.10 probability level, **Significant at the P=0.05 probability level, ***Significant at the P=0.01 probability level, ****Significant at the P=0.001 probability level.

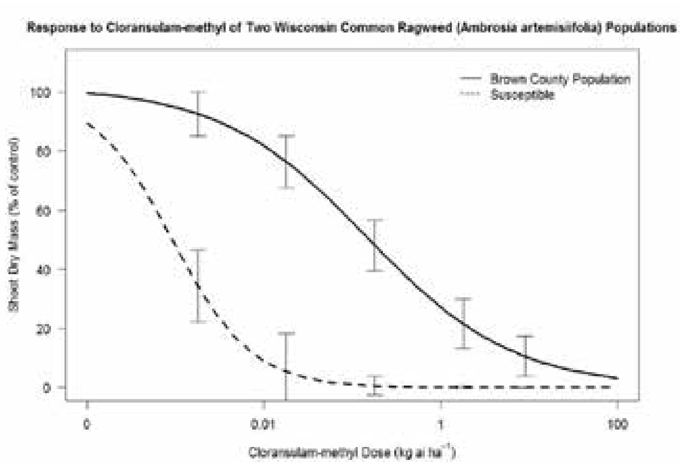

Figure 2. Cloransulam-methyl dose-response models for Brown County (putative resistant) and susceptible common ragweed (Ambrosia artemisiifolia L.) populations 28 days after treatment. A three parameter log logistic function was used for analysis.

Conclusions:

These results confirm the first occurrence of ALS inhibitor-resistant common ragweed in Wisconsin. The population was initially identified in Brown County in 2013.

Several components are key to a comprehensive, effective control strategy to combat herbicide-resistant weeds. The use of alternative herbicide sites-of-action and tank-mixing multiple herbicide sites-of-action will improve herbicide-resistant weed control. An early planting date, coupled with the use of a preemergence residual herbicide program, will allow crops to gain a competitive advantage over weeds. All herbicides should be applied at the correct timing, and in particular postemergence herbicide applications should occur when weeds are small and actively growing.

To ensure the greatest efficacy, consult the herbicide label recommendations to ensure application before maximum weed size limits and to use appropriate rates. Furthermore, special care should be used to clean tillage and harvest equipment thoroughly as they can quickly spread weed seed among fields. The focus of these best management practices is to diversify weed control methods, reduce weed seed additions to the soil seedbank, and utilize the most effective methods possible.

For updates on Wisconsin weeds please visit the Wisconsin Crop Weed Science website at http://wcws.cals.wisc.edu/. Further information on controlling Palmer amaranth or other herbicide-resistant weeds can be found at: http://www.takeactiononweeds.com/. Finally, if you believe you may be facing herbicide-resistant weeds in your fields, please contact your local county extension agent.

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