

Response of Selected Indiana Horseweed Populations to Glyphosate Rates

Vince M. Davis, J. Earl Creech, and William G. Johnson

Introduction

Glyphosate resistant (GR) horseweed (*Conyza canadensis*) has become an important weed problem in many states. However, few studies have reported levels of glyphosate tolerance for different populations collected within a state. We surveyed 782 sites throughout Indiana in 2003 (Figure 2) to determine the distribution of GR horseweed. From the sites, 392 samples of horseweed were collected, and 203 showed some level of glyphosate tolerance screened with a 2X rate (1.73 kg ae ha⁻¹) glyphosate. Samples demonstrating < 60% visual control rating were classified GR. Somewhat tolerant samples demonstrated 60 to 85% control, and susceptible samples > 85% control. Statewide screening results, and a more detailed county map is in figure 2.

Objectives

- Develop glyphosate dose response relationships to determine I₅₀'s and R:S ratios for selected horseweed populations.

- Determine validity of using a single rate, discriminating dose technique to confirm glyphosate resistance.

Materials and Methods

A greenhouse experiment was conducted in the fall 2004 to evaluate the response of 21 horseweed populations to different glyphosate rates. Of the 21 populations, four were known susceptible control populations and four were known GR control populations. The remaining of populations were selected based on a range of tolerance to glyphosate from a discriminating dose screen conducted in the spring of 2004. Experimental design was a randomized complete block with a factorial arrangement of eight glyphosate rates and 21 horseweed populations replicated three times. Glyphosate rates evaluated were 0, 0.22, 0.43, 0.86, 1.72, 3.45, 6.90, and 10.35 (kg ae ha⁻¹). The 1X rate is 0.86 (kg ae ha⁻¹) Glyphosate applications were applied in a hooded spray chamber at 187 L ha⁻¹. Daytime and nighttime greenhouse temperatures were 27° and 14° C respectively. Visual control ratings were determined at 21 DAT with 0 as no apparent reduction in biomass and 100 is plant death. Control data at the 1.72 (kg ae ha⁻¹) rate were subjected to analysis of variance and means were separated with Fisher's Protected LSD at the 0.05 level. Data from all treatments were subjected to the non linear regression model proposed by Seefeldt et al. (1995). The expression relating response y to dose x is

$$y = C + \frac{D - C}{1 + (x/I_{50})^b}$$

where C = lower limit, D = upper limit, b = slope, and I₅₀ = the herbicide dose giving 50% injury.

Table 1. Relative ranking of horseweed populations based on percent control of a 2X glyphosate screen. The control values are based on visual ratings at 21 DAT. I₅₀ values are based on a range of (0.25X, 0.5X, 1X, 2X, 4X, 8X, and 12X) glyphosate application rates, and the color symbols can be used to compare with relative ranking based on I₅₀ values in figure 1.

Population number	Control %	I ₅₀ ^b kg ae ha ⁻¹	R:S ^c
90 ³	100	0.43	1 ● S
397 ^a	99	0.20	1 ● S
395	99	0.42	1 ● S
280	99	0.17	1 ● S
30	66	1.52	5 ● T
7056 ^a	57	1.95	6 ● R
79	55	1.41	5 ● R
404 ^a	54	1.51	5 ● R
307	53	1.79	6 ● R
281	53	1.68	6 ● R
130	47	2.20	7 ● R
499 ^b	43	1.78	6 ● R
394	42	3.96	13 ● R
73	42	2.96	10 ● R
366	40	3.60	12 ● R
69	38	2.29	8 ● R
25	27	5.02	16 ● R
356	23	2.43	8 ● R
260	20	7.53	25 ● R
184	15	2.45	8 ● R
396	15	4.07	13 ● R
LSD	(36)	-	-

^aHorseweed populations used as controls
^bR:S values were determined by pooling I₅₀ values for all susceptible populations.
^cI₅₀ values calculated using Seefeldt's model

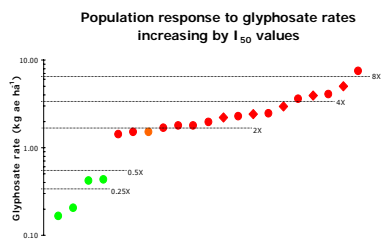


Figure 1. Relative ranking of horseweed populations based on I₅₀ values. Green circles are glyphosate susceptible (>85% control), orange circles are tolerant (60-85% control), red circles are glyphosate resistant (<60% control) separated by one standard deviation by analysis of variance and red diamonds are glyphosate resistant and separated by two standard deviations.

Glyphosate resistant and susceptible horseweed populations collected less than 250 meters apart

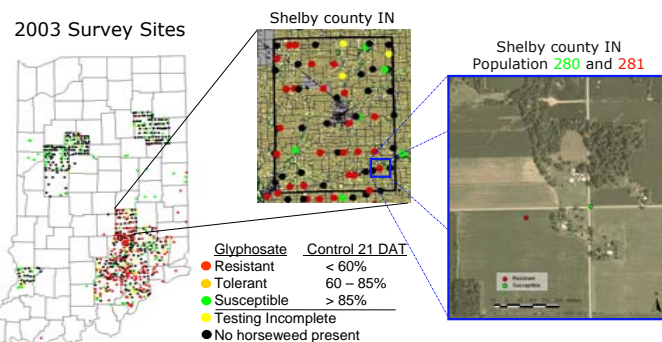


Figure 2. Initial glyphosate screening results for Shelby county Indiana. Enlarged view from Shelby county shows the geographically closest resistant (281) and susceptible (280) populations screened thus far. Samples were separated by less than 250 meters.

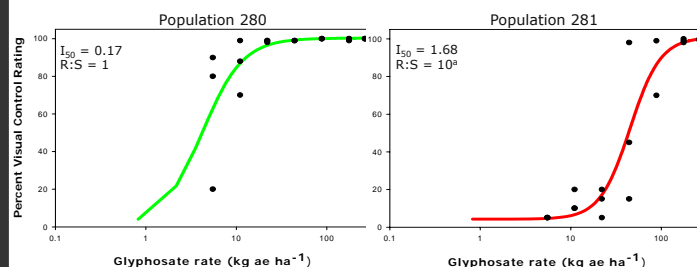


Figure 3. Dose response curves for horseweed populations 280 and 281 and their respective images with all eight glyphosate rates of one replication. Dose response curves were prepared with SigmaPlot v. 9.

Conclusions

- Use of a single rate, discriminating dose of glyphosate is an accurate technique for confirmation of R and S populations. Correlation between I₅₀ values from dose response equation and percent control with a 2X rate was 0.89.
- Indiana population 260 demonstrated 25 fold resistance (R:S = 25) using pooled susceptible I₅₀ values and is the highest resistance ratio in horseweed reported thus far.
- Populations very close in geographic proximity can be quite different in glyphosate tolerance. Population 280 and 281 showed ten fold differences in glyphosate tolerance, but were separated by less than 250 meters.

Literature Cited

Seefeldt, S. S., J. E. Jensen, and E. P. Fuerst. 1995. Log-logistic analysis of herbicide dose-response relationships. Weed Tech. 9:218-227.