

# Evaluation of Garlic Mustard Control with Spring and Fall Herbicide Application

## Introduction

Garlic mustard is a highly aggressive, non-native biennial herb that has colonized the deciduous woodland forest floor of North America. It is an effective competitor in these areas and can displace native vegetation. Hardwood forests are of greatest concern as garlic mustard can interfere with the formation of mycorrhizal associations that these saplings are dependant upon for regeneration of forests. In the upper Midwest garlic mustard first germinates in April forming rosettes throughout the summer that persist through the winter. Rosettes that survive the winter flower the following May. While herbicides have been evaluated for managing garlic mustard, studies have primarily evaluated the effectiveness of glyphosate and found it to be effective at controlling garlic mustard plants in the second year when applied in late fall, early spring and at primary bolting. However, control was not as effective at all of these timings at controlling seedlings. Thus even if treatments are effective, management would be required annually until the seedbank was depleted or competitive species establish to prevent germination. Limited information is available as to the effectiveness of other herbicides in controlling both seedlings and 2nd year garlic mustard plants.

## Objective

The objective of this study is to evaluate the effectiveness of various herbicide treatments in reducing cover of 2nd year and seedling garlic mustard plants as well as evaluate the effectiveness of applications in preventing seed production the summer after treatments.

**Figure 1:** Phenological growth stages of garlic mustard at various treatment application timing in Green Bay, Sparta, Postville



**Table 1:** Garlic mustard (ALAPE) treatment response at rosette stage in early spring at 89 DAA in Green Bay

Treatment	Rate	ALAPE seedling	ALAPE 2 <sup>nd</sup> year	Grams of seed/ m <sup>2</sup>
		-----% cover-----		
Plateau <sup>a</sup>	6 fl oz/a	0.0 CD	0.2 B	0.0 B
Journey <sup>a</sup>	16 fl oz/a	0.2 CD	0.3 B	0.0 B
Oust <sup>b</sup>	0.5 oz/a	0.3 CD	1.2 B	0.033 B
Escort <sup>b</sup>	0.5 oz/a	1.3 B	1.0 B	0.0 B
Sureguard <sup>b</sup>	3 oz/a	10.0 AB	5.2 B	0.553 B
Roundup <sup>b</sup>	22 fl oz/a	18.3 A	5.8 B	0.553 B
Untreated		10 AB	49.0 A	5.706 A

Means within column followed by the same letter are not significantly different (P<0.05)

a -MSO added to the treatment at the rate of 32 fl oz/a  
b -NIS added to the treatment at the rate of 0.25% V/V

## Materials & Methods

Field studies were conducted in Green Bay, Sparta and Postville in 2007. At each site, distinct phenological stages of garlic mustard were present (Figure 1), with rosettes present in the spring Green Bay site, plants just beginning to produce a stem (early bolting) at the Sparta site, plants with visible stems expanding (late bolting) at the Postville site, and only fall rosettes present at the fall Green Bay site. Experiments were designed as randomized complete block with 3-5 replications. At all sites treatments were broadcasted using a CO<sub>2</sub> backpack sprayer at 15 gallons per acre to plots that ranged between 7 – 10 ft wide and 20-30 ft long. All data were analyzed by analysis of variance (ANOVA) using SAS PROC GLM at each site separately. Data were transformed to meet the normality and homogeneity variance assumptions of ANOVA and means were separated using Tukeys (P <0.05).

## Results

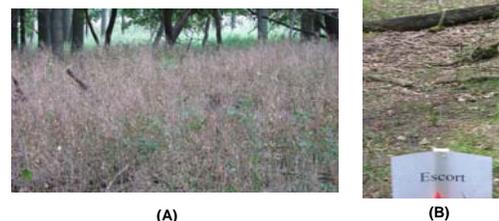
All spring applications in Green Bay reduced the cover of 2nd year plants compared to untreated areas 89 days after application (DAA), but seedling control varied among treatments with plateau, journey, oust, and escort (Figure 2B) treatments reducing seedling cover greater than sureguard and roundup treatments (Table 1). Spring application at the early bolting stage at the Sparta site reduced 2nd year cover of garlic mustard compared to untreated plots with plateau, journey (Figure 3C), escort, sureguard, kjm44 and certainty reducing the cover of 2nd year plants to 0% 83 DAA (Table 2). However, the seed mass/m<sup>2</sup> and seedling cover was reduced in all treatments compared to untreated areas with plateau, journey, oust, sureguard, kjm44 and certainty eliminating seedling cover 83 DAT.

**Table 2:** Garlic mustard treatment response at early bolting in Sparta and late bolting stage in Postville at 69 DAA

Treatment	Rate	-----Sparta-----			-----Postville-----		
		ALAPE Seedling	ALAPE 2 <sup>nd</sup> year	Grams of seed/ m <sup>2</sup>	ALAPE Seedling	ALAPE 2 <sup>nd</sup> year	Grams of seed/ m <sup>2</sup>
		-----% cover-----			-----% cover-----		
Plateau <sup>a</sup>	6 fl oz/a	0 B	0 C	0.0 B	0.0 B	1.5 C	0.0 B
Journey <sup>a</sup>	16 fl oz/a	0 B	0 C	0.0 B	0.0 AB	1.7 C	0.0 B
Overdrive <sup>a</sup>	4 oz/a	1.4 AB	5 BC	0.064 B	6.3 A	15.0 BC	0.968 B
Banvel <sup>a</sup>	4 oz/a	0.4 B	11 B	0.164 B	5.0 AB	16.3 BC	0.630 B
Oust <sup>b</sup>	0.5 oz/a	0 B	0.2 C	0.0 B	0.0 B	5.3 C	0.0 B
Escort <sup>b</sup>	0.5 oz/a	0.2 B	0 C	0.0 B	0.0 B	1.3 C	0.0 B
Sureguard <sup>b</sup>	3 oz/a	0 B	0 C	0.0 B	1.3 AB	5.0 C	3.008 B
Kjm44 <sup>a</sup>	2.5 oz/a	0 B	0 C	0.0 B	6.3 AB	3.8 C	0.0 B
Certainty <sup>b</sup>	2 oz/a	0 B	0 C	0.0 B	0.0 B	3.8 C	0.0 B
Basagran <sup>b</sup>	16 fl oz/a	1 B	1 C	0.008 B	3.8 AB	25.0 AB	2.253 B
Roundup <sup>c</sup>	22 fl oz/a	1.2 AB	8.8 BC	0.21 B	1.3 AB	0 C	0.0 B
Untreated		3.4	22 A	1.094 A	6.7 AB	40.0 A	12.95 A

Means within column followed by the same letter are not significantly different (P<0.05)

a -MSO added to the treatment at the rate of 32 fl oz/a  
b -NIS added to the treatment at the rate of 0.25% V/V  
c -AMS added to the treatment at the rate of 10 lbs/100 gal



**Figure 2:** Comparison of garlic mustard untreated control (A) to 99% control effect of escort in spring (B) at 89 DAA in Green Bay

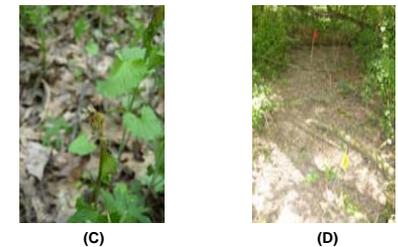
Spring application at late bolting stage in the Postville site also resulted in a reduction of 2nd year cover with roundup, escort, oust, plateau, journey, sureguard, kjm44 and certainty providing greater than 95 % reduction at 68 DAA (Table 2). However, seedling control varied among treatments and only plateau, journey, oust, escort and certainty treatments reduced seedling cover to 0%.

**Table 3:** Garlic mustard treatment response to late fall application at rosette stage in Green Bay at 219 DAA

Treatment	Rate	ALAPE Seedling	ALAPE 2 <sup>nd</sup> year	ALAPE seedling	ALAPE 2 <sup>nd</sup> year
		-----% cover-----		-----No. per m <sup>2</sup> -----	
Journey <sup>a</sup>	16 fl oz/a	23.0 B	8.0 BC	449 A	1.4 BC
Oust <sup>b</sup>	0.5 oz/a	5.3 B	1.5 C	80 AB	0.6 BC
Escort <sup>b</sup>	0.5 oz/a	17.5 B	0 C	401 AB	0 C
Sureguard <sup>b</sup>	3 oz/a	4.8 B	31.3 AB	27 B	28.0 ABC
Certainty <sup>b</sup>	2 oz/a	6.8 B	0.8 C	148 AB	0.6 BC
Roundup	22 fl oz/a	50.0A	10.0 BC	274 AB	42.6 AB
Untreated		17.5 B	51.3 A	279 AB	43.2 A

Means within column followed by the same letter are not significantly different (P<0.05)

a -MSO added to the treatment at the rate of 32 fl oz/a  
b -NIS added to the treatment at the rate of 0.25% V/V  
c -AMS added to the treatment at the rate of 10 lbs/100 gal



**Figure 3:** (C) Bud injury effect of journey at early bolting stage in Sparta at 17 DAA. (B) Effective control of garlic mustard adults by roundup at late bolting stage in Postville at 17 DAA.

Late fall application of all treatments except sureguard at the Green Bay site showed the reductions in cover of 2nd year plants compared to untreated plots with escort eliminating the 2nd year cover of garlic mustard at 219 DAA (Table 3). No treatments reduced seedling cover compared to the untreated control at the fall application.

## Conclusion

Results across four sites demonstrate that a range of herbicides can effectively reduce the cover of 2nd year plants applied in late fall and spring with plateau, journey, oust and escort showing the most consistent results across sites. Control of seedlings proved to also be accomplishable at all three sites when treatments are applied after emergence in the spring with plateau, journey, oust and escort. Roundup, the standard treatment in most control efforts, varied in its success across all sites with the reduction in cover of 88%, 60%, 100% (Figure 3D), and 81% in spring Green Bay, Sparta, Postville, and fall Green Bay respectively. This indicates that the effectiveness of roundup may differ depending on stage of growth or environmental factors specific to each site. While land managers are hesitant to apply broadcast herbicide treatments due to impact on non-target vegetation, these results demonstrate that effective control of both 2nd year and seedling garlic mustard plants is possible with a single broadcast treatment. This would be an affordable and effective option for areas that are heavily infested with few desirable plants.