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Spraying Glyphosate at Freezing Temperatures and Other Techniques for Controlling Garlic Mustard (Ohio)

Mark Frey, Presidio Trust, 34 Graham St., San Francisco, CA 94129, 415/561-4148, Fax: 415/561-4437, mfrey@presidiotrust.gov

From 2000 to 2002, I investigated novel ways to control garlic mustard (Alliaria petiolata) in glaciated northern Ohio. During this time, I conducted experiments that explored three questions: 1) Can land managers spray Roundup Pro (glyphosate) earlier in the spring to minimize harming spring ephemerals? 2) Do adult plants produce viable seed after they have been pulled? and 3) How can pulled plants best be stored on-site?

My study sites were located near Wooster, Ohio, where forests are generally small, surrounded by agricultural land, and typically dominated by red maple (Acer rubrum), white ash (Fraxinus americana), and elms (Ulmus spp.) (Braun 1989). For the first trial, I examined the efficacy of a 1-percent Roundup Pro application to control first-year rosettes (those that had germinated the previous spring) under a variety of temperature conditions. In a floodplain area, I sprayed four 5-ft x 10-ft (1.5-m x 3-m) plots in late autumnÑ four in mid-winter, four in late winter, and left four untreated as controls. Treatments were replicated in 2001-2002 at an upland site. Garlic mustard density averaged 54 plants/m^2 in November of 2000 for the floodplain plots and 111 plants/m^2 in November of 2001 for the upland plots. Percent cover averaged 12.2 percent in 2000 and 64 percent in 2001. I selected spray times that spanned the cold-weather months (for example, the late autumn application was in November in 2000 and December in 2001). During 2000-2001, I sprayed only on days when there was no rain. In 2001-2002, I sprayed on days when temperatures were as close to freezing as possible during the target window. Although the label for Roundup Pro does not specify a temperature requirement (Monsanto 2002), a customer service representative told me that the product only works when air temperatures are above 40ûF (4.4ûC).

I found that an application of glysophate sprayed at 23.6 to 31.4ûF (-4.7 to -0.3ûC) reduced garlic mustard density by 84 to 94 percent. Applications at 33.8 to 55.0ûF (1.0 to 12.8ûC) reduced density by 87 to 100 percent. Although native species density was lower in control plots than in plots sprayed with Roundup at any time, mean garlic mustard densities decreased by 12 percent in the first year and 41 percent in the second. This occurred because garlic mustard plants may die during the period from germination to bolting, although the percent cover of the remaining plants tends to increase until bolting (in this case by 12.8 in the 2000-2001 trial and 150.2 percent in the 2001-2002 trial). These findings suggest that spraying glyphosate at air temperatures down to and just below freezing is an effective control strategy for garlic mustard rosettes. Given a broader effective temperature range, managers can spray earlier in the spring, thus avoiding damage to spring ephemerals.

Herbicide is not an effective control strategy for adult (bolting) plants. Although pulling is effective, a large volume of pulled plants may potentially produce viable seed. Solis (1998) reported anecdotal evidence that garlic mustard could produce viable seed after it has been pulled. To test this hypothesis, I collected plants in May 2001 at three phenological stages: five or fewer open flowers, more than five open flowers, and post-flowering. Ten plants were used for each treatment combination with four replicates for each phonological stage.

Germination occurred in 2002 from seeds produced by plants pulled at all phenological stages. The two earliest stages resulted in far lower frequency (averaging 25 percent of plots) and number (0.3 seedlings per 10 plants) than the latest stage (94 percent and 17.5 seedlings per 10 plants). Pulled plants can, indeed, produce viable seed and should be handled carefully. If the plants are consolidated on-site, a follow-up must be planned.

To determine if there is a way to leave pulled plants in bags on site, I tested three types of bags for their ability to reduce seed viability. Treatments included 1) opaque black plastic garbage bags (30 gallon, 2 mil), 2) double-layer paper feed bags (1/3 BBL brown), 3) opaque white woven-mesh plastic feed bags (18-x-30 cm poly), and 4) a no-bag control. There were four replicates per treatment, with each replicate including about 500 plants harvested on June 10, 2001 and bundled together. I sampled seeds monthly from June through November, and in February at the onset of germination. Viability was determined using a standard Tetrazolium test (Grabe 1970) on ten random seeds per sample date.

After two months, no tested seeds in the plastic bags were viable. After eight months, the mesh bag and paper bag treatments had reduced viability to 80 percent while the control remained at 100 percent. Hundreds of seeds germinated in each treatment, except those in plastic bags. Although no tested seeds from the plastic bag treatment were viable, two seedlings survived until June and died in July. This result suggests that plastic bags effectively kill the vast majority of seeds. Decomposable plastic should be investigated for effective on-site disposal.

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