Dickinson Natural Products Weed Control Efficacy Study

Patrick M. Carr[1], Timothy J. Winch[1], Glenn B. Martin[1], and Jeff J. Gunderson[2],
[1]North Dakota State University Dickinson Research Extension Center
[2]Midwest Organic and Sustainable Education Service, Spring Valley WI

SUMMARY
Herbicides generally are prohibited from use in organic management systems. However, a small number of products incorporating naturally-occurring active ingredients are permitted under the USDA National Organic Program. These herbicides could be an important tool for organic farmers and, for that reason, a study was conducted to determine the efficacy of five different herbicide treatments on controlling grass and broadleaf weeds in southwestern North Dakota in 2009: Green Match (active ingredient [a.i.] = lemongrass oil), Matratac AG (a.i. = clove oil), Racer (a.i. = ammonium nonanoate), and vinegar (20% acetic acid). All products were applied in plots arranged in a randomized complete block design prior to seeding hard red spring wheat (cv. FBC Dylan). Treatment blocks were replicated four times. Weed control was rated at 1, 7, 14, 21, and 42 days after application. Grain yield was determined when wheat reached physiological maturity. Visual ratings indicated that all herbicides controlled weeds compared with weedy plots where no herbicide was applied ($P < 0.05$). Wheat yield was enhanced from 44 to 61%, depending on the herbicide treatment. Results of this preliminary study suggest herbicides or products having herbicidal activity do have potential in organic management systems, but caution is urged since many are not cleared for use as herbicides in field crops in North Dakota. The one exception in this study was Green Match, which could be used for weed control in wheat during 2009.

INTRODUCTION
The National Organic Program along with organic certification groups emphasize preventative and cultural measures for weed control. However, oftentimes tillage is relied upon heavily for weed control on many organic farms. Unfortunately, the deleterious impacts of excessive tillage on soil structure, organic matter content and humus formation are well known. Recent interest in reduced- or conservation-till, organic farming systems has kindled interest in natural products that might provide organic farmers with a burn-down herbicide option. There are few products that are registered under the USDA National Organic Standards for use as herbicides. These herbicides typically use naturally-occurring substances for weed control, such as clove and garlic oils, soap salts or acids. Little research has been conducted to determine their efficacy in controlling weeds in North Dakota or neighboring states.

MATERIALS AND METHODS
The 2009 growing season began much later than is typical. Cool temperatures prevented early emergence of summer annual weeds and delayed the onset of regrowth by winter annual weeds. Seeding was delayed much later than is recommended so that annual weeds would emerge or resume growth before treatments were applied. A decision was made to seed on 15 June, much later than is recommended, even though the weed population was lower than anticipated. Hard red spring wheat (cv. FBC Dylan) was seeded at 90 lb PLS/acre using a John Deere 750 grain drill in rows 15 cm apart.

All treatments were applied using a hooded bicycle-type sprayer with a 7.5-ft boom and 8004 nozzle tips at a rate of 150 gallons per hectare (60 gpa) on 18 June, beginning at 8:30 AM and ending at 10 AM, under partly cloudy skies and at a relative humidity of 55%. Wind speed during the application period achieved a maximum velocity of 2.7 mph. Treatments were applied in 10 by 20 ft plots that were arranged in a randomized complete block and replicated four times. An unsprayed 5-ft border separated adjacent plots within each block.

Above-ground weed biomass was collected from a 0.25-m^2 area in each plot on 17 June and separated into grass and broadleaf weed samples. The weed population was low and consisted predominately of common lambsquarters, kochia, Russian thistle, and dandelion for broadleaf species, and green foxtail and barnyardgrass for grass species. Weed samples were dried at 130^{o}F until a constant weight was reached, and then weighed. Weights were reported as g/m^2. A second biomass sample was collected on 19 June, approximately 24 hr after the treatments were applied, following the same procedure.

A visual efficacy rating (% control) was given by comparing the density and necrosis of weeds in the center of each plot to the 5-ft untreated area separating adjacent plots by three individuals independently at 1, 7, 14, 21, and 42 days after treatments were applied. A mean was computed from the three ratings each date by plot combination and recorded. Plot centers were marked by flags but otherwise not identified to minimize bias during the rating process. The lack of identifying plot treatments explains how the mean visual efficacy rating did not = 0 for most dates in weedy check plots (refer to Table 1).

Above-ground crop and weed biomass samples were collected from a 0.25-m^2 area on 13 August. Biomass collection occurred as described earlier. Cool weather delayed grain harvest until 18 September, when grain yield was determined by harvesting the cener 8.7-m^2 (93-ft^2) area in each plot using a research harvester.

Data were analyzed using the PROC ANOVA procedure available from SAS. Results of the analyses are summarized in Tables 1 and 2.

RESULTS

It was observed, beginning approximately 7 days after the application of the treatments, that purslane was present at varying populations in plots; very few if any plants occurred in some plots while there appeared populations >4 plants/0.1-m^2 in the untreated border area separating plots, outside the study elsewhere in the field, and in at least one plot in each of the four blocks of treatments included in the study. This observation suggested varying levels of soil activity on this weed species since no purslane was observed before or within a few days after the treatments were applied.

Differences in grass and broadleaf weed biomass were not detected between plots receiving herbicide treatments and the weedy check plots where no herbicide treatment was applied just prior and shortly after the treatments were applied (Table 1). However, visual weed ratings indicated weeds were controlled in plots receiving all herbicide treatments compared with weedy check plots. Differences in visual weed ratings between plots receiving different herbicide treatments generally were not detected, except at 14 days after seeding FBC Dylan wheat (i.e., 15 days after herbicide application) when weed control appeared superior in plots receiving the Green Match treatment compared with Racer.

Differences in grass and broadleaf weed biomass were not detected in plots receiving herbicide treatments and weedy check plots when the wheat crop reached physiological maturity (Table 2). However, more biomass was produced by wheat in plots where herbicides were applied compared with weedy check plots, except when Racer was used. Less wheat biomass was produced in plots receiving the Racer treatments than in plots where Green Match and Vinegar were applied.

Wheat yield was greater in plots were herbicides were applied compared with the weedy check plots (Table 2). These results demonstrate that all herbicides evaluated at Dickinson in 2009 did control weeds compared with weedy check plots. This work will be expanded and continue in 2010.

ACKNOWLEDGEMENT

The authors wish to thank Tim Winch, agricultural technician along with student workers Ben Russ and Chalsy Steier for their assistance in conducting this study, along with all the suppliers who provided the herbicides that were evaluated in this study.

Table 1. Pre-treatment application (PRE) and Post-treatment application (POST) weed biomass and visual weed ratings (percent visual weed control) at 1, 7, 14, 21, and 42 days after seeding (DAS) for six natural products at the North Dakota State University, Dickinson Research Extension Center in 2009.

	PRE		POST		Visual Weed Control				
	g/m2				-%-				
Treatment	Grass	Broadleaf	Grass	Broadleaf	1 DAS	7 DAS	14 DAS	21 DAS	42 DAS
Green Match	70	5	65	0	39	26	40	27	39
Matratec AG	43	3	16	3	23	29	33	27	26
Matratec AG + Act90	38	19	13	3	28	33	37	35	38
Racer	65	8	40	0	36	23	18	20	23
Vinegar (20%)	30	11	8	0	49	44	59	68	52
Weedy check	51	8	105	0	0	2	6	2	2
Mean	42	8	35	1	25	22	28	26	26
CV %	77	238	162	358	47	47	39	37	36
P-value	0.68	0.48	0.32	0.6	0.003	0.006	0.0006	<0.0001	0.0002
LSD (0.05)	NS	NS	NS	NS	21	19	19	17	16

Table 2. Crop, grass weed, and broadleaf weed biomass, and hard red spring wheat grain yield following the application of six natural products at the North Dakota State University, Dickinson Research Extension Center in 2009.

	Rate[1]	Biomass (g/m2)			Wheat grain yield	
Treatment	-%-	Crop	Grass	Broadleaf	kg/ha	Bu/acre
Green Match	14	487	32	65	1982	29
Matratec AG	8	404	83	41	1720	26
Matratec AG + Act90	8	397	85	43	1799	27
Racer	6	338	122	76	1717	26
Vinegar (20%)	100	464	150	29	1953	29
Weedy check	-	236	238	73	1238	18
Mean		332	101	47	1487	22
CV %		18	80	73	15.7	15.7
P-value		0.002	0.10	0.48	0.019	0.19
LSD (0.05)		108	NS	NS	411	6

[1]Number indicates percent of total product (active ingredient plus inerts) in solution applied at a rate of 60 gallons per acre.