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Fallow Method Affects Downy Brome Population in Winter Wheat

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Downy brome (*Bromus tectorum* L.) is a prevalent weed infesting winter wheat (*Triticum aestivum* L.) in the Great Plains. Long-term field research was initiated in 1980 on a Williams loam soil (fine-loamy, mixed Typic Argiborolls) near Sidney, MT, to determine the effect of stubble mulch (SM), minimum-till (MT), and no-till (NT) fallow methods on downy brome proliferation in winter wheat-fallow cropping systems. In 1981, downy brome was not observed in the plot area. By 1989, downy brome comprised 32% of the winter wheat community phytomass in the SM method, but was not detected in winter wheat of the MT or NT methods. Winter wheat grain yield in 1989 was 23 and 29% less in the SM method infested with downy brome than in the MT or NT methods, respectively. Pronamide eliminated downy brome during the fallow period in the MT and NT methods, and thus reduced downy brome population in the following winter wheat crop.

In the semiarid region of the Great Plains, fallow increases the stability of winter wheat production. Soil-stored water from precipitation received during fallow reduces winter wheat susceptibility to drought. Stubble mulching with a sweep plow is the conventional method of weed control during fallow in the Great Plains. This method maintains plant residue on the soil surface, which increases precipitation storage in soil and reduces wind and water erosion (1, 4, 6). Other fallow methods, where herbicides replace some or all of the tillage operations, are also effective in storing precipitation in soil in the Great Plains (9, 10). For example, SM, MT, and NT were similar in precipitation storage efficiency in the northern Great Plains (1, 9). The MT and NT, however, maintained higher plant residue levels on the soil surface than SM, therefore increasing soil protection from erosion.

One drawback with SM, however, has been proliferation of downy brome, as sweep plowing is inconsistent in controlling this species (2, 6, 7, 8). Imposing other fallow weed control practices may improve downy brome control.

The objective of this study was to compare the effect of SM, MT, and NT fallow methods on downy brome proliferation over 10 yr in a winter wheat-fallow cropping system.

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Abbreviations: MT, minimum-till; NT, no-till; SM, stubble mulch; WUE, water use efficiency.

Table 1. Effect of fallow method on downy brome infestation and winter wheat grain yield, WUE, and N uptake in 1989.

Fallow method	Community composition		Grain		
	Wheat	Downy brome	Yield	WUE	N uptake
	% of total phytomass		bu/acre	bu/acre/in.	lb/acre
SM	68	32	18.3	1.67	31.1
MT	100	0	23.0	2.15	37.6
NT	100	0	25.7	2.27	39.4
LSD (0.05)	16	16	3.2	0.45	4.2

MATERIALS AND METHODS

This study was conducted on a Williams loam soil near Sidney, MT. Average yearly precipitation is 13.6 in., with 78% received between April and September. The site was established in a winter wheat-fallow region where fallow begins in August after winter wheat harvest and continues for 13 mo until winter wheat is planted in September.

Three fallow methods were compared: SM, MT, and NT. The weed control operations for SM in each fallow year (1982, 1984, 1986, and 1988) began in late May, and consisted of sweep plowing, followed by rodweeding in June and July, and disking to prepare a seedbed in September. Pronamide for grass control plus chlorsulfuron for broadleaf weed control were applied at 0.5 lb a.i./acre and 0.5 oz a.i./acre, respectively, after wheat harvest in late September of each crop-production year (1981, 1983, 1985, 1987, and 1989) for both MT and NT. In addition, weed control in the MT plots included sweep plowing as needed each fallow year, followed by disking to prepare a seedbed in September. Glyphosate was applied at 0.7 lb a.i./acre (plus a surfactant at 0.25% v/v) as needed for weed control during fallow summers for the NT method. For both MT and NT, the first weed control operation in the fallow years occurred in late June. Herbicide application was at 13.5 gal/acre. Plot size was 24 by 130 feet, with plots arranged in a randomized complete block design with four replications.

'Norstar' winter wheat at 60 lb/acre was planted with a deep-furrow hoe drill by mid-September in alternate years, starting in 1981. Ammonium nitrate was broadcast at 40 lb N/acre at planting. At maturity, an area of 4 by 130 feet was harvested from the center of each plot to determine grain yields.

Soil water content to a depth of 6 ft was determined each cropping year using the neutron scatter technique at planting and after harvest at one location in each plot. Grain water-use-efficiency (WUE) was calculated by dividing grain yield by crop water use during the growing season (precipitation plus difference in soil water content from planting to harvest).

In 1989, after five cycles of winter wheat-fallow, phytomass production of winter wheat and downy brome and yield components (culms per square yard, kernels per culm, and 1000-kernel weight) of winter wheat were determined from two 5-sq ft subsamples from each plot. Grain N concentration was determined using macro Kjeldahl procedure (3). Grain N uptake on a per acre basis was calculated by multiplying grain N concentration by grain yield in pounds per acre.

All data were subjected to analyses of variance, and differences among treatment means were determined at the 0.05 level of probability.

Table 2. Effect of fallow method on winter wheat grain yields and WUE in 1981, 1983, 1985, and 1987.

Fallow method	Year of study			
	1981	1983	1985	1987
	bu/acre			
Grain yield				
SM	21.7	31.2	19.5	31.1
MT	21.1	30.0	20.2	32.1
NT	19.5	32.7	23.2	34.3
LSD (0.05)	NS	NS	NS	NS
	bu/acre/in.			
WUE				
SM	1.70	2.26	1.93	1.94
MT	1.64	2.10	1.91	1.96
NT	1.52	2.29	2.29	2.14
LSD (0.05)	NS	NS	NS	NS

RESULTS AND DISCUSSION

Downy brome was not observed in winter wheat until 1987, when it was present in the SM plots. By 1989, after five cycles of winter wheat-fallow, downy brome comprised 32% of the community phytomass in the SM plots, but was not detected in the MT or NT plots (Table 1). Seed source of downy brome may have been from a low initial seedbank population in the plot area or from adjacent roadsides, which were heavily infested with downy brome. In the MT and NT, pronamide controlled downy brome and prevented seed production, thus restricting population growth.

In 1989, winter wheat from the SM infested with downy brome yielded 23 and 29% less than MT and NT, respectively, and WUE was reduced by 22 and 26%, respectively (Table 1). Prior to the 1989 crop, fallow did not affect grain yields or WUE (Table 2). Yield loss in SM in 1989 resulted from reduced culms per square yard, while kernels per culm and kernel weight were not affected (Table 3). Grain N uptake also was reduced 21% in SM when compared with NT winter wheat (Table 1). This reduction in culms per square yard and N uptake may reflect downy brome competition for water and N during the growing season.

One producer-controlled factor affecting downy brome control during fallow is timing of weed control operations (5, 8, 10). For example, with SM fallow in Nebraska, highest weed control resulted when sweep plowing occurred immediately after winter wheat harvest, with one or more additional fall operations based on downy brome infestation levels. The following spring, the site needed to be tilled by March or early April to ensure effective control (4, 6). With reduced-till methods, atrazine control of downy brome was greater when applied in October than August or April (5).

In the northern Great Plains, fallow operations are not traditionally performed in the fall after harvest with stubble mulch fallow (2). Low precipitation levels in the summer and fall after winter wheat harvest do not stimulate extensive weed growth, and producers hope to maintain stubble in an upright position to trap snow, thereby in-

Table 3. Effect of fallow method on yield components of winter wheat in 1989.

Fallow method	Yield components		
	Heads/sq yd	Kernels/head	Kernel wt
	——— no. ———		g
SM	253	28.6	0.019
MT	356	28.4	0.018
NT	368	27.9	0.017
LSD (0.05)	56	NS	NS

creasing precipitation storage. In this study, pronamide applied in late September on MT and NT prevented downy brome from establishing and producing seed the following May or June. Delaying tillage until late May with SM allowed downy brome to establish by early spring. Because wet soils in the spring sometimes inhibited timely tillage operations in SM, downy brome was able to produce seed before initial tillage.

It may be advisable for producers to consider applying residual herbicides such as pronamide to ensure fall and early-spring downy brome control, if they prefer not to till in the fall. Pronamide, however, rapidly degrades when average soil temperature exceeds 70°F, and therefore would be less effective if applied in August (11). Thus, pronamide should not be applied until mid-September. Glyphosate offers another option for control of downy brome during April or May of the fallow period. These herbicides prevent downy brome seed production during fallow and subsequently reduce the level of downy brome infesting the following winter wheat. If economics prohibit the use of herbicides for all fallow acreage, producers could target herbicide application only for sites where downy brome is present, then SM the remaining acres for general weed control.

INTERPRETATIVE SUMMARY

Because of erratic precipitation in the northern Great Plains, producers are exploring alternative fallow methods to increase precipitation storage in soil in a winter wheat-fallow cropping system. Stubble mulching is the prevalent method used for fallow in this area, but downy brome has developed into a serious weed problem with this method. Our results show that implementing MT or NT fallow methods where pronamide is applied in late fall inhibits downy brome proliferation. This new technology will lessen downy brome's detrimental impact on winter wheat production in the northern Great Plains.

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