FALL PREPLANT TRIFLURALIN (TREFLAN) APPLICATIONS IN WHEAT

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Green and yellow foxtail are important grass weeds in North Dakota wheat fields. Green foxtail was present in 94 percent and yellow foxtail in 33 percent of the wheat fields in the state during 1979 (1).

Trifluralin is an effective herbicide for control of foxtail in wheat under normal environmental conditions. Spring treatments with trifluralin must be applied and incorporated shallowly after planting. However, spring application of trifluralin requires application and tillage during a busy period and the shallow incorporation after seeding leaves a loose soil surface susceptible to wind erosion. Fall application of trifluralin would be advantageous because farmers would have a longer period for treatment and fall incorporation would reduce the potential for soil erosion compared to spring post-seeding treatment.

The objectives of this research were to determine weed control and wheat tolerance to fall-applied trifluralin as influenced by formulation, soil incorporation, wheat seeding depth and combinations with triallate (Far-go).

MATERIALS AND METHODS

General. Ten experiments were conducted at several locations in North Dakota between the fall of 1977 and the summer of 1982. Weed infestations at the various experiment sites ranged from light to moderate (2 to 60 plants per square yard). Soil type, land preparation, treatment date, seeding date, and wheat cultivar seeded at each site are presented in Table 1.

The herbicides formulated as a liquid were applied in water with a bicycle wheel type sprayer delivering 17 gallons per acre (gpa) at 35 pounds per square inch (psi). The granular formulation treatments were applied with a cone-type applicator. Fall-applied herbicides were incorporated with a field cultivar with overlapping shovels in all experiments except the 1981 experiments at Absaraka, which were incorporated with a tandem disk. The entire area of the experiment was cultivated and harrowed each spring before wheat was seeded. The experiments were randomized complete blocks with four replications.

Fall application with and without incorporation. Both the liquid and granular formulations of trifluralin were applied at 0.75 pound per acre on silty clay soil with pH 7.5 to 7.9 and organic matter 6.0 to 6.5 percent in three experiments at Fargo, 0.5 pound per acre on sandy loam soil with pH 6.8 to 7.2 and organic matter 2.2 to 2.7 percent in two experiments at both Minot and Williston, or 0.5 pound per acre on loamy sand soil with pH 7.3 and organic matter 3.7 percent in one experiment at Absaraka. Trifluralin was either soil incorporated (2 to 3 inches) immediately after application or applied on the surface.

Depth of incorporation. Trifluralin liquid was applied at 0.5 and 1.0 pound per acre on loamy sand soil with pH 7.3 and organic matter 3.7 percent at Absaraka in the fall of 1980 and 1981. Trifluralin was incorporated in the soil immediately after application with a field cultivar in 1980 or tandem disc in 1981 operating at depths of 3 or 6 inches.

Depth of seeding. Trifluralin liquid was applied at 0.5, 1.0 and 1.5 pound per acre on loamy sand soil with pH 7.3 and organic matter 3.7 percent at Absaraka in the fall of 1981. Trifluralin was incorporated in the soil immediately after application with a tandem disc operating at depths of 3 or 6 inches. Wheat seeding depth was 0.5 to 0.75 inch to the back half and 1 to 1.5 inch to the front half of each plot.

Fall application with triallate. Trifluralin liquid was applied at 0.75 pound per acre on silty clay soil with pH 7.5 to 7.9 and organic matter 6.0 to 6.5 percent in three experiments at Fargo, 0.5 pound per acre on sandy loam soil with pH 6.8 to 7.2 and organic matter 2.2 to 2.7 percent in two experiments at both Minot and Williston, or 0.5 pound per acre on loamy sand soil with pH 7.3 and organic matter 3.7 percent in one experiment at Absaraka. Triallate liquid was applied at 1.0 pound per acre at all locations alone or in combination with trifluralin. Treatments were soil incorporated (2 to 3 inches) immediately after application.

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Table 1. Soil type, land preparation, treatment date, seeding date and wheat cultivar seeded at the experimental sites.

Experimental site	Soil type	Land preparation	Treatment date	Seeding date	Wheat cultivar
Fargo	Silty clay	Plowed	10/24/77	5/14/78	Kitt
Fargo	Silty clay	Wheat stubble	10/24/77	5/14/78	Kitt
Fargo	Silty clay	Plowed	10/26/78	5/17/79	Era
Minot	Sandy loam	Chisel plowed	11/3/78	5/15/79	Coteau
Williston	Sandy loam	Fallow	11/2/78	5/14/79	Ellar
Absaraka	Loamy sand	Plowed	10/30/80	5/4/81	Era
Absaraka	Loamy sand	Plowed	10/30/81	5/21/82	Era
Absaraka	Loamy sand	Plowed	10/30/81	5/21/82	Era
Minot	Sandy loam	Fallow	10/27/81	4/23/82	Coteau
Williston	Sandy loam	Fallow	10/28/81	5/3/82	Len

Table 2. Weed control, wheat injury and yield with fall applied trifluralin granules and liquid.

	Weed control[b]				Wheat		
	Green foxtail		Common lambs-	Russian	Stand reduction[c]		
Treatment[a]	Ave.	range	quarters	thistle	Ave.	Range	Yield
	(%)				(%)		(bu/A)
Granules incorporated	90	(78-98)	98	73	9	(0-13)	31
Granules surface	85	(65-94)	92	64	5	(0-10)	30
Liquid incorporated	87	(76-97)	97	70	9	(0-16)	32
Liquid surface	70	(51-95)	67	54	1	(0-5)	30
Control	0		0	0	0		24
LSD (0.05)	8		9	15	4		5

[a]Trifluralin rates were 0.75 lb/A onsilty clay and 0.5 lb/A on sandy loam or loamy sand soils.
[b]Green foxtail control values are an average of eight, common lambsquarters three and Russian thistle one experiment.
[c]Wheat stand reduction values are an average of eight and yield five experiments.

RESULTS

Fall application with and without incorporation. Green foxtail control the year following fall-applied trifluralin ranged from 51 to 98 percent depending on the trifluralin formulation and whether incorporated or surface applied (Table 2). Trifluralin control of green foxtail was similar with the granules surface applied or incorporated and the liquid formulation incorporated averaged over eight experiments. Green foxtail control was 17 percent less when trifluralin liquid fall applied was not incorporated compared to incorporated. Common lambsquarters and Russian thistle control from fall-applied trifluralin followed a trend similar to foxtail control. Control of common lambsquarters and Russian thistle was similar when the granules were surface applied or incorporated and the liquid formulation was incorporated, but reduced when the liquid was surface applied (Table 2).

Wheat stand reductions with fall applications of trifluralin ranged from 0 to 16 percent depending on the formulation and whether incorporated or surface applied (Table 2). Wheat injury averaged over eight experiments was greatest with the granular and liquid formulations of trifluralin incorporated and least when the liquid formulation was not incorporated in the fall. Wheat stand reductions from surface applied granular treatments were intermediate, averaging 5 percent. All fall trifluralin treatments increased wheat yield compared to that from untreated plots (Table 2); however, no yield difference was observed between trifluralin formulations whether incorporated or surface applied.

Depth of incorporation. Fall-applied trifluralin liquid formulation at 0.5 and 1.0 pound per acre gave similar weed control when incorporated with the tillage tool at a depth of 3 inches; however, at the 6-inch fall tillage depth, yellow foxtail and common lambsquarters control increased as trifluralin rate increased (Table 3). The higher percentage weed control with 1.0 than 0.5 pound per acre trifluralin at the deep but not the shallow fall tillage depth possibly resulted from greater dilution of trifluralin in the soil with the deep incorporation.

Wheat injury increased as trifluralin rate increased from 0.5 to 1.0 pound per acre at both fall tillage depths (Table 3); however, wheat injury was less at 1.0 pound per acre and tended to be less at 0.5 pound per acre when the tillage tool was operated at 6 rather than 3 inches in the fall. All trifluralin treatments increased wheat yield compared to untreated plots (Table 3); how-

Table 3. Weed control, wheat injury and yield with fall applied trifluralin liquid as influenced by herbicide rate and depth of tillage[a].

Tillage depth	Trifluralin rate	Weed control: Yellow foxtail	Weed control: Common lambsquarters	Wheat: Stand reduction	Wheat: Yield
(inch)	(lb/A)	(%)	(%)	(%)	(bu/A)
3	0.5	93	85	6	39
3	1.0	95	87	15	37
6	0.5	85	77	3	38
6	1.0	96	87	10	40
Control	0	0	0	0	31
LSD (0.05)		7	10	4	5

[a]Yellow foxtail and common lambsquarters control values or wheat stand reduction and yield are an average of two experiments that were conducted at Absaraka in 1981 and 1982.

ever, trifluralin rates and tillage incorporation depth did not influence wheat yield.

Depth of seeding. Wheat injury increased as trifluralin rate increased from 0.5 to 1.5 pound per acre at both fall tillage incorporation depths regardless of whether the wheat was seeded 0.75 or 1.5 inches deep (Table 4). However, fall-applied trifluralin generally caused less injury to wheat which was seeded 0.75 than 1.5 inch deep regardless of rate or fall tillage depth based upon both yield and stand reduction in the one experiment conducted at Absaraka in 1982 (Table 4). Wheat injury from trifluralin at 1.0 pound per acre was reduced 30 and 8 percent and yield increased 6 and 5 bushels per acre when wheat seeding depth was 0.75 compared to 1.5 inch in the 3- and 6-inch fall tillage depth plots, respectively.

Table 4. Wheat stand reduction and yield with fall applied trifluralin liquid as influenced by herbicide rate, depth of tillage and seeding depth at Absaraka in 1982.

Tillage depth	Trifluralin rate	Wheat seeding depth (inch): Stand reduction 0.75	Stand reduction 1.5	Yield 0.75	Yield 1.5
(inch)	(lb/A)	(%)		(bu/A)	
3	0.5	6	9	38	36
3	1.0	4	34	39	33
3	1.5	30	34	34	31
6	0.5	0	4	39	34
6	1.0	3	11	41	36
6	1.5	19	26	39	35
Control	0	0	0	32	29
LSD (0.05)		8		5	

Fall application with triallate. Green foxtial control with fall application of trifluralin and wild oat control with fall application of triallate was similar when the treatments were applied alone or in combination (Table 5). However, wheat stand reductions were greater with fall trifluralin-triallate combinations than with either herbicide applied alone (Table 5). Wheat stand reductions averaged 9, 1, and 15 percent with trifluralin alone, triallate alone or trifluralin-triallate combinations, respectively. All herbicide treatments increased wheat yield compared to untreated plots (Table 5); however, wheat yields were similar from trifluralin, triallate, or combinations of trifluralin and triallate treated plots.

Table 5. Weed control, wheat injury and yield with fall applied trifluralin and triallate liquid alone or in combination.

Treatment[a]	Control[b]: Green foxtail	Control[b]: Wild oat	Wheat[c]: Stand reduction	Wheat[c]: Yield
	(%)		(%)	(bu/A)
Trifluralin	87	21	9	32
Triallate	2	84	1	30
Trifluralin + triallate	91	87	15	31
Control	0	0	0	24
LSD (0.05)	7	12	4	5

[a]Trifluralin rates were 0.75 lb/A on silty clay or 0.5 lb/A on sandy loam and loamy sandy soils. Triallate rates were 1.0 lb/A regardless of soil type.

[b]Green foxtail control values are an average of eight and wild oat six experiments.

[c]Wheat stand reduction values are an average of eight and wheat yield five experiments.

DISCUSSION

Trifluralin, applied in the fall, gave good foxtail control the following season. Control of foxtail with trifluralin was similar with the granular and liquid formulation incorporated or the granular formulation surface applied. However, foxtail control was reduced when trifluralin liquid was not incorporated in the fall.

Excellent green foxtail control (90 percent or more) was obtained in four out of eight experiments with trifluralin granules surface applied in the fall. However, to obtain consistent foxtail control under a wide range of climatic and soil conditions, triflurailin granules should be incorporated. Foxtail control with trifluralin granules applied on the soil surface ranged from 78 to 98 percent when incorporated and from 65 to 94 percent when not incorporated.

Although volatilization may not have been a big factor in trifluralin loss from granules left on the surface in the fall in these experiments, trifluralin vapor loss may still be important under certain conditions. Trifluralin volatilizaiton from soil or granules is influenced by moisture (2, 3, 4), temperature (3, 4) and soil type (3). Sufficient trifluralin could be lost as vapors from surface applications to decrease foxtail control if conditions were abnormally warm or moist following fall application. Incorporation of trifluralin would serve as insurance against such factors reducing weed control.

Trifluralin, applied in the fall, resulted in wheat stand reductions ranging from 0 to 34 percent depending on the rate, formulation, depth of herbicide incorporation, depth of wheat seeding and whether trifluralin was applied alone or in combination with triallate. However, wheat appears to have the ability to compensate for much of the stand loss. Wheat stand reductions with trifluralin became less obvious with advancing maturity because of increased tillering of remaining plants.

To maximize wheat tolerance to fall application of trifluralin, trifluralin should be applied alone (not in combination with triallate). Data from limited experiments also indicate that wheat should be seeded shallow and trifluralin incorporated deep (incorporation tool operated at a depth of 4 to 6 inches). Deep incorporation of trifluralin is generally considered important for consistent weed control.

LITERATURE CITED

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Table 1. U.S. No. 1 yield Cwt/A of Redsen and three standard varieties grown at Park River and Grand Forks, North Daktoa (4 years data).

	1979		1980		1981		1982		Average		
Variety	Park River	Grand Forks	Park River	Grand Forks	Park River	Grand Forks	Park River	Grand Forks	Park River	Grand Forks	Average both locations
Redsen	223	244	227	152	162	260	257	230	217.3	221.5	219.4
Norland	193	228	262	162	121	174	126	173	174.4	184.3	179.9
Red Pontiac	252	244	332	219	200	291	270	229	263.5	245.8	254.6
Bison	165	191	204	176	101	207	143	166	153.3	185.0	169.1
Average	208.3	226.8	256.3	177.3	146.0	233.0	199.0	199.5	202.4	209.1	205.8

Table 2. Percent total solids of Redsen and three standard varieties grown at Park River and Grand Forks, North Dakota.

	1979		1980		1981		1982		Average		
Variety	Park River	Grand Forks	Park River	Grand Forks	Park River	Grand Forks	Park River	Grand Forks	Park River	Grand Forks	Average both locations
Redsen	20.9	20.3	19.9	19.9	20.1	20.1	19.9	21.2	20.2	20.4	20.3
Norland	19.9	20.1	19.0	19.2	18.4	18.8	18.8	19.4	19.0	19.4	19.2
Red Pontiac	19.4	20.5	17.9	18.2	18.8	19.0	18.2	19.7	18.6	19.4	19.0
Bison	19.7	20.9	19.7	18.6	19.4	19.7	18.8	20.7	19.4	20.0	19.7
Average	20.0	20.5	19.1	19.0	19.2	19.4	19.0	20.3	19.3	19.8	19.5