Weed Spectrum Change and Control in Reduced-till Wheat

Stephen D. Miller and John D. Nalewaja

No-till crop production in North Dakota has expanded from 31,000 acres in 1981 to over 200,000 acres in 1983. Advantages of no-till farming include a reduction in fuel usage, lower equipment costs and reduced labor (2). Crop residues left on the surface in a no-till crop system reduce soil erosion and the combination of crop residues and reduced soil disruption with no-till increase moisture conservation (3).

Weed populations and weed species are influenced by tillage system (1,4,5,6). Triplett and Lytle (6) reported that annual grass weeds, vine weeds and perennial weeds were greater in corn grown under no-till than conventional-till systems. Similarly Donaghy and Stobbe (1) reported that quackgrass and Canada thistle populations increased under no-till compared to conventional-till systems, while several annual weed populations such as green foxtail and wild oat decreased.

The objectives of this research were to determine weed spectrum, weed control and wheat yield with several herbicide treatments applied in combination with conventional, reduced and no-till cropping conditions.

MATERIALS AND METHODS

A field experiment was conducted at the Agricultural Experiment Station at Fargo from 1978 to 1983 on a silty clay soil. The experiment was a split-block with tillage treatments as the main plots and weed control treatments as the subplots. The treatments were replicated four times and plots were 15 by 30 feet. Tillage and weed control treatments were applied to the same plot area each year.

Wheat stubble was harrowed to distribute the crop residue, tillage treatments and an annual fertilizer application of 80 pounds per acre N were applied in the fall prior to soil freeze-up each year. The tillage treatments included no-till (seeding directly into the stubble), reduced-till (fall chisel plowing with spring field cultivation and harrowing) or conventional-till (fall mold board plowing with spring field cultivation and harrowing). Paraquat (Paraquat, Gramoxone) plus surfactant was applied at 0.5 pound per acre plus 0.5% volume per volume in 1978 and 1979 and glyphosate (Roundup) plus surfactant applied at 0.37 pound per acre plus 0.5% volume per volume in 1980, 1981, 1982, and 1983 to control emerged weeds after seeding in the no-till treatment.

Wheat was seeded at 90 pounds per acre to a depth of 1½ to 2 inches in rows spaced 6 inches apart all years. Weed control treatments included: grass control (diclofop [Hoelon] at 0.75 pound per acre applied at the two to three-leaf stage of wheat), broadleaf control (2,4-D at 0.5 pound per acre applied at the five to six-leaf stage of wheat), grass and broadleaf control (diclofop and 2,4-D applied at similar rates and stages as listed above) and no grass or broadleaf control. All herbicides were applied with a bicycle wheat plot sprayer delivering 8.5 gallons per acre at 35 pounds per square inch. Weed counts by individual species were determined one to two weeks prior to wheat harvest each season and wheat yield was based on a combine-harvested sample dried to a constant moisture.

RESULTS

The experimental area had a moderate infestation of green foxtail and broadleaf weeds, few wild oat and non perennial weeds when the experiment was initiated; however, after six years of no-till wheat, weed populations had changed considerably.

Annual grass weed species were dominant each year in all tillage systems (Table 1); however, the dominant grass species changed over time. Wild oat populations increased while green foxtail populations tended to decrease after six years regardless of tillage system. Populations of annual grass weed species differed among the tillage systems. Wild oat populations after six years were highest in the reduced-till system and lowest in the no-till system. For example, wild oat populations in 1983 were 32 percent higher in the conventional-till and 86 percent higher in the reduced-till system compared to the no-till system. Green foxtail populations were initially two and three times higher in the no-till and reduced-till system, respectively, than in the conventional-till system; however, by 1983 foxtail populations were similar under all tillage systems.

Annual broadleaf weed populations increased only slightly over the six-year period the experiment was conducted, probably because the high grass weed populations

Miller was formerly associate professor (current address, Plant Science Department, University of Wyoming, Laramie, WY 82701) and Nalewaja is professor, Department of Agronomy.

Table 1. Weed populations in untreated control plots in several tillage systems from 1978 and 1983 in North Dakota.

Weed	Tillage System[1]	Year 1978	1979	1980	1981	1982	1983
		(Number/A × 1000)					
Wild oat	NT	—	58	29	218	1481	1016
	RT	—	14	44	421	2134	1887
	CT	—	14	44	305	1800	1350
	LSD (0.05)	—	29	15	121	203	218
Green foxtail	NT	246	581	581	1379	436	87
	RT	392	494	552	667	638	145
	CT	116	290	232	638	696	116
	LSD (0.05)	72	261	159	203	102	NS
Kochia	NT	87	145	73	131	—	203
	RT	44	203	73	116	—	363
	CT	58	73	15	44	—	131
	LSD (0.05)	NS	144	44	58	—	131
Wild mustard	NT	—	44	102	—	87	102
	RT	—	44	97	—	189	232
	CT	—	15	44	—	262	174
	LSD (0.05)	—	15	44	—	58	58
Canada thistle	NT	—	—	44	116	73	44
	RT	—	—	29	73	29	29
	CT	—	—	0	0	0	0
	LSD (0.05)	—	—	29	44	29	29
Perennial thistle	NT	—	—	—	14	29	44
	RT	—	—	—	0	0	15
	CT	—	—	—	0	0	0
	LSD (0.05)	—	—	—	14	29	29

[1] NT = seeding directly into stubble with paraquat or glyphosate applied to control emerged weeds, RT = fall chisel plow with spring field cultivation and harrowing or CT = fall mold board plow with spring field cultivation and harrowing.

reduced broadleaf weed germination (Table 1). The dominant broadleaf weed species varied with years. For example, kochia was the dominant broadleaf weed in 1978, 1979, and 1981, while wild mustard was dominant in 1980 and 1982. The dominant broadleaf weed in 1983 was influenced by the tillage system. Kochia was the dominant broadleaf weed in the no-till and reduced-till system while wild mustard was dominant in the conventional-till system. Populations of annual broadleaf weeds were influenced by tillage system. For example, kochia populations were two and three times higher in the no-till and reduced-till systems, respectively, compared to the conventional-till system; wild mustard populations were 70 and 123 percent higher in the conventional and reduced-till system compared to the no-till system in 1983.

Perennial broadleaf weeds began to appear in the reduced and no-till systems within two years but were not present in the conventional-till system after six years (Table 1). Perennial broadleaf weed populations were higher in the no-till than reduced-till system regardless of species. In addition to Canada thistle and perennial sowthistle, scattered dandelion and common milkweed plants were observed throughout the no-till area.

Wild oat control was 90 percent or greater and green foxtail control 70 percent or greater with diclofop in all tillage systems when averaged over years (Table 2). Wild oat populations were higher, but green foxtail populations were similar in 2,4-D-treated compared to untreated control plots. For example, wild oat populations were 35, 35, and 22 percent higher in the 2,4-D-treated than untreated control plots in the no-till, reduced-till, and conventional-till systems, respectively. Green foxtail populations were within 13 percent of those in untreated compared to 2,4-D-treated plots with the various systems.

Kochia populations in spring wheat were reduced 73 to 90 percent by 2,4-D and control appeared to be adequate in all tillage systems (Table 2). Wild mustard control with 2,4-D was 100 percent regardless of tillage system. However, wild mustard populations were 65, 218 and 210 percent higher in the diclofop than untreated control plots in the no-till, reduced-till, and conventional-till systems; respectively.

Canada thistle and perennial sowthistle were only present in reduced and no-till plots (Table 2). However, 2,4-D applications prevented these two perennial weeds from becoming well established in both systems during the period the research was conducted. Canada thistle control tended to be better with 2,4-D in the reduced than no-till system and probably related to levels of infestation in the two systems.

Table 2. Influence of tillage system and herbicide treatment on wheat yield and weed populations, 1978 to 1983.[1]

Tillage system[2]	Treatment herbicide	Rate	Wheat yield	Weed					
				Wioa	Grft	Kocz	Wimu	Cath	Pest
		(lb/A)	(bu/A)	(Number/A × 1000)					
NT	None	0	16	560	552	128	84	69	29
	Diclofop	0.75	26	29	101	145	130	58	29
	2,4-D	0.75	20	755	494	29	0	15	0
	Dic/ + 2,4-D	0.75 to .5	34	44	131	15	0	15	0
		Mean	24	347	320	79	54	39	14
RT	None	0	12	900	481	160	140	40	8
	Diclofop	0.75	22	58	116	218	305	29	8
	2,4-D	0.5	16	1219	465	44	0	0	0
	Dic/ + 2,4-D	0.75 to .5	31	87	131	15	0	0	0
		Mean	20	566	298	109	111	17	4
CT	None	0	20	703	348	64	124	0	0
	Diclofop	0.75	30	58	87	58	261	0	0
	2,4-D	0.5	23	857	392	15	0	0	0
	Dic/ + 2,4-D	0.75 to .5	35	73	102	15	0	0	0
		Mean	27	423	232	38	96	0	0
	LSD (0.05)	Till by herb	7	119	142	84	44	33	24
		Till	4	79	98	54	28	21	16

[1] Wheat yield is an average of six years and number of wild oat, green foxtail, kochia, wild mustard, Canada thistle and perennial sowthistle an average of 5, 6, 5, 4, 4 and 3 years, respectively.

[2] NT = seeding directly into stubble with paraquat or glyphosate applied to control emerged weeds, RT = full chisel plow with spring field cultivation and harrowing or CT = full mold board plow with spring field cultivation and harrowing.

Wheat yields were lowest in the reduced and highest in the conventional-till system when averaged over years and herbicide treatments (Table 2). Wheat yields averaged 26 and 11 percent lower in the reduced and no-till system, respectively, compared to the conventional-till system. The only time wheat yields were not significantly lower was when both grass and broadleaf weeds were controlled.

Wheat yields were closely related to weed populations (Tables 1 and 2). Wheat yields were lowest in all tillage systems when no herbicide treatment was applied and highest when both diclofop and 2,4-D were applied. Wheat yields were 212, 258 and 175 percent higher when diclofop and 2,4-D were applied than when no herbicide treatment was applied in the no-till, reduced-till, and conventional-till systems, respectively. Wheat yields were increased more by diclofop than 2,4-D applications, probably because of the high grass weed populations all years (Tables 1 and 2).

DISCUSSION

The influence of tillage system on weed populations over a six-year period was species specific. Wild oat and wild mustard populations tended to be lower, green foxtail populations similar, and kochia, Canada thistle, and perennial sowthistle populations higher in no-till than conventional or reduced-till systems. Annual weed populations under the reduced-till system generally were higher than those observed in the no-till or conventional-till system, indicating that intermediate tillage levels may be an ideal environment for many common annual weed species in spring wheat.

Perennial weeds were not present in the conventional-till system after six years of continuous wheat but began to appear in the reduced and no-till systems within two years. 2,4-D applied in the crop reduced but did not prevent the establishment of perennial broadleaf weeds under the no-till system. Weed control programs for no-till and reduced-till crop production systems would need to prevent perennial weed establishment. Crop rotation and in-crop and post-harvest herbicide treatments would need to be integrated to help control perennial weeds.

Weed populations were effectively reduced under all tillage systems with herbicides. However, if herbicide treatments did not provide broad spectrum weed control, it only served to accentuate a particular weed problem. Control of broadleaf weeds without control of grass species increased the wild oat problem, or control of grass species without control of broadleaf species increased the wild mustard problem under all tillage systems.

The data indicated that tillage by moldboard plowing was important to the control of weeds and that with the use of herbicides, weeds could be controlled with reduced tillage systems.

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