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The Influence of a Hairy Vetch (*Vicia villosa*) Cover Crop on Weed Control and Corn (*Zea mays*) Growth and Yield[1]

WILLIAM S. CURRAN, LYNN D. HOFFMAN, and EDWARD L. WERNER[2]

Abstract. Influences of a hairy vetch cover crop and residual herbicides were examined in field corn in 1991 and 1992. Hairy vetch was seeded in mid-August and killed the following May with tillage, mowing, or glyphosate plus 2,4-D (no-till). These cover crop management systems were compared with a no-cover treatment. Residual herbicides including atrazine plus metolachlor applied PRE at three rates and nicosulfuron plus thifensulfuron applied POST at a single rate were compared within cover crop management systems. All cover crop management systems effectively controlled hairy vetch except mowing in 1992. The corn population was reduced in mow treatments containing uncontrolled vetch. Hairy vetch mulch suppressed some weeds in the no-till treatments in 1991, but more annual grass was noted late in the season with no-till into hairy vetch than with the no-cover treatments in 1992. Residual herbicide performance was similar across cover crop management systems, except for fall panicum control which decreased in some no-till systems. Unlike soil-applied herbicides, performance of POST herbicides was unaffected by cover crop management systems. **Nomenclature:** Atrazine, [6-chloro-*N*-ethyl-*N*′-(1-methylethyl)-1,3,5-triazine-2,4-diamine]; glyphosate, [*N*-(phosphonomethyl)glycine]; metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide]; nicosulfuron (2-[[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-*N,N*-dimethyl-3-pyridinecarboxamide); thifensulfuron, (3-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]-2-thiophenecarboxylic acid); 2,4-D, (2,4-dichlorophenoxy)acetic acid; corn, *Zea mays* (L.) 'Doeblers 48X'; fall panicum, *Panicum dichotomiflorum* Michx. #[3] PANDI; hairy vetch, *Vicia villosa* (Roth) # VICVI.

Additional index words: Cultural weed control, mulch, no-till, reduced herbicide rates, winter annual legume, atrazine, metolachlor, nicosulfuron, thifensulfuron, PANDI, VICVI.

INTRODUCTION

Hairy vetch is a winter annual legume suitable as a cover crop in many of the corn-producing areas of the U.S. Cover crops such as hairy vetch can reduce soil erosion, improve soil fertility, and increase crop production (10). In the northeastern U.S., hairy vetch is seeded in late summer, grows rapidly in the spring, and generally must be killed or suppressed prior to planting a grain crop such as corn. Hairy vetch is successful as a winter cover because of its excellent winter survival and nitrogen contribution to succeeding crops (3,13).

Cover crops can effect weed emergence, weed growth, and herbicide activity. Crop residues can reduce weed seed germination and seedling growth by shading, lowering soil temperature, and acting as a physical barrier (8). Residues of rye (*Secale cereale* L.) and other small grains can inhibit weed emergence and growth in numerous cropping systems (20, 21). Depending on the cover crop and the weed species, weed biomass may be reduced by as much as 90% for 30 to 60 d after killing the cover crop (21). Hairy vetch residue in a no-till system suppressed weed emergence, but the degree of suppression depended on the quantity of vetch biomass (12, 26). Hairy vetch and other legume cover crops contain allelopathic compounds (29), but allelopathy does not appear to be a major factor with hairy vetch left on the soil surface (25). In contrast, changes in light extinction and diurnal soil temperature amplitude contribute to weed suppression by live hairy vetch compared with desiccated vetch or bare soil treatments (25).

Several herbicides have been used successfully to control hairy vetch prior to corn establishment (28). Dicamba (3,6-dichloro-2-methoxybenzoic acid), 2,4-D, or combina-

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[3]Letters following this symbol are a WSSA-approved computer code from Composite List of Weeds, Revised 1989. Available from WSSA, 1508 West University Ave., Champaign, IL 61821-3133.

tions of dicamba or 2,4-D with paraquat (1,1′-dimethyl-4,4′-bipyridinium ion) effectively killed a hairy vetch cover crop prior to corn establishment; control of hairy vetch with paraquat alone or with glyphosate was less consistent (28). In general, hairy vetch is easily managed prior to grain crop establishment with an appropriate herbicide.

Tillage or mechanical incorporation also can kill or suppress hairy vetch and other cover crops (19). Tillage also can influence the types of weeds and their severity as soil mixing disrupts vegetative structures, improves soil aeration, releases volatile inhibitors, enhances seed-soil contact, and exposes weed seed to light (9, 11, 27). Tillage generally stimulates annual weed emergence (25). Ogg and Dawson (18) found that weed species responded differently to tillage. Emergence of four broadleaf species was stimulated, three broadleaf species were unaffected, and one grass species was reduced by tillage.

Mowing a cover crop can eliminate the need for a "burndown" herbicide and still maintain mulch on the soil surface to prevent soil erosion. However, the success of mowing as a means of controlling annual cover crops is variable (6, 12, 14). Johnson et al. (14) observed decreased corn stands with rye and hairy vetch in mowed plots that did not receive herbicide treatment. Mowing hairy vetch prior to the mid-bloom stage of growth failed to control the vetch adequately (12). In the absence of residual herbicides, mowing a winter rye cover crop at corn planting was also ineffective in killing the rye which subsequently competed with the grain crop (6). Other researchers have reported that cover crops can compete with corn if not killed completely prior to corn establishment (16).

Crop residues can affect herbicide performance (2, 7). Herbicides may be intercepted by and remain bound to crop residues (2). Wheat (*Triticum aestivum* L.)t straw mulch reduced the activity of metolachlor (1), while alachlor [2-chloro-*N*-(2,6-diethylphenyl)-*N*-(methoxymethyl)methoxymethyl)acetamide] and atrazine were initially adsorbed on corn residue but later released with rainfall (7). Some research suggests that crop residue may act as a physical barrier making uniform spray coverage more difficult (7). In other research, crop residues had little effect on herbicide activity (15).

Limitations may exist in using cover crops and residual herbicides. Cover crops may provide some weed suppression, but herbicide programs need to be adjusted to account for cover crop residue-herbicide interactions. Growers using cover crops and desiring to minimize herbicide inputs may need to alter further their weed management approach. This experiment was designed to evaluate methods of hairy vetch control and to determine the effect of hairy vetch control on subsequent weed control and corn performance.

MATERIALS AND METHODS

The experiment was established in adjacent fields of the Russell E. Larson Agricultural Research Farm near Rock Springs, PA during 1990 and 1991. The soil was a Hagerstown silt loam soil (fine, mixed, mesic Typic Hapludult) containing 2% organic matter with a pH of 6.7 and 6.4 in 1990 and 1991, respectively. The fields were previously in oats (*Avena sativa* L.) and were prepared by plowing, disking, and cultimulching before seeding hairy vetch at 34 kg/ha in mid August. Plots not seeded to hairy vetch (no-cover) were included for comparison.

The following spring, hairy vetch was killed or suppressed in early May using either tillage (till), mowing (mow), or a preplant application (no-till) of the butoxyethyl ester of 2,4-D plus the isopropylamine salt of glyphosate applied at 0.56 + 0.42 kg ae/ha, respectively. The no-cover plots also were treated with 2,4-D plus glyphosate. Tillage and mowing operations were performed by making two passes with a rotary cultivator[4] or a rotary mower[5], respectively. An estimate of aboveground hairy vetch biomass was determined just prior to cover crop kill by removing three 0.5-m^2 samples per replication from outside the treatment area.

Nitrogen was applied to the soil surface as ammonium nitrate at 180 kg N/ha before corn planting. No attempt was made to adjust N rates between plots with and without hairy vetch, but the supplemental nitrogen rate should have sufficiently eliminated any effect of the legume N on corn growth and yield. High phosphorus and potassium levels were maintained throughout the study by adding P and K according to soil test information prior to corn planting. Corn 'Doebler's 48X' was planted at 63 000 plants/ha in 76-cm rows following the cover-crop management treatments in early May. Subplot herbicides included atrazine plus metolachlor applied PRE at 0.9 plus 1.1, 1.3 plus 1.7, or 1.8 plus 2.2 kg ai/ha, respectively. These rates correspond to 0.5X, 0.75X, and 1.0X the manufacturers' recommended rate for annual weed control in no-till corn. An

[4]Lely Roterra 72, Lely Corp., P.O. Box 1060, Wilson, NC 27893.
[5]Bush Hog 3110, Bush Hog Corp., P.O. Box 1039, Selma, AL 36702.

additional herbicide treatment included nicosulfuron plus thifensulfuron applied POST at 35 g plus 4.5 g ai/ha, respectively, with crop oil concentrate[6] at 2.34 L/ha. All herbicides were applied with a tractor-mounted compressed air sprayer equipped with 8002[7] flat fan nozzles calibrated to deliver 187 L/ha at 207 kPa. PRE herbicides were applied immediately following corn planting; POST herbicides were applied about 4 weeks after corn planting (WAP)[8] when corn was in the three- to four-leaf stage of growth.

The experiment was arranged in a split-plot design with four cover crop management systems (no-cover, no-till, till, and mow) as main plots and herbicide treatments for annual weed control as subplots. Individual plots were 3 by 7.5 m and included four rows of corn. Visual estimates of vetch and weed control as well as weed density by species were recorded 4 and 8 WAP. The 4 WAP evaluations were taken just prior to application of the POST treatment. Above-ground weed biomass, separated into annual broadleaf and grass species, was measured 12 WAP.

Weed species in 1991 included smooth pigweed (*Amaranthus hybridus* L. # AMACH), giant foxtail (*Setaria faberi* Herrm. # SETFA), fall panicum, and scattered populations of common lambsquarters (*Chenopodium album* L. # CHEAL), Pennsylvania smartweed (*Polygonum pensylvanicum* L. # POLPY), and yellow nutsedge (*Cyperus esculentus* L. # CYPES). In addition to these weeds, species in 1992 included yellow foxtail (*Setaria glauca* (L.) Beauv. # SETLU) and scattered populations of quackgrass (*Elytrigia repens* (L.) Nevski # AGRRE) and common dandelion (*Taraxicum officinale* Weber # TAROF). Because of variable populations, perennial weed species were excluded from the biomass measurements. All density and biomass measurements were made by collecting two 0.5-m^2 samples per plot. Biomass samples were oven dried for 48 h at 70 C and then weighed. Corn population and corn height measurements were taken 6 WAP by counting the total number of plants per plot and measuring the height of five plants in the middle two rows of each four-row plot. Grain yields were determined in late fall by harvesting the middle two rows and adjusting to 15.5% moisture.

Temperature and rainfall varied considerably between the two years. The 1991 season was exceptionally warm and dry, whereas 1992 temperatures were below the seasonal average for central Pennsylvania and precipitation was close to normal for the area. Average daily temperatures for April, May, and June were 2, 5, and 3 C higher, respectively, in 1991 than in 1992 with the 30-yr average temperature for the region falling somewhere between the two years. Because of the dry weather in 1991, approximately 2.5 cm/ha water were applied as a single irrigation in early June to assist in the establishment of both crop and weed species.

All data were subjected to analysis of variance to evaluate differences among cover crop management systems, herbicide treatments, and their interaction. Percent control data were transformed using double arcsin transformations (22), but non-transformed data are presented as transformation did not affect outcome. Weed density data were square root transformed prior to analysis to correct for heterogeneity of variance. Fisher's Protected Least Significant Difference ($P \leq 0.05$) was used to compare treatment means.

[6]Prime Oil, Terra International, Inc., 6555 Quince Rd., Suite 202, Memphis, TN 38119.

[7]Spraying Systems Co., P.O. Box 7900, Wheaton, IL 60189-7900.

[8]Abbreviations: WAP, weeks after planting.

RESULTS AND DISCUSSION

Above-ground hairy vetch biomass at corn planting was 3800 and 4700 kg/ha in 1991 and 1992, respectively. Both amounts were similar to values previously reported (3, 25). Year-by-treatment interactions occurred for cover crop management systems, weed control, and corn performance parameters. Interactions between years were due to the ineffectiveness of some cover crop control treatments in 1992 with subsequent reduced corn populations, growth, and yield. Because of these interactions, the corn performance and weed control data are presented separately for 1991 and 1992.

1991 cropping season. The vetch was flowering by early May in 1991, and the weather was warm and dry for several days following implementation of the cover crop management systems. Control of hairy vetch was excellent (100%) regardless of method or residual herbicide treatment (data not shown). Cover crop management systems by herbicide treatment interactions were not significant in 1991 although both main effects were significant for weed control. Corn population was uniform throughout the experiment and unaffected by cover crop management systems or herbicide treatments (data not shown). Corn height 6 WAP was less in no-till plots followed by the mow plots although differences in crop height were not reflected in grain yield (data not presented). Grain yields were similar regardless

Table 1. Effect of cover crop management systems on weed density and biomass in 1991[a].

Cover crop management system	Weed density									
	4 WAP				8 WAP				Weed biomass[b]	
	AMACH	SETFA	PANDI	CYPES	AMACH	SETFA	PANDI	CYPES	Grass	Broadleaf
	no./m^2								g/m^2	
No-cover	24 b	4 a	9 ab	21 a	15 a	5 a	9 b	31 a	13 a	16 a
No-till	3 a	8 a	5 a	9 a	10 a	7 a	3 a	22 a	5 a	8 a
Till	5 a	7 a	19 b	13 a	8 a	11 a	8 ab	24 a	12 a	19 a
Mow	9 ab	10 a	8 a	13 a	12 a	10 a	10 b	28 a	7 a	11 a

[a]Means within a column followed by the same letter are not different at the 5% level according to Fisher's Protected LSD. Data pooled over herbicide treatments.
[b]Observations made 12 WAP.

of cover crop management systems or herbicide treatments. The low to moderate weed populations in 1991 along with excellent growing conditions apparently contributed to the competitiveness of the corn.

Smooth pigweed populations were higher in the no-cover treatments compared with the no-till and till treatments 4 WAP (Table 1). Giant foxtail density did not differ among treatments at 4 WAP, whereas fall panicum density was greatest in till treatments followed by the no cover. By 8 WAP, smooth pigweed and giant foxtail populations did not differ among cover crop management systems, whereas fall panicum densities remained lower in the no-tillage plots compared with the no-cover or mow treatments. Yellow nutsedge was unaffected by cover crop management systems.

Weed biomass did not differ among cover crop management systems 12 WAP, and the quantities of broadleaf and grass species were similar (Table 1). In general, differences in weed density were more apparent at the early evaluation period than later in the season. These results agree in part with previous research suggesting that the potential for weed suppression by a cover crop is greatest shortly after the cover crop has been killed or suppressed (21, 26).

Herbicide treatments affected the density of weed species except yellow nutsedge (Table 2). Metolachlor can effectively control yellow nutsedge (23). Lack of herbicide activity on this species probably was a result of insufficient herbicide mobilization because of dry weather. Smooth pigweed, giant foxtail, and fall panicum densities were greatest in the untreated plots and lowest in the PRE treatments 4 WAP. Control of smooth pigweed and giant foxtail with atrazine plus metolachlor was good regardless of rate, whereas fall panicum populations were lower in the 1X herbicide rate compared with the 0.5X rate. Weed control in the POST treatment was similar to the untreated plots 4 WAP as POST application occurred after the 4 wk

Table 2. Effect of herbicides on weed density and biomass in 1991[a].

Herbicide[c]	Rate[d]	Weed density									
		4 WAP				8 WAP				Weed biomass[b]	
		AMACH	SETFA	PANDI	CYPES	AMACH	SETFA	PANDI	CYPES	Grass	Broadleaf
	kg/ha	no./m^2								g/m^2	
Untreated	0	29 c	16 b	21 c	15 a	26 c	24 c	15 b	32 a	30 c	60 b
Atrazine + metolachlor	0.9 + 1.1	2 ab	5 a	6 b	16 a	7 ab	8 b	6 ab	28 a	7 ab	1 a
Atrazine + metolachlor	1.3 + 1.7	5 ab	2 a	4 ab	11 a	13 b	5 ab	8 b	28 a	5 a	2 a
Atrazine + metolachlor	1.9 + 2.2	0 a	2 a	1 a	10 a	6 ab	2 a	4 ab	16 a	2 a	0 a
Nicosulfuron + trifensulfuron[e]	0.03 + 0.004	15 bc	11 ab	19 c	18 a	3 a	5 ab	3 a	28 a	2 a	2 a

[a]Means within a column followed by the same letter are not different at the 5% level according to Fisher's Protected LSD. Data pooled over cover management systems.

[b]Observations made 12 WAP.

[c]Atrazine plus metolachlor applied PRE and nicosulfuron plus thifensulfuron applied POST.

[d]PRE herbicides applied at 0.5, 0.75, and 1X labeled rates and POST herbicides applied at labeled rates.

[e]POST application of nicosulfuron plus thifensulfuron followed 4 WAP evaluations.

Table 3. Effect of cover crop management systems and herbicide treatments on corn population, height, and grain yield in 1992[a].

Cover crop management system	Herbicide[b]	Rate[c]	Population	Height[d]	Yield
		kg/ha	no./ha	cm	kg/ha
No-cover	Untreated	0	58620 b	36 c	5390 de
	Atrazine + metolachlor	0.9 + 1.1	56470 b	34 c	6330 d–f
	Atrazine + metolachlor	1.3 + 1.7	54320 b	34 c	6650 ef
	Atrazine + metolachlor	1.9 + 2.2	59160 b	34 c	6420 ef
	Nicosulfuron + thifensulfuron	0.03 + 0.004	54860 b	34 c	6570 ef
Mean			56690 c	34 bc	6270 c
No-till	Untreated	0	44640 b	36 c	5660 d–f
	Atrazine + metolachlor	0.9 + 1.1	45720 b	38 c	6280 d–f
	Atrazine + metolachlor	1.3 + 1.7	42490 b	36 c	6420 ef
	Atrazine + metolachlor	1.9 + 2.2	45180 b	35 c	6350 d–f
	Nicosulfuron + thifensulfuron	0.03 + 0.004	36040 ab	29 a–c	6060 d–f
Mean			42810 b	35 c	6160 c
Till	Untreated	0	43030 b	33 bc	4030 bc
	Atrazine + metolachlor	0.9 + 1.1	37650 ab	30 a–c	5480 d–f
	Atrazine + metolachlor	1.3 + 1.7	44100 b	31 a–c	6100 d–f
	Atrazine + metolachlor	1.9 + 2.2	44100 b	32 a–c	5530 d–f
	Nicosulfuron + thifensulfuron	0.03 + 0.004	39800 b	26 a–c	6030 d–f
Mean			41740 b	30 ab	5430 b
Mow	Untreated	0	9680 a	11 ab	2470 a
	Atrazine + metolachlor	0.9 + 1.1	40340 b	38 c	5160 cd
	Atrazine + metolachlor	1.3 + 1.7	48410 b	40 c	5710 d–f
	Atrazine + metolachlor	1.9 + 2.2	50020 b	38 c	5930 d–f
	Nicosulfuron + thifensulfuron	0.03 + 0.004	9680 a	10 a	3730 b
Mean			31620 a	28 a	4600 a

[a]Interaction means and main effect means are examined separately within a column (not statistically compared). Means followed by the same letter are not different at the 5% level according to Fisher's Protected LSD.

[b]Atrazine plus metolachlor applied PRE and nicosulfuron plus thifensulfuron applied POST.

[c]PRE herbicides applied at 0.5, 0.75, and 1X labeled rates and POST herbicides applied at labeled rates.

[d]Observations made 6 WAP.

assessment. Weed control with the POST herbicides was equivalent to that with the 1X PRE herbicide 8 WAP. All herbicides reduced weed biomass in a similar manner.

1992 cropping season. Because of cool and wet conditions, hairy vetch was in the late vegetative stage of development at corn planting in 1992. This caused the winter annual legume to resume growth following some of the mowing treatments. Specifically, control of hairy vetch in the mow plots was inadequate in the absence of the PRE herbicides (Figure 1). In addition, based on visual observations (data not shown), hairy vetch residue appeared to dissipate more rapidly following corn planting in 1992 than the previous season, leaving little of the original biomass by late summer. The cover crop management system by herbicide treatment interaction was significant for most weed control and corn performance variables in 1992. In addition, cover crop management also affected corn performance (Table 3), but its influence on weed control was variable (Table 4). In general, herbicide treatments reduced weed density even though increasing herbicide rates did not always improve the level of control.

Corn populations were greatest in the no-cover plots and least in the mow main plots (Table 3). Herbicide treatment had no effect on corn stand except for when mowing was combined with the untreated or POST herbicide treatments. Corn also was shorter in these treatments probably due to uncontrolled hairy vetch. Corn grain yields were greater in the no-cover and no-till plots and lowest in the mow main plot treatments. Inadequate control of the hairy vetch and subsequent cover crop competition likely were responsible for the reduction in corn growth and stand and eventual yield loss in these treatments. Grain yields were similar across PRE herbicides regardless of cover crop management systems.

Other research also suggests that cover crops can interfere with successful corn establishment and influence final population and yield (6, 14, 16). Mowing winter rye at corn planting was ineffective in killing the rye which sub-

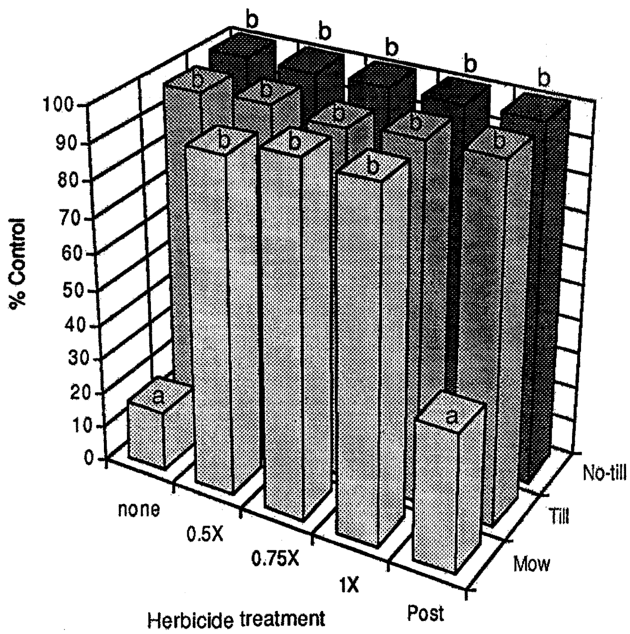

Figure 1. Effect of cover crop management systems and herbicide treatments on hairy vetch control in 1992. Bars with the same letter are not significantly different at the 5% level according to Fisher's Protected LSD. Herbicides include none, atrazine plus metolachlor at 0.5, 0.75, and 1X rates applied PRE, and labeled rates of nicosulfuron plus thifensulfuron applied POST.

sequently competed with the grain crop and reduced yield (6). Hairy vetch control with mowing was inadequate when performed at the early bud stage of growth but more successful at mid-bloom (12). In this study, the success of mowing for suppressing hairy vetch also was effective at the mid-bloom stage in 1991 but ineffective in 1992 when the vetch was still in the vegetative stage of growth. Atrazine application following mowing probably improved the level of vetch control and made the success of mowing less dependent on cover crop stage of growth (Figure 1).

Quackgrass and common dandelion populations were variable and did not respond to cover crop or herbicide treatments (data not shown). In general, it appeared that the cover crop had less effect on weed populations in 1992 compared with the previous season. As expected, weed populations were highest in the untreated herbicide checks 4 WAP, although the density of smooth pigweed, yellow foxtail, and fall panicum did not differ in the mow treatments regardless of herbicide (Table 4). The hairy vetch in the mowed untreated and in POST herbicide treatments was only partially controlled and not only competed with the corn but also likely suppressed weed growth.

Annual broadleaf weed populations were greatest in the untreated tillage plots 8 WAP, principally due to the number of smooth pigweed plants (Table 4). The tillage operation may have stimulated smooth pigweed germination. Certain annual broadleaf weed populations often increase in conventional tillage systems principally due to increased soil mixing (9, 24). Some researchers also have speculated that certain broadleaf weeds are more susceptible to mulch effects than a bare soil surface (20, 21).

In contrast, annual grass populations 8 WAP had increased dramatically in the no-tillage treatments, particularly in the untreated check and lowest rate of atrazine plus metolachlor (Table 4). Fall panicum, which often emerges well into mid-summer, was the predominant species in the grass-infested plots. Atrazine plus metolachlor can be marginally effective on fall panicum (5), and this limitation was more apparent at reduced rates under a higher crop residue environment. Limited tillage systems maximize the potential for weed growth from seed at or near the soil surface (30), and annual grass populations frequently are found to be higher in no-till compared with conventional tillage systems (24, 30). Although soil moisture was not monitored in this experiment, it is often greater under conservation tillage systems that maintain crop residue near the soil surface (4, 17). Corak et al. (4) reported higher soil moisture during the second 4-wk period following planting in a hairy vetch mulch compared with no cover. The rainfall pattern in 1992 was characterized by frequent low intensity events which may have maintained a surface moisture status capable of promoting fall panicum germination in the no-till hairy vetch systems.

Although the untreated check often had the highest weed population, weed density in general did not respond to increasing residual herbicide rates. The exception was late emerging grasses, primarily fall panicum, in the no-tillage plots (Table 4). Performance of the POST herbicide treatment was less variable over cover crop systems than the soil-applied herbicides, particularly by 8 wk after planting.

In this study, hairy vetch was effectively managed with a herbicide or with tillage prior to corn establishment, while mowing proved inadequate. Satisfactory control of the winter annual legume cover crop was critical for the successful establishment and subsequent grain yield of corn. Delaying the mowing operation until hairy vetch blooms or combining mowing with a PRE broadleaf herbicide such as atrazine may improve the success of the mowing strategy. The no-till hairy vetch mulch provided some early season weed suppression in 1991, but this

Table 4. Effect of cover crop management systems and herbicide treatments on weed density and biomass in 1992[a].

Cover crop management system and herbicide[c]	Rate[d]	Weed density								Weed biomass[b]	
		4 WAP				8 WAP					
		AMACH	SETFA	PANDI	CYPES	AMACH	SETFA	PANDI	CYPES	Grass	Broadleaf
	kg/ha	no./m								g/m	
No-cover											
Untreated	0	27 a–c	0 a	3 a	51 ab	31 a	31 a	0 a	154 b–c	40 a–e	77 b–d
Atrazine + metolachlor	0.9 + 1.1	0 a	0 a	0 a	19 ab	5 a	0 a	0 a	68 a–c	8 a	3 a
Atrazine + metolachlor	1.3 + 1.7	0 a	0 a	0 a	8 a	5 a	6 a	0 a	49 a–c	13 ab	5 a
Atrazine + metolachlor	1.9 + 2.2	0 a	0 a	3 a	11 a	0 a	0 a	6 a	43 a–c	15 ab	8 a
Nicosulfuron + trifensulfuron[e]	0.03 + 0.004	0 a	0 a	0 a	121 bc	0 a	21 a	12 a	121 a–d	8 a	5 a
Mean		5 ab	0 a	1 a	42 bc	9 a	12 a	4 a	100 b	17 a	20 a
No-till											
Untreated	0	48 bc	0 a	3 a	29 a	31 a	31 a	272 c	117 a–d	69 de	135 d
Atrazine + metolachlor	0.9 + 1.1	8 ab	0 a	0 a	19 ab	15 a	12 a	210 bc	49 a–c	73 e	30 ab
Atrazine + metolachlor	1.3 + 1.7	0 a	0 a	3 a	13 a	11 a	0 a	86 ab	37 a–c	31 a–e	6 a
Atrazine + metolachlor	1.9 + 2.2	3 a	0 a	5 a	8 a	18 a	31 a	43 ab	68 a–c	23 a–c	5 a
Nicosulfuron + trifensulfuron[e]	0.03 + 0.004	32 ab	0 a	0 a	38 ab	5 a	18 a	6 a	52 a–c	23 a–c	9 a
Mean		18 b	0 a	2 a	22 ab	16 a	19 a	124 c	44 c	44 c	37 b
Till											
Untreated	0	67 c	0 b	21 b	169 c	130 b	18 a	0 a	179 cd	53 b–e	95 cd
Atrazine + metolachlor	0.9 + 1.1	0 a	0 a	3 a	19 ab	5 a	6 a	0 a	74 a–d	22 a–c	21 ab
Atrazine + metolachlor	1.3 + 1.7	0 a	0 a	0 a	3 a	3 a	0 a	0 a	31 ab	9 ab	8 a
Atrazine + metolachlor	1.9 + 2.2	0 a	0 a	0 a	19 ab	5 a	0 a	25 a	43a–c	9 ab	5 a
Nicosulfuron + trifensulfuron[e]	0.03 + 0.004	8 ab	0 a	0 a	94 a–c	0 a	0 a	3 a	216 d	39 a–e	17 ab
Mean		15 ab	0 a	5 a	61 c	29 a	5 a	5 a	108 b	26 ab	29 ab
Mow											
Untreated	0	0 a	0 a	0 a	0 a	12 a	6 a	0 a	33 ab	33 a–e	29 ab
Atrazine + metolachlor	0.9 + 1.1	11 ab	0 a	3 a	5 a	24 a	15 a	55 ab	62 a–c	62 c–e	33 a–c
Atrazine + metolachlor	1.3 + 1.7	5 a	0 a	0 a	14 a	8 a	12 a	58 ab	52 a–c	25 a–d	23 ab
Atrazine + metolachlor	1.9 + 2.2	0 a	0 a	5 a	5 a	0 a	31 a	31 a	43 a–c	40 a–e	19 ab
Nicosulfuron + trifensulfuron[e]	0.03 + 0.004	0 a	0 a	0 a	0 a	6 a	62 a	21 a	0 a	25 a–d	20 ab
Mean		3 a	0 a	2 a	5 a	10 a	25 a	33 b	38 a	37 bc	25 ab

[a]Interaction means and main effect means are examined separately within a column (not statistically compared). Means followed by the same letter are not different at the 5% level according to Fisher's Protected LSD.

[b]Observations made 12 WAP.

[c]Atrazine plus metolachlor applied PRE and nicosulfuron plus thifensulfuron applied POST.

[d]PRE herbicides applied at 0.5, 0.75, and 1X labeled rates and POST herbicides applied at labeled rates.

[e]POST application of nicosulfuron plus thifensulfuron followed 4 WAP evaluations.

system had the highest annual grass population late in the 1992 season compared with other cover crop treatments. Although the cover crop mulch for the most part did not adversely affect herbicide performance, species common to reduced tillage environments could become more problematic in no-till cover crop systems (e.g., fall panicum). POST control of these problem weed species may allow for effective management of the weeds without concern for interactions with cover crop residues.

Although above-ground hairy vetch biomass was slightly higher at corn planting time in 1992 than in 1991, the residue appeared to dissipate more quickly in 1992. Previous research suggests that the greatest potential for weed suppression with cover crops is within the first 30 d following desiccation (21, 26), and perhaps both hairy vetch stage of growth at planting time and climatic conditions following cover crop kill affect mulch longevity and subsequent weed control. These results suggest that research that examines climatic condition effects on hairy vetch stage of growth, mulch longevity, and weed species response is needed to utilize more effectively cover crops such as hairy vetch in grain crop production systems.

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