Weed Control for Corn Planted into Sod

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INTRODUCTION

Tilling permanent vegetation initiates processes that degrade soil resources and make sustainable production difficult. Erosion is increased asmuch as 100 times and continued cropping causes soil organic matter to decline. This, in turn reduces soil structural stability and rainfall infiltration, increases runoff, and accelerates erosion Erosion and organic matter loss are less intense in the Midwest than in the Midsouth where the thermic climate accelerates organic decomposition and intense rainstorms increase erosion.

While growing annual crops, no-tillage systems reduce soil erosion by 90 to 99%, closer to the geologic rate than the losses from tilled agriculture. Organic debris from the crop, weed growth or a cover crop protect the soil from raindrop impact and slow the overland flow of runoff. Even with no cover, untilled soil resists erosion more strongly than recently tilled soil (Van Doren et al., 1984). Bruce et al. (1995) reported that crop yields increased with continued no-tillage. They attributed this to increased organic matter in the soil surface, which improved rainfall infiltration and water available for the crop. Several years were required to restore productivity on a site degraded by tilled annual cropping. One tillage cycle destroyed the benefits derived from several years of no-tillage.

Several million acres of hghly erodible cropland were enrolled in the CRP (Conservation Reserve Program) in the Midsouth during the 1980s. These contracts are maturing, and commodity price levels common in 19% could accelerate conversion of this land to annual cropping. Development of *systems* for no-tillage planting into sod would preserve soil benefits accumulated during the CRP years and increase sustainability while producing annual crops.

Some of the first successful no-tillage reported involved corn planted into sod killed with herbicides (Davidson and Barrons, 1954; Moody et al., 1961; Triplett et al., 1964). The introduction of atrazine in 1959 facilitated the subsequent development of no-tillage production systems. High atrazine rates control cool season perennial grasses found in the Midwest with or without contact herbicides. Despite the obvious benefits, such systems have not been widely developed for use in the Midsouth. Atrazine does not control warm season perennial grasses common in the Midsouth, such as johnsongrass *(Sorghum halepense* [L.] Pers.), bermudagrass *(Cynodon dactylon* [L.] Pers.), broomsedge *(Andropogon virginicus* L.), and *Paspalum* sp., and no other suitable herbicides have been available to control all of these grasses except johnsongrass, which can be controlled effectively with nicosulfuron and primisulturon. A recently published survey of vegetation present on CRF' sites in Kentucky Martin et al., 1996) found vegetation similar to the lower Midsouth.

Williams and Wicks (1978) listed bermudagrass and johnsongrass as major detriments to reduced tillage with herbicides available at that time. Timely corn *(Zea mays* L.) planting into dormant sod compounds the problem because preemergence applications of herbicides, active solely through foliar uptake, are ineffective. Vegetation control is essential for no-tillage production of any crop.

Herbicides are becoming available for no-tillage planting into sod. Products that control perennial vegetation, and transgenic corn hybrids that tolerate pre- and postemergence applications of these herbicides, have been developed. Triplett et al. (1964) stated that herbicides for no-tillage must: 1) control vegetation present, 2) prevent growth of weeds from seed, 3) not injure the crop, 4) not injure succeeding crops, and 5) be economical. Objectives of this study were to evaluate various herbicide combinations and rates for control of untilled perennial vegetation as a means of producing *corn*, to meet the first four requirements listed above.

MATERIALS AND METHODS

Corn was planted into untilled sod in 1995 and 1996 at the Mississippi Agricultural and Forestry Experiment Station's North Mississippi Branch, Holly Springs, Black Belt Branch, Brooksville; and Coastal Plain Branch, Newton. Soils at these respective sites were Grenada silt loam (fine-silty, mixed, thermic Glossic Fragiudalfs) with a 2-5% slope; Brooksville silty clay fine, montmorillonitic, thermic Agric Chromuderts) with a 1 to 3% slope; and Prentiss fine sandy loam (coarse loamy siliceous, thermic Glossic Fragiudults) with a 2-5% slope. Plant species identified on the various sites are

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listed in Table 1.

Both discrete rate and logarithmic (variable) rate applications were made to evaluate herbicides. Both methods were used on plots 10 ft x 30 ft arranged in randomized complete block designs with three replications. The center two rows of each 4-row plot were sprayed using a CO_2-pressurized backpack sprayer and hand-heldboom.Allherbicides were applied in 17.7 gal/a at 30 psi. In the logarithrmc study, herbicide rate was reduced 50% for each 5 ft of plot length sprayed. Logarithmic applications provide a continuum of rates that range from no effect on vegetation to complete control. Herbicide rate required for control was determined by measuring from the point spraying began to the point of 90% control. This distance was used to calculate. the rate. A 4-row planter was used to plant into a predominantly bermudagrass sod at Newton; Holly Springs, bermudagrass and broomsedge; and Brooksville, fescue *(Festuca arundinacea)* and dallisgrass *(Paspalum dilatatum).* At Brooksville, logarithrmc rate studies were located in fescue sod and in broomsedge, late boneset, and johnsongrass, vegetation common on CRP sites. Various treatments (Table 3) were planted to Pioneer hybrid 3165, Pioneer hybrid 3245IR (imidazolinone resistant) and Dekalb hybrid 689 Liberty Link (glufosinate-ammonium resistant) hybrids, as appropriate, at 25,000 seeds/a.

In the discrete rate plots, PRE (treatments) were applied at planting as dormancy of warm season perennial species was ending 22 March to 10 April , and POST applications were made to active vegetative growth 21-28 DAP (d after planting) depending on growing conditions. The first logarithrmc rate applications were made when warm season perennials were dormant and at succeeding 14-d intervals until full vegetative growth occurred. All plots received broadcast fertilizer according to soil test recommendations. Additional N was applied sidedress at 8-10 leaf stage. Weed control ratings were recorded approximately 56 DAP for both discrete and logarithmic rate applications. Data were subjected to statistical analysis and means were separated by LSD at the 0.05 probability level.

RESULTS *AND* DISCUSSION

In preliminary results from the 1995 logarithrmc rate studies, several herbicides applied separately failed to control warm season perennial grasses at the highest rates used These herbicides included atrazine, paraquat, and cyanazine, which were eliminated from the 1996 logarithmic trials. Corn hybrids resistant to imidazolinone herbicides were included at all locations, and imazapyr and imazethapyr applied alone in the logarithmic study controlled perennial grasses (Table 1) at 0.5 lb a.i./arate except for imazethapyr on broomsedge. Imazapyr also gave excellent control of these grasses when applied three and five weeks after planting, while imazethapyr showed very low weed control at 0.5 lb ai./a. In 1996, logarithmic applications were made at 2-wk intervals on three dates, beginning in March when warm season perennials were dormant and ending in mid-April when these perennials were actively growing. Lower herbicide rates were required for control with successively later treatment dates (Table 2).

In preliminary results from discrete rate plots at Brooksville, atrazine tank mixed with paraquat or glufosinate provided 90% control of fescue, but paraquat alone was ineffective (less than 30% control, see Table 3). Also, an understory of bermudagrass, dallisgrass, and broomsedge present in the fescue sward was not controlled and developed rapidly, competing with the growing crop. Treatments containing imazapyr provided 90% control of bermudagrass, johnsongrass (data not shown) and broomsedge. Atrazine combined with either paraquat or glyphosate PRE did not control bermudagrass or johnsongrass at any of the three locations. Cool season species present on the sites were controlled readily with most herbicides used and were not competitive with the crop. Imazapyr provided season long (120 d) control (90%) of both perennial and summer annual species even at our lower rates.

Seven herbicide combinations provided 90% control, or greater, of one or more warm season perennial grasses (Table 3). All of these included imazapyr or imazethapyr or glufosinate, either alone or combined with other herbicides. In 1996, a mixture of imazapyr and imazethapyr identified as X-996 became available. X-996 failed to control perennial grasses at rates used but did control many other species at all locations.

In the discrete rate plots at Holly Springs, vegetation control with glyphosate PRE and glufosinate POST was excellent early but was unsatisfactory at 56 DAP except on broomsedge. Neither herbicide has soil residual activity, and weeds included both summer annuals and perennials that recovered from the initial application. For effective weed control with non-residual herbicides, correct timing of application was critical. Successful herbicide systems included an application at planting that suppressed the perennial grasses before the POST applications were made. Corn hybrids, those resistant to either imidazolinone or glufosinate, provided crop safety for postemergence application of effective herbicides. We observed no crop injury to resistant hybrids at any herbicide rate used.

At the Newton location, on a mostly

bermudagrass site, control with a combination paraquat plus atrazine PRE and imazapyr POST provided excellent control (90%). No other herbicide combinations were effective. Neither glyphosate nor paraquat applied postemergence with a hooded sprayer were effective for control of bermudagrass.

Warm season annuals posed a problem at all locations (see Table 1) when no soil residual herbicides were used or POST applications were not correctly timed. However, the use of imazapyr or imazethapyr PRE gave excellent control of the warm season annuals. Glyphosate PRE + glufosinate POST failed to give 90% control of these warm season annuals due to no soil residual activity and warm season annuals emerged after their use.

Cotton *(Gossypium hirsutum* L.) was planted in 1996 at one location following application of imazapyr at 0.5 and 1.0 lb ai./A in 1995. There were no crop injury symptoms observed at either rate. Triplett (1985) reported less soil residual carryover of atrazine and simazine applied to sod than when applied to tilled soil. Thus, these imidazolinone herbicides may be acting similarly.

Results from these preliminary trials indicate that with new technology available, methods of producing corn in untilled sod comprised of perennial species common in the Midsouth is possible. Additional work will be needed to verify these results at other locations, and to investigate other candidate herbicides as to rates and time of application for most effective control.

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Table 1. Species present on one or more of the three study sites.

Warm Season Grasses	**Winter Annuals**
Bennudagrass *Cynodon dactylon* L. Pers.	Chickweed mousear *Cerastium vulgatum* L.
Broomsedge *Andropogon virginicus* L.	Carolina geranium *Geranium carolinianum* L.
Johnsongrass *Sorghum halepense* L. Pers.	Henbit *Lamium amplexicaule* L.
Dallisgrass *Paspalum dilatatum* Poir.	Little barley *Hordeum pusillum* Nutt
	Hairy vetch *Vicia villosa* Roth
Broadleaf	Ryegrass *Lolium* sp.
Late. boneset *Eupatorium serotinum* Michx.	
Wild carrot *Daucus carota* L.	**Warm Season Annuals**
White health aster *Aster pilosus* Willd.	Yellow foxtail *Setariaglauca* L. Beauv.
Bullthistle *Cirsium vulgare* (Savi) Tenore	Crabgrass, southern *Digitaria ciliaris* (Retz.) Keol
Milkweed *Asclepias syiaca* L.	Broadleaf signalgrass *Brachiaria platyphylla* Griseb
Horsenettle *Solanum carolinense* L.	
Curly dock *Rumex crispus* L.	
Cool Season Grass	
Fescue *Festuca arundinacea* Schreb	

Table 2. Minimum rate of herbicide required for 90% bermudagrass control Herbicide applied with indeterminate logarithmic sprayer in 17.7 gal/a spray volume.

Treatment Herbicide	Initial Rate	Application Date and Weed Growth Stage		
		15 March Dormant	1 April Early Vegetative	15 April Vegetative
	lb ai/a	---Herbicide Rate (lb ai/a) ---		
Imazapyr	0.5	>0.5	0.19	0.04
Imazethapyr	*0.25*	>0.25	0.21	0.13
Glufosinate	0.84	>0.84	>0.84	0.57
x-9%	*0.22*	>0.22	>0.22	0.18
LSD(0.05)			0.01s	0.056

Table 3. Effect of PRE and POST herbicide treatments on broomsedge, bermudagrass, and fescue at three locations. Ratings 56 DAP.

	Treatment Herbicide	Rate	Broomsedge		Bermudagrass		Fescue	
			1995	1996	1995	1996	1995	1996
		lb ai/a			% Control[1]			
1	Paraquat+atrazine PRE +	0.5+1.0	54bc	---[2]	---	---	90a	---
	a imazapyr PRE	0.5	---	98a	---	96a	---	---
	b imazapyr POST	0.25	---	---	93a	---	---	---
	c paraquat POST*	0.6	---	---	23d	---	85a	---
	d glufosinate POST	0.75	---	---	---	40c	---	---
	e glyphosate POST*	0.6	---	---	53bc	---	---	---
	f imazethapyr POST	0.125	53bc	---	---	---	88a	---
2	Glyphosate+atrazine PRE +	I 25+1.0	53bc	---	23d	---	50b	---
	a imazapyr PRE	0 5	---	96ab	---	96a	---	93ab
	b paraquat POST*	0 6	70ab	---	17d	---	---	---
	c glyphosate POST*	0 6	---	---	50c	---	---	---
	d sethoxydin POST	0 2	---	---	53bc	---	---	77d
	e imazethapyr POST	0 125	---	---	33d	---	---	90ab
3	Glufosinate+atrazine PRE +	.2+1.0	84bc	---	20d	---	90a	---
	a glyphosate POST*	0.6	---	---	67bc	---	---	---
	b glufosinate POST	0.375	---	---	---	80b	---	92ab
4	Paraquat PRE +	0.5	---	---	---	---	28cd	---
	a cyanazine PRE	2.0	25d	---	---	---	28cd	---
	b imazapyr PRE	0.5	---	---	---	---	---	95a
	c imazapyr POST	0.5	---	---	---	---	---	93ab
	d glufosinate POST	0.75	---	90b	---	---	---	87bc
5	Glyphosate PRE +	1.25	---	---	---	---	---	---
	a cyanazine PRE	2.0	53bc	---	---	---	---	---
	b imazapyr PRE	0.5	---	95ab	---	90a	---	---
	c imazethapyr POST	0.5	---	50d	---	37c	---	---
	d glufosinate POST	0.4	---	90b	---	80b	---	---
	e X-9% POST	0.1	---	78c	---	33cd	---	---
6	Glufosinate PRE	0.15	---	90b	---	37c	---	---
		LSD(.05)	25	6.0	16.5	6.9	12	6.7

[1] % control based on a visual rating on a scale of 0 = no control up to 100 = complete control
[2] Species not present or no treatment applied
*Hooded sprayer
Means followed by same letter do not significantly differ (P = .05 Duncan's MRT)