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Evaluation of Three Winter Cereals for Weed Control in Conservation-Tillage Nontransgenic Cotton[1]

D. WAYNE REEVES, ANDREW J. PRICE, and MICHAEL G. PATTERSON[2]

Abstract: The increased use of conservation tillage in cotton production requires that information be developed on the role of cover crops in weed control. Field experiments were conducted from fall 1994 through fall 1997 in Alabama to evaluate three winter cereal cover crops in a high-residue, conservation-tillage, nontransgenic cotton production system. Black oat, rye, and wheat were evaluated for their weed-suppressive characteristics compared to a winter fallow system. Three herbicide systems were used: no herbicide, preemergence (PRE) herbicides alone, and PRE plus postemergence (POST) herbicides. The PRE system consisted of pendimethalin at 1.12 kg ai/ha plus fluometuron at 1.7 kg ai/ha. The PRE plus POST system contained an additional application of fluometuron at 1.12 kg/ha plus DSMA at 1.7 kg ai/ha early POST directed (PDS) and lactofen at 0.2 kg ai/ha plus cyanazine at 0.84 kg ai/ha late PDS. No cover crop was effective in controlling weeds without a herbicide. However, when black oat or rye was used with PRE herbicides, weed control was similar to the PRE plus POST system. Rye and black oat provided more effective weed control than wheat in conservation-tillage cotton. The winter fallow, PRE plus POST input system yielded significantly less cotton in 2 of 3 yr compared to systems that included a winter cover crop. Use of black oat or rye cover crops has the potential to increase cotton productivity and reduce herbicide inputs for nontransgenic cotton grown in the Southeast.

Nomenclature: Black oat, *Avena strigosa* Schreb. ‘SoilSaver’; rye, *Secale cereale* L. ‘Elbon’; wheat, *Triticum aestivum* L. ‘Pioneer P26 J61’; cotton, *Gossypium hirsutum* L. ‘Deltapine DP 5690’, ‘Deltapine NuCotn 35B’.

Additional index words: Allelopathy, cover crops.

Abbreviations: DAP, days after planting; PDS, postemergence-directed spray; POST, postemergence; PRE, preemergence.

INTRODUCTION

Conservation-tillage systems are primarily used to address concerns about soil erosion, soil quality, and water availability (Blevins et al. 1971; Bradley 1995; Kaspar et al. 2001; Reeves 1994, 1997). Cotton hectarage in conservation-tillage systems is estimated to be 30% in the United States and approaches 60% in the southeastern United States (Anonymous 2003). Approximately 90% of the U.S. cotton grown in 2001 received herbicides (Anonymous 2002). Practical alternatives to the intensive use of herbicides for controlling weeds in cotton production offer economical as well as environmental benefits.

The use of cover crops in conservation tillage offers many advantages, one of which is weed suppression through physical as well as chemical allelopathic effects (Nagabhushana et al. 2001; Phatak 1998). Cereal rye (*Secale cereale* L.) and soft red winter wheat (*Triticum aestivum* L.) are the two of the most common winter cover crops recommended for cotton production in the United States (Jost et al. 2004; McCarty et al. 2003; Monks and Patterson 1996). Both of these cover crops also contain allelopathic compounds that inhibit weed growth (Akemo et al. 2000; Chase et al. 1991; Perez and Ormeno-Nunez 1991; Yenish et al. 1996). Yenish et al. (1996) reported increased short-term weed control using a rye cover crop in no-till corn (*Zea mays* L.) but not season-long control.

In southern Brazil, black oat (*Avena strigosa* Schreb.) is the predominant cover crop on millions of hectares of conservation-tilled soybean [*Glycine max* (L.) Merr.] be-

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[2] Agronomist, J. Phil Campbell, Sr.—Natural Resource Conservation Center, 1420 Experiment Station Road, Watkinsville, GA 30677; Plant Physiologist, National Soil Dynamics Laboratory, Agriculture Research Service, U.S. Department of Agriculture, 411 South Donahue Drive, Auburn, AL 36832; Professor, Agronomy and Soils Department, Auburn University, 202 Funchess Hall, Auburn, AL 36830. Corresponding author’s E-mail: aprice@ars.usda.gov.

cause, in part, of its weed-suppressive capabilities (Derpsch et al. 1991). Black oat has recently been introduced in the southeastern United States through a joint release between Auburn University and The Institute of Agronomy of Paraná, Brazil, and is currently marketed as ‘‘SoilSaver black oat’’ (Bauer and Reeves 1999). In a greenhouse study, allelopathic compounds released from black oat were shown to inhibit cotton root elongation by 16% compared to rye when residue was mixed with soil (Bauer and Reeves 1999). However, in a field study in which residue remained on the soil surface, cotton stand establishment was not affected by black oat, rye, or wheat winter covers, and cotton lint yield was higher in plots containing black oat residue than in rye (Bauer and Reeves 1999). To our knowledge, no other published research has been conducted evaluating black oat as a winter cover crop preceding row crop establishment in the United States.

Typically, cooperative extension service recommendations in the southeastern United States encourage growers to terminate cereal winter covers relatively early, citing concerns for excessive residue interfering with planting operations or excessive moisture depletion (Jost et al. 2004; McCarty et al. 2003). Cooperative extension service recommendations also generally advocate waiting approximately 2 to 4 wk after desiccating cereal winter covers before planting cotton to avoid allelopathic effects on the following crop (Reeves 1994).

The Brazilian conservation-tillage system is based on terminating cover crops during early reproductive growth, by treating with glyphosate and mechanically rolling the covers, to form a dense mat of residue (>4,480 kg/ha) on the soil surface into which crop seeds are planted (Derpsch et al. 1991; Reeves 2003). In the southeastern United States, winter cereal cover crops reach anthesis and can be terminated in a timely fashion prior to the recommended planting windows for cotton. Ashford and Reeves (2003) evaluated a mechanical roller-crimper as an alternative method for termination of black oat, rye, and wheat cover crops. Results showed that use of a roller-crimper plus glyphosate at 0.84 kg ai/ha at anthesis was as effective at the same growth stages as using glyphosate at 1.68 kg/ha for all covers evaluated. Few growers are currently using roller-crimpers to manage cover crops; however, grower interest in this management technique exists because of its potential for reducing erosion and increasing infiltration and soil water storage (Truman et al. 2002).

While some researchers have evaluated weed-suppressive qualities of winter cover crops, few experiments have evaluated cotton response. Therefore, our objective was to evaluate weed control provided by black oat, rye, and wheat as winter cover crops within three herbicide input systems, compared to winter fallow, for conservation-tilled, nontransgenic cotton using the Brazilian system of managing cover crops. Cotton yield was also evaluated for each cover and herbicide input system.

MATERIALS AND METHODS

Field experiments were conducted from fall 1994 through fall 1997 at the Alabama Agricultural Experiment Station’s Wiregrass Research and Extension Center, located near Headland, AL. The soil was a Dothan fine sandy loam (fine-loamy, siliceous, thermic Plinthic Paleudults). The experimental area had been in a conservation-tillage system (strip-tillage consisting of subsoiling and approximately 30 cm of surface disturbance within the row) for the previous 8 yr and had a high population of Palmer amaranth (*Amaranthus palmeri* S. Wats.).

The experimental design was a strip-plot design with a factorial treatment arrangement and four replications of each treatment. Horizontal strips consisted of black oat, rye, wheat, or fallow. The seeding rate was 120 kg/ha for all cereal cover crops, and 56 kg of nitrogen (N) as ammonium nitrate was applied to the cover crops in fall 1994 and 1995 after establishment. Cover crops were no-till, drill seeded in early November of 1994, 1995, and 1996 and were terminated 3 wk prior to planting cotton in early May each year with an application of glyphosate at 1.12 kg/ha using a compressed CO_2 backpack sprayer delivering 140 L/ha at 147 kPa. Biomass from black oat, rye, wheat, and fallow plots was measured immediately before glyphosate application in all years. The aboveground portion of each cover crop and weeds in the winter fallow plots were clipped from three randomly selected 0.25-m^2 sections in each plot, dried at 60 C for 72 h, and weighed.

Within 3 d after glyphosate application, the covers were rolled with a mechanical roller-crimper, as described by Ashford and Reeves (2003), to flatten all residues on the soil surface. The cotton variety, DP 5690, was planted in 1995, and DP NuCotn 35B was planted in 1996 and 1997. Cotton was planted with a four-row planter equipped with row cleaners and double-disk openers. Cotton seeds were planted at 13 to 20 seeds per meter of row. Plots were four 92-cm-wide rows that were 9.1 m long.

Vertical plots were herbicide input systems consisting of (1) no herbicide, (2) preemergence (PRE) herbicides alone, or (3) PRE plus postemergence (POST) herbicides. The PRE herbicide low input system consisted of pendimethalin at 1.12 kg ai/ha plus fluometuron at 1.7 kg ai/ha. The PRE plus POST high input system contained additional applications of fluometuron at 1.12 kg/ha plus DSMA at 1.7 kg ai/ha early POST directed (PDS) and lactofen at 0.2 kg ai/ha plus cyanazine at 0.84 kg ai/ha late PDS.

In 1995, because the site had a well-developed hardpan, the experimental area was in-row subsoiled prior to planting with a narrow-shanked parabolic subsoiler, equipped with pneumatic tires to close the subsoil channel. In 1996 and 1997, the area was subsoiled prior to planting with a bent-leg subsoiler (paratill) 2 wk prior to planting. Weed control was determined by visual ratings (0% = no control, 100% = complete control) early in the season (approximately 30 days after planting [DAP]) and late in the season (60 DAP). All weed species present at both ratings were evaluated for control, as a reduction in total aboveground biomass resulting from both reduced emergence and growth, and the combined average for each rating and treatment was calculated. Only ratings determined at 60 DAP are reported.

Alabama Cooperative Extension System recommendations were used for insect control and nutrient management. Seed cotton yield was determined by machine harvesting the middle two rows of each plot with a spindle picker.

All data were subjected to analysis of variance (ANOVA) using the General Linear Models procedure in SAS (1998) to evaluate the effect of a 3 (herbicide input level) × 4 (winter cover) factorial treatment arrangement. Herbicide input levels and winter covers were considered fixed effects, while year effects were considered random. Nontransformed data for visual evaluations were presented because arcsine square-root transformation did not affect data interpretation. Means for appropriate main effects and interactions were separated using Fisher's protected least significant difference test at $P = 0.1$. When interactions occurred, data were presented separately, and when interactions did not occur, data were combined.

RESULTS AND DISCUSSION

Cover Crop Biomass. There was a year-by-treatment effect; therefore, results are presented by year. In 1995, residue production was similar for all winter cereal covers, averaging 5,230 kg of dry matter per hectare. Winter weeds produced 1,410 kg/ha in fallow plots. Dominant winter weeds in the fallow system in all 3 yr were cutleaf eveningprimrose (*Oenothera laciniata* Hill) and common chickweed [*Stellaria media* (L.) Vill.]. The severe winter of 1995 to 1996 resulted in differences in residue production by the covers. Biomass averaged 6,250, 4,370, 1,320, and 870 kg/ha for rye, wheat, black oat, and winter fallow, respectively, in 1996. The minimum nighttime temperature from November 1 to March 31 was below 0 C for 56 nights from 1995 to 1996 (−13 C, lowest temperature) compared to 33 nights from 1994 to 1995 (−8 C, lowest temperature) and 26 nights from 1996 to 1997 (−10 C, lowest temperature). In 1997, residue production was similar for rye (2,840 kg/ha) and black oat (2,770 kg/ha); however, wheat produced less biomass (1,600 kg/ha). Because N fertilizer was not applied to winter covers in 1997, biomass production was less than in earlier years. Winter weeds produced 770 kg/ha in fallow plots. Yenish et al. (1996) reported that rye planted in a sandy loam soil resulted in biomasses ranging from 4,540 to 5,140 kg/ha in North Carolina. Bauer and Reeves (1999) reported an average biomass of 5,300, 2,980, and 3,010 kg/ha for rye, black oat, and wheat, respectively, planted in a loamy sand soil in South Carolina. Ashford and Reeves (2003) reported a higher biomass for rye, black oat, and wheat in east-central Alabama when evaluating the effectiveness of a roller-crimper for cover crop desiccation. They also reported that, averaged over 2 yr, biomass was 10,100, 9,700 and 9,100 kg/ha for rye, black oat, and wheat, respectively. They attributed a decrease in black oat biomass to freeze injury in 1999, when temperatures were as low as −10 C. In all years, residue disturbance from tillage and planting was minimal, and residue formed a dense mat over the soil surface, as in the Brazilian conservation-tillage cover crop management system, with the exception of the fallow plot treatment.

Weed Control. There was a year-by-treatment effect; therefore, results are presented by year. Grasses (primarily large crabgrass [*Digitaria sanguinalis* (L.) Scop.] and Texas panicum [*Panicum texanum* Buckl.]), nutsedges ([*Cyperus esculentus* L.] and [*C. rotundus* L.]), sicklepod [*Senna obtusifolia* (L.) Irwin and Barnaby], and Palmer amaranth were the dominant weed species present during cotton production all 3 yr. Although there were significant cover-by-herbicide input level interactions, no cover crop was effective in controlling weeds without herbicide(s) (Table 1). Without herbicide, black oat provided more effective weed control (on the basis of visual ratings and weed biomass) than rye (35 vs. 26%) in 1995, but in 1996, rye gave greater control than black oat (54 vs. 18%) due to winter kill of black oat. In 1997, all

Table 1. Weed control[a] affected by cover crop and herbicide system for 3 yr at the Alabama Agricultural Experiment Station's Wiregrass Research and Extension Center in Headland, AL.

	1995[b]				1996[c]				1997[d]			
	Herbicide input system[e]				Herbicide input system				Herbicide input system			
Cover crop	High	Low	None	Mean	High	Low	None	Mean	High	Low	None	Mean
	Weed control (%)											
Fallow	94	86	13	64	72	43	22	45	56	57	45	53
Black oat	95	91	35	74	78	55	18	50	74	68	56	66
Rye	94	89	26	70	91	82	54	76	73	71	56	67
Wheat	94	87	14	65	82	43	20	51	69	63	52	61
Mean	94	88	22		81	58	28		68	65	52	

[a] Averaged over Palmer amaranth, sicklepod, annual grasses, and nutsedges.

[b] 1995 least significant difference ($LSD_{(0.10)}$) for cover crop = 6; for herbicide level = 4; for cover crop within herbicide level interaction = 8; for herbicide level within cover crop interaction = 7.

[c] 1996 $LSD_{(0.10)}$ for cover crop = 8; for herbicide level = 10; for cover crop within herbicide level interaction = not significant (NS); for herbicide level within cover crop interaction = NS.

[d] 1997 $LSD_{(0.10)}$ for cover crop = 21; for herbicide level = 18; for cover crop within herbicide level interaction = NS; for herbicide level within cover crop interaction = NS.

[e] Herbicide input systems consisted of: no herbicide, preemergence (PRE) herbicides alone, or PRE plus postemergence (POST) herbicides. The PRE herbicide low input system consisted of pendimethalin at 1.12 kg ai/ha plus fluometuron at 1.7 kg ai/ha. The PRE plus POST high input system contained additional applications of fluometuron at 1.12 kg/ha plus DSMA at 1.7 kg ai/ha early POST directed (PDS) and lactofen at 0.2 kg ai/ha plus cyanazine at 0.84 kg ai/ha late PDS.

covers averaged across herbicide input systems provided similar levels of weed control (61 to 67%), providing numerically increased weed control compared to winter fallow. Weed control following wheat and winter fallow were similar all years, averaging 14, 20, and 52% in 1995, 1996, and 1997, respectively. In all years, rye cover and, in 2 yr, black oat in combination with PRE herbicides provided weed control similar to high input herbicide systems. Reddy (2003) reported that rye reduced total weed density 27% in a no-till soybean system 6 wk after planting. Black oat's popularity as a cover crop in Brazil is largely because of its ability to control both annual grasses and small-seeded broadleaf weeds (Derpsch 1985, 1990).

Cotton Yield. There was a year-by-treatment effect; therefore, results are presented by year. Averaged across-winter covers and seed cotton yields were 3,860 and 3,280 kg/ha for the high herbicide input system and the low input system, respectively, in 1995 (Table 2). With-

Table 2. Seed cotton yields affected by cover crop and herbicide system for 3 yr at the Alabama Agricultural Experiment Station's Wiregrass Research and Extension Center in Headland, AL.

	1995[a]				1996[b]				1997[c]			
	Herbicide input system[d]				Herbicide input system				Herbicide input system			
Cover crop	High	Low	None	Mean[e]	High	Low	None	Mean	High	Low	None	Mean
	Seed cotton (kg/ha)											
Fallow	3,660	3,010	—[f]	3,335	2,320	440	0	920	1,000	870	300	723
Black oat	3,840	3,630	—	3,735	3,170	1,150	30	1,450	1,320	1,500	830	1,217
Rye	3,980	3,350	—	3,665	4,130	3,470	1,670	3,090	1,460	1,220	690	1,123
Wheat	3,970	3,120	—	3,545	3,340	1,550	220	1,704	1,320	1,100	250	890
Mean	3,863	3,278	—		3,240	1,653	480		1,275	1,173	518	

[a] 1995 least significant difference ($LSD_{(0.10)}$) for cover crop = not significant (NS); for herbicide level = 472; for cover crop within herbicide level interaction = NS; for herbicide level within cover crop interaction = NS.

[b] 1996 $LSD_{(0.10)}$ for cover crop = 405; for herbicide level = 486; for cover crop within herbicide level interaction = NS; for herbicide level within cover crop interaction = NS.

[c] 1997 $LSD_{(0.10)}$ for cover crop = 293; for herbicide level = 253; for cover crop within herbicide level interaction = NS; for herbicide level within cover crop interaction = NS.

[d] Herbicide input systems consisted of: no herbicide, preemergence (PRE) herbicides alone, or PRE plus postemergence (POST) herbicides. The PRE herbicide low input system consisted of pendimethalin at 1.12 kg ai/ha plus fluometuron at 1.7 kg ai/ha. The PRE plus POST high input system contained additional applications of fluometuron at 1.12 kg/ha plus DSMA at 1.7 kg ai/ha early POST directed (PDS) and lactofen at 0.2 kg ai/ha plus cyanazine at 0.84 kg ai/ha late PDS.

[e] Calculated using high and low herbicide input systems only.

[f] No harvestable yield.

out herbicide, there were no harvestable yields. There were no significant differences between cover crops averaged across herbicide input system, cover crops within herbicide input system, or herbicide input system within a cover crop. Seed cotton yields with the low input system following black oat (3,630 kg/ha) were comparable to those following the winter fallow and high herbicide input system (3,660 kg/ha).

In 1996, yields averaged across winter covers were 488, 1,653, and 3,240 kg seed cotton per hectare with no, low, and high herbicide input systems, respectively. Averaged across herbicide input systems, winter covers affected seed cotton yields in 1996, averaging 920, 1,450, 1,704, and 3,090 kg/ha for fallow, black oat, wheat, and rye, respectively (Table 2). Cotton following rye yielded more than fallow, wheat, and black oat covers. Seed cotton yields were similar following black oat and wheat, despite black oat being winter killed and producing only 1,320 kg/ha dry biomass, compared to 4,370 kg/ha biomass from wheat. Yields following either black oat or wheat were greater than those following winter fallow.

In 1997, a relatively dry fall occurred during late boll development, resulting in lower yields. Yields averaged across winter covers were 518, 1,173, and 1,275 kg seed cotton per hectare with no, low, and high herbicide input programs, respectively (Table 2). The no herbicide system yielded less than both the low and high input programs, but unlike in 1995 and 1996, there was no yield benefit from the high herbicide system compared to the low input system. The reduced yield potential as a result of the dry fall masked the yield response between the high input and low input systems. The failure to apply N fertilizer to the cover crops in 1997 reduced cover crop biomass to only 2,840 kg/ha for rye, 2,770 kg/ha for black oat, and 1,600 kg/ha for wheat, values that were 31 to 53% of the maximum achieved in other years by these cover crops. Despite this, winter covers, averaged over herbicide input systems, affected seed cotton yields in 1997, averaging 723, 1,217, 890, and 1,123 kg/ha for fallow, black oat, wheat, and rye, respectively. The fallow and wheat covers yielded less than the black oat and rye covers. Similar to 1996, there were no interactions in 1997 between cover crops and herbicide input systems.

Cotton stand establishment and growth were not evaluated in this study. Other research that used the Brazilian cover crop management system, within-row subsoiling, and a similarly equipped no-till planter resulted in a stand establishment similar to a conventional-tillage system (J. Terra, personal communication). However, cotton growth may have been influenced by allelopathic compounds leached from the black oat, rye, and wheat cover crops.

There was a strong weed control benefit for planting conservation-tilled cotton using the Brazilian cover crop management system; that is, cover crops grown to produce large amounts (>4,480 kg/ha) of residue rolled to form a dense mat on the soil surface (Derpsch et al. 1991; Reeves 2003). Our results suggest that rye and black oat cover crops are more effective than wheat for weed control in conservation-tilled cotton. In 2 of 3 yr, black oat biomass was equivalent to rye and was equivalent to or greater than wheat. However, current inferior cold tolerance of black oat compared to rye may limit its zone of utilization. Our results also agree with reports that rye is more weed suppressive than wheat (Phatak 1998). Systems that did not include herbicides were not effective at controlling weeds adequately the entire season and resulted in substantial yield losses. However, when black oat or rye was used along with PRE herbicides, similar weed control to the high input system was attained.

Results also indicate a strong yield benefit for planting conservation-tilled cotton using the Brazilian cover crop management system, compared to a winter fallow system. The winter fallow, high herbicide input system yielded significantly less seed cotton in 2 of 3 yr, compared to systems that included a winter cover crop. We attribute the observed increase in yield to many factors, including the observed decrease in weed competition, as well as other nonmeasured but known benefits of conservation-tillage systems, including increased water infiltration, reduced water evaporation from the soil, and increased soil quality (Phillips et al. 1980). Because winter covers provide early-season weed control, high-biomass cover crop systems that exclude PRE herbicides should be evaluated for the potential of allowing flexibility in POST herbicide applications as well as reducing early-season weed interference in total POST herbicide systems.

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LITERATURE CITED

Akemo, M. C., E. E. Regnier, and M. A. Bennett. 2000. Weed suppression in spring-sown rye (*Secale cereale*)–pea (*Pisum sativum*) cover crop mixes. Weed Technol. 14:545–549.

Anonymous. 2002. USDA-NASS. Web page: http://usda.mannlib.cornell.edu/reports/nassr/other/pcu-bb/agcs0502.pdf. Accessed: May 5, 2004.

Anonymous. 2003. Conservation Tillage Study Prepared for The Cotton Foundation, December 2002, by Doane Marketing Research, St. Louis, MO. Web page: http://www.cotton.org/news/2003/tillage-survey.cfm. Accessed: June 5, 2004.

Ashford, D. L. and D. W. Reeves. 2003. Use of a mechanical roller-crimper as an alternative kill method for cover crops. Am. J. Altern. Agric. 18: 37–45.

Bauer, P. J. and D. W. Reeves. 1999. A comparison of winter cereal species and planting dates as residue cover for cotton grown with conservation tillage. Crop Sci. 39:1824–1830.

Blevins, R. L., D. Cook, S. H. Phillips, and R. E. Phillips. 1971. Influence of no-tillage on soil moisture. Agron. J. 63:593–596.

Bradley, J. F. 1995. Success with no-till cotton. *In* M. R. McClelland, T. D. Valco, and R. E. Frans, eds. Conservation-Tillage Systems for Cotton. Arkansas Agricultural Experiment Station, Rep. 160. Pp. 31–33.

Chase, W. R., G. N. Muraleedharan, and A. R. Putnam. 1991. 2,2′-oxo-1,1′-azobenzene: selective toxicity of rye (*Secale cereale* L.) allelochemicals to weed and crop species: II. Chem. Ecol. 17:9–19.

Derpsch, R. 1985. Guia de Plantas para Adubação Verde de Inverno. Documentos IAPAR No. 9 (May 1985). Londrina, Paraná: Instituto Agronômico do Paraná (IAPAR), Secretaria da Agricultura e do Abastecimento. 96 p.

Derpsch, R. 1990. Do crop rotation and green manuring have a place in the wheat farming systems of the warmer areas? *In* D. A. Saunders, ed. Wheat for the Nontraditional Warm Areas. Proceedings of an International Conference, 29 June–3 August 1990, International Maize and Wheat Improvement Center. Mexico, D.F.: CIMMYT. Pp. 284–299.

Derpsch, R., C. H. Roth, N. Sidiras, and U. Köpke. 1991. Controle da erosão no Paraná, Brazil: Sistemas de cobertura do solo, plantio directo e prepare conservacionista do solo. GmbH, Eschborn, Germany: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ).

Jost, P., S. Brown, S. Culpepper, G. Harris, B. Kemerait, P. Roberts, D. Shurley, and J. Williams. 2004. Conservation tillage. *In* P. Jost, ed. 2004 Georgia Cotton Production Guide. University of Georgia Cooperative Extension Service. Web page: http://www.griffin.uga.edu/caes/cotton/2004guide/conservationtillage.pdf. Accessed: November 1, 2004.

Kaspar, T. C., J. K. Radke, and J. M. Laflen. 2001. Small grain cover crops and wheel traffic effects on infiltration, runoff, and erosion. J. Soil Water Conserv. 56:160–164.

McCarty, W. H., A. Blaine, and J. D. Byrd. 2003. Cotton no-till production. Mississippi State University Cooperative Extension Service Publ. P1695.

Monks, C. D. and M. G. Patterson. 1996. Conservation Tillage Cotton Production Guide. Alabama Cooperative Extension System Publ. ANR-952.

Nagabhushana, G. G., A. D. Worsham, and J. P. Yenish. 2001. Allelopathic cover crops to reduce herbicide use in sustainable agriculture systems. Allelopathy J. 8:133–146.

Perez, J. F. and J. Ormeno-Nunez. 1991. Difference in hydroxamic acid content in roots and root exudates of wheat (*Triticum aestivum* L.) and rye (*Secale cereale* L.) possible role in allelopathy. Chem. Ecol. 17:1037–1043.

Phatak, S. C. 1998. Managing pests with cover crops. *In* C. Shirley, G. Bowman, and C. Cramer, eds. Managing Cover Crops Profitably. Burlington, VT: Sustainable Agriculture. Pp. 25–33.

Phillips, R. E., R. L. Blevins, G. W. Thomas, W. W. Frye, and S. H. Phillips. 1980. No-tillage agriculture. Science 208:1108–1113.

Reddy, K. N. 2003. Impact of rye cover crop and herbicides on weeds, yield, and net return in narrow-row transgenic and conventional soybean (*Glycine max*). Weed Technol. 17:28–35.

Reeves, D. W. 1994. Cover crops and rotations. *In* J. L. Hatfield and B. A. Stewart, eds. Advances in Soil Science: Crops Residue Management. Boca Raton, FL: Lewis. Pp. 125–172.

Reeves, D. W. 1997. The role of soil organic matter in maintaining soil quality in continuous cropping systems. Soil Tillage Res. 43:131–167.

Reeves, D. W. 2003. A Brasilian model for no-tillage cotton production adapted to the southeastern USA. Proceedings of the II World Congress on Conservation Agriculture—Producing in Harmony with Nature, August 11–15, 2003. Iguassu Falls, Paraná, Brazil. Pp. 372–374.

[SAS] Statistical Analysis Systems. 1988. SAS/STAT User's Guide. Cary, NC: Statistical Analysis Systems Institute. 1028 p.

Truman, C. C., D. W. Reeves, J. N. Shaw, and C. H. Burmester. 2002. Soil management effects on intertill erodibility of two Alabama soils. *In* E. Van Santen, ed. Proceedings of the 25th Annual Southern Conservation Tillage Conference for Sustainable Agriculture—Making Conservation Tillage Conventional: Building a Future on 25 Years of Research, 24–26 June 2002. Special Rep. 1, Auburn, AL: Alabama Agricultural Experiment Station and Auburn University. Pp. 288–294.

Yenish, J. P., A. D. Worsham, and A. C. York. 1996. Cover crops for herbicide replacement in no-tillage corn (*Zea mays*). Weed Technol. 10:815–821.