WEED MANAGEMENT IN STRIP- AND CONVENTIONAL-TILLAGE NON-TRANSGENIC AND TRANSGENIC COTTON

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ABSTRACT

Studies were conducted to evaluate weed management systems in non-transgenic, bromoxynil-resistant, and glyphosate-resistant cotton in strip- and conventional-tillage environments. Tillage did not affect weed control, cotton lint yields, or net returns. Early season stunting in strip-tillage cotton was 5% or less, regardless of herbicide system or cultivar and was transient. Excellent (>90%) control of common lambsquarters, common ragweed, *Ipomoea* species including entireleaf, ivyleaf, pitted, and tall morningglories, and prickly sida was achieved with systems containing bromoxynil, glyphosate, and pyrithiobac early postemergence (EPOST). Glyphosate systems provided better and more consistent control of large crabgrass than bromoxynil and pyrithiobac systems. Bromoxynil and pyrithiobac EPOST did not control sicklepod unless applied in mixture with MSMA and followed by (fb) a late postemergence-directed (LAYBY) treatment of prometryn plus MSMA. Palmer amaranth was controlled (>90%) with all glyphosate and pyrithiobac systems and the bromoxynil system that included a broadcast soil-applied herbicide treatment. Bromoxynil systems without a broadcast soil-applied herbicide treatment controlled Palmer amaranth 87% or less. Herbicide systems that included glyphosate EPOST controlled sicklepod with or without a soil-applied herbicide treatment. The highest yielding cotton included all the glyphosate systems and bromoxynil systems that contained a soil-applied herbicide treatment. Non-transgenic systems that included a soil-applied herbicide treatment yielded less than soil-applied treatment plus glyphosate EPOST system. Net returns from glyphosate systems were generally higher than net returns from bromoxynil or pyrithiobac systems.

INTRODUCTION

Historically, cotton has been grown in a conventional-tillage environment using primary and secondary tillage. Prior to the registration of postemergence (POST) herbicides with over-the-top selectivity, cotton producers used intensive soil-applied herbicide treatments and high rates of relatively non-selective herbicides and specialized equipment for postemergence-directed (PDS) applications (Buchanan, 1992; McWhorter and Bryson, 1992; Wilcut et al., 1995, 1997).

Strip-tillage cotton acreage is increasing across North Carolina and the Southeastern Coastal Plain (Anonymous 2002). There are several advantages for utilizing strip-tillage production systems. These advantages include: (1) water conservation and reduction of sand blasting of cotton on sandy soils, (2) reduced tillage operations and the number of trips made across the field, and (3) improvement in soil tilth and water-holding capacity over time (Bradley, 1995). Strip-tillage production systems work well in soils that develop a hardpan or plow layer that impedes root growth (Sholar et al., 1995).

Low weed control has been cited as the major limitation to adoption of cotton in conservation-tillage cotton production (McWhorter and Jordan, 1985). Soil-applied herbicides do not provide season-long weed control in cotton, therefore proper selection of POST herbicides and other inputs are crucial for maximum weed control, cotton yield, and economic returns (Crowley et al., 1979;

Culpepper and York, 1997; Wilcut et al., 1995, 1997). In the past 5 years, advances in biotechnology and new postemergence over-the-top (POT) technology have broadened cotton growers' options for weed management strategies (Culpepper and York, 1997, 1999; Wilcut et al. 1996). Bromoxynil, glyphosate, and pyrithiobac control a broad spectrum of weeds POST (Askew and Wilcut, 1999; Culpepper and York, 1997, 1998, 1999; Dotray et al., 1996; Jordan et al., 1993a; Paulsgrove et al., 1998; Scott et al., 2001). Bromoxynil and glyphosate can be used only in their respective transgenic herbicide-resistant cultivars (York and Culpepper, 2000).

In previous studies have evaluated weed management with bromoxynil, glyphosate, and pyrithiobac in non-transgenic, bromoxynil-resistant, and glyphosate-resistant conventional- and no-tillage cotton environments have been evaluated (Askew et al., 2002; Culpepper and York, 1999). The recent increase in reduced-tillage cotton production on the mid-Atlantic and Southeastern Coastal Plain and the lack of data concerning weed management in reduced-tillage systems necessitates additional research. The objectives of this research were to evaluate weed control, cotton response and yield, and net economic returns in strip-tillage and conventional-tillage non-transgenic and transgenic cotton using pyrithiobac, bromoxynil, and glyphosate weed management systems.

MATERIALS AND METHODS

Site Preparation.

Field studies were established at the Central Crops Research Station located near Clayton, NC in 1999; the Cherry Farm Unit near Goldsboro, NC in 1999 and 2000; the Peanut Belt Research Station near Lewiston-Woodville, NC in 1999; and the Upper Coastal Plain Research Station near Rocky Mount, NC in 1999 and 2000. Soils were a Norfolk loamy sand (fine-loamy, siliceous, thermic Typic Paleudult) with 1.0% organic matter and pH 5.9 at Clayton; a Wickham loamy sand (fine-loamy, mixed, thermic Typic Hapludult) with 2.1% organic matter and pH 6.2 at Goldsboro; a Norfolk loamy sand (fine-loamy, siliceous, thermic Aquic Paleuduls) with 1.1% organic matter and pH 5.9 at Lewiston-Woodville; and a Goldsboro loamy sand (fine-loamy, siliceous, thermic Typic Paleudult) with 1.0% organic matter and pH 6.0 at Rocky Mount.

Land preparation began with desiccation of a wheat (*Triticum aestivum* L.) cover crop with glyphosate at 1.0 lb ai/acre 2 wk prior to planting. For conventionally tilled plots, soil was disked and smoothed and seed were planted with conventional equipment. In strip-tillage plots, the subsoiler shank of a strip-till rig with the planter units removed was utilized to open the soil and destroy plowpans beneath the rows. The fluted coulters smoothed the soil and broke up large clods. Rolling crumblers mounted immediately behind the fluted coulters served to further smooth the seedbed. Seed were then planted using a conventional planter. Cotton cultivars, ‘Paymaster 1220RR’ (glyphosate-resistant), ‘Stoneville BXN 47’ (bromoxynil-resistant), and ‘Stoneville 474’ (non-transgenic), were planted on May 13, 1999 at Clayton, May 17, 1999 and May 25, 2000 at Goldsboro; May 10, 1999 at Lewiston; and May 11, 1999 and May 9, 2000 at Rocky Mount. Cotton was seeded at 4 seed/foot of row. Plots were 25 feet long and four 38-inch rows wide at Clayton and Goldsboro and 25 feet long and four 36-inch rows wide at Rocky Mount and Lewiston.

Experimental Design.

The experimental design was a randomized complete block with treatments replicated three times. A split-plot treatment arrangement with main plot tillage and subplot herbicide system was utilized to facilitate tillage and planting. Fifteen herbicide systems were evaluated in each main plot and differed between the tillage regimes. The difference between the tillage regimes was due to the additional paraquat PRE treatment in strip-tilled cotton for control of emerged weed vegetation at planting.

Herbicide Programs. Five herbicide systems were evaluated for each cotton cultivar and three cultivars were grown in each tillage regime for a total of 15 herbicide systems in each tillage regime. The five herbicide systems in non-transgenic cotton included: 1) no herbicide treatment, 2) pendimethalin at 0.75 lb ai/acre plus fluometuron at 1.0 lb ai/acre PRE fb pyrithiobac at 0.032 lb ai/acre plus MSMA at 1.0 lb ai/acre EPOST fb prometryn at 1.0 lb ai/acre plus MSMA at 2.0 lb ai/acre at LAYBY, 3) the aforementioned system with hand weeding as needed (ASN) to keep plots weed-free, 4) pendimethalin at 0.75 lb ai/acre PRE banded (46 cm wide) on the seed drill (PREBAN) fb pyrithiobac at 0.032 lb ai/acre plus MSMA at 1.0 lb ai/acre EPOST fb pyrithiobac at 0.032 lb ai/acre plus clethodim at 0.125 lb ai/acre POST fb prometryn at 1.0 lb ai/acre plus MSMA at 2.0 lb ai/acre at LAYBY, and 5) pyrithiobac at 0.032 lb ai/acre plus MSMA at 1.0 lb ai/acre EPOST fb pyrithiobac at 0.032 lb ai/acre plus clethodim at 0.125 lb ai/acre POST fb prometryn at 1.0 lb ai/acre plus MSMA at 2.0 lb ai/acre at LAYBY. Herbicide programs for bromoxynil-resistant cotton included: 1) no herbicide treatment, 2) pendimethalin at 0.75 lb ai/acre plus fluometuron at 1.0 lb ai/acre PRE fb bromoxynil at 0.35 lb ai/acre plus MSMA at 1.0 lb ai/acre EPOST fb prometryn at 1.0 lb ai/acre plus MSMA at 2.0 lb ai/acre at LAYBY, 3) the aforementioned system with hand weeding ASN to keep plots weed-free, 4) pendimethalin at 0.75 lb ai/acre PREBAN fb bromoxynil at 0.35 lb ai/acre plus MSMA at 1.0 lb ai/acre EPOST fb bromoxynil at 0.35 lb ai/acre plus clethodim at 0.125 lb ai/acre POST fb prometryn at 1.0 lb ai/acre plus MSMA at 2.0 lb ai/acre at LAYBY, and 5) bromoxynil at 0.35 lb ai/acre plus MSMA at 1.0 lb ai/acre EPOST fb bromoxynil 0.35 lb ai/acre plus clethodim at 0.125 lb ai/acre POST fb prometryn at 1.0 lb ai/acre plus MSMA at 2.0 lb ai/acre at LAYBY. Herbicide programs for glyphosate-resistant cotton included: 1) no herbicide treatment, 2) pendimethalin at 0.75 lb ai/acre plus fluometuron at 1.0 lb ai/acre PRE fb glyphosate at 1.0 lb ai/acre EPOST fb prometryn at 1.0 lb ai/acre plus MSMA at 2.0 lb ai/acre at LAYBY, 3) the aforementioned system with hand weeding ASN to keep plots weed-free, 4) pendimethalin at 0.75 lb ai/acre PREBAN fb glyphosate at 1.0 lb ai/acre ANS fb prometryn at 1.0 lb ai/acre plus MSMA at 2.0 lb ai/acre at LAYBY, and 5) glyphosate at 1.0 lb ai/acre ANS fb prometryn at 1.0 lb ai/acre plus MSMA at 2.0 lb ai/acre at LAYBY.

Glyphosate ANS treatments were applied when visually estimated weed control dropped below 80% (Askew and Wilcut, 1999). The number of ANS applications necessary varied from two to four depending on weed management program, weed densities, and location. In all instances, the first glyphosate ANS treatment was applied POST on two- to four-leaf cotton. Subsequent ANS treatments were applied PDS.

Application Information. Nonionic surfactant at 0.25% (v/v) was included with EPOST, POST, and LAYBY herbicide treatments except bromoxynil, clethodim, and glyphosate treatments. Crop oil concentrate at 1.0% (v/v) was included with all clethodim treatments. Herbicides were applied with a compressed-CO_2 sprayer calibrated to 15 gallons per acre at 30 PSI. Application dates were May 9 to May 25 (PRE and PREBAN), May 28 to June 25 (EPOST and POST), and June 30 to July 10 (LAYBY) depending on location and year.

Data Collection. Late-season weed control, based on leaf discoloration and biomass reduction, was estimated visually on a scale of 0 to 100 where 0 = no control and 100 = death of all plants (Frans et al., 1986). Three separate injury parameters (stunting, discoloration, and stand reduction) were visually estimated for cotton 2 to 3 wk after POST treatment and late in the season using the aforementioned scale. Overall injury was also estimated as a combination of the three injury parameters. The two center rows of each plot were harvested once with a spindle picker modified

for small-plot harvesting. Lint and seed yield were adjusted based on the 2-year statewide average percent lint composition of each cultivar (Bowman, 1998).
Economic Analysis. An enterprise budget developed by the North Carolina Cooperative Extension Service (Brown and Cole, 1997) that included operating inputs, fixed costs, and cotton yield value was modified to represent the various weed management programs. Adjustments to operating costs included crop seed and technology fees (where applicable), herbicide application and incorporation costs, and herbicide and adjuvant costs. Cost of seed, technology fee, herbicides, and adjuvants were based on averages of quoted prices from two local agricultural suppliers. Planting costs including costs of seed and technology fees per acre were \$11.75, \$18.00, and \$22.00 for non-transgenic, bromoxynil-resistant, and glyphosate-resistant cotton, respectively. Estimated costs of POST, LAYBY, and PRE applications were \$1.17, \$2.23, and \$3.16 ha^{-1}, respectively, based on performance rates of machines and hourly operation costs (Anonymous, 1998b). Chemical costs per acre were as follows: bromoxynil, \$9.17; clethodim, \$10.30; crop oil concentrate, \$0.68; fluometuron, \$8.10; glyphosate, \$9.10; MSMA POST, \$2.77; MSMA LAYBY, \$5.53; pendimethalin, \$4.06; prometryn, \$7.49; pyrithiobac, \$10.21; and nonionic surfactant, \$0.22. Crop value, based on seasonal averages of the New York Cotton Exchange minus normal discounts, was adjusted in the budget by multiplying the lint yield from each herbicide program by an estimated market price of \$0.64 per lb.

Statistical Analysis.
Nontreated control plots could not be harvested due to uncontrolled weed biomass interference with machinery. The nontreated control and the weed-free checks for each variety were removed prior to analysis to improve homogeneity of variance in the weed control data. Percent data were arcsine squareroot transformed to stabilize variance. Data were subjected to ANOVA and treatment sums of squares were partitioned to reflect the split-plot treatment design and year-location effects (McIntosh, 1983). Where year and location effects were not significant, data were pooled. Data were analyzed separately if significant year by location effects resulted. Appropriate transformed means were separated using Fisher's Protected LSD at $P = 0.05$, however, non-transformed means are presented for clarity.

RESULTS AND DISCUSSION

Cotton Response.
Early season cotton injury for no PRE treatments was 4, 12, and 14% for glyphosate-tolerant, bromoxynil-tolerant, and non-transgenic cultivars, respectively (data not shown). This injury was indicative of early season weed pressure due to lack of soil-applied herbicide treatment. Glyphosate is a better broad-spectrum herbicide, controlling more broadleaves and grasses, than the other two herbicides resulting in less cotton stunting due to reductions in early-season weed interference. Averaged over years, locations, and tillage options, EPOST herbicides did not injure cotton (data not shown) and the slight discoloration (<5%), chlorosis on the lower cotton leaves, was transient and indicative of a urea herbicide (Ahrens, 1994; Anonymous, 1998a). Averaged over years, locations, and tillage option, there was no significant stand reduction and no differences in late-season injury among the various herbicide systems. Untreated cotton, regardless of cotton cultivar was stunted at least 80% late season (data not shown). Cotton tolerance to pyrithiobac is generally excellent unless applications are made during cold wet conditions (Allen et al., 1997; Harrison et al., 1996; Jennings et al., 1999).

Weed Control.
A herbicide system main effect was observed on all weed control data, and tillage did not affect weed control (Tables 2, 3, 4, and 5). Furthermore there was no herbicide system or tillage system

interaction among locations or over years. Thus all weed control data were pooled over location and year. Observed weed densities and growth stages were recorded in the non-treated plots at time of EPOST applications (Table 1).

Common lambsquarters was controlled ≥98% with all bromoxynil- and glyphosate-containing herbicide systems and with pyrithiobac systems that used a broadcast treatment of PRE herbicides (Table 2). Bromoxynil EPOST and glyphosate EPOST control common lambsquarters (Askew and Wilcut, 1999; Culpepper and York, 1997; Paulsgrove and Wilcut, 1999, 2001). Pyrithiobac EPOST does not control common lambsquarters (Culpepper and York, 1997; Porterfield et al., 2002). Pendimethalin plus fluometuron PRE and prometryn LAYBY control common lambsquarters (Paulsgrove and Wilcut, 1999, 2001; Wilcut et al., 1995; York and Culpepper 2000). The lower levels of common lambsquarters control with the no PRE and banded PRE systems in non-transgenic cotton, results from the lack of EPOST control from pyrithiobac and the resultant poor coverage of common lambsquarters with the LAYBY treatment of prometryn plus MSMA (data not shown).

Common ragweed was controlled at least 98% with all herbicide systems (Table 2). Fluometuron PRE, prometryn LAYBY, and glyphosate and bromoxynil EPOST control common ragweed (Culpepper and York, 1997, 1998; York and Culpepper, 2000). Pyrithiobac does not control common ragweed but does suppress it long enough to allow adequate coverage with the LAYBY treatment of prometryn plus MSMA (Paulsgrove et al., 1996).

All glyphosate systems controlled large crabgrass at least 98% (Table 2). Most bromoxynil- and pyrithiobac-containing systems controlled less large crabgrass than glyphosate systems but control was still at least 91%. As previously mentioned, neither bromoxynil nor pyrithiobac control annual grasses like large crabgrass. Clethodim, fluometuron, glyphosate, pendimethalin, prometryn, and MSMA control annual grasses like large crabgrass (York and Culpepper, 2000).

Yellow nutsedge was controlled at least 97% with all herbicide systems except one bromoxynil system which controlled 92% (Table 2). Pendimethalin, fluometuron, bromoxynil, and prometryn do not control yellow nutsedge. Glyphosate, MSMA, and pyrithiobac control yellow nutsedge (Wilcut et al., 1995; Wilcut, 1998).

Ipomoea morningglories are not controlled adequately full-season with current registered soil-applied herbicides in cotton (Crowley et al., 1979; Culpepper and York, 1997). All herbicide systems controlled the four morningglory species at least 92% with only minor differences among systems (Table 3). Although pyrithiobac controls tall morningglory less than other

Ipomoea spp. (Sunderland et al., 1995), the plants were suppressed and controlled by the later prometryn plus MSMA LAYBY treatment (data not shown). Bromoxynil, pyrithiobac, and glyphosate EPOST control *Ipomoea* morningglory species as does prometryn plus MSMA LAYBY (Askew and Wilcut, 1999; Culpepper and York, 1997, 1998; Webster et al., 2000). The vining growth nature of *Ipomoea* morningglories interferes with harvesting efficiency in cotton resulting in yield and fiber quality reductions (Wood et al., 1999). Thus near complete control of these weeds is desired to optimize harvesting efficiency.

All glyphosate systems and pyrithiobac systems that used soil-applied herbicide(s) controlled Palmer amaranth ≥96% (Table 3). Less effective control was provided by pyrithiobac systems that did not use a soil-applied herbicide treatment and by all bromoxynil systems. Previous research has also shown less effective control of Palmer amaranth with bromoxynil while glyphosate and pyrithiobac are considered effective EPOST treatments (Culpepper and York, 1998; Dotray et al., 1996; Scott et al., 2001).

Prickly sida was controlled at least 98% with all glyphosate systems and with bromoxynil and pyrithiobac systems that used a broadcast PRE soil-applied treatment (Table 3). The total POST bromoxynil and pyrithiobac systems controlled less prickly sida (87 to 91%). POST prickly sida control with bromoxynil and pyrithiobac requires timely application (Culpepper and York, 1997; Paulsgrove and Wilcut, 1999). Pendimethalin and fluometuron do not provide acceptable control of prickly sida (Paulsgrove and Wilcut, 1999; Wilcut et al., 1988).

Glyphosate systems controlled sicklepod at least 98% (Table 3). Several bromoxynil systems controlled less sicklepod than other systems. When MSMA was included with either pyrithiobac EPOST or bromoxynil EPOST, sicklepod was stunted such that a height differential was obtained between cotton and sicklepod. This height differential allowed for more effective control by the subsequent application of prometryn or MSMA LAYBY. Sicklepod control with LAYBY treatments was increased in other research when MSMA was added to bromoxynil EPOST (Paulsgrove and Wilcut, 1999, 2001) and pyrithiobac EPOST (Wilcut and Hinton, 1997).

Cotton Yield and Economic Returns.
All glyphosate herbicide systems were among the highest yielding with equivalent yields also obtained with bromoxynil and pyrithiobac systems that included the use of a soil-applied PRE herbicides (Table 4). High yields reflect high levels of weed control obtained with each herbicide system (Tables 2 and 3). Although cotton treated with the total POST bromoxynil, pyrithiobac, and glyphosate yielded similarly to cotton treated with the soil-applied treatments plus the aforementioned EPOST herbicides, the yield in the total POST system was 9% less. The lower yields in all cultivars from the total POST system reflects stunting from uncontrolled weeds due to the lack of a soil-applied herbicide treatment. Similar results have been reported for non-transgenic, transgenic bromoxynil-resistant, and transgenic glyphosate-resistant cotton (Askew and Wilcut, 1999; Buchanan and Burns, 1970; Culpepper and York, 1999; Scott et al., 2001). Glyphosate cotton that included a soil-applied herbicide treatment yielded $\geq$98% of the weed-free yield for the glyphosate-resistant cultivar. Equivalent protection of weed-free cotton yield was also achieved with bromoxynil EPOST plus a soil-applied herbicide treatment, and with pyrithiobac EPOST plus a broadcast PRE soil-applied treatment.

Net returns were similar to yield returns (Table 4). The highest net returns were obtained with all glyphosate systems. While several bromoxynil and pyrithiobac EPOST systems provided net returns equivalent to several of the glyphosate systems, they provided lower net returns than the best glyphosate system. High cotton yields and net returns were reflective of high levels of weed control (Tables 2 and 3). Total POST systems provided net returns that were statistically equivalent to the same herbicide systems with a soil-applied herbicide treatment. However total POST systems had net returns that were 11, 23, and 31% less for glyphosate, bromoxynil, and pyrithiobac systems, respectively, that included a soil-applied herbicide system. These differences likely reflect lower yields from early season weed interference and the increased cost of herbicide systems in the bromoxynil and pyrithiobac systems. Similar results for net returns in conventional tillage non-transgenic and transgenic cotton have been reported (Scott et al., 2001; Vencill, 1998).

These data show that economically effective weed management can be obtained in both conventional- and strip-tillage cotton production environments. The registration of POST herbicides for non-transgenic and transgenic cotton has provided producers new options for broad-spectrum weed control if used in a system that includes soil-applied, EPOST, and LAYBY herbicide treatments. Glyphosate in particular, provides broad-spectrum weed control, high cotton yields, and net returns while requiring minimal inputs of soil-applied herbicides. Tillage production systems did not influence weed control, yield, or net returns in non-transgenic and transgenic cotton.

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Table 1. Effect of herbicide systems on late season common lambsquarters, common ragweed, large crabgrass, yellow nutsedge, Palmer amaranth, prickly sida, and sicklepod control averaged over locations and/or years and tillage options[a].

Cultivar[b] and herbicide system[c]	Common lambsquarters	Common Ragweed	Large crabgrass	Yellow Nutsedge	Palmer amaranth	Prickly sida	Sicklepod
				%			
Bromoxynil-resistant							
Broadcast PRE	100 a	98 B	92 de	92 B	92 b	98 ab	95 ab
Banded PRE	100 a	100 A	97 abc	98 A	87 c	96 abc	87 cd
No PRE	100 a	100 A	94 cde	96 Ab	78 d	87 d	85 d
Glyphosate-resistant							
Broadcast PRE	100 a	99 Ab	99 a	98 A	100 a	99 a	100 a
Banded PRE	100 a	100 A	99 a	98 A	100 a	99 a	100 a
No PRE	99 a	100 A	98 ab	95 Ab	100 a	99 a	98 ab
Non-transgenic							
Broadcast PRE	99 a	100 A	91 e	99 A	100 a	98 ab	93 abc
Banded PRE	82 b	99 Ab	95 bcd	98 A	96 ab	93 bcd	92 bc
No PRE	53 c	100 A	92 e	97 A	92 b	98 ab	95 ab

[a]Numbers within a column followed by the same letter are not significantly different at the 5% level as determined by Fisher's Protected LSD test.

[b]Cultivars were 'Stoneville BXN 47', 'Paymaster 1220 RR', and 'Stoneville 474' for bromoxynil-resistant, glyphosate-resistant, and non-transgenic cotton, respectively.

[c]Herbicide programs for bromoxynil-resistant cotton included: 1) pendimethalin at 0.75 lb ai/acre plus fluometuron at 1.0 lb ai/acre PRE fb bromoxynil at 0.35 lb ai/acre plus MSMA at 1.0 lb ai/acre EPOST, 2) Pendimethalin PREBAN fb bromoxynil plus MSMA EPOST fb bromoxynil plus clethodim at 0.125 lb ai/acre, and 3) bromoxynil plus MSMA EPOST fb bromoxynil plus clethodim POST. Herbicide programs for glyphosate-resistant cotton included: 1) pendimethalin and fluometuron PRE fb glyphosate at 1.0 lb ai/acre EPOST, 2) pendimethalin PREBAN fb glyphosate ANS (applied POT if cotton had less than five leaves and PDS if cotton had more than four leaves), and 3) glyphosate ANS. Herbicide programs in non-transgenic cotton included: 1) pendimethalin plus fluometuron PRE fb pyrithiobac at 0.032 lb ai/acre plus MSMA at EPOST, 2) pendimethalin PREBAN fb pyrithiobac plus MSMA EPOST fb pyrithiobac plus clethodim, and 3) pyrithiobac plus MSMA EPOST fb pyrithiobac plus clethodim POST. All herbicide systems included a LAYBY of prometryn at 1.0 lb ai/acre, MSMA at 2.0 lb ai/acre, and NIS at 0.25% v/v.

Table 2. Effect of herbicide systems on late season entireleaf, ivyleaf, pitted, and tall morningglories, prickly sida, and sicklepod control averaged over locations and/or years and tillage options[a]. Effect of herbicide systems on cotton yield, percentage of weed-free yield potential, and economic return averaged over locations and/or years and tillage options[a].

Cultivar[b] and herbicide system[c]	Entireleaf morningglory	Ivyleaf morningglory	Pitted morningglory	Tall morningglory	Yield	Weed-free yield	Return
	%	%	%	%	lb/acre	%	$/acre
Bromoxynil-resistant							
Broadcast PRE	98 a	96 Abc	98 ab	98 A	820 abc	94 ab	294 bcd
Banded PRE	98 a	95 Abc	98 ab	98 A	810 abc	92 ab	270 cde
No PRE	99 a	97 abc	98 ab	100 A	720 cd	80 c	215 f
Glyphosate-resistant							
Broadcast PRE	98 a	93 bc	95 b	99 A	930 a	99 a	349 ab
Banded PRE	99 a	95 abc	96 ab	99 A	930 a	98 a	379 a
No PRE	98 a	92 c	96 ab	97 A	880 ab	91 ab	312 abc
Non-transgenic							
Broadcast PRE	99 a	99 a	98 ab	97 A	770 bcd	92 ab	241 cdef
Banded PRE	99 a	98 ab	98 ab	96 A	750 bcd	97 bc	217 def

[a]Numbers within a column followed by the same letter are not significantly different at the 5% level as determined by Fisher's Protected LSD test.

[b]Cultivars were 'Stoneville BXN 47', 'Paymaster 1220 RR', and 'Stoneville 474' for bromoxynil-resistant, glyphosate-resistant, and non-transgenic cotton, respectively.

[c]Herbicide programs for bromoxynil-resistant cotton included: 1) pendimethalin at 0.75 lb ai/acre plus fluometuron at 1.0 lb ai/acre PRE fb bromoxynil at 0.35 lb ai/acre plus MSMA at 1.0 lb ai/acre EPOST, 2) Pendimethalin PREBAN fb bromoxynil plus MSMA EPOST fb bromoxynil plus clethodim at 0.125 lb ai/acre, and 3) bromoxynil plus MSMA EPOST fb bromoxynil plus clethodim POST. Herbicide programs for glyphosate-resistant cotton included: 1) pendimethalin and fluometuron PRE fb glyphosate at 1.0 lb ai/acre EPOST, 2) pendimethalin PREBAN fb glyphosate ANS (applied POT if cotton had less than five leaves and PDS if cotton had more than four leaves), and 3) glyphosate ANS. Herbicide programs in non-transgenic cotton included: 1) pendimethalin plus fluometuron PRE fb pyrithiobac at 0.032 lb ai/acre plus MSMA at EPOST, 2) pendimethalin PREBAN fb pyrithiobac plus MSMA EPOST fb pyrithiobac plus clethodim, and 3) pyrithiobac plus MSMA EPOST fb pyrithiobac plus clethodim POST. All herbicide systems included a LAYBY of prometryn at 1.0 lb ai/acre, MSMA at 2.0 lb ai/acre, and NIS at 0.25% v/v.