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Weed Populations in Conventional and Conservation Tillage Management Cotton and Soybean Systems

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Introduction

Approximately 8,000 species, or 3% of all known plants, are considered to be weeds in agriculture. Holm et al. (1) estimated that about 200 weeds are responsible for 95% of the agricultural weed problems worldwide. Of these, about 80 weeds are categorized as the primary or most troublesome species (2, 3).

The most common weeds are not necessarily the most troublesome. Some weeds may be very abundant in crops without causing interference, such as winter annuals that emerge, flower, and set seeds early enough that crop growth and yield are unaffected. The most troublesome and important weeds are those that are difficult to control or that compete effectively with crops for light, nutrients, water, and space during the crop's growing season (4). In addition, some weeds interfere with crop harvest efficacy and reduce seed and lint quality (5, 6, 7). Ultimately, the most important weeds reduce economic returns to producers by interfering with crop growth, yield, harvest efficiency, and seed and fiber quality.

More than 200 plant species are currently recorded as weeds in cotton production in the United States (5). Weeds of cotton belong to 43 plant families; 19% are monocots (Monocotyledonae), while 81% are dicots (Dicotyledonae). Thirty to 40 species are important weeds throughout the U.S. Cotton Belt, regardless of the type of tillage production system (6).

The number of weeds in U.S. soybean production is higher than in cotton because soybeans are usually planted on a broader spectrum of soil types (e.g. heavier clay soils) with less seedbed preparation in the spring and usually with fewer tillage operations and herbicide applications. In addition, soybean production includes a larger portion of the United States and ultimately more environmental conditions than cotton.

The Mississippi Delta Management Systems Evaluation Area (MDMSEA) project was established as a consortium of several federal, state, and local agencies to improve water quality and incorporate safe and effective innovative agricultural management systems. One of three MDMSEA sites, the Deep Hollow Lake (DH) watershed near Sidon, Leflore County, Mississippi, was maintained with agronomic and "edge of field" best management practices including erosion prevention structures, conservation tillage, and reduced herbicide management systems.

The objectives of this research were to establish a baseline list of plant species in the Deep Hollow watershed and environs, to determine weed populations levels at the initiation of the project, and to detect weed shifts at MDMSEA DH as a result of conservation tillage and reduced herbicide management systems.

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Materials and Methods

The DH site selected for the study area included an area of cropland (soybean and cotton) that had been under cultivation for more than a half century. In addition to the cropland areas, DH included established grass filter strips along selected field borders (established in 1996), field borders, typical Delta Region bottomland hardwood forest, the levee along the Yazoo River, DH Lake and adjacent shore line with aquatic and semi-aquatic vegetation.

Plant species data were determined by two methods. The first method of sampling was to record each species by habitat for crop areas, grass filter strips, field borders, riparian areas, and in and around the oxbow lake at DH. Plants were collected, and vouchers were placed in the Southern Weed Science Research Unit Herbarium (SWSL) at Stoneville, Mississippi. Data were recorded and updated following the discovery of species new to the area or within a given habitat.

In the second method, plants by species were counted in a 9.75-foot-long by 3.25-foot-wide area at points 200 feet apart in reduced-tillage cotton and soybean fields in the DH watershed (approximately 250 acres) and in a conventional tillage cotton field adjacent to the DH watershed area (approximately 200 acres). Baseline weed species data were gathered at grid points in 1996 on May 9, May 30-31, June 19, June 27, and July 12. From 1997 to 1999, data were gathered twice (mid-June and late June or early July) during each summer for each field, except in mid-August 1997 for one soybean field. In each year, data were gathered prior to canopy closure, thus the late date of sampling in 1997 was due to late-planted soybean. Weed nomenclature follows the accepted common and scientific names in *Composite List of Weeds* published by the Weed Science Society of America (1989). Mean number of plants per acre was calculated for each treatment per year, and the standard error of the means was calculated for select weeds.

Conventional tillage operations in cotton included fall subsoil and bedding rows and spring double incorporation of preplant-incorporated herbicides, rebedding, knocking the tops of the beds down, planting, and up to three cultivations per year. Reduced-tillage operations in cotton excluded spring tillage associated with preplant-incorporated herbicide application and cultivations. In soybean, tillage operations were limited to occasional bedding in the fall.

Results and Discussion

From 1995 through 2001, 473 plant species were detected at DH, representing 94 families (or about 60% of the documented flora of the Mississippi Delta Region). These included six species of ferns (Pteridophyta) and 467 species of flowering plants (Spermatophyta), of which two species in two families are conifers (Gymnospermae), 136 species and 14 families are Monocotyledoneae (monocots, including grasses, sedges, rushes, lilies, orchids, etc.), and 329 species in 74 families are Dicotyledoneae (dicots or broadleaf plants).

The area surrounding the cotton and soybean fields consisted of a typical bottomland hardwood forest predominated by oaks, pecan, elm, and hackberry on the sandy, slightly elevated soils. Oaks, maples, boxelder, gums, bald cypress, cottonwood, water hickory, and locusts dominated areas in poorly drained, fine-textured soils in low areas and near the lake. Forest understory was dominated by scattered shrubs and woody vines and numerous herbaceous species. Transition areas between the forest

Table 1. The 25 most common weeds in cotton and soybean at Deep Hollow, Mississippi Delta Management Systems Evaluation Area, Sidon, Leflore County, Mississippi (1996-1999).

Common name	Scientific name
Annual bluegrass	*Poa annua* L.
Broadleaf signalgrass	*Brachiaria platyphylla* (Link.) A.S. Hitchc.
Carpetweed	*Mollugo verticillata* L.
Common chickweed	*Stellaria media* (L.) Vill.
Common purslane	*Portulaca oleracea* L.
Curly dock	*Rumex crispus* L.
Cutleaf eveningprimrose	*Oenothera laciniata* Hill
Cutleaf geranium	*Geranium disectum* L.
Honeyvine milkweed [2]	*Ampelamus albidus* (Nutt.) Britt.
Horsenettle	*Solanum carolinense* L.
Ivyleaf morningglory [1, 2, 3]	*Ipomoea hederacea* (L.) Jacq.
Johnsongrass	*Sorghum halepense* (L.) Pers.)
Pitted morningglory [1, 2, 3]	*Ipomoea lacunosa* L.
Prickly sida [1, 2, 3, 4]	*Sida spinosa* L.
Purple nutsedge [1]	*Cyperus rotundus* L.
Redvine [4]	*Brunnichia ovata* (Walt.) Shinners
Sibara	*Sibara virginica* (L.) Rollins
Sicklepod [3,4]	*Senna obtusifolia* (L.) Irwin & Barneby
Southern crabgrass [1, 2]	*Digitaria ciliaris* (Retz.) Koel.
Spurges [1, 2, 3, 4]	*Euphorbia* ssp.
Swinecress	*Coronopus didymus* (L.) Small
Trumpetcreeper [3, 4]	*Campsis radicans* (L.) Seem. ex Bureau

[1]Among the most common weeds of cotton in Mississippi according to Dowler et al (8).
[2]Among the most troublesome weeds of cotton in Mississippi according to Dowler et al (8).
[3]Among the most common weeds of soybean in Mississippi according to Dowler et al (8).
[4]Among the most troublesome weeds of soybean in Mississippi according to Dowler et al (8).

Table 2. Average sedge, grass, and broadleaf weed populations at Deep Hollow, Mississippi Delta Management Systems Evaluation Area, Sidon, Leflore County, Mississippi (1996-1999).[1]

Crop	Tillage	Weed density (standard error)			
		1996	1997	1998	1999
		no./A	*no./A*	*no./A*	*no./A*
Sedge weeds					
Soybean	Reduced	12,250 (4,720)	**2,220** **(1,200)**	**1,630** **(630)**	**90** **(60)**
Cotton	Reduced	4,490 (2.090)	**1,610** **(640)**	**980** **(580)**	**0**
Cotton	Conventional	0	2,770 (1,870)	4,980 (4,310)	1,640 (1,550)
Grass weeds					
Soybean	Reduced	26,090 (5,360)	**3,180** **(480)**	**7,480** **(1,250)**	**390** **(230)**
Cotton	Reduced	3,110 (640)	**290** **(130)**	**400** **(100)**	**570** **(330)**
Cotton	Conventional	0	0	20 (20)	0
Broadleaf weeds					
Soybean	Reduced	33,660 (3,500)	**16,830** **(1,700)**	**15,780** **(4,460)**	36,400 (1,110)
Cotton	Reduced	14,570 (2,400)	**2,630** **(520)**	**3,600** **(1,300)**	**1,790** **(470)**
Cotton	Conventional	0	390 (210)	1,300 (1,720)	130 (70)

[1]Bold numbers represent a reduction in weed population from the initial year of study (1996).

and fields (field borders) were predominated by grasses, sedges, rushes, and herbaceous plant species, many previously reported as weeds of agriculture, forests, and natural plant communities (9).

A total of 195 species — 29 in cotton exclusively, 90 in soybeans exclusively, and 76 in both crops — were present in cropland at DH. Plants from the general surveys within crops were classified into two distinct groups: (1) those that were weedy (historically reported as weeds of cotton, soybean, or other row crops); and (2) those that were of incidental occurrence (data not shown).

Weed population shifts were detected over the 4-year study period (1996-1999) at DH. Within the DH watershed area, weed populations declined during the growing season each year and over the 4-year study period, regardless of the weed groups (sedges, grasses, and broadleaf weeds) (Table 2). Regardless of the weed group, weed populations were greater in soybean than in cotton from 1996 to 1999.

In reduced-tillage soybean, sedge weed populations declined from 12,250 plants per acre in 1996 to 90 plants per acre in 1999. In reduced-tillage cotton, sedge populations per acre declined from 1996 (4,720 plants) to 1999 (0 plants). With the exception of 1996 (0 plants), sedge weed population levels per acre were similar in conventional-tillage cotton in 1997 and 1999 (2,770 and 1,640 plants) but were higher in 1998 (4,980 plants). In addition to sedge control with herbicides, an increase or decrease in sedge weed populations from one year to the next might be due to environmental conditions during April and May (i.e., rainfall during April and May of 1998 was greater than in 1999 at DH).

Grass weed populations per acre in reduced-tillage soybean decreased from 1996 (26,090 plants) to 1997 (3,180 plants), but they increased in 1998 (7,480 plants), and then sharply declined in 1999 (390 plants). Grass weed populations per acre declined in reduced-tillage cotton from 1996 (3,110 plants) to 1997 (290 plants). In 1997, 1998, and 1999, grass weed populations were not significantly different in reduced-tillage cotton (290, 400, and 570 plants per acre, respectively). In conventional cotton production, grass weed populations were less than 20 plants per acre from 1996 to 1999.

As with sedge and grass weed populations, broadleaf weed populations were greater in soybean than in cotton during the 4-year period (1996-1999) (Table 2). After a decline in broadleaf weed populations per acre in reduced-tillage soybean from 1996 (33,660 plants) to 1997 and 1998 (16,830 and 15,780 plants, respectively), populations increased in 1999 (36,400 plants). Broadleaf weed populations were greater in reduced-tillage cotton each year (1996 to 1999) when compared with the conventional-tillage cotton. In reduced-tillage cotton, the broadleaf weed population per acre was 14,570 plants in 1996, 2,630 plants in 1997, 3,600 plants in 1998, and 1,790 plants in 1999. In conventional cotton for these years, broadleaf weed populations were 0, 390, 1,300, and 130 plants per acre, respectively.

Weed species shifts were detected within a crop, between crops (cotton and soybean), and between conventional and reduced-till cotton. Weed shifts usually occurred in four categories: (1) populations decreased in both crops (crabgrass and honeyvine milkweed fell into this category); (2) populations of species such as trees and woody vines increased in both crops (data not shown); (3) populations increased initially and then decreased in both crops (barnyard grass, ivyleaf morningglory, pigweeds, and trumpet creeper fell into this category); and (4) populations increased, decreased, or remained the same over time in one crop while remaining constant or decreasing in the other crop (goosegrass fell into this category).

In glyphosate-resistant soybean in 1998 and 1999 and bromoxynil-resistant cotton in 1997 and 1998, many of the most troublesome grass, sedge, and broadleaf weeds were effectively controlled. However, weed populations of certain annual species increased, including pigweed when bromoxynil-resistant cotton was planted. In reduced-tillage and glyphosate-resistant soybean or bromoxynil-resistant cotton cropping systems, some perennial species, especially woody and viney species, increased early in the growing season, but acceptable weed control was obtained by the use of a hooded-sprayer or herbicide rotation.

Although weed populations fluctuated over time, population levels of only 12 of the 68 weed species (or species complexes) were higher in 1999 than at the initiation of this study. Of these 12 species, three are perennials (bigroot morningglory, horsenettle, and trumpetcreeper), three species are annual grasses, and the remaining six species are broadleaf annual weeds. Of the weeds that increased, only carpetweed, a low-growing annual, should have little competitive effect on cotton and soybean growth and yield. Populations of a few species fluctuated over years and were greater as a result of environmental conditions, including seasonal rainfall (riceflatsedge and yellow nutsedge) and fluctuations in normal temperatures (cutleaf geranium, henbit, shepherd’s-purse and sibara) (data not shown).

The reductions in weed populations observed over time in the reduced-tillage cotton and soybeans may be due to environmental conditions, the use of a hooded sprayer (variable-rate technology), or the use of glyphosate-resistant soybean and bromoxynil-resistant cotton. However, these results are encouraging for farmers because tillage operations typically associated with preplant-incorporated herbicide application and cultivations were not required to effectively control most weed species. Additional data is needed to determine whether populations of several of the woody species (such as bigroot morningglory, horsenettle, etc.) will increase over time in the reduced-tillage cotton and soybean areas regardless of the level of reduced tillage or the use of hooded sprayer management technologies.

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