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WEED SCIENCE

Tropical Spiderwort (*Commelina benghalensis* L.) Control and Emergence Patterns in Preemergence Herbicide Systems

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ABSTRACT

Tropical spiderwort is an exotic, invasive weed in the southern USA that has become one of the most troublesome cotton weeds in Georgia and Florida. Due to the continuous emergence pattern of tropical spiderwort, successful management will require a multi-component approach that includes an effective herbicide with soil residual activity. Field studies were conducted in Georgia and North Carolina to evaluate the effectiveness of several preemergence herbicides in suppressing tropical spiderwort emergence. The most effective (≥80% control) herbicides in 2002 at 6 wk after treatment (WAT) were clomazone at 0.42 and 1.05 kg ai/ha, fluometuron at 1.68 kg ai/ha, and *s*-metholachlor at 1.07 and 1.60 kg ai/ha. In 2003 and 2004, only *s*-metolachlor at 1.60 kg/ha controlled tropical spiderwort >80%. Because of soil type restrictions in 2003 and 2004, lower rates of fluometuron were used, and tropical spiderwort control was reduced 24 to 49%. Diuron, flumioxazin, norflurazon, and prometryn provided <70% control. Linear relationships were observed for tropical spiderwort emergence over time during the first 80 d after planting (DAP) for the herbicides evaluated. Rates of tropical spiderwort emergence for most treatments were similar to the untreated control (1.61% per day). Flumioxazin at 0.035 kg/ha (1.22% per day) and *s*-metolachlor at 1.07 and 1.60 kg/ha (0.73 and 0.50% per day, respectively) had lower rates of emergence than the untreated control. The time at which 40% of the total emergence for the season in the untreated control occurred was termed the E_{40}. Application of *s*-metolachlor at 1.07 kg/ha delayed E_{40} populations by 21 d relative to the untreated control, while *s*-metolachlor at 1.60 kg/ha suppressed emergence below the E_{40} until cotton canopy closure in Georgia. The application of herbicides with soil residual activity will be crucial for management of tropical spiderwort.

Tropical spiderwort (*Commelina benghalensis* L.), also known as Benghal dayflower, is an exotic weed that has recently invaded cropping systems in the southeastern coastal plain of the USA and become a significant pest. Tropical spiderwort was first observed in the continental USA in 1928 (Faden, 1993) and was designated a federal noxious weed in 1983 (USDA-APHIS, 2000). Tropical spiderwort was present in Georgia in 1997 but was not considered a common or troublesome weed of cotton (Dowler, 1998). In 1998, Georgia extension agents ranked *Commelina* spp. among the top 39 most troublesome weeds across all crops (Webster and MacDonald, 2001). Tropical spiderwort became problematic and was ranked as the ninth most troublesome weed in Georgia cotton by 2001, and the most troublesome cotton weed in Georgia and Florida following the 2004 growing season (Webster, 2001; 2005). In 2004, the Georgia Department of Agriculture confirmed the presence of tropical spiderwort in 29 Georgia counties (Prostko et al., 2005). In Georgia, it is estimated that more than 80,000 ha are currently infested with tropical spiderwort and its range is continuing to expand. Tropical spiderwort has also been identified in Alabama, Louisiana, and North Carolina (Faden, 1993; Krings et al., 2002; Thomas and Allen, 1993; Webster et al., 2005a), although the extent of distribution in these states has not been reported.

There are several possible explanations for the rapid spread of tropical spiderwort through agricul-

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tural fields in Georgia and Florida. First, tropical spiderwort appears to be well suited for high input agricultural production. Under high nutrient availability, tropical spiderwort had a higher relative growth rate than a related non-invasive (but alien) congener, *Commelina bracteosa* Hassk (Burns, 2004). Tropical spiderwort will often establish itself in moist soil and then move into drier parts of a field (Holm et al., 1977). Irrigation is common for crop production in the Georgia coastal plain. The second factor contributing to the apparent range expansion and significance of tropical spiderwort as a troublesome weed is its tolerance to many commonly used herbicides, especially glyphosate (Culpepper et al., 2004; Foloni et al., 2003; Spader and Vidal, 2000). Since commercial introduction in 1997, glyphosate-tolerant cotton has readily been accepted by growers across the southeastern USA. Glyphosate-tolerant cotton cultivars were planted on 89% of the 525,000 ha of cotton in Georgia, while neighboring states (Alabama, Florida, North Carolina, and South Carolina) planted these cultivars on 91 to 100% of their cotton hectares (Fernandez-Cornejo and McBride, 2002; USDA-AMS, 2002; 2003). Glyphosate-tolerant technology has allowed growers to reduce the use of soil-applied herbicides in cotton (Culpepper and York, 1998; 1999).

Glyphosate is used extensively throughout the region and is effective against most common weeds; however, it is not effective in managing tropical spiderwort (<55% control) in the field (Culpepper et al., 2004) because of herbicide tolerance and continuous germination throughout the growing season (Prostko et al., 2005). Tropical spiderwort control with glyphosate in greenhouse studies has proven variable (Foloni et al., 2003; Santos et al., 2001). Control with glyphosate is size dependent, and the size of the tropical spiderwort plants used in these greenhouse studies was not reported.

Glyphosate is applied two to four times on most glyphosate-tolerant cotton cultivars in Georgia and may be the only herbicide used in some instances (Culpepper et al., 2004). Elimination of herbicides with soil residual activity may have played a role in the rapid domination of these cropping systems by tropical spiderwort. The influence of preemergence herbicides on tropical spiderwort and other *Commelina* species has not been previously reported. The objectives of these studies were to evaluate the efficacy of herbicides with soil residual activity that were commonly used prior to adoption of glyphosate-tolerant cotton cultivars on tropical spiderwort and to determine the effect of these treatments on tropical spiderwort emergence patterns.

MATERIALS AND METHODS

Field studies were conducted in grower fields with naturalized populations of tropical spiderwort in 2002 (two locations), 2003 (two locations), and 2004 near Cairo, GA, and in 2003 and 2004 near Goldsboro, NC. Soils in Georgia were Tifton loamy sand (fine-loamy, kaolinitic, thermic Plinthis Kandiudults) with organic matter ranging from 0.9 to 2.0% and pH ranging from 5.7 to 6.4. Plots were four rows spaced 76 cm apart and 7.6 m in length. Cotton cultivars were different for each site-year in Georgia. In 2002, Deltapine DP485 B/RR (Delta Pine and Land Co., Scott, MS) and Stoneville ST4793 B/RR (Stoneville Pedigreed Seed Co.; Memphis, TN) were planted, in 2003 Deltapine DP555 B/RR and Deltapine 5690 were planted, and in 2004 Deltapine DP424 B2/RR was planted. Pendimethalin (930 g ai/ha; Prowl; BASF Corp. Agric. Prod.; Research Triangle Park, NC), which is ineffective in managing tropical spiderwort (Culpepper et al., 2004), was applied preemergence following cotton planting to control small-seeded broadleaf and grass weeds. Cotton planting occurred between 30 April and 26 May for all sites except in 2004 when cotton planting was delayed until 8 June. Vacuum seed planters were used that spaced cotton seeds 10 cm apart. Cultural practices, such as fertilization, insect management, and plant growth management, were standard for Georgia (Jost et al., 2005).

Soil in North Carolina was a Pantego loam (fine-loamy, siliceous, semiactive, thermic Umbric Paleaquults) with 6.0% organic matter and pH 4.6. Plots in North Carolina were 3.7 m wide and 4.6 m in length and prepared in bare soil without a crop.

Studies were arranged as a randomized complete block design with four replications. All herbicide treatments were applied to the soil surface prior to weed and crop emergence. Treatments in 2002, 2003, and 2004 included flumioxazin (Valor; Valent Corp.; Walnut Creek, CA) at 0.072 kg ai/ha, pyrithiobac (Staple; E.I. DuPont de Nemours and Co.; Wilmington, DE) at 0.048 kg ai/ha, and *s*-metolachlor (Dual Magnum; Syngenta Crop Protection; Greensboro, NC) at 1.07 and 1.60 kg/ha. Treatments in 2002 also included clomazone (Command; FMC Corp.; Philadelphia, PA) at 0.42 kg ai/ha and 1.05

kg/ha, diuron (Direx; Griffin L.L.C.; Valdosta, GA) at 1.68 kg ai/ha, and fluometuron (Cotoran; Griffin L.L.C.; Valdosta, GA) at 1.68 kg ai/ha. Additional treatments in 2003 and 2004 included clomazone at 0.84 kg/ha, diuron at 1.12 kg/ha, flumioxazin at 0.035 kg/ha, fluometuron at 1.12 kg/ha, norflurazon (Zorial; Syngenta Crop Protection; Greensboro, NC) at 1.57 kg/ha, fluometuron at 1.12 kg/ha plus norflurazon at 1.12 kg/ha, metolachlor (Stalwart; Sipcam Agro USA, Inc.; Roswell, GA) containing both *s*- and *r*- isomers) at 1.12 kg/ha, and prometryn (Caparol; Syngenta Crop Protection; Greensboro, NC) at 1.12 kg/ha. Treatments were applied using a CO_2-pressurized backpack sprayer equipped with flat-fan nozzles calibrated to deliver 140 L/ha at 160 kPa.

Visual estimates of tropical spiderwort control were evaluated between the last two rows of each plot at 3 and 6 wk WAT based on a scale of 0 (no control) to 100 (plant death) in Georgia. In 2003 and 2004, emergence of tropical spiderwort was quantified each week from four randomly placed 0.25 m^2 quadrants between the first and second rows of cotton. All tropical spiderwort plants were then physically removed each week through cultivation and/or hand hoeing. In North Carolina, tropical spiderwort emergence was quantified in the entire 17 m^2 area in each plot and emerged tropical spiderwort plants were killed with spot applications of paraquat following data collection. Weekly emergence data were collected in Georgia between planting and 2 wk after cotton canopy closure [78 to 81 d after planting (DAP)] and in North Carolina until late July (73 to 77 d after study initiation).

Tropical spiderwort control data were subjected to analysis of variance. While there were common treatments, due to the differences in treatment structure, data from the two locations in 2002 were analyzed separately from 2003 and 2004 data. Data were combined over locations in 2002 and combined over locations and years in 2003 and 2004 due to lack of significant year and location effects. Treatment means were separated using Fisher's Protected LSD at $P = 0.05$. The relationship between cumulative tropical spiderwort emergence and time for each treatment was fit to a linear regression model. Differences among rates of tropical spiderwort emergence (slope of the regression) were evaluated using a *t*-test (Glantz and Slinker, 2001). The tropical spiderwort population density that was equivalent to 40% of the total season emergence in the untreated control (E_{40}) was estimated from the linear regression and a 95% confidence interval calculated. In Georgia, the E_{40} in the untreated control represented tropical spiderwort population densities of 182 to 705 plants/m^2, while in North Carolina the E_{40} represented tropical spiderwort populations of 14 and 17 plants/m^2.

RESULTS AND DISCUSSION

Tropical spiderwort control (2002). The most effective treatments in controlling tropical spiderwort at 6 WAT were clomazone at 1.05 kg/ha, fluometuron, and *s*-metholachlor (Table 1). At 3 WAT, *s*-metolachlor at 1.60 kg/ha provided greater control than at 1.07 kg/ha (93 vs. 85%). By 6 WAT, *s*-metolachlor controlled tropical spiderwort 99% at both rates due to soil residual activity, while tropical spiderwort continued to emerge and grow in the untreated control. Clomazone at 1.05 kg/ha provided control (>87%) similar to that of *s*-metolachlor, but was superior to clomazone at 0.42 kg/ha (71 and 81% control at 3 and 6 WAT, respectively). Tropical spiderwort control from fluometuron was lower than with *s*-metolachlor at 3 WAT, but at 6 WAT (89%) was similar to clomazone at 1.05 kg/ha (94%). Fluometuron was a standard component of cotton weed management prior to the adoption of glyphosate-tolerant cotton systems. Fluometuron was applied to 90% of Georgia cotton hectares in 1996 (prior to glyphosate-tolerant cotton), but only 10% in 2001 (USDA-NASS, 2004). The reduction in fluometuron use may have contributed to the rapid domination of cropping systems by tropical spiderwort. Diuron efficacy on tropical spiderwort was 73 and 74%, while control with flumioxazin was 58 and 67% at 3 and 6 WAT, respectively. Previous research demonstrated a beneficial effect in controlling tropical spiderwort when diuron or flumioxazin were added to late, postemergence-directed applications of glyphosate or MSMA, relative to glyphosate or MSMA alone (Culpepper et al., 2004). While neither diuron nor flumioxazin individually provided satisfactory control, each of these may be a beneficial component of an overall management system aimed at suppressing tropical spiderwort emergence. Pyrithiobac control of tropical spiderwort was <38%.

Limited rainfall in 2002 likely affected the results of all of the herbicide treatments. Rainfall between April and August totaled 32.7 cm, <50% of the 83-year average rainfall for these five months (Hoogenboom, 2005). While there was apparently enough rainfall to activate the herbicides, the limited moisture may have reduced tropical spiderwort germination and emergence. Tropical spiderwort is considered a monsoon weed in its native habitat, which is characterized by rapid germination and completion of the lifecycle during the limited monsoon season while soil moisture is plentiful (Kaul et al., 2002).

Table 1. Tropical spiderwort control at 3 and 6 wk after treatment (WAT) by several preemergence herbicides evaluated at two Georgia locations in 2002

Treatment	Rate (kg ai/ha)	Control (%)^z	
		3 WAT	6 WAT
Clomazone	0.42	71 c	81 c
Clomazone	1.05	87 ab	94 ab
Diuron	1.68	74 c	73 d
Flumioxazin	0.072	58 d	67 d
Fluometuron	1.68	76 c	89 b
s-Metolachlor	1.07	85 b	99 a
s-Metolachlor	1.60	93 a	99 a
Pyrithiobac	0.048	34 e	37 e

[z] Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD ($P = 0.05$).

Tropical spiderwort control (2003 and 2004). The most effective treatment for tropical spiderwort in 2003 and 2004 was *s*-metolachlor (Table 2). At 3 WAT, *s*-metolachlor at 1.07 and 1.60 kg/ha controlled tropical spiderwort 79 and 90%, respectively, and 90 and 96% at 6 WAT, respectively. In 2004, metolachlor (containing both *s*- and *r*-isomers) was not as effective as *s*-metolachlor, but did control tropical spiderwort 83% at 6 WAT. Clomazone at 0.84 kg/ha controlled tropical spiderwort 70%. The rate of clomazone was reduced in 2003 and 2004 relative to 2002 and was not as effective. All of the other herbicides applied did not provide commercially acceptable control ($\leq$60% control at 6 WAT) of tropical spiderwort. Diuron and fluometuron, each applied at 1.68 kg/ha, provided marginal to good control of tropical spiderwort in 2002 (73 and 89% at 6 WAT, respectively) (Table 1). Reducing diuron and fluometuron rates to 1.12 kg/ha because of soil type restrictions decreased tropical spiderwort control to 36 and 50% at 6 WAT, respectively (Table 2). Growers in Georgia typically do not use diuron or fluometuron at rates greater than 1.12 kg/ha because of excessive cotton injury on the coarse-textured soils. Flumioxazin control of tropical spiderwort was not adequate (<55%) at either rate.

Rainfall patterns in 2003 were consistent during the early growing season and similar to the 83-year average rainfall (Hoogenboom, 2005). Rainfall was low in July 2004, but the study site was irrigated as needed through center pivot irrigation. Adequate moisture in 2003 and 2004 may have 1) allowed for sufficient herbicide activation, 2) contributed to vertical movement of some of the more mobile herbicides through the soil profile, 3) provided environmental conditions for herbicide degradation, and 4) provided favorable conditions for tropical spiderwort emergence.

Table 2. Tropical spiderwort control at 3 and 6 wk after treatment (WAT) by several preemergence herbicides evaluated at two Georgia locations in 2003 and one Georgia location in 2004

Treatment	Rate (kg ai/ha)	Control (%)^z	
		3 WAT	6 WAT
Clomazone	0.84	70 c	70 c
Diuron	1.12	26 h	36 f
Flumioxazin	0.035	35 g	52 e
Flumioxazin	0.072	41 f	54 de
Fluometuron	1.12	40 fg	50 e
Fluometuron + norflurazon	1.12 + 1.12	49 e	60 d
Metolachlor (*r*- and *s*- isomers)	1.12	61 d	83 b
s-Metolachlor	1.07	79 b	90 a
s-Metolachlor	1.60	90 a	96 a
Norfulazon	1.57	20 i	25 gh
Prometryn	1.12	26 h	31 fg
Pyrithiobac	0.048	20 i	22 h

[z] Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD ($P = 0.05$).

Rates of tropical spiderwort emergence. Tropical spiderwort emergence requires warm soil temperatures (Budd et al., 1979; Ferreira et al., 1999; Kim et al., 1990; Matsuo et al., 2004; Walker and Evenson, 1985) and emergence will continue as long as the soil remains warm, if it is not impeded by a crop canopy. Once the cotton canopy forms, tropical spiderwort emergence will be limited and growth of newly germinated seedlings will be suppressed. Effectiveness of herbicide treatments will be a function of herbicide dissipation and degradation. Therefore, success of an herbicide treatment should be evaluated by the length of residual control prior to canopy closure. The relationship between cumulative tropical spiderwort emergence (as a percentage of the untreated control) and time was described by linear regression for each herbicide (Fig. 1). A linear increase in cumulative tropical spiderwort emergence contrasts with previous observations in South Africa that characterized tropical spiderwort emergence as a single flush (following the initial season in which seed were sown in the plots) (du Toit and Le Court De Billot, 1991). This continual emergence of tropical spiderwort in the current study may reflect the nature of a depth- and age-structured soil seed bank in fields with naturalized tropical spiderwort populations.

In the untreated controls, tropical spiderwort emergence increased at a rate of 1.61% each day (Table 3). The most effective treatments in suppressing rate of tropical spiderwort emergence included *s*-metolachlor. The rate of tropical spiderwort emergence was reduced 55% by *s*-metolachlor at 1.07 kg/ha (0.73% per day) and 69% by *s*-metolachlor at 1.60 kg/ha (0.50% per day) relative to the untreated control. In contrast, metolachlor (mixture of *s*- and *r*-isomers) was not as effective in suppressing tropical spiderwort emergence (1.73% per day), probably due to the lower content of the active isomer, *s*-metolachlor.

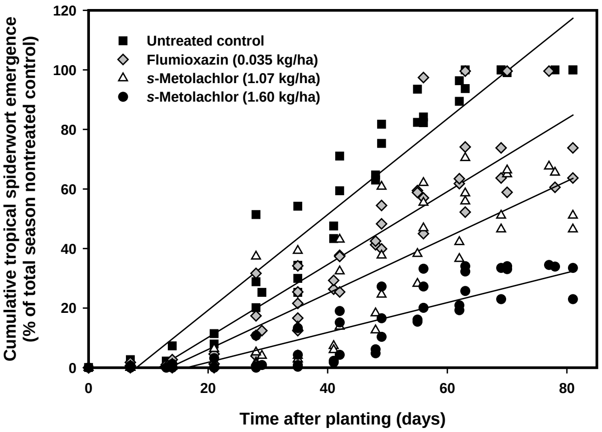

Figure 1. Cumulative tropical spiderwort emergence (to 81 d after planting) for three preemergence herbicides that had lower rates of emergence than the untreated control. Data combined over five site-years in Georgia and North Carolina in 2003 and 2004.

In the untreated control, the E_{40} population level of tropical spiderwort occurred 33 (± 2.1) DAP, while the E_{40} occurred at 54 (± 4.7) DAP in plots treated with s-metolachlor at 1.07 kg/ha, a 21-d advantage. *S*-metolachlor was applied preemergence immediately following cotton planting in this study. Because of potential cotton injury when applied prior to cotton emergence, s-metolachlor must be applied

Table 3. Parameter estimates of the linear regression describing the relationship between cumulative tropical spiderwort emergence and time. Data combined over five site-years in Georgia and North Carolina in 2003 and 2004.

Treatment	Rate (kg ai/ha)	y-intercept (std err)	Rate of emergence (std err)[y]	R^2	*p*-value	E_{40} (95% C.I.)[z]
Clomazone	**0.84**	**-21.9 (6.3)**	**1.72 (0.13)**	**0.77**	**<0.0001**	**36 (± 3.5)**
Diuron	**1.12**	**-23.4 (8.4)**	**2.09 (0.18)**	**0.74**	**<0.0001**	**31 (± 4.4)**
Flumioxazin	**0.035**	**-14.3 (4.0)**	**1.22 (0.08)***	**0.81**	**<0.0001**	**45 (± 3.0)**
Flumioxazin	**0.072**	**-12.1 (7.2)**	**1.29 (0.15)**	**0.59**	**<0.0001**	**41 (± 5.4)**
Fluometuron	**1.12**	**-24.8 (9.2)**	**1.98 (0.19)**	**0.68**	**<0.0001**	**33 (± 4.8)**
Fluometuron + norflurazon	**1.12 + 1.12**	**-17.2 (6.2)**	**2.10 (0.13)**	**0.84**	**<0.0001**	**28 (± 3.6)**
Metolachlor (*r*- and *s*-isomers)	**1.12**	**-27.3 (7.5)**	**1.73 (0.16)**	**0.92**	**<0.0001**	**39 (± 4.4)**
***s*-Metolachlor**	**1.07**	**-12.7 (4.5)**	**0.73 (0.09)***	**0.73**	**<0.0001**	**54 (± 4.7)**
***s*-Metolachlor**	**1.60**	**-8.2 (2.0)**	**0.50 (0.04)***	**0.74**	**<0.0001**	**>81**
Norflurazon	**1.57**	**-16.0 (4.7)**	**1.95 (0.10)**	**0.89**	**<0.0001**	**29 (± 2.7)**
Prometryn	**1.12**	**-11.5 (7.4)**	**1.63 (0.16)**	**0.69**	**<0.0001**	**29 (± 5.0)**
Pyrithiobac	**0.048**	**-12.2 (6.9)**	**1.67 (0.15)**	**0.73**	**<0.0001**	**32 (± 4.4)**
Untreated control	**--**	**-12.9 (3.9)**	**1.61 (0.08)**	**0.92**	**<0.0001**	**33 (± 2.1)**

[y] For values followed by an asterisk, the rate of emergence was less than untreated control and differences were analyzed using *t*-test.

[z] E_{40} is the time in days after planting (DAP) in which tropical spiderwort population density was equivalent to 40% of the total season emergence in the untreated control with the 95% confidence interval in parentheses. The predicted E_{40} for *s*-metolachlor at 1.60 kg ai/ha (>81) did not occur during this study.

postemergence to cotton that is at least 7.6 cm tall in the southeastern coastal plain (Anonymous, 2004). This could represent a 3-wk delay in *s*-metolachlor application relative to this study.

The extra time afforded by this treatment allows for cotton canopy closure before most tropical spiderwort establishment can occur. One of the principles of weed interference in crops is that the more competitive plant will dominate the interaction. Delaying tropical spiderwort emergence with *s*-metolachlor will shift the competitive advantage to cotton, especially if cotton canopy closure will occur soon after tropical spiderwort emergence (Webster et al., 2005b). When *s*-metolachlor was applied at 1.60 kg/ha, cotton canopy closure in Georgia occurred prior to achieving the E_{40} population density, therefore this treatment provided an advantage of at least 48 d relative to the untreated control.

Flumioxazin at 0.035 kg/ha was effective in suppressing the rate of tropical spiderwort emergence (1.22% per day) relative to the untreated control (Table 3). This provided a 12 d delay in E_{40} population density relative to the untreated control. Flumioxazin at 0.072 kg/ha had a similar rate (1.29 % per day) of tropical spiderwort emergence compared to flumioxazin at 0.035 kg/ha. Flumioxazin at 0.072 kg/ha was not different than the untreated control, indicating that flumioxazin was on the edge of significantly affecting rate of tropical spiderwort emergence. This conclusion is supported by the substandard control (<54%) from flumioxazin at 3 and 6 WAT.

Rate of tropical spiderwort emergence for clomazone (1.72% per day) was not different from the untreated control. In Georgia, visual ratings of tropical spiderwort control from clomazone were 70% at 3 and 6 WAT (Table 2). One potential reason for this apparent discrepancy between rate of tropical spiderwort emergence and tropical spiderwort control could involve the methods employed in this study and the herbicidal effect of clomazone. Clomazone is a preemergence herbicide that prevents carotenoid synthesis, causing a whitening of the plant tissue and inhibiting seedling growth (Devine et al., 1993). Each week, new tropical spiderwort emergence was quantified, and plants were removed through physical weed control methods (i.e. hand hoeing or cultivation). While treated tropical spiderwort seedlings were present and quantified, it is likely that many of the seedlings demonstrating clomazone injury did not survive the herbicide treatment and were not included in the visual rating of weed control at 3 and 6 WAT. This problem likely did not affect the other preemergence herbicides, as visual ratings of weed control were consistent with the findings for emergence patterns.

Rate of tropical spiderwort emergence was not suppressed by pyrithiobac (1.67% per day) compared with the untreated control (1.61% per day). Previous research indicated that pyrithiobac had postemergence activity on tropical spiderwort, but only minimal soil residual activity (Culpepper et al., 2004). All other treatments, including diuron, prometryn, norflurazon, fluometuron, and fluometuron plus norflurazon, had tropical spiderwort emergence rates that were at least as high as the untreated control (1.63 to 2.10% per day).

Peak tropical spiderwort emergence in cotton typically occurs in June or July in Georgia; however, this could be shifted into August in the absence of a crop, as was seen in North Carolina. Cotton planted in April or May will have a decided advantage because plants can work towards canopy closure prior to emergence of tropical spiderwort (Webster et al., 2005b). Cotton canopy closure will significantly curtail tropical spiderwort emergence. In 2004, cotton planting was delayed until middle June in order to allow for similar time of emergence of tropical spiderwort and cotton, and to remove cotton canopy closure as a factor in suppressing emergence. In spite of the delay in cotton planting date, emergence patterns in each of the herbicide treatments were relatively similar to those observed with April and May plantings.

CONCLUSIONS

The most consistent herbicide treatment in this study in terms of tropical spiderwort control and suppression of tropical spiderwort emergence across all site-years was *s*-metolachlor. Only *s*-metolachlor controlled tropical spiderwort >90% at 6 WAT. Tropical spiderwort rate of emergence was suppressed by *s*-metoachlor relative to the untreated control. Application of *s*-metolachlor at 1.07 kg/ha delayed E_{40} population 21 d relative to the untreated control, while *s*-metolachlor at 1.60 kg/ha suppressed emergence below the E_{40} for the entire season. Although flumioxazin at 0.035 kg/ha suppressed rate of tropical spiderwort emergence compared with the untreated control, visual control ratings did not exceed 52%. The low visual ratings were attributed to ground cover by a few tropical spiderwort plants that survived the flumioxazin application. Flumioxazin delayed the E_{40} tropical spiderwort population by at least 8 d.

Many of the commonly used preemergence herbicides in cotton will not be beneficial in managing tropical spiderwort. Due to the continuous emergence pattern of tropical spiderwort, successful management will require a multi-component approach, including an effective herbicide that provides soil residual activity (i.e. *s*-metolachlor). Fluometuron and diuron may also be beneficial in suppressing tropical spiderwort populations; however, their use will have to be in conjunction with *s*-metolachlor.

In spite of the importance of tropical spiderwort throughout the world, published studies that have specifically evaluated herbicide efficacy on tropical spiderwort are limited. Tropical spiderwort will continue to be a significant troublesome weed in Georgia and Florida. The current study demonstrated that tropical spiderwort will survive and thrive in the coastal plain of North Carolina. Based on these findings, there is a potential for tropical spiderwort to spread throughout the US cotton growing region. In addition, it is likely that tropical spiderwort may invade non-cropland areas (Kabat, 2003; Shigenobu and Kobori,1997).

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DISCLAIMER

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