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Tropical Spiderwort Identification and Control in Georgia Field Crops

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Introduction

Tropical spiderwort (*Commelina benghalensis* L.) is a noxious, exotic, invasive weed that has become a serious pest in many Georgia agricultural production areas (Figure 1). Tropical spiderwort is native to tropical Asia and Africa. In its native region, it is an herbaceous perennial weed. In the temperate climate of the south, however, it behaves as an annual weed (Holm *et al.,* 1977).

While its path of introduction into the United States is unclear, tropical spiderwort was first observed in the continental United States in 1928 and was common throughout Florida by the mid-1930s (Faden 1993). In 1983, the U.S. Department of Agriculture designated tropical spiderwort as a Federal noxious weed (USDA-APHIS 2000). Tropical spiderwort is among the world's worst weeds, considered a weed in 25 crops in 28 countries (Holm *et al.,* 1977). In 1998, tropical spiderwort was present in Georgia but was not considered an important weed of cotton (Webster and MacDonald 2001). By 2001, however, it had quickly become very problematic and was ranked as the ninth most troublesome cotton weed (Webster 2001). By 2003, tropical spiderwort was clearly the most troublesome weed of cotton and third most troublesome weed of peanut in several south Georgia counties.

Figure 1. Tropical spiderwort in peanut, Grady County, 2004. [E.P. Prostko]

Figure 2. Reddish hairs at sheath apex. [H. Pilcher]

Tropical spiderwort, also known as Bengal dayflower, is related and similar in appearance to the dayflower species that have become more common in agricultural fields over the past decade. In addition to tropical spiderwort, the most common dayflower species in Georgia include spreading dayflower (*Commelina diffusa* Burman f.), Asiatic dayflower (*Commelina communis* L.), marsh dayflower [*Murdannia keisak* (Hassk.) Hand.-Mazz.] and doveweed [*Murdannia nudiflora* (L.) Brenan.]. There are three identifying features of tropical spiderwort. First, tropical spiderwort can be distinguished from the other dayflower species by its short broad leaves (a leaf length to width ratio of <3:1). The other dayflower species have leaf blades that are relatively longer and narrower than tropical spiderwort. Second, tropical spiderwort will often have reddish (or sometimes white) hairs on the sheath apex (point at which the leaf attaches to the stem) (Figure 2). Finally, the most definitive way of identifying tropical spiderwort is through the presence of subterranean flowers (Figure 3, page 2 and Figure 7, page 3). Tropical spiderwort is the only *Commelina* species found in the United States with subterranean flowers.

Results from a recent survey illustrates the distribution of tropical spiderwort in Georgia (Figure 4, page 2). Additionally, several county extension agents, particularly those near the Florida border, have ranked tropical spiderwort as the most important weed species in their county. The increase in the prevalence of tropical spiderwort in Georgia may be attributed in part to the adoption

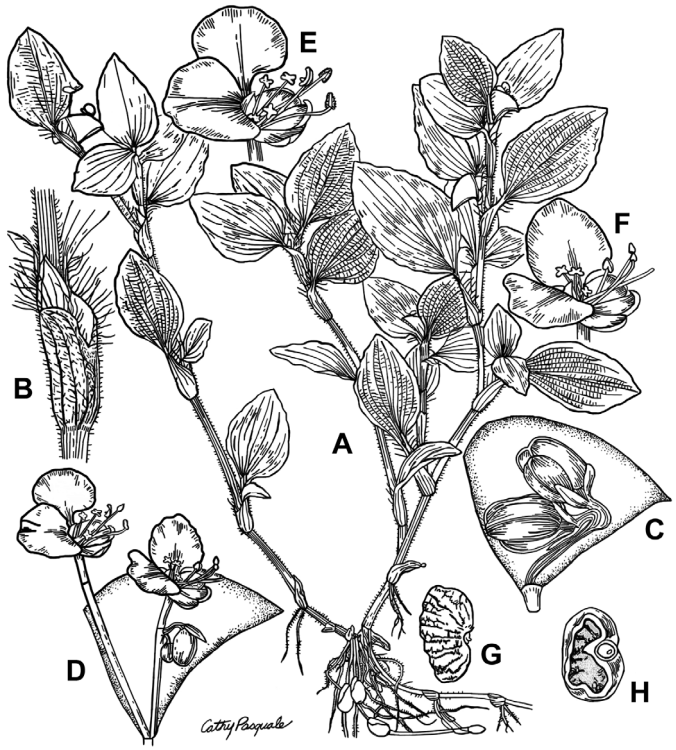

Figure 3. Drawing of tropical spiderwort (*Commelina benghalensis* L.) showing (A) whole plant with aerial and subterranean flowers; (B) leaf sheath; (C) cross-section of spathe with flower buds; (D) cross-section of spathe with open flowers; (E) imperfect flower; (F) perfect flower; (G) seed from subterranean flower; and (H) cross-section of seed from aerial flower. [Illustration by Cathy Pasquale, courtesy of USDA, Animal and Plant Health Inspection Service.]

of weed management programs that lack the use of residual herbicides along with the adoption of reduced tillage production practices. Additionally, invasive plant species, after introduction, often go long periods of time (lag period) during which the pest increases in distribution or density without being noticed as an obvious pest.

As with many troublesome weeds, tropical spiderwort is most competitive with crops when adequate moisture is present. Some of the *Commelina* species are common to wetlands. Tropical spiderwort thrives in wet areas, but once established, it can also persist in dry soils.

Biology

Upon initial observation, tropical spiderwort appears to be a grass (Figures 5a and 5b, page 3). While not a grass, it is a monocot (in contrast to a dicot or broadleaf weed) that has some botanical similarities to other monocot families such as the sedges (Cyperaceae), rushes (Juncaceae), and grasses (Poaceae). The leaves and stems are thicker and more succulent than grasses. Leaf blades are ovate to lanceolate, 1 to 3 inches long and 0.5 to 1.5 inches wide. The stems are sprawling and will creep along the ground and root at the nodes. Broken vegetative cuttings of stem are capable of rooting and reestablishing following cultivation (Budd *et al.,* 1979). Short rhizomes develop approximately 6 weeks after emergence and by 12 weeks can form an average of 6 rhizomes, each measuring 4 inches in length (Walker and Evenson 1985a).

Tropical spiderwort is unique in that it produces both aerial and underground flowers (Maheshwari and Maheshwari 1955) (Figures 6 and 7, page 3). Both aerial and underground flowers are enclosed in spathes (Figure 2). Each aerial flower can produce 1 large seed and 4 smaller seeds, while underground flowers can produce 1 large seed and 2 smaller seeds (Walker and Evenson 1985a) (Figure 8, page 4). Aerial flowers are chasmogamous (normal, open flowers), lilac or blue, and are self-fertilized. The underground spathes develop on the rhizomes and are cleistogamous (flowers are self-fertilized and do not open) (Walker and Evenson 1985a). Underground flowers begin to form by 6 weeks after emergence, while aerial flowers form 8 to 10 weeks after emergence (Walker and Evenson 1985a). Two leaf seedlings of tropical spiderwort have been observed to have subterranean flowers when grown in the greenhouse (M. G. Burton, North Carolina State University, Weed Ecologist, personal communication, 2004). In aerial flowers, an immature fruit was formed within 2 to 3 days of flower opening and was ripe within 14 to 22 days after flower opening (Walker and Evenson 1985a). Growing in rice paddies in the Phillippines, tropical spiderwort produced in excess of 1,600 seeds/plant (Pancho 1964). Plants

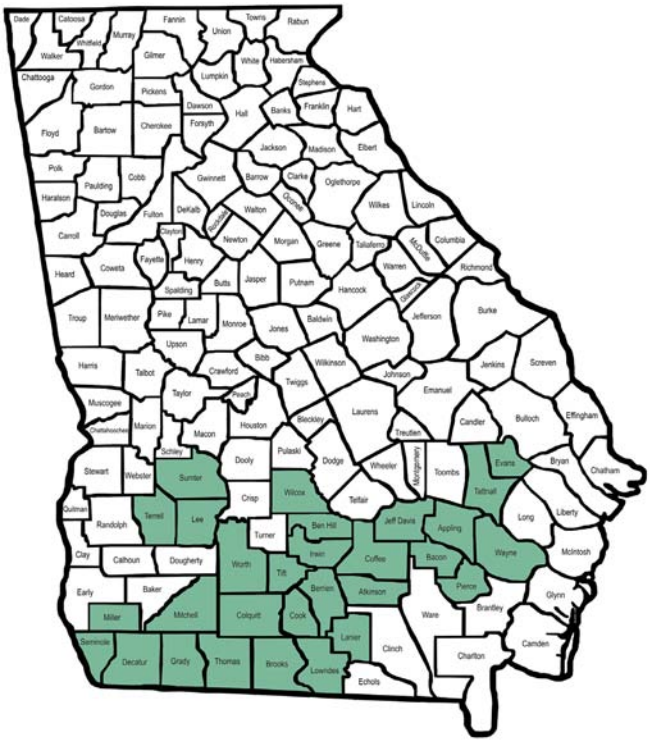

Figure 4. Tropical spiderwort distribution in Georgia (November 2004). Confirmed by Georgia Department of Agriculture.

Figure 5a (left). One leaf seedling of tropical spiderwort. **Figure 5b** (right). Tropical spiderwort seedling with filamentous cotyledonary stalk. [E.P. Prostko]

grown from underground seeds, however, were capable of producing 8,000 seeds/m^2, while those originating from aerial seeds produced 12,000 seeds/m^2 (Walker and Evenson 1985a).

Four types of seed are produced: large aerial seeds, small aerial seeds, large underground seeds, and small underground seeds. Small aerial seeds accounted for 73 to 79 percent of the total number of seeds produced. These seeds tended to have a stronger dormancy than large seeds. Less than 3 percent of freshly harvested, aerial seeds germinated when placed in favorable conditions (Walker and Evenson 1985b). Underground seeds represented less than 3 percent of the seeds produced and did not exhibit as much dormancy. Ninety percent of these larger seeds germinated under favorable conditions (Walker and Evenson 1985a). Clipping the seed coat or exposing the seed to temperatures in excess of 90 degrees C for 2 hours removed the state of dormancy for all seed types (Walker and Evenson 1985b).

Plants that developed from aerial seeds tended to be smaller, developed aerial flowers earlier (43 days after emergence), and produced more aerial fruits relative to plants that originated from underground seeds (Walker and Evenson 1985a). The optimum depth for tropical spiderwort emergence was 0 to 2 inches, with large seeds capable of emerging from a 6 inch depth (Walker and Evenson 1985b).

Tropical spiderwort has been identified as an alternate host of the southern root-knot nematode (*Meloidogyne incognita*) (Valdez 1968). A recent survey in Georgia has shown that the southern root-knot nematode is widely distributed across the cotton production regions of the state. In fact, southern root-knot nematodes were recovered from more than 65 percent of the soil samples collected in the survey. (R.C. Kemerait, University of Georgia, Extension Plant Pathologist, personal communication, 2003).

Competition

Results from systematic studies on the influence of various tropical spiderwort populations on crop yield are limited. Cotton and peanut field trials are being conducted in Georgia and results will be available in the near future.

Control – Cotton

Tropical spiderwort infestation has become a severe problem in several cotton producing areas. Studies evaluating response of tropical spiderwort to herbicides and herbicide systems have been conducted in Georgia over the past 5 years (2000-2004) and are discussed below. Conclusions based on these trials will be revised as future data are collected.

Preemergence or Delayed Preemergence Herbicide Applications: Residual control of spiderwort is the backbone of a successful cotton weed management program because its seeds will continually germinate and emerge throughout the season. A critical question that needs to be answered is when to apply an effective residual herbicide. Should it be applied at planting, early postemergence, and/or late postemergence?

Research indicates that several herbicides provide varying levels of residual control of tropical spiderwort. Pooled over five locations during 2002, 2003, and 2004, Staple® and Zorial® provided poor residual control of

Figure 6. Tropical spiderwort aerial flowers. [A.S. Culpepper]

Figure 7. Tropical spiderwort subterranean flowers. [E.P. Prostko]

Figure 8. Tropical spiderwort seeds. [H. Pilcher]

tropical spiderwort and Direx® was only slightly more effective (Table 1). Residual control with Cotoran® and Command® was more effective, providing 70 to 82 percent control at 20 to 25 days after application; however, control by 45 to 55 days after application was less than 60 percent with these herbicides. Clearly, Dual Magnum® is the most effective residual herbicide currently labeled in cotton. **(Do not apply Dual Magnum® as a preemergence treatment to cotton!)**

Data presented in Table 1 show tropical spiderwort control following herbicide treatments, which subsequently received rainfall within 5 days of application. Thus, the likelihood of getting better control than what is reported in Table 1 is low, but the likelihood of getting less control, as it may not rain near application timing, is extremely high.

Table 1. Response of tropical spiderwort to residual herbicides applied prior to spiderwort emergence.*

Herbicide	Tropical Spiderwort Control - %	
	20 to 25 day after treatment	45 to 55 day after treatment
Command 3ME (2 to 2.5 pt/A)	82 b	59 b
Cotoran 4L (2 to 3 pt/A)	70 c	54 bc
Direx 4LL (2 to 3 pt/A)	58 d	44 c
Dual Magnum** 7.62 EC (1 pt/A)	90 a	82 a
Staple 85SP (0.8 oz/A)	25 f	26 d
Zorial 80WDG (1.75 lb/A)	45 c	41 c

* Data pooled over two locations in Grady County during both 2002 and 2003 and one location in 2004. Irrigation or rainfall occurred at each location within 5 days of herbicide application. Numbers within a column followed by the same letter are not different at *P = 0.05.*

** In Georgia, do not apply Dual Magnum preemergence in cotton.

Early Postemergence Applications: For effective control, tropical spiderwort should be less than three inches tall at the time of postemergence herbicide applications. Even with timely applications, tropical spiderwort can tolerate several of the more commonly used herbicides. Postemergence-directed applications of Cotoran® plus MSMA is the most effective early postemergence treatment. Most growers are not willing to make directed applications to small cotton, however. Thus, their options include Staple® in conventional or transgenic cotton and glyphosate, glyphosate plus Staple®, or glyphosate plus Dual Magnum® in Roundup Ready® cotton. A pre-mix of glyphosate and Dual Magnum is sold by the trade name of Sequence®.

During 2000-2002, glyphosate alone did not provide adequate control of tropical spiderwort. However, in 2003 and 2004, glyphosate alone provided very effective postemergence control. Growing conditions is the latter two years were near ideal, hence the improved performance as compared to the observed results in 2000-2002. Control of spiderwort with glyphosate alone likely will not be very successful during most years. Staple® at 1.2 oz/A is 10 to 20 percent more effective than glyphosate alone in controlling emerged spiderwort (data not shown). The addition of Staple® at 0.6 oz/A with glyphosate also improved spiderwort control 7 percent when compared to glyphosate applied alone (Table 2). Similarly, mixing Dual Magnum® with glyphosate improved control compared to glyphosate alone. Dual does not provide postemergence control but offers good to excellent residual weed control, reducing plant survival from continuous tropical spiderwort flushes. An application of Dual Magnum® applied early postemergence to the crop appears to be the most effective component of a tropical spiderwort weed management program in Roundup Ready® cotton.

Table 2. Response of 1- to 3-inch tropical spiderwort to foliar cotton herbicides.*

Herbicide	Tropical Spiderwort Control - %
	21 day after treatment
Roundup UltraMax 5.5SC (26 oz/A)	53 c
+ Staple 85SP (0.6 oz/A)	60 b
+ Dual Magnum 7.62EC** (1 pt/A)	80 a

* Data pooled over four locations in Grady County during 2001 and 2002. Irrigation or rainfall occurred at each location within 7 days of herbicide application. Numbers within a column followed by the same letter are not different at P = 0.05.

** In Georgia, do not apply Dual Magnum preemergence in cotton.

Directed Applications: MSMA is more effective than glyphosate alone in Roundup Ready® cotton (Table 3). The addition of herbicides such as Aim®, Caparol®, Direx®, or Valor® with glyphosate or MSMA improved tropical spiderwort control. When timely directed applications are made, however, the recurring issue is not how much postemergence control is achieved, but rather which products have greater residual activity. Of those products in Table 3, Direx® at 1 qt and Valor® at 1 to 2 oz/A would likely provide greater residual control. Adequate residual control from Direx® or Valor® may last as little as 10 days if either too little or to much rainfall is received. Similar to earlier season applications, Dual at

layby may be the most effective option and is currently being evaluated in research trials. Dual can be tank-mixed with glyphosate, Caparol + MSMA, or Cotoran + MSMA as long as it is applied at least 80 days before harvest.

Table 3. POST response of 3 to 4 inch tropical spiderwort to cotton layby herbicide applications.*

Herbicide	Tropical Spiderwort Control - %
	21 day after treatment
Roundup UltraMax (26 oz/A)	40-70
+ Aim 2EC (1 oz/A)	85-95
+ Valor 51WG (1 oz/A)	75-85
+ Direx 4L (1 pt/A)	70-80
+ Harvade (8 oz/A)	<70
MSMA (2.67 pt/A)	70-80
+ Direx 4L (2 pt/A)	85-95
+ Caparol 4L (2 pt/A)	85-90

* Data pooled over four locations in Grady County during 2001 and 2002. Irrigation or rainfall occurred at each location within 7 days of herbicide application.
** Expected range of control is from data collected from two to six replicated field trials.

Control – Peanut

Dense populations of tropical spiderwort have the potential to cause severe peanut yield losses and can also interfere with harvest efficiency (Figure 9). Information about the control of tropical spiderwort in peanuts is limited. Recommendations for tropical spiderwort control are subject to change based upon results from on-going studies.

Row Spacing: Recent research results from the University of Florida suggest that twin-row spacing may improve the control of tropical spiderwort in peanut (Table 4). Tropical spiderwort control may be greater in twin rows than single rows because of the earlier canopy closure and subsequent shading effects.

Table 4. Tropical spiderwort control in peanut as influenced by row spacing.*

Row Spacing	Tropical Spiderwort Control - %
Twin (8")	84 a**
Single (36")	72 b

* Averaged over 5 different herbicide treatments.
** Means in the same column with the same letter are not significantly different.
Source: Yoder *et al.,* 2003.

Residual Herbicides: Field trials conducted in Georgia over the past several years have shown that Dual Magnum® provides good to excellent residual control (>80%) of tropical spiderwort (Table 5). Greatest residual control with Dual Magnum® can be obtained when the application is followed by at least 0.5" of rainfall or irrigation within 7 to 10 days. Dual Magnum® can be applied preplant incorporated, preemergence, and postemergence in peanut. However, Dual Magnum does not provide postemergence control of tropical spiderwort. Less expensive, generic formulations of metolachlor, the active ingredient in Dual Magnum®, are available. These formulations may not provide the same length of residual control of tropical spiderwort because of reduced active ingredient rates (Parallel®, Stalwart®, Me-Too-Lachlor®).

Figure 9. Tropical spiderwort infestation in peanut, Grady County. [E.P. Prostko]

Table 5. Tropical spiderwort control in peanut with Dual Magnum® at 1.33 pt/A applied preemergence, Grady County, 2003-2004.

Time (DAT)*	Tropical Spiderwort Control - %		
	2003	2004	2-Year Average
12-20	96	97	97
26-28	94	94	94
41-49	94	96	95
64-76	86	95	91

* DAT = days after treatment.

Postemergence Herbicides: Gramoxone Max® provides excellent control of emerged tropical spiderwort if applied before the 5-leaf stage. Consequently, the combination of Gramoxone Max® plus Dual Magnum® applied "at-cracking" or early postemergence may provide the greatest contact and residual control (Table 6). When using Gramoxone Max® and Dual Magnum® in combination, the addition of either Basagran® or Storm® is also recommended to reduce peanut injury. The use of extra surfactants or adjuvants in this 3-way mixture is **NOT** recommended. Since it is unlikely that this mixture will provide full-season control, escaped tropical spiderwort plants can be managed with postemergence applications of Cadre® or Pursuit®. These herbicides are most

effective when applied before tropical spiderwort exceeds the 5-leaf stage and when favorable environmental conditions exist (*i.e.,* ample soil moisture, warm temperatures, and high humidity). Cadre® and Pursuit® will also provide some residual control of tropical spiderwort. Dual Magnum® can be tank-mixed with Cadre® or Pursuit® to extend the length of residual control, but the total in-crop use rate of Dual Magnum® cannot exceed 2.8 pt/A/year. Results from trials conducted in Australia indicated that Basagran® provides excellent (>90%) postemergence control of tropical spiderwort when applied between the 2 and 5-leaf stage of growth (Walker 1981). However, no residual control from Basagran can be expected.

Table 6. Tropical spiderwort control in peanut with Gramoxone Max® + Dual Magnum® combinations applied 16 to 21 days after planting, Grady County, 2002-2004.*

Time (DAT)**	Tropical Spiderwort Control - %				
	2002	2003	2004		4-Location Average
			Test 1	Test 2	
7-14	98	96	95	94	96
29-32	95	96	93	93	94
49-62	94	85	84	98	88
77-98	94	68	69	--	77

* Gramoxone Max @ 5.5 oz/A + Dual Magnum @ 1.33 pt/A.
** DAT = days after treatment

Control – Field Corn

Due to its late emergence pattern, tropical spiderwort is usually not a significant problem in early-planted field corn in terms of its potential impact on yield. However, uncontrolled tropical spiderwort plants that emerge later in the corn season can continue to produce seed and contribute to future weed problems in subsequent rotational crops. Post-harvest or fallow control options for tropical spiderwort are discussed later in this publication.

Atrazine and Dual Magnum® are two commonly used corn herbicides that have good to excellent residual activity on tropical spiderwort (Barnes 2003). Both of these herbicides are registered for preplant incorporated, preemergence, and postemergence use in field corn. They do not provide adequate postemergence control of tropical spiderwort, however. The Dual II Magnum® formulation may be more suitable than Dual Magnum for preplant incorporated or preemergence use in field corn because it contains a crop safener. If these residual herbicides are used preplant incorporated or preemergence in early-planted corn, they may not provide acceptable control of tropical spiderwort because they will most likely degrade before the weed emerges. Numerous pre-packaged atrazine + Dual combinations are available.

Tropical spiderwort can be controlled in field corn with postemergence applications of Basagran®, and 2,4-D amine or post-directed/lay-by applications of Gramoxone Max®, Evik®, or Aim® (Table 7). These herbicides do not provide residual control of tropical spiderwort, however.

Table 7. Tropical spiderwort control in field corn with lay-by herbicides, Grady County, 2004.

Herbicide**	Rate/A	Tropical Spiderwort Control - %		
		Test 1	Test 2	2-Location Average
Aim 2EC + Agrioil	1.5 oz + 1% v/v	93 a***	85 ab	89
Evik 80 DF + 80/20	2.0 lb + 0.5% v/v	68 b	87 ab	78
Gramoxone 3SC + 80/20	16 oz + 0.25% v/v	95 a	82 b	89
Untreated	---	0 c	0 d	0

* Ratings at 6 to 8 days after application.
** Tropical spiderwort size at application: 1-6" tall; cotyledon-7 leaf stage.
*** Means in the same column with the same letter are not significantly different according to Duncan's Multiple Range Test (P=0.05).

Control – Soybeans

Only a few field trials have been conducted in Georgia regarding the control of tropical spiderwort in soybeans. Much of the information for soybeans is based upon results from control studies in other crops. Narrower row spacings and increased soybean plant populations will help improve the control of tropical spiderwort through competition and shading.

The most effective herbicide control strategies for tropical spiderwort involve combinations of both preemergence and postemergence conventional herbicides. Preemergence herbicides with residual activity on tropical spiderwort include Axiom®, Dual Magnum®, Canopy SP®, Canopy XL®, and Sencor®. Postemergence herbicides that have fair to good activity on tropical spiderwort include Basagran®, Classic®, and Pursuit®. Gramoxone Max® or Aim® can be used post-directed. When using Gramoxone Max® post-directed, the soybeans must be at least 8 inches in height and the herbicide should not be sprayed higher than 3 inches on the soybean plant.

In RR soybean systems, glyphosate can provide fair to good control of tropical spiderwort if it is applied to plants that are 3 inches tall or less and under ideal grow-

Table 8. Tropical spiderwort control in RR soybeans with Roundup WeatherMax®, Classic® and Pursuit®, 2004.

Herbicide**	Rate/A	Tropical Spiderwort Control - %		
		Grady County	Tattnall County	2-Location Average
Roundup WeatherMax 5.5 SC	22 oz	48	76	62
Pursuit 2L + 80/20	4 oz + 0.25% v/v	80	91	86
Roundup WeatherMax 5.5 SC + Pursuit 2L + 80/20	22 oz + 4 oz + 0.25% v/v	74	91	83
Classic 25DF	0.5 oz	61	86	74
Roundup WeatherMax 5.5SC + Classic 25DF + 80/20	22 oz + 0.5 oz + 0.25% v/v	65	88	77
Untreated	--	0	0	0
LSD 0.05	**--**	**8**	**12**	**--**

* Ratings at 20 to 24 days after application.
** Tropical spiderwort size at application: 1-4" tall; 2-5 leaf stage.

ing conditions. Pursuit® or Classic® can be tank-mixed with glyphosate to improve the control of tropical spiderwort in RR soybeans (Table 8).

Control – Fallow or Post-harvest

Because tropical spiderwort can germinate and emerge up until frost, growers must implement fallow or post-harvest control strategies in an effort to reduce seed production (Figure 10). This can be accomplished by using either tillage or herbicides. If fields are tilled, they should be cultivated every 3-4 weeks while tropical spiderwort is emerging. If herbicides are preferred, emerged tropical spiderwort plants can be treated with Gramoxone Max®, 2,4-D amine, or a combination of Gramoxone Max®+ 2,4-D. In order for post-harvest/fallow herbicide treatments to be effective, they must be applied after the plants have recovered from any damage caused by harvesting equipment, when they are actively regrowing, and less than 6 inches in height. Tropical spiderwort will be killed by the first frost.

Figure 10. Tropical spiderwort infestation after corn harvest, Grady County. [A.S. Culpepper]

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