Winter Fallow Management of Volunteer Peanut (*Arachis hypogaea* L.) and Cutleaf Eveningprimrose (*Oenothera laciniata* Hill)

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ABSTRACT

Volunteer peanut and cutleaf eveningprimrose are part of the epidemiology of spotted wilt disease of peanut and other susceptible crops in the Southeastern U.S. Coastal Plain. Studies were conducted on the timing and frequency of fallow harrowing, integrated with applications of glyphosate or tribenuron-methyl, for control of volunteer peanut and cutleaf eveningprimrose. Spring harrowing was generally more effective in controlling volunteer peanut than fall or winter harrowing. Conversely, cutleaf eveningprimrose was controlled by sequential harrowing in the fall, winter, and spring, with single harrowing less effective. In general, spring applications of glyphosate or tribenuron-methyl were equally effective in controlling volunteer peanut and cutleaf eveningprimrose in absence of tillage.

Key Words: Integrated weed management, reduced tillage, spotted wilt, tomato spotted wilt tospovirus.

Volunteer peanut results from excessive harvest losses from the preceding peanut crop caused by disease-weakened plants, delayed harvest, wet soils, improperly operated harvest equipment, and weed roots that entangle pods as they are being dug and inverted (Wilcut *et al.*, 1994). Frequently, losses from early harvested peanut germinate and emerge soon after harvest, continuing until frost. For the duration of the winter fallow season, volunteer peanut may germinate and emerge as soil and ambient air temperatures warm. A second infestation usually occurs in the spring and is often an annoyance to cotton (*Gossypium hirsutum* L.) and corn (*Zea mays* L.) growers. York *et al.* (1994) identified several volunteer peanut control strategies based on commonly used postemergence herbicides in rotation. They speculated that fallow tillage could be used to manage volunteer peanut in conventional tillage systems, although they indicated that fallow tillage could delay planting of spring crops. They also concluded that volunteer peanut is seldom present at densities to reduce cotton and corn yield through competition.

Spotted wilt, caused by tomato spotted wilt tospovirus (TSWV), is a serious disease of peanut, tobacco (*Nicotiana tabacum* L.), and various vegetable crops (Halliwell and Philley, 1974; Cho *et al.*, 1989; Culbreath *et al.*, 1991; 1992). Weeds have been implicated in the epidemiology of spotted wilt (Cho *et al.*, 1986, 1989). Two of the most epidemiologically important species in the Southeastern U.S. are thought to be volunteer peanut and cutleaf eveningprimrose (*Oenothera laciniata* Hill) (Chamberlin *et al.*, 1992, 1993; Johnson *et al.*, 1996). Both species are alternate hosts for TSWV, attract thrips vectors, and support thrips reproduction, which are critical attributes for weeds in viral disease epidemics (Duffus, 1971). Furthermore, both species have been hypothesized to act as transitory hosts between consecutive growing seasons (Chamberlin *et al.*, 1992, 1993). It is plausible that region-wide efforts to control volunteer peanut and cutleaf eveningprimrose in winter fallow areas may contribute to the overall management of spotted wilt. Therefore, studies were initiated in 1996 to develop integrated strategies to control volunteer peanut and cutleaf eveningprimrose in winter fallow areas.

Materials And Methods

Field studies were initiated in the fall of 1996 and 1997 at the Attapulgus Research Farm located near Attapulgus, GA and at the Coastal Plain Experiment Station Ponder Farm located near Tifton, GA. Both sites were the locations of peanut weed science research plots the preceding summer. The Attapulgus site had excessive harvest losses due to poor

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harvest conditions caused by excessive rainfall in 1996 and extremely heavy weed infestations in 1997. Harvest losses both years were estimated at 25 to 33% out of a weed-free yield potential of 3500 kg/ha. The Ponder Farm site had excessive harvest losses due to heavy annual grass infestations both years. Harvest losses were visually estimated at 20 to 40% out of a weed-free yield potential of 3000 kg/ha. Both sites also had heavy natural infestations of cutleaf eveningprimrose.

The experimental design was a split-plot with four replications. Main plots were timings of winter tillage with a disk harrow. Tillage treatments were harrowing in November, January, March, November/January, November/March, January/March, November/January/March, and a nontilled control for a total of eight tillage treatments. Main plots were 24 m long and 3.7 m wide, with a 1.8-m border separating tillage treatments. The disk harrow had blades 41 cm in diameter, spaced 23 cm apart. The overall width of the implement was 3.0 m. The harrow was set to till the plots 10- to 15-cm deep during one pass.

Subplots were herbicides applied 2 wk after the March tillage. Herbicides were glyphosate [*N*-(phosphonomethyl)glycine] at 0.8 kg ae/ha, tribenuron-methyl {2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)methylamino]carbonyl]amino]sulfonyl]benzoic acid} at 17 g ai/ha plus the organosilicone surfactant Kinetic® (an organosilicone surfactant containing polyalkyleneoxide modified polydimethylsiloxane and nonionic surfactants, Helena Chemical Co., Memphis, TN) at 0.13% (v/v), and a nontreated control. Tribenuron-methyl is registered for use on small grains (8 to 17 g/ha) and reported to be efficacious on volunteer peanut (J. W. Todd, pers. commun., 1996) and cutleaf eveningprimrose control (Shaw, 1996). Subplots were 6.1 m long and 3.7 m wide, with a 3.0-m alley separating subplots. All herbicides were applied with a tractor-mounted plot sprayer pressurized with CO_2 calibrated to deliver 234 L/ha.

Visual estimates of percentage volunteer peanut and cutleaf eveningprimrose control were recorded prior to planting corn in early April on a scale of 0 to 100, where 0 = no control and 100 = complete weed control. Corn was planted at both sites with plot location maintained using permanent corner markers. Visual estimates of percentage corn injury were recorded 3 wk after emergence using the same scale.

Data were subjected to analysis of variance using a mixed model. Degrees of freedom were partitioned to test tillage effects and herbicide effects, singularly and in combination. Means were separated using Fisher's Protected Least Significant Difference test ($P \leq 0.05$).

Results and Discussion

Data analyses showed significant location effects and a significant interaction of tillage and herbicide treatment for volunteer peanut and cutleaf eveningprimrose control. However, data analysis showed nonsignificant year effects. Therefore, data are presented for each location pooled over years.

Volunteer Peanut Control. Tillage systems that included spring harrowing were the most effective tillage systems in controlling volunteer peanut (Table 1). In these systems, herbicides did not consistently increase control. This was particularly true at the Ponder Farm. Harrowing in the fall, winter (or in combination) without a herbicide, did not consistently control volunteer peanut. Fall or winter harrowing coupled with a spring harrowing did not appreciably improve volunteer peanut control compared to spring harrowing alone.

Both herbicides applied in the spring were marginally effective in controlling emerged volunteer peanut, with little consistent difference in volunteer peanut control between glyphosate and tribenuron-methyl at both locations (Table 1). Both herbicides increased volunteer peanut control provided by fall and winter harrowing, although volunteer peanut control by spring harrowing was not consistently improved by either herbicide.

The use and timing of harrowing are not dictated exclusively by volunteer peanut control. Land preparation for winter cover crops, herbicide incorporation, and stale seedbed weed control strategies dictate the timing and frequency of harrowing in peanut production. If volunteer peanut control is a critical part of a crop production system, harrowing in the spring will provide acceptable control. If spring harrowing is not feasible, an application of either glyphosate or tribenuron-methyl provides 74 to 86% control of volunteer peanut.

Cutleaf Eveningprimrose Control. Sequential harrowing in the fall, winter, and spring effectively controlled cutleaf eveningprimrose without the need for herbicides (Table 1). Harrowing fewer than three times provided less cutleaf eveningprimrose control than three sequential harrowing operations, making spring herbicide applications beneficial.

Glyphosate and tribenuron-methyl controlled cutleaf eveningprimrose similarly, although either herbicide alone with without tillage was marginally effective (73 to 76%). Our results agree with Guy and Ashcraft (1996) who controlled only 78% cutleaf eveningprimrose with glyphosate at 0.8 kg/ha. Reynolds *et al.* (2000) controlled 42 to 84% cutleaf eveningprimrose with glyphosate at 0.6 kg/ha. Their results, as well as ours, show that cutleaf eveningprimrose control with glyphosate is inconsistent and marginal.

Herbicide combinations containing tribenuron-methyl are generally considered to be among the best options for cutleaf eveningprimrose control (Shaw, 1996). However, Guy and Ashcraft (1996) found preplant treatment of tribenuron-methyl plus thifensulfuron {3-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]-2-thiophenecarboxylic acid} plus glyphosate provided inconsistent control (33 to 73%) of cutleaf eveningprimrose, while Reynolds *et al.* (2000) found control varied from 58 to 84%. Our data with tribenuron-methyl alone for cutleaf eveningprimrose control are in general agreement with these earlier studies.

These data suggest that volunteer peanut and cutleaf eveningprimrose can be partially controlled with fallow harrowing tailored to the predominant weed and its life cycle. Volunteer peanut is a warm-season species and will be present when soil and ambient air temperatures are conducive for seed germination and plant growth. Hence, spring harrowing was generally the most effective timing for volunteer peanut control compared to fall or winter harrowing. A single harrowing for volunteer

Table 1. Interactive effects of fallow tillage and herbicides on volunteer peanut and cutleaf eveningprimrose control, 1997 and 1998[a].

Time of tillage			Herbicide	Attapulgus		Ponder Farm	
Fall	Winter	Spring	treatment[b]	Volunteer peanut	Cutleaf eveningprimrose	Volunteer peanut	Cutleaf eveningprimrose
				------- % control ------		------ % control ------	
No	No	No	Tribenuron-methyl	79	74	83	73
			Glyphosate	86	75	81	76
			None	0	0	0	0
Yes	No	No	Tribenuron-methyl	77	79	80	78
			Glyphosate	81	80	67	75
			None	42	44	80	58
Yes	Yes	No	Tribenuron-methyl	82	90	82	87
			Glyphosate	88	90	75	89
			None	48	70	66	86
Yes	No	Yes	Tribenuron-methyl	83	87	80	86
			Glyphosate	87	91	84	88
			None	67	73	74	83
Yes	Yes	Yes	Tribenuron-methyl	85	94	86	89
			Glyphosate	83	94	82	90
			None	61	91	77	89
No	Yes	no	Tribenuron-methyl	82	77	84	83
			Glyphosate	85	83	83	83
			None	48	60	69	73
No	Yes	Yes	Tribenuron-methyl	85	88	87	85
			Glyphosate	85	89	78	88
			None	66	73	80	85
No	No	Yes	Tribenuron-methyl	82	84	80	85
			Glyphosate	81	83	82	78
			None	76	70	80	76
LSD (0.05)				14	10	14	16

[a]Data for each location were pooled over years.

[b]Herbicides were applied 2 wk after the spring tillage, before planting corn.

peanut control costs approximately $10.80/ha (M. C. Lamb, pers. commun., 2000). However, with volunteer peanut being a warm-season species and emergence occurring sporadically during the cool season, fallow harrowing may be effective at other times based on the prevailing environmental conditions. In contrast, cutleaf eveningprimrose is a cool-season biennial weed, with most infestations occurring during cooler times of the year, making regular harrowing throughout the fallow season necessary for consistent control. Three harrowing operations cost approximately $32.30/ha.

Glyphosate and tribenuron-methyl are equally effective in controlling volunteer peanut and cutleaf eveningprimrose, but control of both species with either herbicide is inconsistent. If cropping systems or weather conditions do not allow timely fallow harrowing for weed control, either herbicide will provide some control of these weeds. The choice of treatments may be dictated on potential for herbicide carryover to spring planted crops. Glyphosate has no soil residual properties and will not affect spring planted crops when applied before planting. Tribenuron-methyl has soil residual properties, causing a 45-d interval between application and planting most warm-season crops (Anon., 1999). We did not observe any injury to corn at either location throughout the duration of these trials (data not shown). Regardless, the stated 45-d interval between tribenuron-methyl application and planting summer crops will restrict its use for volunteer peanut and cutleaf eveningprimrose control.

Glyphosate (0.8 kg ae/ha) treatment costs approximately $32.20/ha (L. E. Zipperer, pers. commun., 2000), including cost of application (Givan and Shurley, 2000). Tribenuron-methyl costs approximately $28.70/ha, including adjuvant and application costs. Spring harrowing for volunteer peanut control ($10.80/ha) is less costly than either herbicide treatment. While many factors will influence the strategy chosen, spring harrowing is the least costly way to control volunteer peanut.

It is more costly to control cutleaf eveningprimrose than volunteer peanut. Generally, the cost of controlling cutleaf eveningprimrose with glyphosate, tribenuron-methyl, or three fallow harrowing operations are similar, with tribenuron-methyl being slightly less costly than the others. The three fallow harrowing operations necessary to control cutleaf eveningprimrose cost $32.30/ha, compared to glyphosate ($32.20/ha) and tribenuron-methyl treatment ($28.70/ha).

Neither of these weeds will likely reduce yield of summer annual crops. However, both of these weeds have been implicated to affect occurrence of spotted wilt of peanut, tobacco, and vegetable crops by serving as alternate hosts of tomato spotted wilt virus and thrips vectors. Before this disease became endemic to the Southeastern U.S., these weeds were not considered serious weed pests of summer annual crops and were generally nuisances. With the development of spotted wilt as a limiting factor of peanut production in the Southeastern U.S., interest has been expressed in controlling these weeds during fallow times of the year as part of an integrated strategy to manage spotted wilt. Our data suggest that fallow harrowing, timed according to the nature of the weeds, will provide best control of the tillage systems evaluated. Glyphosate and tribenuron-methyl can be substituted if tillage and cropping systems prevent timely harrowing.

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