Silverleaf Nightshade (*Solanum Elaeagnifolium*) Control in Cotton with Glyphosate at Reduced Rates

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ABSTRACT

Silverleaf nightshade is a pernicious perennial weed that reduces lint yield and quality on thousands of cotton hectares on the southern High Plains of Texas and in southwestern Oklahoma. Field experiments were conducted in 1992 and 1993 to evaluate silverleaf nightshade control with glyphosate applied at low rates during the previous fall. Glyphosate at the labelled use rate of 1.7 kg ha^{-1} gave 97% control of silverleaf nightshade approximately one year after application. Glyphosate at rates of 0.8, 1.1, 1.3, and 1.5 kg ha^{-1} provided similar control.

KEYWORDS: fall applications, perennial weed control, whiteweed

Silverleaf nightshade (*Solanum elaeagnifolium* Cav.) is a perennial, pernicious weed to 810,000 ha of cotton on the southern High Plains of Texas (Abernathy and Keeling, 1979) and to several thousand ha in southwestern Oklahoma (Westerman and Murray, 1990). It is considered a serious weed problem in the southwestern United States and in other semiarid regions of the world (Boyd et al., 1984). Silverleaf nightshade is native to Central America and the southern United States (Cuthbertson et al., 1976). Widespread and repeated use of dinitroaniline herbicides, which do not control this weed, coupled with reduced tillage and hand-hoeing have led to an increased silverleaf nightshade population in Texas and Oklahoma (Abernathy, 1975; Smith and Wiese, 1973).

The biology and ecology of silverleaf nightshade indicates this weed could be competitive in most cropping systems. Silverleaf nightshade is rhizomatous, has an erect to spreading growth habit, grows 30 to 90 cm in height, and becomes woody with maturity. The taproot can grow to at least 274 cm (Davis et al., 1945) and may extract water from greater soil depths than cotton (*Gossypium hirsutum*), which rarely exceeds 150 cm in root depth (Green et al., 1988). Silverleaf nightshade has linear to oblong leaves that are 5 to 10 cm long (Alexander et al., 1990). The leaves and stem are covered with coarse, short hairs, which vary in density according to biotype. Silverleaf nightshade is commonly called "whiteweed" because of the silvery green appearance that is apparent on the underside of the leaf surfaces (Alexander et al., 1990). It produces round fruit that turns from green to yellow or golden brown as the plant matures (Smith and Wiese, 1970). Each berry may

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contain from 40 to 120 seeds, which indicates that dense populations can produce more than 40 million seed per ha annually (Alexander et al., 1990). Silverleaf nightshade can reproduce by roots and rhizomes in addition to seed (Cuthbertson et al., 1976; Alexander et al., 1990). Uncontrolled growth of one plant per 10-m of cotton row increased silverleaf populations by tenfold after one year and up to 40-fold after two years (Smith et al., 1990).

Yield losses approaching 75% due to silverleaf infestations have been reported (Abernathy and Keeling, 1979). Silverleaf nightshade densities of 32 plants per meter of row reduced cotton plant height, boll size, harvest efficiency, and lint yield up to 50% in Oklahoma studies (Green et al., 1987). Yield loss in cotton and grain sorghum was related directly to silverleaf nightshade population density (Smith and Wiese, 1973). Green et al. (1987) reported that silverleaf nightshade was more competitive in dryland cotton than in irrigated cotton. In Wagga, Australia, 9 silverleaf nightshade plants per square meter reduced wheat yield by 12% under favorable soil conditions (Cuthbertson et al., 1976).

Silverleaf nightshade has been controlled by mechanical (Alexander et al., 1990; Davis et al., 1945), biological (Keeling and Abernathy, 1985; Parker, 1986), cultural (Alexander et al., 1990), and chemical (Abernathy and Keeling, 1979; Cuthbertson et al., 1976; Smith and Wiese, 1970; and Westerman and Murray, 1994) means. Mechanical control by moldboard plowing or subsurface tillage can deplete root reserves if used frequently over a period of years. Chemical control with spot (Westerman and Murray, 1994), shielded (Westerman and Murray, 1994), or rope-type (Abernathy and Keeling, 1979) treatments and in fallow (Eleftherohorinos et al., 1993) areas can be effective also. Silverleaf nightshade control with glyphosate at 7.2 to 10.8 g acid equivalent L^{-1} can cause cotton injury and reduce lint yields 10 to 14% if applied once per season or 13 to 39% if applied more than once per season (Westerman and Murray, 1990).

Silverleaf nightshade control with glyphosate applied at reduced rates in the fall has not been determined. The objective of this research was to evaluate silverleaf nightshade control with glyphosate applied at the normal labelled use rate of 1.7 kg ha^{-1} compared to control with glyphosate applied at reduced rates in the fall.

MATERIALS AND METHODS

Field experiments were conducted in 1992 near Lamesa [Amarillo fine sandy loam (Fine-loamy, mixed, thermic Aridic Paleustalf)] and Wolfforth [Amarillo fine sandy loam], Texas and in 1993 near Ropesville [Acuff loam (Fine-loamy, mixed, thermic Aridic Paleustoll)], Texas. Test plots at all locations were in soils with less than 1.2% organic matter and a pH between 7.5 and 7.8. Cotton was planted in May during 1992 and 1993 in 102-cm rows. Individual plots were 8.1 by 15.2 m. Glyphosate at 0.6, 0.8, 1.1, 1.3, 1.5, and 1.7 kg ha^{-1} (0.38X, 0.50X, 0.68X, 0.75X, 0.88X, and 1X current label recommendations) was applied postemergence using a tractor-mounted compressed-air sprayer that delivered a carrier volume of 70 L ha^{-1} at a pressure of 166 kPa using 8001 nozzles. All treatments, which were applied to cotton at the 80% open boll stage and to silverleaf nightshade in the green-berry stage, included a 0.5% by volume nonphytotoxic nonionic surfactant (X-77, Chevron Chemical Co., San Francisco) and 2% by volume ammonium sulfate (S-Sul Sprayable Ammonium Sulfate, American Plant food Corp., Fort Worth). Glyphosate application dates are given in Table 1.

Silverleaf nightshade control by glyphosate was evaluated 2 to 5 weeks after treatment (WAT), 42 WAT, and 51 to 55 WAT (Table 1). Data collected at each evaluation date included visual ratings for percent silverleaf nightshade control and silverleaf nightshade population. Visual silverleaf nightshade control was based on a scale of 0% (no injury) to 100% (complete kill) as compared to nontreated control plots.

The experimental design was a randomized complete block design with three or four replications. All data were subjected to a general linear model. Means were separated using Fisher's Protected LSD Test at a 5% probability level (Steel and Torrie, 1980).

Table 1. Glyphosate application and silverleaf nightshade evaluation dates in three Texas locations.

Event	Location		
	Lamesa	Wolfforth	Ropesville
Herbicide application†	11 Sep 1992	10 Sep 1992	9 Sep 1993
First evaluation	15 Oct 1992	24 Sep 1992	23 Sep 1993
Second evaluation	4 May 1993	3 Jul 1993	25 Jun 1994
Third evaluation	21 Jun 1993	3 Sep 1993	26 Sep 1994

†Cotton growth stage was 80% open boll and silverleaf nightshade stage was green berry.

RESULTS AND DISCUSSION

Silverleaf nightshade control and stand reduction as a result of glyphosate treatments varied with location. These differences may have been due to different silverleaf nightshade biotypes and environmental conditions. Without exception, silverleaf nightshade was controlled at least 94% approximately 1 year after treatment with glyphosate at 0.8 kg ha^{-1} at all locations.

Glyphosate at the normal recommended use rate of 1.7 kg ha^{-1} controlled silverleaf nightshade 100% at 34 days after treatment (DAT) near Lamesa (Table 2). Silverleaf nightshade control was 93% with glyphosate at 0.6 kg ha^{-1}. Glyphosate at 0.6 kg ha^{-1} controlled silverleaf nightshade 98%, and reduced stand by 97% at 289 DAT (Table 2). Silverleaf nightshade control and stand reduction at glyphosate levels of 0.6 and 1.7 kg ha^{-1} were not different at either 289 or 382 DAT.

Near Wolfforth, glyphosate at 1.7 kg ha^{-1} controlled silverleaf nightshade 100% at 14 DAT (Table 3). Silverleaf nightshade control ranged between 40 and 83% when glyphosate was applied at rates from 0.6 to 1.3 kg ha^{-1}. Silverleaf nightshade was controlled 87%, and stands reduced 90% with glyphosate at 0.6 kg ha^{-1} at 296 DAT. Glyphosate at 0.8 to 1.7 kg ha^{-1} controlled silverleaf nightshade 97 to 100%

Table 2. Silverleaf nightshade control near Lamesa, Texas with fall applications of glyphosate in 1992.

Glyphosate Rate‡	Initial Population	Silverleaf Nightshade Control and Population: 34 DAT† Control	34 DAT† Population	289 DAT Control	289 DAT Population	382 DAT Control	382 DAT Population
kg ha^{-1}	$Plot^{-1}$§	%	$Plot^{-1}$	%	$Plot^{-1}$	%	$Plot^{-1}$
0.0	25 a¶	0 d	26 b	0 a	22 b	0 b	16 b
0.6	39 a	93 c	4 a	98 a	1 a	98 a	1 a
0.8	31 a	100 a	0 a	100 a	0 a	98 a	1 a
1.1	22 a	95 bc	5 a	100 a	0 a	100 a	0 a
1.3	36 a	98 bc	2 a	100 a	0 a	100 a	0 a
1.5	26 a	100 a	0 a	100 a	0 a	100 a	0 a
1.7	31 a	100 a	0 a	100 a	0 a	100 a	0 a

†Days after treatment.
‡All glyphosate treatments were applied with 0.5% nonionic surfactant and 2% ammonium sulfate.
§Mean silverleaf nightshade populations in 8.1 by 15.2 m plots.
¶Population and control means within the same column followed by the same letter are not significantly different at the 5% probability level according to Fisher's Protected LSD Test.

Table 3. Silverleaf nightshade control near Wolfforth, Texas with fall applications of glyphosate in 1992.

Glyphosate Rate‡	Initial Population	Silverleaf Nightshade Control and Population: 14 DAT† Control	14 DAT† Population	296 DAT Control	296 DAT Population	358 DAT Control	358 DAT Population
kg ha^{-1}	Plot^{-1}§	%	Plot^{-1}	%	Plot^{-1}	%	Plot^{-1}
0.0	32 a¶	0 e	30 a	0 c	16 a	0 c	32 a
0.6	20 a	40 d	12 b	87 b	2 b	77 b	5 c
0.8	13 a	53 d	6 c	100 a	0 b	100 a	0 b
1.1	19 a	77 c	7 c	100 a	0 b	93 a	1 b
1.3	22 a	83 bc	6 c	100 a	0 b	100 a	0 b
1.5	27 a	93 ab	3 d	100 a	0 b	100 a	0 b
1.7	18 a	100 a	0 d	97 a	1 b	97 a	1 b

†Days after treatment.
‡All glyphosate treatments were applied with 0.5% nonionic surfactant and 2% ammonium sulfate.
§Mean silverleaf nightshade populations in 8.1 by 15.2 m plots.
¶Population and control means within the same column followed by the same letter are not significantly different at the 5% probability level according to Fisher's Protected LSD Test.

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Table 4. Silverleaf nightshade control near Ropesville, Texas with fall applications of glyphosate in 1992.

Glyphosate Rate‡	Initial Population	Silverleaf nightshade control and population					
		14 DAT†		289 DAT		382 DAT	
		Control	Population	Control	Population	Control	Population
kg ha^{-1}	$Plot^{-1}$§	%	$Plot^{-1}$	%	$Plot^{-1}$	%	$Plot^{-1}$
0.0	20 a¶	0 c	22 a	0 c	46 a	0 d	71 a
0.6	17 a	93 b	2 b	91 b	12 b	89 c	7 b
0.8	13 a	100 a	0 b	97 a	10 b	94 b	3 b
1.1	12 a	100 a	0 b	99 a	7 b	98 ab	2 b
1.3	13 a	100 a	0 b	98 a	6 b	97 ab	2 b
1.5	18 a	100 a	0 b	99 a	10 b	98 ab	2 b
1.7	17 a	100 a	0 b	99 a	10 b	99 a	1 b

†Days after treatment.
‡All glyphosate treatments were applied with 0.5% nonionic surfactant and 2% ammonium sulfate.
§Mean silverleaf nightshade populations in 8.1 by 15.2 m plots.
¶Population and control means within the same column followed by the same letter are not significantly different at the 5% probability level according to Fisher's Protected LSD Test.

at 296 DAT (Table 3). Glyphosate rates ranging from 0.8 to 1.5 kg ha^{-1} provided control of silverleaf nightshade similar to glyphosate at 1.7 kg ha^{-1} at 358 DAT.

Near Ropesville, glyphosate at 1.7 kg ha^{-1} controlled silverleaf nightshade 100% at 14 DAT, while the lowest rate of glyphosate (0.6 kg ha^{-1}) provided 93% control of silverleaf nightshade (Table 4). Glyphosate at 0.6 kg ha^{-1} controlled silverleaf nightshade 91% at 289 DAT (Table 4). Glyphosate at 1.1 kg ha^{-1} controlled silverleaf nightshade 98% at 382 DAT, whereas glyphosate at 0.6 and 0.8 kg ha^{-1} controlled silverleaf nightshade by 89% and 94%, respectively. Glyphosate at 1.1 kg ha^{-1} provided silverleaf nightshade control similar to 1.7 kg ha^{-1}.

Over all locations, glyphosate rates of 1.1 (0.68X) and 1.7 (1X) kg ha^{-1} provided similar silverleaf nightshade control approximately one year after treatment (Table 5). Glyphosate at 1.1 kg ha^{-1} reduced silverleaf nightshade populations between 93 and 100% over all locations. Glyphosate at 0.8 kg ha^{-1} controlled silverleaf nightshade an average of 97% over all locations. Only the 0.6 kg ha^{-1} glyphosate rate controlled silverleaf nightshade less effectively than glyphosate at 1.7 kg ha^{-1}. However, glyphosate at 0.6 kg ha^{-1} provided 88% silverleaf nightshade control when averaged over locations.

Table 5. Silverleaf nightshade control with fall applications of glyphosate approximately one year after treatment near Lamesa, Wolfforth, and Ropesville, Texas in 1992 and 1993.

Glyphosate Rate‡	Location: Lamesa 382 DAT†	Wolfforth 358 DAT	Ropesville 382 DAT	AVG
kg ha^{-1}	%			
0.0	0 b§	0 c	0 d	0
0.6	98 a	77 b	89 c	88
0.8	98 a	100 a	94 b	97
1.1	100 a	93 a	98 ab	97
1.3	100 a	100 a	97 ab	99
1.5	100 a	100 a	98 ab	99
1.7	100 a	97 a	99 a	99

†Days after treatment.
‡All glyphosate treatments were applied with 0.5% nonionic surfactant and 2% ammonium sulfate.
§Control means within the same column followed by the same letter are not significantly different at the 5% probability level according to Fisher's Protected LSD Test.

CONCLUSIONS

Glyphosate rates of 0.8, 1.1, 1.3, and 1.5 kg ha^{-1} controlled silverleaf nightshade at least 93% and reduced stand at least 77% approximately one year after treatment at all three locations. Control and stand reduction at these reduced rates were similar to results at the recommended rate (1.7 kg ha^{-1}); however, the lowest glyphosate rate (0.6 kg ha^{-1}) did not provide as consistent silverleaf nightshade control as did the 1.7 kg ha^{-1} rate. These results indicate that fall application rates of glyphosate at rates as low as 0.8 kg ha^{-1} can provide effective long-term silverleaf nightshade control while substantially reducing herbicide costs.

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