

WINTER WEED CONTROL IN SUGARCANE

James L. Griffin and Wilson A. Judice

School of Plant, Environmental, and Soil Sciences

Louisiana State University Agricultural Center, 104 Sturgis Hall, Baton Rouge, LA 70803

Corresponding author: JGriffin@agcenter.lsu.edu

ABSTRACT

Field research conducted at four locations over two years evaluated winter weed control programs for Italian ryegrass (*Lolium multiflorum* Lam.), spotted burclover (*Medicago arabica* (L.) Huds.), purslane speedwell (*Veronica peregrina* L.), and spiny sowthistle (*Sonchus asper* (L.) Hill). The most predominant weeds were Italian ryegrass and spotted burclover. The subsequent effect of the winter weeds on growth of third stubble 'LCP 85-384' sugarcane (*Saccharum* spp. hybrids) was also evaluated. Atrazine at 2.1 kg ai/ha, diuron at 2.7 kg ai/ha, a hexazinone plus diuron premix at 0.6 + 2.1 kg ai/ha, and metribuzin at 1.7 kg ai/ha were applied in mid-March alone and with a 2,4-D plus dicamba premix at 0.8 plus 0.3 kg ai/ha or paraquat at 0.7 kg ai/ha. Other treatments included 2,4-D plus dicamba at 0.8 + 0.3 kg ai/ha and paraquat at 0.7 kg/ha applied alone and together. At 21 days after application, 2,4-D plus dicamba applied with paraquat controlled Italian ryegrass, spotted burclover, purslane speedwell, and spiny sowthistle 91, 84, 87, and 70%, respectively. Italian ryegrass control for paraquat applied alone or with atrazine, diuron, hexazinone plus diuron, and metribuzin was 84 to 93%. For treatments that did not include paraquat, Italian ryegrass control with the herbicide treatments was no more than 20%. Spotted burclover control when atrazine or diuron was applied with 2,4-D plus dicamba and when hexazinone plus diuron or metribuzin was applied with paraquat was equal to that of 2,4-D plus dicamba plus paraquat. For treatments that did not include 2,4-D plus dicamba or paraquat, spotted burclover control was no more than 41%. Purslane speedwell control when 2,4-D plus dicamba and paraquat were applied alone was equal to that when the herbicides were applied together. For spiny sowthistle, control with 2,4-D plus dicamba was equal to that of 2,4-D plus dicamba plus paraquat. When 2,4-D plus dicamba was applied with paraquat sugarcane ground cover on top of the beds was 38% (1.9 times that of the nontreated control) and sugarcane canopy height was 67 cm (34% greater than the nontreated control). For all herbicide treatments except paraquat applied alone, ground cover was equal to that of 2,4-D plus dicamba plus paraquat.

INTRODUCTION

In Louisiana, sugarcane (*Saccharum* spp. hybrids) is vegetatively planted in late summer and cultured as a perennial. Sugarcane shoots emerging from lateral buds on planted stalks are killed during winter and growth resumes in late February or early March. Because of mild winters, infestations of winter weeds are common. Preemergence herbicides including atrazine, diuron, or metribuzin are applied at planting to control summer weeds and promote sugarcane establishment (Anonymous 2009). These herbicides are also effective on winter annual broadleaf weeds, but in most cases herbicides do not provide residual control throughout the entire winter period. Established and actively growing winter annual weeds can slow emergence and growth of sugarcane following the winter dormant period (Griffin et al. 2004). Winter

vegetation on sugarcane rows can also disrupt normal tillage practices by delaying soil warming and drying in early spring. Elimination of winter annual weeds allows for PRE herbicides to be more uniformly distributed on the soil surface and may promote more efficient application of banded nitrogen fertilizer.

Italian ryegrass (*Lolium multiflorum* Lam.) seeds germinate throughout the winter period and established plants are difficult to control (Miller et al. 2002). In previous research, the standard herbicides, metribuzin, terbacil, and diuron applied in mid-March controlled Italian ryegrass no more than 38% (Griffin et al. 2004). These herbicides when applied alone or with 2,4-D will control many broadleaf weeds (Anonymous 2009). Paraquat provides good to excellent control of annual bluegrass (*Poa annua* L.), geraniums (*Geranium* spp.), common chickweed (*Stellaria media* L.), henbit (*Lamium amplexicaule* L.), and shepherdspurse (*Capsella bursa-pastoris* L.) (Miller et al. 2002). In research conducted two years paraquat alone at 0.53 or 0.70 kg ai/ha controlled Italian ryegrass 66 to 80% 28 days after a mid-February application (Griffin et al. 2004). Diuron at 3.2 kg ai/ha applied with paraquat increased Italian ryegrass control by 11 to 17 percentage points over that of paraquat alone. Although Italian ryegrass was not completely controlled with paraquat or paraquat plus diuron, efficacy was sufficient to reduce weed competition such that sugarcane growth and yield were not reduced. Of concern is the negative effect that paraquat could have on sugarcane. Griffin et al. 2004 reported that sugarcane rapidly recovered from over-the-top applications of paraquat applied at 0.70 kg ai/ha in mid-March and in early April. Findings from this research contributed to the labeling of paraquat in Louisiana for application to sugarcane up to 4-leaf¹.

Winter annual weeds are prevalent in Louisiana sugarcane fields. Weed size can vary considerably depending on time of weed emergence and growing conditions during the winter. This can affect weed control obtained with postemergence herbicides (Miller et al. 2002). Broadleaf weeds that are particularly troublesome include spotted burclover and vetches (*Vicia* spp.), which can grow very tall and form dense mats over the sugarcane stubble. Typically 2,4-D applied alone or with dicamba is used to control winter annual broadleaf weeds (Anonymous 2009). When both grass and broadleaf weeds are present, a combination of paraquat plus a herbicide with broadleaf activity such as atrazine, diuron, or metribuzin would be desirable. Because paraquat is a contact herbicide causing rapid injury, there is concern that antagonism (reduced weed control) may occur when applied with other herbicides.

Research was conducted to compare various winter weed control programs for Italian ryegrass, spotted burclover, purslane speedwell, and spiny sowthistle. The subsequent effect of winter weed control on growth of third stubble 'LCP 85-384' sugarcane was also evaluated.

¹ Gramoxone Inteon, Syngenta Crop Protection.

MATERIALS AND METHODS

Experiments were conducted in 2004 at two sites in St. James, LA and in 2005 at sites in St. James and St. Gabriel, LA to evaluate control of winter weeds and the subsequent effect of weed control on growth of third stubble 'LCP 85-384' sugarcane. Information related to the four sites are presented in Table 1. Herbicide treatments included postemergence applications of atrazine at 2.1 kg ai/ha, diuron at 2.7 kg ai/ha, hexazinone plus diuron² at 0.6 + 2.1 kg ai/ha, or metribuzin at 1.7 kg ai/ha, each applied alone and in combination with 2,4-D plus dicamba³ at 0.8 + 0.3 kg ai/ha or paraquat at 0.7 kg ai/ha. For comparison, 2,4-D plus dicamba at 0.8 plus 0.3 kg/ha and paraquat at 0.7 kg/ha were applied alone and together. A nontreated control was also included. Herbicide treatments were applied in mid-March each year with a CO₂ backpack sprayer calibrated to deliver 93.5 l/ha. Nonionic surfactant was added to all treatments at 0.25% v/v. Each experiment was designed as a randomized complete block with 4 replications. Plot size was 1.8 m (1 row) by 15.2 m with an untreated row between plots.

Herbicide application date, weed height, weed population, and sugarcane height at application are presented in Table 1. Visual control of winter weeds was determined 21 days after treatment (DAT). The rating scale for weed control ranged from 0 to 100%, with 0% = no control and 100% = all plants present at application were dead with no new plants emerged. Percent sugarcane ground cover was determined visually and represented the total amount of sugarcane foliage covering a 60 cm area on the top of the row. Sugarcane height was measured from the soil to the uppermost leaves of the crop canopy. In 2004, ground cover and height were measured May 25. In 2005, ground cover was measured May 26 at St. Gabriel and June 2 at St. James and height was measured June 14 and June 2, respectively. Because of variability in sugarcane stands, yield was not determined.

Data were subjected to the Mixed Procedure in SAS (SAS Institute 2003). Locations, years, and replications (nested within location and years), and all interactions containing these effects were considered random effects (Carmer et al. 1989). All other variables were considered fixed effects. Considering locations/years as environmental or random effects allows for inferences to be made for treatments imposed across a range of environments (Carmer et al. 1989; Hager et al. 2003). Least square means were calculated and mean separation ($P=0.05$) was produced using PDMIX800 in SAS which is a macro for converting mean separation output to letter groupings (Saxton 1998).

RESULTS AND DISCUSSION

Winter weeds at each experimental site included Italian ryegrass, spotted burclover, purslane speedwell, and spiny sowthistle. Italian ryegrass and spotted burclover were the predominant weeds. Other weeds were also present but not at sufficient populations to evaluate. Weed control obtained 21 DAT provided an assessment of initial control and weed regrowth. Italian ryegrass at the mid-March application in the four experiments ranged in height from 5 to

² Hexazinone plus diuron formulated as the premix DuPont K4 60 DF.

³ 2,4-D plus dicamba formulated as the premix Weedmaster 3.87 L.

61 cm and represented a major component of the weeds present (Table 1). Italian ryegrass control was no more than 20% when atrazine, diuron, hexazinone plus diuron, or metribuzin was applied alone or with 2,4-D plus dicamba (Table 2). In previous research, Italian ryegrass was controlled no more than 38% with diuron and metribuzin applied in March (Griffin et al. 2004). In the present study paraquat provided 92% control of Italian ryegrass 21 DAT. When atrazine, diuron, hexazinone plus diuron, or metribuzin was applied with paraquat, ryegrass control ranged from 84 to 93% and was equal to that of paraquat alone. Ryegrass control was not reduced when 2,4-D plus dicamba was applied with paraquat (91% control). Previous research has shown significant injury to sugarcane with paraquat, but recovery was rapid and yield was not affected (Griffin et al. 2004). In the present research, the population and cover of winter weeds was such that sugarcane injury was minimal.

In the four experiments, spotted burclover represented a major component of the weeds present and at the mid-March application height ranged from 15 to 36 cm (Table 1). At 21 DAT spotted burclover control with atrazine, diuron, hexazinone plus diuron, or metribuzin applied alone ranged from 32 to 41% (Table 2). Spotted burclover control was 68% with 2,4-D plus dicamba and the addition of atrazine, diuron, hexazinone plus diuron, or metribuzin did not increase control. Spotted burclover control with paraquat alone was 51% and the addition of atrazine, diuron, hexazinone plus diuron, or metribuzin improved control 16 to 26 percentage points. When paraquat was applied with 2,4-D plus dicamba, spotted burclover was controlled 84%. Control was equal to that of 2,4-D plus dicamba plus atrazine or diuron and to that of paraquat plus metribuzin or hexazinone plus diuron.

At the mid-March application purslane speedwell was no more than 8 cm tall and sowthistle height ranged from 10 to 61 cm (Table 1). Both weeds represented only a small proportion of the total weed population in the experiments. Purslane speedwell control with 2,4-D plus dicamba plus paraquat was 87% (Table 2). Control was equal to that where 2,4-D plus dicamba or paraquat was applied alone or with atrazine, diuron, hexazinone plus diuron, or metribuzin, and where atrazine or metribuzin was applied alone. Sowthistle control with 2,4-D plus dicamba plus paraquat was 70% (Table 2). Control was equal to that of 2,4-D plus dicamba applied alone and with atrazine, diuron, hexazinone plus diuron, or metribuzin and to that of paraquat applied with hexazinone plus diuron or metribuzin.

The presence of winter weeds can slow the growth and tillering of sugarcane as it emerges from the winter dormant period (Griffin et al. 2004). Sugarcane ground cover on the 60 cm area on the row top in late May and early June where herbicide was not applied was only 20% (Table 3). The herbicide treatment providing the most consistent weed control, 2,4-D plus dicamba plus paraquat, resulted in sugarcane ground cover rating of 38%, which was 1.9 times that of the nontreated control. With the exception of paraquat applied alone, all herbicide treatments resulted in sugarcane ground cover equal to that of 2,4-D plus dicamba plus paraquat. This indicates that although control with some herbicides treatments was inadequate, the level of control was sufficient to allow sugarcane to tiller and produce biomass. This same response has been observed in previous research (Griffin et al. 2004). It should be noted that all sites in the present study were selected because of heavy winter weed pressure and sugarcane stands were less than optimum. Sugarcane height in late May/mid June for 2,4-D plus dicamba plus paraquat was 67 cm, 34% greater than the 50 cm height for the nontreated control (Table 3). With the

exception of diuron and hexazinone plus diuron applied alone, all herbicide treatments resulted in sugarcane height equal to that of 2,4-D plus dicamba plus paraquat, again indicating that weed control was sufficient to allow maximum sugarcane growth.

The herbicide treatments evaluated in this study are representative of weed control programs used by Louisiana sugarcane growers. In many cases growers wait until March to apply herbicides to control winter weeds. Although many of the treatments in this study were effective, weed residue remained on the soil surface late into the growing season. This residue could release allelochemicals (Griffin and Dabney 1990) that can hinder sugarcane growth. Weed residue can also delay soil warming which can slow emergence and growth of sugarcane and can interfere with subsequent applications of preemergence herbicides and affect spring tillage operations. Paraquat is effective on Italian ryegrass and 2,4-D plus dicamba is effective on broadleaf weeds. The combination of paraquat and 2,4-D plus dicamba provided broad spectrum weed control. Paraquat applied with hexazinone plus diuron and with metribuzin controlled grass and broadleaf weed equal to that of the paraquat and 2,4-D plus dicamba combination. Growers should identify fields infested with ryegrass and spotted burclover early in the year and apply herbicide as early as possible. Paraquat and 2,4-D plus dicamba, although effective on winter weeds, do not provide soil residual weed control and follow up application of preemergence herbicide to control summer weeds would be necessary. When paraquat is applied with hexazinone plus diuron or metribuzin, both winter weed control and residual activity would be obtained. In planning weed control programs to be implemented in late winter and early spring, growers should consider both herbicide cost and application cost if multiple trips across the field are needed.

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Table 1. Locations, soil characteristics, application dates, crop size, and weed height and population at application for winter weed control experiments conducted in 2004 and 2005.

Variable	2004		2005	
Location	St. James, LA	St. James, LA	St. Gabriel, LA	St. James, LA
Soil type/pH	silty clay loam/ 7.4	silty clay/ 6.4	silty clay/ 6.9	silty clay/ 6.4
Application date	March 13	March 14	March 14	March 14
Crop size (cm)	8-15 (2-3 leaf)	8-15 (2-3 leaf)	5-8 (1-2 leaf)	25-33 (4-5 leaf)
Weed height	-----cm-----			
Italian ryegrass	5-20	5-20	18-61	15-41
Spotted burclover	15-20	15-20	25-36	15-20
Purslane speedwell	3-8	3-8	3-8	3-8
Spiny sowthistle	15-61	15-61	20-61	10-20
Weed population	-----no./m ² or % ground cover-----			
Italian ryegrass	22-32	11-65	11-32	11-65
Spotted burclover	95%	10-95%	40-60%	20-60%
Purslane speedwell	11-22	22-32	11-22	11-22
Spiny sowthistle	11-32	22-32	11-22	11-22

Table 2. Italian ryegrass, spotted burclover, purslane speedwell, and spiny sowthistle control 21 days after selected herbicide treatments were applied in mid-March.^a

Treatment ^b	Rate	Italian ryegrass	Spotted burclover	Purslane speedwell	Spiny sowthistle
	kg ai/ha	-----%			
Atrazine	2.1	2 cd	32 d	77 bc	29 f
Diuron	2.7	20 b	35 d	52 d	33 f
Hexazinone + diuron	0.6 + 2.1	16 b	41 cd	74 c	49 de
Metribuzin	1.7	8 bcd	39 cd	84 abc	46 e
2,4-D + dicamba	0.8 + 0.3	14 bcd	68 b	89 a	63 abc
2,4-D + dicamba + atrazine	0.8 + 0.3 + 2.1	15 bc	71 ab	85 ab	68 a
2,4-D + dicamba + diuron	0.8 + 0.3 + 2.7	14 bcd	81 ab	86 ab	68 a
2,4-D + dicamba + hexazinone + diuron	0.8 + 0.3 + 0.6 + 2.1	18 b	69 b	87 ab	70 a
2,4-D + dicamba + metribuzin	0.8 + 0.3 + 1.7	8 bcd	69 b	89 a	69 a
Paraquat	0.7	92 a	51 c	86 ab	48 e
Paraquat + atrazine	0.7 + 2.1	84 a	68 b	90 a	56 cde
Paraquat + diuron	0.7 + 2.7	89 a	67 b	87 ab	57 bcde
Paraquat + hexazinone + diuron	0.7 + 0.6 + 2.1	90 a	77 ab	86 ab	61 abcd
Paraquat + metribuzin	0.7 + 1.7	93 a	72 ab	88 ab	67 abc
2,4-D + dicamba + paraquat	0.8 + 0.3 + 0.7	91 a	84 a	87 ab	70 a
Nontreated		0 d	0 e	0 e	0 g

^a Data averaged across 4 experiments. See Table 1 for description of experiments.

^b Hexazinone + diuron formulated as the premix DuPont K4 60 DF. 2,4-D + dicamba formulated as the premix Weedmaster 3.87 L.

Table 3. Sugarcane ground cover and height as affected by selected herbicide treatments applied in mid-March for winter weed control.^a

Treatment ^b	Rate	Sugarcane	
		Ground cover ^c	Height ^c
	kg ai/ha	%	cm
Atrazine	2.1	34 abc	58 abc
Diuron	2.7	29 bcd	56 bc
Hexazinone + diuron	0.6 + 2.1	27 bcd	56 bc
Metribuzin	1.7	35 abc	62 ab
2,4-D + dicamba	0.8 + 0.3	33 abc	65 ab
2,4-D + dicamba + atrazine	0.8 + 0.3 + 2.1	42 a	65 ab
2,4-D + dicamba + diuron	0.8 + 0.3 + 2.7	42 a	64 ab
2,4-D + dicamba + hexazinone + diuron	0.8 + 0.3 + 0.6 + 2.1	40 a	65 ab
2,4-D + dicamba + metribuzin	0.8 + 0.3 + 1.7	36 abc	58 abc
Paraquat	0.7	26 cd	58 abc
Paraquat + atrazine	0.7 + 2.1	40 a	58 abc
Paraquat + diuron	0.7 + 2.7	40 a	63 ab
Paraquat + hexazinone + diuron	0.7 + 0.6 + 2.1	36 abc	60 abc
Paraquat + metribuzin	0.7 + 1.7	34 abc	61 ab
2,4-D + dicamba + paraquat	0.8 + 0.3 + 0.7	38 ab	67 a
Nontreated		20 d	50 c

^a Data averaged across 4 experiments. See Table 1 for description of experiments.

^b Hexazinone + diuron formulated as the premix DuPont K4 60 DF. 2,4-D + dicamba formulated as the premix Weedmaster 3.87 L.

^c In 2004 ground cover and height were measured on May 25 at both locations. In 2005 ground cover was measured May 26 at St. Gabriel and June 2 at St. James and height was measured June 14 at St. Gabriel and June 2 at St. James.