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Evaluation of spring herbicide programs during a three-year sugarcane (*Saccharum* spp. hybrids) cropping cycle

Alice A. Wright[1], Douglas J. Spaunhorst[1] and Eric Petrie[2]

[1]Research Agronomist, U.S. Department of Agriculture, Agricultural Research Service, Sugarcane Research Unit, Houma, LA, USA and [2]Research Technician, Retired, U.S. Department of Agriculture, Agricultural Research Service, Sugarcane Research Unit, Houma, LA, USA

Research Article

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Correspondence author:
Alice Wright; Email: alice.wright@usda.gov

Abstract

A limited number of herbicides and sites of action are registered for use on sugarcane in Louisiana. Repeated use of the same sites of action can lead to the evolution of herbicide resistance by weeds. Therefore, it is critically necessary to evaluate additional sites of action to provide growers with options for rotating herbicides to reduce the risk of resistance. Topramezone, indaziflam, and a formulation that includes mesotrione, bicyclopyrone, atrazine, and *S*-metolachlor, along with more common herbicides (pendimethalin, and metribuzin, clomazone, and diuron), were evaluated in the spring for injury to sugarcane, weed control, sugarcane yield, and sugar yield. Of these treatments, clomazone applied with diuron was the only herbicide combination to consistently injure the crop, with injury estimates ranging from 11% to 36%, which frequently resulted in reduced sugar yield with losses between 2.3% to 24.1% of the nontreated control. In most treatments, an increase in itchgrass counts was observed between harvests, indicating that additional control strategies will be needed in fields infested with this weed. However, topramezone alone and with triclopyr was well tolerated by sugarcane, with injuries ranging from 0% to 11% 2 wk after treatment. Indaziflam and combined application of mesotrione, bicyclopyrone, atrazine, and *S*-metolachlor injury was at or under 10% 2 wk after treatment. The tolerance of sugarcane for these herbicides suggests that they can be incorporated into weed management strategies in sugarcane production. These herbicides would increase the sites of action available to be applied to sugarcane and help mitigate the risk of herbicide-resistant weeds.

Introduction

Sugarcane is a perennial grass crop that, in Louisiana, is planted in August or September and harvested in the fall of the following year with two or more ratoon crops harvested in subsequent years before replanting. Weed management in sugarcane relies primarily on tillage and herbicide application. However, few herbicides and fewer sites of action are registered for use in sugarcane production (Orgeron and Wright 2023). This can lead to growers applying the same herbicides year after year, setting the stage for the evolution of herbicide-resistant weeds. A more diversified herbicide program in sugarcane is needed.

Sugarcane is a perennial grass crop, and the weeds that are most difficult to manage are grasses and sedges, including itchgrass and bermudagrass [*Cynodon dactylon* (L.) Pers.], johnsongrass [*Sorghum halepense* (L.) Pers.], yellow nutsedge (*Cyperus esculentus* L.), and purple nutsedge (*Cyperus rotundus* L.). These weeds can cause significant yield losses if left unchecked. Itchgrass is one of the worst weeds in sugarcane fields, with severe infestations causing up to 43% reduction in sugar yields (Lencse and Griffin 1991) or more (Millhollon 1992). Bermudagrass infestations, when severe, can reduce the number of harvestable stalks, thereby decreasing yield. These yield reductions can range from 8% to 32% depending on the harvest year for the crop (Richard and Dalley 2007). If bermudagrass is not managed early, its interference can have a cumulative effect, with yields declining after subsequent crop harvests (Richard 1993). Purple nutsedge infestations can also reduce yield: in pot studies, sugarcane shoot counts and shoot height decreased as nutsedge tuber density increased (Etheredge et al. 2010a). In addition to grasses and sedges, morningglory (*Ipomoea* sp.) is a problem because it can twine around the mature stalks and interfere with harvest. Controlling these weeds early with a preemergence herbicide, prior to canopy closure, is critically necessary because morningglory can germinate after canopy closure. When left uncontrolled, red morningglory (*I. coccinea* L.) can reduce yield by 27% (Jones and Griffin 2009).

Growers rely on applications of preemergence herbicides after planting, and twice more in early spring and in May or June before canopy closure. Preemergence herbicides are necessary because postemergence options for grass control in sugarcane are few, mostly being limited to asulam herbicide alone (Millhollon 1976, Richard 1990, Richard and Griffin 1993) or applied with a sulfonylurea (Dalley and Richard 2008). Paraquat can be applied in the late winter for weed control without substantially affecting yield (Griffin et al. 2004). However, resistance to this herbicide has been confirmed in Italian ryegrass (*Lolium multiflorum* Lam.) (Coco 2022). Common preemergence applications include pendimethalin and metribuzin; pendimethalin is generally effective against itchgrass (Millhollon 1993). Metribuzin can provide enough suppression of bermudagrass to prevent yield reductions throughout the multiyear life cycle of the crop (Richard 1993). A combination of reduced or conventional tillage with broadcast applications of pendimethalin and metribuzin have been found to be most effective at reducing bermudagrass cover (Dalley et al. 2013). Clomazone and diuron applied in early spring can cause up to 85% injury to bermudagrass (Spaunhorst 2021). Triclopyr applied with an inhibitor of photosystem II (PS II), such as hexazinone or diuron, caused injury to this weed at similar rates when applied in early spring (Spaunhorst 2021). For management of red morningglory at layby, atrazine, diuron and hexazinone, or flumioxazin applied as a postemergence application provided 90% control. As a preemergence herbicide, sulfentrazone provided the longest control of red morningglory with 82% control at 77 d after treatment (Jones and Griffin 2008). In another study, azafenidin and sulfentrazone applied preemergence separately provided 90% or greater control of red morningglory, however this control decreased in the absence of rain after herbicide application (Viator et al. 2002).

Inhibitors of 4-hydroxphenylpyruvate dioxygenase (HPPD) registered for use in sugarcane fields provide an alternative site of action to the dinitroanalines and PS II inhibitors that are frequently applied. Registered chemistries include mesotrione and topramezone (Jhala et al. 2023). These herbicides inhibit the HPPD enzyme, resulting in bleaching of susceptible plants and eventual plant death (Schulz et al. 1993). Another recently registered chemistry, indaziflam, acts as a cellulose biosynthesis inhibitor (Brabham et al. 2014). Both topramezone and indaziflam have been used with success outside the United States. Topramezone was well tolerated by sugarcane varieties planted in China and was effective in controlling common grasses and broadleaf weeds (Ma et al. 2023). In Iran, testing of multiple rates of indaziflam showed an increase in sugarcane yield and a reduction in weed biomass (Sharafizadeh and Nikpay 2023). Indaziflam was also effective against morningglory and itchgrass in sugarcane production in Brazil (de Castro 2024). Rotating these herbicides with current herbicide strategies in Louisiana sugarcane production would broaden the herbicide sites of action available in sugarcane production and reduce the risk of weeds evolving herbicide resistance. To that end, herbicide programs incorporating HPPD inhibitors or indaziflam were evaluated alongside more commonly used herbicide programs for their weed control efficacy and effects on yield.

Materials and Methods

Experimental Location, Design, and Field Preparation Description

Field studies were conducted from 2016 to 2020 at the U.S. Department of Agriculture's Sugarcane Research Unit Ardoyne Farm in Schriever, LA (29.64°N, 90.84°W). Sugarcane varieties 'HoCP 96-540' (Tew et al. 2005) and 'L 01-299' (Gravois et al. 2011) were planted in separate trials with two replicates (Test 1 and Test 2) for each variety, planted a year apart. HoCP 96-540 and L 01-299 were selected because they were the predominant varieties in the industry at the time, covering approximately 37% and 22% of the acreage of sugarcane in 2014 (Gravois and Legendre 2014). Herbicide treatments were arranged in a randomized complete block design with four replications. Each plot was three rows wide (5.5 m) by 9.1 m long, and rows were spaced 1.8 m apart. The whole stalks of each variety were hand-planted with three stalks placed parallel to each other in the furrow and overlapping the next set by about 10% to reduce the potential for gaps. Once in the furrows, the stalks were covered with 7 to 8 cm of soil by pulling soil from each edge of the furrow using disk blades and packing it with a land roller implement. Plots were maintained according to standard practice: furrows were cultivated in mid-March and 32% liquid urea ammonium nitrate was knifed in at 134 kg ha^{-1}, and immediately incorporated in mid to late April. Herbicides were applied in mid-March and sugarcane was harvested in the fall (Table 1). Plots were grown for two subsequent years as ratoon crops.

Table 1. Dates of sugarcane planting, herbicide application, and harvest at the Ardoyne Farm from 2015 to 2020.

Variety	Planting	Herbicide Application	Harvest
L 01-299	September 2016	March 17, 2017	November 20, 2017
		March 7, 2018	October 31, 2018
		March 21, 2019	November 4, 2019
	August 2017	March 8, 2018	November 19, 2018
		March 21, 2019	November 6, 2019
		March 11, 2020	September 30, 2020
HoCP 96-540	August 2015	April 8, 2016	December 14, 2016
		March 17, 2017	November 17, 2017
		March 7, 2018	October 30, 2018
	September 2016	March 17, 2017	November 16, 2017
		March 8, 2018	October 31, 2018
		March 21, 2019	November 5, 2019

Herbicide Application

Herbicides were applied to plots in the spring after sugarcane emerged from winter dormancy, which typically occurred when the most recently formed leaf collar measured 5 cm tall. A total of 12 different treatments, including a nontreated (weedy) control, were evaluated (Table 2). A crop oil concentrate, Grounded (Helena Agri-Enterprises, Collierville, TN), was added at a 10 mL L^{-1} to treatments containing topramezone. Herbicides were applied from a multiboom sprayer attached to the three-point hitch on a tractor. XR11003 VS flat-fan nozzle tips (TeeJet Technologies, Glendale Heights, IL) were used and the sprayer was calibrated to deliver 187 L ha^{-1}. Treatment dates are provided in Table 1. An additional treatment of 2,130 g ai ha^{-1} of pendimethalin (Prowl H_2O; BASF, Research Triangle Park, NC) and 840 g ai ha^{-1} of metribuzin (Tricor DF; UPL, Cary, NC) was applied at the end of May prior to canopy closure. Plant canes were clipped in early spring and the mowed cane leaves were incorporated with cultivation prior to the herbicide applications. Due to the severity of winter annual weeds in the second ratoon crops, dicamba and 2,4-D (Weedmaster; Nufarm, Alsip, IL) were applied at 140 and 400 g ae ha^{-1}, respectively, in mid-February.

Data Collection

Crop injury was visibly assessed 2 wk after treatment and scored on a scale of 0% to 100% with 0% being no injury and 100% being

Table 2. Herbicides applied in the spring.

Treatment number	Herbicide	Product	Rate	Manufacturer[a]
			g ai ha^{-1}	
1	Topramezone	Armezon	22.4	BASF
2	Topramezone	Armezon	56.1	BASF
3	Clomazone and Diuron	Command 3ME	1,260	FMC
		Direx 4L	2,800	Drexel Chemical
4	Pendimethalin and Atrazine	Prowl H2O	3,200	BASF
		Atrazine 4L	2,240	Drexel Chemical
5	Metribuzin	Tricor DF	1,680	UPL
6	Metribuzin	Tricor DF	2,520	UPL
7	Pendimethalin and Metribuzin	Prowl H2O	3,200	BASF
		Tricor	2,520	UPL
8	Topramezone and Triclopyr	Armezon	22.4	BASF
		Trycera	1,120	Helena Agri-Enterprises
9	Topramezone and Triclopyr	Armezon	44.9	BASF
		Trycera	1,120	Helena Agri-Enterprises
10	*S*-metolachlor, Atrazine, Mesotrione, and Bicyclopyrone	Acuron	2,900	Syngenta Crop Protection
11	Indaziflam	Alion	36.6	Bayer Crop Science

[a]Manufacturer locations: BASF, Research Triangle Park, NC; Bayer Crop Science, Creve Coeur, MO; Drexel Chemical Co., Memphis, TN; FMC Corporation, Philadelphia, PA; Helena Agri-Enterprises, LLC, Collierville, TN; Syngenta Crop Protection, Greensboro, NC; UPL, Cary, NC.

plant death. Weed density was assessed in August each year, 5 mo after herbicide application. At approximately the center of each plot on the hipped bed, two 0.3-m^2 quadrants were placed adjacent to the sugarcane. Weed density and species present were recorded. Stalk counts for each plot were recorded in the summer each year, 3 mo after herbicide application. For each plot, the height of 12 random stalks was recorded in July each year, 4 mo after herbicide application. Plots were harvested using a combine chopper harvester, and canes were collected in a modified dump wagon with load cells in the axle and tongue that recorded total sugarcane yield (Johnson and Richard 2005). The dump wagon enabled collecting a sample of the billets being harvested that was later processed for sucrose content. Billets were crushed in a roller mill and the juice collected for Brix and pol determination using a refractometer and saccharimeter. Theoretical recoverable sucrose (TRS) was calculated according to the method reported by Chen and Chou (1993). Total sugar yield per plot was estimated by multiplying sugarcane yield by TRS.

Statistical Analysis

All statistical analyses were performed with R software (v 4.3.1) (R Core Team 2024) using the TIDYVERSE and GGPLOTS2 packages. Where there were no significant differences, duplicate test years were combined for each harvest for individual varieties. Where this could not be performed, data were presented separately as either Test 1 or Test 2. Data were checked for normality and equal variance using a Shapiro-Wilk test and an *F*-test, respectively. When these conditions were met, ANOVA was performed followed by Tukey's honestly significant difference test where the ANOVA detected significant differences. Where normality was not met (this was often the case for crop injury), a Kruskal-Wallis test was performed.

Results and Discussion

Crop Response to Herbicide Treatment

Crop response to herbicide application varied between test years for both varieties and could not be grouped together for analysis (Table 3). Overall, treatment with clomazone and diuron caused the most injury to the crop. Injury 2 wk after application ranged from 15% to 36% for L 01-299 and from 11% to 31% for HoCP 96-540. It has been well established that clomazone can cause injury to sugarcane and potentially reduce yield (Richard 1996). Some older varieties of sugarcane have shown injury and yield loss to high rates of diuron (Millhollon and Matherne 1968). Other herbicide treatments also caused injury, but it was less severe and varied between test years. Treatment with Acuron (*S*-metolachlor, atrazine, mesotrione, and bicyclopyrone) caused minor injury of 3% to 10% to L 01-299 across all years in both tests, and injury to HoCP 96-540 in all harvest years except plant cane in the second test. The higher rate of topramezone with triclopyr caused mild injury (1% to 9%) to HoCP 96-540 across all tests in both test years. Topramezone alone caused mild to no injury: 0% to 8% at 22.4 g ai ha^{-1} and 0% to 10% at 56.1 g ai ha^{-1}. Injury from indaziflam was low, ranging from 0% to 8% injury to L 01-299 and 0% to 6% injury to HoCP 96-540.

Weed Response to Herbicide Treatment

Weed counts and species were evaluated in each plot in August, 5 mo after herbicide application. Overall, there were similar shifts in species composition over time in both varieties (Figure 1). Initially, the plant cane chamber-bitter (*Phyllanthus urinaria* L.) was the predominant weed. However, it decreased in incidence with subsequent harvests and was absent by the third harvest, except in Test 1 with HoCP 96-540. Purple nutsedge increased in incidence from the first harvest to the third, except in Test 1 with HoCP 96-540, when incidence decreased from the second harvest to the third harvest. Of particular concern is the increase in itchgrass incidence following subsequent harvests of L 01-299 (Figure 1). Closer examination of individual treatments did show some significant differences between harvest years in both itchgrass and purple nutsedge (Figures 2 and 3). While there were no statistically significant differences between harvests in Test 1 (Figure 2A), the number of itchgrass plants increased over subsequent harvests with an application of topramezone at 22.4 g ai ha^{-1}, clomazone and diuron, Acuron (*S*-metolachlor, atrazine, mesotrione, and bicyclopyrone), and indaziflam. In Test 2, the increase in the number of itchgrass plants in subsequent harvests was more pronounced and observed after all treatments (Figure 2B).

Table 3. Visual estimates of percent injury to crop two weeks after herbicide treatment.[a]

		L 01-299						HoCP 96-540					
		Plant cane		1st Ratoon		2nd Ratoon		Plant cane		1st Ratoon		2nd Ratoon	
Treatment Number	Treatment	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
1	Topramezone 22.4g	0 a	4 b	5 bc	7 bc	8 d	2 b	4 ab	0 a	0 a	3 abc	5 b	3 ab
2	Topramezone 56.1g	0 a	7 abc	6 bc	10 c	8 cd	2 abc	6 ab	0 a	0 a	8 c	7 bc	6 b
3	Clomazone and Diuron	29 b	29 d	36 d	16 c	15 e	19 d	11 b	20 b	19 b	28 d	31 d	14 c
4	Pendimethalin and Atrazine	0 a	8 bc	6 b	9 c	4 bcd	2 abc	3 a	0 a	1 a	2 abc	3 ab	4 b
5	Metribuzin 1,680 g	3 a	10 bc	8 bc	7 bc	5 bcd	3 abc	0 a	0 a	1 a	7 abc	7 c	4 ab
6	Metribuzin 2,520 g	4 a	9 c	10 bc	7 b	6 bcd	3 b	0 a	1 a	0 a	8 abc	6 bc	6 ab
7	Pendimethalin and Metribuzin	4 a	14 c	12 c	10 c	8 cd	5 c	1 a	3 a	0 a	8 bc	11 c	7 b
8	Topramezone 22.4 g and Triclopyr	0 a	7 bc	7 bc	8 bc	5 bc	1 ab	2 a	3 a	0 a	3 abc	6 bc	4 ab
9	Topramezone 44.9 g and Triclopyr	0 a	5 abc	11 c	8 bc	8 cd	1 ab	3 ab	1 a	1 a	3 b	9 c	6 b
10	*S*-metolachlor, Atrazine, Mesotrione, and Bicyclopyrone	3 a	6 bc	9 c	9 c	10 de	1 ab	6 ab	0 a	1 a	7 c	8 c	6 b
11	Indaziflam	2 a	5 b	8 bc	5 b	2 ab	0 a	0 a	0 a	0 a	6 a	6 b	1 a
12	Nontreated control	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a

[a]Letters indicate significant differences ($P < 0.05$) between treatments within a harvest year for each test run per variety.

This may be due to heavy rainfall and flooding in October 2019 that may have contributed to the spread of itchgrass seed that year, leading to heavier infestations the following year. Because Test 1 concluded in fall 2019 but Test 2 did not conclude until fall 2020, this flooding may account for the difference in significance for itchgrass counts between the two tests. The increases in itchgrass counts in the third harvest from previous harvests were significant with applications of topramezone at 22.4 g ai ha^{-1}, metribuzin at 1,680 g ai ha^{-1}, metribuzin at 2,520 g ai ha^{-1}, topramezone at 44.9 g ai ha^{-1} with triclopyr, and Acuron. This suggests that supplemental control strategies will be needed in fields where itchgrass is a problem. These supplemental control options are principally asulam applied postemergence or pendimethalin applied preemergence (Millhollon 1993).

Purple nutsedge also showed a similar trend across treatments (Figure 3). In both tests, treatment 4 (which consisted of pendimethalin and atrazine) produced a significant increase in purple nutsedge counts by harvest year 3. Purple nutsedge is difficult to manage in sugarcane, and severe infestations require postemergence treatment with a sulfonylurea, such as halosulfuron (Etheredge et al. 2010b).

Crop Yield

Stalk counts and heights were assessed for each plot. There were no significant differences in stalk counts, but there were differences in stalk heights (Table S1). Plots treated with clomazone and diuron frequently had the shortest stalks, which is likely due to enhanced crop injury to sugarcane observed following herbicide treatment. Stalk height was otherwise not consistent and varied between treatment and crop year for each variety.

Plot weights were collected for each plot at harvest. There were no significant differences in plot weights for HoCP 96-540, however there were for L 01-299 (Table S2). Across both test years and all harvests, plots treated with clomazone and diuron consistently produced the lowest plot weight, although this difference was not always significant. This decrease in weight is likely due to the shorter stalks and herbicide injury to the crop.

For most harvests across both test years and varieties, TRS was not significant (data not shown). However, total sugar per hectare obtained from L 01-299 (combining plot weight and TRS) was not significantly different between treatments (Table 4). Significant differences in HoCP 96-540 total sugar per hectare were observed only in Test 1 of the plant cane and for first ratoon in both tests. In both instances, the lowest yield came from plots treated with clomazone and diuron, although for first ratoon, this was not significantly different from treatment with pendimethalin and atrazine. The reduced yield of sugarcane treated with clomazone and diuron is likely a result of the shorter stalks (Table S1) and lower plot weight (Table S2).

These data reiterate the need to exercise caution when applying clomazone to sugarcane in the spring after dormancy because this treatment can negatively impact sucrose yield more than weed competition alone. However, the findings also suggest that the herbicides examined here are viable options for weed management in sugarcane. While topramezone and triclopyr caused mild injury, there was no effect on yield. For growers with bermudagrass infestations, these herbicides could be incorporated into a weed management strategy. Triclopyr, when paired with an HPPD inhibitor such as topramezone or mesotrione, can suppress bermudagrass (Brosnan and Breeden 2013, Spaunhorst

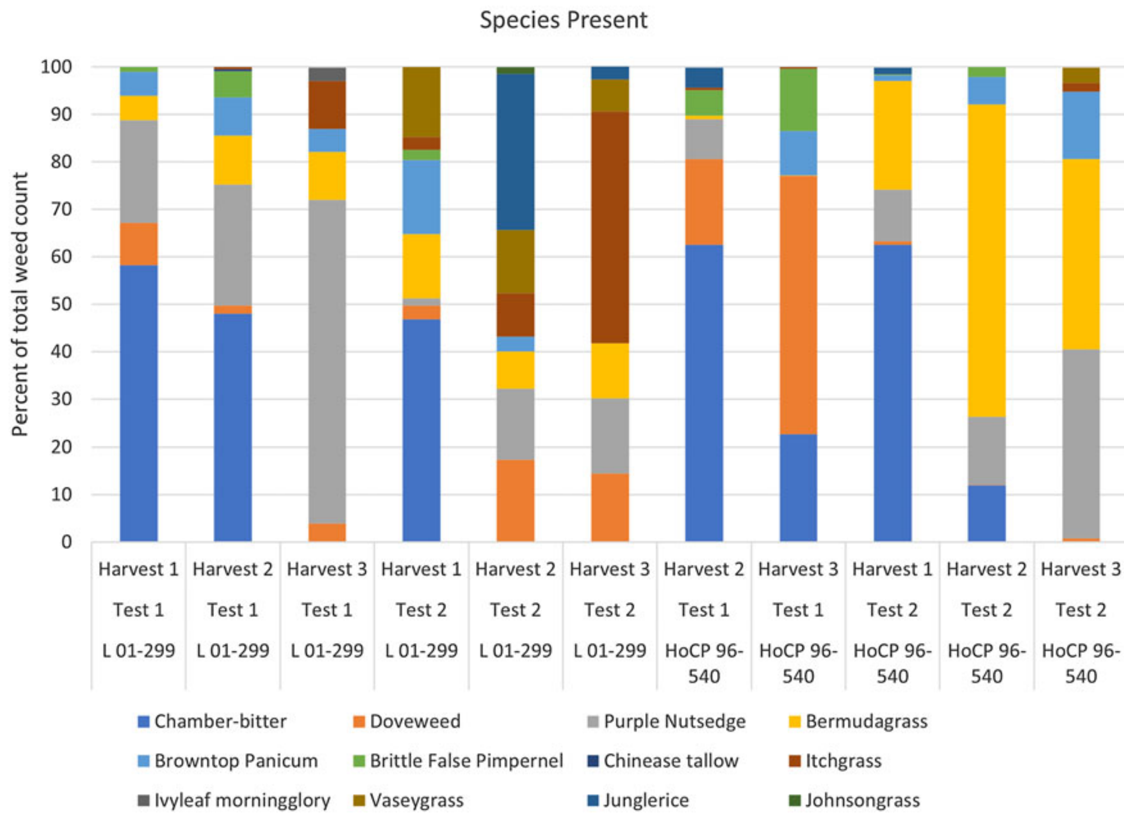

Figure 1. Compilation of weed counts across all treatments for each variety, test, and harvest year. Weed counts were not recorded for Harvest 1 of Test 1 for the ‘HoCP 96-540’ sugarcane variety.

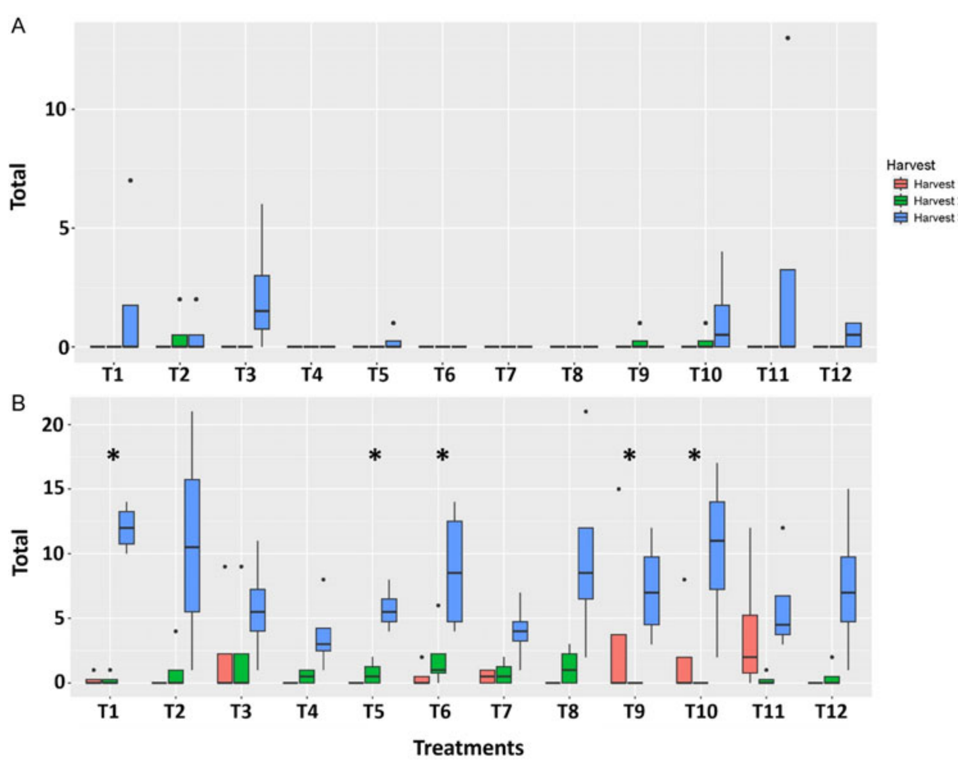

Figure 2. Box plot of itchgrass counts across harvests of sugarcane variety ‘L 01-299’ for A) Test 1 and B) Test 2. Statistically significant increases are marked with an asterisk. Treatment numbers match those in Table 2.

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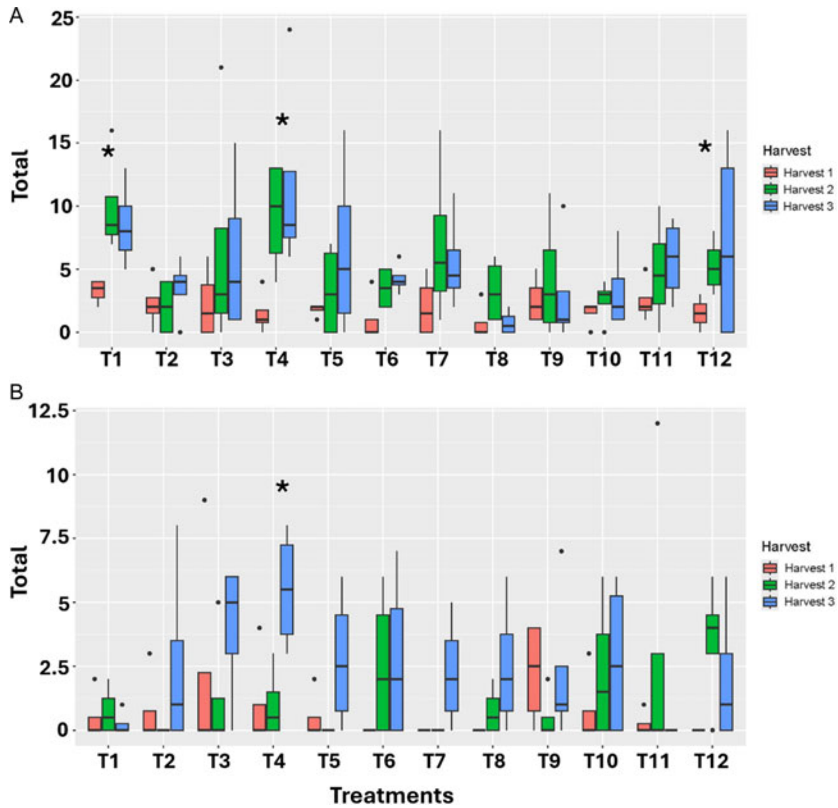

Figure 3. Box plots of purple nutsedge counts across harvest years for sugarcane variety 'L 01-299' A) Test 1 and B) Test 2. Treatments in which there were significant difference between harvest years are marked with an asterisk. Treatment numbers match those in Table 2.

2021). Spaunhorst (2021) observed up to 62% injury, which may be sufficient suppression to allow for canopy closure before bermudagrass can interfere with the sugarcane to affect yield. Although not an HPPD inhibitor, indaziflam was included in this study because Alion was recently registered for use on sugarcane. Indaziflam alone has not been found effective in preventing purple nutsedge emergence but was effective in managing doveweed (Ramanathan et al. 2023).

The limited number of herbicides registered for use on sugarcane (Orgeron and Wright 2023) highlights the need to diversify herbicide programs as much as possible to reduce the risk posed by herbicide-resistant weeds. HPPD inhibitors such as topramezone are ideal for this because resistance has been reported in few species, limited thus far too wild radish (*Raphanus raphanistrum* L.), waterhemp [*Amaranthus tuberculatus* (Moq.) Sauer], and Palmer amaranth (*Amaranthus palmeri* L.) (Busi et al. 2022, Hausman et al. 2011, Jhala et al. 2014). The wild radish population has become resistant to herbicides in Australia via repeated applications of pyrasulfotole, but it was also resistant to mesotrione and topramezone (Busi et al. 2022). In Illinois, resistant waterhemp was observed after annual HPPD inhibitor applications, either mesotrione, topramezone, or tembotrione. Most concerning is that this population was also resistant to atrazine, which was also applied with an HPPD inhibitor for several years (Hausman et al. 2011). HPPD inhibitor and triazine resistance was also confirmed in Palmer amaranth (Jhala et al. 2014). Annual bluegrass (*Poa annua* L.) resistance to indaziflam has been reported (Brosnan et al. 2020). While these weed species are currently not problematic in Louisiana sugarcane production, topramezone and indaziflam should be used in rotation with other herbicides to diversify sites of action and reduce the risk for resistance evolution.

Most interestingly, the shift in weed species overall highlights the need to rotate herbicides between years. Special care will need to be taken with respect to itchgrass. Itchgrass is one of the worst weeds in the world, in part due to its ability to self-pollinate and its prolific seed production (Holm et al. 1977, Millhollon and Burner 1993). As this highly competitive weed can significantly decrease sugarcane yield (Lencse and Griffin 1991, Millhollon 1992) growers will need to be vigilant in scouting for it in fields and surrounding areas. The herbicide treatment strategies here will need to be adjusted for managing itchgrass in fields where it is established. It would also be of interest to, on a larger scale, examine shifts in weed populations under different management strategies. Sugarcane is unique among row crops in that, as a perennial, it is kept in the ground for four years or longer. As weed pressure can cause a decrease in yield over subsequent harvests, it is important to understand how weed species adapt to sugarcane production and how weed management strategies need to be tailored to reduce the effect of those weeds and promote crop longevity. The impact of weather and how it contributes to weed seed dispersal, as was suspected of playing a role in the increased incidence of switchgrass in test 2, also needs to be considered.

Practical Implications

Louisiana sugarcane growers currently have a limited number of herbicides and sites of action registered for use. This increases the likelihood that herbicide resistance will evolve in weeds. Any additional sites of action, like HPPD-inhibitors or cellulose

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Table 4. Extrapolated sugar yield for plots in kg ha^{-1}.[a]

		L 01-299					HoCP 96-540				
			1st Ratoon		2nd Ratoon		Plant Cane			2nd Ratoon	
Treatment Number	Treatment	Plant Cane	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	1st Ratoon	Test 1	Test 2
1	Topramezone 22.4g	11440	12110	8620	10030	6670	15640 ab	12190	12150 ab	12110	7470
2	Topramezone 56.1g	11970	12380	9410	9530	6520	14000 ab	12180	12330 ab	11850	7800
3	Clomazone and Diuron	10490	10770	6840	7780	5840	13790 b	10910	11270 b	10970	7520
4	Pendimethalin and Atrazine	11700	12190	9110	9260	7090	15260 a	12840	11570 b	11680	8130
5	Metribuzin 1,680 g	12090	12510	9880	9080	6900	13930 ab	11780	12380 ab	12110	7790
6	Metribuzin 2,520 g	11910	12130	8710	10880	6520	14540 ab	12330	12100 ab	12060	8140
7	Pendimethalin and Metribuzin	12520	12680	8620	9090	7220	15400 a	12480	12610 ab	11860	8310
8	Topramezone 22.4g and Triclopyr	12270	11950	8780	9780	7720	15530 a	12160	12870 ab	12000	8310
9	Topramezone 44.9 g and Triclopyr	11380	12450	8910	9430	7110	15010 ab	11370	12470 ab	11800	8040
10	S-metolachlor, Atrazine, Mesotrione, and Bicyclopyrone	10870	12750	9250	9740	7530	14220 ab	12150	13580 a	11440	7590
11	Indaziflam	12430	12670	9860	10530	7970	15570 ab	10540	12130 ab	11650	8560
12	Nontreated control	12300	11780	9010	9660	7650	14420 ab	11280	12000 ab	11230	7010

[a]Where there were significant differences ($P < 0.05$) between treatments within harvest year, those differences are indicated by a letter. The absence of a letter means there were no significant differences between treatments for that harvest.

biosynthesis inhibitors, can help diversify herbicide application programs and reduce the risk for resistance. In addition, itchgrass is the worst weed currently facing Louisiana sugarcane growers. This research shows that growers cannot rely on a single site of action alone year after year as weed pressure, especially itchgrass, will increase in subsequent ratoon crops, requiring that the field be rotated into a fallow period prior to replanting. Ratoon longevity is a priority among growers due to the expense of replanting and weed management, particularly with respect to aggressive weeds like itchgrass, is a critical component of extending ratoon longevity and delaying replanting.

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