RED MORNINGGLORY (*IPOMOEA COCCINEA*) CONTROL AND COMPETITION IN SUGARCANE

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ABSTRACT

Red morningglory (*Ipomoea coccinea* L.) control is critical to prevent climbing and wrapping of sugarcane (*Saccharum* spp. hybrids) plants. Several morningglory control options beginning with the layby cultivation in May are practiced by Louisiana farmers. Herbicide can be applied at the layby cultivation or delayed until June to extend the period of residual weed control. Another option is to control weeds late season with a directed application of herbicide. Research was conducted to compare various weed control programs for residual activity on red morningglory and to evaluate the subsequent effect on sugarcane growth and yield. Red morningglory control 56 days after the layby application on May 26 was 86% for pendimethalin plus atrazine at 2.24 kg ai/ha, but control at 77 days was 48%. In contrast, pendimethalin plus sulfentrazone at 0.35 kg ai/ha applied at layby controlled red morningglory 93% 77 days after application. When application of atrazine and sulfentrazone was delayed until June 23, red morningglory control 49 days after treatment was 71% for atrazine and 95% for sulfentrazone. Delayed application of flumioxazin at 0.28 kg ai/ha controlled red morningglory equal to that of sulfentrazone 49 days after treatment, but weed re-infestation occurred later in the season with flumioxazin. Although differences in weed control were observed among the herbicide treatments applied in May and June, differences in sugarcane and sugar yield were not detected. Late season directed application of paraquat with atrazine or sulfentrazone in July controlled red morningglory no more than 39% and sugarcane and sugar yield were reduced an average of 39 and 50%, respectively. To support the weed control study, a red morningglory competition study was also conducted. The weedy treatment control represented red morningglory competition with sugarcane from May until harvest. For this treatment red morningglory infestation level (IL) at harvest, based on sugarcane stalk wrapping by red morningglory, was 89%. For the weed-free control where weed competition from May until harvest was eliminated, yield was 1.4 times that of the weedy control. Other treatments represented scenarios where sugarcane is kept weed free for a period of time after the layby cultivation in May and weeds re-infest over time, a situation which would occur as residual activity of herbicides decrease. Other treatments represented scenarios where sugarcane is not treated at layby and weeds emerging thereafter are controlled later in the growing season. The weed control and the weed competition studies support one another and show that red morningglory is capable of germinating under a sugarcane canopy from layby in May until harvest. Left uncontrolled, red morningglory can significantly reduce yield. For control of red morningglory, herbicides that provide extended residual activity would be most desirable. Sulfentrazone provided excellent residual weed control whether applied at the layby cultivation in May or 4 weeks later in June. In contrast, atrazine did not provide long term residual control of red morningglory whether applied in May or June. When control is insufficient, an effective

overtop herbicide or herbicide combination would be needed to kill red morningglory wrapping sugarcane stalks and to improve harvest efficiency.

INTRODUCTION

Sugarcane (*Saccharum* spp. hybrids) is a tropical crop grown primarily in Florida, Louisiana, and Texas in the continental U.S. In 2004, sugarcane was grown in Louisiana on 186,870 ha with an average yield of 6,200 kg sugar/ha (Anonymous 2005). Sugarcane in Louisiana is grown as a perennial with three to five annual harvests made from a single, vegetatively propagated planting. The row tops are relatively undisturbed during the entire crop cycle, which contributes to weed proliferation. Although several species of morningglory are present in Louisiana sugarcane fields, red morningglory (*Ipomoea coccinea* L.) is particularly troublesome (Webster 2000). Season-long red morningglory competition with sugarcane reduced sugar yields as much as 30% (Millhollon 1988). Germination and emergence of morningglory is most prevalent after the final layby cultivation where climbing and wrapping of sugarcane stalks reduce the number of millable stalks per hectare (Millhollon 1988; Thakar and Singh 1954). Ivyleaf morningglory (*Ipomoea hederacea* L. Jacq.) decreased sugarcane yield 20 to 25%, mainly from physical hindrance of plant growth and decreased harvest efficiencies (Thakar and Singh 1954). The frequent need to manually remove morningglory vines from mechanical harvesters is troublesome.

In the mid-1990's, as much as 75% of the Louisiana sugarcane hectarage received an atrazine application in the spring or at layby in June to control morningglory (Rogers et al. 1996). The use of atrazine was based on economics and the ability to provide soil residual control. Millhollon (1988) observed 84% control of red morningglory 60 d after treatment (DAT) with 1.8 kg ai/ha atrazine applied preemergence (PRE) in the first year of a 2-year study. In the second year of the study, red morningglory was controlled 88 to 93% with atrazine 90 DAT. In this study, atrazine was applied in mid-June, which was standard practice in sugarcane at the time. In recent years, however, growers have reported red morningglory control failures with atrazine applied at layby in early to mid-May (Griffin et al. 2000). Viator et al. (2002a) showed that red morningglory control failures were not a result of atrazine resistance through an altered triazine binding site. In a 2-year study, application of atrazine in the first year at 1.68 kg ai/ha controlled red morningglory 74 and 96% 45 DAT depending on location, but control declined to 71 and 83% the second year (Viator et al. 2002b). The reduced control of morningglory was attributed to two factors: 1) a shift in grower preference to plant sugarcane variety LCP 85-384 and 2) a change in cultural practices in Louisiana that favored earlier applications of layby herbicide in early to mid-May as opposed to early to mid-June (Viator et al. 2002a). The underlying assumption for the earlier application of herbicide was that longer residual weed control from atrazine into the growing season would be expected.

Other herbicides labeled for morningglory control in sugarcane include diuron, metribuzin, terbacil, sulfentrazone, and hexazinone (Anonymous 2006). Diuron PRE at 1.68 kg ai/ha controlled red morningglory 53% 60 DAT and increasing the diuron rate to 2.24 kg ai/ha increased control to 76% (Millhollon 1988). Viator et al. (2002b) showed that higher rates of diuron at 3.36 kg ai/ha controlled red morningglory 83 to 99% 45 DAT in one year, but only 73 to 75% in another. In the same study, sulfentrazone at 0.14, 0.28, or 0.42 kg ai/ha controlled red

morningglory at least 94% in one year, but no more than 80% the following year. Red morningglory control with terbacil at 0.84 kg ai/ha or metribuzin at 1.12 kg ai/ha was 92 and 96%, respectively, the first year but was 30 and 60%, respectively, the second year. The difference in control between years was attributed to the timing of activating rainfall, soil pH, and organic matter.

In Louisiana under current production practices several control options for morningglory are available. The first is the application of herbicides with grass and broadleaf activity immediately following the layby cultivation in May. Another option is to apply a grass herbicide in May and delay application of broadleaf herbicide until June to extend the period of residual weed control. The last option is to forego herbicide use at layby and remove grass and broadleaf weeds in July with a directed application of paraquat plus an effective broadleaf herbicide. Even though June and July herbicide applications may control morningglory, competition with sugarcane during the period since the layby cultivation in May could affect sugarcane growth and yield potential. Research was conducted to compare weed control programs for red morningglory with herbicides applied following the layby cultivation in late May and with subsequent applications in late June and July. Additionally, the effect of red morningglory competition on sugarcane growth and yield was evaluated.

MATERIALS AND METHODS

Two investigations, a weed control study and a weed competition study, were conducted in 2005 near Port Allen, LA, in West Baton Rouge Parish and near White Castle, LA, in Iberville Parish in fields of second stubble 'LCP 85-384' with natural infestations of red morningglory. The soil type in West Baton Rouge Parish was a Commerce silt loam (fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts) with 1.8% organic matter and a pH of 6.5. The soil type in Iberville Parish was a Commerce silty clay loam (fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts) with 1.3% organic matter and a pH of 6.3. At both sites, each experiment was designed as a randomized complete block with 4 replications. Plot size was 5.5 m (3 rows of sugarcane at 183-cm spacing) by 15.2 m.

Red Morningglory Control Study.

To initiate the study, the experimental area at both locations was treated with 2,4-D at 1.12 kg ai/ha on May 25, 2005 to kill emerged red morningglory and complete control was obtained. Layby herbicide application was made the following day on May 26, 2005. Pendimethalin at 2.78 kg ai/ha was co-applied with all atrazine and sulfentrazone treatments at the layby timing and alone on May 26 prior to all June 23 delayed layby treatments. Atrazine (2.24 and 3.36 kg ai/ha) and sulfentrazone (0.35 and 0.42 kg ai/ha) were applied at the layby and delayed layby application timings. Flumioxazin at 0.14 and 0.28 kg ai/ha was also applied delayed layby. As a comparison, paraquat at 0.63 kg ai/ha was co-applied with 2.24 kg ai/ha of atrazine or 0.35 kg ai/ha of sulfentrazone on July 21 to represent a late-season weed control application. No other herbicide was applied prior to application of the paraquat treatments. For the delayed layby application, morningglory plant height ranged from 2 to 25 cm and for the late season application morningglory height ranged from 2 to 160 cm. For all treatments herbicide was directed to the row middles and the lower 60 cm of sugarcane stalks. All herbicide

treatments were applied with a CO_2 backpack sprayer calibrated to deliver 93.5 l/ha. Nonionic surfactant was added to the delayed layby and late season treatments at 0.25% v/v.

Visual control of red morningglory was determined on June 23, July 21, and August 11. The June 23 rating represents 28 days after the layby application. The July 21 rating represents 56 days after the layby application and 28 days after the delayed layby application. The August 11 rating represents 77 days after the layby application, 49 days after the delayed layby application, and 21 days after the late season application. 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. An estimate of the red morningglory infestation was determined by the number of stalks wrapped (SW) and the percentage of individual stalks wrapped from the base to the top of the canopy (PSW). Ratings for SW were made for each plot based on a scale of 0 to 10, with 0 = no stalks wrapped by red morningglory and 10 = all stalks wrapped to some degree with red morningglory. PSW by red morningglory was based on a scale of 0 to 10, with at 0 = none of the stalk wrapped and 10 = the whole stalk was wrapped based on an average for all stalks in each plot. The SW and PSW ratings were summed, divided by 20, and expressed as a percentage to provide a quantified index for red morningglory infestation level (IL). A maximum rating of 10 for both SW and PSW would correspond to an IL value of 100% (all stalks in the plot wrapped to the top of the crop canopy).

Due to severe sugarcane lodging at the White Castle location in August 2005 from Hurricane Katrina, sugarcane stalk population, height, and yield data were collected only at the Port Allen site. Stalk height was measured from the soil surface to the collar of the youngest leaf on five randomly selected stalks. Plots were hand harvested in early November and ten randomly selected stalks were weighed to determine average stalk weight. Stalk samples were then crushed and the juice was extracted for analysis of theoretical recoverable sugar using standard methodology (Chen and Chou 1993). Sugar yield was calculated by multiplying theoretical recoverable sugar, expressed as kilograms of sugar per 1,000 kg of sugarcane, by sugarcane yield.

Red Morningglory Competition Study.

To initiate the competition study, the entire experimental area was treated with 2,4-D at 1.12 kg ai/ha on May 25, 2005 to kill emerged weeds and complete control was obtained. Experiments were initiated on May 26. For the weed- free maintenance treatments, specific plots were maintained weed free from May 26 until June 23, July 21, August 11, or August 25. Following these dates, red morningglory was allowed to naturally re-infest the plots. For the weedy duration of interference treatments specific plots remained weedy from May 26 until June 23, July 21, August 11, or August 25, after which plots were maintained weed free for the remainder of the growing season. Weed-free and weedy (May 26 – November 9) controls were included for comparison. Atrazine at 2.24 kg ai/ha, 2,4-D at 0.8 kg ai/ha plus dicamba at 0.28 kg ai/ha, and hand weeding were used in the season-long weed-free control and in the weedy treatments after the specified weed removal dates. For the weed-free treatments, plots were maintained weed free until the specified dates using only 2,4-D plus dicamba and hand weeding. Data collected at both locations included red morningglory IL using the scale previously described. Sugarcane height, sugarcane stalk population, and sugarcane and sugar yield were determined only at the Port Allen location.

Data for both the weed control and the weed competition studies were subjected to the Mixed Procedure in SAS (SAS Institute 2003). Location, replications (nested within location), and all interactions containing either of these effects were considered random effects (Carmer et al. 1989). All other variables were considered fixed effects. Considering locations 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 ($P \leq 0.05$) was produced using PDMIX800 in SAS which is a macro for converting mean separation output to letter groupings (Saxton 1998).

RESULTS AND DISCUSSION

Red Morningglory Control Study.

On June 23, 28 days after the layby application on May 26, pendimethalin (2.78 kg ai/ha) plus atrazine at 2.24 and 3.36 kg ai/ha and pendimethalin plus sulfentrazone at 0.35 and 0.42 kg ai/ha controlled red morningglory at least 94% (Table 1). On July 21, 56 days after layby treatments were applied, pendimethalin plus atrazine at 2.24 kg ai/ha controlled red morningglory 86% compared with 91 to 95% control for the other layby treatments. When application of atrazine and sulfentrazone was delayed until June 23, red morningglory was

Table 1. Red morningglory percentage control in sugarcane as influenced by herbicide treatments applied on May 26 (layby), on June 23 (delayed layby), and on July 21 (late season)[a]

Treatment	Rate kg ai/ha	Application timing	Jun 23[b]	Jul 21	Aug 11
			Mean percentage control[c]		
Atrazine	2.78 + 2.24	Layby	94 a c	86 b	48 de
Atrazine	2.78 + 3.36	Layby	95 a	91 a	53 d
Sulfentrazone	2.78 + 0.35	Layby	95 a	94 a	93 a
Sulfentrazone	2.78 + 0.42	Layby	95 a	95 a	94 a
Atrazine	2.78 fb 2.24	Delayed layby	0 b	95 a	71 c
Atrazine	2.78 fb 3.36	Delayed layby	0 b	95 a	76 bc
Sulfentrazone	2.78 fb 0.35	Delayed layby	0 b	95 a	95 a
Sulfentrazone	2.78 fb 0.42	Delayed layby	0 b	95 a	95 a
Flumioxazin	2.78 fb 0.14	Delayed layby	0 b	94 a	71 c
Flumioxazin	2.78 fb 0.28	Delayed layby	0 b	95 a	85 ab
Paraquat + atrazine	0.63 + 2.24	Late season	0 b	0 c	38 e
Paraquat + sulfentrazone	0.63 + 0.35	Late season	0 b	0 c	39 e

[a]Experiments conducted in 2005 near Port Allen and White Castle, LA. Pendimethalin at 2.78 kg ai/ha was applied on May 26 in combination with the atrazine and sulfentrazone layby treatments and also alone prior to the atrazine, sulfentrazone, and flumioxazin delayed layby treatments. "fb" = followed by.

[b]For the rating dates: Jun 23 = 28 d after the layby application; Jul 21 = 56 d after the layby application and 28 d after the delayed layby application; Aug 11 = 77 d after the layby application, 49 d after the delayed layby application, and 21 d after the late season application. Scale for the % control values: 0% = no control, 100% = all weeds controlled.

[c]Means within each column followed by the same letter are not significantly different ($P \leq 0.05$).

controlled 95% 28 DAT. On August 11, control of red morningglory with atrazine was no more than 53% when applied at layby and no more than 76% when applied in June. This compares with at least 93% for sulfentrazone applied in May or June. Other research has shown that atrazine will provide residual control of red morningglory for around 35 days, whereas sulfentrazone can provide control to 77 days (Jones and Griffin 2008). Flumioxazin applied at 0.14 kg ai/ha in June following pendimethalin controlled red morningglory in August equal to that of atrazine applied in June, but at 0.28 kg ai/ha flumioxazin control following a June application was equal to that of sulfentrazone. Red morningglory control on August 11, 21 days after paraquat was applied with atrazine or sulfentrazone late season in July, was no more than 39%. The poor control was due to lack of coverage of red morningglory foliage which had begun to wrap sugarcane stalks. Neither paraquat nor sulfentrazone are labeled for over-the-top application to sugarcane in July.

Ratings for SW and PSW were used to calculate an index for red morningglory infestation level (IL), which further quantified the effect of the herbicide treatments. On June 23, all treatments applied at layby provided complete control and morningglory plants were not present (Table 2). By July 21, red morningglory had begun to emerge following the layby application but IL was no more than 7% and was similar across all layby treatments. On the July 21 rating, red morningglory was not present when herbicides were applied in June indicating that all herbicides provided postemergence control. In contrast where the late season herbicide had not been applied, IL in July was 49 and 53%. On August 11, red morningglory had wrapped stalks where atrazine was applied at layby and IL was 39% and was 55 and 58% on November 9. Where atrazine was applied in June (delayed layby) at 2.24 and 3.36 kg ai/ha, residual control was provided into August (IL = 11 and 4%, respectively) and November (IL = 23 and 5%, respectively) (Table 2). These findings clearly show that delaying atrazine application until June can extend the effective weed control period when compared with the traditional application at the layby cultivation in May. Since red morningglory are capable of germinating and growing under a sugarcane canopy late into the growing season (Jones et al. 2006), residual control from herbicides is critical.

When sulfentrazone was applied in May (layby) or in June (delayed layby), red morningglory was not present in August or November (Table 2). When flumioxazin at 0.14 and 0.28 kg ai/ha was applied in June (delayed layby), red morningglory IL in August was 20 and 18%, respectively, and by November IL was 41 and 16%, respectively. For both sulfentrazone and flumioxazin, herbicide must be directed under the crop canopy to provide coverage of emerged weeds and to avoid direct contact with the whorl of the sugarcane plants and subsequent injury (Anonymous 2006). When paraquat plus atrazine or sulfentrazone was applied late season, red morningglory IL was around 50% and IL continued to increase as the season progressed; around 77% in August and 100% in November (Table 2). Even though both atrazine and sulfentrazone are effective postemergence on red morningglory, lack of control was due to the directed application and poor coverage of red morningglory foliage.

Table 2. Red morningglory infestation level in sugarcane and sugarcane stalk population, sugarcane yield, and sugar yield as influenced by herbicide treatments applied on May 26 (layby), on June 23 (delayed layby), and on July 21 (late season)[a]

			Red morningglory percentage infestation level[b]				Sugarcane		
Treatment	Rate kg ai/ha	Application timing	Jun 23[c]	Jul 21	Aug 11	Nov 9	Stalk population (1,000/ha)	Yield (1,000 kg/ha)	Sugar yield (kg/ha)
Atrazine	2.78 + 2.24	Layby	0 bd	7 b	39 b	55 b	92.4 a	54.3 a	6,834 a
Atrazine	2.78 + 3.36	Layby	0 b	3 b	39 b	58 b	87.4 a	49.1 a	6,874 a
Sulfentrazone	2.78 + 0.35	Layby	0 b	0 b	0 e	0 e	98.2 a	59.7 a	8,136 a
Sulfentrazone	2.78 + 0.42	Layby	0 b	0 b	0 e	0 e	87.9 a	51.9 a	6,841 a
Atrazine	2.78 fb 2.24	Delayed layby	17 a	0 b	11 d	23 d	90.1 a	58.5 a	7,876 a
Atrazine	2.78 fb 3.36	Delayed layby	19 a	0 b	4 de	5 e	87.9 a	56.4 a	7,543 a
Sulfentrazone	2.78 fb 0.35	Delayed layby	23 a	0 b	0 e	0 e	99.1 a	58.3 a	7,787 a
Sulfentrazone	2.78 fb 0.42	Delayed layby	22 a	0 b	0 e	0 e	91.9 a	56.0 a	7,503 a
Flumioxazin	2.78 fb 0.14	Delayed layby	21 a	0 b	20 c	41 c	97.3 a	62.6 a	8,298 a
Flumioxazin	2.78 fb 0.28	Delayed layby	20 a	0 b	18 de	16 de	94.1 a	58.9 a	7,894 a
Paraquat + atrazine	0.63 + 2.24	Late season	18 a	53 a	77 a	100 a	81.3 a	36.9 b	4,137 b
Paraquat + sulfentrazone	0.63 + 0.35	Late season	17 a	49 a	76 a	100 a	66.5 b	32.1 b	3,596 b

[a]Experiments conducted in 2005 near Port Allen and White Castle, LA. Pendimethalin at 2.78 kg ai/ha was applied on May 26 in combination with the atrazine and sulfentrazone layby treatments and also alone prior to the atrazine, sulfentrazone, and flumioxazin delayed layby treatments. "fb" = followed by. Sugarcane stalk population and yield determined only at the Port Allen site.

[b]Red morningglory infestation level (IL) was based on number of stalks wrapped (SW) and the percentage of individual stalks wrapped from the base to the top of the canopy (PSW). Ratings for SW (not shown here) were made for each plot based on a scale of 0 to 10, with 0 = no stalks wrapped by red morningglory and 10 = all stalks wrapped to some degree with red morningglory. PSW (not shown her) by red morningglory was based on a scale of 0 to 10, with at 0 = none of the stalk wrapped and 10 = the whole stalk was wrapped based on an average for all stalks in each plot. The SW and PSW ratings were summed, divided by 20, and expressed as a percentage to provide a quantified index value for red morningglory IL. A maximum rating of 10 for both SW and PSW would correspond to an IL value of 100% (all stalks in the plot wrapped to the top of the crop canopy).

[c]For the rating dates: Jun 23 = 28 d after the layby application; Jul 21 = 56 d after the layby application and 28 d after the delayed layby application; Aug 11 = 77 d after the layby application, 49 d after the delayed layby application, and 21 d after the late season application; Nov 9 = 167 d after the layby application, 139 d after the delayed layby application, and 111 d after the late season application.

[d]Means within each column followed by the same letter are not significantly different ($P \leq 0.05$).

At the Port Allen location sugarcane height was not affected by the herbicide treatments (data not shown). Sugarcane stalk population was reduced only where paraquat plus sulfentrazone was applied late season (Table 2), which may be attributed to sulfentrazone injury. Differences in sugarcane and sugar yield were not observed among the herbicide treatments applied in May or June, but sugarcane and sugar yield were reduced an average of 39 and 50%, respectively, when herbicides were applied in July. It should be noted that sugarcane yield and sugar yield were based on hand cut samples. In reality, some of the plots in this study would have been very difficult, if not impossible, to harvest with a combine sugarcane harvester. The results, however, do show the effect that red morningglory competition can have on sugarcane production.

Red Morningglory Competition Study.

The weedy treatment control would represent the worst case scenario where red morningglory is allowed to compete with sugarcane from May until harvest. For the two locations, red morningglory IL changed from an average of 14 to 48% from June through August and by November IL was 89% (Table 3). The weed-free control would represent the best case scenario where weed competition from May until harvest is eliminated. The weed-free treatments represent what could be expected when herbicide applied May 26 controls weeds for a specified period of time after which herbicide concentration in soil is insufficient to prevent reinfestation. For all weed-free treatments, no more than 3% IL was observed in August (Table 3). By November, however, IL was 24% when weeds were allowed to reinfest after June 23, but only 8 to 9% when weeds were allowed to reinfest after July 21, August 11, or August 25. These findings show that red morningglory reinfestation can occur after August stressing the need for herbicides that provide long residual activity. In the weed control study, sulfentrazone applied in May or June provided season long red morningglory control (Tables 1 and 2). The weedy treatments in the competition study represent what could be expected when herbicide is not applied in May and applications are made later to control emerged weeds and to provide residual control thereafter. When control measures were implemented, red morningglory IL for the weedy until June 23, July 1, and August 11 treatments was 14, 48, and 50%, respectively (Table 3). These findings emphasize the need for application of effective herbicides later in the growing season.

Sugarcane height and stalk population in August at the Port Allen location were each equivalent for the weedy and weed-free treatments (data not shown). This is not unexpected because the study was not initiated until May 25, at which time all red morningglory in the plots were killed. In May when the layby cultivation was made, sugarcane has produced the tillers that would become harvestable stalks. However, weed competition can reduce stalk diameter and weight which can affect yield. Comparing the weedy treatment where red morningglory was allowed to compete with sugarcane from May until harvest and the weed-free control where weed competition from May until harvest was eliminated, red morningglory competition reduced sugarcane yield and sugar yield around 27% (Table 3). Sugarcane and sugar yields for the other weed-free and weedy treatments were equal to the weed-free control. As also noted for the weed control study, sugarcane was hand- harvested in the competition study. When morningglory has wrapped sugarcane stalks, slower mechanical harvester speeds can be expected. Breakage of stalks due to wrapping may also affect the number of stalks placed in the loading wagon from the combine harvester. These factors, however, were not investigated in this study. In many cases in commercial sugarcane production, when wrapping of sugarcane stalks with red morningglory is extensive, harvest is abandoned, resulting in total yield loss.

Table 3. Red morningglory infestation level, and sugarcane yield and sugar yield as influenced by red morningglory competition[a]

Competition treatment	Red morningglory percentage infestation level[b]				Sugarcane yield (1,000 kg/ha)	Sugar yield (kg/ha)
	Jun 23 [c]	Jul 21	Aug 11	Nov 9		
Weedy / May 26 – Nov 9	14 a	43 a	48 a	89 a	41.0 b	4,984 b
Weed free / May 26 – Nov 9	0 b	0 b	0 b	0c	56.2 a	6,864 a
Weed free / May 26 - Jun 23	0 b	0 b	3 b	24 b	56.2 a	6,885 a
Weed free / May 26 - Jul 21	0 b	0 b	2 b	8 c	56.7 a	6,740 a
Weed free / May 26 – Aug 11	0 b	0 b	0 b	9 c	49.6 ab	6,237 ab
Weed free / May 26 – Aug 25	0 b	0 b	0 b	8 c	45.4 ab	5,610 ab
Weedy / May 26 - Jun 23	14 a	0 b	0 b	0 c	49.8 ab	5,907 ab
Weedy / May 26 – Jul 21	15 a	48 a	0 b	0 c	47.9 ab	6,003 ab
Weedy / May 26 - Aug 11	17 a	45 a	50 a	0 c	48.4 ab	6,058 ab
Weedy / May 26 – Aug 25	14 a	48 a	54 a	0 c	48.5 ab	5,954 ab

[a]Experiments were conducted in 2005 near Port Allen and White Castle, LA. Sugarcane stalk population and yield determined only at the Port Allen site. To initiate the study the entire experimental area was treated with 2,4-D at 1.12 kg ai/ha on May 25 to kill emerged weeds and complete control was obtained. Experiments were initiated on May 26. For the weed-free maintenance treatments, plots were maintained weed free for the specified dates and red morningglory was allowed to naturally re-infest thereafter. For the weedy treatments, plots remained weedy for the specified dates and plots were maintained weed free thereafter.

[b]Red morningglory infestation level (IL) was based on number of stalks wrapped (SW) and the percentage of individual stalks wrapped from the base to the top of the canopy (PSW). Ratings for SW (not shown here) were made for each plot based on a scale of 0 to 10, with 0 = no stalks wrapped by red morningglory and 10 = all stalks wrapped to some degree with red morningglory. PSW (not shown her) by red morningglory was based on a scale of 0 to 10, with at 0 = none of the stalk wrapped and 10 = the whole stalk was wrapped based on an average for all stalks in each plot. The SW and PSW ratings were summed, divided by 20, and expressed as a percentage to provide a quantified index value for red morningglory IL. A maximum rating of 10 for both SW and PSW would correspond to an IL value of 100% (all stalks in the plot wrapped to the top of the crop canopy).

[c]Means within each column followed by the same letter are not significantly different ($P \leq 0.05$).

In conclusion, results from both the control and competition study substantiate the negative effect that red morningglory can have in sugarcane. In the weed control study sulfentrazone applied at 0.35 kg ai/ha in May or June provided excellent season long red morningglory control. Atrazine at 2.24 kg ai/ha was more effective when applied in June rather than in May, but regardless of the time of application, significant re-infestation of red morningglory occurred late in the growing season. Flumioxazin applied in June, like atrazine, did not provide residual control later into the growing season. Directed application of paraquat with atrazine or sulfentrazone in late July was ineffective because vines had begun to climb sugarcane stalks and spray coverage was an issue. Directed application of these herbicides has been very effective in field situations when weeds are small. From a yield perspective, results from both the weed control and competition study show that control measures implemented in May or June can maximize yield and also that red

morningglory not controlled by June can result in yield loss. Herbicides with excellent sugarcane tolerance and with postemergence and residual activity are available for control of red morningglory in sugarcane (Jones and Griffin 2008). Additionally, red morningglory can be effectively controlled in July or August with 2,4-D or 2,4-D plus dicamba (Siebert et al. 2004).

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