

## RED MORNINGGLORY (*IPOMOEA COCCINEA*) RESPONSE TO TILLAGE AND SHADE

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### ABSTRACT

Field research conducted over 3 years evaluated red morningglory seedling emergence from June through September in a fallowed sugarcane field. Tillage to a 10.2 cm depth was compared with no tillage where glufosinate at 0.37 kg ai/ha was used to eliminate red morningglory. In July, 4 weeks after initial tillage, red morningglory seedling emergence was equal whether soil was tilled or not tilled. Seedling emergence in August and September, however, was 1.5 and 3.9 times greater, respectively, for the tillage treatment. Total season emergence of red morningglory was 34% greater where soil was tilled compared with no-tillage. In October, seed population in soil for the tilled and no tillage treatments was equivalent and had decreased an average of 35% from June. For the undisturbed control where seed production occurred, seed population in soil increased 1.4 fold across the growing season. Red morningglory emergence and growth in response to 0, 30, 50, 70, or 90% shade established using enclosures covered with shade cloth was evaluated in three years of field research. Red morningglory seedling emergence 20 to 41 days after soil was tilled to a 10.2 cm depth decreased 5 and 8% for the 30 and 50% shade treatments, respectively, compared with no shade (full sunlight). Increasing shade to 70 and 90% decreased seedling emergence 37 and 43%, respectively. Shade did not affect red morningglory height, but biomass per plant decreased 27 and 48% as shade level increased to 70 and 90%, respectively. Leaf and stem weight was lower when red morningglory plants were grown under 90% shade compared with 30%. Plant leaf area was greater under all shade levels compared with that for plants grown in full sunlight. Red morningglory tolerance to a shade environment stresses the need for effective weed control programs at the layby cultivation and later in the growing season to prevent climbing and wrapping of sugarcane stalks and reduced harvest efficiency.

### INTRODUCTION

In Louisiana, sugarcane is grown as a perennial with three to five annual harvests made from a single, vegetatively propagated planting. During the entire crop cycle, the row tops are relatively undisturbed which contributes to weed proliferation. Both grass and broadleaf weeds are problematic in sugarcane. Especially troublesome are morningglory. In Louisiana, morningglory species include ivyleaf morningglory [*Ipomoea hederacea* (L.) Jacq], entireleaf morningglory (*Ipomoea hederacea* var. *integriuscula* Gray), pitted morningglory (*Ipomoea lacunosa* L.), smallflower morningglory [*Jacquemontia tamnifolia* (L.) Griseb.], and red morningglory (*Ipomoea coccinea* L.). Red morningglory is both the most common and troublesome broadleaf weed in Louisiana sugarcane (Webster 2000). Season-long red morningglory

competition with sugarcane has reduced sugar yields 24 to 30% (Millhollon 1988). Germination and emergence of morningglories after the layby cultivation result in climbing and wrapping of sugarcane stalks reducing the number of millable stalks per hectare (Jones and Griffin 2009).

Morningglory seeds germinate over a wide range of temperatures (Cole and Coats 1973; Egley 1990; Gomes et al. 1978; Hardcastle 1978). Hardcastle (1978) in a laboratory study reported red morningglory germination was favored by 144 h of 20 to 30 C temperatures. In Louisiana these soil temperature levels would occur when layby tillage in sugarcane is performed in May (Viator et al. 2002). Tillage stimulates germination of weed seeds by aerating soil and repositioning seeds closer to the soil surface where conditions are more favorable to germination (Egley 1986). In sugarcane, tillage is usually accompanied by a flush of weed seedlings. The extent that seedlings develop and compete with sugarcane is dependent on rainfall, effectiveness of soil applied herbicides, and competition from the sugarcane crop. Sugarcane is a rapidly growing crop often growing as much as 2.5 cm per day during the hottest part of the growing season (B. Legendre, personal communication). Rapid shading of row middles by sugarcane plants is essential to aid in weed control late in the season when herbicides become ineffective. It is not uncommon for red morningglory to germinate late in the growing season under a heavy crop canopy (Jones and Griffin 2009).

The fact that red morningglory emerges late into the growing season in sugarcane in Louisiana suggests that it may be somewhat shade tolerant. Murdock et al. (1986) reported decreased pitted morningglory emergence and dry weight as soybean [*Glycine max* (L.) Merr.] row spacing decreased from 91 to 30 cm due to more rapid shading with the closer row spacing. Norsworthy (2004) reported that pitted morningglory emergence was not influenced by soybean canopy formation, but sicklepod [*Senna obtusifolia* (L.) Irwin and Barneby] and common cocklebur (*Xanthium strumarium* L.) emergence were reduced as much as 68 and 33%, respectively. Giant foxtail (*Setaria faberi* Herrm.) seed weight and above ground dry weight decreased linearly with increasing shade intensity (Knake 1972). Decreases were attributed to fewer leaves, stems, and fruiting structures per plant. Shading also affected giant foxtail internode length, but not the number of nodes per plant. Giant foxtail was unable to survive in a 95% or greater shade environment, again emphasizing the importance of crop canopy in reducing weed competition.

Research to address weed response to shade has been conducted with field bindweed (*Convolvulus arvensis* L.) (Dall'Arnellina and Zimdahl 1988), yellow (*Cyperus esculentus* L.) and purple nutsedge (*Cyperus rotundus* L.) (Keeley and Thullen 1978; Patterson 1982a; Santos et al. 1997), showy croton (*Crotalaria spectabilis* Roth) (Patterson 1982b), velvetleaf (*Abutilon theophrasti* Medik.) (Bello et al. 1995), and silverleaf nightshade (*Solanum elaeagnifolium* Cav.) (Boyd and Murray 1982). Shading has affected shoot number, plant height, leaf and stem dry weight, leaf area, chlorophyll content per unit leaf area, and reproductive development. Research was conducted in Louisiana to evaluate the effect of tillage and shade on red morningglory seedling emergence and growth. Results from this research would be

directly applicable to the development of effective and season long weed control programs.

## MATERIALS AND METHODS

Field research was conducted near Port Allen, LA, in West Baton Rouge Parish in a fallowed sugarcane field with a natural red morningglory infestation. The soil type was a Commerce silt loam (fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts) with 1.8% organic matter and pH of 6.5.

### Tillage Study.

A completely randomized design was used and experiments were conducted in 2001, 2002, and 2004. Three areas, each 9.1 by 9.1 m, were used to compare red morningglory emergence following weed removal by tillage or chemical treatment (no tillage). Areas were divided into subplots measuring 0.28 m<sup>2</sup> and data were collected only once from each subplot. Red morningglory emergence was determined from 10 sub-plots selected at random in each treatment in July, August, and September. Experiments were initiated in June each year with tillage of the entire treatment area. After seedlings were counted in July, August, and September, weeds were removed using a rotary tiller set a depth of 10.2 cm (tillage treatment) or chemically using glufosinate at 0.37 kg ai/ha (no tillage treatment). Complete control of emerged seedlings was achieved by both treatments.

At initiation of the study each year in June and at completion of the study in October, bulb planters were used to take soil core samples 6.4 cm in diameter and 10.2 cm in depth from randomly assigned subplots within the two tillage treatments and also from a season long undisturbed control. For the undisturbed control, red morningglory plants had set seeds and seeds were visible on the soil surface in October. For all treatments, soil core samples were taken with minimal disturbance of the soil and care was used in the undisturbed control to collect seed present on the soil surface. Soil core samples were placed between two 18 mesh (1 mm openings) testing sieves. Soil was washed from the sample and red morningglory seeds were counted. Only seeds that were full and hard to the touch were considered in the counts. No attempt was made to evaluate seed germination or viability.

### Shade Study.

The experimental design was a randomized complete block with four replications. Four experiments were conducted per year in 2001, 2002, and 2004. Shading was achieved by use of 0.6 by 0.6 by 0.6-m wooden structures covered with black polypropylene fabric<sup>1</sup> used as shading material. Intensities of shade were 0, 30, 50, 70, and 90% (100, 70, 50, 30, or 10% of full sun light). Shade intensities expressed as PAR with the polypropylene fabric were confirmed within three percent using an AccuPAR Linear PAR Ceptometer<sup>2</sup>. To initiate the study, the experimental area was

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<sup>2</sup> Decagon Devices, Inc., 950 NE Nelson Court, Pullman, WA 99163.

tilled to a 10.2 cm depth with a rotary tiller. Data including, red morningglory seedling emergence, plant height, above ground fresh weight biomass of leaves and stems, and leaf area were collected from each shade enclosure 20 to 41 d after initial tillage depending on when red morningglory plants in the no shade (full sunlight) treatment reached three to six leaf. Data for individual experiments were collected on June 21, July 21, August 11, and September 21, 2001; June 19, July 16, August 14, and September 5, 2002; and July 15, August 11, September 27 and November 1, 2004. Leaf area was measured using a LI-Cor LI-3100 area meter<sup>3</sup>. Data were expressed as a percent of the full sunlight treatment. For the full sunlight treatment, average values were 55.2 plants/m<sup>2</sup>, 9.94 cm plant height, 13.2 g/m<sup>2</sup> total above ground biomass, 0.24 g biomass/plant, 0.15 g leaf weight/plant, 0.09 g stem weight/plant, and 31.5cm<sup>2</sup> leaf area/plant.

In the tillage and shade studies data were subjected to the Mixed Procedure in SAS (SAS Institute 2003) with each year/experiment considered as random effect parameters. Based on the mixed procedure used, data were pooled over years and experiments. Considering years as environmental or random effects permit inferences about treatments to be made over a range of environments (Carmer et al. 1989; Hager et al. 2003). Type III statistics were used to test the fixed effects, and least square means were used for mean separation at P= 0.05. Letter groupings were converted using the PDMIX800 macro in SAS (Saxton 1998).

## RESULTS AND DISCUSSION

### Tillage Study.

Red morningglory emergence in July, August, and September represented the number of seedlings present around 28 days after each imposition of either tillage or chemical treatment. On the July sampling date, red morningglory emergence was equal whether soil was tilled or not tilled and emergence averaged 69 plants/m<sup>2</sup> (Table 1). In August, weed emergence was 33% less in plots that were not tilled. For the September sampling date only 15 plants/m<sup>2</sup> emerged in the no tillage plots, 74% less than when plots were tilled.

For the tillage treatment, red morningglory seedling emergence across the growing season did not change (Table 1). This was probably due to aeration of soil and repositioning of weed seeds with tillage operations which stimulated seed germination and seedling emergence (Egley 1986). The decrease in red morningglory emergence as the season progressed for the no tillage treatment and the greater separation between tillage treatments for the September sampling date compared with August was probably due to soil settling and crusting from rainfall and lack of tillage. Viable seeds may have been present deeper in the soil and would germinate later with soil disturbance. Total season emergence was 129 plants/m<sup>2</sup> in the no tillage plots compared with 194 plants/m<sup>2</sup> where plots were tilled, a 1.5 fold increase.

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<sup>3</sup> LI-COR Biosciences, 4421 Superior Street, Lincoln, NE 68504-0425.

Soil samples were collected in June when the study was initiated and in October when the study was terminated. A decrease in seed population would be directly related to the number of seedling that had emerged across the growing season as well as seeds that may have deteriorated. In the season long undisturbed control, red morningglory flowered and set seed. In October, seeds were visible on the soil surface in the undisturbed control. When the study was initiated seed population was uniform for the areas designated as the tillage treatments and as the undisturbed control and seed population averaged 4.2 seeds/core (Table 1). In October the seed bank had decreased 38% for the no tillage treatment and 32% for the tilled treatment. In contrast, seed population in the undisturbed control increased 1.4 fold across the growing season. The soil seed population in October was equal for the tillage treatments and averaged 54% less than the undisturbed control. Strahan et al. (1999) reported that for itchgrass (*Rottboellia cochinchinensis* L.), another major weed problem in Louisiana sugarcane, frequent tillage during a single summer fallow period reduced the seed population in the soil by around 95%. A no tillage fallow program where herbicide was used to kill emerged itchgrass periodically throughout the summer fallow period was as effective in reducing the seed reservoir as was frequent tillage. In a multi-state study, spring soil disturbance either had no effect or soil disturbance reduced total seedling emergence compared with undisturbed soils and the response was weed species and location dependent (Myers et al. 2005).

In the present study results show, regardless of whether soil was tilled or not tilled, a significant reduction in red morningglory seed population in the soil occurred from June through October (Table 1). However, for the experimental site used in this study a significant population of red morningglory seeds was still present at the end of the growing season. The significant reduction in seedling emergence in September when plots were not tilled during the summer period shows that elimination of tillage may provide a cultural control method to help in management of red morningglory in the sugarcane crop as well. Research has shown positive economic benefit to eliminating tillage operations in sugarcane without sacrificing crop yield (Judice et al. 2006).

### **Shade Study.**

For the shade study, data were collected 20 to 41 days after each tillage operation and expressed as a percent of the full sunlight treatment. Red morningglory seedling emergence decreased 5 and 8% for the 30 and 50% shade treatments, respectively, compared with full sunlight (Table 2). Increasing shade level to 70 and 90% decreased emergence 37 and 43%, respectively. Norsworthy (2004) reported that pitted morningglory emergence was not influenced by shading in soybean planted in narrow and wide row spacings compared with a non-crop treatment. Murdock et al. (1986), however, reported decreased pitted morningglory emergence and dry weight in soybean planted in closer row spacings. In the present study, shade level did not affect height of red morningglory. Variability in height observed among plants within each treatment contributed to the inability to detect significant differences. Total above ground biomass under 50, 70, and 90% shade decreased 19, 35, and 58%, respectively,

compared with full sunlight (Table 2). When expressed on a per plant basis, above ground biomass decreased 27% under 70% shade and 48% under 90% shade.

As shade level increased, fewer plants emerged and produced less biomass (Table 2). Compared with full sunlight, red morningglory plants grown under 90% shade produced leaves with 48% less weight per plant but with 19% greater leaf area (Table 2). Leaf thickness and density could account for the responses observed. Stem weight per plant was reduced for both the 70 and 90% shade treatments (31 and 50% reduction, respectively). Results show that red morningglory deprived of sunlight is capable of partitioning growth into leaves rather than stems. Increased partitioning of plant biomass into leaves and away from stems has also been reported for showy crotalaria (Patterson 1982b). Boyd and Murray (1982) reported silverleaf nightshade had increased leaf area when shade was increased, however, leaf weight per unit area decreased because leaf thickness was affected.

In respect to weed crop competition, the ability of red morningglory to germinate and emerge under a 90% shade environment emphasizes the importance of rapid crop canopy development. This research was conducted with the intent to relate the response of red morningglory to shade to what could happen under a sugarcane canopy. In Louisiana, photosynthetically active radiation (PAR) measured in the sugarcane canopy at ground level was reduced an average of 61% in early June for 'L 97-128' and 'L 99-226' compared with 29% for 'LCP 85-384' and 'HoCP 96-540' (Bittencourt et al. 2009). By late July PAR reduction was equal and averaged 90% for 'L 97-128', 'Ho 95-988', 'L 99-226', and 'L 99-233' compared with 78% for 'LCP 85-384' and 'HoCP 96-540'. The differences observed among the varieties in the ability to restrict sunlight within the crop canopy could have a significant effect on weed emergence and growth. Using the red morningglory response data to shade in the present study it would be expected that seedlings would emerge and plants would grow into late July and August underneath a sugarcane canopy. A common practice in sugarcane is to apply atrazine in May following the last cultivation and red morningglory control can be expected for around five weeks (Jones and Griffin 2008). If red morningglory pressure is high, germination and emergence later in the growing season and subsequent climbing and wrapping of sugarcane stalks would be expected. These findings further emphasize the need to implement weed control programs for red morningglory that increase residual activity of soil applied herbicides and extend weed control into August.

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**Table 1. Influence of tillage on red morningglory seedling emergence from June through September and on number of red morningglory seeds in soil core samples collected at initiation of the study in June and at completion in October.<sup>a</sup>**

Treatment <sup>b</sup>	Seedling emergence				Seed population in soil	
	July	August	September	Total	June	October
	no./m <sup>2</sup>				no./soil core sample	
No tillage	69 a <sup>c</sup>	45 b	15 c	129* <sup>c</sup>	4.0 b <sup>c</sup>	2.5 d
Tillage	69 a	67 a	58 ab	194	4.4 b	3.0 cd
Season long undisturbed	-	-	-	-	4.2 b	6.0 a

<sup>a</sup> Experiments were conducted in 2001, 2002, and 2004. In June of each year experimental areas were tilled using a rotary tiller set at a depth of 10.2 cm. Soil core samples were 6.4 cm in diameter and 10.2 cm in depth.

<sup>b</sup> For the no tillage treatment, glufosinate at 0.37 kg ai/ha was used to eliminate weeds after data were collected each month. For the tillage treatment soil was tilled after data were collected each month using a rotary tiller set at a depth of 10.2 cm.

<sup>c</sup> Means within rows and columns for each parameter followed by the same letter are not significantly different according to the *t* test on least square means at P= 0.05. An asterisk (\*) indicates that total seedling emergence was different for the tillage treatments.

**Table 2. Influence of shade on red morningglory seedling emergence, plant height, fresh weight biomass, leaf and stem weight, and plant leaf area expressed as percent of the no shade (full sunlight) treatment.<sup>a</sup>**

Shade level	Seedling emergence	Average plant height	Total above ground biomass	Above ground biomass per plant	Leaf weight per plant	Stem weight per plant	Leaf area per plant
%				% of full sun			
0	100 a <sup>b</sup>	100 a	100 a	100 a	100 a	100 a	100 c
30	95 b	127 a	90 ab	92 a	89 a	97 a	148 a
50	92 b	135 a	81 bc	87 a	80 ab	93 ab	133 ab
70	63 c	119 a	65 c	73 b	77 ab	69 bc	131 ab
90	57 c	124 a	42 d	52 c	52 b	50 c	119 b

<sup>a</sup> Experiments were conducted in 2001, 2002, and 2004. Data collected 20 to 41 days after tillage and installation of shade enclosures when red morningglory plants in full sun reached 3- to 6-leaf stage. Data averaged across three years and four experiments within each year. For the full sunlight treatment, average values were 55.2 plants/m<sup>2</sup>, 9.94 cm plant height, 13.2 g/m<sup>2</sup> total above ground biomass, 0.24 g biomass/plant, 0.15 g leaf weight/plant, 0.09 g stem weight/plant, and 31.5 cm<sup>2</sup> leaf area/plant.

<sup>b</sup> Means within each column followed by the same letter are not significantly different according to the *t* test on least square means at P=0.05.