

2009

Seasonal growth and shading potential of sugarcane (*Saccharum* spp. hybrids) and shade response of perennial weeds

Mariana Ferreira Bittencourt

Louisiana State University and Agricultural and Mechanical College, mbitte1@lsu.edu

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_theses

Recommended Citation

Bittencourt, Mariana Ferreira, "Seasonal growth and shading potential of sugarcane (*Saccharum* spp. hybrids) and shade response of perennial weeds" (2009). *LSU Master's Theses*. 847.
https://digitalcommons.lsu.edu/gradschool_theses/847

This Thesis is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Master's Theses by an authorized graduate school editor of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.

SEASONAL GROWTH AND SHADING POTENTIAL OF SUGARCANE (*SACCHARUM*
SPP. HYBRIDS) AND SHADE RESPONSE OF PERENNIAL WEEDS

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Science

in

The School of Plant, Environmental and Soil Sciences

by

Mariana Ferreira Bittencourt
B.S., Federal University of Uberlândia, 2007
May 2009

ACKNOWLEDGEMENTS

First, I would like to thank God who gave me the most wonderful life and family; He gave me the love for science, my health and intelligence to guide my studies. It was hard to stay so far away from home but God's presence gave me power and peace to keep pursuing my objective.

I thank my friend Edison Hidalgo, who has always treated me with all his attention, friendship and carefulness. He is the person who provided me the opportunity to come to LSU. I will be thankful forever for the confidence that Edison had in my potential. I am deeply indebted to him, thank you very much Edison. I hope to have an opportunity to help somebody one day as you helped me.

I sincerely thank Dr. Griffin for being literally a professor, who cares about his students, who wants them to learn as much as they can and who helps them to go where they want to go. With him I learned about science, and I also learned about how to be a real professional. Dr. Griffin, you are a great person and made my goal to obtain a master's degree possible. I will always remember that.

Thank you Joey Boudreaux for being a great friend and for being a teacher; I learned a lot with you. I will never forget what you did for me when I arrived in Baton Rouge and all the help you gave me during my stay at LSU.

I would also like to thank José Mite, Sunny Bottoms and Justin Hensley for all the help they gave to me and for being good friends.

Thank you my sister Renata for being so special, for loving me and for helping me always in everything, I love you. Thank you my family for your support. Thank you my friends at LSU for sharing great times with me and my friends from Brazil: Daniela, Omar, Camila, Ana Cristina

and Angélica for staying with me, even when I was so far away. You kept me strong by remembering me and by providing love to me.

I want to give a special thank for my mom Ana and my dad William. They gave me all I have: my love for life, my pride, my personality, my happiness, my power for seeking what I want. At all moments of my life my mom and dad did their best for me and my sister, and without them I would not be where I am today. Mom, dad, and Renata you mean the world to me and I offer this victory for you. I love you.

I will remember forever the time I spent at LSU. The people I have met, the friends I have gained and the lessons I have learned. It was very difficult studying so far from home but I did it! Thank you God for all your love and for all you have done in my life!

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	ii
ABSTRACT	v
CHAPTER	
1 INTRODUCTION.....	1
SUGARCANE VARIETIES.....	1
WEEDS AND WEED CONTROL IN SUGARCANE.....	4
LITERATURE CITED.....	8
2 SEASONAL GROWTH, SHADING POTENTIAL, AND YIELD OF SIX SUGARCANE VARIETIES.....	11
INTRODUCTION.....	11
MATERIALS AND METHODS	14
RESULTS AND DISCUSSION	16
LITERATURE CITED.....	30
3 JOHNSONGRASS AND BERMUDAGRASS RESPONSE TO SHADE.....	33
INTRODUCTION.....	33
MATERIALS AND METHODS	35
RESULTS AND DISCUSSION	36
LITERATURE CITED.....	41
4 SUMMARY	44
VITA.....	48

ABSTRACT

Seasonal growth characteristics and shading ability of six sugarcane varieties were compared during the second production year. For each variety, trend analysis of data showed a significant linear trend. Differences in shoot emergence among the varieties were observed beginning in early April and as the season progressed, shoot production and shoot height increased for 'L 97-128', 'Ho 95-988', 'L 99-226', and 'L 99-233' but lagged for 'HoCP 96-540' and 'LCP 85-384'. Beginning in mid-April ground cover increased most rapidly for L 99-233. In late May ground cover was around 60% for LCP 85-384 and HoCP 96-540; around 70% for L 97-128, Ho 95-988, and L 99-233; and was approaching 90% for L 99-226. Sugarcane canopy height across the growing season was consistently greater for L 97-128 and L 99-233 and averaged 21% more than for the other varieties in early June and 15% more in mid-July. Based on photosynthetically active radiation (PAR) data collected in the row middles, sunlight 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. 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. Shade studies were conducted in fields with natural infestations of bermudagrass and johnsongrass using enclosures (0.61 x 0.61 x 0.61m) covered with shade cloth providing 30, 50, 70 and 90% shade. At 55 days, bermudagrass ground cover under full sunlight was 88% compared with 10% for 90% shade; above ground biomass for 90% shade was reduced 95%. Exposure to 90% shade for 35 days decreased johnsongrass plant population 86% and above ground biomass 90%. With 30% shade, dry weight of bermudagrass was reduced 30% and johnsongrass biomass was reduced 45%. Based on this research the varieties L 97-128, L

99-226, and L 99-233 should be competitive with bermudagrass and johnsongrass. In contrast, the open canopy of HoCP 96-540 would be conducive to weed reinfestation.

CHAPTER 1

INTRODUCTION

In 2007, sugarcane was grown on approximately 169,563 hectares by 609 producers in Louisiana (a decrease of 6,070 hectares when compared to the 2006 crop) (Anonymous 2008). The total value of the sugarcane crop to Louisiana growers, processors and landlords for sugar was \$666.9 million, which ranks sugarcane as the number one agronomic crop in Louisiana.

SUGARCANE VARIETIES

The LSU AgCenter sugarcane variety development team consists of breeders, plant pathologists, entomologists, and weed scientists, each contributing to the assessment of variety characteristics. Variety recommendations are based primarily on yield (tonnage and sugar), stubble longevity, disease/insect reaction, cold tolerance and herbicide tolerance. Sugarcane varieties can vary in regard to growth characteristics which can directly affect weed competition. In 2007, 'LCP 85-384' was the leading sugarcane variety occupying approximately 46% of the acreage and followed by the two new varieties 'HoCP 96-540' and 'L 97-128', with 31 and 12 % of the acreage, respectively. In 2007, over 81% of the plant-cane crop was planted to HoCP 96-540 and L 97-128 while only 5% was planted to LCP 85-384 (Ben Legendre, personal communication 2008).

The sugarcane variety LCP 85-384, released in 1993 by the LSU AgCenter, USDA and the American Sugarcane League, has significantly impacted the Louisiana sugar industry. In 2003, LCP 85-384 represented 88% of the total Louisiana sugarcane acreage (Robert et al. 2004). LCP 85-384 was derived from a cross made between 'CP 77-310' as the female parent and 'CP 77-407' as the male parent. The resulting variety had excellent sugar yields, high plant population of small diameter stalks, good stubbling, good adaptation to all soil types, and cold tolerance. LCP

85-384 is considered to be an early-maturing variety that has superior sugar and cane yields (Milligan et al. 1994; Sugarcane Variety Identification Guide 2008). Over the past few years LCP 85-384 has become susceptible to rust (*Puccinia melanocephala*) and has lost vigor and stubbling ability.

The sugarcane variety HoCP 96-540 was released in 2003 and was selected by ARS researchers at Houma from progeny of the cross 'LCP 86-454' as the female parent and LCP 85-384 as the male parent (Tew et al. 2005a). HoCP 96-540 has consistently yielded 10 to 15% more sugar per acre than LCP 85-384 in both plant-cane and ratoon crops. HoCP 96-540 is a medium maturing variety that shows good response to the ripener glyphosate, high sugar per acre, good stubbling ability, good adaptation to all soil types, and has shown field resistance in Louisiana to smut (*Ustilago scitaminea* Syd. & P. Syd), leaf scald (*Xanthomonas albilineans*), and mosaic (sugarcane mosaic virus - SCMV) diseases. HoCP 96-540 is moderately susceptible to rust, and has a moderate population of medium-sized stalks. Like most commercial cultivars, including LCP 85-384, HoCP 96-540 has exhibited susceptibility to ratoon stunting disease (*Clavibacter xyli* subsp. *Xyli*) (RSD) and the sugarcane borer (*Diatraea saccharalis* (Fabricius)).

'Ho 95-988' was released for commercial planting in 2004 primarily because of its genetic diversity, resistance to many of the diseases that plague the industry, and increased yield potential. Ho 95-988, was selected by ARS researchers at Houma, Louisiana from progeny of the cross made between 'CP 86-941' as the female parent and 'US 89-012' as the male parent (Tew et al. 2005b). The variety is unique in that it does not share common ancestry with LCP 85-384. Three of the four grandparents of Ho 95-988 are wild-derivative clones, two involving *Saccharum spontaneum* and one involving *S. robustum*. The fourth grandparent is a BC2 derivative of the Hawaiian cultivar 'H 49-3646'. Ho 95-988 is a medium maturing variety that

has consistently yielded 7% more sugar per acre than LCP 85-384 in both plant-cane and ratoon crops, has a high population of medium-sized stalks with good stubbling ability, and is adapted to all soil types. Ho 95-988 has shown field resistance to leaf scald, and mosaic diseases, but has exhibited susceptibility to smut, sugarcane borer and rust. Stalks of this variety can become brittle during peak summer growth.

The sugarcane variety L 97-128, released in 2004 by the LSU AgCenter, was selected from progeny of the cross 'LCP 81-010' as the female parent and LCP 85-384 as the male parent (Gravois et al. 2008). It is a very early maturing variety, with early season vigor, an average population of large-diameter stalks, and good stubbling ability and is adapted to all soil types. L 97-128 has moderate sugarcane rust disease resistance, very early sugar, and high sugar/sucrose content. L 97-128 is susceptible to RSD, sugarcane borer, smut, and has the propensity to produce excess tillers.

The variety 'L 99-226' was selected from progeny of the cross 'CP 89-846' as the female parent and 'LCP 81-030' as the male parent (Anonymous 2006a; LaBorde et al. 2008). L 99-226 has an average population of large-diameter stalks with good stubbling ability. It is considered to be a medium maturity variety, with very good shading, high tonnage, and is adapted to all soil types and is resistant to rust (Robert et al. 2004). L 99-226 has good yield potential and has sugarcane borer resistance. It is moderately susceptible to smut and RSD and is prone to lodging.

The variety 'L 99-223' was selected from progeny of the cross made between 'CP 79-348' as the female parent and 'CP 91-552' as the male parent (Anonymous 2006b; LaBorde et al. 2008). L 99-233 has a high population of small diameter stalks with excellent stubbling ability. L 99-233 is a medium maturity variety with high sugar per acre, and good shading ability and is

adapted to all soil types and resistant to rust. L 99-223 is susceptible to RSD, sugarcane borers, and it is moderately susceptible to smut and lodging.

In a preliminary study conducted in 2007 at St. Gabriel, LA, the plant cane crop of HoCP 96-540 had lower shoot population than LCP 85-384, L 97-128, and L 99-226 in mid-April (Griffin and Boudreaux 2007). However, by mid-May differences in shoot population were not observed among the varieties. In late June and late July, L 97-128 and L 99-233 were taller than LCP 85-384. In late June photosynthetically active radiation (PAR) at ground level for L 99-226 was reduced 97% compared with 80% HoCP 96-540. Sugarcane is grown as a perennial with four 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. Sugarcane varieties that produce a high population of stalks per hectare with leaves less upright in growth habit would be expected to be more competitive with weeds in respect to shading. Rapid shading of row middles by sugarcane plants is essential to aid in weed control late in season when herbicides become ineffective (Jones et al. 2006).

WEEDS AND WEED CONTROL IN SUGARCANE

Weeds are a major factor limiting sugarcane production and herbicide cost is a large investment for growers. The major weed problems in sugarcane in Louisiana are the annual grasses, itchgrass [*Rottboellia cochinchinensis* (Lour.) W.D. Clayton], broadleaf signalgrass [*Brachiaria platyphylla* (Griseb.) Nash], and browntop panicum (*Panicum fasciculatum* Sw.); the perennial grasses, johnsongrass [*Sorghum halepense* (L.) Pers.] and bermudagrass [*Cynodon dactylon* (L.) Pers.]; annual morningglories (*Ipomoea* spp.); and nutsedges (*Cyperus* spp.) (Webster 2000).

The harvest of several ratoon crops from a single vegetative planting, along with the lack of disturbance of row tops, often leads to the proliferation of perennial weeds in the sugarcane crop cycle. Richard (1995) reported that bermudagrass biomass in July increased by 340% from the plant-cane to first-ratoon crop and 490% between the first- and second-ratoon crops. Perennial weeds often reduce cane and sugar yield, and this impact can be more dramatic in the ratoon crops. Johnsongrass allowed to interfere season-long with sugarcane reduced cane and sugar yield 23 and 17% in the plant-cane crop and 42 and 35% in the first-ratoon crop, respectively (Millhollon 1995). A major factor leading to the proliferation of johnsongrass in sugarcane is that postemergence control in the crop can be quite variable and seldom exceeds 75% (Richard 1986; Richard and Griffin 1993).

Sugarcane cultivars differ in regard to time of emergence following planting in fall and in spring after winter dormancy; stalk population; canopy characteristics, such as leaf architecture; and ratooning ability (measured by survival and vigor of the crop following repeated annual harvests); all of which may affect the variety's competitiveness with weeds. Most weeds in Louisiana sugarcane are shade intolerant and herbicide programs combined with rapid sugarcane growth would result in greater late season control (Jones et al. 2006).

In a greenhouse study Patterson (1982a) reported shading of 40% or more reduced shoot number, leaf area, total dry weight, and tuber number of both yellow nutsedge (*Cyperus esculentus* L.) and purple nutsedge (*Cyperus rotundus* L.). The two nutsedge species showed no difference in shade tolerance. In another study with yellow nutsedge, Keeley and Thullen (1978) reported the average number of shoots and tubers and dry matter also decreased with decreasing light intensity. As sunlight was reduced, yellow nutsedge flower production decreased and was eliminated with less than 70% of full sunlight. Santos et al. (1997) reported

with 20% shading yellow nutsedge was less affected than purple nutsedge when comparing shoot and tuber number, dry weight, and plant height. For shoot and tuber dry weight, both species responded linearly to increasing shade level.

In greenhouse studies, shading reduced height, dry matter accumulation, leaf production, leaf area, and reproductive development of showy croton (*Crotalaria spectabilis* Roth) (Patterson 1982b). Shading of showy croton increased the partitioning of plant biomass into leaves and away from stems. Velvetleaf (*Abutilon theophrasti* Medik.) leaf and branch number, plant biomass, and seed number decreased linearly with increasing shade (Bello et al. 1995). In contrast, velvetleaf seed weight increased with increasing shade.

Dry matter production of seedling and established silverleaf nightshade (*Solanum elaeagnifolium* Cav.) decreased with increased shading (Boyd and Murray 1982). Seedling plants did not flower when exposed to 63% or greater shade, while established plants did not flower when grown under 92% shade. Leaves of silverleaf nightshade grown under 92% shade contained 35% less chlorophyll per unit leaf area compared with unshaded plants. Leaf area increased with increasing shade, however, leaf weight per unit area decreased because leaf thickness was affected.

Germination at the lower layers of the soil profile results in the death of the seedling (Roberts and Totterdell 1981), so seeds that do not require light to germinate, as johnsongrass and bermudagrass seeds, need some way of detecting environmental factors associated with soil depth. Koller (1972) and Thompson and Grime (1983) suggest that the sensitivity of seeds to fluctuations in temperature, which rapidly diminish with increasing soil depth, could act as a depth-sensing mechanism.

Seeds of johnsongrass, which are often buried in cultivated soils (Van Esso et. al 1986), require large diurnal fluctuations in temperature before they reach high percentage of germination.

Ghersa et. al. (1992) concluded that shade modified the thermal amplitudes at the depths where johnsongrass seeds were buried. Significant differences in germination were found for seeds buried at 3 cm under different conditions of shade. More than twice as many seedlings emerged in bare-soil conditions as in simple shade, and more than twice as many seedlings emerged in simple shade as under double shading. Shade apparently modified no factors other than temperature, so it is reasonable to conclude that the change in soil-temperature regime was the variable that regulated seed germination in different layers.

Bermudagrass seeds germinate when daily temperatures are above 18°C (65°F), rhizomes and roots become dormant at soil temperatures below 18°C (65°F) and they are killed at temperatures below 1°C (30°F) (California Department of Food and Agriculture, EncycloWeedia 2002). Both stolon and rhizome branching intensities were reduced in response to lower light levels (Dong and de Kroon 1994). Half the biomass of rhizomes and roots was produced compared to the control in trials in which plants were shaded by 64% (Burton et al. 1959; Newman 1992).

Little work has been done to evaluate the effect of shade by the sugarcane canopy on weed emergence and competitiveness. Field research was conducted to evaluate johnsongrass and bermudagrass growth in response to varying shade regimes. In conjunction with this research, seasonal changes in shoot production, canopy width and height, and light penetration into the sugarcane canopy were evaluated for the varieties LCP 85-384, Ho 95-988, HoCP 96-540, L97-128, L99-226, and L99-233. Variety selection could play an important role in the management of problematic weeds. Results from this research could be directly applicable to the development of effective and

season long weed control programs that consider specific characteristics of sugarcane varieties, and their impact on weed competition.

LITERATURE CITED

Anonymous. 2006a. Notice of Release of Sugarcane Variety L 99-226. Sugar Bull. 84(9):14-15.

Anonymous. 2006b. Notice of Release of Sugarcane Variety L 99-233. Sugar Bull. 84(9):16-17.

Anonymous. 2008. Louisiana Agricultural Summary. Louisiana State University Agricultural Center, Louisiana Cooperative Extension Service. Web page: <http://www.lsuagcenter.com/agsummary/index.aspx>. Accessed January 13, 2009.

Bello, I. A., M. D. K. Owen, and H. M. Hatterman Valenti. 1995. Effect of shade on velvetleaf (*Abutilon theophrasti*) growth, seed production, and dormancy. Weed Technol. 9:452-455.

Boyd, J. W. and D. S. Murray. 1982. Effects of shade on silverleaf nightshade (*Solanum elaeagnifolium*). Weed Sci. 30:264-269.

Burton, G. W., J. E. Jackson, and F. E. Knox. 1959. The influence of light reduction upon the production, persistence and chemical composition of coastal bermudagrass, *Cynodon dactylon*. Agronomy Journal 51:537-542.

California Department of Food and Agriculture, EncycloWeedia. 2002. Bermudagrass [*Cynodon dactylon* (L.) Pers]. Ed by: Healy, E. A., S. Enloe, J. M. DiTomaso, B. Roberson, N. Dechoretz, S. Schoenig, P. Akers, L. Butler, and J. Garvin. Non-Cropland Weed group, UC Extension Service, Weed Science Program, Department of Vegetable Crops, The University of California. Davis, CA. 95616.

Dong, M., and H. de Kroon. 1994. Plasticity in morphology and biomass allocation in *Cynodon dactylon*, a grass species forming stolons and rhizomes. Oikos 70(1): 99-106.

Ghersa, C. M., R. L. Benesch Arnold and M. A. Martinez-Ghersa. 1992. The role of fluctuating temperatures in germination and establishment of *Sorghum halapense*. Regulation of germination at increasing depths. Functional Ecology 6: 460-468.

Gravois, K. A., K. P. Bischoff, S. B. Milligan, F. A. Martin, J. W. Hoy, T. E. Reagan, C. A. Kimbeng, C. M. LaBorde and G. L. Hawkins. 2008. Registration of 'L 97-128' sugarcane. J. Plant Registrations. 2:24-28.

Griffin, J. L. and J. M. Boudreaux. 2007. Comparisons of sugarcane varieties for growth and shading potential. Sugarcane Research Annual Progress Report. p. 151.

- Jones, C. A., J. L. Griffin, L. M. Etheredge, Jr., and W. E. Judice. 2006. Response of red morningglory (*Ipomoea coccinea* L.) to shade and soil applied herbicides. Proc. South. Weed Sci. Soc. 59:3.
- Keeley, P. E. and R. J. Thullen. 1978. Light requirement of yellow nutsedge (*Cyperus esculentus*) and light interception by crops. Weed Sci. 26:10-16.
- Koller, D. 1972. Environmental control of seed germination. Seed Biology 2: 1-101.
- LaBorde, C., B. L. Legendre, K. Bischoff, K. Gravois, and T. Robert. 2008. Sugarcane Variety Identification Guide. Agriculture Center, Louisiana State University. Pub. 3056, pp 18-21.
- Millhollon, R. W. 1995. Growth and yield of sugarcane as affected by johnsongrass (*Sorghum halepense*) interference. J. Am. Sugar Cane Technol. 15:32-40.
- Milligan, S. B., F. A. Martin, K. P. Bischoff, J. P. Quebedeaux, J. W. Hoy, T.E. Reagan, B. L. Legendre, and J. D. Miller. 1994. Registration of 'LCP 85-384' sugarcane. Crop Sci. 34:819.
- Newman, D. 1992. Element Stewardship Abstract for *Cynodon dactylon* – Bermudagrass. The Nature Conservancy. 1815 North Lynn St., Arlington, Virginia.
- Patterson, D. T. 1982a. Shading responses of purple and yellow nutsedges (*Cyperus rotundus* and *C. esulentus*). Weed Sci. 30:25-30.
- Patterson, D. T. 1982b. Effects of shading and temperature on showy crotonia (*Crotalaria spectabilis*). Weed Sci. 30:692-697.
- Richard, E. P., Jr. 1986. Influence of surfactants on the toxicity of asulam to johnsongrass (*Sorghum halepense*) and sugarcane (*Saccharum* sp.). Weed Sci. 34:299-303.
- Richard, E. P., Jr. and J. L. Griffin. 1993. Johnsongrass (*Sorghum halepense*) control in sugarcane (*Saccharum* sp.) with asulam applied alone and in mixtures. Weed Technol. 7:657-662.
- Richard, E. P., Jr. 1995. Bermudagrass interference during a three year sugarcane crop cycle. Proc. Int. Soc. Sugar Cane Technol. 21:31-39.
- Robert, T. J., K. A. Gravois, W. R. Jackson, H. L. Waguespack, D. D. Garrison. 2004. A Report on the 2003 Outfield Variety Tests. Sugar Bull. 82(9):30-33.
- Roberts, E. H. and S. Totterdell. 1981. Seed dormancy in *Rumex* species in response to environmental factors. Plant, Cell and Environment 4: 97-106.

- Santos, B. M., J. P. Morales Payan, W. M. Stall, T. A. Bewick, and D. G. Shilling. 1997. Effects of shading on the growth of nutsedges (*Cyperus* spp.). *Weed Sci.* 45:670-673.
- Tew, T. L., W. H. White, M. P. Grisham, E. O. Dufrene, Jr, D. D. Garrison, J. C. Veremis, Y. Pan, E. P. Richard, Jr, B. L. Legendre, J. D. Miller. 2005a. Registration of "HoCP 96-540" Sugarcane. *Crop Science.* 45:785-786.
- Tew, T. L., D. M. Burner, B. L. Legendre, W. H. White, M. P. Grisham, E. O. Dufrene, Jr., D. D. Garrison, J. C. Veremis, Y. Pan, E. P. Richard, Jr. 2005b. Registration of "Ho 95-988" Sugarcane. *Crop Sci.* 45:1660.
- Thompson, K. and J. P. Grime. 1983. A comparative study of germination response to diurnally fluctuating temperatures. *Journal of Applied Ecology* 20: 141-156.
- Van Esso, M. L., C. M. Ghera And A. Soriano. 1986. Cultivation effects on the dynamics of a johnsongrass seed population in the soil profile. *Soil and Tillage research* 6: 325-335.
- Webster, T. M. 2000. Weed survey - southern states. *Proc. South. Weed Sci. Soc.* 53:247-274.

CHAPTER 2

SEASONAL GROWTH, SHADING POTENTIAL, AND YIELD OF SIX SUGARCANE VARIETIES

INTRODUCTION

In 2007, sugarcane was grown on approximately 169,540 hectares by 609 producers in Louisiana (Anonymous 2008). The total value of the sugarcane crop to Louisiana growers, processors and landlords for sugar was \$666.9 million, ranking sugarcane as the number one agronomic crop. Sugarcane is grown as a perennial with four to five annual harvests made from a single, vegetatively propagated planting. The sub-tropical climate in Louisiana is such that sugarcane is killed each year by winter freeze and the growing season is much shorter than in more traditional sugarcane growing areas. Therefore, it is imperative that sugarcane varieties be developed for Louisiana. The LSU AgCenter sugarcane variety development team consists of breeders, plant pathologists, entomologists, and weed scientists, each contributing to the assessment of variety characteristics. Variety recommendations are based primarily on tonnage and sugar yield, stubble longevity, disease/insect reaction, cold tolerance and herbicide tolerance. Sugarcane varieties can vary in regard to growth characteristics which can directly affect weed competition.

The sugarcane variety 'LCP 85-384' was released in 1993 and in 2003 was grown on 88% of the total sugarcane acreage in Louisiana (Robert et al. 2004). The variety had excellent sugar yields, high plant population of small diameter stalks, good stubbling, good adaptation to all soil types, and cold tolerance. LCP 85-384 is considered to be an early-maturing variety that has superior sugar and cane yields (Milligan et al. 1994; LaBorde et al. 2008). However, since 2000 LCP 85-384 has become susceptible to rust and has lost vigor, and stubbling ability. In 2007, LCP 85-384 was grown on approximately 46% of the planted acreage followed by the newer

varieties, 'HoCP 96-540' and 'L 97-128' with 31 and 12%, respectively, of the acreage (Ben Legendre, personal communication 2008).

The sugarcane variety HoCP 96-540 was released in 2003 (Tew et al. 2005a) and has yielded 10 to 15% more sugar than LCP 85-384 in both plant-cane and ratoon crops. HoCP 96-540 is a medium maturing variety that produces a moderate population of medium-sized stalks. The sugarcane variety L 97-128, released in 1993 by the LSU AgCenter, is a very early maturing variety with early vigor and an average population of large-diameter stalks, has good stubbling ability, and is adapted to all soil types (Gravois et al. 2008). 'Ho 95-988' was released for commercial planting in 2004 primarily because of its genetic diversity, resistance to many of the diseases that plague the industry, and increased yield potential. Ho 95-988 is a medium maturing variety that has consistently yielded 7% more sugar than LCP 85-384 in both plant-cane and ratoon crops (Tew et al. 2005b). Ho 95-988 produces a high population of medium-sized stalks, has good stubbling ability, and is adapted to all soil types.

Two of the more recently released varieties are 'L 99-226' and 'L 99-223'. L 99-226 produce an average population of large-diameter stalks and has good stubbling ability (Anonymous 2006a; LaBorde et al. 2008) L 99-226 is a medium maturity variety, with very good shading, high tonnage, resistant to rust, and is adapted to all soil types (Robert et al. 2004). L 99-223 produces a high population of small diameter stalks and has excellent stubbling ability (Anonymous 2006b; LaBorde et al. 2008). L 99-223 is a medium maturity variety, with good shading ability and high sugar and is adapted to all soil types and resistant to rust. L 99-226 has sugarcane borer resistance but L 99-223 is susceptible to sugarcane borers. Both varieties are prone to lodging. In a preliminary study conducted in 2007 at St. Gabriel, LA, the plant-cane crop of HoCP 96-540 in mid-April had lower shoot population than LCP 85-384, L 97-128, and

L 99-226 (Griffin and Boudreaux 2007). In mid-May, L 99-128 and L 99-233 were taller and produced a wider canopy than HoCP 96-540 and LCP 85-384. In June and July, L 97-128 and L 99-233 were taller than LCP 85-384. Because of the perennial nature of sugarcane and availability of new varieties it is difficult to conduct long term studies where varieties are compared within the same experiment. Research has addressed sugarcane variety response to preemergence and postemergence herbicides (Griffin and Kitchen 1990; Miller et al. 1998; Richard 1989, 1996). For the most part, sugarcane varieties are consistent in their reaction to labeled herbicides. Some varieties, however, are more sensitive to asulam particularly when applied in late June or July (Richard and Griffin 1993). The differences among sugarcane varieties in growth characteristics may also affect their ability to compete with weeds. Sugarcane varieties that emerge early in the spring following the winter dormant period and that produce a high population of stalks per hectare with leaves less upright in growth habit would be more competitive with early emerging weeds. Shading from the crop would be especially important after the layby cultivation in May as weed reestablish. The degree of shading by the crop canopy would be especially critical to the reestablishment of bermudagrass (*Cynodon dactylon* L. Pers.), a major weed problem in sugarcane in Louisiana. Richard (1995) reported that bermudagrass biomass in July increased by 340% from the first production year (plant cane) to the second production year (first ratoon crop) and 490% between the second and third production years.

Selection of a sugarcane variety could therefore play an important role in the management of problematic weeds. Seasonal changes in sugarcane shoot production, canopy width and height, and light penetration into the crop canopy during the first and

second production years for the varieties LCP 85-384, L 97-128, HoCP 96-540, Ho 95-988, L 99-226, and L 99-233.

MATERIALS AND METHODS

The sugarcane varieties: LCP 85-384, L 97-128, HoCP 96-540, Ho 95-988, L 99-226 and L 99-233 were planted using whole stalks in 2006 at the Sugar Research Station in St. Gabriel, LA.

The soil type was a Commerce silt loam (fine silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquept) with 1.01% organic matter and pH of 5.9. Varieties were planted in a randomized complete block experimental design with four replications and plots consisted of three rows, each 1.8 by 15.24 meters in length. Cultural practices each year included February application of paraquat to control winter weeds, tillage of row sides and middles and application of pendimethalin at 4 kg ai/ha plus metribuzin at 1.5 kg ai/ha in March, followed by side dress fertilization of UAN (32%) consisting of 134 kg N/ ha, separated applications of 67 kg K/ha and a layby tillage and application of pendimethalin at 3.36 kg/ha plus atrazine at 4.48 kg/ha. In this study, weeds were eliminated as a factor affecting sugarcane growth.

Data collection was initiated in the spring of 2007 (first production year) and 2008 (second production year) when plants were emerging following the winter dormant period. Sugarcane shoot population was determined by counting all shoots in the center row of each 3-row plot. Canopy height and width were determined at five randomly selected areas in the center row of each plot. Height measurements were made to the uppermost leaves of the crop canopy and width represented the distance between the outmost leaves of the canopy. Percent ground cover was determined visually and represented the total amount of sugarcane foliage covering the area from the center of the sugarcane drill to the center of the row middle. In 2007 shoot population data were collected April 11, canopy height data was collected May 15, June 27 and July 24, and

canopy width data were collected May 15. In 2008, data were collected every 7 to 10 days for shoot population (March-April), canopy width and ground cover (March-May), and canopy height (March-July).

Additionally, in June of 2008 five stalks in each plot were selected and marked and measurements of height from the ground to the uppermost leaf collar were made every 7 to 10 days until August. Beginning in June, photosynthetically active radiation (PAR) was measured during cloud-free days at noon using an AccuPAR Linear PAR Ceptometer¹. Ten subsample measurements were made in each plot holding the Ceptometer 5 cm above ground level in the center of the row middles of each plot. Averages of the 10 subsamples were compared with those for a full sun light measurement to calculate PAR reduction. Measurements were made June 26, 2007 and in 2008 every 7 to 10 days beginning June 2 until August 28. Lodging caused by Hurricane Gustav on September 1, 2008 prevented data collection thereafter.

In mid-August of 2008, stalk population was determined by counting number of stalks from a randomly selected 6-m section from the center row of each plot. Sugarcane was harvested November 7, 2008 using a commercial single row chopper harvester and a dump wagon fitted with three load cells capable of being tared between plots to determine total sugarcane yield. Before harvesting, samples of six randomly selected stalks were hand harvested and weighed to determine average stalk weight. Stalk samples were then crushed and the juice was extracted for analysis of sugar concentration using near infrared spectroscopy as the standard methodology described by Berding et al. (2004). Sugar yield was calculated by multiplying theoretical recoverable sugar (TRS) (kg/mt) by sugarcane yield (mt/ha).

¹ Decagon Devices, Inc., 950 NE Nelson Court, Pullman, WA 99163.

Data in common for the two years to include shoot population in April; plant height in May, June, and July; canopy width in May, and PAR reduction in June were subjected to mixed procedure in SAS³. Years and replications (nested within years) were considered random effects (Carmer et al. 1989), which permits 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 $P \leq 0.05$. Letter groupings were converted using the PDMIX800 macro in SAS (Saxton 1998). Data collected during the growing season for shoot population, canopy width, ground cover, canopy height, uppermost collar height, and PAR reduction for the six varieties were analyzed in SAS³. Significant variety by date interactions were observed for all parameters measured except shoot population and data for each variety were analyzed over time using trend analysis. A significant variety effect was also observed for data collected over time and mean separation was performed using Fisher's protected LSD at $P \leq 0.05$. Stalk population in August and stalk weight, TRS, sugarcane yield, and sugar yield were analyzed in SAS and mean separation was performed using Fisher's protected LSD at $P \leq 0.05$.

RESULTS AND DISCUSSION

First and Second Production Years. Averaged across the 2007 and 2008 growing seasons shoot population in April was greatest for L 99-226 and averaged 23% more than for HoCP 96-540 and around 15% more than for L 97-128 and Ho 95-988 (Table 2.1). comparisons are made within and among columns. A variety that emerges rapidly and produces high shoot population should be competitive with early emerging weeds. Plant height for all varieties increased from May through July an average of 2.3 to 2.9 fold (Table 2.1). In May, June, and July height was

Table 2.1. Shoot population, height, canopy width, and canopy light penetration for six sugarcane varieties.¹

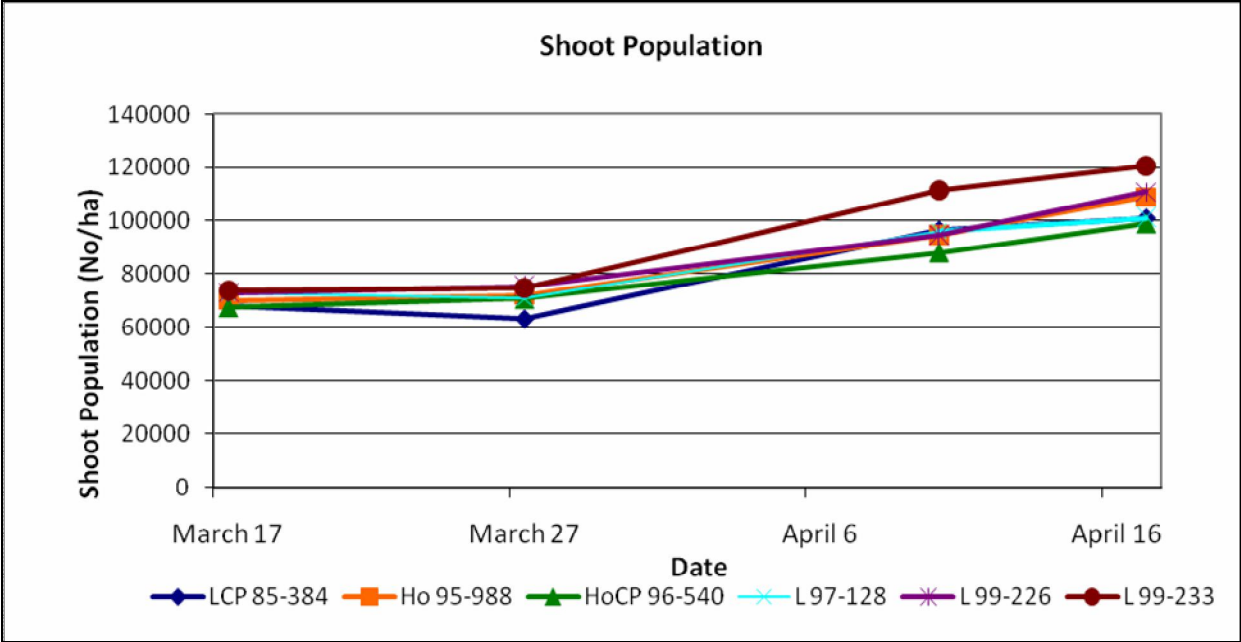
Varieties	Shoot population	Height			Canopy width	PAR ¹
	April	May	June	July	May	June
	no./ ha	-----cm-----			cm	% reduction
LCP 85-384	104,090 ab ²	86.4 i	157.8 g	205.1 cd	79.9 c	61.1 c
Ho 95-988	99,320 bc	83.4 ij	175.9 e	219.0 b	90.1 b	79.7 b
HoCP 96-540	92,300 c	76.4 ij	168.7 ef	219.3 b	75.8 c	62.4 c
L 97-128	100,180 bc	100.5 h	194.7 d	234.8 a	90.2 b	83.2 ab
L 99-226	113,490 a	75.8 j	164.6 fg	206.9 c	104.0 a	87.1 a
L 99-233	107,630 ab	97.1 h	197.9 cd	243.2 a	94.0 b	80.6 b

¹Data averaged for 2007 (first production year) and 2008 (second production year). Canopy light penetration was determined by measuring PAR (photosynthetically active radiation) using a AccuPAR Ceptometer placed 5 cm above ground level in the center of row middles of each plot. Data expressed as percent reduction compared with full sunlight measurements.

²Means within columns followed by the same letter are not significantly different using LSD ($P \leq 0.05$). For height data mean comparisons are made within and among columns.

greatest for L 97-128 and L 99-233. In June and July, height was lowest for LCP 85-384 and L 99-226, averaging 19% less than L 99-233 in June and 15% less than L 99-233 in July. Sugarcane canopy width was greatest for L 99-226 and was 23% less for LCP85-384 and 27% less for HoCP 96-540 (Table 2.1). Reduction in PAR provides a measure of the ability of varieties to reduce light penetration into the crop canopy and would be affected by shoot population, height, and canopy width. In June, reduction in PAR was greatest for L 99-226 (87%) and lowest for LCP 85-384 and HoCP 96-540 (62%) (Table 2.1). Comparing growth parameters for L 99-226 and HoCP 96-540, height for the two varieties was equal, but early season shoot population, canopy width, and PAR reduction was greater for L 99-226. This suggests that L 99-226 would be a stronger competitor with weeds across the growing season than HoCP 96-540. The rapid development in shoot population early in the season along with the wide canopy for L 99-226 would be especially important where bermudagrass is a problem. Bermudagrass is difficult to control with herbicides (Richard 1995). The suppression of bermudagrass with herbicide along with early competition from the crop should enhance the ability to manage bermudgrass infestations. The greater height, canopy width, and PAR reduction for L99-233 and L 97-128 in comparison with HoCP 96-540 also indicate that L 99-233 and L 97-128 could be more competitive with weeds.

Second Production Year. Changes in growth characteristics of the six varieties in first stubble were measured across the growing season in 2008. For changes in shoot population from mid-March to mid-April a significant linear trend was observed for all varieties (Figure 2.1). Sugarcane shoot emergence was slow during March but in April differences in shoot population among the varieties were evident. Shoot population tended to be lowest for LCP 85-384 and HoCP 96-540 and highest for L 99-233. For changes in sugarcane canopy width significant



Trend Analysis results for six sugarcane varieties in 2008.

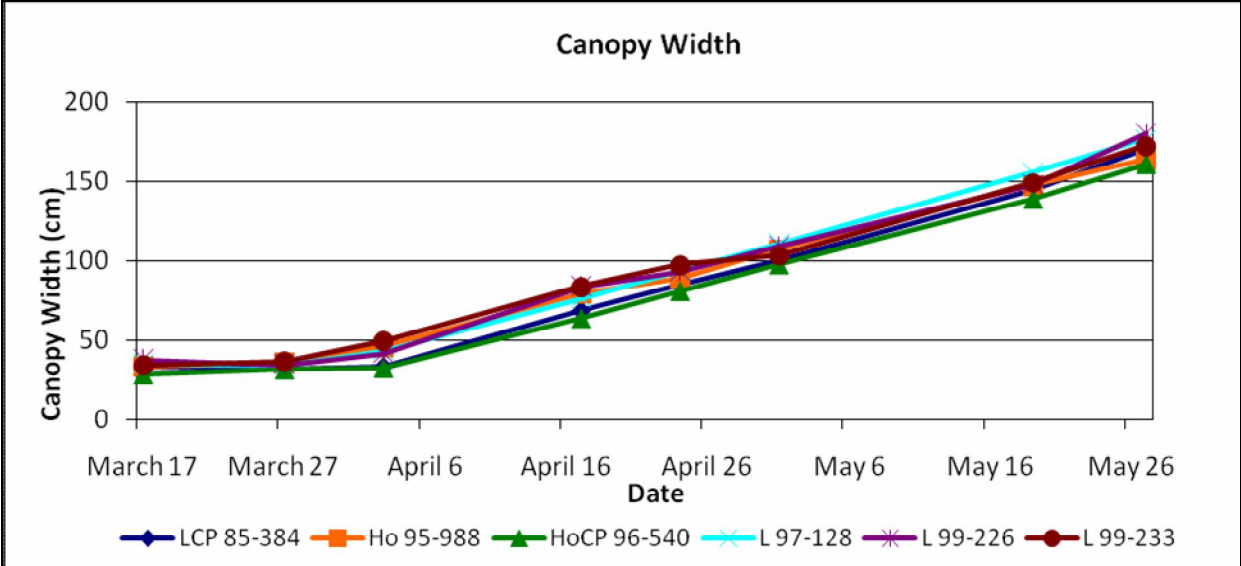
Trend Analysis with P values	Variety					
	LCP 85-384	Ho 95-988	HoCP 96-540	L 97-128	L 99-226	L 99-233
Linear	0.0001	0.0001	0.0001	0.0003	0.0001	0.0001
Quadratic	NS	NS	NS	NS	NS	NS

Figure 2.1. Changes in shoot population for six sugarcane varieties from March through April, 2008.¹

¹ Significant variety by date interactions were not observed. Data for each variety over time were analyzed using Trend Analysis to evaluate significance of linear and quadratic responses.

linear and quadratic trends were observed (Figure 2.2). Canopy width changed little for the varieties in March. In late March/early April sugarcane growth and canopy development increased for L 97-128, Ho 95-988, L 99-226, and L 99-233, but not for LCP 85-384 and HoCP 96-540. During April and May, canopy width for LCP 85-384 and HoCP 96-540 tended to be less than the other varieties.

Sugarcane ground cover is a reflection of shoot population, biomass accumulation, and growth characteristics of the varieties. For all varieties, changes in ground cover from mid-March through late May followed a linear trend (Figure 2.3). In comparing growth characteristics of sugarcane varieties, LCP 85-384 and HoCP 96-540 have an upright growth habit whereas leaf blades of L 99-226 tend to grow outward from the stalk rather than upright (Ben Legendre, personal communication). Because of these differences leaves of L 99-226 could shade row middles more quickly than other commercial varieties. Percentage ground cover was consistently less for LCP 85-384 and HoCP 96-540 compared with the other varieties. Beginning in mid-April, ground cover increased most rapidly for L 99-233. In late May, ground cover was leveling off and was around 60% for LCP 85-384 and HoCP 96-540 and around 70% for L 97-128, Ho 95-988, and L 99-233. In contrast, ground cover in late May for L 99-226 was approaching 90%. The wider growth habit of L 99-226 would contribute to more rapid canopy closure and reduced sunlight in the row middles. For all varieties, changes in sugarcane canopy height from mid-March through mid-July and uppermost leaf collar height from June through August followed highly significant linear trends (Figures 2.4 and 2.5). For both canopy height and collar height values were consistently greater for L 97-128 and L 99-233. On August 28, when the last data were collected, uppermost collar height was 226 cm for LCP 85-384, 239 cm for HoCP 96-540, 238 cm for Ho 95-988, 215 cm for L 99-226 compared with 245 cm for L 97-128 and 240 cm for

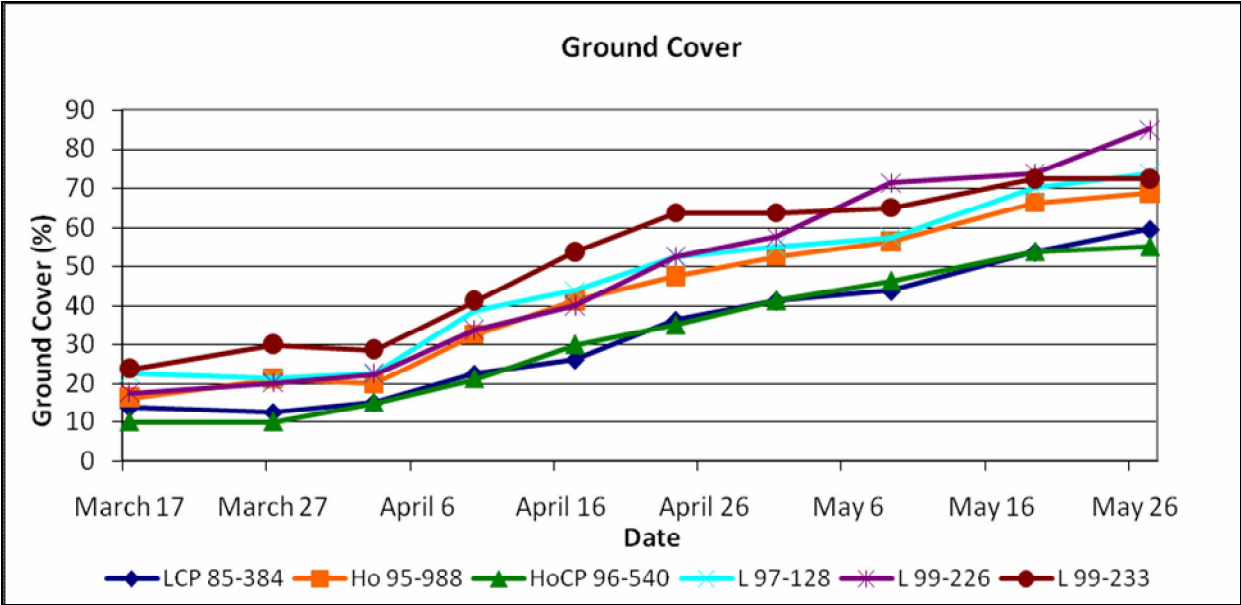


Trend Analysis results for six sugarcane varieties in 2008.

Trend Analysis with P values	Variety					
	LCP 85-384	Ho 95-988	HoCP 96-540	L 97-128	L 99-226	L 99-233
Linear	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Quadratic	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Figure 2.2. Changes in canopy width for six sugarcane varieties from March through May, 2008.¹

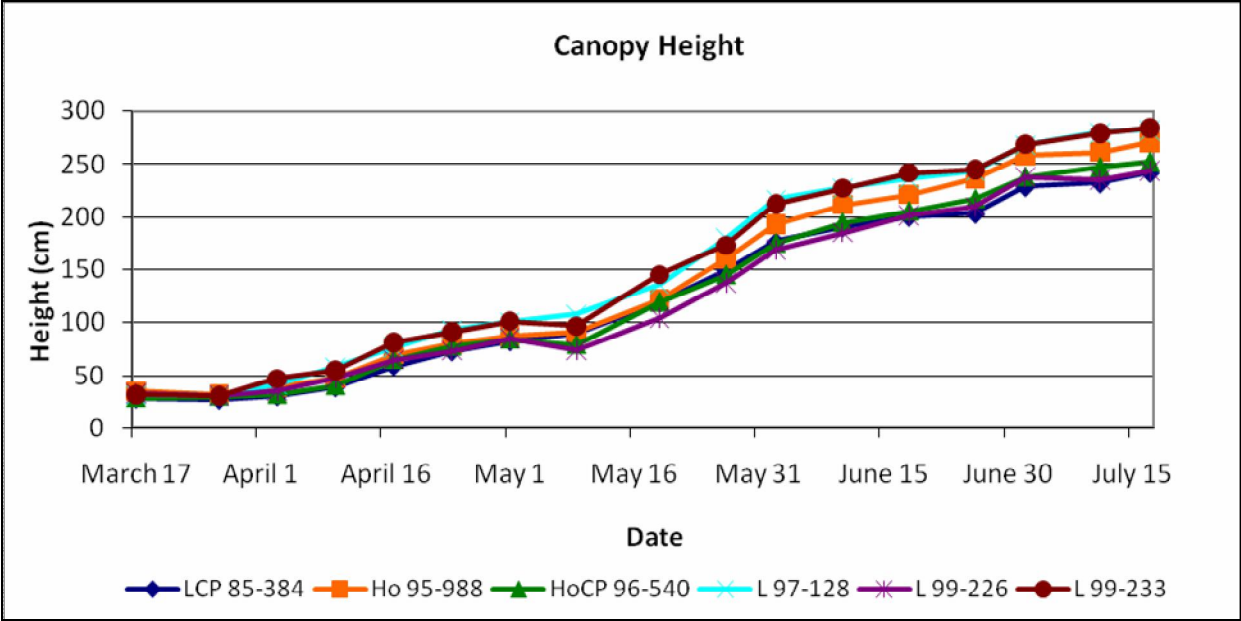
¹ Significant variety by date interactions were observed. Data for each variety over time were analyzed using Trend Analysis to evaluate significance of linear and quadratic responses.



Trend Analysis results for six sugarcane varieties in 2008.

Trend Analysis with P values	Variety					
	LCP 85-384	Ho 95-988	HoCP 96-540	L 97-128	L 99-226	L 99-233
Linear	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Quadratic	0.0008	NS	NS	NS	0.0109	0.0015

Figure 2.3. Changes in ground cover for six sugarcane varieties from March through May, 2008.¹ Significant variety by date interactions were observed. Data for each variety over time were analyzed using Trend Analysis to evaluate significance of linear and quadratic responses.

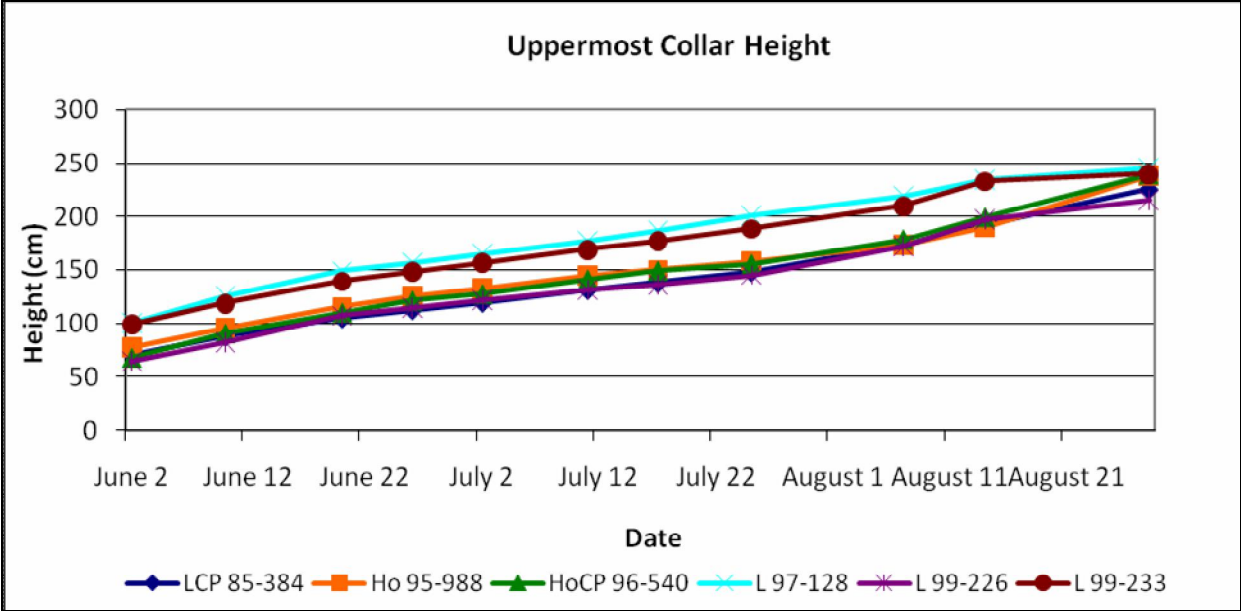


Trend Analysis results for six sugarcane varieties in 2008.

Trend Analysis with P values	Variety					
	LCP 85-384	Ho 95-988	HoCP 96-540	L 97-128	L 99-226	L 99-233
Linear	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Quadratic	0.0006	0.0001	0.0001	NS	0.0001	0.0017

Figure 2.4. Changes in canopy height for six sugarcane varieties from March through July, 2008.¹

¹ Significant variety by date interactions were observed. Data for each variety over time were analyzed using Trend Analysis to evaluate significance of linear and quadratic responses.



Trend Analysis results for six sugarcane varieties in 2008.

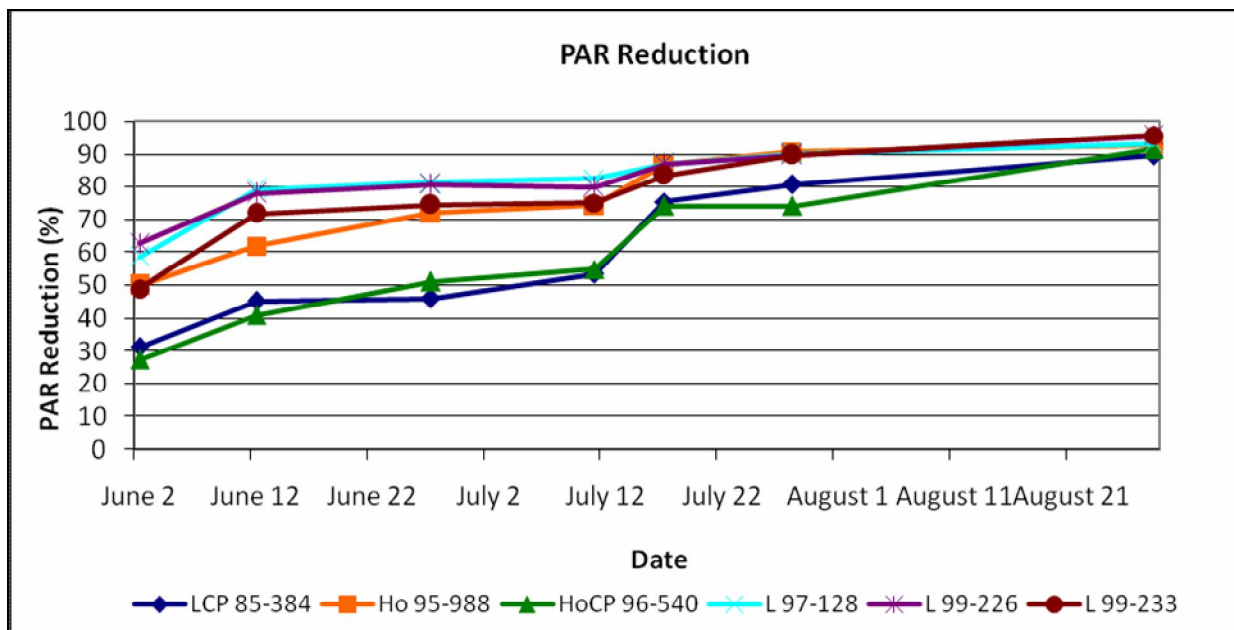
Trend Analysis with P values	Variety					
	LCP 85-384	Ho 95-988	HoCP 96-540	L 97-128	L 99-226	L 99-233
Linear	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Quadratic	0.0016	0.0001	0.0056	0.0085	0.0006	0.0605

Figure 2.5. Changes in uppermost collar height for six sugarcane varieties from June through August, 2008.¹

¹ Significant variety by date interactions were observed. Data for each variety over time were analyzed using Trend Analysis to evaluate significance of linear and quadratic responses.

L 99-233. Sugarcane shoot population, canopy width, ground cover, and height would all affect light penetration into the sugarcane canopy. Based on PAR data collected in the bottom of the row middles, light reduction across the growing season followed a linear trend and was lowest for LCP 85-384 and HoCP 96-540 (Figure 2.6). In early June, PAR was reduced an average of 61% for L 97-128 and L 99-226 compared with 29% for LCP 85-384 and HoCP 96-540. Reduction in PAR for LCP 85-384 and HoCP 96-540 in mid-July was less than 60% compared with around 75 to 85% PAR reduction for the other varieties. PAR reduction of 90% was reached in late July for Ho 95-988, L 97-128, L 99-226, and L 99-233 but 90% PAR reduction was not attained for LCP 85-384 and HoCP 96-540 until late August.

A significant variety effect was observed for shoot population, canopy width, ground cover, and canopy height data collected from March through July (Table 2.2). Average shoot population and ground cover were highest for L 99-233 and equivalent to that for L 99-226. Average canopy width was greatest for L 99-226 and equivalent to that for L 97-128 and L 99-233. Average canopy height was highest for L 97-128 and L 99-233 and greater than for all other varieties. For canopy width and ground cover values were lowest for LCP 85-384 and HoCP 96-540. Differences observed among the six sugarcane varieties suggest that variety selection could play an important role in weed management. Based on growth characteristics L 99-233 and L 97-128 were most aggressive early in the season and followed closely by L 99-226. The wide canopy and ground cover with L 99-233 and L 99-226 would be especially beneficial in early season weed management. In a pot study where sugarcane was grown with purple nutsedge (*Cyperus rotundus* L.), L 97-128 shoot and root dry weight averaged around 2.0 times that for LCP 85-384, Ho 95-988, and HoCP 96-540 (Etheredge et al. 2006). Of the varieties, L 97-128 produced the highest



Trend Analysis results for six sugarcane varieties in 2008.

Trend Analysis with P values	Variety					
	LCP 85-384	Ho 95-988	HoCP 96-540	L 97-128	L 99-226	L 99-233
Linear	0.0001	0.0001	0.0001	0.001	0.0001	0.0001
Quadratic	NS	NS	NS	NS	NS	NS

Figure 2.6. Changes in percentage PAR (photosynthetically active radiation) reduction for six sugarcane varieties from June through August, 2008.¹

¹ Significant variety by date interactions were observed. Data for each variety over time were analyzed using Trend Analysis to evaluate significance of linear and quadratic responses.

Table 2.2. Average shoot population, canopy width, ground cover, canopy height, uppermost collar height, and percentage PAR (photosynthetically active radiation) reduction for six sugarcane varieties during the 2008 growing season.¹

Varieties	Shoot population no./ha	Canopy width cm	Ground cover %	Canopy height cm	Uppermost	Reduction in PAR %
					collar height cm	
LCP 85-384	86,710 bc	77.3 c	33 d	127.7 c	174.8 bc	58 c
Ho 95-988	89,430 bc	82.8 b	42 c	141.8 b	180.0 bc	73 b
HoCP 96-540	83,440 c	74.1 c	32 d	131.3 c	184.3 b	58 c
L 97-128	88,140 bc	84.9 ab	46 bc	152.9 a	213.1 a	80 a
L 99-226	94,580 ab	87.2a	47 ab	127.5 c	172.9 c	81 a
L 99-233	100,620 a	85.6 ab	51 a	153.7 a	203.9 a	74 b

¹Data represent averages for data collected every 7 to 10 days for shoot population (March-April), canopy width and ground cover (March-May), canopy height (March-July), and uppermost collar height and reduction in PAR (June – August).

shoot population and height indicating that growth characteristics of sugarcane varieties affect the ability to compete with purple nutsedge.

A significant variety effect was also observed for uppermost collar height and PAR reduction data collected from June through August (Table 2.2). Average uppermost collar height was highest for L 97-128 and L 99-233 and greater than all other varieties. Differences in growth habit among the varieties in the present study were reflected in light interception within the sugarcane canopy. Reduction in PAR averaged around 80% for L 97-128 and L 99-226. For comparison PAR was reduced 58% for LCP 85-384 and HoCP 96-540 and around 74% for Ho 95-988 and L 99-233. 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. Purple nutsedge shoot population and shoot dry weight when grown under 70 and 90% shade were reduced an average of 82 and 92%, respectively (Etheredge et al. 2006). Exposure to 70 and 90% shade decreased red morningglory (*Ipomoea coccinea* L.) plant population 37 and 43%, respectively, and biomass per plant 27 and 48%, respectively (Jones et al. 2006). In a preliminary study bermudagrass ground cover and above ground biomass were reduced around 50% more when exposed to 90% shade compared with 70% shade (unpublished data). Using these findings for bermudagrass and the PAR reduction for the sugarcane varieties observed in the present study it would be expected that bermudagrass would more readily reestablish in June and July in LCP 85-384 and HoCP 96-540 compared with L 97-128, Ho 95-988, L 99-226, and L 99-233.

In 2008, stalk population in August and stalk weight and TRS did not differ among the sugarcane varieties (Table 2.3). Sugarcane yield was equivalent for L 97-128, HoCP 96-540, Ho 95-988, L 99-226, and L 99-233 and averaged 53.18 mt/ha (Table 2.3). Sugarcane yield for LCP

Table 2.3. Stalk population in August and sugarcane stalk weight, sugar per ton, and yield for six sugarcane varieties in 2008 (second production year).¹

Variety	Stalk population	Stalk weight	TRS ¹	Sugarcane yield	Sugar yield
	no./ha	kg/stalk	kg/ton	-----mt/ha-----	
LCP 85-384	18,540 ab ²	1.45 ab	118 a	39.03 b	4.60 c
Ho 95-988	18,860 ab	1.49 ab	125 a	55.50 a	6.92 ab
HoCP 96-540	19,030 ab	1.78 a	123 a	59.97 a	7.39 a
L 97-128	19,190 ab	1.44 ab	119 a	46.96 ab	5.60 bc
L 99-226	17,240 b	1.64 ab	120 a	52.45 a	6.26 ab
L 99-233	19,840 a	1.34 b	122 a	51.01 ab	6.19 ab

¹ Stalk population data were collected on August 14, 2008 and sugarcane was harvested on November 7. TRS = Theoretical recoverable sugar.

² Means followed by the same letter within columns followed by the same letter are not significantly different using LSD 0.05.

85-384 averaged 30% less compared with that for HoCP 96-540, Ho 95-988, and L 99-226. Highest sugar yield was observed for HoCP 96-540 (7,390 kg/ha) and yield was equivalent to that for Ho 95-988, L 99-226, and L 99-233. For LCP 85-384 and L 97-128 sugar yield averaged 31% less than for HoCP 96-540.

Sugarcane variety recommendations in Louisiana are based primarily on yield (tonnage and sugar), stubble longevity, disease/insect reaction, and cold tolerance. This research shows that sugarcane varieties vary in regard to growth characteristics which can affect their ability to compete with weeds. Weed control measures represent a major investment in a sugarcane production system. Findings could be applicable to the development of effective and season long weed control programs that consider specific characteristics of sugarcane varieties, and their impact on weed competition. It may be possible for growers to select varieties that would be most productive where specific weed problems exist and to customize weed control programs based on variety selection.

LITERATURE CITED

- Anonymous. 2006a. Notice of Release of Sugarcane Variety L 99-226. Sugar Bull. 84(9):14-15.
- Anonymous. 2006b. Notice of Release of Sugarcane Variety L 99-233. Sugar Bull. 84(9):16-17.
- Anonymous. 2008. Louisiana Agricultural Summary. Louisiana State University Agricultural Center, Louisiana Cooperative Extension Service. Web page: <http://www.lsuagcenter.com/agsummary/index.aspx>. Accessed January 13, 2009.
- Berding, N., D. Marston, W. F. McClure, M. V. Eerten and B. Prescott. (2004). FT-NIR spectrometry and automated presentation for high-speed at-line analysis of disintegrated sugarcane. Proc. INCIS 11: 81-87
- Carmer, S. G., W. E. Nyquist, and W. M. Walker. 1989. Least significant differences for combined analyses of experiments with two- and three-factor treatment designs. Agron. J. 81:665-672.

- Etheredge, L. M., Jr., J. L. Griffin, C. A. Jones, and J. M. Boudreaux. 2006. Interference of purple nutsedge (*Cyperus rotundus* L.) in Louisiana sugarcane. Proc. South. Weed Sci. Soc. 59:97.
- Gravois, K. A., K. P. Bischoff, S. B. Milligan, F. A. Martin, J. W. Hoy, T. E. Reagan, C. A. Kimbeng, C. M. LaBorde and G. L. Hawkins. 2008. Registration of 'L 97-128' sugarcane. J. Plant Registrations. 2:24-28.
- Griffin, J. L. and L. M. Kitchen. 1990. Sugarcane response to selected preemergence and postemergence herbicides. J. Am. Soc. Sugarcane Technol. 10:61-65.
- Griffin, J. L. and J. M. Boudreaux. 2007. Comparisons of sugarcane varieties for growth and shading potential. Sugarcane Research Annual Progress Report. p. 151.
- Hager, A. G., L. M. Wax, G. A. Bollero, and E. W. Stoller. 2003. Influence of diphenylether herbicide application rate and timing on common waterhemp (*Amaranthus rudis*) control in soybean (*Glycine max*). Weed Technol. 17:14-20.
- Jones, C. A., J. L. Griffin, L. M. Etheredge, Jr., and W. E. Judice. 2006. Response of red morningglory (*Ipomoea coccinea* L.) to shade and soil applied herbicides. Proc. South. Weed Sci. Soc. 59:3.
- LaBorde, C., B. L. Legendre, K. Bischoff, K. Gravois, and T. Robert. 2008. Sugarcane Variety Identification Guide. Agriculture Center, Louisiana State University. Pub. 3056, pp 18-21.
- Miller, D. K., E. P. Richard, Jr., and J. L. Griffin. 1998. Sugarcane (*Saccharum* spp. hybrids) response to simulated fallow field residues of metribuzin and sulfometuron. Weed Technol. 12:454-457.
- Milligan, S. B., F. A. Martin, K. P. Bischoff, J. P. Quebedeaux, J. W. Hoy, T. E. Reagan, B. L. Legendre, and J. D. Miller. 1994. Registration of 'LCP 85-384' sugarcane. Crop Sci. 34:819.
- Richard, E. P., Jr. 1989. Response of sugarcane (*Saccharum* sp.) cultivars to preemergence herbicides. Weed Technol. 3:358-363.
- Richard, E. P., Jr. 1996. Sugarcane (*Saccharum* spp. hybrids) tolerance to clomazone. Weed Technol. 10:90-94.
- Richard, E. P., Jr. 1995. Bermudagrass interference during a three year sugarcane crop cycle. Proc. Int. Soc. Sugar Cane Technol. 21:31-39.
- Richard, E. P., Jr. and J. L. Griffin. 1993. Johnsongrass (*Sorghum halepense*) control in sugarcane (*Saccharum* sp.) with asulam applied alone and in mixtures. Weed Technol. 7:657-662.

- Robert, T. J., K. A. Gravois, W. R. Jackson, H. L. Waguespack, D. D. Garrison. 2004. A Report on the 2003 Outfield Variety Tests. *Sugar Bull.* 82(9):30-33.
- Saxton, A. M. 1998. A macro for converting mean separation output to letter groupings in Proc. Mixed. *In Proceedings of the 23rd SAS Users Group Ino-tillageage.*, Cary, NC: SAS Institute. Pp. 1243-1246.
- Tew, T. L., W. H. White, M. P. Grisham, E. O. Dufrene, Jr, D. D. Garrison, J. C. Veremis, Y. Pan, E. P. Richard, Jr, B. L. Legendre, J. D. Miller. 2005a. Registration of "HoCP 96-540" Sugarcane. *Crop Science.* 45:785-786.
- Tew, T. L., D. M. Burner, B. L. Legendre, W. H. White, M. P. Grisham, E. O. Dufrene, Jr., D. D. Garrison, J. C. Veremis, Y. Pan, E. P. Richard, Jr. 2005b. Registration of "Ho 95-988" Sugarcane. *Crop Sci.* 45:1660.

CHAPTER 3

JOHNSONGRASS AND BERMUDAGRASS RESPONSE TO SHADE

INTRODUCTION

Sugarcane (*Saccharum* spp. hybrids) is a tropical crop grown, commercially for sugar, only in Florida, Louisiana, and Texas in the continental U.S. In 2007, sugarcane was grown on approximately 169,540 hectares by 609 producers in Louisiana (Anonymous 2008). The total value of the sugarcane crop to Louisiana growers, processors and landlords for sugar was \$666.9 million, ranking sugarcane as the number one agronomic crop. In Louisiana sugarcane is planted in August and September and three to five annual harvests are made from the initial planting. Sugarcane enters a dormant period during the winter and regrowth occurs usually in March. Weeds are a major factor limiting sugarcane production and herbicide cost is a large investment for growers. Johnsongrass (*Sorghum halepense* L. Pers.) and bermudagrass (*Cynodon dactylon* L. Pers.) are especially troublesome in sugarcane because of their perennial nature (Anonymous 2004) and the ineffectiveness and/or inconsistency of herbicide treatments (Anonymous 2007).

Johnsongrass is well suited for competition with sugarcane, because of its rapid growth rate and ability to reproduce from seeds and rhizomes (Matherne et al. 1997). Richard (2004) investigated the effect of johnsongrass competition in sugarcane by transplanting one johnsongrass plant per 2.7 m, 1.8 m, and 0.9 m of row at the same time sugarcane was planted. In the first production year, johnsongrass at the lowest initial plant density reduced sugarcane stalk population 9% and 14% at the highest density when compared with a weed-free control. In another study when allowed to interfere with sugarcane seasonlong, johnsongrass reduced sugarcane and sugar yield 23 and 17%, respectively, in the first production year and 42 and 35%,

respectively, the following year (Millhollon 1995). A major factor leading to the proliferation of johnsongrass in sugarcane is that postemergence control with asulam can be quite variable and seldom exceeds 80% (Richard and Griffin 1993; Griffin et al. 2006).

Bermudagrass interferes with sugarcane by reducing tiller formation and survival through competition for soil nutrients (Richard and Dalley 2007; Richard 1995, 1997). Production of bermudagrass allelochemicals can also inhibit crop growth (Vasilakoglou et al. 2005). Bermudagrass infestations, when left unchecked, can develop quickly due to prolific production of stolons and rhizomes (Horowitz 1972). Richard (1995) reported that bermudagrass biomass increased by 340% from the first to the second production year and 490% between the second and third production year. Under heavy bermudagrass infestations, sugarcane yield was reduced by as much as 26% (Richard 1997). In sugarcane, tillage is limited to the row sides and furrows and once bermudagrass becomes established on the row top, it is virtually impossible to control (Richard and Dalley 2007). Bermudagrass interference with sugarcane is critical following planting and in the spring as sugarcane emerges and tillering is initiated. At the layby cultivation in May, bermudagrass in the row middles is eliminated with tillage. Because of its prostrate growth habit and intolerance to shading, bermudagrass is limited in its ability to reestablish and compete under a sugarcane canopy (Horowitz 1972). In late summer, as shading from the crop increases, bermudagrass responds by increasing dry matter allocation to leaves and stolons (Dong and Pierdominici 1995; Fernández et al. 2002). Juraimi et al. (2004) reported that shading of bermudagrass reduced shoot number, plant height, leaf and stem dry weight, leaf area, chlorophyll content per unit leaf area, and reproductive development.

Sugarcane varieties differ in regard to time of emergence following planting and in the spring after the winter dormancy period. Those that produce a high population of stalks per

hectare with leaves less upright in growth habit would be competitive with weeds in respect to shading. Field research was conducted to evaluate johnsongrass and bermudagrass growth parameters and above ground biomass production in response to varying shade levels. Results from this research could be useful in variety selection and in planning season long weed control programs for johnsongrass and bermudagrass.

MATERIALS AND METHODS

Field research was conducted to evaluate the effects of shade on growth on johnsongrass in 2008 and on bermudagrass in 2007 and 2008. Field sites of natural infestations of both johnsongrass and bermudagrass established for several years at the Central Research Station, near Baton Rouge, LA were used. The soil type for the field sites was a Mhoon silty clay loam (fine-silty, mixed, nonacid, thermic Typic Fluavaquent) with 1.9% OM and a pH of 6.3.

The experimental design used each year was a randomized complete block with four replications and five shade level treatments. The johnsongrass experiment was repeated in 2008. Shade enclosures (0.61 x 0.61 x 0.61m) constructed using wood frames wrapped in polypropylene² fabric on the four sides and top with the bottom left open were used. Shade intensities of 0, 30, 50, 70, and 90% (100, 70, 50, 30, or 10% of full sun light) were based on the light restriction levels of black polypropylene fabric shading material. Shade intensities expressed as photosynthetically active radiation (PAR) with the polypropylene fabric were confirmed within three percent using an AccuPAR Linear PAR Ceptometer³. To initiate the study, the experimental area was tilled to a 10.2 cm depth with a rotary tiller

² DeWitt Company, 905 S. Kings Highway, Sikeston, MO 63801.

³ Decagon Devices, Inc., 950 Nelson Court, Pullman, WA 99163.

and shade enclosures were immediately placed on the soil surface. For each experiment soil moisture was present when shade enclosures were installed. During the five weeks that shade enclosures remained in the johnsongrass areas, rainfall was 16.1 cm for the first experiment and 22 cm for the second experiment. During the eight weeks that shade enclosures remained in the bermudagrass areas rainfall was 35.6 cm in 2007 and 18.7 cm in 2008. Rainfall was not a limiting factor to growth of johnsongrass or bermudagrass.

For the johnsongrass study, plant population, plant height, and total above ground biomass were determined 35 days after experiments were initiated. This timing corresponded to when growth of the plants reached the top of the shade enclosure. Johnsongrass plants were seedlings rather than rhizomatous. For the bermudagrass study, plant height and total ground cover were determined 35, 45 and 55 days after experiments were initiated. Ground cover was determined visually based on the percentage of the soil surface within each enclosure covered with plant leaves and stems using a 0 to 100% scale where 100= plant tissue covering the entire soil surface under the enclosure. For both weeds, biomass removed at the soil level was dried at 60 C for 48 hours and weighed. Plant height was measured from the soil to the uppermost leaf tip for 10 randomly selected johnsongrass plants from each enclosure and to the top of the bermudagrass canopy at 10 randomly selected areas in each enclosure. Data collected for johnsongrass and bermudagrass were averaged across experiments and response to shade levels was analyzed using Trend Analysis in SAS⁴.

RESULTS AND DISCUSSION

Johnsongrass. A highly significant linear trend was observed for all johnsongrass growth parameters in response to shade level (Table 3.1). Plant population 35 days after the study was

²SAS institute. 2003. SAS User's Guide: Statistics. Version 9.1. SAS Institute. Cary, NC.

Table 3.1. Johnsongrass growth response to shade.^a

Shade level	Plant population	Average plant height	Above ground biomass	Biomass per plant
%	no./0.37m ²	cm	g/0.37m ²	g/plant
0	76	23.0	20.5	0.70
30	56	28.3	12.1	0.48
50	38	31.5	8.8	0.47
70	12	37.3	1.5	0.16
90	11	40.8	2.1	0.18
Trend Analysis results ^b				
Linear	0.0001	0.0004	0.0001	0.0002
Quadratic	NS	NS	NS	NS

^aShade enclosures (0.61 x 0.61 x 0.61m) were constructed of wood and wrapped in polypropylene fabric shading material on four sides and top. Shade enclosures were placed on the soil after the experimental area was tilled to a depth of 10.2 cm. Data were collected 35 days after placement of shade enclosures and represent an average across two experiments.

^bSignificance level indicated by p values for linear and quadratic responses using Trend Analysis for each parameter. NS = not significant.

initiated, averaged 76 plants per enclosure for full sunlight and decreased to 11 plants per enclosure for 90% shade, an 86% decrease in plant population. In contrast, plant height increased as shade level increased. For full sun light, plant height averaged 23.0 g compared with 40.8 g for 90% shade, a 1.8 fold increase. This response is expected since etiolation of plants is a common response to reduced light (Smith 1982). Although plant height increased in response to shade, this was not reflected in an increase in above ground biomass. Total above ground biomass decreased 90% as shade level increased from 0 to 90%. Using plant population and above ground biomass data, biomass per plant was calculated. Above ground biomass per plant decreased from 0.70 g for plants grown in full sun light to 0.18 g for 90% shade, a 74% decrease.

Johnsongrass has an upright growth habit and is capable of reaching heights of approximately 2 m (Richard and Griffin 1993). In this study, height of shade boxes precluded data collection past 35 days. Reduction in sunlight decreased seedling emergence and increased plant height. Johnsongrass plants exposed to shade were taller but were spindly and less biomass per plant was produced compared with plants grown in full sunlight. Effective preemergence herbicide treatments are available for seedling johnsongrass control that will give the sugarcane crop a competitive advantage (Anonymous 2007). In situations where herbicides are ineffective, an early emerging sugarcane crop that produces a high shoot population and rapid ground cover would suppress johnsongrass growth. In preliminary research 'L 97-128' and 'L 99-226' sugarcane reduced light penetration 86% in July compared with 64% for 'HoCP 96-540' (Griffin and Boudreaux 2007).

Bermudagrass. A highly significant quadratic trend was observed for bermudagrass plant height 35, 45, and 55 days after experiments were initiated (Table 3.2). For each date, average

Table 3.2. Bermudagrass growth response to shade. ^a

Shade level	Average plant height			Ground cover			Above ground biomass
	35 days	45 days	55 days	35 days	45 days	55 days	
%	-----cm-----			-----%-----			g/0.37m ²
0	13.8	20.8	25.4	58	74	88	177
30	21.1	26.1	31.0	38	44	63	104
50	25.9	28.3	32.9	32	39	50	74
70	24.7	25.7	30.7	19	18	21	17
90	18.4	20.9	24.9	13	12	10	9
Trend Analysis results ^b							
Linear	0.0305	NS	NS	0.0001	0.0001	0.0001	0.0001
Quadratic	0.0001	0.0012	0.0001	NS	NS	NS	NS

^aShade enclosures (0.61 x 0.61 x 0.61m) were constructed of wood and wrapped in polypropylene fabric shading material on four sides and top. Shade enclosures were placed on the soil after the experimental area was tilled to a depth of 10.2 cm. Plant height and ground cover data were collected 35, 45, and 55 days after placement of shade enclosures and biomass data were collected at 55 days. Data represent an average across two experiments.

^bSignificance level indicated by p values for linear and quadratic responses using Trend Analysis for each parameter. NS = not significant.

plant height for full sunlight increased as shade level increased to 50% shade and then decreased as shade level increased to 90%. Unlike johnsongrass, bermudagrass has a prostrate growth habit and as bermudagrass reestablishes stolons are produced resulting in less upright plant growth. This response was clearly observed for bermudagrass grown in full sunlight and at 30% shade. For ground cover, a highly significant linear trend was observed at 35, 45, and 55 days after the study was initiated (Table 3.2). Ground cover was greatest for full sunlight and decreased as shade level increased. Ground cover for full sunlight was reflected in production of numerous stolons as well as leaves and stems and, by 55 days, ground cover was 88%. In contrast for 90% shade, foliar growth was affected and ground cover at 55 days was only 10%. Juraimi et al. (2004) reported that shading of bermudagrass reduced shoot number, plant height, leaf and stem dry weight, leaf area, chlorophyll content per unit leaf area, and reproductive development. In comparing full sunlight to 90% shade, ground cover increased 4.5 fold at 35 days, 6.2 fold at 45 days, and 8.8 fold at 55 days. In comparing across dates, under full sunlight, ground cover increased 1.5 fold from 35 to 55 days but for 90% shade, ground cover did not change with time (no more than 13% ground cover). As shade level increased, a linear trend was also observed for above ground biomass (Table 3.2). Biomass 55 days after the study was initiated was 177 g per enclosure for full sunlight and decreased to 9 g per enclosure for 90% shade, a 95% decrease. Both ground cover and above ground biomass data further delineate the effect of reduced sunlight on ability of bermudagrass to reestablish through production of stolons, stems, and leaves (Juraimi et al. 2004). Richard (1995) reported that bermudagrass rapidly reestablished between the first and third production year, indicating the ability of bermudagrass to compete with sugarcane. With the prostrate growth habit of bermudagrass, shading from the sugarcane canopy especially later in the growing season would be critical to long term control.

Effective herbicide treatments are not available for bermudagrass control once bermudagrass becomes established in sugarcane (Anonymous 2007). Therefore, shading provided from a rapidly developing crop canopy would be advantageous. In comparing johnsongrass and bermudagrass in response to shade, 90% shade reduced johnsongrass biomass 74% compared with 95% for bermudagrass. In other research 90% shade reduced purple nutsedge (*Cyperus rotundus* L.) shoot dry weight 92% (Etheredge et al. 2006) and reduced red morningglory (*Ipomoea coccinea* L.) total biomass 57% (Jones et al. 2006). Because sugarcane varieties differ in growth characteristics they may also differ in respect to their competitiveness with weeds. In a pot study where sugarcane was subjected to purple nutsedge interference, L 97-128 shoot and root dry weight averaged around 2.0 times that for LCP 85-384, Ho 95-988, and HoCP 96-540 (Etheredge et al. 2006). Sugarcane varieties that emerge early in the spring following the winter dormant period and that produce a high population of stalks with leaves less upright in growth habit should be more competitive with weeds because of shading. Variety selection could play an important role in the management of problematic weeds, especially bermudagrass where control measures are not effective. Findings also point to the need to implement the most effective chemical and cultural control measures for bermudagrass both at planting and in the subsequent crops to delay reestablishment over time.

LITERATURE CITED

- Anonymous. 2004. Ten most common and troublesome weed species in Louisiana. Proc. South. Weed Sci. Soc. 57:393-403.
- Anonymous. 2007. Louisiana Suggested Chemical Weed Control Guide. Louisiana State University Agricultural Center. Pub. 1565, Pp. 86-99.

- Anonymous. 2008. Louisiana Agricultural Summary. Louisiana State University Agricultural Center, Louisiana Cooperative Extension Service. Web page: <http://www.lsuagcenter.com/agsummary/index.aspx>. Accessed January 13, 2009.
- Dong, M. and M. G. Pierdominici. 1995. Morphology and growth of stolons and rhizomes in three clonal grasses as affected by different light supply. *Vegetatio*. 116:25–32.
- Etheredge, L. M., Jr., J. L. Griffin, C. A. Jones, and J. M. Boudreaux. 2006. Interference of purple nutsedge (*Cyperus rotundus* L.) in Louisiana sugarcane. *Proc. South. Weed Sci. Soc.* 59:97.
- Fernández, O. N., O. R. Vignolio, and E. C. Requesens. 2002. Competition between corn (*Zea mays*) and bermudagrass (*Cynodon dactylon*) in relation to the crop plant arrangement. *Agronomie (Paris)* 22:293–305.
- Griffin, J. L. and J. M. Boudreaux. 2007. Comparisons of sugarcane varieties for growth and shading potential. *Sugarcane Research Annual Progress Report*. p. 151.
- Griffin, J. L., D. K. Miller, and M. E. Salassi. 2006. Johnsongrass (*Sorghum halepense*) control and economics of using glyphosate-resistant soybean in fallowed sugarcane fields. *Weed Technol.* 20:980-985.
- Horowitz, M. 1972. Spatial growth of *Cynodon dactylon* (L.) Pers. *Weed Res.* 12:373–383.
- Jones, C. A., J. L. Griffin, L. M. Etheredge, Jr., and W. E. Judice. 2006. Response of red morningglory (*Ipomoea coccinea* L.) to shade and soil applied herbicides. *Proc. South. Weed Sci. Soc.* 59:3.
- Juraimi, A. S., S. H. Donald, A. Drennan, and A. Nurina. 2004. The effects of shading on the growth, development and partitioning of biomass in bermudagrass (*Cynodon dactylon* (L.) Pers.). *J. Biol. Sci.* 4: 756-762.
- Matherne, R. J., R. D. Breaux, and R. W. Millhollon. 1977. Culture of Sugarcane for Sugar Production in the Mississippi Delta, USDA Agriculture Handbook No. 417.
- Millhollon R. W. 1995. Growth and yield of sugarcane as affected by johnsongrass (*Sorghum halepense*) interference. *J. Am. Sugar Cane Technol.* 15:32–40.
- Richard, E. P., Jr. and C. D. Dalley. 2007. Sugarcane response to bermudagrass interference. *Weed Technol.* 21: 941–946.
- Richard E. P., Jr. 1995. Bermudagrass interference during a three year sugarcane crop cycle. *Proc. Int. Soc. Sugar Cane Technol.* 21:31–39.
- Richard E. P., Jr. 1997. Effects of fallow bermudagrass (*Cynodon dactylon*) control programs on newly planted sugarcane (*Saccharum* spp. hybrids). *Weed Technol.* 11:677–682.

- Richard E. P., Jr. 2004. Johnsongrass effects on sugarcane growth and chopper harvester efficiency. *J. Amer. Soc. Sugar Cane Technol.* 24:119.
- Richard, E. P., Jr. and J. L. Griffin. 1993. Johnsongrass (*Sorghum halepense*) control in sugarcane (*Saccharum* sp.) with asulam applied alone and in mixtures. *Weed Technol.* 7:657–662.
- Smith H. 1982. Light quality, photoperception, and plant strategy. *Annu. Rev. Plant Physiol.* 33: 481-518
- Vasilakoglou, I., K. Dhima, and I. Eleftherohorinos. 2005. Allelopathic potential of bermudagrass and johnsongrass and their interference with cotton and corn. *Agron. J.* 97:303–313.

CHAPTER 5

SUMMARY

Sugarcane variety development programs are comprised of a team of breeders, plant pathologists, entomologists, and weed scientists each contributing to the assessment of variety characteristics. Variety recommendations are based on several factors including yield (tonnage and sugar), stubble longevity, disease/insect reaction, cold tolerance and herbicide tolerance. Growth characteristics of sugarcane varieties vary which can directly affect their ability to compete with weeds. Research was conducted to compare seasonal growth characteristics and shading ability of the sugarcane varieties LCP 85-384, Ho 95-988, HoCP 96-540, L97-128, L99-226, and L99-233 during the first and second production years.

Data collected across the growing season in the second production year for sugarcane shoot population, height, canopy width, ground cover, and reduction in photosynthetically active radiation (PAR) showed significant variety by date interactions. Data were analyzed for each variety over time using trend analysis and for all growth parameters a linear trend was observed. Shoot population from March through April tended to be lowest for LCP 85-384 and HoCP 96-540 and greatest for L 99-233. Differences in emergence of shoots among the varieties were observed beginning in early April and as the season progressed shoot production and height increased for Ho 95-988, L 97-128, L 99-226, and L 99-233 but lagged for LCP 85-384 and HoCP 96-540. Differences in overall canopy development among the varieties were observed into late May. Sugarcane ground cover, a reflection of shoot population and biomass accumulation for the varieties, from March through May was consistently less for LCP 85-384 and HoCP 96-540 compared with the other varieties. Beginning in mid-April ground cover increased most rapidly for L 99-233. In late May ground cover was around 60% for LCP

85-384 and HoCP 96-540, around 70% for Ho 95-988, L 97-128 and L 99-233, and was approaching 90% for L 99-226.

Sugarcane canopy height across the growing season was consistently greater for L 97-128 and L 99-233 and averaged 21% more than for the other varieties in early June and 15% more in mid-July. Based on PAR data collected in the bottom of the row middles, sunlight in the sugarcane canopy 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. By late July PAR reduction was equal and averaged 90% for Ho 95-988, L 97-128, L 99-226 and L 99-233 compared with 78% for LCP 85-384 and HoCP 96-540.

When growth parameters could be compared among varieties for both the first and second production years differences were also observed. Shoot population in April was greatest for L 99-226 and lowest for HoCP 96-540. Height in June and July was greatest for L 97-128 and L 99-233 and lowest for LCP 85-384 and L 99-226. Canopy width in May, however, was greatest for L 99-226 and lowest for HoCP 96-540 and LCP 85-384. Differences in growth characteristics among the varieties were reflected in PAR reduction in June and light penetration into the canopy was most restricted for L 97-128 and L 99-226 and least restricted for LCP 85-384 and HoCP 96-540. In the second production year stalk population in August was greater for L 99-233 than for L 99-226 but was equal to the other varieties. Sugar yield for HoCP 96-540 the second year (7,390 kg/ha) was greater than for LCP 85-384 and L 97-128 but equal to the other varieties.

Findings suggest that variety selection could play an important role in the management of problematic weeds. Based on shoot production, height, and canopy development early in the growing season (April and May) L 97-128, L 99-226, and L 99-233 would be

most competitive and LCP 85-384 and HoCP 96-540 would be least competitive. In June, July, and August as the canopy begins to close, shading from the crop canopy would be greatest for L 97-128 and L 99-226 followed by Ho 95-988 and L 99-233. Shade tolerant weeds emerging later in the growing season would be expected to be very competitive with HoCP 96-540. In this study weeds were eliminated as a contributing factor to sugarcane growth and yield. The high yield potential for HoCP 540 observed in this study might not be realized if weed pressure was great.

Research was conducted to evaluate the influence of shade on growth and development of the perennial weeds bermudagrass and johnsongrass, both major problems in sugarcane. Fields with natural weed infestations were tilled and enclosures (0.61 x 0.61 x 0.61m) covered with shade cloth providing 30, 50, 70 and 90% shade were placed in the field. Weed growth in the enclosures was compared to that of full sunlight (no shade treatment). A significant linear trend was observed for all johnsongrass growth parameters in response to shade level. Comparing full sunlight to 90% shade 35 days after the study was initiated, plant population decreased 86%, plant height increased 77%, total above ground biomass decreased 90%, and above ground biomass per plant decreased 74%.

For bermudagrass ground cover a significant linear trend in response to shade was observed. For full sunlight ground cover at 35, 45, and 55 days was 58, 74, and 88%, respectively, compared with 13, 12, and 10%, respectively, for 90% shade. As shade level increased a linear trend was also observed for above ground biomass. Biomass 55 days after the study was initiated was 177 g per enclosure for full sunlight and decreased to 9 g per enclosure for 90% shade, a 95% decrease. Johnsongrass appears more tolerant to shade than bermudagrass which is not unexpected since johnsongrass has an upright growth habit compared with prostrate growth habit

for bermudagrass. Because sugarcane varieties differ in growth characteristics they may differ in respect to their competitiveness with weeds. Sugarcane varieties that emerge early in the spring following the winter dormant period and that produce a high population of stalks per hectare with leaves less upright in growth habit would be expected to be more competitive with weeds because of shading. Shading from the crop would be especially important where bermudagrass is a problem. Therefore variety selection could play an important role in the management of problematic weeds, especially bermudagrass where control measures are not effective. Findings also point to the need to implement the most effective chemical and cultural control measures for bermudagrass both at planting and in the crop seasonlong to help prevent reestablishment of bermudagrass over time.

VITA

Mariana Ferreira Bittencourt is a daughter of William R. and Ana F. Bittencourt. Born in September 1984, in Uberlandia, Minas Gerais, Brazil. She received a Bachelor of Science degree in agronomy from Federal University of Uberlandia in March 2007. Mariana enrolled in the Department of Agronomy and Environmental Management graduate program under the direction of Dr. James Griffin in 2007 and is currently a candidate for the degree of Master of Science in agronomy with an educational and research emphasis in sugarcane weed science.