BERMUDAGRASS INTERFERENCE DURING A THREE-YEAR SUGARCANE CROP CYCLE

E.P. Richard, Jr.

Sugarcane Research Unit, Agricultural Research Service
U.S. Department of Agriculture
Houma, Louisiana 70361, USA

ABSTRACT

Field studies were conducted in Louisiana, USA to assess the development and competitiveness of bermudagrass (Cynodon dactylon L.) Pers. over a three-year sugarcane (Saccharum intraspecific hybrids) crop cycle. Soil cores (76 mm dia.) containing perennating bermudagrass were placed within the planted sugarcane drill(s) on the 1.8 m wide raised beds in late February. In late July above-ground bermudagrass biomass development in the plant cane crop was 76 kg/ha. Biomass increased 340% between the plant cane and first stubble crops and 490% between the first stubble and second stubble crops. Sugarcane yield reductions associated with full season bermudagrass competition were similar for the three crops and did not reflect the large differences in bermudagrass development observed in the successive crops. When compared with the weed-free control plots, full season bermudagrass competition reduced cane and sugar yields on average by 5% per year with the primary effect on cane yields (t/ha). Total cane yields for the crop cycle were reduced to similar extents following bermudagrass competition for 1, 2, or 3-years suggesting that bermudagrass’s influence on sugarcane development extended beyond the crop in which the competition was imposed. Although not as aggressive as many of the taller growing weeds, bermudagrass developing in the plant cane crop is capable of causing yield reductions which warrant the development of control strategies.

Key words: Bermudagrass, interference, competition, sugarcane, Cynodon dactylon, Saccharum sp.

INTRODUCTION

The perennial culture of sugarcane grown at relatively wide row spacings and its slow early season growth creates conditions which are conducive to the development of bermudagrass and has made it a serious weed of sugarcane throughout the world (Holm et al.). In Louisiana, the number of sugarcane fields infested with bermudagrass is increasing.
Several additional factors may contribute to its increased incidence in Louisiana. Growers rely on cultivation and herbicides to control weeds because labor is neither economical nor available to spot treat or hand remove scattered infestations of bermudagrass. The size of sugarcane farms has increased. As a result deep plowing of fallow fields has been replaced by shallow discing which is faster. The interval between discings has also increased. When rainfall occurs shortly after discing new bermudagrass plants can easily form from severed stolons and rhizomes which may have been moved by the discing equipment. Pre-emergence and post-emergence herbicides used for the control of weeds in sugarcane are relatively ineffective on bermudagrass. Finally, bermudagrass development on the banks of drainage ditches and on field roads has been encouraged through the use of mowing and post-emergence applications of MSMA (monosodium salt of methylarsionic acid) which selectively remove competing weeds. Once established in these areas, bermudagrass creeps into the field via stolon and rhizome growth and in conjunction with movement by tillage equipment.

Sugarcane is most susceptible to competition from warm-season weeds within the first eight to ten weeks after emergence when it is in the tillering phase of growth (Ali et al., Blanco et al., Fadavomé et al., Ibrahim, Turner, Verma): Early season competition generally results in reduced sugarcane stalk populations which ultimately affects net cane and sugar yields. Where perennial weeds are involved these reductions generally are more severe in the subsequent ratoon crops (Millhollon).

Dalapon (2,2-dichloropropanoic acid) has been used for the post-emergence control of bermudagrass in sugarcane (Stamper). Dalapon is no longer available to growers in the USA and its use has declined in recent years because current sugarcane cultivars appear to be more sensitive to Dalapon injury (Richard). There is no other selective pre-emergence or post-emergence herbicide labeled for the control of bermudagrass in sugarcane in the USA.

The objective of these studies was to assess bermudagrass's competitiveness and development in progress under Louisiana culture and to determine if a control strategy is warranted.

**MATERIALS AND METHODS**

Sugarcane cultivar CP65-357 was planted in early autumn in a field which was not infested with bermudagrass. Whole stalks of sugarcane were planted by hand in preformed 1.8 m wide raised sugarcane beds which had been opened to a depth of approximately 150 mm to create a planting furrow. Within the planting furrow two whole stalks approximately 2.3 m long were placed side-by-side with a 10 to 12%
overlap of the ends and covered with approximately 100 mm of soil. Immediately after planting the field was treated with atrazine [6-chloro-N-ethyl-N'-(1-methylethyl)-1,3,5-triazine-2,4-diamine] at 2.2 kg ai/ha applied as a 900 mm band ahead of the planted drill to reduce the influence of competing weeds.

In late February bermudagrass was transplanted into the field at 0.9 m intervals on rows of the planted drill to simulate an infestation not totally destroyed during the spring-summer fallow period. A commercial bulb planter was used to remove a core of perennial bermudagrass from an adjacent ditch bank for transplanting. The cylindrical core with a diameter of 76 mm and a length of about 100 mm contained dormant bermudagrass stolons as well as roots and some rhizomes. Bermudagrass tips/growth were clipped prior to placing the bermudagrass containing cores in holes which had been formed earlier with the same bulb planter.

The entire field was re-treated with atrazine at 3.4 kg/ha applied on a 900 mm band in late March. A broadcast application of atrazine at 2.2 kg/ha directed under the crop canopy was made after the layby (last cultivation) in early June. During the layby cultivation, soil placed on top of the planting drill partially covered some of the bermudagrass. Spring and layby treatments of atrazine were continued for the remainder of the three year crop cycle. When winter weeds were present in the stubble crops the March application of atrazine also included 2,4-D [2,4 dichlorophenoxy acetic acid] at 2.2 kg/ha. Escaped weeds were controlled as needed by hoeing.

To evaluate the development of bermudagrass all of the bermudagrass top-growth in equivalent sized plots, included in the randomization for each replication, was harvested in late July during either the plant cane, first stubble or second stubble crops. Harvested bermudagrass was oven-dried at 65°C for four days before determining bermudagrass biomass production. Bermudagrass was allowed to compete with sugarcane in the first year of the three year crop cycle (plant cane crop only), first two years of the three year crop cycle (plant cane crop and first stubble crops), and for the entire three year crop cycle (plant cane through the second stubble crops). At the completion of a competition period bermudagrass was removed in early March of the subsequent stubble crop. Once the bermudagrass was removed the plots were kept free of bermudagrass for the remainder of the crop cycle by hoeing at two to three week intervals.

Counts of millable sugarcane stalks and measurements of their height were made during the last two weeks of August. Stalks were considered to be millable if the collar of the leaf just below the whorl was at least 1.4 m above the ground. Stalk height was measured from the base of the stalk to the youngest visible leaf collar on 12 stalks (four/row) in each plot. Yearly harvests from the field were performed with a whole stalk, mechanical harvester. Second ratoon crops were harvested in early November and plant cane crops were harvested in late November or early December.
with the first ratoon crops being harvested at a period between these two harvest dates.

Harvested stalks were burned prior to weighing to determine cane yields. Within each plot 15 harvested stalks were randomly sampled, their mass determined and then crushed in a three-roller mill. The extracted juice was analyzed for brix by hydrometer and the content of sugar (sucrose) by polarimetry using standard methods (Chen). Theoretically recoverable sugar (TRS) yields were calculated by standard methods (Legendre and Henderson). The experiment was repeated on an adjacent site planted to the cultivar CP65-357 in the subsequent autumn. The experiments were arranged in randomized complete blocks with either six (Study A) or five (Study B) replications per treatment. Individual plots were three rows (5.8 m) wide by 11.0 (Study A) or 9.1 (Study B) m long and were separated by a 0.9 m buffer. Data from the two studies were combined since there were no significant location effects, and subjected to either factorial (± competition by crop year) or analysis of variance (bermudagrass development and crop cycle effects). Bermudagrass biomass data were transformed by logarithms.

Means were separated by the 0.05 level of probability using least square means tests because of the unequal number of replications at the two locations.

RESULTS AND DISCUSSION

By late July when assessments of bermudagrass growth were made the grass had recovered from the standard layby cultivation, closure of the sugarcane leaf canopy was nearly complete and shading was beginning to cause some yellowing of the bermudagrass foliage. Bermudagrass topgrowth biomass was removed from the cores at the time of transplanting. By July above ground bermudagrass production in the plant cane crop had reached 76 kg/ha (Figure 1). Bermudagrass biomass production increased 3.4 fold (76 kg/ha to 262 kg/ha) from the plant cane to first stubble crop and 4.9 fold (262 kg/ha to 1278 kg/ha) from the first stubble to second stubble crop.

Spring emergence of sugarcane shoots and leaf canopy closure are generally slower in the stubble crops and by the second stubble crop stalk populations and net cane yields of CP65-357 are significantly lower (Richard). It is not known if Bermudagrass development would continue at this sustained rate if additional stubble crops had been allowed to develop. Cultivation of the rowsides, a critical component of sugarcane culture in Louisiana, limits bermudagrass development to the undisturbed planted area of the row. At some point, intraspecific competition would probably limit additional biomass development in this area. In severe infestations, common bermudagrass biomass has been shown to range from 360 to 720 g/m² on a dry weight basis (Horowitz). In this study bermudagrass was harvested from the entire
row surface, but since the row sides were cultivated, the majority of the 1278 kg/ha of bermudagrass harvested in the second stubble crop was from the uncultivated row top. This area comprised less than 50% of the total row surface. Thus bermudagrass density probably approached the severe infestation levels reported by Horowitz'6.

Sugarcane stalk numbers were highest in the first stubble crop and lowest in the second stubble crop, and stalk mass was highest in the plant cane crop and lowest in the second stubble crop (Table 1). This is typical for CP65-357 in Louisiana (Richard'3). Full season bermudagrass competition within any one crop did not significantly reduce the number of millable stalks or their mass. Competition by crop-year interactions were not observed in these studies indicating that trend towards lower stalk numbers was consistent throughout the three year crop cycle. The extent of the difference in stalk numbers between weed free and weedy treatments did appear to increase slightly in the stubble crops where bermudagrass was better established (Table 1 and Figure 1).

**TABLE 1. Effects of full season bermudagrass competition (Comp) mass on millable stalk counts, mass and juice quality during the various sugarcane crops**

<table>
<thead>
<tr>
<th>Crop Year</th>
<th>Counts</th>
<th>Mass</th>
<th>TRS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hoed Weedy Mean</td>
<td>Hoed Weedy Mean</td>
<td>Hoed Weedy Mean</td>
</tr>
<tr>
<td>Plant/cycle</td>
<td>84.7</td>
<td>84.5</td>
<td>84.6b</td>
</tr>
<tr>
<td>First stubble</td>
<td>92.5</td>
<td>89.3</td>
<td>90.9a</td>
</tr>
<tr>
<td>Second stubble</td>
<td>79.4</td>
<td>76.7</td>
<td>78.0c</td>
</tr>
<tr>
<td>Mean</td>
<td>85.5</td>
<td>83.5</td>
<td>84.4b</td>
</tr>
</tbody>
</table>

*a Means within a column followed by the same letter are not significantly different at the 0.05 level of probability as determined by least square means tests.

TRS values for the extracted juice was not affected by either bermudagrass competition or the crop cycle (Table 1). Crops were harvested in November and December in these studies. Delaying the harvests probably gave the sugarcane ample time to mature and mask any small differences which may have been associated with either bermudagrass competition or the number of prior harvests.

35
Cane and sugar yields were affected by both full season bermudagrass competition and crop stage (Table 2). Yield reductions associated with full season bermudagrass competition reflected the cumulative tendencies towards lower stalk numbers and stalk mass where bermudagrass was allowed to compete throughout the growing season of each crop. As expected cane and sugar yields decreased with each successive harvest regardless of the presence or absence of bermudagrass. When averaged over the full crop cycle, full season bermudagrass competition significantly reduced cane yields on average by 5.2 t/ha and sugar yields by 600 kg/ha. The greatest reductions tended to occur in the second stubble crop where bermudagrass development was greatest.

Crop cycle responses to bermudagrass competition of various durations were also monitored. Total millable stalk production, average stalk mass and the TRS values for the extracted juice were not affected by full season bermudagrass competition in either the plant cane only, the plant cane and first stubble crops or in all three crops of the full cycle when compared with those from plots that were maintained bermudagrass-free throughout the three-year crop cycle (Table 3). However, bermudagrass not yet fully established needed to compete only in the plant cane crop to reduce total yields of cane and sugar. No further reduction in these parameters was observed following full season bermudagrass competition for two or three years in the stubble crops.
Iongrass competition imposed in the subsequent ratoon crops was observed in the two crop years. This was not observed in the two crop year ratoon crops contributed to additional suppression.

TABLE 2. Effects of full season bermudagrass competition (Comp) on cane and sugar yields during the various sugarcane crops.¹

<table>
<thead>
<tr>
<th>Crop Year</th>
<th>Cane Yield</th>
<th>Sugar Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hoed</td>
<td>Weedy Mean</td>
</tr>
<tr>
<td></td>
<td>(t/ha)</td>
<td>(kg/ha x 10⁶)</td>
</tr>
<tr>
<td>Plant 1/c</td>
<td>97.0</td>
<td>93.0</td>
</tr>
<tr>
<td>First stubble</td>
<td>91.2</td>
<td>87.1</td>
</tr>
<tr>
<td>Second stubble</td>
<td>83.1</td>
<td>76.4</td>
</tr>
<tr>
<td>Mean¹</td>
<td>90.5A</td>
<td>85.3B</td>
</tr>
<tr>
<td>Comp</td>
<td>0.0044</td>
<td>0.0019</td>
</tr>
<tr>
<td>Crop year</td>
<td>0.0001</td>
<td>7.9</td>
</tr>
<tr>
<td>Comp x Crop yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crew%</td>
<td>6.0</td>
<td></td>
</tr>
</tbody>
</table>

¹ Overall means for competition (upper case) and crop year (lower case) followed by the same letter are not significantly different at the 0.05 level of probability as determined by least squared means test.

Sugarcane has the ability to recover from johnsongrass competition imposed in the previous years of a crop cycle (Millhollen et al.). This was not observed in the two crop cycles of this study. Bermudagrass development in the subsequent ratoon crops was arrested in March by hoeings at two to three week intervals that became less and less frequent as the regenerative potential of the vegetative propagules was reduced. When the aboveground bermudagrass was removed in March most of the bermudagrass foliage was dead due to earlier frosts and freezes. This residue had formed a 500 mm to 600 mm wide mat on top of the bed which may have been dense enough to suppress the early emergence of some sugarcane tillers. It has been suggested that bermudagrass possesses allelopathic properties (Horowitz²). Allelopathic compounds produced during the previous crop may have accumulated to levels in the soil sufficient to carry over into subsequent ratoon crops contributing to the continued suppression.

Yield reductions associated with full season bermudagrass competition were significantly lower than those reported for johnsongrass in Louisiana (Ali et al.; Millhollen et al.). The short stature of bermudagrass may limit its competitiveness. In addition, frequent cultivation of the row sides during the early spring hampers its spread between rows and the layby cultivation in late May or early June partially smoothes much of the bermudagrass growing on top of the row. L’leaf canopy closure occurs shortly after the layby cultivation and contributes to additional suppression.
**TABLE 3. Effects of bermudagrass competition on stalk counts, cane and sugar yields, average stalk mass and TRS contents for a three year crop cycle.**

<table>
<thead>
<tr>
<th>Duration of Competition</th>
<th>Stalk Counts (no./ha x 10³)</th>
<th>Stalk Mass (kg)</th>
<th>TRS (kg/t)</th>
<th>Yield Cane (t/ha) (kg/ha x 10³)</th>
<th>Sugar (kg/ha x 10³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weed-free PC ONLY</td>
<td>255.9</td>
<td>1.009</td>
<td>130.4</td>
<td>271.0 a</td>
<td>35.3 a</td>
</tr>
<tr>
<td>PC - FS</td>
<td>251.1</td>
<td>1.020</td>
<td>128.5</td>
<td>258.0 b</td>
<td>33.1 b</td>
</tr>
<tr>
<td>PC - SS</td>
<td>249.8</td>
<td>0.988</td>
<td>131.0</td>
<td>255.6 b</td>
<td>33.4 b</td>
</tr>
<tr>
<td>P F</td>
<td>0.4154</td>
<td>0.2019</td>
<td>0.1061</td>
<td>0.0082</td>
<td>0.0048</td>
</tr>
<tr>
<td>CV%</td>
<td>3.5</td>
<td>3.5</td>
<td>2.3</td>
<td>4.4</td>
<td>4.2</td>
</tr>
</tbody>
</table>

1 Bermudagrass was allowed to compete with sugarcane throughout the growing season only in the plant cane crop (PC); the plant cane and first stubble crops (PC - FS); and throughout the plant cane, first stubble and second stubble crops (PC - SS).

2 Means within a column followed by the same letter are not significantly different at the 0.05 level of probability as determined by least squared mean tests.

of the bermudagrass. Further, when fields are re-planted in the autumn they are relatively free of bermudagrass rhizomes and stolons. Re-establishment of the grass is further hampered in the newly planted crop by winter frosts and freezes.

Despite the fact that yield reductions associated with bermudagrass competition are not substantial, the development of programs for its control are warranted. These programs should begin in the plant cane crop because the influence of bermudagrass competition during the plant cane crop continues through the stubble crops.

**REFERENCES**


L'INFLUENCE DU CHIENDENT SUR TROIS RECOLTES DE CANNE À SUCRE

E.P. Richard, Jr.

Sugarcane Research Unit, Agricultural Research Service
U.S. Department of Agriculture
Houma, Louisiana 70361, USA

RESUME

Des essais aux champs ont été initiés en Louisiane, USA, avec pour objectifs d’évaluer le développement et la compétitivité du chiendent (Cynodon dactylon (L.) Pers.) par rapport à la canne à sucre (Saccharum hybrides intraspécifiques) sur un cycle de 3 ans. Des carottes de terre (76 mm de diamètre) contenant des rhizomes de chiendent ont été placées dans les rangs de canne plantés sur planche surélevée de 1.8 m de large, à la fin de février. À la fin de juillet, la biomasse des parties aériennes de chiendent dans la canne vierge était de 76 kg/ha. Ce poids augmenta de 340% entre la vierge et la première repousse et de 490% entre la 1ère et la 2ème repousse. Les chutes en rendements canne causées par la compétition du chiendent étaient comparables pour les 3 années et n’étaient pas influencées par l’augmentation de la biomasse. Ceci porte à croire que l’influence du chiendent sur le rendement s’étendait au-delà de la vierge. Cette chute de rendement, en comparaison avec le témoin non-infesté de chiendent, était de l’ordre de 5% en termes de canne et de sucre. Bien qu’il ne soit pas aussi agressif que les herbes de plus grande taille, le chiendent cause des chutes de rendements qui rendent nécessaires son contrôle.
LA INTERFERENCIA DE LA HIERBAFINA CON CAÑA DE AZÚCAR EN UN CICLO DE TRES AÑOS

E.P. Richard, Jr.

Sugarcane Research Unit, Agricultural Research Service
U.S. Department of Agriculture
Houma, Louisiana 70361, USA

RESUMEN

Se hicieron estudios en Louisiana, Estados Unidos de Norteamérica para evaluar el desarrollo y la competencia de la hierba fina (Cynodon dactylon (L.) Pers.) con la caña de azúcar en un ciclo de tres años. Capas de suelo de unos 76 mm de diámetro, manteniendo hierba fina perenne, se colocaron en los campos de siembra de la caña de azúcar; 1,8 m entre surcos, durante fines de febrero. Ya en el mes de julio, la biomasa de hierba fina sobre la superficie del suelo era de 76 kg/ha. La biomasa aumentó en un 340% entre el período de plantilla a saca, y el 490% entre la saca y escoba. La reducción de los rendimientos, debido a la competencia con la hierba fina, fue prácticamente igual en los tres ciclos. Al compararse con los lotes libres de malezas, se estima que esta competencia reduce los rendimientos en un 5% por año, principalmente en toneladas de caña por hectárea. A pesar de no ser la hierba fina tan agresiva como otras malezas de mayor altura, ésta puede reducir los rendimientos de tal manera que se justifiquen estrategias de control.

Palabras claves: Hierba fina, interferencia, competencia, caña de azúcar, Cynodon dactylon, Saccharum sp.