SUGARCANE CULTIVAR YIELD RESPONSE TO PLANTING DATE

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ABSTRACT

As Louisiana farms continue to get larger and more diversified, more sugarcane (*Saccharum* spp. hybrid) acreage is being planted both earlier and later in the cropping season. This research was initiated to determine if the yields of five cultivars were affected by August, September, and October planting dates in Louisiana. CP 70-321, LHo 83-153, CP 79-318, LCP 85-384, and HoCP 85-845 were hand-planted during mid-Aug., mid-Sept., and mid-Oct. in 1996-1999. Data collected at harvest included stalk number and weight, cane yield, sucrose concentration, and sugar yield. For the plant-cane crops, optimum sugar yields for CP 70-321, LHo 83-153, and HoCP 85-845 were obtained with an August planting. These cultivars had similar yields with September and October plantings. The plant-cane sugar yield with the August planting for these cultivars averaged 14.4 Mg ha^{-1} compared with 12.4 and 11.4 Mg ha^{-1} for the September and October plantings, respectively. Higher sucrose concentration and higher stalk populations for the August planting contributed to this yield increase. Planting date did not affect cane or sugar yields of the plant-cane crops of LCP 85-384 and CP 79-318. For HoCP 85-845, the October plantings produced ratoon cane yields that averaged 13.8 Mg ha^{-1} compared to 12.7 and 13.4 for the August and September plantings, respectively. Ratoon sugar yields were not affected by planting date for all other cultivars. Producers should attempt to plant sugarcane cultivars sensitive to planting date in August to insure stand establishment and optimum yields as the crop begins a production cycle that can last four to five years.

INTRODUCTION

Planting date (PD) influences sugarcane canopy development and biomass accumulation (Inman-Bamber, 1994; Robertson and Donaldson, 1998). Research in Australia demonstrated that PD affects sugarcane yields, crop development, and crop maturity (McDonald and Lisson, 2001). Prior research in Louisiana indicated that optimum PDs differed among cultivars (Matherne, 1976). Most cultivars, though, had greater yields with a September PD (Matherne, 1976). Preliminary planting studies indicated inconsistent results due to PD with most cultivars in Louisiana, but trends showing no PD effect with certain cultivars such as LCP 85-384 were apparent (Ricaud and Arceneaux; 1994; Ricaud and Arceneaux; 1995; Ricaud and Arceneaux; 1996). Prior research also showed that PD does not affect ratoon crops (Garrison et al., 2000).

September is historically the peak planting time in Louisiana (Garrison et al., 2000). Producers prefer to delay planting until September because of the lower planting costs associated with taller seedcane. In August, seedcane is often about a half of a meter

shorter than seedcane cut in September, requiring more stalks to plant a given area (Viator and Dufrene, unpublished growth measurement data). However, early lodging of new cultivars and early harvest operations are forcing growers to plant sooner because it is difficult to cut and plant lodged cane, and there are often equipment and labor limitations to the concurrent planting and harvesting of cane in Louisiana (Garrison et al., 2000). This research was initiated to determine if the yield of five cultivars were affected by August, September, and October planting dates in Louisiana.

MATERIALS AND METHODS

Sugarcane was hand-planted during mid-Aug., mid-Sept., and mid-Oct. of 1996-1999 on a Commerce silt loam (aeric fluvaquent, fine-silty, mixed, nonacid, thermic) after a 4 month fallow period at the USDA-ARS-SRRC Sugarcane Research Unit's Ardyone Farm located near Schriever, LA. Plots consisted of three, 1.8 m wide rows that were 4.9 m long. All treatments in all experiments were replicated four times in randomized complete block designs. Planting date served as main plot and cultivar as the sub-plot. The experiment was conducted four times (1996-1999) in adjacent fields with the same soil type.

The planting rate was three mature stalks with a 10 % overlap of adjacent stalks. Progeny from cane that was heat-treated the previous year was used to insure high quality seedcane. Five cultivars were used throughout the experiment: CP 70-321, LHo 83-153, CP 79-318, LCP 85-384, and HoCP 85-845 (Fanguy et al., 1979; Fanguy et al., 1989; Bischoff et al., 1992; Legendre et al., 1994; Milligan et al., 1994). These cultivars occupy 99 % of the Louisiana acreage (Gravois, 1999). Planted stalks, 1.5 meter in length, were covered with 8 cm of packed soil. To insure optimum levels of weed control, metribuzin[1] was applied at 3.4 kg a.i. ha^{-1} immediately after planting, and a mixture of pendimentalin (2.2 kg a.i. ha^{-1}) plus atrazine (4.5 kg a.i. ha^{-1}) was applied in March and May. Nitrogen, phosphorus, and potassium were applied in mid-April at 135, 34, and 68 kg ha^{-1}, respectively, as an injected band on both sides of the planted stalk sections of cane. Sugarcane borers were controlled using tebufenozide at 0.1 kg a.i. ha^{-1} when infestations reached the thresholds defined by Louisiana State University Cooperative Extension recommendations (Legendre, 2000) on 15 July 1996, 20 July 1997, 1 Aug. 1998, and 15 Aug. 1999.

Millable stalks (no. per ha) were counted each year prior to harvest. Stalks counted were = 1.4 m long when measured from the soil surface to the youngest dewlap below the whorl. Plots were harvested with a whole-stalk harvester in December of the year immediately following planting. First and second ratoon crops were harvested in November and October, respectively. Cane yield (Mg ha^{-1}) from the entire plot was determined with a tractor-mounted grab equipped with a hydraulic load cell. A sample, consisting of 15 stalks collected at random from the pile of harvested stalks in each plot, was weighed to determine stalk weight and then crushed in a three-roller mill. Standard analytical testing was conducted on each juice sample collected from the roller mill for

[1] Mention of trade names or commercial products is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA over those not mentioned.

estimating sucrose concentration (g kg^{-1}) (Meade and Chen, 1977). Sugar yield (Mg ha^{-1}) was estimated as the product of cane yield and sucrose concentration and then dividing by 1000.

Plant-cane and ratoon data were analyzed separately using PROC MIXED (SAS, 2001) with cultivar and planting date and their interactions as fixed variables and year and replication and their interactions as random variables. Means of significant effects were separated using the PDIFF option along with the Saxton macro (Saxton, 1998).

RESULTS

Plant-cane planting date response

Significant cultivar by PD interactions indicated that cultivar sugar yield responses differed among PD for the plant-cane crop (Table 1); thus, cultivars were analyzed separately. For CP 70-321, LHo 83-153, and HoCP 85-845, PD significantly increased sugar yield with the August plantings yielding 13.6 to 15.1 Mg ha^{-1} compared to 10.8 to 13.4 Mg ha^{-1} for the September and October plantings (Table 2). Planting date did not affect the sugar yields of LCP 85-384 and CP 79-318, which ranged from 12.0 to 13.5 Mg ha^{-1}. August plantings also had greater cane yields (97.0 to 108.6 Mg ha^{-1}) for CP 70-321, LHo 83-153, and HoCP 85-845 compared with the September and October plantings that yielded 79.6 to 97.8 Mg ha^{-1} (Table 3). Cane yields for LCP 85-384 and CP 79-318 were not affected by PD. Sucrose concentration for the August planting was 4 to 10 g kg^{-1} greater than sucrose concentrations of the October and September plantings for LHo 83-153, and HoCP 85-845 (Table 4). Sucrose concentration for CP 70-321, LCP 85-384, and CP 79-318 were not influenced by PD. Overall, stalk weight was not influenced by PD. However, for LCP 85-384, August plantings produced stalks that were 0.05 to 0.09 kg less than stalks for September and October plantings (Table 5). Stalk numbers were about 12,000 to 19,000 stalks ha^{-1} lower with the September and October plantings compared to the August plantings for CP 70-321 and HoCP 85-845 (Table 6).

Ratoon crops planting date response

The only measured parameter affected by PD in the ratoon crops was sugar yield (Tables 1 and 7). For HoCP 85-845, the October plantings produced ratoon cane yields that averaged 13.8 Mg ha^{-1} compared to 12.7 and 13.4 for the August and September plantings, respectively. Ratoon sugar yields were not affected by PD for CP 70-321, LHo 83-153, CP 79-318, and LCP 85-384 (Table 7).

Plant-cane cultivar effects

Mean sugar and cane yields for August plantings were significantly higher for HoCP 85-845 (15.1 and 108.6 Mg ha^{-1}) compared to CP 79-318 (13.5 and 95.6 Mg ha^{-1}) and LCP 85-384 (13.1 and 90.7 Mg ha^{-1}) (Tables 2 and 3). For the September plantings, LHo 83-153 and LCP 85-384 produced 1.9 and 1.8 Mg ha^{-1}, respectively, more sugar than CP 70-321 (Table 2). Furthermore, all cultivars, excluding CP 79-318, had higher cane yield than CP 70-321 for September plantings. For October plantings, LCP 85-384 had 2.0 and 1.5 Mg ha^{-1} more sugar than CP 70-321 and HoCP 85-845, respectively.

Cane yields with October plantings of LHo 83-153 and LCP 85-384 had 10.9 Mg ha^{-1} greater yields than CP 70-321.

Sucrose concentration for August plantings did not differ among cultivars (Table 4). LCP 85-384 had 6 to 14 g kg^{-1} higher sucrose concentration than all other cultivars for September plantings. For October plantings, LCP 85-384 had 6 and 12 g kg^{-1} higher sucrose concentration compared to LHo 83-153 and HoCP 85-845, respectively. LCP 85-384 had lower stalk weights than all other cultivars for August plantings (Table 5). For September plantings, CP 79-318 had 0.09, 0.14, and 0.14 kg $stalk^{-1}$ greater stalk weight than LHo 83-153, HoCP 85-845, and LCP 85-384, respectively (Table 5). For October plantings, LCP 85-384 had lower stalk weights than all cultivars, excluding LHo 83-153. There were no cultivar differences for stalk number in the August PD (Table 6). LCP 85-384 had about 15,000 and 10,000 more stalks ha^{-1} compared to CP 70-321 and CP 79-318, respectively, for September plantings. Both LCP 85-384 and LHo 83-153 had 18,000 and 13,000, respectively, more stalks ha^{-1} than CP 70-321 for October plantings.

Ratoon crops cultivar effects

For August plantings, LCP 85-384 had higher sugar yields (13.5 Mg ha^{-1}) compared to CP 70-321 (11.7), and CP 79-318 (11.2) (Table 7). Moreover for September plantings, LCP 85-384 had 2.4, 1.6, and 2.1 Mg ha^{-1} higher sugar yields than CP 70-321, LHo 83-153, and CP 79-318, respectively. Similarly in October plantings, LCP 85-384 had 2.6, 1.6, and 2.5 Mg ha^{-1} sugar yields than CP 70-321, LHo 83-153, and CP 79-318, respectively.

DISCUSSION

This study showed that an August planting produced optimal sugar yields for CP 70-321, LHo 83-153, and HoCP 85-845. Results were similar for September and October plantings for all cultivars. Previous research indicated an advantage to mid-August plantings over mid-October plantings, but previous research did not indicate differences between mid-August and mid-September plantings (Garrison et al., 2000). Planting date did not affect sugar or cane yield for LCP 85-384 and CP 79-318. Similarly, Ricaud and Arceneaux (1994, 1995) reported that LCP 85-384 did not respond to PD. August planting resulted in significantly (4 to 10 g kg^{-1}) higher sucrose concentration for LHo 83-153 and HoCP 85-845 compared with the September and October plantings, indicating that PD affected the cane maturation process. This agrees with Muchow et al. (1993) who reported that crop sucrose accumulation depended not only on biomass accumulation but also crop age.

CONCLUSIONS

The concept that a unique planting schedule for individual cultivars is necessary for optimal yield was demonstrated for CP 70-321, LHo 83-153, and HoCP 85-845, but not with LCP 85-384 and CP 79-318. The fact that the latter two cultivars respond similarly across PDs may offer producers flexibility in both early and late planting.

Cultivars sensitive to PD could be planted at the optimal time with cultivars, such as LCP 85-384 and CP 79-318, that have a wide optimal planting window, planted throughout the planting season. Producers, though, should consider the higher cost associated with the need to cut more seedcane at an earlier PD and the cultivar's susceptibility to lodging in developing planting schedules. One must also note that these experiments were conducted on fields that were previously fallow and that experimental results could change in situations, such as successive planting of sugarcane or planting after a rotational crop. As Louisiana farms continue to get larger and more diversified, more sugarcane acreage is being planted both earlier and later in the season. It is important to continuously identify cultivars that tolerate both late and early PDs to increase management flexibility.

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Table 1. Probabilities of F values of fixed effects from all four experiments for cane yield, sucrose concentration, sugar yield, stalk weight, and stalk number for CP 70-321, LHo 83-153, HoCP 85-845, CP 79-318, LCP 85-384 planted on three dates.

Source	Cane yield	Sucrose concentration	Sugar yield	Stalk weight	Stalk number
Plant-cane crop					
Planting date (PD)	0.02	<0.01	0.01	0.24	<0.01
Cultivar	0.03	<0.01	0.05	<0.01	<0.01
Cultivar X PD	0.06	0.16	0.01	0.26	0.49
Ratoon crops					
PD	0.06	0.48	0.05	0.92	0.44
Cultivar	<0.01	0.03	<0.01	<0.01	<0.01
Cultivar X PD	0.92	0.48	0.85	0.99	0.81

Table 2. Mean sugar yield from four experiments for CP 70-321, LHo 83-153, HoCP 85-845, CP 79-318, and LCP 85-384 planted on three dates.

Date of planting	CP 70-321	LHo 83-153	HoCP 85-845	CP 79-318	LCP 85-384
	Mg ha^{-1}				
August	13.6Aab†	14.4Aab	15.1Aa	13.5Ab	13.1Ab
September	11.5Bb	13.4Ba	12.2Bab	12.4Aab	13.3Aa
October	10.8Bc	12.2Bab	11.3Bbc	12.0Aabc	12.8Aa

† Means within a column followed by a different upper case letter or in a row followed by a different lower case letter are significantly different using the Saxton mean separation procedure at P = 0.05.

Table 3. Mean cane yield from four experiments for CP 70-321, LHo 83-153, HoCP 85-845, CP 79-318, and LCP 85-384 planted on three dates.

Date of planting	CP 70-321	LHo 83-153	HoCP 85-845	CP 79-318	LCP 85-384
	Mg ha^{-1}				
August	97.0Aab†	102.7Aab	108.6Aa	95.6Ab	90.7Ab
September	83.2Bc	97.8Ba	93.3Bab	89.3Abc	93.0Aab
October	79.6Bb	90.5Ba	88.0Bab	87.6Aab	90.5Aa

† Means within a column followed by a different upper case letter or in a row followed by a different lower case letter are significantly different using the Saxton mean separation procedure at P = 0.05.

Table 4. Mean sucrose concentration from four experiments for CP 70-321, LHo 83-153, HoCP 85-845, CP 79-318, and LCP 85-384 planted on three dates.

Date of planting	CP 70-321	LHo 83-153	HoCP 85-845	CP 79-318	LCP 85-384
	g kg^{-1}				
August	140Aa†	141Aa	139Aa	142Aa	145Aa
September	139Ab	137Bb	131Bc	139Ab	145Aa
October	136Aab	135Bb	129Bc	137Aab	141Aa

† Means within a column followed by a different upper case letter or in a row followed by a different lower case letter are significantly different using the Saxton mean separation procedure at P = 0.05.

Table 5. Mean stalk weight from four experiments for CP 70-321, LHo 83-153, HoCP 85-845, CP 79-318, and LCP 85-384 planted on three dates.

Date of planting	CP 70-321	LHo 83-153	HoCP 85-845	CP 79-318	LCP 85-384
	kg stalk^{-1}				
August	1.22Aa†	1.18Aa	1.18Aa	1.22Aa	1.04Bb
September	1.22Aab	1.18Abc	1.13Ac	1.27Aa	1.13Ac
October	1.22Aa	1.18Aab	1.18Aa	1.22Aa	1.09Ab

† Means within a column followed by a different upper case letter or in a row followed by a different lower case letter are significantly different using the Saxton mean separation procedure at P = 0.05.

Table 6. Mean stalk number from four experiments for CP 70-321, LHo 83-153, HoCP 85-845, CP 79-318, and LCP 85-384 planted on three dates.

Date of planting	CP 70-321	LHo 83-153	HoCP 85-845	CP 79-318	LCP 85-384
	stalk ha^{-1}				
August	80000Aa†	89000Aa	93000Aa	79000Aa	89000Aa
September	67000Bb	84000Aa	81000ABa	72000Ab	82000Aa
October	64000Bc	77000Aab	74000Babc	71000Abc	82000Aa

† Means within a column followed by a different upper case letter or in a row followed by a different lower case letter are significantly different using the Saxton mean separation procedure at P = 0.05.

Table 7. First and second ratoon mean sugar yield from four experiments for CP 70-321, LHo 83-153, HoCP 85-845, CP 79-318, and LCP 85-384 planted on three dates.

Date of planting	CP 70-321	LHo 83-153	HoCP 85-845	CP 79-318	LCP 85-384
			Mg ha^{-1}		
August	11.7Abc†	12.3Aabc	12.7Bab	11.2Ac	13.5Aa
September	11.6Ac	12.4Abc	13.4ABab	11.9Ac	14.0Aa
October	11.8Ab	12.8Ab	13.8Aa	11.9Ab	14.4Aa

† Means within a column followed by a different upper case letter or in a row followed by a different lower case letter are significantly different using the Saxton mean separation procedure at P = 0.05.