IMPROVING THE HARVEST SEASON BASED ON THE MATURITY IN FOUR SUGARCANE GROWING REGIONS IN CUBA

By

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KEYWORDS: Harvesting Season, Genotypes, Sugarcane Maturation.

Abstract

CLIMATE change, which has resulted in global warming, has affected cane production and altered the period of harvest. New investigations are necessary to determine the critical periods of harvest, based on the interactions resulting from the combination of different genotypes and land-ecosystems. Forty eight trials were conducted in four contrasting sugarcane growing regions of Cuba with three varieties – C 1051-73 (early), C 86-12 (mid-season), My 5514 (late-season) that differ in ripening period. A combination of month of harvest and ages from nine to twenty-four months, in two crops, soil types and ratoon crops for ripening characteristics were studied. At the age of 13 months (typical harvest time in Cuba), the studied regions produced significant differences, higher than those relating to varieties. Consequently, the harvesting season must be reorganised. The Centre-Eastern Region was more efficient, with any variety, while the Eastern Region showed a better behaviour of genotypes in the March-October period.

Introduction

Productivity of sugarcane in Cuba has regressed as a consequence of global warming, mainly due to the long periods of drought and the change in rainfall pattern. The sugar industry has developed a process of reorganisation, which includes the identification of the best lands to produce sugarcane and the optimisation of the harvest. It is necessary to find the optimal dates to begin the harvest season according to agro-ecological zones, as well as the sugarcane cultivar that can be planted. It is also important to know the possible extension of the crop period, if soil and climatic conditions are favourable.

It is necessary to study the ripening pattern of the main cultivars out of the periods traditionally used to harvest them.

Materials and methods

To meet the proposed objectives, 48 experiments at four cane contrasting regions of the country (west, centre-west, centre-east, east) were established over three crop cycles (plant cane, first and second ratoon), harvested during the whole year, and combining crop age from nine to twenty-four months. Three varieties were studied, C 1051-73, C 86-12 and My5514, classified as early-ripening, intermediate-ripening and late-ripening respectively over the normal harvesting period spanning from November to April. The variable studied was the evolution of sucrose using uni- and multi-variant analyses.

Results and discussion

The best period to harvest the cane according to the historical rainfall distribution is between November and April, when only 14–26% of the total volume of rains is received at the four regions studied (Figure 1).

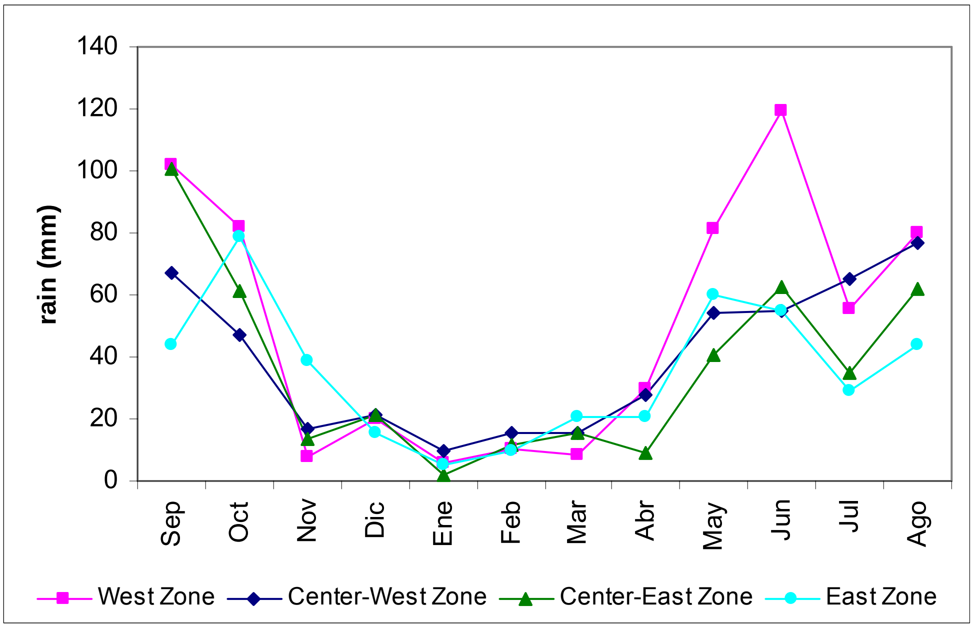
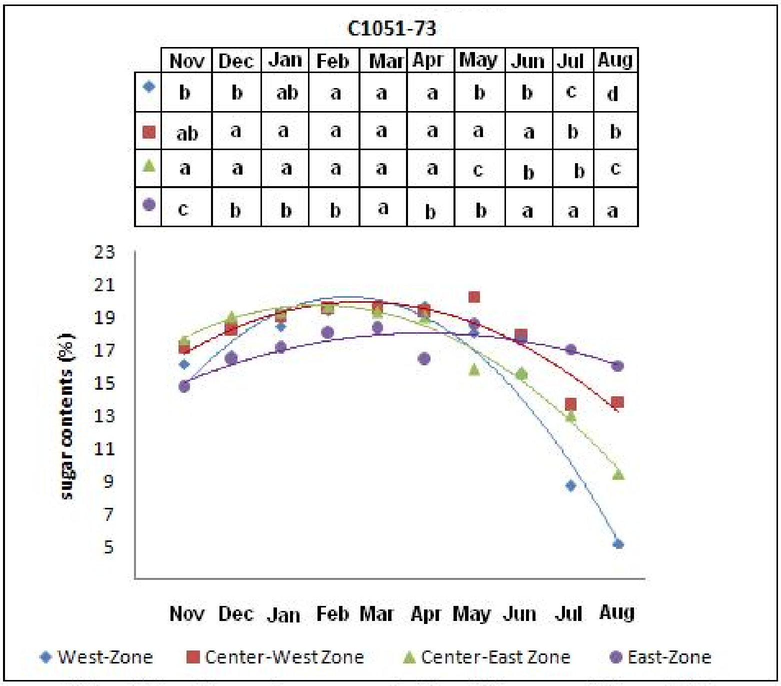


Fig. 1—Annual rainfall distribution for the four zones.

With an increase in the volume of cane, which will entail a lengthening of the harvest season, an earlier harvest would not be possible, whereas delaying harvest until June is achievable except in the western region, and further until August in the Centre-Eastern and Eastern region (Figure 1).

During the first two months (November and December), sucrose content of variety C 1051-73 is low in the Western and Eastern sectors, and it would be reasonable to delay harvest until January (Figure 2). In the Western region, sucrose content declines from May while in the Centre-West, the variety can be harvested from November until June.

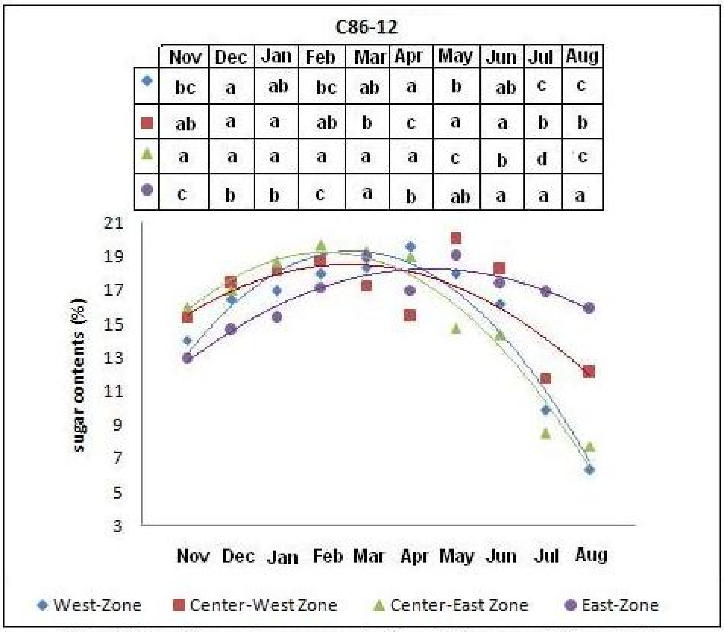


different letters for months express significant differences (Tukey p 0,05)

Fig. 2—Ripening pattern for variety C1051-73.

In the Eastern region, the variety can be harvested until August because of the lower rainfall compared to the other sectors.

Sucrose accumulation for the intermediate variety, C86-12, is strongly influenced by environmental conditions. In the Central-Eastern region, it can be harvested early in the season from November to January (Figure 3). Similarly, in the Eastern zone, C1015-73 demonstrates earliness of ripening and it can be harvested from November to March (Figure 2).

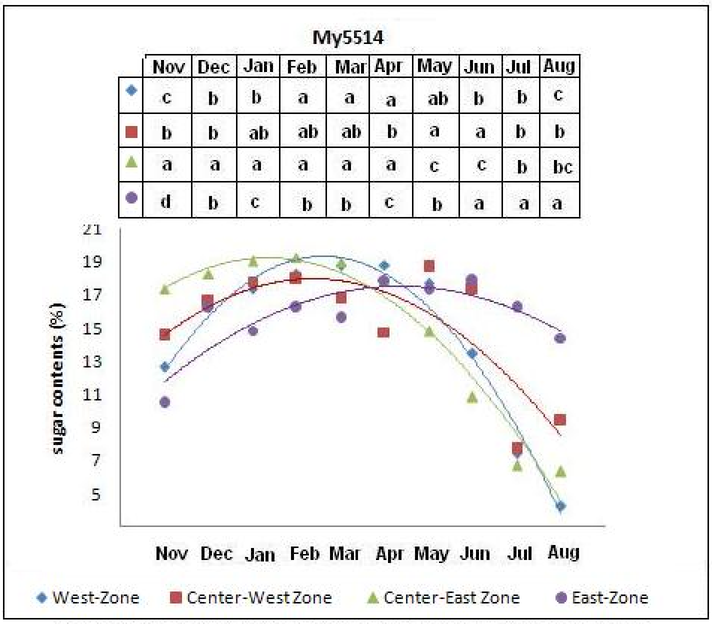


	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
◆	bc	a	ab	bc	ab	a	b	ab	c	c
■	ab	a	a	ab	b	c	a	a	b	b
▲	a	a	a	a	a	a	c	b	d	c
●	c	b	b	c	a	b	ab	a	a	a

different letters for months express significant differences (Tukey p 0,05)

Fig. 3—Dynamics of maturation C86-12 variety.

In the Eastern and Western zone, it is inappropriate to harvest My 5514 at the start of the harvest. Its harvest can delayed further in the Eastern region, which confirms previous observation (Milanes and Tejero, 1995) (Figure 4)



	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
◆	c	b	b	a	a	a	ab	b	b	c
■	b	b	ab	ab	ab	b	a	a	b	b
▲	a	a	a	a	a	a	c	c	b	bc
●	d	b	c	b	b	c	b	a	a	a

different letters for months express significant differences (Tukey p 0,05)

Fig. 4—Pattern of sucrose accumulation for variety My5514.

The environmental component of variation exceeded by far the genotypic effect (Table 1) and is highest in May and August, which is in agreement with Bernal (1986), González (1995), and Jorge *et al*., (2008).

Varieties show specific suitability to harvest dates in the different areas and should be managed individually.

Additionally, a wider range of varieties can be exploited in March in a wider range of environments. Stable varieties are more difficult to obtain.

Table 1—Components of variance for sugar content.

Month		σ^2_G			σ^2_Z			σ^2_{GE}			σ^2_e		
Nov	σ^2	1.64	±	1.77	3.15	±	3.28	0.81	±	0.46	0.33	±	0.06*
	PVT	27.66			57.32			10.21			4.82		
Dec	σ^2	0.26	±	0.34	0.95	±	1.02	0.27	±	0.20	0.37	±	0.07*
	PVT	16.05			54.41			13.12			16.62		
Jan	σ^2	0.43	±	0.45	1.87	±	1.84	0.04	±	0.10	0.46	±	0.09*
	PVT	14.77			66.75			4.37			14.11		
Feb	σ^2	0.34	±	0.36	0.93	±	0.93	0.08	±	0.09	0.27	±	0.05*
	PVT	20.17			58.86			6.86			14.12		
Mar	σ^2	0.42	±	0.63	0.26	±	0.57	0.79	±	0.51	0.66	±	0.13*
	PVT	24.23			24.42			27.52			23.83		
Apr	σ^2	0.00	±		1.09	±	1.62	1.77	±	0.93	0.25	±	0.05*
	PVT	10.34			48.26			35.00			6.39		
May	σ^2	0.24	±	0.28	3.54	±	3.44	0.15	±	0.12	0.26	±	0.05*
	PVT	6.16			84.77			3.67			5.39		
Jun	σ^2	0.69	±	0.98	3.79	±	4.05	1.16	±	0.71	0.80	±	0.16*
	PVT	13.54			62.24			13.89			10.33		
Jul	σ^2	2.58	±	3.08	12.40	±	12.6	2.59	±	1.38	0.50	±	0.10*
	PVT	15.70			71.96			9.94			2.40		
Aug	σ^2	1.52	±	1.53	19.73	±	18.98	0.50	±	0.41	0.97	±	0.19*
	PVT	6.69			87.16			2.39			3.75		

σ^2. Component of variance g. genotype, z. zone, ge. genotype x environments, e. error
* Precise Estimate if ES ≤ 2 σ^2 PVT. Percentage of total variation

It is evident that the major effect of the zones is associated on one hand with the chemical properties of the soils, the most significant of which are nitrogen and potassium available in the first horizon, as well as the acidity.

On the other hand, to the climate elements, minimum temperature and relative humidity, variables that account for more than 34% of the total variation in the first component (Table 2).

Other factors that contribute to the variation include the organic matter content, available phosphorus and accumulated rains four and five months prior to the harvest.

Table 2—Results of the principal component analysis.

	Comp. 1	Comp. 2	Comp. 3	Comp. 4
Value	4.178	2.425	1.566	1.444
% Contribution	34.8	55.0	68.1	80.1
Vector				
Pol % Cane	–0.046	0.632	0.016	0.424
t cane/ha	0.184	**0.884**	0.034	–0.090
t Pol/ha	0.163	**0.957**	0.035	0.060
Minimum temperature	**0.683**	0.081	–0.419	0.049
Relative humidity	**–0.683**	0.186	0.402	–0.088
Cumulative rainfall 4 MBH	–0.025	0.030	0.064	**0.817**
Cumulative rainfall 5 MBH	–0.024	0.031	0.065	**0.834**
pHKCL	**0.938**	0.159	–0.091	–0.044
Organic matter	0.281	0.052	**0.914**	0.090
Nitrogen	**0.944**	0.137	0.225	0.014
Available phosphorus	0.440	–0.014	**–0.869**	–0.031
Available potassium	**–0.868**	–0.207	0.080	0.097

MBH. Month before harvest

The characterisation of the regions from the functions of components 1 and 2 (Figure 5) enabled the differentiation of the western and eastern regions and the central localities, which represent the best agro-climatic potential. The Central regions were those that contained most of nitrogen and available potassium.

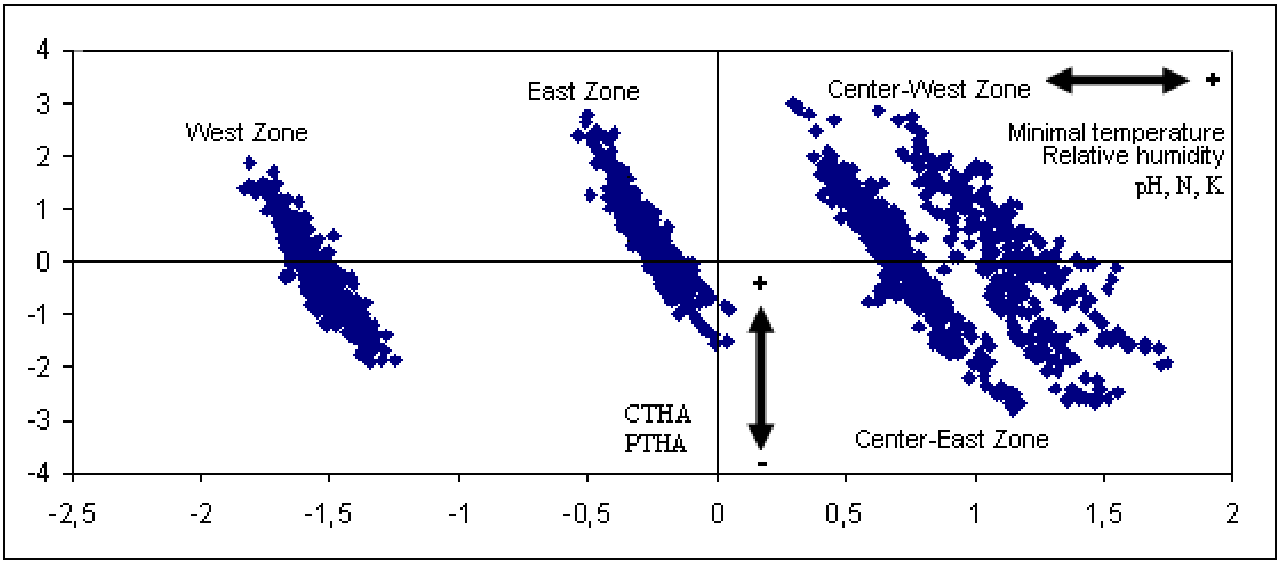


Fig. 5—Graphic representation of the components 1 and 2.

Conclusions

1. Varieties displayed specific adaptation to harvest periods in the different sectors and should be managed individually.
2. Higher Pol % cane was observed at in the East-Centre zone and Western zone at the start of harvest (November–January), compared to the Eastern region. It would be appropriate to start harvest in the East-Central and Western zones.

The environmental effect contributed more to the total variation, and it was associated with the levels of nitrogen and potassium in the first horizon, the acidity of the soil, the minimal temperature and the relative humidity.

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PROGRAMMATION DE LA SAISON DE RÉCOLTE DE LA CANNE À SUCRE PAR RAPPORT À LA MATURITÉ DANS QUATRE RÉGIONS DE CUBA

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MOTS CLÉS: Saison de Récolte, Génotype, Maturation de la Canne à Sucre.

Résumé

LE CHANGEMENT climatique a eu pour conséquence, le réchauffement global qui a affecté la production de la canne à sucre et a perturbé la saison de récolte. De nouvelles études sont nécessaires pour déterminer les périodes critiques de la récolte, basées sur les interactions résultant de la combinaison de différents génotypes et de l’écosystème terrien. Quarante-huit essais ont été établis dans quatre régions contrastées de canne à sucre au Cuba avec trois variétés – C 1051-73 (début), C 86-12 (milieu), My 5514 (fin) qui diffèrent en leur période de maturité. Une combinaison mois de récolte, âges de récolte de 9 à 24 mois, deux saisons de récolte, type de sol et repousses, par rapport aux profiles de mûrissement étaient étudiés. À l’âge de 13 mois (période typique pour la récolte au Cuba), les régions ont démontré des différences significatives pour le mûrissement, plus importantes que celles occasionnées par les variétés. En conséquence, la saison de récolte devrait être réorganisée. L’effet du mûrissement était plus prononcé pour la région Centre-Est quelle que soit la variété, alors que les génotypes se sont mieux distinguées dans la région Est pendant la période mars-octobre.

MEJORAMIENTO DE LA ÉPOCA DE COSECHA BASADOS EN LA MADURACIÓN EN CUATRO REGIONES CAÑERAS DE CUBA

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PALABRAS CLAVES: Época de Corte, Genotipos, Maduración de la Caña.

Resumen

LOS CAMBIOS climáticos causantes del caliento global han afectado la producción y alterado el periodo de cosecha de la caña. Nuevas investigaciones son necesarias para determinar el periodo crítico de cosecha, basándose en los resultados de la interacción de diferentes genotipos y ecosistemas. Se condujeron un total de 48 ensayos en cuatro regiones cañeras cubanas contratantes con tres variedades que difieren en su período de maduración: C1051-73 (temprana), C86-12 (mediana), My5514 (tardía). Una combinación de mes de cosecha y edades entre nueve y 24 meses, en dos cortes, dos tipos de suelos y dos socas fueron estudiadas para madurez. A los 13 meses (periodo típico de cosechas en Cuba), las regiones estudiadas produjeron un efecto significativo y mayor al dependiente de variedades. Basados en ello, la época de corte debe ser reconocida. La región Centro-Oriental fue más eficiente con cualquier variedad, mientras que la región Oriental mostró mejor comportamiento varietal en el periodo marzo–octubre.