EFFECTS OF LOCATION AND TIME OF HARVEST ON YIELDS OF THE THREE MAIN SUGARCANE VARIETIES IN MEXICO

By

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Abstract

IN MÉXICO, during the past three years, a mean 650 000 hectares of sugarcane were cultivated, which delivered more than 46.5 Mt of cane with a maximum commercial cane sugar content of 11.43 to 57 sugar mills, distributed throughout the Pacific Ocean Coast, a transversal belt around parallel 19 and the Mexican Gulf Coast. In this diversity of climates and soils, more than 20 varieties are cultivated, but approximately 65% of the area is planted with three varieties: Mex 69-290, CP 72-2086 and Mex 79-431. In order to determine accurately the effects of time of harvest on these three varieties for optimum harvest scheduling, two field trials were planted in October 2003, with the three varieties mentioned above in two highly contrasting localities in climate and soil, within the country's main sugarcane region. The trials were harvested at six times during the December/2004 – May/2005 harvest season. In the dry zone, cane yield was highest early in the harvest season, in December, January and February, while yields declined from March. In contrast, in the moist zone, the harvest season began with a trend of low cane yields in December and January, reached a maximum in February and March, and again declined during April and May. Reducing sugars in the dry zone showed, in CP 72–2086, low values early in the harvest season, which began to increase significantly in March and maintained high values until the end of the harvest season in May; Mex 69–290 recorded high values in December, which decreased in January, February and March, and increased again in April and May; while Mex 79–431 maintained low values from December to March, with a trend to increase from April. The principal components analysis demonstrated the important effects of locations on cane and sugar yields and time of harvest, the influence of the environment on varietal yields, and verified the dependence of cane yield on its components stalk population, length and diameter. Negative correlations between yield component variables and moisture, reducing sugars and fibre were also found.

Introduction

Nationwide sugarcane cultivation in Mexico occupies approximately 650 000 ha, with an average cane yield of 70.43 t/ha. The State of Veracruz is the largest cane and sugar producer, comprising 22 sugar mills, which crushed 17 797 093 tonnes of cane , with a total sugar output of 1 991 991 tonnes in the 2006–2007 harvest season.

El Potrero Sugar Mill stands out for its high factory efficiency, processing 1 477 426 tonnes of cane, in an area of 20 788 ha, with a sugar output of 187 821 tonnes, thus generating significant economic activity in the region (Manual Azucarero Mexicano, 2008). Two main sugarcane agro-ecological regions can be distinguished in El Potrero: the critical (dry) rainfed zone and the moist rainfed zone.

The main varieties cultivated in the 'El Potrero' mill supply area, according to maturity period, are as follows: early-season CP 72 2086 (26.54%), CP 44-101 (9.23%), and others (6.26%); and intermediate-season: Mex 69-290 (36.23%), Mex 79-431 (8.25%), Mex 68 P-23 (4.54%), and others (8.95%) Thus the El Potrero acreage consists of 42.03% of early-ripening and 57.97% of intermediate–ripening varieties. The two main varieties in the 'El Potrero' mill supply area are: Mex 69-290 and CP72-2086, which represent 62.77% of the sugarcane cultivated land, hence the need to study the influence of age and time of harvest of these varieties on cane and sugar yields, in the two agro-ecological zones that exist in the mill's supply area.

Materials and methods

General aspects of the trials

The experimental work was carried out in two locations of the 'El Potrero' sugar mill, a dry zone, with annual rainfall below 1100 mm, and a moist zone, with approximately 1900 mm of rainfall. The three main varieties grown in the mill areas: CP 72-2086, Mex 69-290 and Mex 79-431, were used in the plant cane cycle. The trials were planted in the two locations in October 2003 and were harvested at six different times from December 2004 to May 2005.

Location 1: Dry zone

Trial 1 was planted at Barrabas Farm located at 19º01'6.5' N 96º33'58.3' W, at 260 metres above sea level, in the central zone of the State of Veracruz,. The climate type at this location is Aw 1 (w) warm sub-humid, intermediate between Aw0 and Aw2, with a R/T (index which results from dividing annual rainfall, expressed in millimetres, by the annual mean temperature in °C) between 43.2 and 55.3, and a percentage of winter rainfall below 5.

Maximum temperature averages 31.35°C, and minimum temperature 19.6°C with a mean temperature of 25.7°C, and a mean annual rainfall of 1085 mm. (Irrigation Department, 2008). The trial was planted on Vertisol soil.

Location 2: Moist zone

Trial 2 was planted in the municipality of Atoyac, located in the central, mountainous zone of the State of Veracruz, at 18°53'42.1' N and 96°47'12.4' W, at an altitude of 511 metres above sea level.

The climate is warm-moist-regular, with a maximum temperature of 29.73°C, a minimum temperature of 18.99°C and a mean temperature of 24.59°C. Mean annual rainfall is 1866 mm. The trial was planted in an Acrisol type soil (Irrigation Department, 2008).

Varieties studied

CP 72-2086 (Parents: CP 62-374 X CP 63-588)

CP 72-2086 has recorded good germination and tillering, fair trashing, and early and heavy flowering. Mean cane yields of CP 72-2083 were 102 and 90.6 t/ha in plant cane and ratoon, respectively (Marin and Velasquez, 1997; Flores, 2001).

Its mean sucrose (pol) percent cane is 14.49% and the fibre content is 13.1%. It is resistant to Smut and Rust, moderately resistant to Mosaic, and susceptible to stem borer attack and to Orange Rust.

Mex 69 290 (parents: Mex 56-476 X Mex 53-142)

Mex 69-290 has recorded fair germination, early tillering and good growth, and fair trashing. Its leaves remain attached to the stalk and are easily removed by hand. It is resistant to lodging, but susceptible to stalk breakage by strong winds.

Mex 69-290 exhibits little or scarce flowering, and is suited for regions with irrigation and rainfed conditions with annual rainfall above 1500 mm and altitude from 0 to 800 metres above sea level. Average cane yields have been 102 t/ha in plant cane, and 92 t/ha in ratoon (Marin and Velasquez, 1997; Flores, 2001). It is resistant to Smut, Rust and Red Streak, susceptible to Pokkah-Boeng and Eye Spot, and tolerant to mealy bug and to stem borer.

Mex 79-431 (parents: Co 421 X Mex 57-473)

Mex 79-431 has recorded good germination and tillering, and good agronomic appearance, even under adverse drought conditions. Ratooning is excellent. It exhibits scarce to fair flowering, with highest percentages occurring in intermediate altitudes and not at higher altitudes or at sea level. It exhibits fair trashing.

Cane yields in trials in plant cane and ratoon are 193 and 173 t/ha, respectively, under irrigated experimental conditions (Marin and Velasquez, 1997; Flores, 2001).

In locations with high humidity, it is susceptible to Eye Spot disease and occasional symptoms of Mosaic (SCMV) have been observed.

Trial layout and treatments

A sub-split plot factorial arrangement (2 × 3 × 6) was used in a randomised block design with four replicates. The experimental plots consisted of six rows 12 m long, spaced at 1.15 m and with an area of 82.8 m^2, with a net plot of four central 12 m long rows, equivalent to 55.2 m^2**.** Experimental factors under study were the following.

a) Location: dry zone (L1) and moist zone (L2).

b) Variety: CP 72-2086 (V1), Mex 69-290 (V2) and Mex 79-431 (V3).

c) Month of harvest: December (M1), January (M2), February (M3), March (M4), April (M5) and May (M6).

Measurements

Temperature and rainfall were measured at intervals throughout the trials. Soil fertility variables (organic matter, total nitrogen, potassium, phosphorus, micronutrients, clay, silt and sand contents, acidity (pH) and Base Exchange Capacity) were measured to a depth of 30 cm at the two locations.

Sugarcane germination percentage, stalk length, diameter and population at six months of age and prior to each harvest date were measured, as well as cane yield, stalk fibre and moisture, juice purity, brix and reducing sugars, sucrose (pol) and theoretical sugar yield per hectare at harvest were determined, according to established methodologies (IMPA, 1983).

The data collected were analysed by ANOVA, regression and main components analyses, using the SAS system for Windows, release 6.12 (SAS Institute Inc. 1989–1996) and the Principal Components Analyses following the methodology described by Pla (1986) and (Bilodeau and Brenner, 1999), without repeated analyses of the data.

Results

Climate

In the moist zone (Trial 2), rainfall was 1162 mm greater than that of the dry zone (Trial 1), (Table 1), which indicates a better sugarcane growth in the former than the latter and therefore higher potential cane yields and less deterioration from untimely harvesting, which was one of the factors under study in both zones.

Temperatures in the dry zone were higher than those of the moist zone by 1.62°C, 1.11°C and 0.61°C for maximum, mean and minimum, respectively. In the dry zone, not only did it rain less, but also temperatures were much higher.

Physical-chemical characteristics of the soils of the studied localities

As shown in Table 2, the physical-chemical characteristics of the soils of locations were adequate for sugarcane cultivation, but in the case of the dry zone, a greater number of growth limiting factors were present (Arcia, 1997), as indicated by low phosphorus and potassium content and intermediate organic matter content, which implies the need for supplementary applications of these nutrients to the soil for sugarcane production.

Table 1—Rainfall and temperature during October, 2003, to May, 2005, at the two trial locations.

Months	Moist zone				Dry zone			
	Rainfall mm	Temperatures °C			Rainfall mm	Temperatures °C		
		Max	Mean	Min		Max	Mean	Min
October 2003	146	28.7	24.4	20.2	28	34	28	22
November	105	27.2	23.4	19.6	117	29	23	17
December	12	24.3	18.7	13.1	23	28	23	17
January 2004	29	25.6	20.5	15.4	13	29	24	18
February	20	26.8	20.8	14.8	13	30	24	17
March	12	29.4	24.2	19.0	1	31	25	19
April	143	30.8	25.4	19.9	78	36	27	18
May	112	32.0	26.7	21.4	68	35	28	20
June	482	31.8	30.9	20.0	167	36	29	22
July	122	32.2	26.4	20.7	102	32	26	20
August	364	33.9	27.6	21.4	218	35	29	22
September	161	31.8	26.2	20.6	151	34	27	19
October	167	33.8	28.3	22.9	78	30	27	24
November	78	28.3	23.3	18.3	17	29	24	19
December	13	26.9	21.7	16.5	4	26	22	17
January 2005	2	28.4	22.2	16.1	4	27	22	17
February	56	27.7	23.1	18.5	15	27	23	19
March	21	29.3	24.1	19.2	12	29	25	20
April	50	33.0	26.7	20.4	2	34	29	23
May	265	32.7	27.2	21.8	87	36	29	22
TOTAL	2 360				1 198			
Mean		29.73	24.59	18.99		31.35	25.7	19.6

Table 2—Characterisation of soil physical-chemical properties, at 0 to 30 cm depth in the trial sites, El Potrero Sugar Mill, Veracruz, Mexico.

Characteristics		Dry zone		Moist zone	
		0 – 30 cm depth	Classification	0 – 30 cmdepth	Classification
Organic matter (%)		2.44	Intermediate	4.27	Rich
Total Nitrogen (%)		0.18	Rich	0.28	Very rich
Phosphorus mg/kg		12.78	Low	131.02	High
Potassium mg/kg		140.0	Low	350.0	High
pH in KCL		5.38	Moderately acid	5.92	Moderately acid
pH in water		6.05	Moderately acid	6.31	Moderately acid
	Ca	13.362	High	5.075	Intermediate
BEC (cmol/kg)	Mg	2.579	Intermediate	3.361	High
	K	0.486	Intermediate	0.563	Intermediate
Fe (mg/kg)		28.60	Very high	56.80	Very high
Cu (mg/kg)		1.40	High	12.00	Very high
Zn (mg/kg)		0.60	Very low	6.40	High
Mn (mg/kg)		30.0	High	208.0	Very high
Sand %		28.20		32.20	
Silt %		39.28	Silty-sand	43.28	Silty
Clay %		32.52		24.52	

Performance of agricultural and quality variables at harvest

Analyses of variance of agricultural variables (cane population, length, diameter and yield) and quality variables (fibre, moisture, reducing sugars, sucrose and tonnes of sugar per hectare) at harvest (Table 3) were carried out, as well as their respective comparisons of means of the most important interactions (Table 4).

Cane yield

There were highly significant differences between locations, varieties, months of harvest and in the interactions location by variety and location by month of harvest (Table 3). By comparing the means of these main effects and their interactions (Table 4) it can be observed that cane yield was significantly higher in the moist zone in all three varieties under study, which demonstrates the effect of the location on the performance of the varieties, and confirms reports by Mariotti (1987) in Argentina, Ghaderi *et al*. (1980) in India and Bernal (1986) in Cuba.

By reviewing the interaction location by month of harvest, it can be noticed that, in the dry zone, cane yield was highest early in the season in December, January and February, and from March there was a decline in cane yield, which became significantly lower in April and May. In contrast, in the moist zone, the cane yield trend was toward low yields in December and January, which then increased to a maximum in February and March, and later decreased during the months of April and May. This clearly shows the need to take into consideration the characteristics of the locations in order to optimise harvest scheduling (Milanes *et al.*, 2007).

Percentage of reducing sugars

Highly significant differences were determined (Table 3) between locations, varieties, months of harvest and the interactions location by variety, location by month of harvest and location by variety by month of harvest in percent reducing sugars.

By comparing the means of these main effects and their interactions (Table 4) it can be observed that reducing sugars (Table 4 and Figure 1) show a different time curve for each variety. Thus, CP 72–2086 recorded low reducing sugar values at the beginning of the harvest season, which increased significantly in March, and maintained these values until the end of the harvest season in May.

Variety Mex 69–290 began harvest with high values in December, then decreased during January, February and March, and again increased in April and May. Variety Mex 79–431 recorded high values in December and January, which reduced significantly in February and March, and later increased significantly in April and May.

The results recorded suggest that variety CP72-2086 should be harvested at the beginning of the harvest season and finalised before March, variety Mex 69-290 should be harvested preferably during the months of January, February and March, while variety Mex 79-431 has best harvest timing in February and March.

Table 3—Results of the analyses of variance of variables assessed at harvest.

S.V.	popul.	length	diam.	yield	fibre	moisture	re. su.	suc.	tst/ha
Rep.	*	*	NS	NS	NS	NS	NS	NS	NS
L	**	**	**	**	**	**	**	**	**
V	**	*	**	**	**	**	**	**	NS
M	**	NS	NS	**	**	**	**	**	**
L*V	**	**	**	**	*	**	**	**	NS
L*M	**	*	**	**	*	**	**	**	**
V*M	NS	NS	NS	NS	NS	NS	**	**	NS
L*V*M	NS	NS	NS	NS	NS	NS	**	**	NS
C.V.	7.47	6.73	3.38	12.67	5.46	1.16	1.12	4.16	14.33

* = P≤ 0.05, ** = P≤ 0.01

S.V.: Source of variation; L: location; V: variety; M: month of harvest; C.V.: coefficient of variation; re. su.: reducing sugars % juice; suc.: sucrose % cane; tst/ha: tonnes theoretical sugar per hectare.

Principal Components Analyses

Components and eigenvectors

As can be noticed in Table 5, the first four components extracted more than 90% of the total variation of the assessed matrix, and the first two reached 72.72%; consequently, it is considered sufficient to work with the information that these two components extracted. In the first component the important variables were: locality, cane yield, stalk population, stalk length, stalk diameter, fibre, reducing sugars, sucrose and tonnes of theoretical sugar per hectare, and in the second component: juice purity and cane moisture were the most important, with opposite signs, this is, with contrary effects, as expected. It is noticeable that the variables associated with yield components had the same sign as did localities, hence the great effect of the former on cane yield. On the other hand, the effect of reducing sugars is contrary to that of sucrose, almost with the same values of components, but with opposite signs; similar results have been reported by Bernal (1986) and Milanes *et al.* (2007).

Relationships and importance of the variables

In the correlation circle (Figure 2), it can be noticed that the effects of variables which are cane yield components are directly opposite to the effect of fibre and reducing sugars, while sucrose and juice purity are associated and opposite to stalk moisture, which logically happens. Supplementary variables show little importance, except locations, also in this case related to the cane yield components.

Behaviour of individuals

In the case of individuals, in a chart, components 1 and 2 have been displayed, and the grouping of the 108 studied individuals into two large groups (Figure 3) is noticeable. The components are associated with each of the two studied locations, which confirms the importance of this factor in the performance of the sugarcane crop.

Table 4—Comparison between means of the most important significant interactions at harvest.

No.	Location x variety interactions		Location x variety x month of harvest interactions	
		Cane yield (t/ha)		Reducing sugars (%)
1	$L_1 \times V_1$ (Dry zone)	49.94 b	$L_1 \times V_1 \times M_1$	0.297 b
2	$L_1 \times V_2$ (Dry zone)	46.36 b	$L_1 \times V_1 \times M_2$	0.285 b
3	$L_1 \times V_3$ (Dry zone)	48.84 b	$L_1 \times V_1 \times M_3$	0.507 b
4	$L_2 \times V_1$ (Moist zone)	118.64 a	$L_1 \times V_1 \times M_4$	0.883 ab
5	$L_2 \times V_2$ (Moist zone)	126.91 a	$L_1 \times V_1 \times M_5$	1.070 ab
6	$L_2 \times V_3$ (Moist zone)	137.73 a	$L_1 \times V_1 \times M_6$	1.407 a
	Standard error	21.19	$L_1 \times V_2 \times M_1$	0.617 ab
	Locality x month of harvest		$L_1 \times V_2 \times M_2$	0.288 b
1	$L_1 \times M_1$ (Dry zone)	56.42 c	$L_1 \times V_2 \times M_3$	0.240 b
2	$L_1 \times M_2$ (Dry zone)	56.46 c	$L_1 \times V_2 \times M_4$	0.507 b
3	$L_1 \times M_3$ (Dry zone)	52.35 c	$L_1 \times V_2 \times M_5$	0.797 ab
4	$L_1 \times M_4$ (Dry zone)	47.48 cd	$L_1 \times V_2 \times M_6$	0.873 ab
5	$L_1 \times M_5$ (Dry zone)	40.78 d	$L_1 \times V_3 \times M_1$	0.470 b
6	$L_1 \times M_6$ (Dry zone)	36.77 d	$L_1 \times V_3 \times M_2$	0.407 b
7	$L_2 \times M_1$ (Moist zone)	122.50 b	$L_1 \times V_3 \times M_3$	0.273 b
8	$L_2 \times M_2$ (Moist zone)	129.43 ab	$L_1 \times V_3 \times M_4$	0.500 b
9	$L_2 \times M_3$ (Moist zone)	132.73 ab	$L_1 \times V_3 \times M_5$	1.003 ab
10	$L_2 \times M_4$ (Moist zone)	136.15 a	$L_1 \times V_3 \times M_6$	1.067 ab
11	$L_2 \times M_5$ (Moist zone)	124.01 b	Standard error	0.812
12	$L_2 \times M_6$ (Moist zone)	129.55 ab		
	Standard error	11.50		

Means in each column followed by different letters are significantly different (Duncan 0.05).

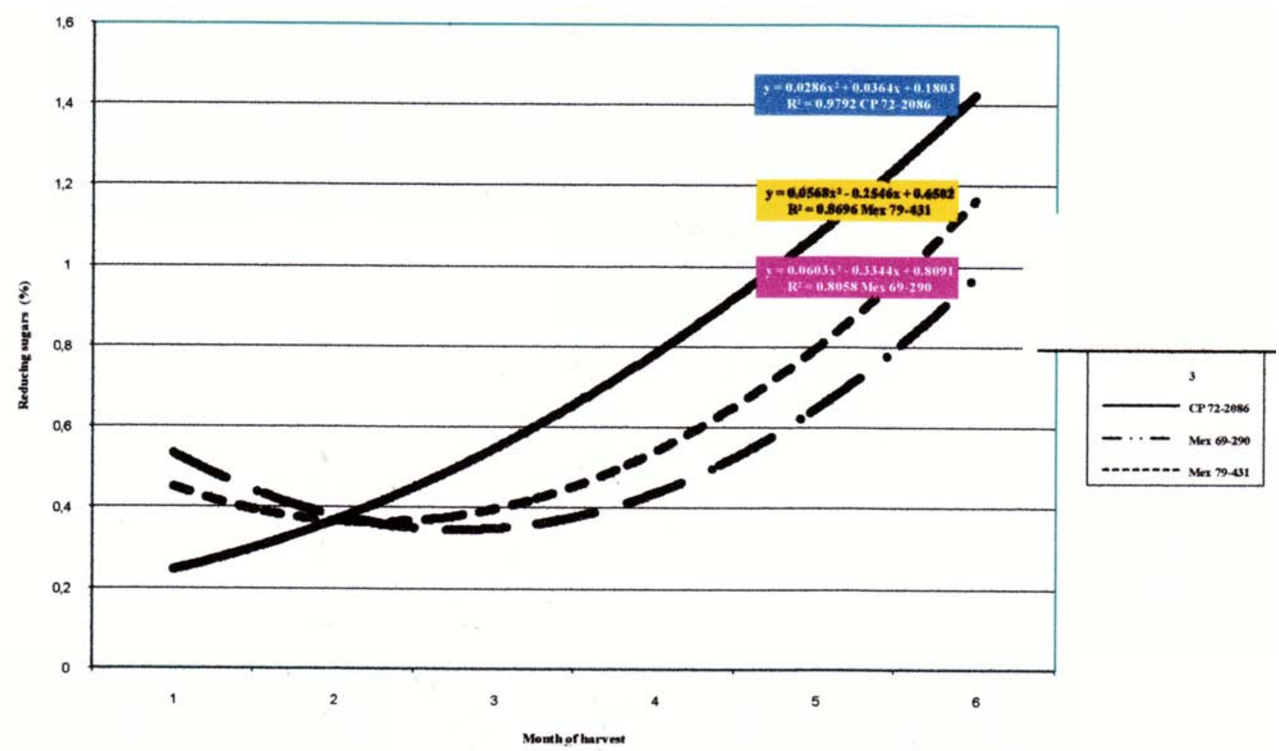

Fig. 1—Trends of reducing sugars over time in the three varieties studied in the dry zone.

Table 5—Eigenvectors, eigenvalues and principal components of variables and individuals studied.

Parameters and variables	Components			
	1	2	3	4
Eigenvalues	6.003814	1.995072	1.228785	0.687575
Percentages	54.58	18.14	11.17	6.25
Cumulative values	54.58	72.72	83.89	90.14
Location (L)	– 0.911	– 0.268		
Variety (B)	– 0.097	– 0.227		
Harvest (C)	0.147	– 0.022		
Replicates (REP)	0.032	0.015		
Cane yield (REN)	– 0.949	– 0.238		
Stalk population (NT)	– 0.748	– 0.012		
Stalk length (AT)	– 0.934	– 0.247		
Stalk diameter (DIA)	– 0.835	– 0.200		
Brix	– 0.669	0.488		
Fibre (FIB)	0.751	0.312		
Moisture (HUM)	– 0.249	– 0.769		
Purity (PUR)	– 0.234	0.566		
Reducing sugars (RED)	0.654	– 0.346		
Sucrose (PLS)	– 0.687	0.680		
Theoretical sugar/ha (RAT)	– 0.974	– 0.010		

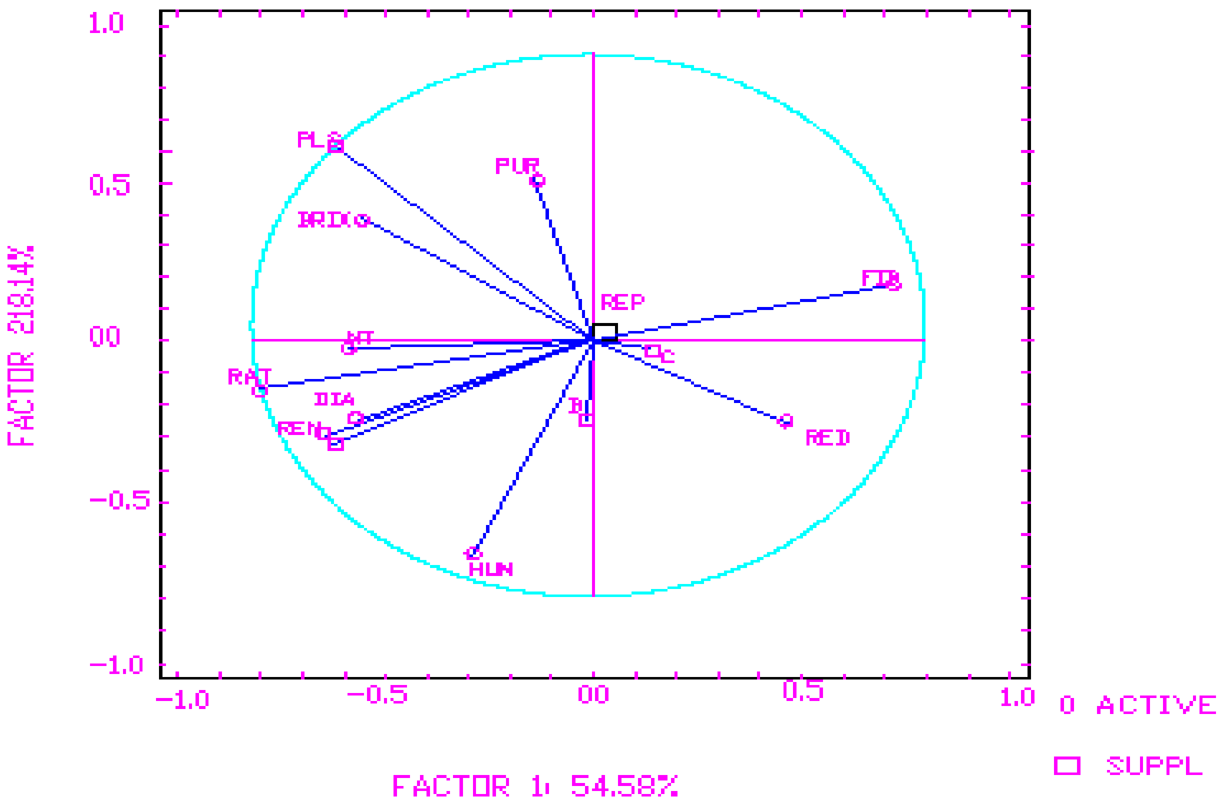

Fig. 2—Correlation circle, with representation of the 15 considered variables, according to their importance in the first and second components.

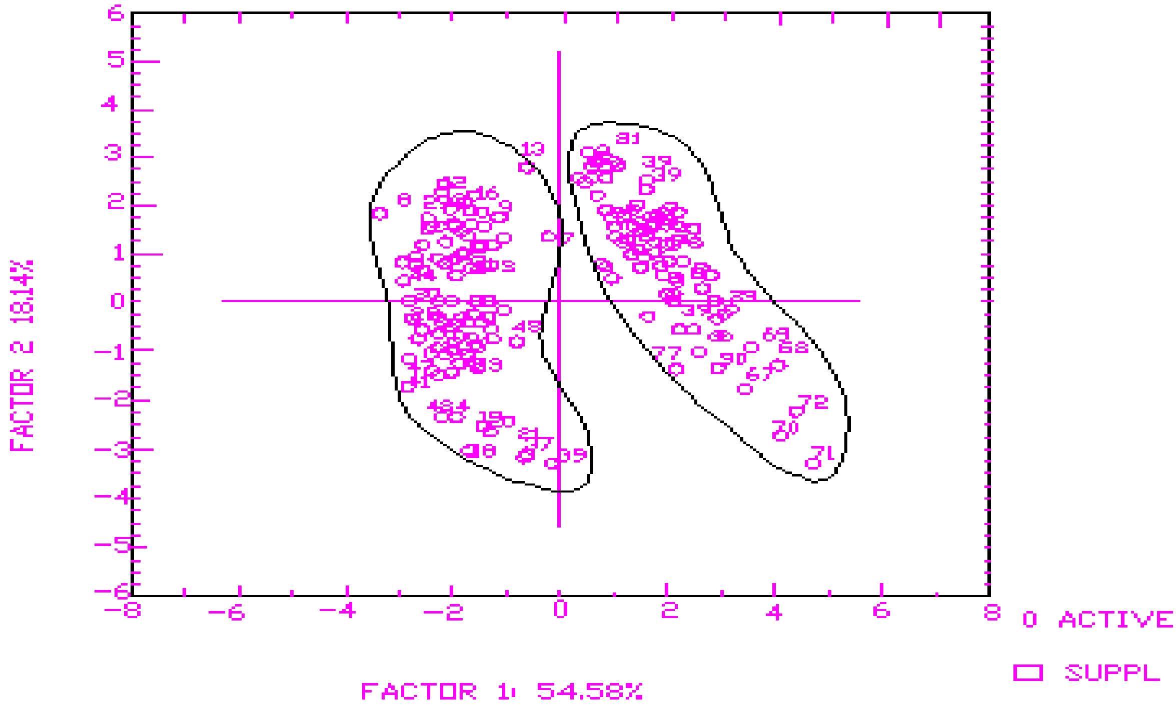

Fig. 3—Behaviour of individuals in the first and second components (in agreement with the importance of variables: location and harvest timing, in both components).

Conclusions

By assessing the location by month of harvest interactions, it is noteworthy that in the dry zone, cane yield was highest early in the season in December, January and February, while yields declined from March. In contrast in the moist zone, the harvest season began with a trend of low cane yields in December and January, and reached a maximum in February and March, and again declined during April and May. This clearly demonstrates the need to take into consideration the characteristics of these locations in order to optimise harvest scheduling.

Reducing sugars presented different trends over time in each variety. In the dry zone, CP 72–2086 exhibited low values (0.297%) early in the harvest season which began to increase significantly in the month of March (0.883%), maintaining these high values until the end of the harvest season in May (1.407%).

Mex 69–290 recorded high values in the month of December (0.617%), which decreased in January (0.288%), February (0.240%) and March (0.507%), and increased again in April and May, with values of 0.797% and 0.873%, respectively.

Mex 79–431 maintained low values from December to March (of 0.470% and 0.500%) with a trend to increase from the month of April (1.003%). These results suggest that variety CP72-2086 should be harvested at the beginning of the harvest season and finalised before March, variety Mex 69-290 should be harvested preferably during the months of January, February and March, while variety Mex 79-431 has best harvest timing in February and March.

The principal components analysis showed important effects of locations on cane and sugar yields and time of harvest, the influence of the environment on varietial yields, and verified the dependence of cane yield on its components stalk population, length and diameter. Negative correlations between yield component variables and moisture, reducing sugars and fibre were also found. The main components analyses demonstrate the total dependence of varietal performance on the conditions of locations and on their harvest management.

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EFFETS DU SITE ET DE LA PERIODE DE RECOLTE SUR LES RENDEMENTS DES TROIS PRINCIPALES VARIETES CULTIVEES AU MEXIQUE

Par

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MOTS-CLÉS: Canne à Sucre, Planification de la Coupe.

Résumé

AU MEXIQUE, au cours des trois dernières années, en moyenne 650 000 ha de canne furent cultivées, et produisirent plus de 46MT de canne avec une teneur en sucre extractible maximum de 11.43 pour 57 sucreries, localisées le long de la côte de l'Océan Pacifique, une ceinture tranversale autour du 19 ème parallèle et la côte du Golfe du Mexique. Dans cette diversité de climats et de sols, plus de 20 variétés sont cultivées, mais approximativement 65% sont plantées avec trois variétés: Mex 69-290, CP 72-2086 et Mex 79-431. Afin de déterminer de façon sure, les effets de la période de coupe sur ces 3 variétés pour planifier des dates de coupe optimum, deux essais furent plantés en Octobre 2003, avec les trois variétés citées, dans deux localités très contrastées d'un point de vue climat et sol, dans la principale région sucrière. Les essais furent récoltés six fois durant la période de récolte de Décembre 2004 à Mai 2005. Dans la zone sèche, le rendement canne fut le plus élevé très tôt dans la période de coupe, en Décembre Janvier et février, alors que les rendements déclinèrent à partir de Mars. Au contraire, dans la zone humide, les rendements canne furent plus faibles au début de la période de coupe, Décembre et Janvier, atteignirent un maximum en Février et Mars, puis déclinèrent en Avril et Mai. Dans la zone sèche, on observa chez CP 72-2086 des valeurs faibles de sucres réducteurs au début de la période de coupe qui augmentèrent significativement jusqu'à Mars et restèrent à des valeurs élevées jusqu'à Mai. Dans la même zone, Mex 69-290 montra des valeurs élevées en Décembre qui déclinèrent en Janvier, Février et Mars puis augmentèrent jusqu'à Mai, tandis que chez Mex 79-431 on observa des valeurs faibles jusqu'à Mars, puis un accroissement à partir d'Avril. L'analyse en composante principale montra des effets importants des sites sur les rendements en canne et en sucre et les dates de coupe, l'influence de l'environnement sur les rendements des variétés, et confirma la corrélation entre le rendement de la canne et ses composantes que sont la population, la longueur et le diamètre des tiges. Par contre, des corrélations négatives furent observées entre les composantes du rendement d'une part et l'humidité, les sucres réducteurs et la fibre d'autre part.

EFECTO DE LA LOCALIDAD Y EL MOMENTO DE COSECHA EN LAS TRES PRINCIPALES VARIEDADES DE CAÑA DE AZÚCAR EN MÉXICO

Por

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PALABRAS CLAVES: Caña de Azúcar, Momento de Cosecha.

Resumen

EN MÉXICO se cultivan con caña de azúcar más de 650 000 hectáreas que tributan las 46.5 millones de toneladas producidas, como promedio de los últimos tres años, a 57 ingenios azucareros, distribuidos a lo largo de la costa del océano pacífico, una franja transversal sobre el paralelo 19 y las costas del golfo de México, los cuales presentan un rendimiento de fábrica de 11.43 como máximo en la mejor zafra; en esta diversidad de clima y suelo, se cultivan mas de 20 variedades, pero el 65% aproximadamente de la superficie está plantada con las variedades: Mex 69-290, CP 72-2086 y Mex 79-431. Con el fin de conocer con precisión el efecto de la edad y la época de cosecha de estas variedades para una óptima programación de su cosecha, se plantaron 2 experimentos, con las tres variedades mencionadas, en dos localidades altamente contrastantes en clima y suelo, del principal macizo cañero del país, los cuales se cosecharon en seis momentos del periodo de la zafra Diciembre/2004 a Mayo/2005. En la zona seca el rendimiento de campo fue mayor a inicios de zafra, en diciembre, enero y febrero, y a partir del mes de marzo se inició un descenso, mientras en la zona húmeda se inició la cosecha con una tendencia de rendimiento bajos en diciembre y enero, que alcanzaron su máximo en febrero y marzo, para declinar durante abril y mayo. Los azúcares reductores presentan un comportamiento específico para cada variedad: En la zona seca, la CP 72-2086 inicia cosecha con valores bajos, que se incrementaron significativamente en marzo, manteniéndose altos hasta el final de la cosecha en mayo; la Mex 69-290 inició la cosecha con valores altos en diciembre, que disminuyó durante enero, febrero y marzo, para volver a incrementarse en abril y mayo; y la Mex 79-431 de diciembre a marzo mantiene valores bajos, con una tendencia a incrementarse a partir de abril. El análisis de componentes principales demostró el efecto importante de las localidades en la producción de caña y azúcar y el momento de cosecha, y la dependencia del efecto ambiental de las variedades, y reafirmó la dependencia del rendimiento de campo de sus componentes población, altura y diámetro. También se encontraron correlaciones negativas o inversas entre las variables del rendimiento agrícola con la humedad, la fibra y los azúcares reductores.