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YIELD PERFORMANCE STUDY AND MATURITY PATTERNS MODELING OF NEW SUGARCANE CULTIVARS

Estudio del rendimiento y modelación del período de madurez en nuevos cultivares de caña de azúcar

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ABSTRACT. The aim of the present work was to assess the performance of new sugarcane cultivars released by the Institute for Sugarcane Research (INICA), as well as to model and to classify its optimal maturity and harvest period. An experiment was carried out in the experimental field of the Territorial Station for Sugarcane Research "Oriente-Sur" under brown and rained soil conditions. Thirty-eight sugarcane cultivars were studied during two crop cycles (cane plant and first ratoon). The variables pol percentage in cane, t cane ha^{-1} and t pol ha^{-1} were recorded in the whole harvest period (November-April). Data were analyzed using analysis of variance, multivariate techniques (AMMI models and clustering) and regression analysis. The best performance cultivars were C86-12, C88-297, C89-559, C90-469, C91-115, C91-522, C95-416, C97-445 and SP70-1284. Cultivars were classified according to its optimal period of maturity in the following harvest schedule groups: early, early-middle, middle, middle-late and later. In addition, it is showed sugarcane cultivars for harvesting in the complete period of harvest . The polynomial equation of second grade displayed the better adjustment for modeling maturity pattern of sugarcane cultivars during the harvest period.

Key words: maturity, AMMI, modeling

RESUMEN. El objetivo del presente trabajo es definir la respuesta agropoductiva de nuevos cultivares de caña de azúcar recomendados por el Instituto de Investigaciones de la Caña de Azúcar (INICA), ubicado en la provincia Santiago de Cuba, así como modelar y clasificar su período óptimo de madurez y cosecha. Para esto, se estableció un experimento en el área experimental "La Mantonia", perteneciente a la Estación Territorial de Investigaciones de la Caña de Azúcar de Oriente-Sur, en un suelo Pardo sialítico en condiciones de secano. Se utilizaron 38 cultivares y se estudiaron durante dos cosechas (caña planta y primer retoño). Las variables evaluadas fueron: porcentaje de pol en caña, t caña ha^{-1} y t pol ha^{-1}, así como el contenido azucarero en todo el período de cosecha (noviembre-abril). Para cumplir los objetivos se realizaron análisis de varianza y análisis multivariados (modelo de Efectos Principales Aditivos e Interacción Multiplicativa (AMM) y análisis de Agrupamiento) así como regresión. Se obtuvo que los cultivares de mejor respuesta agroindustrial resultaron ser: C86-12, C88-297, C89-559, C90-469, C91-115, C91-522, C95-416, C97-445 y SP70-1284. Se determinó el momento óptimo de madurez de los cultivares clasificándolos por el período de cosecha, en los que se identificaron los siguientes grupos: inicio, inicio-medio, medio, medio-final y final de zafra, así como los cultivares que se pueden utilizar en todo el período de zafra. Asimismo, se determinó que la ecuación polinómica de segundo grado resultó la de mejor ajuste para modelar la madurez de los cultivares de caña de azúcar durante el período de zafra.

Palabras clave: madurez, AMMI, modelación

INTRODUCTION

In recent years, the expected results of the managerial improvement system in the sugarcane sector have started to materialize; sugar production stopped growing and encouraging signs of recovery at the required levels have shown up. Sugarcane is grown at the Southeastern part of Cuba with a planted area of 90 000 hectares.

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The elements mentioned before, in addition to increased sugar prices at the international market, demand a higher efficiency in the whole production process until attaining the final product in sugarmills. One of the most practical and economic ways to do it lies on the production of genotypes with a high content of sugar adapted to the edaphoclimatic conditions of the country by developing breeding programs (1).

The contribution of Genetic Breeding has been estimated around 50 % for the main crops in the United States. In Australia, Genetic Breeding accounted for 75 % of increased yields in sugarcane (2, 3). On the other hand, sugarcane cultivars are subjected to deterioration and replacement by new individuals of better response to environmental conditions and with higher agroindustrial and phytosanitary requirements (4).

The difficult circumstances the sugar industry in Cuba has faced with in recent years led to downsize research and trial sites of new cultivars. This situation has caused a low representation among the environments of genetic selection and and destination environments of the cultivars (5).

On the other hand, sugarcane juice is the meeting point of the factors influencing the crop and harvest at random and of difficult quantification (6). However, the studies related to juice quality, recommended varieties by the Sugarcane Research Institute (INICA), have been done in all territories and the edaphoclimatic conditions of those trial sites were determined.

In Cuba, several studies related to genotypes evaluation under different productive environments have been conducted as well as the implications on sugarcane production. The results of these studies confirm the importance and scope of the genotype-environment interaction which aims at the necessary multienvironmental evaluation of cultivars throughout the selection process, mainly at the final stages and their further release to commercial areas (7).

INICA has recommended, since 2002 until 2014, 41 new sugarcane cultivars produced in different provinces. In this regard, when these new cultivars are taken to other territories for their possible introduction to commercial areas, not enough information is available on their agroproductive response, maturity period and harvest season, nor comprehensive knowledge on the quality of sugarcane juices under the new edaphoclimatic conditions.

Likewise, when there is a high number of new cultivars, it is necessary to manage them by coincident maturity periods which has been commonly known as “family of varieties”. It makes easier harvest programming of the sugarcane stems destined to sugar production (8). Hence, the objective of this research has been to define the agroproductive response of new sugarcane cultivars recommended for Santiago de Cuba province, as well as modeling and classifying their optimum maturity and harvest periods.

MATERIALS AND METHODS

The experimental stage of this research started in September 2009, with a field trial at the Experimental Plot “La Mantonia”, Contramaestre municipality, belonging to the Sugarcane Territorial Research Station Oriente-Sur. The study was done on a sialitic brown soil under rainfed conditions.

Plant material and evaluated features

The study included 38 sugarcane cultivars. Out of these, 34 newly recommended by INICA in the last 10 years (Table I) and produced in different geographical areas of the country (5).

Table I. Cultivars used for the study

Number	Cultivar	Number	Cultivar	Number	Cultivar	Number	Cultivar
1	C86-12	11	C88-556	21	C90-501	31	C95-416
2	C86-156	12	C89-147	22	C90-530	32	C97-445
3	C86-165	13	C89-148	23	C90-647	33	SP70-1284
4	C86-251	14	C89-161	24	C91-115	34	B78505
5	C86-406	15	C89-176	25	C91-356	35	C1051-73*
6	C86-56	16	C89-250	26	C91-367	36	C120-78*
7	C87-252	17	C89-559	27	C91-522	37	B7274*
8	C88-297	18	C90-316	28	C92-203	38	C87-51**
9	C88-380	19	C90-317	29	C92-514		
10	C88-553	20	C90-469	30	C93-567		

*- Cultivars widely sold in the study region; **- Control

As control, the cultivar C87-51 was used to determine the agroproductive response of evaluated cultivars. This genotype shows good agroindustrial yield in the Santiago de Cuba province, in addition to have a high sugar content, medium maturity towards the end of the season; it can be harvested throughout the harvest season (9).

Other three widely commercial cultivars in the region were used (B7274, C1051-73 and C120-78). The study was done on the cold cycle (September 2009) and harvested as cane plant (February 2011) and first ratoon (March 2012) with 16 and 12 months of age, respectively.

Experimental design and sampling methodology

A random block desing was used for the trial. Each experimental plot covered 48 m^2 (four rows of 7,5 m long by 1,50 m between rows) with three repetitions per treatment (cultivar). Simultaneously to the trial, an area of 22.5 m^2 (three rows of 5 m long by 1,50 m between rows) was planted for each cultivar, known as "maturity bank". This bank was used for monthly maturity sampling during the harvest period. That is, sampling from November to April for the first harvest (cane plant) and from November to March for the second harvest (first ratoon) and thus the maturity dynamics through the analysis of pol percentage in sugarcane was determined.

The evaluated variables: t sugarcane.ha^{-1}, pol percentage in sugarcane and t pol.ha^{-1}. These were determined taking 1 m long stems; four subsamples per cultivar and replicate were collected which was finally averaged to determine the three harvest variables. This sampling was done for the first and second harvest.

Statistical data processing

Data from evaluated variables, were analyzed regarding their normalcy and homogeneity of variance by Chi and Bartlett-Box F tests. In any case their transformation was necessary. The agroproductive response of the cultivars was determined in each of the harvest by a simple analysis of variance of fix effect. In so doing, genotypes were taken as factor through the following model:

$$Y_{ik} = \mu + G_i + e_{ik}$$

where:

$Y_{ik:}$ is the k observation of the genotype i

μ: General mean

$G_{i.:}$ Effect of the i-esimo genotype

$e_{ik.}$ associated error to k-esima observation of the i-esimo genotype.

Tukey's test (p=0,05) was used for the multiple comparison of means. In all cases, the statistical package STATISTICA (10) was used for data processing.

In order to determine the optimum maturity time and classification of cultivars by their harvest time, the results of the pol percentage in sugarcane evaluated throughout the harvest period were used bor the cane plant and ratoon. Firstly, a factorial fix effect analysis of variance was done to know if there were significant differences in the interaction cultivars-harvest month period. Once it was known as significant, a description was made using the model of Additive Main Effects and Multiplying Interactions (AMMI) (11).

With the results of the AMMI model, two types of bidimensional representations were madee. A first biplot was built for studying the stability and sugar content from the main effects of genotypes and months and the general mean (X axis) and the first component of the AMMI model (Y axis) named $AMMI_1$. A second biplot was built with the first two components of the AMMI model named $AMMI_2$, that shows the relationship between months, genotypes and among these two factors.

A hierarchical grouping of minium variance from Ward (12) was made with the groups of cultivars classified by their maturity using the AMMI model. In so doing, the coordinates of the component vectors one and two of the AMMI models, were used. The squares of the euclidian distances were used as a similarity measure, and cultivars maturity was used as the formation criteria of cultivars during the harvest period with a biological and logical approach.

From the results of the first classification, a second one was made only with the cultivars of the intermediate group. This new analysis allowed to widen the classification of the intermediate maturity group for its importance to the harvest.

The cultivars identified in the initial harvest group of the medium harvest season, served to determine the stability of the sugar concent throughout the harvest period, to identify those cultivars that can be considered with a high and stable sugar content. The procedure used was through the model of the first component of the AMMI model (Y axis) and genotype effect, months and general mean (X axis).

Likewise, modelling analysis by regression (second degree polynomial equation) with the pol percentage variable was used to estimate the optimum maturity time in each cultivar. Data processing included the statistical software package STATISTICA (10).

RESULTS AND DISCUSSION

AGROINDUTRIAL CULTIVARS RESPONSE

The analysis of variance made to each harvest (cane plant and first ratoon) showed significant differences for the three evaluated variables, pol percentage in sugarcane, t sugarcane ha^{-1} and t pol ha^{-1}. Table II shows the results of the multiple means comparison for the evaluated harvest variables. These results, complemented by the stability study of the genotypes in both harvests (results not shown), allowed to determine the genotypes of better response in each evaluated variable.

As for the sugar content, the best cultivars in both harvests and with similar or higher results than the control C87-51 were: C86-12, C86-156, C88-380, C89-161, C89-250, C91-367, C92-203, C93-567, C97-445 and SP70-1284. Other genotypes can be also observed with high values for cane plant (C89-176, C90-647 and C91-356) or first ratoon (B78505, C95-416, C92-514, C91-522, C86-406, C86-165, C86-56, C87-252, C88-297, C88-556, C88-553 and C89-148) with similar or higher values to the control. This instability of the genotypes regarding sugar content could suggest new studies or new locations.

Table II. Results of the analysis of variance for the agroindustrial yield variables

Number	Cultivar	% of pol in sugarcane		t de cane ha^{-1}		t de pol ha^{-1}	
		Plant cane Mean	Ratoon Mean	Plant cane Mean	Ratoon Mean	Plant cane Mean	Ratoon Mean
1	C86-12	17,44 ab	19,37ab	138,50 de	94,33 a	24,18 cde	18,22 a
2	C86-156	16,04 bc	18,87 ab	112,31 efgh	35,35 ef	18,09 def	6,67 ef
3	C86-165	14,99 d	18,43 ab	110,07 efgh	77,11 ab	16,54 def	14,20 ab
4	C86-251	15,72 c	18,29 ab	106,53 efgh	53,89 bcde	16,72 def	9,88 cde
5	C86-406	15,93 c	19,13 ab	139,71 de	52,81 cde	22,34 cdef	10,11 bcde
6	C86-56	14,82 d	18,43 ab	120,47 defg	52,92 cde	17,82 def	9,77 cde
7	C87-252	15,69 c	18,84 ab	100,81 fgh	43,22 def	15,85 def	8,15 def
8	C88-297	15,25 dc	18,43 ab	180,00 bc	67,82 bcd	27,41 bc	12,50 bcd
9	C88-380	17,27 ab	19,19 ab	147,65 cd	45,62 def	25,49 bc	8,77 def
10	C88-553	15,98 c	18,75 ab	152,97 c	49,40 cdef	24,47 cd	9,26 cdef
11	C88-556	16,10 bc	19,28 ab	122,31 defg	46,11 def	19,88 def	8,93 cdef
12	C89-147	16,65 bc	18,11 ab	201,07 ab	50,54 cde	33,69 ab	9,16 cdef
13	C89-148	16,33 bc	18,84 ab	90,69 gh	39,23 ef	14,83 f	7,36 ef
14	C89-161	17,06 ab	18,67 ab	79,46 h	23,49 f	13,58 f	4,39 f
15	C89-176	17,09 ab	17,82 b	134,00 def	53,48 bcde	22,99 cde	9,54 cdef
16	C89-250	18,23 a	19,05 ab	85,22 h	45,00 def	15,51 ef	8,64 def
17	C89-559	14,82 d	18,38 ab	158,76 c	78,96 ab	23,52 cde	14,51 ab
18	C90-316	13,39 e	17,06 bc	127,23 def	43,13 def	17,08 def	7,37 ef
19	C90-317	15,93 c	17,76 b	134,27 def	70,07 abc	21,37 def	12,35 bcd
20	C90-469	17,00 ab	17,15 b	143,54 cde	64,96 bcd	24,47 cd	11,09 bcde
21	C90-501	16,25 bc	17,76 b	130,00 def	30,47 f	21,07 def	5,42 f
22	C90-530	17,12 ab	17,62 b	145,12 cd	64,60 bcd	24,80 bcd	11,38 bcde
23	C90-647	17,50 ab	16,80 c	88,33 gh	60,83 bcde	15,49 ef	10,21 bcde
24	C91-115	17,27 ab	17,65 b	217,89 a	58,81 bcde	37,63 a	10,46 bcde
25	C91-356	18,03 a	17,68 b	121,80 defg	58,23 bcde	21,91 def	10,25 bcde
26	C91-367	18,38 a	18,81 ab	80,00 h	64,54 bcd	14,69 f	12,17 bcd
27	C91-522	17,41 ab	20,04 a	146,23 cd	61,56 bcd	25,40 bc	12,33 bcd
28	C92-203	18,00 a	18,87 ab	104,79 fgh	46,14 def	18,88 def	8,70 def
29	C92-514	16,68 bc	18,64 ab	120,00 defg	70,11 abc	20,04 def	13,11 bc
30	C93-567	17,33 ab	18,35 ab	125,00 defg	55,53 bcde	21,68 def	10,30 bcde
31	C95-416	16,54 bc	19,13 ab	151,60 c	73,36 abc	25,12 bc	14,11 abc
32	C97-445	18,99 a	19,20 ab	132,33 def	63,49 bcd	25,11 bc	12,18 bcd
33	SP70-1284	17,59 ab	19,16 ab	140,63 de	67,67 bcd	24,67 cd	12,96 bcd
34	B78505	16,42 bc	19,28 ab	92,41 gh	83,54 a	15,19 ef	16,14 ab
35	C1051-73	16,63 bc	19,60 a	133,20 def	53,07 bcde	22,28 cdef	10,41 bcde
36	C120-78	16,98 ab	17,33 b	132,88 def	45,09 def	22,73 cde	7,80 def
37	B7274	16,16 bc	19,51 a	127,26 def	48,53 cdef	20,59 def	9,46 cdef
38	C87-51	18,90 a	18,84 ab	135,27 def	47,57 cdef	25,48 bc	8,89
Mean		16,63	18,47	129,98	56,45	21,59	10,44
CV (%)		8,99	5,80	22,31	23,03	21,08	23,95

CV – Coefficient of variation

The agricultural yield showed a higher or similar response compared to the control C87-51 for a high number of cultivars, among them: C91-115, C89-147, C86-12, C86-406, C89-559, C90-317, C90-469, C90-530, C91-522, C95-416, C97-445 and SP70-1284. These results show that a large part of the cultivars adapted to the conditions of the study site.

Genotypes C88-380, C88-553, C89-176 and commercial cultivars C1051-73, C120-78 y B7274 also had high yields for cane plant as well as C86-165, C90-647, C91-356, C91-367, C92-514, C93-567 and B78505 for the ratoon.

For the variable t of pol.ha^{-1} the cultivars of better response compared to the control in both harvests were: C86-12, C88-297, C89-559, C90-469, C91-115, C91-522, C95-416, C97-445 and SP70-1284. Moreover, cultivars C88-380 and C89-147 showed good results in the first harvest; however, they were not stable in the second harvest with low values. The opposite happened with cultivars: C86-165, C90-317, C90-530, C90-647, C91-356, C91-367, C92-514, C93-567 and B78505, that showed low yields in the first harvest, not so in the second one.

Cultivars results for the variable t of pol ha^{-1} are similar to those of agricultural yield (t sugarcane ha^{-1}). This genotype behavior was predictable since the variable t pol ha^{-1} is very much influenced by t sugarcane ha^{-1}, as pointed out by other authors (2, 7).

A study conducted at the central region of Cuba (Ciego de Avila province) including 20 cultivars under rainfed conditions and on red ferralitic soils, reported high sugarcane agroindustrial yields for cultivars C86-12, C89-147 and C90-317[A]. However, these authors said these two latter cultivars reached low sugar contents.

Classification of the cultivars according to their maturity time and harvest

For cane plant, the components of the AMMI model extracted 61,3 % of the variation contained in data for the study of the sugar content throughout the harvest period (Figure 1). Just by looking at the interactions of these cultivars with the months of the harvest period, it can be seen each cultivar and the month where the highest sugar content was reached, and in contrast, where the lowest value was recorded.

In this regard, the sugar content in November was different from the rest of the months of the harvest period, negatively interacting with the late months of the harvest period (March-April) as expected. These two moments have different climatic features which explains previous results.

Likewise, cultivar B78505 strongly associated to the late months of harvest end (March-April), shows that its optimum maturity period coincides with these late months of the harvest period. When performing the grouping analysis with the AMMI model results, three big maturity groups were formed. A first group that interacted with the early months of the harvest period (November-Jannuary) and reached its maximum pol percentage in sugarcane.

This first group named early maturity and start of the harvest period included the following cultivars: C120-78, C88-553, C89-147, C89-161, C90-316, C90-469, C90-501, C90-530, C91-356 and C91-522. The second group of cultivars, considered medium maturity or intermediate harvest period, coincides with most of the cultivars. It includes the following cultivars: C86-12, C86-406, C87-252, C87-51, C88-380, C88-556, C89-148, C89-250, C91-367, C92-514, C93-567, C97-445, SP70-1284 and C1051-73. This group included the cultivar C87-51 used as control and the commercial cultivar C1051-73 traditionally managed throughout the harvest period.

The third group interacts with March-April, that is, cultivars reach the highest sugar content late in the harvest period. This group is composed of: B7274, C86-156, C86-165, C86-251, C86-56, C88-297, C89-176, C89-559, C90-317, C90-647, C91-115, C92-203 and C95-416.

A second analysis (AMMI model and grouping) to the medium maturity cultivars (group with more than 8 cultivars) the month in which each cultivar reaches the highest sugar content and therefore the optimum harvest time could be determined (Figure 2).

Figure 2 shows the three groups derived from the grouping analysis. A first group positively associated to the beginning of the harvest period (December-January). Among them: C86-406, C87-252, C89-148, C93-567, C88-556, C92-514 and C1051-73, whose maturity could be early-medium.

Likewise, there is a second group associated to February (medium harvest period), among which are: C89-250, C86-12, C97-445 and the control C87-51.

[A] Ojeda, E.; Olga, L.P.; Castro, I.; Torres, G. y Castellano, P. ''Comportamiento de cultivares de caña de azúcar en condiciones de seguía en la UPC Comandante Guevara de la Empresa Azucarera Ecuador'', *Memorias 45 Aniversario del Instituto de Investigaciones de la Caña de Azúcar*, Matanzas, Cuba, 2009.

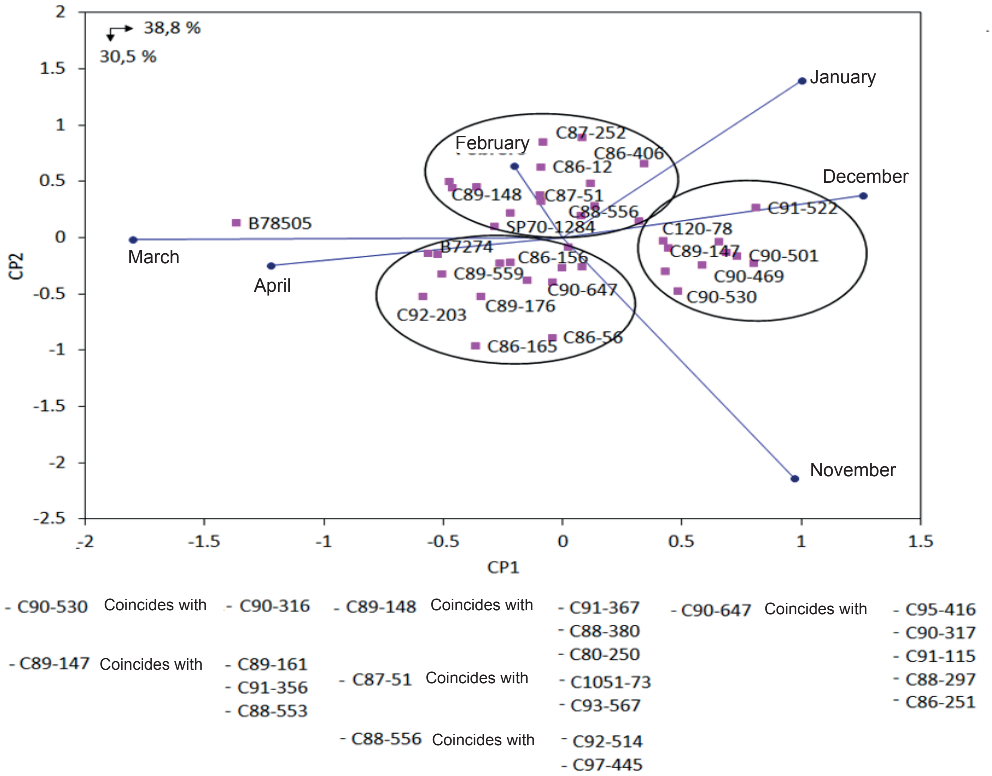

Figure 1. Bidimensional graph of the AMMI model (genotypes and months) and grouping analysis of the cultivars by maturity time (cane plant)

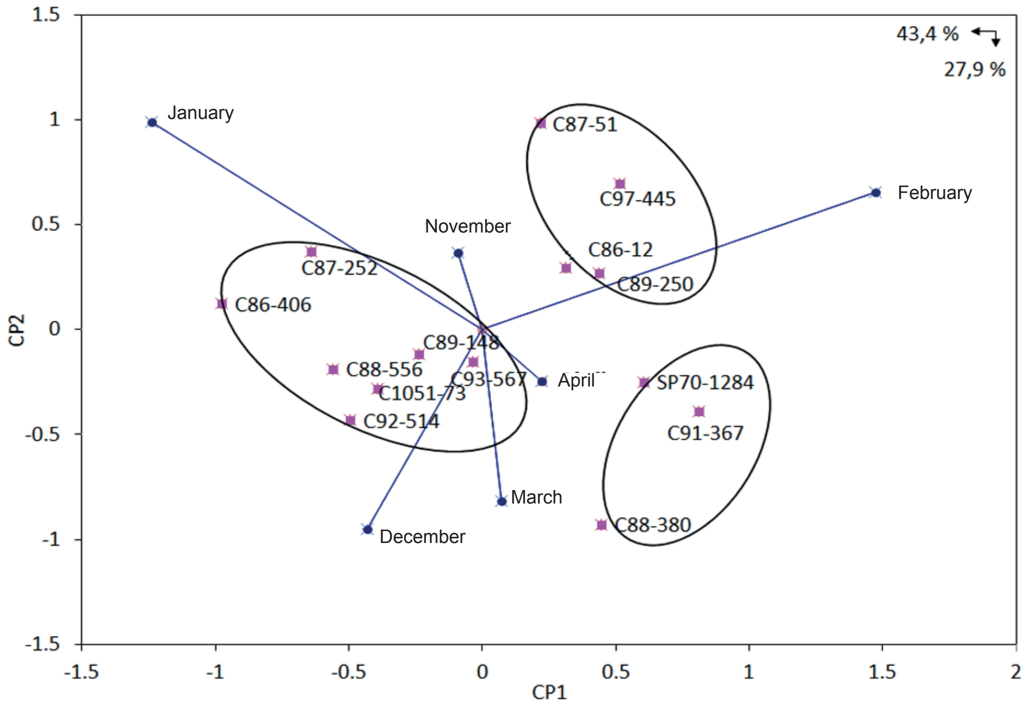

Figure 2. Bidimensional graph of the AMMI model (genotypes and months) and grouping analysis of the cultivars by maturity time (cane plant) with those of the medium harvest period

These results were expected, according to investigations from other authors that have used the same genotypes (9, 13). There is a third group of cultivars associated to medium-end of the harvest period (March - April). Cultivars in this group are: SP70-1284, C91-367 and C88-380.

On the other hand, out of the genotypes group initially identified as of medium maturity, those that can be harvested throught the season were determined, since they have a high and stable sugar content during the harvest season (Figure 3). In this case, the following genotypes can be found: C89-250, C93-567, C89-148, C88-380 and C92-514. Cultivars like C97-445, SP70-1284 and C86-12 can also be considered for showing a high stability in the sugar content during the harvest period with similar results to the control C87-51.

In this regard, a study of new cultivars in the Southeastern Cuban region reported that C86-12 was stable for sugarcane yield (5). On the other hand, it has been pointed out that genotype C89-148 showed a high sugar content in central Cuba and recommended its harvest during the whole harvest period[A].

The combination of these AMMI models and grouping analysis was an effective and sophisticated tool to classify genotypes by their maturity period. The resulting biplots from these models are excellent tools to reduce the bidimension nature of the information derived from the studies of genotype-environment interaction, they have the advantage of visualizing and exploring the relationship among genotypes, among environments and genotypes-environment interactions (14, 15).

When looking at the first ratoon of the AMMI model and the classification of cultivars by their maturity period, three maturity groups were identified (results not shown). These groups are composed of the following cultivars: harvest start (C88-553, C89-147, C89-161, C90-469, C90-501, C90-530, C91-356, C91-367, C92-514, C93-567, C86-156, C86-165 and C90-647), medium harvest period (C86-12, C86-406, C87-252, C88-380, C89-148, C97-445, SP70-1284, C91-522, C86-251, C89-176, C91-115, C92-203, C95-416, C120-78, C1051-73 and the control C87-51) and final harvest period (C88-556, C89-250, C90-316, C86-56, C88-297, C89-559, C90-317, B78505 and B7274).

When comparing the results of cultivars grouping by their maturity period (cane plant and ratoon) their harvests coincide coinciden with the beginning of the harvest season: C88-553, C89-147, C89-161, C90-469, C90-501, C90-530 and C91-356. Medium harvest period: C1051-73, C86-12, C86-406, C87-252, C87-51, C88-380, C89-148, C97-445, SP70-1284 and in the final harvest period: B7274, C86-56, C88-297, C89-559, C90-317, B78505. The rest of the cultivars differ, from one harvest to the other, as to maturity classification (Table III).

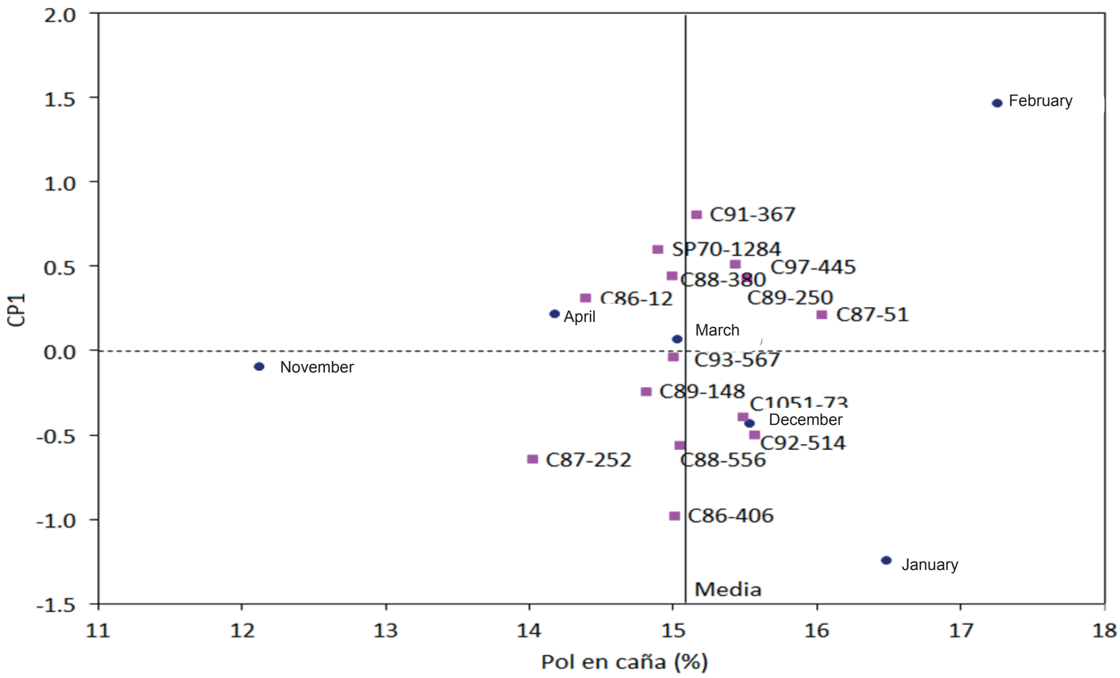

Figure 3. Bidimensional graph of the main effects, genotype markers and months of the AMMI1 model for the pol percentage in sugarcane

The previous results show that limits of the maturity and harvest periods for some cultivars can overlap which is indicative of the importance of studying new cultivars at the sites where the crop is. There is another group of cultivars where grouping cane plant coincides with the first ratoon, that is, early-final and viceversa. In this case, the cultivars are: C90-316, C86-156, C86-165 and C90-647; which suggests deepening on thse results through other studies.

Table IV shows the equation of better adjustment to model maturity dynamics for the studied cultivars. In this case, it came to be the second degree polynomial

Table III. Classification of the cultivars according to their maturity time for cane plant harvest and and first ratoon

Cultivar	Planting material		Cultivar	Planting material	
	Cane plant	First ratoon		Cane plant	First ratoon
C120-78	Start	Medium	C89-176	Final	Medium
C91-522	Start	Medium	C91-115	Final	Medium
C91-367	Medium	Start	C92-203	Final	Medium
C92-514	Medium	Start	C95-416	Final	Medium
C93-567	Medium	Early	C90-316	Start	Final
C88-556	Medium	Final	C86-156	Final	Early
C89-250	Medium	Final	C86-165	Final	Early
C86-251	Final	Medium	C90-647	Final	Early

Table IV. Polynomial equation to model sugarcane cultivars maturity during the season

Maturity*	Cultivar	Adjustment equation	R^2
Start	C120-78	$y = -0{,}5127x^2 + 3{,}5502x + 10{,}54$	$R^2 = 0{,}83$
	C88-553	$y = -0{,}4313x^2 + 2{,}7821x + 10.78$	$R^2 = 0{,}54$
	C89-147	$y = -0{,}4541x^2 + 2{,}9959x + 11{,}61$	$R^2 = 0{,}81$
	C89-161	$y = -0{,}4324x^2 + 2{,}6976x + 12{,}72$	$R^2 = 0{,}75$
	C90-316	$y = -0{,}1743x^2 + 1{,}0067x + 12{,}44$	$R^2 = 0{,}38$
	C90-469	$y = -0{,}3977x^2 + 2{,}536x + 11{,}59$	$R^2 = 0{,}50$
	C90-501	$y = -0{,}4328x^2 + 2{,}6388x + 12{,}51$	$R^2 = 0{,}83$
	C90-530	$y = -0{,}4098x^2 + 2{,}6421x + 11{,}93$	$R^2 = 0{,}72$
	C91-356	$y = -0{,}4584x^2 + 3{,}0926x + 12{,}05$	$R^2 = 0{,}69$
	C91-522	$y = -0{,}6038x^2 + 3{,}9225x + 10{,}70$	$R^2 = 0{,}74$
Medium	C1051-73	$y = -0{,}4768x^2 + 3{,}6165x + 10{,}05$	$R^2 = 0{,}83$
	C86-12	$y = -0{,}7325x^2 + 5{,}405x + 6{,}57$	$R^2 = 0{,}90$
	C86-406	$y = -0{,}6398x^2 + 4{,}5424x + 8{,}80$	$R^2 = 0{,}76$
	C87-252	$y = -0{,}7464x^2 + 5{,}4864x + 6{,}13$	$R^2 = 0{,}87$
	C87-51	$y = -0{,}6039x^2 + 4{,}511x + 9{,}40$	$R^2 = 0{,}75$
	C88-380	$y = -0{,}5655x^2 + 4{,}4441x + 8$	$R^2 = 0{,}77$
	C88-556	$y = -0{,}5049x^2 + 3{,}6398x + 9{,}96$	$R^2 = 0{,}83$
	C89-148	$y = -0{,}5866x^2 + 4{,}5128x + 7{,}90$	$R^2 = 0{,}99$
	C89-250	$y = -0{,}5237x^2 + 3{,}9858x + 9{,}50$	$R^2 = 0{,}81$
	C91-367	$y = -0{,}6348x^2 + 4{,}9475x + 7{,}46$	$R^2 = 0{,}80$
	C92-514	$y = -0{,}5822x^2 + 4{,}0831x + 10{,}10$	$R^2 = 0{,}94$
	C93-567	$y = -0{,}7024x^2 + 5{,}3037x + 7{,}08$	$R^2 = 0{,}82$
	C97-445	$y = -0{,}6979x^2 + 5{,}0347x + 8{,}39$	$R^2 = 0{,}76$
	SP70-1284	$y = -0{,}5082x^2 + 3{,}8486x + 9{,}12$	$R^2 = 0{,}78$
Final	C86-156	$y = -0{,}3694x^2 + 2{,}7048x + 10{,}66$	$R^2 = 0{,}76$
	C86-165	$y = -0{,}0831x^2 + 0{,}6729x + 13{,}09$	$R^2 = 0{,}17$
	C86-251	$y = -0{,}3204x^2 + 2{,}6693x + 9{,}67$	$R^2 = 0{,}94$
	C86-56	$y = -0{,}0985x^2 + 0{,}6422x + 13{,}07$	$R^2 = 0{,}22$
	C88-297	$y = -0{,}3269x^2 + 2{,}3227x + 10{,}55$	$R^2 = 0{,}72$
	C89-176	$y = -0{,}2343x^2 + 1{,}849x + 12{,}70$	$R^2 = 0{,}74$
	C89-559	$y = -0{,}4021x^2 + 3{,}0001x + 9{,}32$	$R^2 = 0{,}71$
	C90-317	$y = -0{,}4021x^2 + 3{,}0001x + 9{,}32$	$R^2 = 0{,}71$
	C90-647	$y = -0{,}3673x^2 + 2{,}7128x + 10{,}50$	$R^2 = 0{,}38$
	C91-115	$y = -0{,}376x^2 + 2{,}8583x + 10{,}63$	$R^2 = 0{,}72$
	C92-203	$y = -0{,}2415x^2 + 2{,}0533x + 12{,}22$	$R^2 = 0{,}55$
	C95-416	$y = -0{,}2698x^2 + 1{,}9641x + 12{,}48$	$R^2 = 0{,}82$
	B7274	$y = -0{,}2865x^2 + 2{,}4595x + 11{,}11$	$R^2 = 0{,}99$
	B78505	$y = -0{,}3127x^2 + 3{,}2444x + 7{,}99$	$R^2 = 0{,}98$

R^2- Regression coefficient * - Cultivars grouping according to the cepa of cane plant equation describing the maturity of the sugarcane like a parabola. Look also there are only four genotypes that showed regression coefficients below 0,5. These cultivars (C90-316, C86-165, C90-647 and C86-56) coincide with those of higher contrast to the results of grouping cane plant and first ratoon. It shows an inconsistent maturity dynamics during the harvest season. These results are very important for sugarmills to plan the harvest strategy.

CONCLUSIONS

- ♦ It was determined that in America Libre the cultivars with the best agroindustrial response were: C86-12, C88-297, C89-559, C90-469, C91-115, C91-522, C95-416, C97-445 and SP70-1284.
- ♦ The optimum maturity period for evaluated cultivars was determined by classifying them according to their harvest period, three groups were identified: Early, Medium and Late. Within the medium group another groups were identified: early-medium, medium and medium-late as well as the cultivars that can be used throughout the season.
- ♦ It was determined that the second degree polynomic equation resulted into the best adjustment for sugarcane cultivars during the season. Except cultivars C90-616, C86-165, C90-647 and C86-56, the rest showed a regression coefficient higher than 0,5.

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