EVALUATION OF SUGARCANE VARIETIES SUITABLE FOR EARLY HARVESTING UNDER TROPICAL CONDITIONS

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ABSTRACT

Sugarcane productivity has increased substantially in the Colombian sugar industry over the last 15 years, and one of the factors that has had an impact on it has been a decrease in harvesting age. To evaluate the profitability of harvesting earlier (11 mo) than the current avg (14.6 mo), 8 varieties were evaluated at two mills (Cauca and Providencia) and harvested at 11 mo. These varieties were compared with the commercial var. MZC 74-275, which is planted on 44% of the cane-growing area in Colombia. Profitability was evaluated on the basis of differential costs for the varieties. At the Cauca Mill, 6 varieties were more profitable than the check; at Providencia, 4 of the 6 varieties. The estimate of profitability also showed that varieties with moderate cane production but high sucrose content were also profitable as an alternative for green cane and mechanized harvesting, given the fact that they are erect. As the profitability of these varieties is higher than that of the commercial check and at younger ages than the traditional varieties, the sugar industry should be committed to maintaining consistency in the harvesting ages.

Keywords: Sugarcane, early harvesting, maturity, sucrose, profitability, Colombia.

INTRODUCTION

The Colombian cane industry currently has the highest level of productivity in the world (Egan 1993), and it has been increasing over the years (Cock et al. 1993). Among the factors that have contributed to this is the decrease in time to cutting, which in 1960 was 18.9 mo vs an avg of 14.6 mo in 1993. Moreover, harvesting is done throughout the year, with the greatest volume of cane harvested and highest yield in sucrose occurring during the second semester (Vivas & Luna 1993). One of the reasons for the smaller harvest in the first semester is the higher rainfall, which has an adverse effect on ratoon growth, percent sucrose recovery and factory extraction rates. Under these circumstances it is desirable to have varieties that can be harvested consistently in the second semester and that outyield the best commercially grown varieties available at present. If varieties are selected for cycles of consistent harvesting (11-12 mo) and maintain a high level of sucrose, they can also serve as an alternative for the first semester harvest.

Generally the varieties developed for the Colombian cane industry are suitable for harvesting at 12-14 mo; however, the historic tendency has been toward varieties that can be harvested at 14 mo (Vivas & Luna 1993). Sugar production is higher as a result of greater cane production per hectare, but the sucrose content is lower (CENICAÑA 1993).

Results of the final selection stages at CENICAÑA (1992) show that genetic variability for high sucrose is greater at 10-12 mo than at later ages, which means that it is possible to identify high-sucrose varieties when selection is done at an early age. These results agree with those obtained by Cuenya & Mariotti (1986) in Argentina and by Cox et al (1990) in Australia, where selection for early maturity and cane production was more efficient at early ages than when done later on. Domaingue et al (1990) evaluated more than 50 varieties in very humid, humid and dry environments, harvesting at both early and late ages. Their results showed that—independent of environment—there were a greater number of varieties selected for sucrose in the early harvests; and sucrose levels were maintained as long as they were harvested at early ages. These results indicate that it is feasible to select high sucrose-producing varieties for early harvest and that they can be used to advantage by the Colombian cane industry as long as there is a commitment to maintain consistency in harvesting age.

The objective of this work was to evaluate varieties suitable for early harvest under the tropical conditions of the Colombian cane industry.

MATERIALS AND METHODS

Six CENICAÑA varieties in the final selection stage, two introduced varieties and the commercial check MZC 74-

275 were evaluated. These varieties were planted in a moist mollisol at the Cauca Sugarcane Mill and in a dry mollisol at the Providencia Mill. The experiments were planted on 20 Aug. 1993 and harvested at the age of 11 mo. A complete randomized block design with four replications was used at the Cauca Mill; three replications at Providencia. The plots consisted of six 125-m long rows, with a distance of 1.5 m between rows. Rainfall during the crop cycle at the Cauca and Providencia mills was 1569 and 1132 mm, resp. Irrigation at both sites was done in accordance with the water table. At the Cauca Mill the crop was fertilized with 70 kg K_2O/ha at planting and 138 kg N/ha 50 days later. At Providencia 115 kg N/ha was applied, but no K fertilizer was used. The experiments were maintained with adequate weed control; and at 7.5 mo sampling was begun to determine the maturation curve. At 9.5 mo the herbicide Fusilade 2000 (fluazifop-p-butyl) was applied as a ripener at a rate of 0.6 l/ha.

Data were taken on lodging at 9 and 11 mo, based on a scale of 1 to 5, where 1 = erect and 5 = >50% lodging in the plot. Harvesting was done after the cane had been burned, using the cane from the whole plot. At the Cauca Mill sucrose content was determined in samples taken from the core sampler when the wagons arrived at the factory. At Providencia, the sucrose content was determined using the methodology of direct analysis, adjusting the values by a factor of 0.80. Data on sucrose content were used to calculate the tonnage of sugar produced per variety. In this paper the percent sucrose content is equivalent to the estimated recoverable sugar at the mill. Given the fact that these varieties have been evaluated for their efficiency in the cutting, loading, transportation and milling operations, varietal indices were defined for these parameters. Profitability was calculated on the basis of net income/kg of sugar/ha/mo (NIKSHM), including preliminary information on field production costs, as follows:

NIKSHM = {(NI/price ton sugar)*1000}/11, where NI = net income/ha; NI = GI - FPC - CLTMP; GI = gross income = (TSH)*price per ton sugar; FPC = field production costs; CLTMP = Costs of loading, transportation, milling and processing.

The profitability of these varieties is studied in comparison (%) to the check, MZC 74-275.

RESULTS

The combined analysis of variance at the two sites showed a significant variety x site interaction for both cane production per hectare (TCH) (P = 0.063) and sucrose content (P = 0.0125); thus the results are presented separately for the two sites.

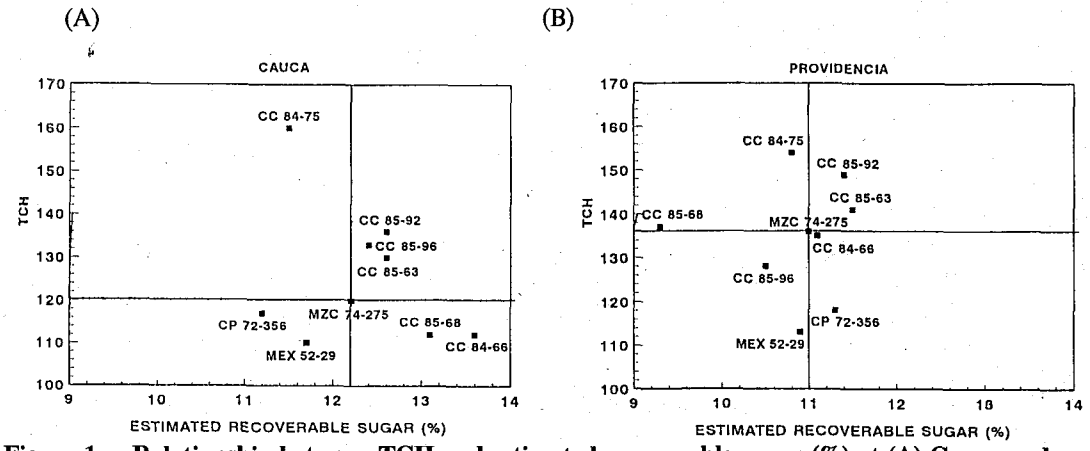


Figure 1. Relationship between TCH and estimated recoverable sugar (%) at (A) Cauca and (B) Providencia mills.

TCH was higher at the Providencia Mill than at Cauca, with values of 134 and 126, resp. The avg sucrose content was 12.35 at Cauca and 10.86 at Providencia. The response of the varieties at each site, considering both their TCH and sucrose content, is shown in Figure 1. At Cauca the varieties that outperformed the commercial var. MZC 74-275 in both sucrose and cane production were CC 85-92, CC 85-96 and CC 85-63. The TCH of the variety CC 84-75 was

33% higher than that of MZC 74-275, but the sucrose content was lower. At Providencia only var. CC 85-92 and CC 85-63 outperformed MZC 74-275. CC 84-75—the same as at the Cauca Mill—had a higher TCH than the check, but a lower sucrose content.

The profitability of the varieties at the two sites is shown in Figure 2. At Cauca there were six varieties that were from 4-36% more profitable than the commercial check; the ones with the highest and lowest values were CC 84-75 and CC 85-68, resp. In addition to the three varieties (CC 85-92, CC 85-96 & CC 85-63) that combined higher TCH and sucrose contents in relation to the commercial check MZC 74-275 (Fig. 1), var. CC 84-66 and CC 85-68, which had lower TCHs but higher sucrose contents than the check, also gave higher incomes. At Providencia four varieties were from 4-29% more profitable than MZC 74-275, with highest and lowest values for var. CC 85-92 and CC 84-66, resp. The same as at the Cauca Mill, var. CC 84-66, which had lower TCHs but higher sucrose content than the check (Fig. 1), was more profitable than MZC 74-275.

The tendency to lodge was similar at both sites (Fig. 3). The varieties with the most lodging at harvest were Mex 52-29, CP 72-356, CC 85-63, CC 85-96 and CC 84-75; the most erect were CC 84-66, CC 85-68 and MZC 74-275. At Cauca the erect varieties tended to have higher sucrose contents; whereas those varieties known for their tendency to lodge had lower values (Fig. 3). This suggests that in var. CC 84-75, CP 72-356 and Mex 52-29, sucrose content decreases as a result of the lodging effect. Var. CC 85-63 and CC 85-96 with intermediate lodging had sucrose contents similar to the erect types, suggesting that they are less sensitive to decreases in their sucrose content as a result of lodging. At Providencia no effect of lodging on sucrose content was noted as the varietal response with respect to sucrose content was similar, regardless of the degree of lodging shown (Fig. 3). Var. CC 85-68—considered as erect and which had a high sucrose content at Cauca—had the lowest sucrose content at Providencia. Thus under the conditions at Providencia, lodging had less impact on the sucrose content of the varieties.

DISCUSSION

The evaluation of varieties suitable for harvesting at an earlier age (11 mo) than the normal avg in Colombia

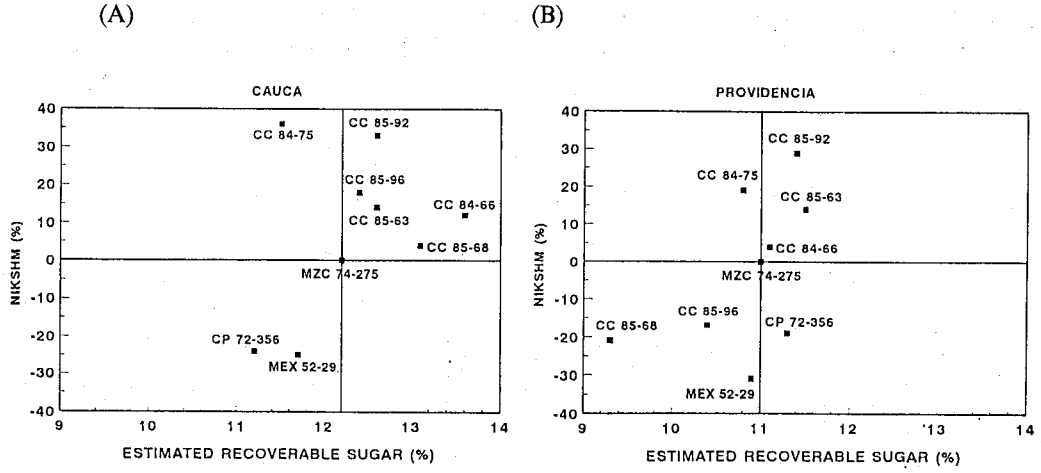


Figure 2. Relationship between NIKSHM and estimated recoverable sugar relative to MZC 74-275 at (A) Cauca and (B) Providencia mills.

(>14.6 mo) shows that there are more profitable varieties than the commercial var. MZC 74-275. CC 85-92, CC 85-96, CC 85-63, CC 84-66 and CC 85-68 are more profitable than Mex 52-29, which is considered early maturing in one of the Colombian cane production zones.

Both the growers and the mills believe that harvesting cane at early ages could decrease cane production and sucrose concn. Nevertheless, the TCHs (range of 110-160) obtained in the 0.11 ha plots of these experiments compete

with those TCHs obtained on a commercial scale with var. MZC 74-275, which produced 138 TCH at Cauca in 1993 when harvested at an age of 15.1 mo and 130 TCH at Providencia, age 14.1 mo. The sucrose contents also compare favorably with the data on recoverable sugar obtained at the factories that same year: 10.35% for Cauca and 11.45% for Providencia (Vivas & Luna 1993).

Given that the future trend in Colombia will be to pay cane on the basis of sucrose content rather than on tonnage, varieties with high sucrose content and moderate tonnage will also be a profitable alternative as is the case of var. CC 84-66 and CC 85-68 at Cauca and CC 84-66 at Providencia, which would not have been considered if the payment were based on tonnage (Fig. 1).

To calculate profitability, the following differential costs were taken into account: loading, harvesting and transportation, all of which are significantly affected by lodging. In comparison to MZC 74-275, the greatest profitability—obtained with varieties of moderate tonnage and high sucrose—was largely due to the fact that they are erect types. There is, therefore, great potential for varieties with such characteristics given the fact that in the near future there will be mechanized harvesting of green cane. It is to be expected, therefore, that the profitability will be greater than under the circumstances in which these experiments were harvested. This shows the importance of evaluating differential production costs for the varieties.

The tendency toward higher sucrose concn. in the erect varieties shows an influence of lodging with respect to lower sucrose content in some varieties. Extreme cases of this situation were found in var. Mex 52-29 and CP 72-356 at Cauca (Fig. 3). These varieties had higher sucrose contents (% juice) at 9.5 mo (Fig. 4), but lodged a few weeks later, which can account for the decrease in sucrose at harvest. Var. CC 84-75, which showed moderate lodging, had a lower sucrose content than the erect varieties. This tendency is in agreement with commercial results in larger areas where lodging has significantly affected the sucrose level as compared to fields where erect cane was harvested. It shows the sensitivity of this variety with decreased sucrose levels as a result of even moderate levels of lodging.

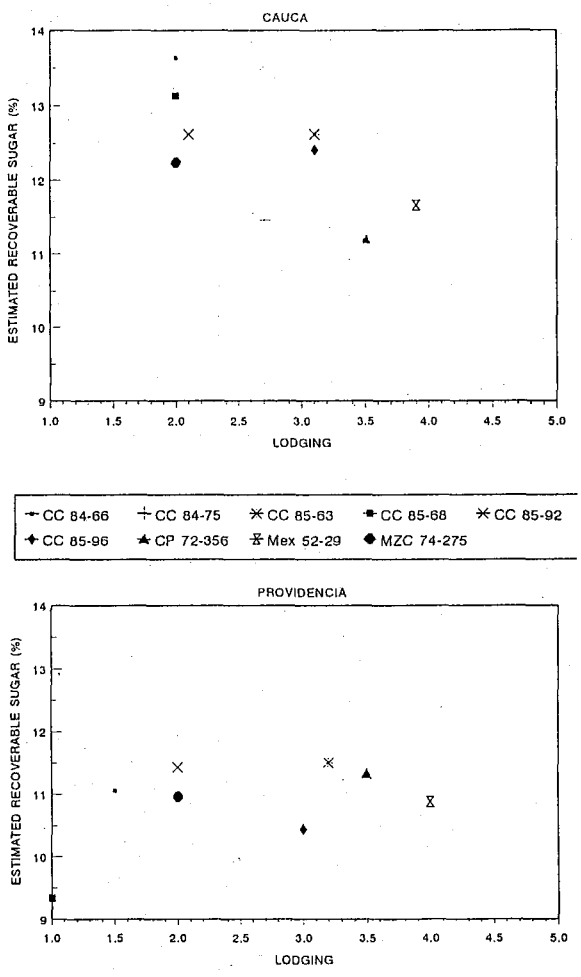


Figure 3. Relationship between recoverable sugar (%) at harvest and lodging at (A) Cauca and (B) Providencia mills.

The fact that lodging did not significantly decrease sucrose content at Providencia (Fig. 3) can be explained by a greater sensitivity of the varieties when the expression of the genes that control sucrose is at a maximum. This could be the reason why at Cauca—where the expression of the genes that control sucrose was greater—lodging had a negative effect on sucrose. One of the reasons for this could have been the application of K at Cauca, which was not done at Providencia. CENICAÑA (1993) has found higher concn. of sucrose when N fertilization is combined with K. The positive effect of K on sucrose levels may possibly have neutralized the effect of the higher rainfall recorded at Cauca.

These results show that there are varieties suitable for harvesting at younger ages than the traditional ones and that are more profitable than the best commercial variety. Within this group varieties of moderate tonnage and high sucrose contents—erect types with great potential for the mechanized harvesting of green cane—are available. Industry has to be committed to maintain consistency in harvesting ages so that the potential observed in the evaluation at the two

sites can be maximized.

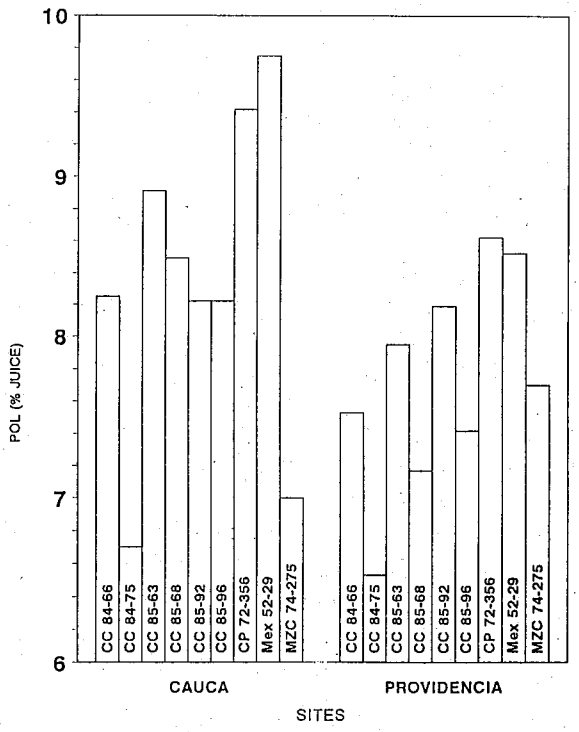


Figure 4. Pol (% juice) for nine cane varieties evaluated at 9.5 mo at two sites.

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EVALUATION DES VARIETES DE CANNE A SUCRE PROPICES A UNE RECOLTE PRECOCE EN MILIEU TROPICAL

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RESUME

La productivité de la canne à sucre a augmenté de façon importante dans l'industrie sucrière colombienne pendant ces quinze dernières années, et l'un des facteurs qui y a le plus contribué est la diminution de l'âge à la récolte. Afin d'évaluer le profit retiré d'une récolte plus précoce (11 mois) que la moyenne courante (14,6 mois), on a évalué 8 variétés récoltées à 11 mois dans deux usines (Cauca et Providencia). On a comparé ces variétés à la variété commerciale MZC 74-275, plantée sur 44 % de la superficie de la zone sucrière colombienne. On a évalué le profit sur la base des différents coûts des variétés. A l'usine Cauca, six variétés ont été plus intéressantes que le témoin; et 4 à Providencia. L'estimation du gain a également montré que les variétés à tonnage modéré mais à haute teneur en sucre étaient rentables et offraient une alternative pour la récolte mécanique en vert étant donné qu'elles restent droites. Comme ces variétés offrent un meilleur profit que le témoin commercial, à un stade plus jeune que les variétés traditionnelles, l'industrie sucrière devrait garder son attention sur un âge constant de la canne à la récolte.

Mots clés: Récolte précoce, maturité, sucrose, profit.

EVALUACION DE VARIEDADES PARA COSECHA TEMPRANA EN CONDICIONES TROPICALES

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RESUMEN

La productividad de azucar se ha incrementado notoriamente en la industria azucarera colombiana en los ultimos 15 años y uno de los factores que ha incidido en ello ha sido la disminución de la edad de cosecha. Con el fin de evaluar la rentabilidad a edades mas tempranas (11 meses) que las edades de cosecha actual (14.6 meses) se evaluaron ocho variedades en dos ingenios (Cauca y Providencia) las cuales se cosecharon a los 11 meses. Estas variedades fueron comparadas con la variedad comercial MZC 74-275, la cual se encuentra sembrada en 44% del area en caña para producción de azucar en Colombia. La rentabilidad se evaluó teniendo en cuenta costos diferenciales para las variedades. En el ingenio Cauca hubo 6 variedades que superaron en rentabilidad al testigo mientras que en Providencia cuatro variedades de las seis de Cauca superaron al testigo. El cálculo de la rentabilidad mostró además que variedades de moderadas producciones de caña pero de alta contenido de sacarosa ademas de ser rentables son una alternativa como variedades para la cosecha en verde y a la cosecha mecanizada, dado el hecho de que estas variedades son erectas. Puesto que la rentabilidad de las variedades supera a la del testigo comercial a edades menores que la convencional, un compromiso de la industria azucarera debe de ser la de mantener consistencia en las edades de cosecha.