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VARIATION OF CONCENTRATION OF SOLUBLE SOLIDS AND AGRICULTURAL YIELD WITH ORGANIC FERTILIZATION IN THREE VARIETIES OF SUGAR CANE (*SACCHARUM SP HYBRID*) FOR THE PRODUCTION OF PANELA IN THE CONDITIONS OF THE ECUADORIAN AMAZON

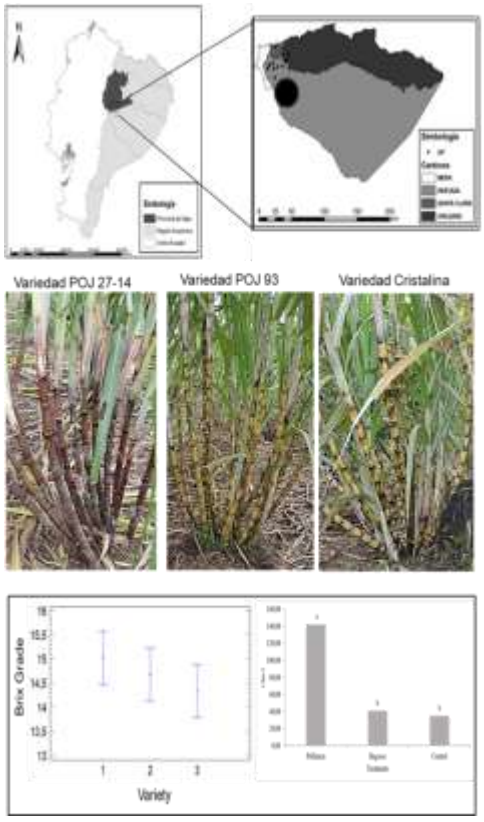
Reinaldo Alemán Pérez[1,*], Carlos Bravo Medina[1], Jorge Freile Almeida[1], Javier, Domínguez Brito[1], Edgar Rubén Iza Guanoluisa[1], Darwin Viáfara[1,],Jorge Luis Alba[1].

[1]*Universidad Estatal Amazónica, Paso lateral, km 2 ½, vía Puyo Tena, Pastaza, Ecuador, CP 160150;*

***Author to whom correspondence should be addressed; e-mail: reinaldoap@gmail.com**

Tel.: +593- 032-888-118 (ext. 123); Fax: +593-032888-118.

. Graphical Abstract



Abstract

The cultivation of sugarcane is an agricultural activity of great socio-economic importance in Ecuadorian Amazon. The study was carried out in the sugarcane production area of the municipality of Simon Bolivar, Pastaza province, Ecuadorian Amazon Region. We used a factorial design in random blocks with three replicates for a total of 27 experimental plots. The study factors were the varieties of sugarcane identified as: POJ 27-14, Crystalline and POJ 93 and two types of organic fertilizers: Pollinaza and sugarcane bagasse at a dose of 9060 kgha^{-1} compared with an absolute control without application of fertilizer. The analysis of combined variance and the Tukey's mean test with a significance level of 5% was performed to detect differences in mean between treatments. The results suggest that the concentration of sugars expressed in brix degrees did not show significant differences between the varieties, but it did show differences between the types of fertilization, being higher with the application of pollinaza with values of 15.9 degrees brix. The agricultural yield was affected according to the variety, registering higher values with variety POJ 27-14 with a yield of 107 t ha^{-1} in comparison with the other two varieties, which showed statistically similar yields.

Keywords: sugarcane, varieties, brix degrees, agricultural yield, Ecuadorian Amazon.

Introduction

The cultivation of sugarcane is an agricultural activity of great socio-economic importance in the world and in America was introduced by Christopher Columbus on his second trip to the continent. Sugarcane is an exhaustive crop and depletes the soil nutrients heavily. Continuous sugarcane cropping with the use of only inorganic fertilizers has led to depletion of essential available nutrients beside organic carbon in the soil (Kumar and Cham, 2013). In Ecuador, it is possible that the cultivation of the panela cane was brought from Colombia, a little before the middle of the sixteenth century, to settle in the hot valleys of the Interandina Region and in some sectors of the Litoral, to later be located in the Eastern and Western foothills of the Andes (Suquilanda, 2004).

In Ecuador this crop constitutes a relevant sector of the economy, since 20% is destined to the panela production and 80% of the total planted area is destined for the sugar production and ethyl alcohol from the juice of cane.

In Ecuadorian amazon region there are provinces that stand out for having sugarcane crops and panela production is one of the main agricultural activities of Pastaza province (ASOCAP, 2012). However, in this province there is not sufficient information on the productive characteristics (agricultural yield and brix degrees) of the different varieties of sugar cane that are grown, as well as the effect of organic fertilizers on this crop. The genetic improvement of sugarcane for panelera agroindustry is oriented to the substitution of genetic materials with low productive potential, through the introduction and evaluation of high yielding varieties and good agroindustrial performance, adaptable to the management conditions of the panela zones (López-Lopera and Tamayo Velez, 2017).

In this context, the need arises to study the agricultural behavior of three varieties of sugarcane, identified as: 1) POJ 27-14; 2) POJ 93 and 3) Crystalline, in the climatic conditions of the Simon Bolívar parish, Pastaza province with the application of organic fertilizer.

Materials and Methods

The investigation was carried out in the "San Carlos" farm, located in the Oswaldo Hurtado enclosure of the Vía Puyo - Macas km 29 belonging to the Simon Bolívar parish of the Pastaza province (figure 1), at a height of 1071 masl, with an average temperature of 29.5 °C, precipitation of 3000 to 4000 mm per year, relative humidity of 86% with the following geographic coordinates: 18184794E and 9817282N.

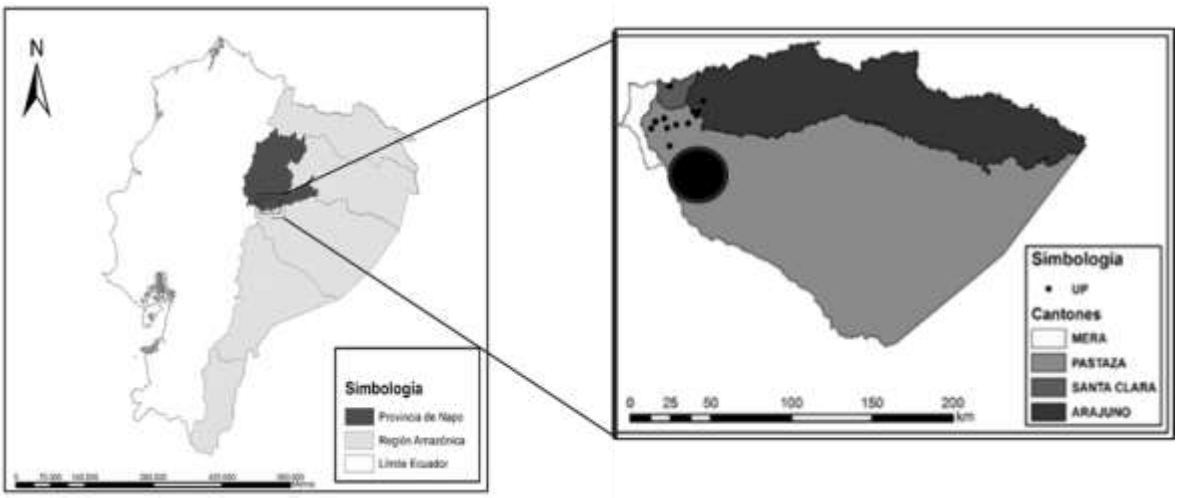


Figure 1: Map of the province of Pastaza. a) Sector where the experiment was developed.

Three varieties of sugarcane (POJ 27-14, Cristalina and POJ-93) and three levels of fertilization were studied, which consisted of two organic fertilizers, poultry litter and bagasse plus a control where fertilization was not carried out. A factorial design was carried out in randomized complete blocks, combining 3 varieties by 3 levels of fertilization (3 x 3). Hence, 9 treatments and three replications were generated for a total of 27 experimental plots.

The Brix Degrees were determined with the aid of a refractometer according to Osorio, 2007 and agricultural yield in t ha^{-1} for which the molly stems of two seedlings (in 3 m^2) were cut and weighed in a balance, to later calculate the yield on a hectare scale.

An analysis of variance was applied to the variables studied and the Tukey test was used to determine differences between the means for the level of significance of ($P < 0.05$). When there was no interaction between the factors, they were studied independently.

Results and Discussion

Concentration of sugar according to varieties and organic fertilization

Figure 2 shows that there is no statistical difference between the varieties in relation to the concentration of sugars, expressed in brix degrees. This may be due to the fact that sugar concentrations are highly influenced by the prevailing climatic conditions in the stage of maturity of the crop, mainly the temperatures and humidity that were the same for the three varieties; however, for the fertilizer factor there is a statistical difference between the poultry litter with the bagasse and control (figure 3), being the value of 15.9 obtained with the larger poultry carcass. There is no statistical difference between the bagasse and the control.

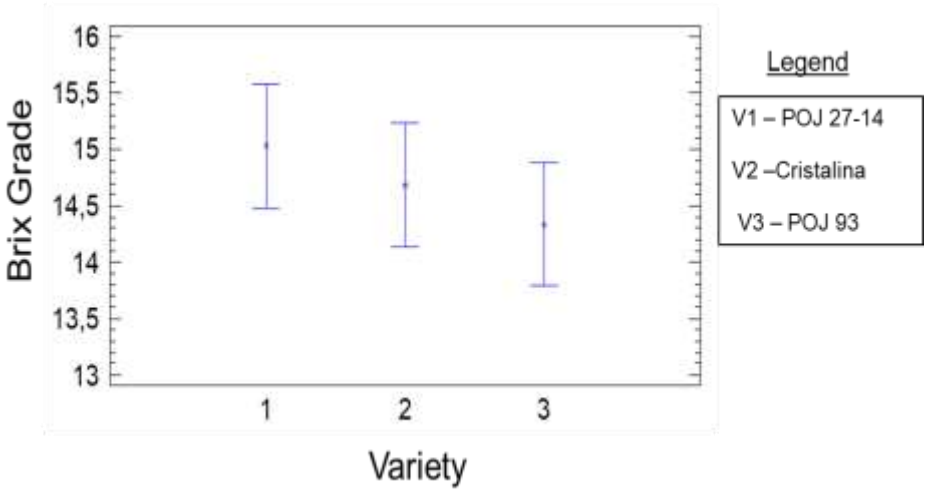


Figure 2. Brix grades in sugarcane according to varieties 300 days after planting. Simón Bolívar-Pastaza Parish. (Tuckey $p < 0.05$)

Patiño (2011), reports for the Cristalina variety an average of 14.20 degrees Brix at harvest age. These values are similar to those of our research, where a value of 14.7 is obtained (figure 2). Hernández et al., 2008, did not find significant differences in the yield of stems and the quality of the juices was not affected, when comparing vinasse, cachaza and chemical fertilization. On the other hand, Arreola-Enríquez, et al., (2004), explain that the quality of the juice (degrees Brix, sucrose, purity and fiber) showed no effect between the treatments, so it can be deduced that with 10 and 15 t -1 of organo-mineral

fertilizer of cachaça it is possible to increase the yield of sugarcane without affecting the quality of the juice.

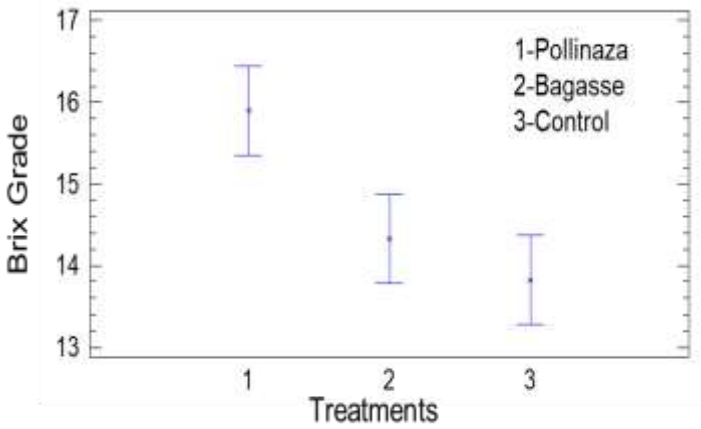


Figure 3. Brix grades in sugar cane according to organic fertilization 300 days after planting. Simon Bolívar-Pastaza Parish. (Tuckey p <0.05)

Variation of agricultural yield according to varieties.

Figure 4 shows the average yield in t ha^{-1} of the varieties POJ 27-14, Cristalina and POJ 93 without considering the fertilization. It can be seen that in POJ 27-14 a yield of 107 t ha^{-1} is obtained, which is statistically higher than that obtained in the other two varieties, followed by the Cristalina variety, and without statistical differences between Crystalline and POJ-93. Patiño (2011) for the Cristalina variety obtained an agricultural yield of 78.35 t ha^{-1} in the Morona Santiago province, whose was higher than the 59 t ha^{-1} of our research. On the other hand, the variety POJ 27-14 with an average of 107 t ha^{-1} was superior to the results obtained by Garcia (2006) in the variety POJ 28-78 with 88.4 t ha^{-1} of yield. Also the results of the variety POJ 93 were superior with yield of 51 t ha^{-1} to those reported by ASOCAP (2012), who state that in recent years the yield of the variety POJ 93 in the province of Pastaza has declined to 40 t ha^{-1}.

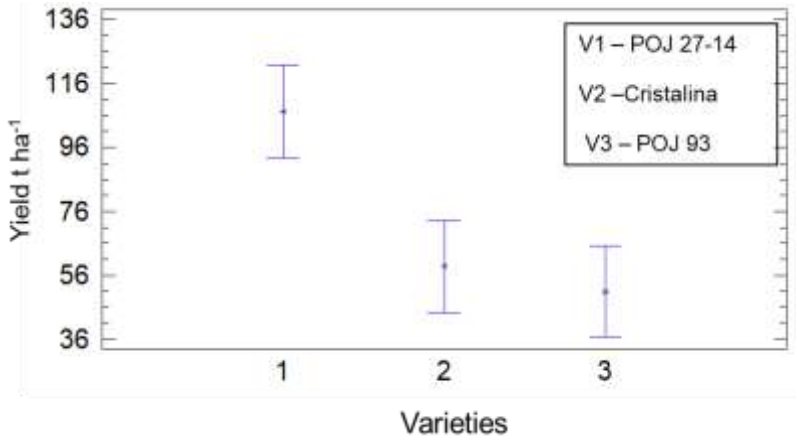


Figure 4. Agricultural yield t.ha-1 in sugarcane according to varieties at 300 days after planting. Simón Bolívar-Pastaza Parish. (Tuckey p <0.05)

Variation of agricultural yield according to organic fertilization

In the fertilizer factor, when a pollinaza is applied, a higher yield is obtained with values of 142 t.ha^{-1} that differs statistically from those obtained with the bagasse and absolute control, however the bagasse and the control do not differ statistically in themselves, being numerically superior when bagasse is applied (figure 5). According to Arreola-Enriquez, et al., (2004) cane yield increased significantly when fertilized with 10 t ha^{-1} of mulch organ-mineral fertilizer (84.6 t ha^{-1}), in comparison with the absolute control and chemical fertilization (35 and 52 t ha^{-1}), respectively.

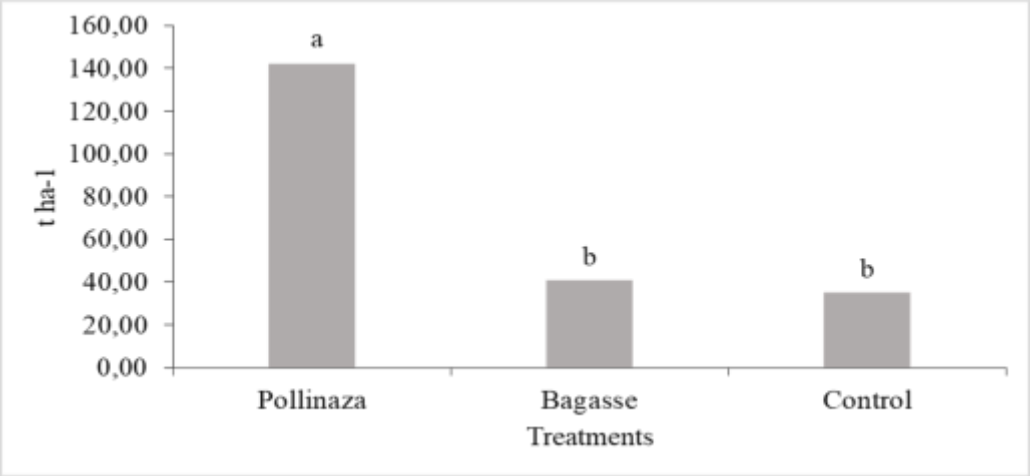


Figure 5: Yield in t ha^{-1} depending on the fertilization treatment, Simon Bolívar-Pastaza.

Conclusions

- The monitoring of these materials POJ 27-14; POJ 93 and Cristalina allowed the identification of varieties with agronomic potential, for soil and climate conditions of the area of study. The use of the pollinaza as organic fertilization, showed better agricultural yield and concentration of soluble solids for the three materials evaluated.
- In general terms, according to the conditions in which the research was developed the variety POJ 27-14 showed the better behavior.

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