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Effect of increasing doses of nitrogen on the technological quality of juice and sugar in virgin cane cultivation at the Sugar Company of Chad (CST) Banda

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Summary:** A study was conducted to determine the optimal level of nitrogen for a better performance of the virgin canes. The vegetal materiel is composed of the variety SP 70-1284. The materiel of laboratory is composed of an electric grinder ("Jeffco" food and fodder cutter grinder, model 265 B, set L 1710), a refractometer (Schmidt+Haensch, HARD-SW model, set 29129) and a polarimeter (Saccharomat Z, set 29305). The test was conducted with the variety SP 70-1284 as an experimental randomized complete block with 9 treatments, with 4 repetitions. The total doses of N of three contributions for the cycle of harvest (35, 70, 105, 140, 175, 210, 245, 280, 0 kg ha 1) correspond to the T1 treatments, T2, T3, T4, T5, T6, T7, T8 and T0. The T0 (14, 79 t s ha^{-1} ± 1, 03) recorded the weak quantity of sugar. The quantity raised of sugar has been observed on the T8 (16, 83 t s ha^{-1} ± 1, 09), T5 (16, 84 t s ha^{-1} ± 1,15) and T7 (16,94 t s ha^{-1}± 1,12). The weak rate of the Brix has been revealed on the T2 (22, 05% ± 0, 84). The T4 (23, 15% ± 0, 77), T3 (23, 21% ± 0, 21), T8 (23, 43% ± 0, 62) recorded the strong rates of the Brix. The elevated Pol rate is gotten with the T8 (20, 90% ± 0, 55), the lowest with the T2 (19, 45% ± 0, 80). The weak rate of Wealth Hugo Simplifiée (RHS) is recorded on the T2 (12, 84% ± 0, 55), the T8 (13, 87% ± 0, 45) got the elevated rate. The dose of 280 kg N ha^{-1} corresponding to T8 appears to be effective and can be used for the profitability of the variety SP 70-1280 to the Agro Industrial Complex of the CST-Banda in Chad.

***Keywords:** Saccharum officinarum, variety, wealth saccharin, mineral fertilization, Chad,*

INTRODUCTION

In the parcels of the Complex Agro Industriel of the CST Banda, the gotten average output, of the order of 80,7 t ha^{-1} of canes is weaker, in relation to other cultures of irrigated canes that can exceed 120 t ha^{-1}. And on the other hand, in relation to the outputs noted in most countries producers of sugar cane as Guatemala (107, 33 t ha^{-1}), Egypt (90, 24 t ha^{-1}) and Australia (86, 66 t ha^{-1}) (FAO, 2009). The production fluctuates from one year to the next because of a certain number of factors responsible of the weak outputs notably, the rarity of the irrigation water, the weak density of plant by unit of surface and the presence of the borers of the stems as well as the use inadequate of manures. Besides, the sugar cane is a culture of long cycle that requires a great deal of nutriments. In these conditions, it would be interesting to test the different increasing doses of nitrogen on the technological quality of juice and sugar. Otherwise, several studies valued the effects of the inorganic of manures on the cultures (Ndikumana and Lumpungu, 1987; Korndörfer and al., 2002;

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Fillols and Chabalier, 2007; Franco and al., 2010; Strong and al., 2013a, 2013b; Useni and al., 2014a, 2014b; Bekeko, 2014; Bidzakim and al., 2014; Asaduzzaman and al., 2014). Thus, inadequate use of fertilizers would be not one of the causes of low sugar yields recorded in the CST-Banda? then, in the setting of this work, we valued the agronomic performances of the variety SP 70-1284 in relation to the nitrogenous manure. A study was conducted to determine the optimal level of nitrogen (N) for the variety SP 70-1284 for a better output of sugar of the virgin canes

Materials and Methods

Study site

The experiment was carried out on the complex of Agro Industrial CST-Banda in southern Chad (latitude 09 ° 11 'N, longitude 18 ° 28'E, 365 m). It shelters a tropical climate Sudano-Guinean with a dry season marked by the harmattan (dry and hot wind) from November to March and a rainy season marked by the monsoon from April to by clear forests and savannas raised in the part October. The average rainfall is 1167.0 $mm.an^{-1}$, the maximum and minimum temperatures of 33.9 and 19.6°C respectively. The duration of exposure is approximately 2908.1 $h.an^{-1}$. Soils are leached ferruginous red, uniformly sandy clay to clay texture with a slightly acid pH surface and very deep acid (Naïtormbaïdé, 2012). The vegetation is characterized by clear forests and wooded savannas in the part of sudan area (DREM 1998). However, the experimental field having sheltered the test is not a fallow.

Plant material

The vegetal material is composed of the variety SP 70-1284. Its harvest cycle is 10 to 12 months. The variety was selected for its interesting agronomic characteristics (rate of sugar, erect port favorable to the manual work and the regularity of the height of the stems) and occupies 21% of the total surface of cane in the company CST-Banda. The level of intensification is improved (plowing, pest control, facility of harvest). The average yield in industrial is 90 $t\ ha^{-1}$

Laboratory equipment

The material of laboratory is composed of an electric grinder ("Jeffco" food and fodder cutter grinder, model 265 B, size 10, set L 1710), of a hydraulic press (Emidecau pinette Ind 125), of a refractometer (Schmidt+Haensch, HARD-SW model, set 29129). of a filter paper Whatman n°91, of a robust balance of precision of type Basic sp DINA, of basic lead acetate (hydroxideacetate of lead (II) or salt horne), of a 250 ml breaker, of the small bottles of 250 ml, a Sartorius precision balance and a polarimeter (Saccharomat Z, set 29305).

Dispositif experimental

The test was conducted with the randomized complete blocks with 9 treatments, with 4 repetitions. The experimental parcel is subdivided 36 fragmentary units measuring each 14,4 x m 10 m. The fragmentary unit is constituted of 8 furrows, therefore each received 2 rows of cuttings. The distance between the furrows is of 1, 40 m and the one enters the 2 rows is of 0,40 m is 8 x (1,40 m + 0,40) x 10 m = 144 m^2 for a fragmentary surface. The density to the plantation is 4 cuttings for 1 m what gives 640 cuttings by fragmentary unit. The different elementary parcels separated of the one meter alleys. The 6 central furrows of every elementary parcel (116 m^2) made the object of observations (analyses of saccharine, weight).

Conducted of culture

The elementary parcels underwent a deep ploughing to a depth of 50-70 cm, followed of a ploughing of 25-45 cm of depth and harrowing. The furrows were made at a depth of 10-20 cm on the lines of plantation. To avoid the infections of parasites, the machetes serving of cut of canes have been disinfected to formalin. The mode of plantation adopted is the one flatbed that consists

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to put the canes cut in the bottom of the furrows. In the beginning of the plantation, the doses of nitrogen were brought (16, 16, 16, 16, 16, 16, 16, 16, 0 kg ha^{-1}) to the bottom of the furrows. The doses correspond respectively to the T1 treatments, T2, T3, T4, T5, T6, T7, T8 and to the T0 witness used. Then, to two months after plantation, a second dose of nitrogen (19, 37, 37, 37, 37, 37, 37, 37, 0 kg ha^{-1}) correspondent to the T1 treatments, T2, T3, T4, T5, T6, T7, T8 and T0 were brought. And the later doses of nitrogen (0, 17, 52, 87, 122, 157, 192, 227, 0 kg ha^{-1}) correspondent to the T1 treatments, T2, T3, T4, T5, T6, T7, T8 and T0 were brought to 4 months. The total doses of nitrogen were brought for the cycle of harvest (35, 70, 105, 140, 175, 210, 245, 280, 0 kg ha^{-1}) that correspond respectively to the T1 treatments, T2, T3, T4, T5, T6, T7, T8 and T0. The manual weeding has been made to the stage young plants (beginning of tillering) and shortly before the rapid growth (4 months after levee or boom stage).

Sampling

The harvest has been done to the optimum of sugars to physiological maturity. Thus, the canes are burnt the evening at the eve of the harvest in order to eliminate the leaves of the canes. The following day morning, the stems of canes of six (6) central furrows of every elementary parcel were harvested by hand with the help of the machetes and were gathered in the field. Then, a sample of 10 canes has been selected randomly on every heap of the elementary parcels and has been brought to the laboratory for the analyses (Kouamé and al, 2010). This sample is constituted of 3 small stems, 4 middle stems and 3 big stems. The height and the diameter of the stems were measured and between nodes attacked by borers counted. The stems were cut to three pieces, a base, middle and top. Among the stems cut to pieces, 3 bases, 3 middles and 3 summits were taken to constitute a secondary sample of 9 pieces of cane. They were reconstituted to be grinding to the laboratory. Each sample has a label on which is marked the number of the blocks and treatments.

Grinding

The electric grinder with the throat of exit is equipped with a cyclone of air separation reducing the evaporation of the pulp. The sample has been deposited in totality in the grinder. The stones and all elements susceptible to damage the grinder blades have been withdrawn of the sample and thrown. The visual quality of the sample is recorded for information only, especially to signal the presence of soil or straw in big quantity. The pulp has been collected full in a bucket of plastic with its label of origin

Weighed of the pulp

The used electronic balance is the type basic DINA sp. It gives a weight in the grams. The pulp is weighed on the balance in a beaker for a weight of 500 g. What constitutes the sample for the pressing? The beaker is placed on the balance whose the calibration is performed by the analyzer. The pulp weight is equal to the measured weight to which one subtracts the weight of the beaker.

Pressing of the sample

This operation aims to extract the juice and to determine the weight of fiber (oilcake). The used hydraulic press is of mark pinette Emidecau Ind. 125. The sample is put in a perforated bowl press and is subjected to a pressure of 344 bars (200 bars manometric ± 5 bars) for a time of 1 minute 30 seconds. After pressing, the raw juice is collected into the beakers of 250 mL. The juice is homogenized carefully before the distribution for the measurement and analyses of Brix and Pol.

Calculation of the fiber

The fiber (oilcake) has been weighed on the same balance always in the beaker whose the load is obtained by the analyzer. Small bags of cloths who has been used to hold back oilcakes have also

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been weighed. The fiber (oilcake) to weigh has been put in the small bags of cloths. The numbers of the blocks and treatments have been marked above. These small bags have been put in the trays containing water for a period of 48 h to eliminate the juice of the residue which cannot be extracted by the press. The bags containing the fibers have been put in a steamroom to 90° c and have been dried for a period of 72 h. Then, the bags containing the dried fibers have been removed of the steamroom and have been weighed. The rate of fiber has been determined the help of a correspondence table from the weight of the oilcake (fiber) gotten after pressing the ground material. The calculation of the fiber has been done on the basis of the following formula:

F (%) = (Weight of cake section - Weight of bag empty) / 5

Determination of the content in sugar of juice extracts

The juice extract of the pulp of each treatment is recovered in the 250 ml beakers. Brix (content of soluble dry matters) of the extract was measured to the help a refractometer at 20 ° C. This measurement includes sucrose, the reducing sugars as well as the organic materials. The same extract was purified by the method of Horne with basic lead acetate (Horne salt) at a rate of 2.5 g per 250 ml of undiluted juice (ICUMSA GS5 / 7-1, I994 and cited by Hoareau al, 2008) and the whole is homogenized. Juice has been filtered with the paper of Whatman 91 in the small bottles of 250 ml and the Pol has been read with the help of a polarimeter. Filtration to the lead acetate has for goal to retain the elements organic and minerals who are contained in the raw juice to obtain a colorful and clear juice, suitable to the polarimeter of measure. The table relative Schmidt to the saccharimeter serves to the determination of Pol of juice in the Brix and the read Pol. The purity of juice corresponds to the rate of Pol in the Brix. The wealth saccharin (RHS) corresponds to the product of Pol juice, has been calculated (Hoarau, 1970). Finally, the sugar content (SE %) and the yield of extractable sugar (TSE / ha), the most relevant evaluation criteria, who takes into account the yield of cane and the technological qualities were calculated:

SE (%) = [(0.84% x Pol c) (1,660) - (0.05 x Fibre% c)] / Purity;

TSE / ha (%) = (SE% x Tc Ha.) / 100; Purity (%) = Pol / Brix x 100;

RHS (%) = (Purity - 30) x Bc / Tc 100: Tons of cane; Bc: Brix corrected; Ha ha; RHS: Wealth Hugo Simplified; SE%: Percentage extractable sugar; Pol c%: Percentage of Pol cane; Fibre % c: Percentage of fiber cane

The measured and registered parameters

The agronomic parameters are carried on: the output in sugar

The technological parameters are carried on: the Brix, the Pol, the RHS and the Purity.

2.3.10 statistical analysis

Data have been analyzed with the software SPSS (Statistical Package heart Social Sciences, version 16.0). The averages of the different parameters separated by the test of multiple arrangement of Student - Newman - KeulS (SNK).

RESULTS

The overall sugar yield varies from one treatment to another based on the performance of canes (no represented). The T0 treatments (14, 79 t s ha^{-1} ± 1, 03), T1 (15, 58 t s ha^{-1} ± 1, 76) and T2 (15, 89 t s ha^{-1} ± 0, 66) recorded the weakest quantity of outputs. On the other hand, with the T8 treatments (16, 83 t s ha^{-1} ± 1, 09), T5 (16, 84 t s ha^{-1} ± 1, 15) and T7 (16, 94 t s ha^{-1}± 1, 12), we have the best yields (figure 1).

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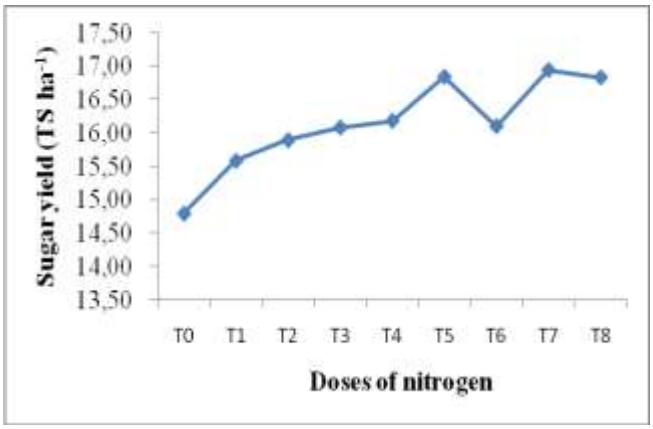

Figure 1: weight of sugar

In the same way, the variance analysis didn't reveal a meaningful difference with regard to the output of sugar to the doorstep of 5% (F = 1,208; P = 0,339). So, the output of sugar evolves of linear manner with the different treatments. The different doses of nitrogen didn't act in the same way on the different technological parameters of the variety SP 70-1284. Indeed, the rate of the weakest Brix is revealed by the T2 treatment (22, 05% ± 0, 84). Whereas the most elevated rates are obtained with the T4 treatments (23,15% ± 0,77), T3 (23,21% ± 0,21), T8 (23,43% ± 0,62) and T7 (23,07% ± 0,36) (figure 2).

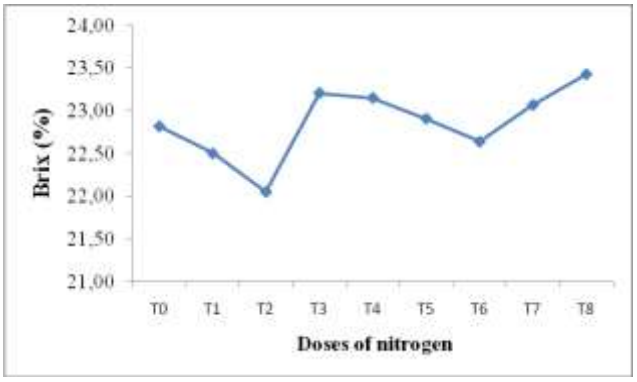

Figure 2: Brix Rate

So, the rate of the Brix doesn't evolve linearly with the doses of N brought. The variance analysis showed that there is a significant difference between the treatments regarding the Brix to the doorstep of 5% (F = 2,574; P = 0,034).

The rate of Pol reveals a pace similar to the one of rate of the Brix (figure 3).

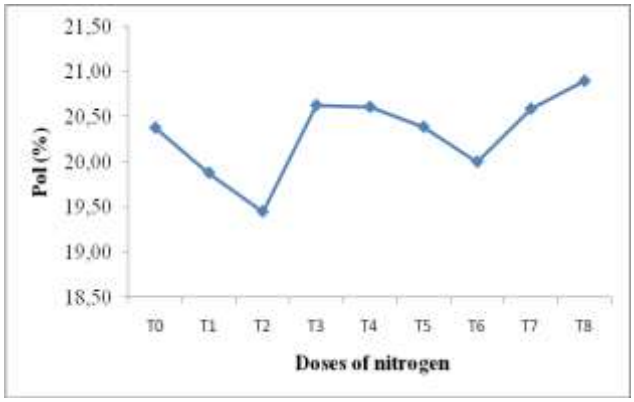

Figure 3: Pol rate

But it tends to evolve according to the different treatments of Nitrogen. The most elevated Pol rates are gotten with the T8 treatments (20,90% ± 0,55), T3 (20,63% ± 0,34), the lowest rates with the T2 treatments (19,45% ± 0,80) and T1 (19,88% ± 1,27). However the variance analysis showed that meaningful difference doesn't exist between the treatments of the Pol viewpoint to the doorstep of 5% (F = 1,809; P = 0,125). The rate of purity of juice is represented on the figure 4.

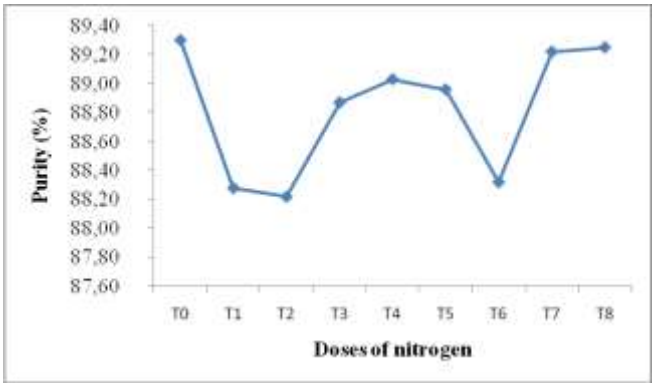

Figure 4: Juice purity rate

The rates of purity are the same whatever the doses of nitrogen who were brought. The weakest rate is recorded on the T2 treatment (88, 22% ± 0, 56) but the highest rate is obtained with the T0 treatment (89,30% ± 0,25) and is followed of the T8 treatment (89,25% ± 2,01). The curve of the purity rate has a sinusoid pace. Indeed, the rate of purity reached its maximum with the T0 treatment before decreasing with the T2 treatment and to increase with the T7 treatments and T8. The variance analysis revealed that there is no

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significant difference between the treatments to the doorstep of 5% (F = 0,320; P = 0,953). The rates of wealth of saccharin are reported on the figure 5.

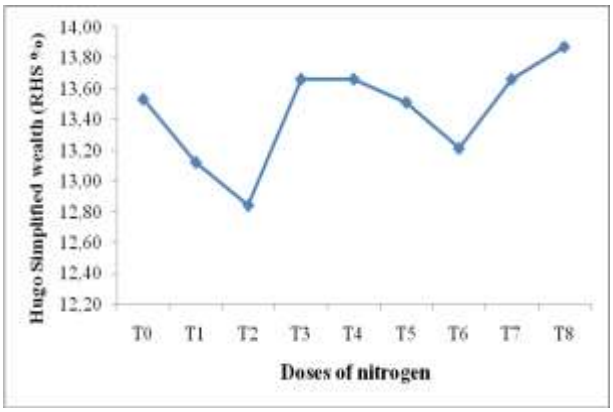

Figure 5: Simplified Hugo Wealth (HHR)

The weakest rate of Wealth Hugo Simplifiée (RHS) is recorded on the T2 treatment (12, 84% ± 0, 55). On the other hand the T8 treatment (13, 87% ± 0, 45) got the most elevated rate. The rate of the RHS believes with the T0 treatment to decrease with the T2 treatment and reaches its maximum then with the T8 treatment. However, the variance analysis revealed that there is no significant difference between the treatments to the doorstep of 5% (F = 1,410; P 0,210).

DISCUSSION

For the parameters agronomic and technological studied, no meaningful difference has not been put to the evidence between the different treatments with regard to the outputs of sugar. Indeed, the outputs of observed sugar were linearly different between the different treatments, because of the variation of the outputs of canes by hectare. These results confirm those obtained by Orlando Filho et al, (1999), Korndörfer et al., 2002; Trivelin et al., (2002) and Strong et al., (2013). Also similar results were reported by the work of Fillols and Chabalier, (2007) which demonstrated that the elevated doses of nitrogen would increase of the output that goes from pair with a linear reduction of sucrose level. But, in general, the increase of output of canes compensates the decrease of wealth and the output of sugar to the hectare increases (Fillols and Chabalier, 2007). The statistical analysis of the results showed that there is a significant difference between the treatments with regard to the rate of the Brix to the doorstep of 5%. The soluble dry matters in presence of impurities correspond to the Brix. In the case of our survey, it has been noted that the percentage of the Brix increased when the dose of nitrogen increased. Thus, the different levels of N had a meaningful effect on the rate of the Brix. Therefore, the percentage of soluble dry matters in the juice of cane has increased. Nevertheless, Ambachew and Abiy (2009); Franco and al, (2010) didn't observe any meaningful effect with different doses of N on the percentage of the Brix with the virgin cane.

These results don't confirm with those obtained in this work. Analysis of variance revealed that there is no significant difference between treatments in relation to the rate of Pol to the doorstep of 5%. Orlando Filho and Zambello Junior (1980) cited by Franco et al, 2010) reported that the Pol rate decreased with a nitrogen dose of 480 kg ha^{-1}. Franco and al., (2010) obtained no significant difference with increasing doses of N (0, 40, 80, and 120 kg ha^{-1}) with the virgin cane. Similarly, Ambachew and Abiy (2009) have also had no significant effect with different levels of N (0, 23, 46, 69, 92, 115, 138 kg ha^{-1}) on the Pol virgin cane. But, they noted that the percentage of Pol decreased when the quantity of N increased. This confirms that the nitrogen affects the technological quality of the sugar cane. However, in the case of our survey, the gotten results are heterogeneous when the quantity of N increased. This survey confirms that the different doses of N didn't have a meaningful effect on the rate of the Pol. It is in conformity with the results obtained by Franco and al (2010) and Ambachew and Abiy (2009). The variance analysis showed that there is not a meaningful difference between the different treatments of the viewpoint of juice purity to the

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doorstep of 5%. Therefore, the average purity level is statistically the same for all treatments. The mentioned test has been achieved in the setting of the system of the burnt canes. This can probably influence the quality of juice by the presence of the ash and the borers of stems even though it is not verified in the present work. Excess nitrogen is probably detrimental to the technological quality of sugarcane (Fillols and Chabalier, 2007). But in the case of our study, it has been noted that the nitrogen did not affect the purity of the juice. This could be due to an early intake N therefore the high level has been minimized on the quality of the juice during the maturity. Similar findings were reported by Ambachew and Abiy (2009); Franco and al., (2010) who have found no significant effect with the different doses of nitrogen on the purity of juice of the virgin canes. As for the rates of sucrose wealth (RHS), the statistical analysis of the results didn't reveal a meaningful difference between the treatments to the doorstep of 5%. Indeed, the result showed whatever the dose of nitrogen who is applied to the sugar cane cultivation in the agro-industrial area of Band-CST, the average wealth per hectare is almost the same. The works of Franco and al., (2010) showed that increasing nitrogen doses caused a meaningful reduction of the concentration of sucrose. it has been demonstrated that the high doses of nitrogen reduce the concentration of the total soluble sugars of several gramineous (Leblanc, 2010). In the same way, Silveira and Crocomo (1981) cited by Franco and al., (2010) reported that the rate of sucrose of the virgin cane also decreases with a higher level of nitrogen. On the other hand, Espironelo and al., (1977) verified that the high rate of nitrogen in the virgin canes didn't influence on wealth of sucrose. However, Espironelo and al., (1987) obtained no significant difference on the rate of sucrose with the increase of nitrogen (0, 70, 140 and 210 kg ha^{-1}). These results corroborate with the results of the present work.

Conclusion

According to the results obtained, the study of virgin canes on the answer of nitrogen in relation to the output of sugar and to the technological quality, the T8 treatment induced a significant increase of the rate of the Brix without discrimination of the other studied parameters (Pol, RHS, Purity and output in sugar) between the averages of the different treatments. To this effect, the dose of the 280 N kg ha^{-1} corresponding to the T8 treatment seems more effective than the other treatments. Therefore, it can be used for the profitability of the variety SP 70-1280 to the Agro Industriel Complex of CST-Banda in Chad

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