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Short Culmination

Evaluation of Different Agam Propagation Methods and Planting Technologies in The Production of Categorized Sugar Cane Seeds in Cuba

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Abstract

The results of two studies in areas of the Registered Seed Bank of the Ciudad Caracas Sugar Company in the province of Cienfuegos are presented, where two methods of agamic propagation (Cuttings and Vitroplants) and two planting technologies (distance between rows at 1 .50 m and 1.80 m), the cultivar used was C10-166, the evaluation was carried out at 11 months of age. The area of the plots of the experiment with traditional technology was 60 m2 and that of the Wide Base was 72 m2. The variables studied were t cane ha-1, stem length (cm), stem diameter (cm) and number of stems m-1, as well as the economic value of propagation by cuttings comparing both planting technologies. The randomized block design with three repetitions was used, simple variance analysis and mean comparison test were performed using the Multiple Range test with Tukey's test (p<0.01 and p<0.05), in addition regressions were performed, of first and third order to determine the variables with the greatest influence on agricultural performance. The results obtained were significant increases in the variables number of stem m-1 and t cane ha-1 in favor of propagation by vitroplants, the broad-based planting technology surpassed the traditional one in stem production and agricultural yield, the number of stems m-1 linear had a positive and significant relationship with sugarcane production and the Benefit/Cost relationship was positive.

Kew Words: planting technologies, propagation methods

Introduction

In sugarcane cultivation, the use of high-quality propagative material is of utmost importance, since it is used for the reproduction of plantations (Jorge *et al*., 2019). The above justifies the need to continue carrying out research in the different categories of seed with adapted and highly productive varieties with the intention of increasing the production (quality and profitability) of the mills (Alfaro *et a*l., 2007).

The production and use of high quality seed plays a determining role in the development and comprehensive improvement of sugarcane agriculture, which constitutes a decisive technological step in obtaining high agricultural and sugar yields per unit of cultivated area. This activity, together with the use of resistant varieties, has become the most important and almost exclusive element available to have healthy plantations.

The agamic multiplication of sugarcane (Saccharum spp.) favors the spread of diseases caused by pathogenic organisms, among which the following stand out: mosaic (Sugarcane mosaic virus), leaf scald (*Xanthomonas albilineans* (Ashby) Dawson), smut (Ustilago scitaminea Sydow) and shoot rickets (Leifsonia xyli subsp. xyli) (Glyn, 2005).

It is important to note that the expenses involved in seed production are cushioned by the expected benefits, which can far exceed the investments, since concentrating efforts for phytosanitary control on the seed is always preferable and more economical than running the risk of spreading on a commercial scale, a pathology transmissible through planting material. (INICA 2021).

A strong seed industry is essential for the supply of vigorous propagation material to producers and for the prospective development of the agricultural sector. Planting sugarcane with categorized seeds is the simplest and most important step to increase crop yields, as an integral part of its agronomic management strategy (Jorge *et al*., 2018).

One of the factors that limits the production of sugar cane is the use of seeds of low phytosanitary quality, since sometimes seeds from commercial areas not from the chain of the seed system (Basic, Registered and Certified) are used. that may be affected by diseases. (Jorge et al., 2020)

Classic methods for the production of healthy sugarcane seed use heat treatments (water or hot air) and the application of chemical products to eliminate pathogenic organisms that affect the crop (Hoy and Flynn, 2001; Glyn , 2005). Furthermore, tissue culture techniques have made it possible to obtain seeds with high genetic purity, health and vigor; For this reason, its use has spread in many sugarcane-growing countries (Pérez-Ponce, 1998; Hoy and Flynn, 2001; Glyn, 2005; Guevara and Ovalle, 2005).

Different authors agree that the seed from micropropagation generally has a greater number of stems, height and weight of the stems and greater cultural and sugar/plot yield than the seed obtained conventionally by cuttings, with or without heat treatment (Anderlini and Kotska, 1986; Jiménez *et al*., 1991; Santana *et al*., 1992; Pérez Ponce, 1998; Comstock and Miller, 2004; Flynn et al., 2005). Jorge *et al*., (2020) pointed out that the response of two cultivars evaluated in the plant cane and first shoot or soca strains, confirmed that the agamic reproduction methods by one-bud cuttings, three-bud cuttings (with prior soaking in water with circulation for 24 hours, heat treatment at 51 ^{0}C for one hour and chemical treatment for fifteen minutes) and vitroplants are effective and safe from a phytosanitary point of view to avoid the presence of Xanthomonas albilineans.

Categorized seed production is a practice of great importance in all agricultural crops because it allows high populations and high agricultural yields to be achieved. The Cuban seed system for the cultivation of sugar cane has 11 Basic Seed Banks and 61 Registered Seed Banks, which have good infrastructure, adequate phytotechnical conditions (irrigation, machinery, productive soils, etc.) and qualified human resources. However, the certified seed areas in Cuba only have 30% under irrigated conditions, so the majority of the seed is controlled, since it does not meet the requirement to be certified as categorized seed. In Cuba, around 70% of the planting is carried out in the period of May-June, at this stage is when the seed deficit is most accentuated since the entire period of least precipitation has passed (November - April) and the seed material propagation is not suitable, hence the importance of increasing yields in seed banks to be able to allocate part of the areas for the production of certified seed, where broad-based planting technology can be an alternative.

This technology provides important benefits for sugarcane production. Among the most relevant are the increase in the population of the fields, better weed control with savings in the number of cleanings and the application of herbicides, greater control of equipment traffic along the median and therefore a decrease in compaction and increase in agricultural yield (Labrada *et al*., 2018).

The objectives of this work were:

1- Compare the components of agricultural yield and sugarcane production in plants reproduced by cuttings and by vitroplants with different planting technologies
2- Evaluate the wide-based furrow planting technology compared to the traditional one (1.50 m) in areas of categorized sugarcane seed with two agamic reproduction methods.
3- Determine the variables that have the greatest influence on t cane ha^{-1}

Materials and Methods

Study Location, Cultivars, Reproduction Methods and Planting Technologies.

The study was developed in the Registered Seed Bank (BSR) of the Ciudad Caracas Sugar Agroindustrial Company in Cienfuegos, located in the town of Manaquita, municipality of Lajas, on Brown soils with carbonate (Hernández et al., 2015). Two experiments were planted in the month of September 2022 and the cane plant was harvested in August 2023, at 11 months of age, the cultivar used was C10-166. Table 1 reflected the treatments used.

Experiments	Agamic Propagation Methods	Planting Technology
Experiment 1	Three-bud cuttings and vitroplants	Traditional (1.50 between rows or furrows)
Experiment 2	Three-bud cuttings and vitroplants	Wide Base (1.40 +0.40).

Table 1. Cultivars, Reproduction Methods and Planting Technologies

Experimental design and variables studied

The area of the plots of the experiment with traditional technology was 60 m^2 (4 rows of 10 m long at a distance between rows of 1.50 m) and the Wide base was 72 m^2 (4 rows of 10 m long at a distance between furrows of 1.80 m). The variables studied were agricultural yield (t cane ha-1 and its components (length of stems (cm), diameter of stems (cm) and number of stems m-1) as well as the economic valuation in propagation by cuttings. comparing both planting technologies. The randomized block design with three repetitions was used.

Statistic analysis

Simple variance analysis and means comparison test were performed using Multiple Range Test with Tukey's test ($p<0.01$ and $p<0.05$) in both experiments. A comparison was also made between the planting technologies with a similar method. of reproduction between the two experiments (it was compared in the reproduction by cuttings planted at 1.50 m between plants (experiment 1) and the wide base (experiment 2), in the same way for the propagation by vitroplants, in addition, regressions of first and third order to determine the variables with the greatest influence on agricultural performance.

To estimate the diameter and height in each plot, 20 stems were chosen at random, while the number of stems was assessed with the total count of the stems of the two central furrows of each plot of the experiments divided by the furrow length (10m).

Agricultural yield was estimated in accordance with what was reported by Martíns and Landell (1995).

t cane ha^{-1} = D^2*h* number of stems linear m^{-1}* (0.007854/ distance between rows)

Where: D^2: diameter squared h: height or length of the stem, and 0.007854 constant.

The statistical processing of the experimental agricultural database was carried out using the Statographics-plus-5.0 statistical package.

For the economic valuation, the cost and price sheet for one hectare of cane planting by the traditional method was taken into account without including the seed (11077 cup) established by AZCUBA, in the case of the wide base it increased by 18.55 %, the cost of basic seed (for a hectare of cane at 1.50 m between plants is 10 ton ha^{-1}, while for the wide base it was estimated at 17.6 ton ha^{-1}), the cost of harvesting and The price per ton of Registered Seed II is also the one established by Grupo Azucarero AZCUBA, the cost of cultural services (for the wide base was 11.43% less because the field closes earlier and comprehensive cleaning tasks decrease).

Results and Discussion

Experiment 1.

The analyzes of variances of Experiment 1 showed significant differences for the stem length, the number of stems linear m^{-1} and the t cane ha^{-1}, in all cases the reproduction by vitroplants was superior to the reproduction by cuttings. Digonzelli *et al*., (2009), in sugarcane seed studies developed in Argentina, obtained positive increases in stem length, number of stems and cane production, when they used vitroplants as planting material, compared to with reproduction by cuttings.

F. Variation	DF	S. squqres	M. squqres	Sig.
Treatments	1	793,5	793,5	**
Mistake	4	157,33	39,33	
X ± ES		248,17± 3,62		

Table 1. Results of the analysis of variance for stem length.

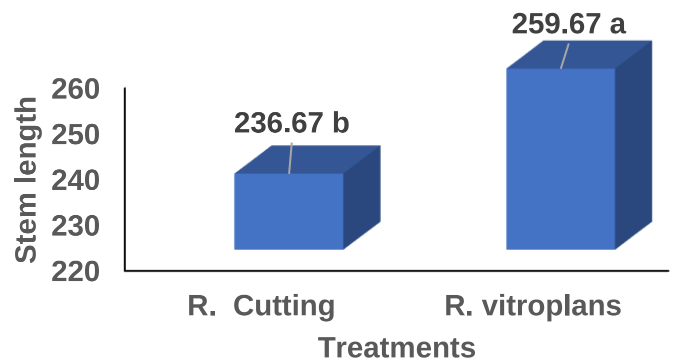

Figure 1. Comparison between treatments

F. Variation	DF	S. squqres	M. squqres	Sig.
Treatments	1	0,03	0,03	ns
Mistake	4	0,02	0,004	
X ± ES		2,72± 0,04		

Table 2. Results of the analysis of variance for stem diameter

F. Variation	DF	S. squqres	M. squqres	Sig.
Treatments	1	29,93	29,93	**
Mistake	4	1,87	0,47	
X ± ES		14,03± 0,39		

Table 3. Results of the analysis of variance for the number of stems m^{-1}

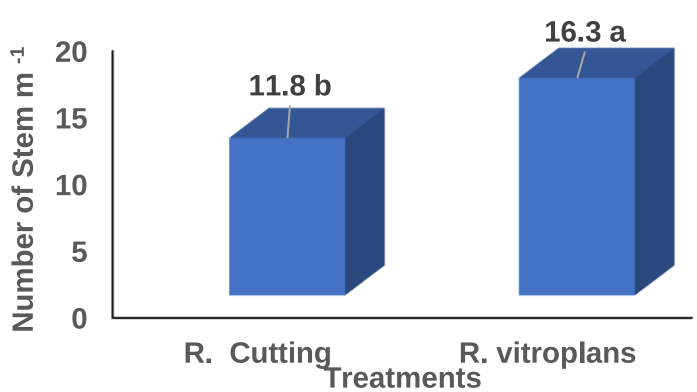

Figure 2. Comparison between treatments

F. Variation	DF	S. squqres	M. squqres	Sig.
Treatments	1	1932,14	1932,14	**
Mistake	4	163,92	40,98	
X ± ES		119,28± 3,70		

Table 4. Results of the analysis of variance for t cane ha^{-1} (TCH)

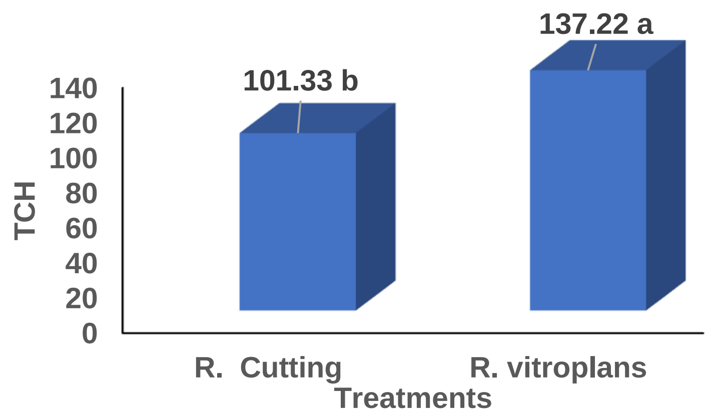

Figure 3. Comparison between treatments

Experiment 2.

In this study, only the variables number of stems linear m^{-1} and cane production showed significant differences, also in favor of vitroplants, which confirmed what was reported in the previous test. Jorge *et al*., (2020) pointed out, the number of stems and the t cane ha^{-1} of the plants from vitroplants was higher than those of the cuttings.

F. Variation	DF	S. squqres	M. squqres		Sig.
Treatments	1	37,5	37,5		ns
Mistake	4	250,0	62,5		
X ± ES		237,5± 4,56			

Table 5. Results of the analysis of variance for stem length

F. Variation	DF	S. squqres	M. squqres		Sig.
Treatments	1	0,03	0,0,3		ns
Mistake	4	0,02	0,004		
X ± ES		2,62± 0,04			

Table 6. Results of the analysis of variance for stem diameter

F. Variation	DF	S. squqres	M. squqres		Sig.
Treatments	1	36,51	36,51		**
Mistake	4	5,23	1,31		
X ± ES		18,87± 0,66			

Table 7. Results of the analysis of variance for number of stems m^{-1}

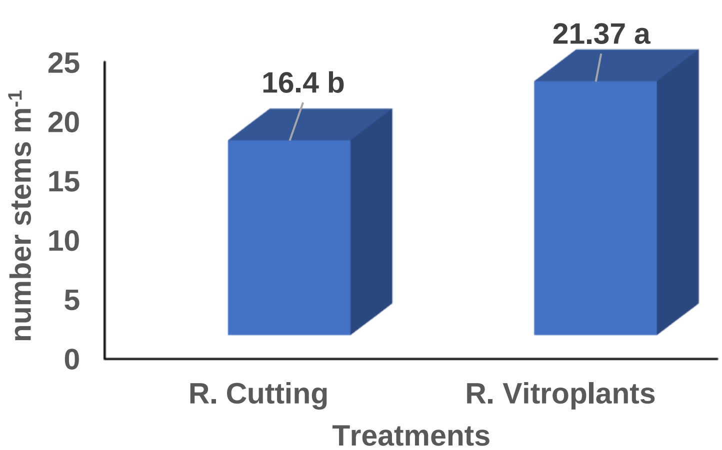

Figure 4. Comparison between treatments

F. Variation	DF	S. squqres	M. squqres		Sig.
Treatments	1	1082,73	1082,73		*
Mistake	4	297,02	74,26		
X ± ES		143,66 ± 0,66			

Table 8. Results of the analysis of variance for t cane ha^{-1} (TCH)

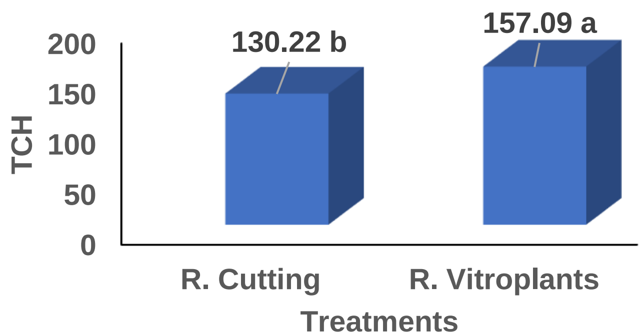

Figure 5. Comparison between treatments

Comparison Between Plantation Technologies with Similar Form of Reproduction in the Variable t cane ha^{-1}

The results of this comparison both in propagation by cuttings and by vitroplants expressed significant differences between the treatments (Tables 9 and 10). The broad-based planting method in both cases outperformed the traditional one. Labrada *et al.*, (2018) in commercial areas stated that agricultural performance, in all cycles and strains evaluated, showed that broad-based technology significantly exceeded traditional technology (1.60) during the 2017-2018 harvest and An increase of 34.4% increase in agricultural production was achieved.

Jorge and Suárez (2020) in categorized seed areas reflected that the variables number of stems and t cane ha^{-1} achieved significant increases when the wide-based planting system was used in the plant cane and shoot strains.

F. Variation	DF	S. squqres	M. squqres		Sig.
Treatments	1	1251,95	1251,95		*
Mistake	4	188,46	47,11		
X ± ES		115,78 ± 3,96			

Table 9. Results of the analysis of variance for t cane ha^{-1} (TCH). Planting by cuttings

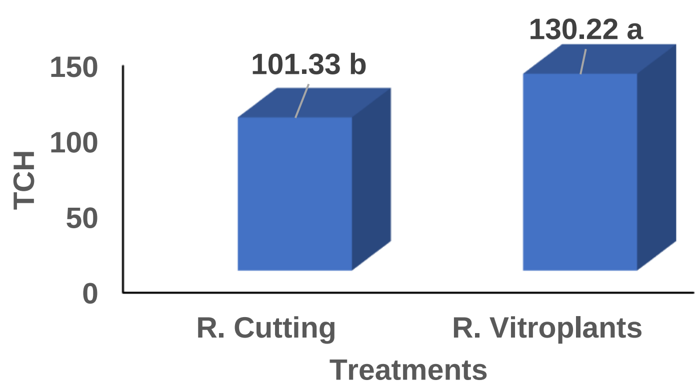

Figure 6. Comparison between treatments

F. Variation	DF	S. squqres	M. squqres		Sig.
Treatments	1	592,03	592,03		*
Mistake	4	272,48	68,12		
X ± ES		147,16 ± 4,77			

Table 10. Results of the analysis of variance for t cane ha^{-1} (TCH). Planting by wide base

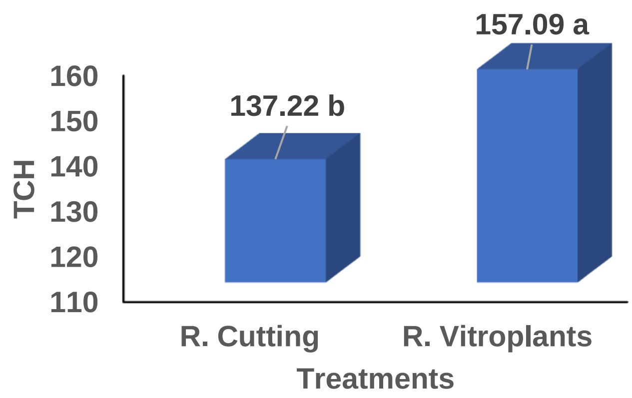

Figure 7. Comparison between treatments

Table 11 showed that Wide Base planting technology had a positive effect on the benefit/cost ratio.

Treatments	Traditional	Wide Base
Planting cost without including seed	11077	13132
Seed Cost	15238,8	26820,29
Harvest cost/ton	231,46	231,46
Total cost from harvest	23453,8418	31760,9412
Attentions cultural	4288,41	3798,27
Total planting cost	**26315,8**	**39952,29**
Performance in T cane ha^{-1}	101,33	137,22
Price per ton of registered seed	1220	1220
Total sales value	**123622,6**	**167408,4**
Benefit in CUP	**73852,9582**	**95695,1688**
Real Profit in CUP	**69564,5482**	**91896,8988**
Difference		**22332,3506**
Benefit/cost ratio		**1,3210**

Table 11: Economic valuation. Traditional planting technology

Relationship between the component variables of agricultural yield with cane production.

Figures 7, 8 and 9 expressed that for the conditions of these studies, as the number of stems increased, cane production increased, reaching a coefficient of determination (R^2) greater than 89%, while the stem length variables and stem diameter, its best fit was with a third order relationship and in both cases the R^2 was low, however the height achieved more than 46% and the diameter less than 14%. These results confirmed those expressed by Mariotti (1977) and Jorge *et al*., (1989), who indicated that the number of stems and stem length are the variables that have the greatest influence on agricultural yield (t cane ha^{-1}).

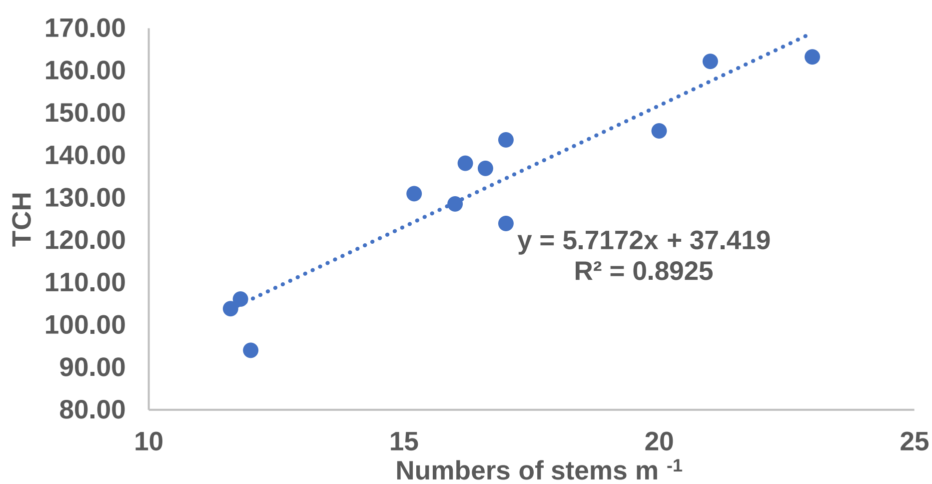

Figure 7. Relationship between the numbers of stems m^{-1} and the t cane ha^{-1}

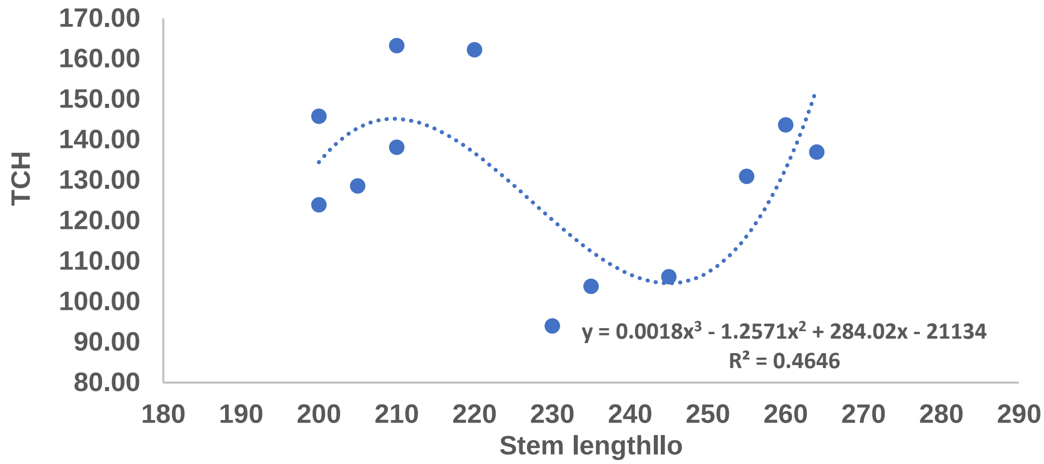

Figure 8. Relationship between stem length and t cane ha^{-1}

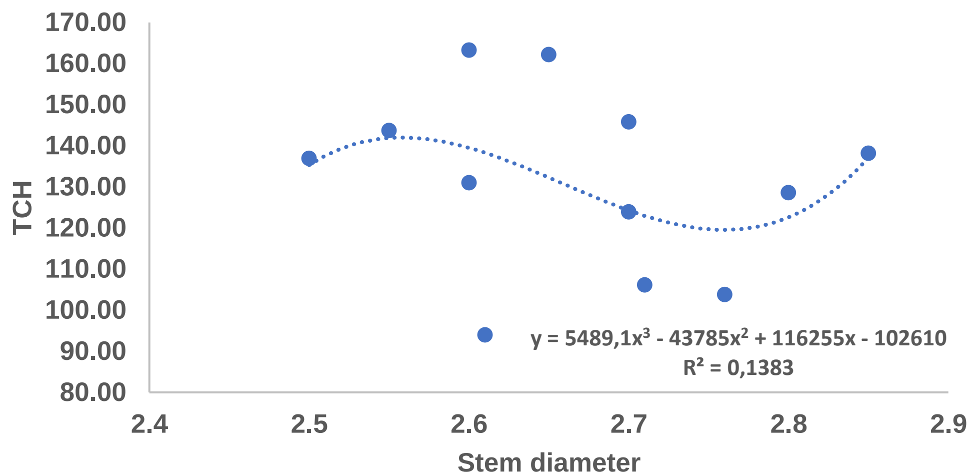

Figure 9: Relationship between stem diameter and t cane ha-1

Conclusions

1. Significant increases were achieved in both studies in the variables stem number m^{-1} and t cane ha^{-1} in favor of propagation by vitroplants, which are important components in seed production.
2. The wide-based planting technology surpassed the traditional one (1.50 m) in the production of stems and agricultural yield in the two agamic propagation methods, so it is advisable to increase the areas of categorized seed of cane. sugar with it.
3. The Benefit/Cost ratio expressed positive results (1.32) in the wide-based planting technology when planted with cuttings
4. The variable number of stems m^{-1} linear had a positive and significant relationship with agricultural yield, which confirms it as the component that exerts the greatest influence on sugarcane production.

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