

Analysis of high quality seed cane production of Registered Nurseries in Tucumán, Argentina, from 2008 to 2012

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ABSTRACT

In 2000/2001, in Tucumán province (Argentina) Estación Experimental Agroindustrial Obispo Colombres (EEAOC) started to conduct Vitroplantas Project, with the aim of producing high quality seed cane of commercial varieties already grown in the province, and promoting the rapid spread of new cultivars released by the EEAOC Sugarcane Breeding Program (PMGCA-EEAOC). This top quality seed cane presents either no incidence or only minimum incidence of systemic diseases (ratoon stunting disease and leaf scald) and pests, and is vigorous and completely true to type. The use of this type of seed contributes to controlling the spread of systemic diseases and increasing crop productivity. Under the terms of EEAOC Vitroplantas Project, high quality seed cane is produced by means of meristem culture and micropropagation techniques. The seedlings thus obtained are subsequently acclimatized in greenhouses and then multiplied in the field, specifically in plots used as part of a nursery network, which comprises a Basic Nursery and Registered and Certified Nurseries. This work particularly analyzes variety distribution, high quality seed cane production levels, and sanitary status of the Registered Nurseries of EEAOC Vitroplantas Project (Tucumán), during the last five years (2008-2012).

Key words: high quality seed cane, nurseries, micropropagation.

RESUMEN

Análisis de la producción de caña semilla de alta calidad en semilleros Registrados en Tucumán, R. Argentina, desde 2008 hasta 2012

En 2000/2001, la Estación Experimental Agroindustrial Obispo Colombres (EEAOC) inició el Proyecto Vitroplantas. Los principales objetivos de este proyecto son producir caña semilla de alta calidad de las variedades ya difundidas comercialmente y favorecer la rápida difusión de las nuevas variedades liberadas por el Programa de Mejoramiento Genético de Caña de Azúcar de la EEAOC (PMGCA-EEAOC). Esta caña semilla de alta calidad se caracteriza por presentar ninguna o mínima incidencia de enfermedades sistémicas (RSD y escaldadura de la hoja) y de plagas, además de tener un elevado vigor y una identidad genética garantizada. El empleo de este tipo de simiente permite controlar la propagación de enfermedades sistémicas e incrementar la productividad de los cañaverales. En el Proyecto Vitroplantas-EEAOC, la producción de caña semilla de alta calidad se realiza empleando las técnicas de cultivo de meristemas y micropropagación. Los plantines así obtenidos se rustican en los invernáculos y luego se multiplican en el campo, utilizando un esquema de semilleros: Básico, Registrados y Certificados. En el presente trabajo, se analiza la distribución de variedades, los niveles de producción de caña semilla de alta calidad y el estado sanitario de los semilleros Registrados del Proyecto Vitroplantas- EEAOC (provincia de Tucumán), durante los últimos cinco años (2008-2012).

Palabras clave: caña semilla de alta calidad, semilleros, micropropagación.

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INTRODUCTION

Sugarcane is commercially multiplied by means of cane setts, called "seed cane". This kind of agamic propagation favors the spread of systemic diseases, among which the most important is ratoon stunting disease (RSD). RSD is caused by a bacterium, *Leifsonia xyli* subsp. *xyli*, and plants thus affected present no visible symptoms. Unfortunately, all varieties planted in Tucumán province (Argentina) are susceptible to this disease, which causes important production losses (Gillaspie Jr. and Davis, 1992; Victoria *et al.*, 2004; Glyn, 2005).

Other important systemic sugarcane diseases in Tucumán are: leaf scald (caused by *Xanthomonas albilineans*), *Sugarcane mosaic virus* (SCMV), and sugarcane smut, whose causal agent is *Sporisorium scitamineum*.

Traditionally, cane growers in Tucumán have used the same cane they deliver to the mills as seed for planting, without paying attention to issues such as seed cane health, vigor and genetic identity, which are attributes of high quality seed cane. The lack of seed cane that would meet such standards has posed a limit to sugarcane crop production in Tucumán for years (Scandaliaris *et al.*, 1999).

In 2000-2001, Estación Experimental Agroindustrial Obispo Colombres (EEAOC) gave origin to Vitroplantas Project, which primarily aimed to produce high quality seed cane from the varieties already commercially planted in the province, and to promote the quick spread of new varieties released by the EEAOC Sugarcane Breeding Program (PMGCA-EEAOC). Such high quality seed cane produced by Vitroplantas Project is free from systemic diseases (RSD and leaf scald) and pests, or presents minimum incidence levels of these. Moreover, this material is highly vigorous and has a guaranteed genetic identity.

By using this type of seed, it is possible to control the spread of diseases, especially RSD, and to enhance crop productivity (Digonzelli *et al.*, 2010).

In Vitroplantas Project (EEAOC), high quality seed cane is obtained through meristem culture techniques and micropropagation. Such seedlings are acclimatized in a greenhouse and later multiplied in the field, in a complex of nurseries: the Basic Nursery and Registered and Certified Nurseries (Digonzelli *et al.*, 2005; Giardina *et al.*, 2010). These are plots where high quality seed cane is reproduced, ensuring that its health, genetic identity and vigor standards are kept by proper management and control measures. These stages of multiplication in the field are necessary to make enough seed cane available for commercial planting (Guzmán *et al.*, 1993; Victoria *et al.*, 1997; Victoria *et al.*, 1999; Digonzelli *et al.*, 2010).

The Basic Nursery is planted with those *in vitro* produced seedlings, which have also been acclimatized in EEAOC greenhouse facilities, and seed cane thus

multiplied is used, at its plant cane and first ratoon crop ages, to plant the Registered Nurseries. The material produced in the latter is used to plant Certified Nurseries, which eventually supply seed cane for commercial plantations (Digonzelli *et al.*, 2009).

The management and control of the Basic Nursery remain exclusively under EEAOC technicians' charge. The Registered Nurseries are controlled by seed cane growers, who are properly advised and controlled by EEAOC professionals. Seed cane growers assume full responsibility for the management of the Certified Nurseries, but may turn to EEAOC technicians for counseling whenever they deem it necessary (Digonzelli *et al.*, 2005).

This work analyzes variety distribution, high quality seed cane production levels and sanitary conditions of the Registered Nurseries of EEAOC Vitroplantas Project in Tucumán province, throughout the last five years (2008-2012).

DESCRIPTION OF THE ANALYSIS

The Registered Nurseries comprise fields which belong to mills, cooperatives and cane growers (seed cane producers). These plots are managed by seed cane growers, in accordance with the particular productive schemes and facilities available in each nursery. Nonetheless, they receive counseling and support from EEAOC professionals, who also control phytosanitary conditions in these plots.

EEAOC technicians assist growers in charge of the Registered Nurseries during planting, ensuring that proper agronomic management practices are followed, and keeping a record of rows planted with each variety.

In April, apart from sampling for RSD and leaf scald presence, EEAOC staff also estimates seed cane production per variety in each plot. Thus three spots are chosen at random in each plot (replications) and three 10-meter-long rows are tagged. In each of these three tagged rows, stalk number along those 10 meters is recorded for each variety. With values corresponding to average stalk number in 10-meter-long rows and average weight of 30 stems, peeled and topped at natural breaking point, seed cane production is estimated for each variety planted in the nursery plot. These results are contrasted with the ones obtained by the seed cane growers when the growing season comes to an end, and if these values do not coincide, the average is considered.

In this work, production values were calculated using the averages estimated according to row number of each variety, and every event that had taken place in the plots was considered (lodging, frosts of different severity degrees, cane delivered to the mill on account of variety problems or complete damage caused by freeze, etc.). To calculate variety distribution and seed cane production per hectare, a value of 62.5 rows/ha was considered.

In order to evaluate sanitary conditions of the Registered Nurseries from April onwards, when the seed cane is approximately seven months old, samples of the basal third part of 20 stalks are collected in every hectare or fraction of the nursery plot, discriminating varieties and seed cane ages. Sampling is carried out randomly, taking only one stalk per stool. The samples are delivered to the laboratory of the EEAOC Phytopathology Department, where the presence of RSD and scald leaf causal agents is determined by means of tissue blot immunoassay (TBIA).

With the results of these tests, the percentages of disease incidence in the nursery plots are calculated (number of affected stalks/ total number of analyzed stalks, expressed as percentage). In this work, average disease incidence was calculated using the means estimated according to row number of each variety.

ANALYSIS OF VARIETY DISTRIBUTION AND PRODUCTION IN REGISTERED NURSERIES FROM 2008 TO 2012

1.- Variety distribution in Registered Nurseries

Figures 1 to 5 show variety distribution in the Registered Nurseries of EEAOC Vitroplantas Project from 2008 to 2012, expressed as percentage of the total area.

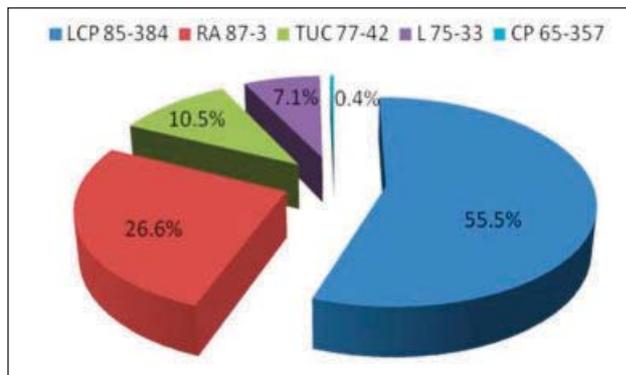


Figure 1. Variety distribution (%) in Registered Nurseries. Tucumán (Argentina), 2008.

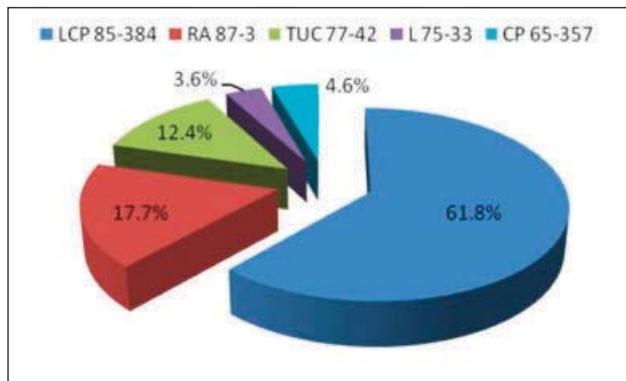


Figure 2. Variety distribution (%) in Registered Nurseries. Tucumán (Argentina), 2009.

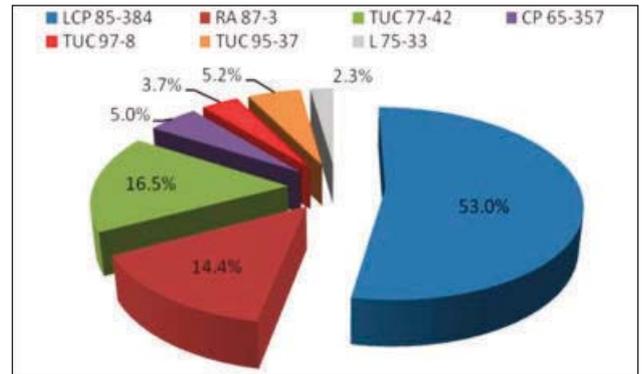


Figure 3. Variety distribution (%) in Registered Nurseries. Tucumán (Argentina), 2010.

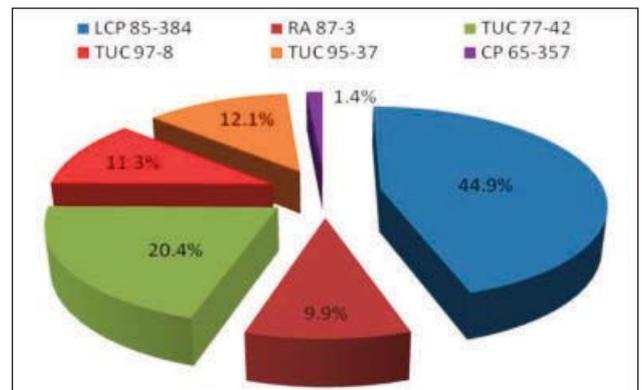


Figure 4. Variety distribution (%) in Registered Nurseries. Tucumán (Argentina), 2011.

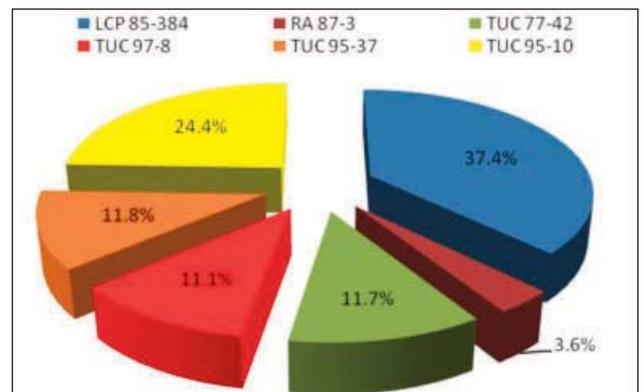


Figure 5. Variety distribution (%) in Registered Nurseries. Tucumán (Argentina), 2012.

Variety distribution in the Registered Nurseries in Tucumán reflects the homogeneous variety offer and the clear prevalence of LCP 85-384 cultivar in the whole province. This is the most widely grown variety in Tucumán, and in some districts it is planted over more than 80% of the total sugarcane area (Ostengo *et al.*, 2012). This predominance of a single variety puts the province at serious risk, since its major agro-industrial activity centers around practically only one cultivar.

With the aim of diversifying sugarcane crop composition in Tucumán, the PMGCA-EEAOC released

four varieties between 2009 and 2013. These are the cultivars TUC 95-37, TUC 97-8, TUC 95-10 and TUC 00-19, all of which have shown a very good productive behavior, as well as a highly satisfactory degree of adaptation to local agroecological conditions, and typical management and harvesting practices adopted in Tucumán (Costilla *et al.*, 2011; Cuenya *et al.*, 2011; Cuenya *et al.*, 2013).

These releases have had an impact on variety composition in the Registered Nurseries. TUC 95-37 and TUC 97-8 were released in 2009, and they were planted in the Registered Nurseries as soon as the following growing season (2010) began. Furthermore, these cultivars became increasingly commonplace in the following two seasons (2011 and 2012).

In 2011, TUC 95-10 cultivar was released and by 2012, almost 25% of the total area of the Registered Nurseries in the province had been planted with it. As a consequence of all the processes mentioned above, the area planted with LCP 85-384 in the Registered Nurseries decreased from 62% in 2009 to 37% in 2012. That is how the Vitroplantas Project has been pursuing the goal of promoting the rapid spread of new varieties obtained by the PMGCA-EEAOC, thus helping to efficiently favor the diversification of sugarcane crops in Tucumán.

The most recently released variety, TUC 00-19, was introduced in 2013 and is currently being planted in the Basic Nursery of Vitroplantas Project.

2.- Mean seed cane production in Registered Nurseries

In Figure 6, average seed cane production per hectare in Registered Nurseries from 2008 to 2012 is shown.

Mean seed cane production varied from 82 to 90 tonnes per unit of area in the 2008-2012 period (Figure 6). These mean values reflect the high productive capacity of the Registered Nurseries.

It is worth remarking that in all these years under evaluation, moderate and even severe freezes occurred, affecting several nurseries. That is why it became necessary to eliminate apical internodes affected by cold temperatures in some plots before using the seed cane. In some other cases, the damage was so serious that cane quality declined, so cane was delivered to the mills after being topped to a greater extent than usual. Consequently, seed cane production in these plots was affected negatively. In spite of all this, the production of the Registered Nurseries in all the years evaluated remained within levels considered to be high under the conditions prevailing in Tucumán province (>76 t/ha) (Soria *et al.*, 2000).

In Figure 7, seed cane production/ha from 2008 to 2012 is shown, while differentiating the two crop ages exploited in the nurseries (plant cane and first ratoon).

Figure 7 shows that first ratoon cane led to a higher production than plant cane. This is naturally expected, as

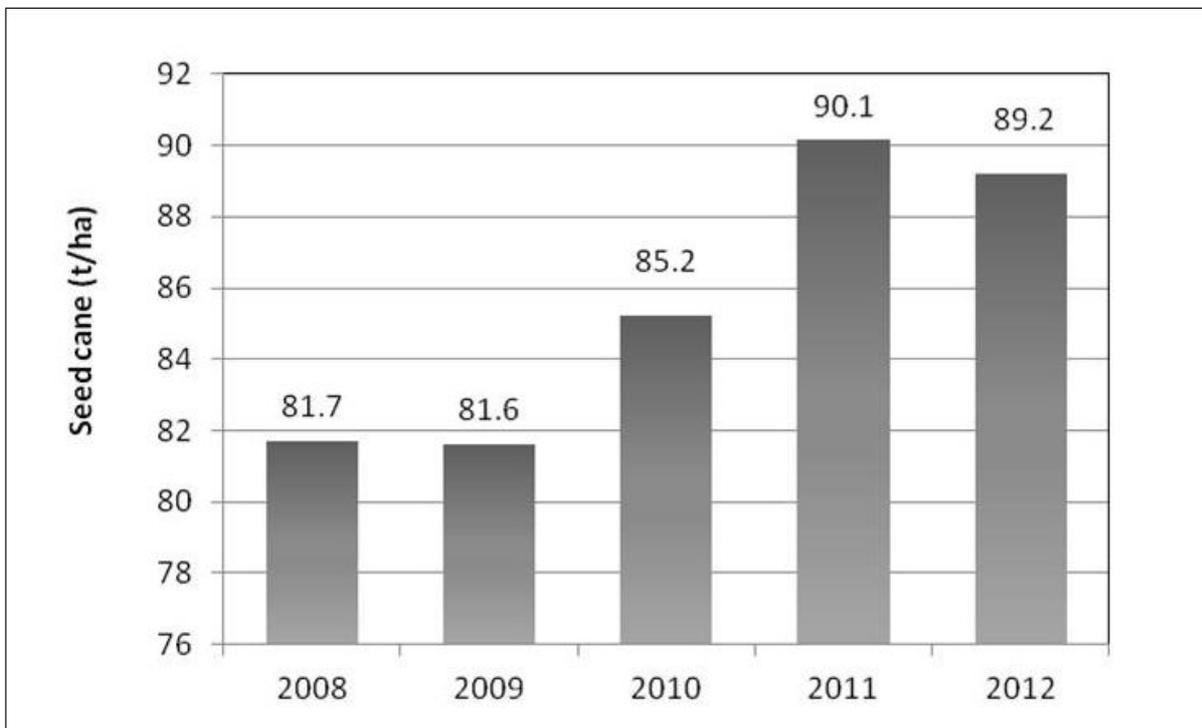


Figure 6. Seed cane production (t/ha) in Registered Nurseries in 2008-2012. Tucumán, Argentina.

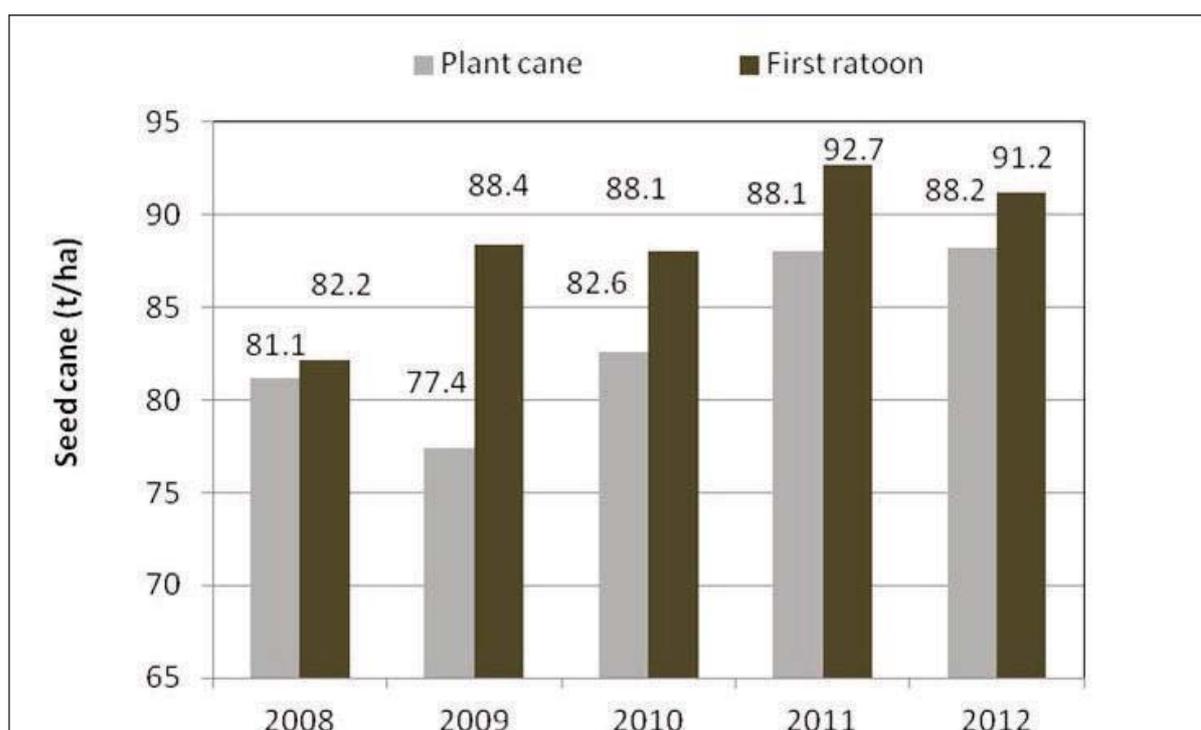


Figure 7. Seed cane production (t/ha) in Registered Nurseries at plant cane and first ratoon crop ages (years 2008 to 2012). Tucumán, Argentina.

phenological stages at plant cane age develop later than at first ratoon, which shortens the period where growth can be taken advantage of under the conditions prevailing in Tucumán.

Differences in production between plant cane and first ratoon ranged from 1.3% in 2008 to approximately 14.0% in 2009. It must be considered that the availability of varieties, the geographical position of the nurseries and environmental conditions change every year, and this has an effect on the productive potential of the nursery plots.

Table 1 displays the area planted with Registered Nurseries and the number of nurseries in the 2008-2012 period.

Throughout the analyzed period, the area planted with Registered Nurseries grew constantly, from an initial 103 ha area in 2008 to 264 ha in 2012. The number of

Table 1. Total area (ha) and number of Registered Nurseries in 2008-2012. Tucumán, Argentina.

Year	Total area of Registered Nurseries (ha)	Number of Registered Nurseries
2008	103.5	39
2009	128.4	35
2010	141.3	44
2011	134.4	49
2012	264.2	51

nurseries followed a similar trend, totaling 51 in 2012 as compared with 39 in 2008.

In Figure 8, mean seed cane production is analyzed according to districts within the sugarcane area in Tucumán, while considering both crop ages aforementioned, and all the varieties planted from 2008 to 2012.

From 2008 to 2012, general average seed cane production in Registered Nurseries varied according to district: it ranged between approximately 82 t/ha (Simoca) and 90 t/ha (Chicligasta and La Cocha). It must be remarked that these mean values are representative of the two seed cane crop ages considered in this study (plant cane and first ratoon), as well as of all the cultivars planted, the different management practices adopted, and the agroecological and climatic conditions that prevailed throughout the five years analyzed.

In all the districts of Tucumán province, average seed cane production in Registered Nurseries ranked as high production, which demonstrates the productive potential of the propagated material, even under different agroecological conditions and management systems. The difference between the district with the lowest production level (Simoca: 82.5 t/ha) and those with the highest (Chicligasta and La Cocha: 90.4 t/ha) amounted to 8.7%.

In Table 2, seed cane production in the Registered Nurseries during 2008-2012 is analyzed in relation to varieties.

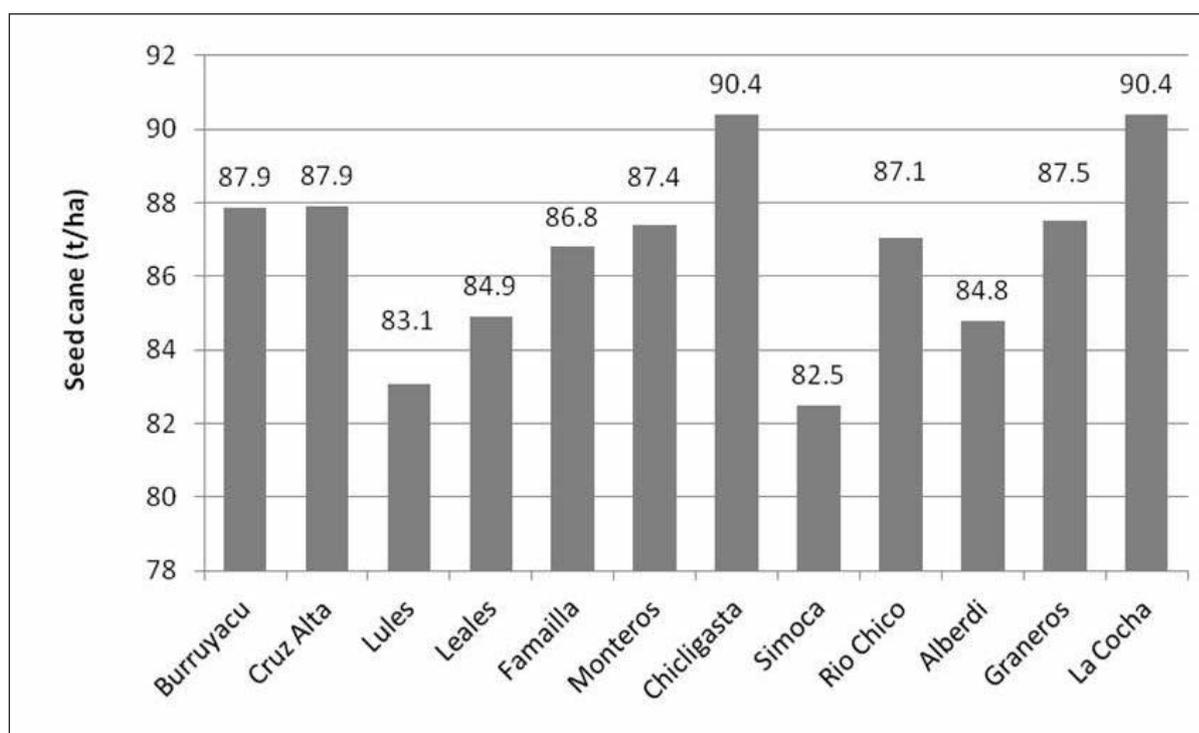


Figure 8. General average seed cane production (t/ha) in Registered Nurseries, considering provincial districts. Tucumán (Argentina), years 2008 to 2012.

Table 2. Seed cane production (t/ha) in Registered Nurseries according to varieties in 2008-2012. Tucumán, Argentina.

Year	Varieties							
	LCP 85-384	RA 87-3	TUCCP 77-42	CP 65-357	TUC 95-37	TUC 97-8	L 75-33	TUC 95-10
2008	83.7	79.5	83.7	80.0			71.4	
2009	83.5	77.5	73.7	81.1			71.7	
2010	87.8	82.1	82.2	85.8	80.7	81.0	83.5	
2011	90.8	88.0	90.9	88.8	89.3	89.0		
2012	87.1	95.0	89.6		91.5	85.5		92.2
General average	86.6	84.4	84.0	83.9	87.2	85.2	75.5	92.2

In Table 2, it can be observed that variety TUC 95-10 outdid all others, by producing 92.2 t/ha. In this respect, it is necessary to bear in mind the following: even if it is true that data about TUC 95-10 was only collected in 2012, if we consider yield for all the other varieties in only that year, TUC 95-10 was still superior, except for RA 87-3. Moreover, TUC 95-10 was evaluated with regard to its production in 2012 only at its plant cane age, as the variety was first planted in the Registered Nurseries that year. Hence, a higher production could be expected when the crop reaches first ratoon age.

LCP 85-384, RA 87-3, CP 65-357, TUCCP 77-42, TUC 95-37 and TUC 97-8 presented a similar seed cane production throughout the 2008-2012 period, which shows that these cultivars have a high productive capacity. It

should be mentioned that intermediate production levels of TUC 95-37 and TUC 97-8 were negatively affected, since in 2010 these cultivars were only available in the Registered Nurseries at plant cane age.

On the other hand, L 75-33 was the least productive variety, with a mean seed cane production of 75.5 t/ha.

3.- Sanitary conditions of Registered Nurseries

Figure 9 illustrates the sanitary status of the Registered Nurseries in the 2008-2012 period. RSD incidence varied between 0.03% and 0.77%, whereas leaf scald incidence ranged from 0.00% and 1.41%. In both cases, these values were below the threshold levels accepted in countries like Colombia, Guatemala and Cuba, where seed cane production and multiplication schemes

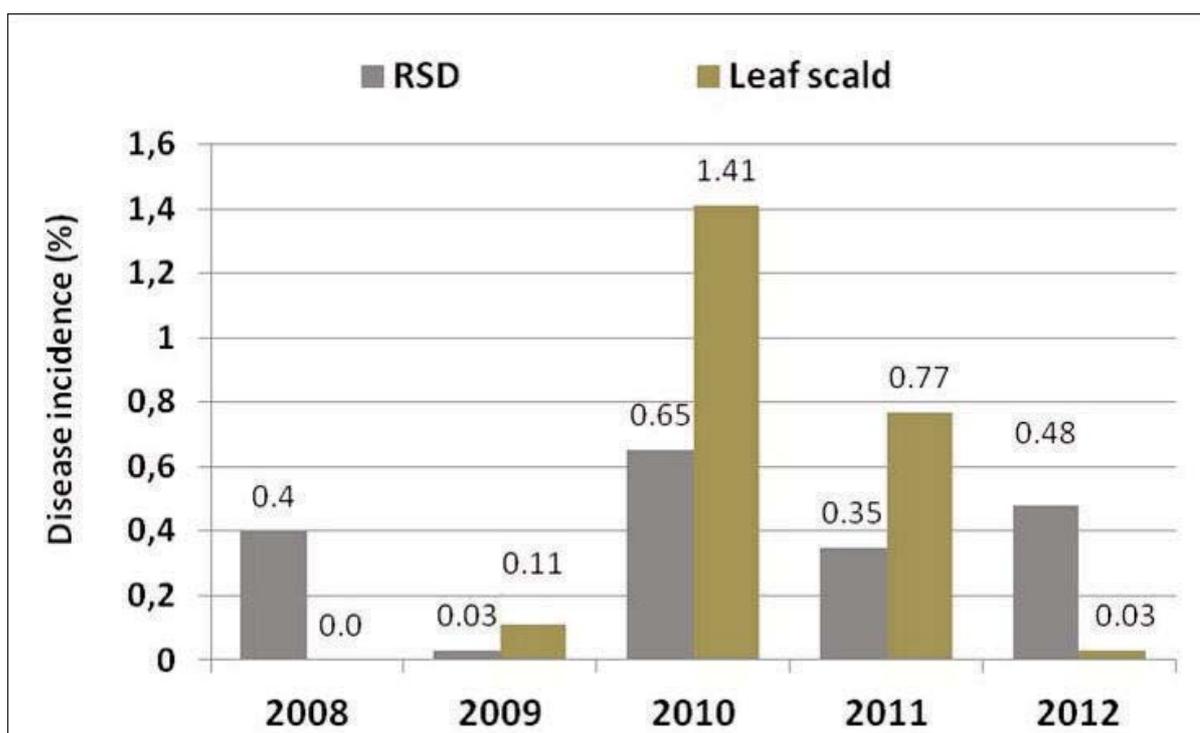


Figure 9. RSD and leaf scald incidence percentages in Registered Nurseries during the 2008-2012 period. Tucumán (Argentina).

are similar to ours. Specifically, in Colombia tolerated RSD incidence levels reach up to 2% in semi-commercial nurseries (equivalent to our Registered Nurseries); Cuba accepts a percentage not superior to 3% and Guatemala, 5% (Soto *et al.*, 1997; Victoria y Calderón, 1995).

CONCLUSIONS

In the 2008-2012 period, high quality seed cane production in the Registered Nurseries of EEAOC Vitroplantas Project was within the range of high production, as considered for conditions like those in Tucumán province (> 76 t/ha).

This production clearly reflected the productive potential of each variety, as well as the effect of crop age (plant cane or first ratoon).

In all the districts within the province and in all the evaluated years, seed cane production was high, suggesting that this material has an excellent productive potential, even under different management systems and climatic and agroecological conditions.

Among the provincial districts within the sugarcane area, the most outstanding were Chicligasta and La Cocha, as they concentrated the highest seed cane production levels per hectare in their corresponding Registered Nurseries, throughout the time span considered.

The Registered Nurseries also presented very good sanitary conditions during this period, with RSD and leaf

scald incidence levels that remained below tolerance threshold levels established in different sugarcane producing countries.

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