PLENE, AN INNOVATIVE APPROACH FOR SUGARCANE PLANTING IN BRAZIL

By

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One-Budded Cane Setts, Setts Treatments.**

Abstract

PLENE™ concept is an evolutionary way of planting sugarcane to replace the current high cost path requiring heavy equipment and intensive labour. With Plene™, Syngenta developed a methodology for producing sugarcane one-budded setts treated with proprietary crop protection and coatings that allows germination, crop stand and vigour. This protocol, associated with an industrial cutting and stalk treatment technologies and a lighter planting machine, provides a dramatic improvement in planting operations, reducing the amount of seed cane from 18 t of stalks to 1.5 t of Plene™ per hectare. This technology has the potential to simplify the planting process and represents a good strategy for sustainable sugarcane production. This paper summarises five field trials carried out to evaluate the performance of Plene™ sugarcane technology in São Paulo State, Brazil. Results have shown that the ideal number of buds per linear metre is 8 when a 1.5 m space between rows is adopted. Application of Plene slurry just after the cutting process increased the shelf life time from 2 to 7 days using 70% buds germination as a reference. Emergence trial results showed the importance of crop protection for the Plene™ technology and, at 48 days after planting assessment, Plene™ plots reached 72% emergence compared to 20% in untreated plots. As a conclusion, the combination of crop protection technologies and polymers in Plene™ is able to maintain the viability of the buds before planting and assures ideal germination and crop stand after planting, thus showing this to be an excellent technology for modern sugarcane planting.

Introduction

The current agronomic technology and industrialisation of sugarcane, associated with tradition and infrastructure, are factors that limit the production in Brazil and, to reach ambitious targets in the near future, an expansion of planted area is needed. Research and new technologies are important to ensure progress in yield, productivity and cost reduction, and the Plene™ concept is being developed in this context.

This Syngenta technology consists of production of healthy cane setts, with one bud and 4 cm long, treated with proprietary crop protection and planted with a 'light' planter (similar to a grain planter). This innovative technology for planting is appropriate for renovation or expansion of areas due to less impact from mechanical operations, and is feasible even under minimum tillage.

The possible combination of planting operations and crop management such as insect, fungus and nematode control provides a lower cost, higher efficacy and efficient logistics.

In the past, and even nowadays, several research projects have been carried out to modernise the planting process. Clements (1940) evaluated the effect of different sizes of stalks and number of buds (1 to 5 buds) and found that smaller sizes and fewer buds were the best; however, rot disease development was higher due to the larger exposed area of the cut faces. Ricci Junior *et al*. (2009), working with shorter sugarcane stalks (30 cm) and two buds without fungicide, reported that sprouting and tillering were significantly damaged due to pineapple disease (*Ceratocystis paradoxa*).

Casagrande and Vasconcelos (2008) reported that there is a sprouting gradient due to age differences between the buds, from the top (younger) to bottom (older). Alvarez (1975) and Pange *et al.* (1962) reported that old stalks are unsuitable for planting, the ideal is seven to nine months stalk age, and the top third germinates better than the middle and bottom third.

Valdez Manzano (1976), Rincones (1973), Escober (1968) and Martin (1951) found that for seed cane without fungicide treatment, the interval between cutting and planting should be the lowest possible, no more than 4–7 days.

This work aimed at studying the best small segment density for planting, sprouting of buds originating from different segments (top, middle and base) of the stalks, planting position of these segments in the ground, and shelf life of the buds produced with the Plene^{TM} technology.

Materials and methods

All the trials were conducted at Holambra Field Station (22’38’’S, 47’05’’W) in Holambra, SP, Brazil, between December 2007 and June 2009. Anova and ‘t’ test were applied for statistical analysis of the five trials.

Planting density (Trial No. 1)

Small segments (4 cm long) with one bud were taken off from the middle and top of the cane stalks of the cultivar RB86-7515. They were treated through industrial proprietary Syngenta crop protection (Plene^{TM}).

The segments were planted in furrows 30 cm deep, fertilised in accordance with requirement and covered with 5–8 cm of soil. Plot size was 4 rows of 5 m in length and the experimental design adopted was randomised complete blocks (RCB) and factorial scheme (3 × 2); three density treatments, namely four, eight and 12 segments with one bud per linear metre and two chemical treatments: 1) treated one-bud sett and 2) non-treated one-bud sett. Each treatment was replicated four times. Evaluations of germination (% emergence), height (up to dewlap), stalk diameter (4th knot), cane yield and sugar content were made to derive the optimum density of small segments.

Segment and age of bud (Trial No. 2)

Small segments originating from top, middle and bottom of mother stalks were removed from nine and 12 month age cane stalks. They were treated with the industrial proprietary treatment of Plene^{TM}. Planting was made in furrow 30 cm deep, fertilised according to requirement and covered with 5–8 cm of soil.

The experimental design adopted was a RCB and factorial scheme (3 × 2); three segment treatments, namely bottom, middle and top and two ages, namely 12 and 9 months. Each treatment was replicated four times; plot-size was 4 rows of 5 m long.

Measurements and data recording included evaluations of emergence, stalk height and diameter, cane and sugar yield.

Segment size (Trial No. 3)

Small segments of different lengths (4, 6, 8, 10 and 12 cm) were taken from top and middle of mother stalks. They were treated through industrial proprietary treatment before being planted in furrows 30 cm deep, fertilised at recommended rates and covered with 5–8 cm of soil.

The experimental design adopted was a RCB with 4 replications with plot size of 4 rows of 5 m long. Evaluations of emergence, stalk height, stalk diameter, cane yield and kg sugar/ha were the parameters measured.

Bud planting angle (Trial No. 4)

Small segments were produced in a similar way to those in Trial No. 1 (density of planting trial). They were treated through industrial proprietary crop protection (Plene^{TM}) and the management to planting was the same except that eight one-bud setts were planted per linear metre for all the plots.

The experimental design adopted was RCB with four repetitions; plot size adopted was 4 rows of 5 m long. To study the best planting bud position of small segments in the furrow, they were planted at different angles with regard to the soil surface as illustrated in Figure 1. The four treatments had segments placed at: 1) 0º, 2) 90º, 3) 180º, 4)270º.

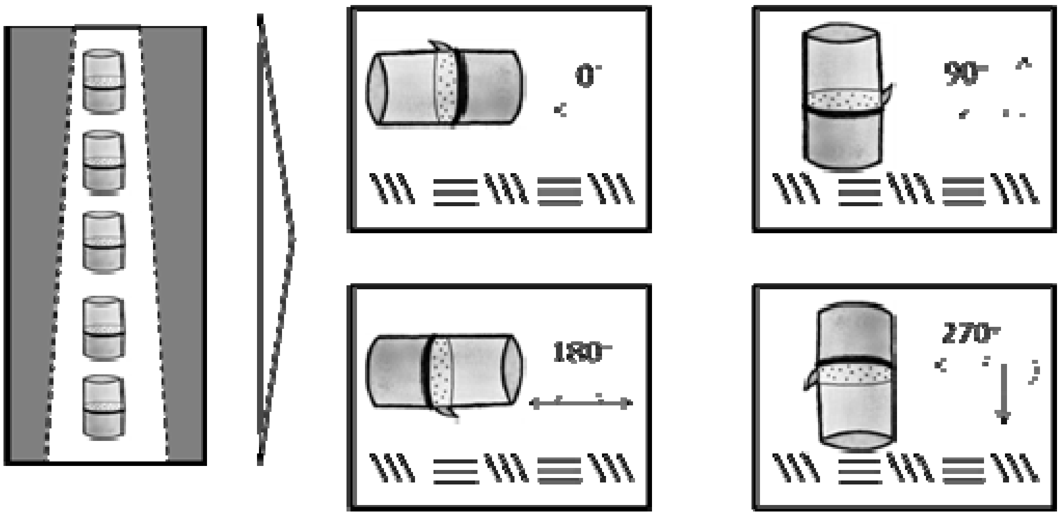

Fig. 1—Bud positions at different angles to the soil surface.

Shelf life (Trial No. 5)

A pot trial was carried out in the greenhouse where eight small segments, cut and chemically treated immediately after cutting in comparison to those treated only at planting time, were planted in pots of 20 L.

Periods of storage of small segments were 0, 3, 5, 7, 10 and 12 days. The experimental design adopted was a completely randomised design with a factorial scheme of 2 x 6 (two treatment times and 6 periods of storage); all treatments replicated four times.. Germination (% emergence) at 45 days after planting was evaluated.

Results and discussion

Planting density (Trial No. 1)

Emergence of one-budded setts, height and diameter of stalks, yield and sugar/ha were evaluated and showed that bud setts treated with Syngenta products were clearly superior to untreated budded setts, and it was significant for one density at least. Height was the parameter that showed superiority of treated bud setts for the three densities evaluated.

In general, eight and 12 buds/linear metre were superior to four, mainly for yield and sugar/ha. Summarising, the results showed that 8 buds per linear metre, after being treated chemically, showed the ideal density for Plene™ technology for the variety RB86 7515 and the necessity to treat the small segments with chemicals to improve the emergence, height and yield.

These data are in according with Ricci Jr *et al.* (2009) and Clements (1940) where they found the importance of crop protection when the stalk length is smaller than that of conventional cane setts (4 cm and one-bud sett versus 40 cm and 3 buds) (Tables 1, 2, 3 and 4).

Table 1—Emergence percentage of Plene™ at 22 and 36 DAP planted in different densities, in comparison with untreated bud setts. Holambra, SP.

Treatments	% Emergence–22 DAP[2]			% Emergence–36 DAP		
	4/ metre	8/ metre	12/ metre	4/ metre	8/ metre	12/ metre
Untreated	15.0 aA	14.7 aA	14.6 aA	31.3 aA	40.6 aA	29.8 aA
Treated[1]	26.9 aA	28.4 bA	27.3aA	60.6 bA	50.3 aA	51.9 bA
Standard error (s.e.)	5.1935			6.6802		

[1] Industrial proprietary treatment
[2] DAP: days after planting
Means within columns followed by the same small letter not significantly different by 't' test. Means within rows followed by the same capital letter not significantly different by 't' test. Both at 10% probability.

Table 2—Height and diameter of Plene™ at 192 DAP planted in different densities, in comparison with untreated bud setts. Holambra, SP, Brazil, 2008/09.

Treatment	Height (cm)–192 DAP			Diameter (mm)–192 DAP		
	4/ metre	8/ metre	12/ metre	4/ metre	8/ metre	12/ metre
Untreated	150.3 aA	158.3 aA	176.5 bA	28.9 aA	28.8 aA	28.8 aA
Treated[1]	174.3 bA	172.3 bA	190.8 bB	30.3 bA	29.6 aA	30.4aA
Standard error (s.e.)	4.2247			0.5517		

[1] Industrial proprietary treatment
[2] DAP: days after planting
Means within columns followed by the same small letter not significantly different by 't' test. Means within rows followed by the same capital letter not significantly different by 't' test. Both at 10% probability.

Table 3—Yield of Plene™ at 552 DAP planted in different densities, in comparison with untreated bud setts. Holambra, SP, Brazil, 2008/09.

Treatment	Yield (t/ha)–552 DAP[2]		
	4/ metre	8/ metre	12/ metre
Untreated	144.7 aA	167.2 aA	148.9 aA
Treated[1]	155.8 aA	214.4 bB	188.4 abA
Standard error (s.e.)	17.6932		

[1] Industrial proprietary treatment
[2] DAP: days after planting
Means within columns followed by the same small letter not significantly different by 't' test. Means within rows followed by the same capital letter not significantly different by 't' test. Both at 10% probability.

Table 4—ATR and Sugar at 552 DAP when Plene™ is planted in different densities, in comparison with untreated bud setts. Holambra, SP, Brazil, 2008/09.

Treatment[1]	ATR (kg/t)–552 DAP[2]			Sugar (kg/ha)–552 DAP		
	Bottom	Middle	Top	Bottom	Middle	Top
Untreated	132.3 aA	129.4 aA	125.9 aA	14,284 aA	18,499 aA	14,206 aA
Treated[1]	128.3 aA	127.2 aA	128.4 aA	17,137 aA	21,479 aA	20,437 bA
Standard error (s.e.)	4.6507			4,5013		

[1] [1] Industrial proprietary treatment
[2] DAP: days after planting
Means within columns followed by the same small letter not significantly different by 't' test. Means within rows followed by the same capital letter not significantly different by 't' test. Both at 10% probability.

Segment/age (Trial No. 2)

Segments of nine month age were shown to be significantly superior to 12 months for all different segments (top, middle and bottom) and all parameters evaluated, except for diameter where 12 month age for all different segments were superior to nine months, as expected because of low stand (Tables 5, 6, 7 and 8). Casagrande and Vasconcelos (2008) reported that there is a sprouting gradient due to age differences between the bud age, from the top (younger) to bottom (older) and Alvarez (1975) and Pange *et al.* (1962) showed that old stalks are unsuitable for planting, the ideal is seven to nine month stalk age, and the top third germinates better than the middle and bottom third.

Table 5—Emergence of one-bud setts (4 cm) taken from bottom, middle and top segment of the mother stalks at nine and 12 month age. Holambra, SP, Brazil, 2008/09.

Treatments[1]	% Emergence – 23 DAP[2]			% Emergence – 37 DAP		
	Bottom	Middle	Top	Bottom	Middle	Top
12 month age	0.94 aA	4.69 aA	14.38 aB	8.44 aA	13.13 aA	37.50 aB
9 month age	54.69 bA	55.94 bA	70.00 bB	66.88 bA	68.13 bA	76.88 bB
Standard error (s.e.)	3.3379			2.3641		

[1] Industrial proprietary treatment
[2] DAP: days after planting
Means within columns followed by the same small letter not significantly different by ‘t’ test. Means within rows followed by the same capital letter not significantly different by ‘t’ test. Both at 10% probability.

Table 6–Height and diameter of one-bud setts taken from bottom, middle and top segment of the mother stalks at nine and 12 month age. Holambra, SP, Brazil, 2008/09.

Treatment[1]	Height (cm)–200 DAP[2]			Diameter (mm)–200 DAP		
	Bottom	Middle	Top	Bottom	Middle	Top
12 month age	67.13 aA	77.12 aA	107.88 aB	33.00 aA	32.79 aA	32.12 aA
9 month age	137.85 bA	129.18 bA	136.13 bA	28.78 bA	28.43 bA	28.58 bA
Standard error (s.e.)	6.9479			0.8210		

[1] Industrial proprietary treatment
[2] DAP: days after planting
Means within columns followed by the same small letter not significantly different by ‘t’ test. Means within rows followed by the same capital letter not significantly different by ‘t’ test. Both at 10% probability.

Table 7—Yield of one-bud setts taken from bottom, middle and top segment of the mother stalks at nine and 12 month age. Holambra, SP, Brazil, 2008/09.

Treatment[1]	Yield (t/ha)–514 DAP[2]		
	Bottom	Middle	Top
12 month age	130.39 aAB	126.60 aA	151.76 aA
9 month age	169.81 bA	175.88 bA	176.00 aA
Standard error (s.e.)	9.9696		

[1] Industrial proprietary treatment
[2] DAP: days after planting
Means within columns followed by the same small letter not significantly different by ‘t’ test. Means within rows followed by the same capital letter not significantly different by ‘t’ test. Both at 10% probability.

Table 8—ATR (kg/t) and Sugar (kg/ha) of one-bud setts taken from bottom, middle and top segment of the mother stalks at nine and 12 month age. Holambra, SP, Brazil, 2008/09.

Treatment[1]	ATR (kg/t)–514 DAP[2]			Sugar (kg/ha)–514 DAP		
	Bottom	Middle	Top	Bottom	Middle	Top
12 month age	126.03 aB	116.93 aA	110.66 aA	13 942 aA	12 385 aA	13 943 aA
9 month age	116.21 bA	129.94 bB	115.21 aA	16 292 aA	19 979 bB	16 791 aA
Standard error (s.e.)	2.6049			1192.67		

[1] [1] Industrial proprietary treatment
[2] DAP: days after planting
Means within columns followed by the same small letter not significantly different by 't' test. Means within rows followed by the same capital letter not significantly different by 't' test. Both at 10% probability.

Segment size (Trial No. 3)

Evaluations of germination (% emergence) at 24 and 35 DAP, height and diameter at 207 DAP showed that there was no difference between the segment sizes (4, 6, 8, 10 and 12 cm) tested. However, the best cane yield was obtained with segments of 12 cm and the best kg sugar/ha was with 10 cm long setts. Clements (1940), in his studies about sprouting, found working with different sizes and number of buds (1 to 5 buds per stalk), the best size was with the smaller length of stalk and fewer buds (Table 9).

Table 9—Effect of different size of segments with one bud for planting (4, 6, 8, 10 and 12 cm). Holambra, SP, Brazil, 2008/09.

Treatments	% emergence		Height (cm)	Diameter (mm)	t/ha	ATR	kg sugar/ha
Plene Size	24 DAP[1]	35DAP	207 DAP		514 DAP		
1) [2] 4 cm	43.3	56.0	103.9	29.3	153.5 a	137.9	18,737 a
2) [2] 6 cm	36.8	57.8	104.5	27.6	162.8 ab	131.5	18,625 a
3) [2] 8 cm	42.0	52.8	108.1	30.9	171.2 ab	133.4	19,975 ab
4) [2] 10 cm	43.3	62.3	109.5	28.1	177.6 ab	137.4	23,685 b
5) [2] 12 cm	42.0	58.5	123.5	27.9	195.4 b	122.2	21,062 ab
Standard error (s.e.)	3.2641	2.8740	4.2521	0.5109	14.5787	3.5758	1,300,82

[1] DAP: days after planting
[2] Treated: industrial proprietary treatment

Bud planting angle (Trial No. 4)

Germination (% emergence) at 25 and 36 DAP was slower with the cane setts/segments placed at 180º and 270º. This may be due to these bud positions requiring more energy to emerge from the soil.

These slower developments resulted in lower stalk height at 125 DAP. Angles of 0º and 90º were the best positions; however, they were similar to the randomised position. Stalk height at 125 DAP confirmed that angles of 0º and 90º were the best positions. Diameter at 125 DAP, yield and kg sugar/ha (550 DAP) of all angles of bud planting, including the randomised position, showed no significant difference between the treatments.

These data are interesting because they show that, if the one-budded setts are treated with Plene's products, it is not necessary to plant the setts in a determined position. Nickell (1977) found similar results when studying depth and angle of planting (Table 10).

Table 10—One-budded cane setts planted with different bud position in soil (0º, 90º, 180º, 270º and randomised). Holambra, SP, Brazil, 2008/09.

Treatments	% emergence		Height (cm)	Diameter (mm)	t/ha	ATR	kg sugar/ha
[2]Planting angle	25 DAP[1]	36 DAP	125 DAP		550 DAP		
1) 0º	50.6 b	66.9 b	54.6 b	24.9	165.5	138.2	21.610
2) 90º	45.6 b	65.0 b	55.0 b	26.6	155.9	138.5	19.350
3) 180º	30.0 a	59.7 ab	48.4 ab	26.2	162.0	137.0	19.820
4) 270º	24.4 a	53.1 a	45.2 a	25.6	161.5	136.3	19.390
5) Randomised	44.4 b	68.1 b	46.6 a	25.1	165.5	134.4	19.580
Standard error (s.e.)	4.6505	3.2914	2.8750	0.7868	8.2368	3.4688	2.4359

[1] DAP: days after planting
[2] Planting angle means the angle formed in regarding to ground.

Shelf life (Trial No. 5)

Small segments treated immediately after cutting, assuming a threshold of 70% emergence, storage at room temperature, the evaluation of germination (% emergence) at 45 days after planting showed that shelf life for one-budded setts treated with proprietary crop protection is seven to ten days. However, shelf life of small segments cut and left untreated until planting time, showed a drastic decline after two days of storage.

In the latter case, a high infection level of saprophyte fungi and other organisms was observed that probably killed the majority of buds in five days (Table 11 and Figure 2). Other researchers (Valdez Manzano, 1976; Rincones, 1973; Escober,1968; and Martin, 1951) found similar results and reported that, for seedlings without fungicide treatment, the interval between cutting and planting should be the lowest possible, no more than 4–7 days.

Bud setts untreated attacked by fungus. Plene™ Bud setts.

Fig. 2—Comparison of untreated and treated one-budded setts. Holambra, SP, Brazil, 2009.

Table 11—Shelf life of segments chemically treated immediately after cutting in comparison with segments treated only at planting time. Holambra, SP, Brazil, 2008.

Treatment time	Days of storage Plene					
	0	3	5	7	10	12
Treatment immediately after cutting	70[1] aA	70 aA	50 aA	65 aA	57.5 aA	42.5 aA
Treatment before planting	70 aA	25 bB	5 bB	0 bB	0 bB	0 bB
Standard error (s.e.)		14.89				

[1] Germination percentage

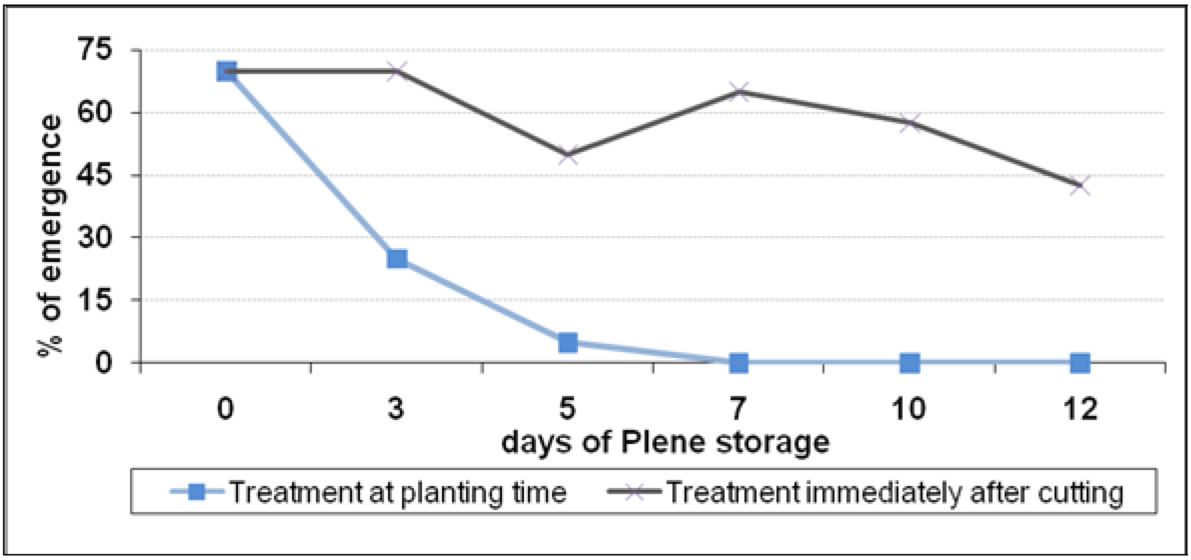

Fig. 3—Shelf life for Plene™, considering segments treated only at planting time in comparison with segments treated immediately after cutting and storage at room temperature for different periods (0–12 days). Evaluation at 45 days after planting. Holambra, SP, Brazil, 2008.

The Plene™ concept is being developed by Syngenta Crop Protection with contribution from Brazilian mills to make a major breakthrough in cane planting. Several aspects covered in this paper show the viability of this technology to revolutionise sugarcane planting, with a simplified process, efficient logistics and sustainable cane production.

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PLENE, UN CONCEPT INOVANT DE PLANTATION DE CANNE A SUCRE AU BRESIL

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MOTS CLEFS: Tige de Cane,
Bouture, Traitement de Boutures.

Résumé

LE CONCEPT Plene^{TM} est novateur, il a remplacé la méthode onéreuse habituelle de plantation qui nécessita un degré élevé de mécanisation et une main d'œuvre abondante. Grâce à Plene^{TM}, Syngenta a développé une méthode évoluée pour produire des boutures traitées d'un œil possédant des caractéristiques de résistance et de vigueur favorisant une bonne germination et levée. Cette méthode associe la préparation et le traitement industriel des boutures à une plantation espacée, elle améliore l'efficience des opérations de plantation en réduisant la quantité de boutures utilisées de 18 t à 1.5 t par hectare. La technologie Plene^{TM} a la capacité de simplifier la plantation et contribue à une production de canne à sucre durable. Cet article résume cinq essais conduits pour évaluer les performances de la technique Plene^{TM} et réalisés dans l'état de São Paulo au Brésil. Les résultats démontrent qu'avec un espacement de 1.5 m d'espacement entre deux lignes, la densité de 8 boutures est optimum. L'application de la pâte Plene au moment de la coupe des boutures allonge leur durée de vie de 2 à 7 jours dans 70% des cas. Les essais sur la levée montrent l'efficacité de la protection par la technique PleneTM, avec un taux de germination de 72% avec traitement contre 20% sans. En conclusion, la combinaison de la protection offerte par la technique et l'utilisation de polymères PleneTM permet de conserver les boutures en vie avant plantation et d'assurer la germination et la survie des plants, tout ceci pouvant représenter une excellente technique de plantation moderne de canne à sucre.

PLENE, UN ENFOQUE INNOVADOR PARA SIEMBRA DE CAÑA DE AZUCAR EN BRASIL

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**PALABRAS CLAVE: Tallo de Caña,
Semilla con una Yema, Tratamiento de Semilla.**

Resumen

EL CONCEPTO Plene™ es una forma evolutiva en la siembra de caña de azúcar para sustituir la práctica actual que requiere maquinaria pesada y mano de obra intensiva. Con Plene™, Syngenta desarrolló una metodología para trozos de caña con una yema tratados con recubrimientos protectores de su propiedad que permiten buenas germinación, densidad y vigor. Este protocolo, asociado con tecnologías industriales de corte y tratamiento de las estacas y una máquina sembradora liviana, ofrece una notable mejora en las operaciones de siembra, reduciendo la cantidad de semilla de caña de 18 t a 1.5 t por hectárea con Plene™. Esta tecnología tiene el potencial de simplificar el proceso de siembra y representa una buena estrategia para una producción sostenible de caña de azúcar. Este documento resume cinco estudios de campo llevados a cabo en el estado São Paulo, Brasil para evaluar el desempeño de la tecnología de Plene™. Los resultados han demostrado que el número ideal de yemas por metro lineal es de 8 cuando se adopta un espaciamiento de 1.5 m entre surcos. La aplicación de Plene justo después del proceso de corte aumenta el tiempo de vida útil de 2 a 7 días tomando el 70% de germinación de las yemas como referencia. La emergencia de las yemas en los ensayos puso de manifiesto la importancia de la protección fitosanitaria de la tecnología Plene™ y, a los 48 días al realizar la evaluación de la siembra, las parcelas con Plene™ alcanzaron el 72% de emergencia, frente al 20% en las parcelas no tratadas. Como conclusión, la combinación en Plene™ de las tecnologías de protección de cultivos y polímeros es capaz de mantener la viabilidad de las yemas antes de la siembra y asegura una germinación y densidad de tallos ideales después de la siembra, lo que demuestra que se trata de una excelente tecnología para la siembra moderna de la caña de azúcar.