

SUGAR LOSSES CAUSED BY THE SUGARCANE BORER (*DIATRAEA SACCHARALIS*) IN TUCUMÁN, ARGENTINA

By

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KEYWORDS: Sugarcane, *Diatraea saccharalis*, Losses.

Abstract

THE SUGARCANE borer, *Diatraea saccharalis* is the most damaging pest of the sugarcane in Tucumán Province. Galleries produced in the stalk by the larvae are gateways to pathogens. Their effect generates losses in stalk weight, and reduces the quality and amount of sucrose and juice extraction in factories. The objective of this study was to evaluate the losses caused by *Diatraea saccharalis* on three sugarcane varieties and on cane under storage. During the 2005 harvest seasons, observations with three commercial varieties, LCP 85-384, TUCCP 77-42, and CP 65-357, detected significant losses on field and factory yield. Reductions of 0.42% in the stalk weight and 0.20% in pol were observed for each 1% attack, producing a 0.22% loss for each point of infestation loss on the factory yield, with a 620 to 650 g/t of cane loss of sugar, depending on the variety. In addition, the variety LCP 85-384 was assayed at three different dates: June, August and October, during the 2006 harvesting season, to evaluate the effect of storage on losses following *D. saccharalis* attack. Sugar losses were much greater after 4 days post harvest storage. This difference was higher as the harvest season progressed.

Introduction

The sugarcane borer, *Diatraea saccharalis* (F.), is the most damaging sugarcane pest in Tucumán province. Adult moths oviposit on sugarcane leaves. Eggs may be laid singly or in masses, and early instar larvae feed cryptically on leaves, whorls, or other succulent plant tissue. Young shoots die, since *D. saccharalis* bores into primary shoots killing the apical meristem, which reduces the number of millable stalks per unit area (McGuire *et al.*, 1965). Older larvae, generally third instar and older, feed almost exclusively within tunnels in stalks; there, they are protected, making it difficult to control the insect with contact insecticides.

Pupation occurs within chambers constructed by mature larvae, often leaving an emergence hole, covered with a thin layer of plant tissue that can be pushed open to allow the adult moth to emerge from the stem. *D. saccharalis* causes damage throughout the year, from sugarcane germination to harvesting time. In addition to killing shoots, the galleries in stems open the way for several pathogenic microorganisms which destroy the sugar stored in stalks (Smith *et al.*, 1993).

In the Lower Rio Grande Valley of Texas, the Crambine stalkborers *Eoreuma loftini* (Dyar) and *D. saccharalis* damage 20% of sugarcane internodes annually (Legaspi *et al.*, 1999). These authors also quantified the relationships between stalkborer damage and sugar yield and quality to estimate the monetary loss incurred at these levels of damage, with sugar losses of 108 g/kg cane.

In Cuba, losses attributed to *D. saccharalis* were estimated at 20% of sugar production (Gallo *et al.*, 1988). In Cuba, Barreto (1954) found a reduction of 0.02329% sucrose per 1% increase in bored internodes. In Mexico, Ruiz *et al.* (1968) estimated a loss of 1.68 lbs sucrose/ton sugarcane per 1% of increase in bored stalks.

In Argentina, one key factor that can decrease yields is sugarcane storage after harvest and before crushing in the mills (Romero *et al.*, 1990). This practice is common due to the diversity in the harvest and transport systems used and the dynamics of reception of the raw material at the mill. Cane harvested with traditional methods (not under green cane harvesting conditions) can be stored in Tucumán from 3 to 7 days, with weight losses up to 1.46% per storage day being reported, although this varied along the harvest season (Romero *et al.*, 1993). No data exist on the impact of sugarcane storage at different infestation levels of *D. saccharalis*.

The objective of this study was to evaluate the losses caused by *Diatraea saccharalis* on three sugarcane varieties throughout the harvesting season and the impact of sugarcane storage before crushing on yields.

Materials and methods

To assess losses, three major varieties at various infestation levels were analysed throughout the harvest season. Considering storage, one variety was sampled at various infestation levels during three periods of the harvest season, and sugar production measured at 1 day and 4 days after sampling.

Sugarcane samples were collected from Fronterita (Famailla Departament, Tucumán) sugar factory fields. Samples were weighed, juice was extracted and analysed and sugarcane pol %, brix and fibre were determined. All sucrose parameters were determined at the chemistry laboratories of Estación Experimental Agroindustrial Obispo Colombes.

During the 2005 harvest season, samples of three of the most important commercial varieties in the province: LCP 85-384 (65.2% of sugarcane planted area), TUCCP 77-42 (17.2%) and CP 65-357 (5.8%), were assayed. Sampling of each variety occurred in May, July, August and October at 45 days intervals. At each sampling date, six hundred stalks per variety were collected from the field and taken to the experimental mill.

The individual stalks were grouped by infestation level in order to obtain 5 infestation categories: unattacked cane, cane with 1–10%, 11–20%, 21–30%, and >40% of bored internodes. Then, for each category, three samples of 10 stalks each were taken to the laboratory to perform the corresponding quality analysis. To avoid excessive variability, the same plot was sampled at each sampling date.

In addition, three samplings were performed in June, August and October during the 2006 harvesting season, to evaluate the interaction of storage on losses to LCP 85-384 from *D. saccharalis* attack. Sampling dates were set every 45 days, as previously described. Each time, the same methodology as described above was followed in creating the different infestation level categories. However, in this case, six groups of 10 stalks each were made and arranged in two sets of 3 samples each. One set of samples was analysed the day after harvest, and the other, 4 days later.

The regression lines were estimated for sugar losses for each evaluated variety, LCP 85-384, TUCCP 77-42 and CP 65-357, in relation to the infestation level in cane. Differences among varieties were evaluated by means of ANOVA followed with Duncan's multiple comparisons test. In addition, to evaluate regression slopes for LCP 85-384 cane with and without storage, R program (R development core team, 2009) lineal model was used.

Results and discussion

Figure 1 shows the observed sugar losses for the three varieties, combining all the harvest periods. Figures 2, 3 and 4 show sugar loss values, combining all harvest periods, for each variety.

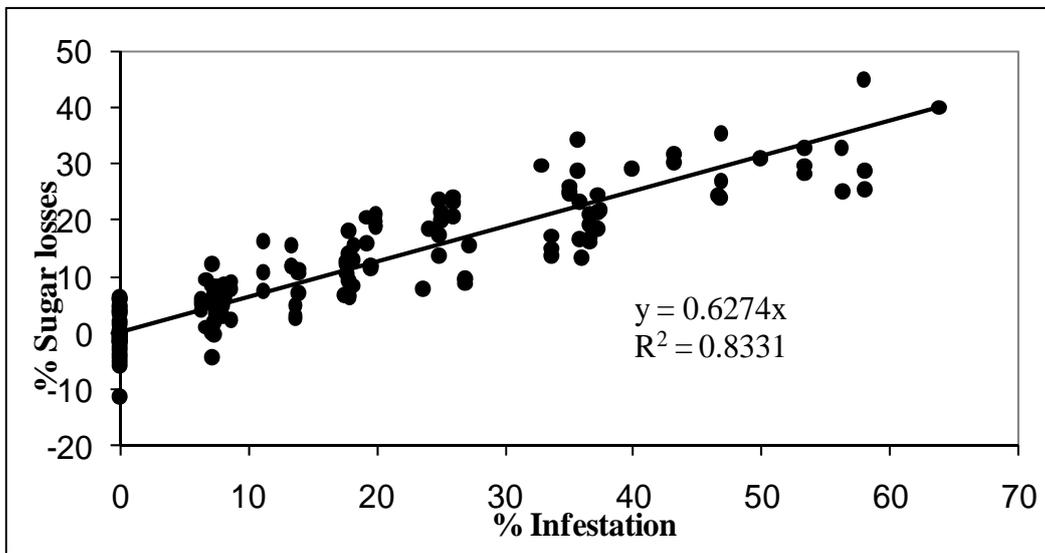


Fig. 1—Sugar losses in relation to infestation percentage combining the three varieties analysed.

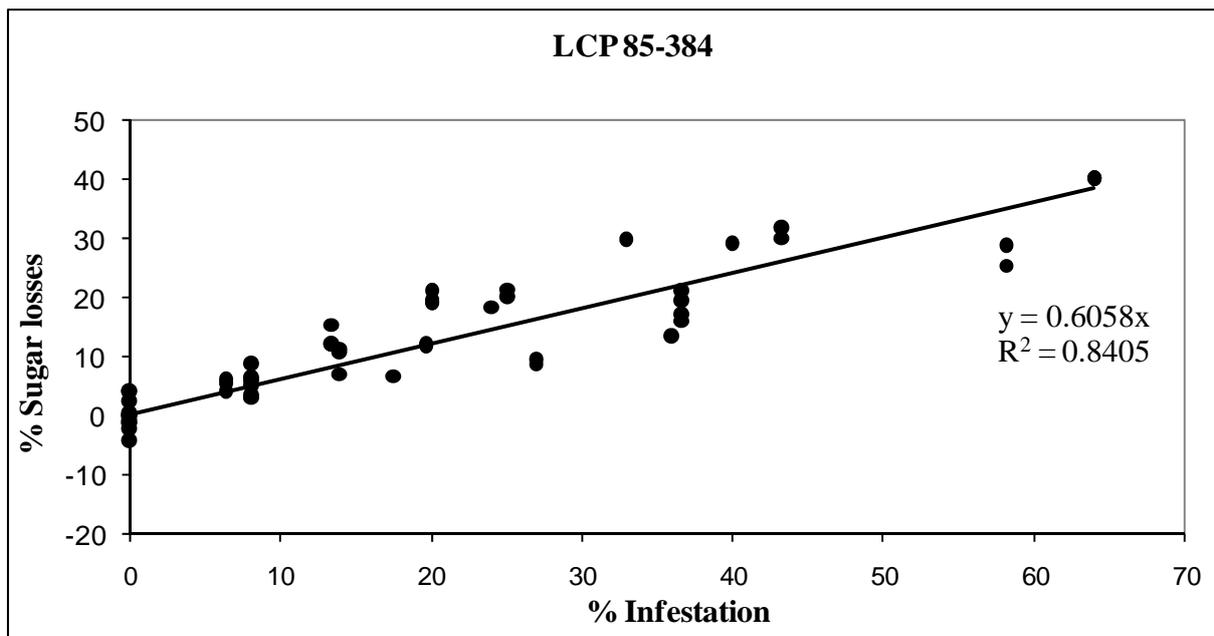


Fig. 2—Sugar loss in LCP 85-384.

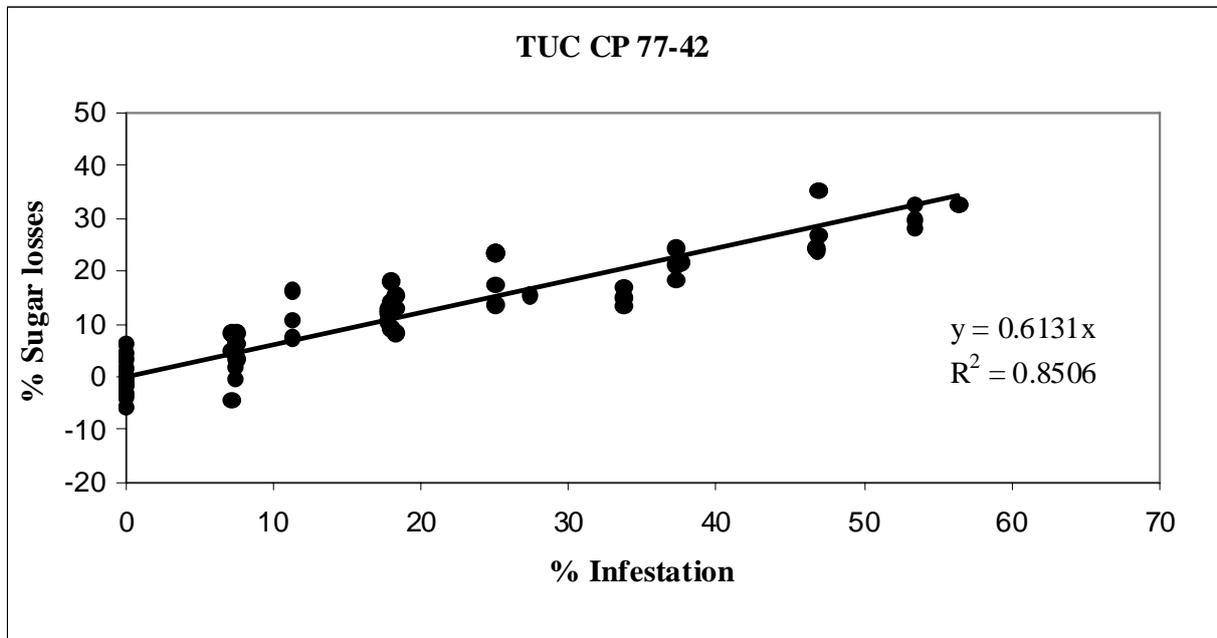


Fig. 3—Sugar loss in TUCCP 77-42.

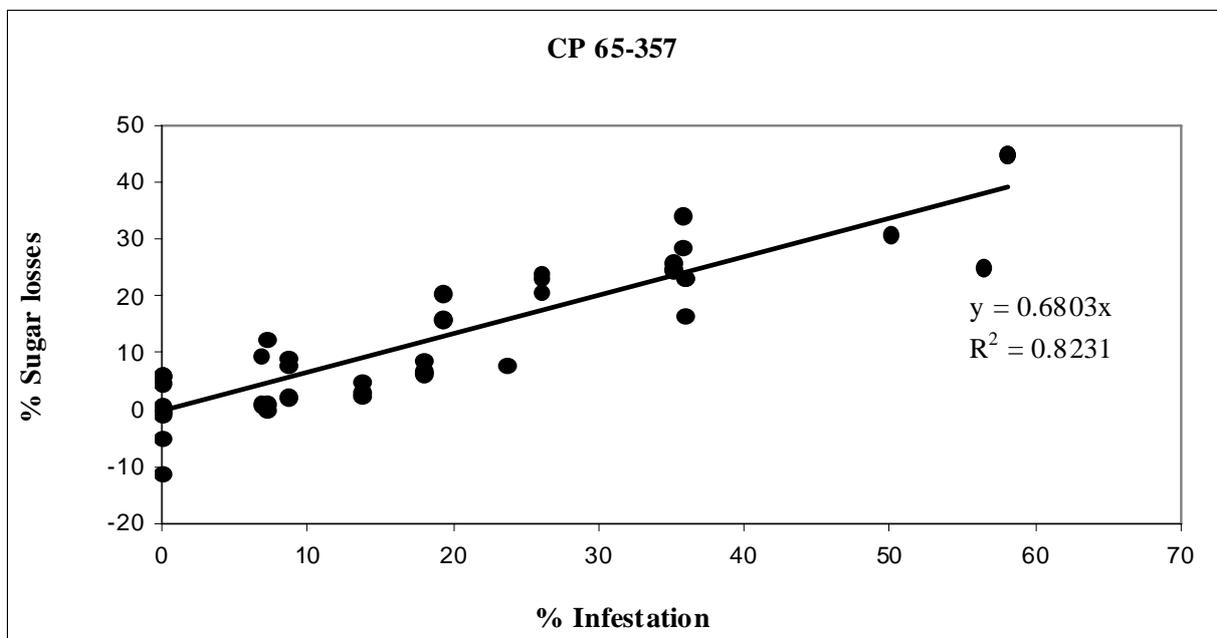


Fig. 4—Sugar loss in CP 65-357.

Calculated sugar losses for all varieties and the four harvest dates of sugarcane are shown in Table 1. Reductions of 0.42% in stalk weight and 0.20% in pol of sugarcane for each 1% of attack were estimated, producing a 0.22% loss in factory yield for each % point of infestation, with a 620 to 650 g/t loss of sugar, depending on the variety.

Table 1—Weight, factory and sugar per stalk losses increase in relation to infestation levels. Data grouped for the three varieties studied and for all sampling dates;

Infestation (%)	Weight decrease/stalk (%)	Factory yield losses (%)	Sugar loss/ t (%)
0	0.00	0.00	0.00
5	2.14	1.12	3.23
10	4.28	2.24	6.42
15	6.42	3.35	9.56
20	8.56	4.47	12.65
25	10.70	5.59	15.69
30	12.84	6.71	18.68
40	17.12	8.94	24.53
50	21.40	11.18	30.18

The ANOVA analysis revealed significant differences among the different harvest times in the case of CP 65-357 in which sugar per stalk values diminished on successive dates ($F = 2.86$ $P = 0.0396$) (Table 2).

Table 2—Average (\pm SE) sugar (g) per stalk for each variety on four harvesting dates;

Varieties	May	July	August	October
CP 65-357	92.8 \pm 2.2	87.7 \pm 3.2	84.3 \pm 3.7	82.4 \pm 3.6
LCP 85-384	89.6 \pm 2.7	88.5 \pm 2.5	89.9 \pm 2.6	85.9 \pm 3.5
TUC 77-42	87.3 \pm 2.9	86.7 \pm 3.1	86.1 \pm 3.1	85.0 \pm 3.9

Figures 5, 6, and 7 illustrate sugar losses in LCP 85-384 cane, in relation to infestation percentage and to storage after harvesting for 1 or 4 days before processing, considering three harvesting dates.

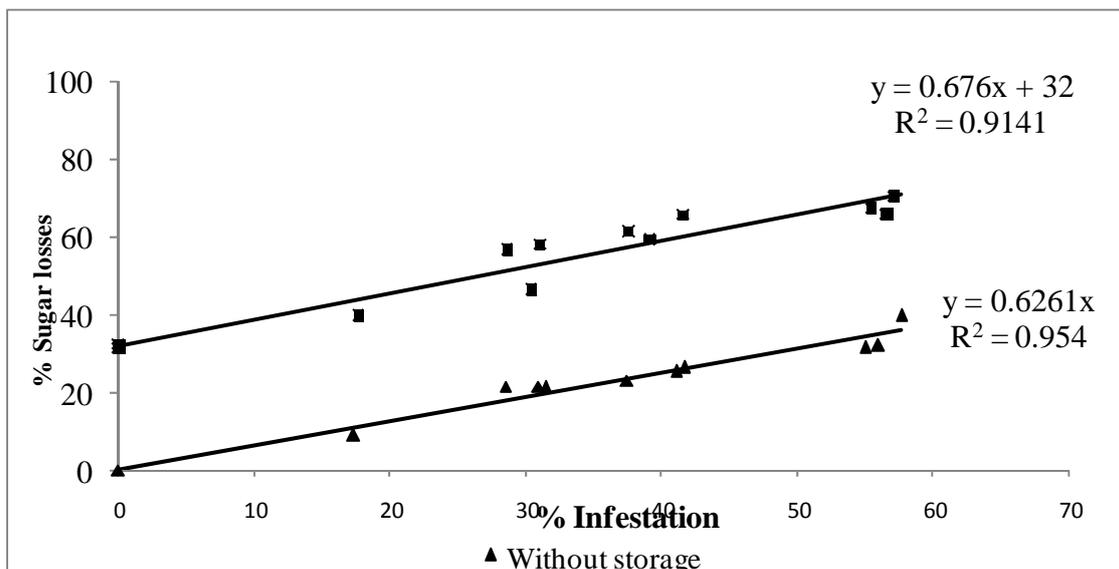


Fig. 5—Sugar losses per stalk in cane with and without storage in June.

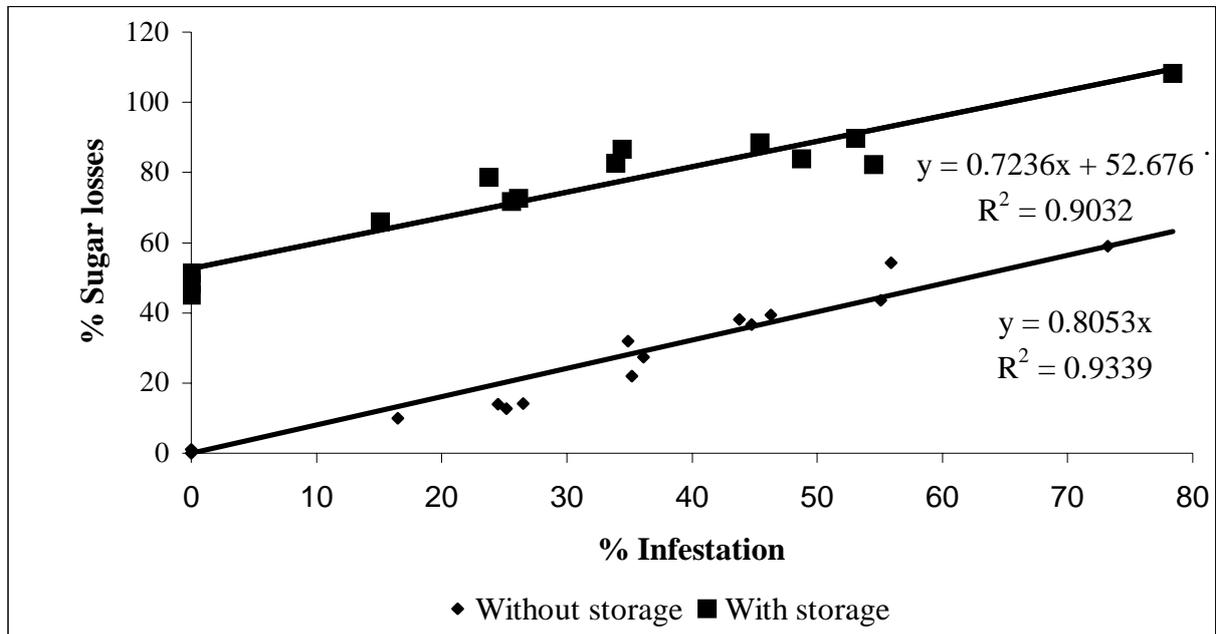


Fig. 6—Sugar losses in cane with and without storage in August.

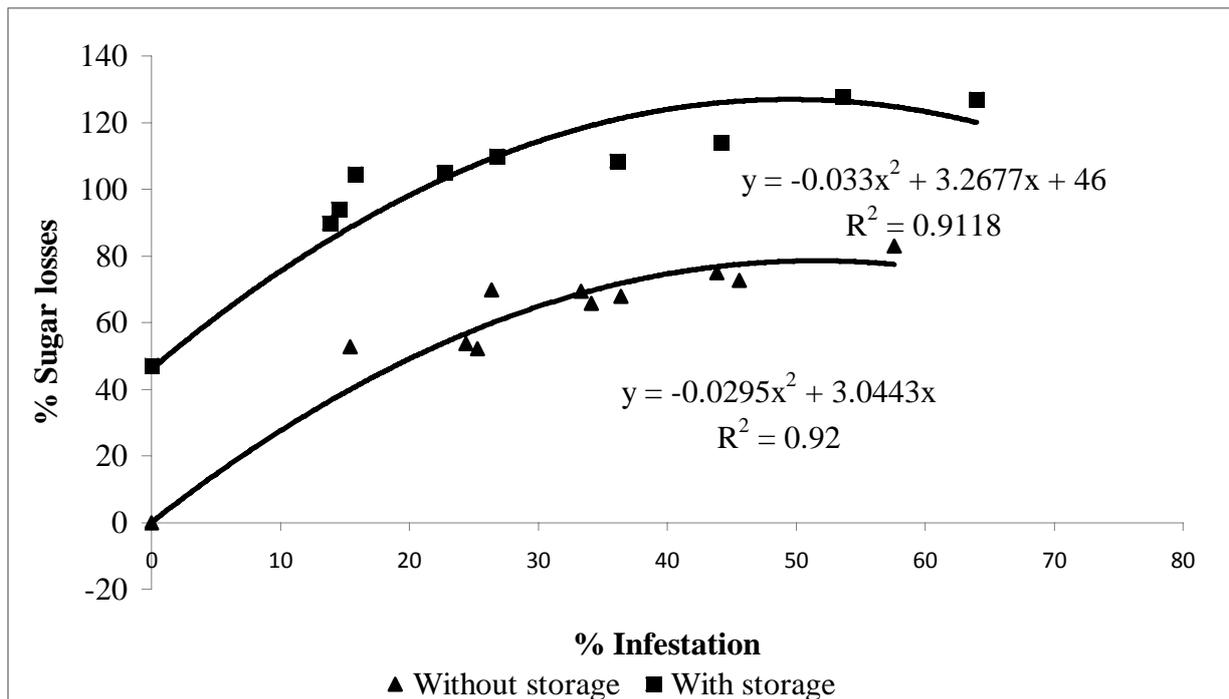


Fig. 7—Sugar losses per stalk in cane with and without storage in October.

In Table 3, the relationship that exists between sugar loss (kg per tonne of cane) and infestation levels is shown. It is quite evident that storage has a very large incidence, increasing the losses, and also that those losses increase along the harvest season.

In June, sugar losses per tonne of cane and per percent of infestation amounted to 676 g when cane was stored. By contrast, cane without storage led to lower sugar losses: 626 g/t of cane and per percent of infestation. In August, sugar losses reached 723 g/t of cane and per percent of

infestation in the case of cane with storage, and 805 g in the case of cane without storage. Although sugar loss rates in cane with storage are lower than those in cane without storage, the total sugar loss in cane with storage is significantly higher as losses for cane without damage with 4 days storage begins with more than 50% losses. In October, losses were even greater with cane storage, reaching levels higher than 1.3–1.84 kg of sugar per tonne of cane and per percent of infestation. In the case of cane without storage, losses amounted to 1.2–1.7 kg of sugar per tonne of cane and percent of infestation. In this last case, there is a point at which losses do not increase, even though infestation goes on increasing.

Table 3—Sugar losses (kg per tonne of cane) in relation to infestation percentages in cane, 1 or 4 days after harvest, considering different harvesting dates.

Infestation (%)	June		August		October	
	1 d storage	4 d storage	1 d storage	4 d storage	1 d storage	4 d storage
0	0.00	32.00	0.00	45.00	0.00	46.00
1–10	6.26	38.76	8.13	53.65	14.46	61.53
11–20	12.52	45.52	16.26	62.30	27.45	75.40
21–30	18.78	52.28	24.39	70.95	49.00	98.20
31–40	25.04	59.04	32.52	79.60	64.65	114.40
41–50	31.30	65.80	40.65	88.25	74.40	124.00

The analysis to compare the linear models obtained revealed that there were no significant differences between sugar loss regression slopes for cane with and without storage as they are parallel lines ($P > 0.05$, data not shown). By contrast, there were significant differences in the intercepts from the two categories (with and without storage).

In 2006, 11,451,000 t of cane were milled in the province, with an average of 7.61% *D. saccharalis* infestation (Salvatore *et al.*, 2008). If we consider the lowest sugar loss, 620 g/t of cane, the estimated losses reached a total of 54,506 t sugar.

Data of losses of sugar per infestation percent obtained in this research are used by sugarcane growers to decide on harvesting dates. When harvested late, during warmer months, higher temperatures increase deterioration and thus sugar losses.

Conclusions

As *D. saccharalis* infestation percentage rises, sugar losses become higher. Sugar losses were much greater after 4 days post-harvest storage than after 1 day; this difference increased as harvest time advanced.

Acknowledgments

We thank Silvia Zossi for analysing samples and Adriana Manes for her assistance in the writing of the English version of this paper. Thanks are also due to two reviewers whose comments improved the manuscript.

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PERTES EN SUCRE CAUSÉES PAR LE FOREUR DE LA CANNE À SUCRE (*DIATRAEA SACCHARALIS*) À TUCUMÁN, ARGENTINE

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MOTS CLÉS: Canne à Sucre, *Diatraea saccharalis*, Pertes.

Résumé

LE RAVAGEUR le plus dévastateur de la canne à sucre dans la Province de Tucumán est le foreur *Diatraea saccharalis*. Les galeries formées dans la tige sont des points d’entrées pour les pathogènes. Ces dégâts entraînent des pertes de poids de la tige, réduisent la qualité et la quantité de saccharose, et rendent difficile l’extraction du jus à l’usinage. Une étude a été entreprise afin de déterminer les pertes causées par le *D saccharalis* sur trois variétés de canne à sucre et sur la canne stockée avant l’usinage. Pendant la récolte de 2005, les observations faites sur les variétés industrielles, LCP 85-384, TUCCP 77-42 et CP 65-357 ont démontré des pertes significatives au champ et à l’usine. Pour chaque 1% d’entrenœuds attaqués, des réductions de 0,42% en poids de canne et 0,20% en pol ont été observées, causant des pertes de 0,22% à l’usinage. Dépendant de la variété, une chute en saccharose de 620 à 650 g/t de canne a été observée. En sus, la variété LCP 85-384 infestée par *D. saccharalis* a été échantillonnée en juin, août et octobre, pendant la récolte de 2006 pour évaluer l’effet du stockage. Une diminution en saccharose plus élevée après 4 jours de stockage post-récolte était constatée. La différence était plus marquée à mesure que la récolte progressait.

PERDIDAS DE AZÚCAR CAUSADAS POR EL GUSANO PERFORADOS DE LA CAÑA DE AZÚCAR (*DIATRAEA SACCHARALIS*) EN TUCUMÁN, ARGENTINA

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PALABRAS CLAVE: Caña de Azúcar, *Diatraea saccharalis*, Pérdidas.

Resumen

EL GUSANO PERFORADOR de la caña de azúcar, *Diatraea saccharalis*, es la principal plaga del cultivo de caña de azúcar en la Provincia de Tucumán. Las galerías producidas por las larvas son puerta de entrada a patógenos. Su efecto, genera pérdidas de peso en los tallos, reduce la calidad y el contenido de sacarosa y disminuye la extracción de jugo en la fábrica. El objetivo de este trabajo fue evaluar las pérdidas causadas por *Diatraea saccharalis* en tres variedades de caña de azúcar con y sin estacionamiento. Durante la zafra 2005, se realizaron ensayos en 3 variedades comerciales: LCP 85-384, TUCCP 77-42 y CP 65-357 y se determinó que el ataque provoca importantes pérdidas en el rendimiento cultural y fabril. Se encontraron reducciones por cada 1% de ataque de 0,42% en el peso de los tallos y de 0,20% en pol % caña, lo que produce pérdidas en el rendimiento fabril de 0,22% por punto de infestación, con una pérdida de azúcar de 620 a 650 g/t de caña, dependiendo de la variedad. Además, se realizaron ensayos con la variedad LCP 85-384 en tres diferentes fechas: Junio, Agosto y Octubre, durante la zafra 2006, se evaluó el efecto de las pérdidas por estacionamiento al ataque de *D. saccharalis*. Las pérdidas de azúcar fueron altas luego de 4 días de estacionamiento. Estas diferencias fueron mayores a medida que avanzaba la temporada de zafra.