SUGARCANE RESPONSE TO TWO BIOTIC STRESSORS: *DIATRAEA SACCHARALIS* AND *MAHANARVA FIMBRIOLATA*

By

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Abstract

THE SUGARCANE borer (*Diatraea saccharalis*) and spittlebug (*Mahanarva fimbriolata*) are considered important sugarcane pests in South America. Damage caused by these pests has already been studied for each species separately; however, knowledge of sugarcane's response to attack by these two pests combined as well as the effect on sugarcane yield has not. The aim of this work was to evaluate the plant response to infestations of these two biotic stressors. Treatments comprised high and low sugarcane borer infestations, spittlebug infestation, both sugarcane borer and spittlebug infestations combined, and controls (uninfested plants). Plots comprised 2 m^2 caged and uncaged sugarcane stalks. Damage attributed to spittlebug nymph attack alone, or in combination with borer attack, decreased the diameter of the stalks. When compared to the control (caged stalks), such damage resulted in a significant reduction in yield: (17.6%), where stalks were attacked by spittlebug nymphs alone; (15.5%) from spittlebug nymphs + sugarcane borer combined and (6.9%) from sugarcane borer alone. There was no significant difference among the treatments in levels of soluble solids and apparent sucrose. However, when evaluating the sucrose yield per unit area, spittlebugs did affect sugar production (individually and in combination with the borer). Therefore, infestation by these pests does lead to yield reduction in the sugarcane crop.

Introduction

The sugarcane borer, *Diatraea saccharalis* (Fabricius, 1794) (Lepidoptera: Crambidae), is a key pest of sugarcane and occurs in several countries of the Americas, including Brazil where is distributed in all producing regions (Gagliumi, 1973; White *et al.*, 2008). Also, due to the increase of mechanical harvest (green cane) and decrease of traditional system (burned cane), the trash layer that is kept on the soil surface has brought changes in environmental characteristics within the sugarcane habitat. These changes have favoured an increase in populations of the spittlebug *Mahanarva fimbriolata* (Stål, 1854) (Hemiptera: Cercopidae), a native pest which is now also considered a key pest of sugarcane in Brazil (Dinardo-Miranda *et al.*, 2001; Mendonça *et al.*, 1996).

In spite of the importance of the two sugarcane pests and their simultaneous occurrence, mainly during the rainy season, there is no information on how sugarcane responds to these pests combined (biotic stress). Current information on plant-insect response aiming at implementing

economic thresholds is usually from infestations where only one pest was present or where one pest was kept under control (White *et al.*, 2008; Madaleno *et al.*, 2008).

According to Peterson and Higley (2001), stress interactions represent the potential relationships among different agents that produce stress in a plant. Thus, the knowledge of infested plant response by two pests combined (e.g.: spittlebug and sugarcane borer) can be an important tool for decision making. Therefore, the aim of this work was to evaluate the sugarcane plant response where both biotic stressors were present.

Material and methods

The experiment was carried out in the São Martinho Sugar Mill, located in São Paulo State, Brazil, (21º19'S and 48º06'W), from December 2007 to October 2008. The variety selected was SP80-3280 (4th ratoon), which is susceptible to spittlebug and sugarcane borer (Dinardo-Miranda, 2003).

The trial was a randomised complete block design with six treatments and four replications. Each plot comprised a 2 m row of sugarcane. Plots were individually protected using a cage structure surrounded by voile fabric to prevent insect movement, except the unprotected control (check). However, when the cages were placed over the plants (72 days after harvest), stalks already bored by sugarcane borer were noticed. Thus, plants were naturally infested. Pests were monitored on every stalk at 2 to 3-day intervals.

Treatments comprised single or combined infestations of spittlebug and sugarcane borer at different levels of Infestation Intensity (I.I.) as follows: high sugarcane borer infestation (I.I.: 15.80%), low sugarcane borer infestation (I.I.: 2.75%), spittlebug nymph infestation (3.07 nymphs/m), both sugarcane borer and spittlebug nymph infestation (I.I.: 13.63% and 2.95 nymphs/m), caged control (I.I.: 0.12% and 0.60 nymphs/m) and unprotected control (check). In spite of an effort to have no spittlebug infestation on sugarcane borer only infested plots, a very low infestation was observed (0.64 nymphs/m). This was attributed to the resident soil population of this pest. Similarly, plots that should have only spittlebug infestations, were also infested by sugarcane borer before cage placement. However, infestation levels were also very low (II: 3.07%).

The stalks were manually harvested around three hundred days after ratoon emergence (nine months after the infestation started). All stalks (n=25) were taken from each plot and their weight, length, and diameter recorded. Stalks were then shredded and juice extracted using a hydraulic press, as suggested by Tanimoto (1964). Immediately after the extraction, the level of soluble solids (Brix) and the apparent sucrose (Pol) were determined according to Scheneider (1979). The sucrose yield per area was estimated using the sucrose content (Pol) and the stalk yield.

Data were analysed (Anova) and means compared using LSD (P = 0.05).

Results anddiscussion

Spittlebug injury negatively affected (F=3.27, P=0.034) the diameter of stalks (Table 1). The stalks infested by spittlebugs, either individually or in combination with the sugarcane borer, were significantly shorter and thinner than non-infested stalks. Feeding by spittlebug nymphs results in plant dehydration, lower nutrition, and possibly plant death (Dinardo-Miranda, 2003).

As the spittlebug affected stalk characteristics, yield was significantly lower (F=3.45, P=0.0284) than yield from non-infested stalks. This was also noted for stalks infested by spittlebugs alone or infested by both spittlebugs and sugarcane borer. On the other hand, stalks infested only by sugarcane borer did not show a significant reduction in stalk yield, compared to the controls (protected and unprotected stalks). The stalk yield losses due to borer infestation is 1.14% per each 1% of infestation intensity (CTC, 2007).

In spite of different pest infestations, all caged plants had similar levels of Brix; however, uncaged plants had significantly higher Brix than caged plants (F=10.64, P=0.0002). However, the

apparent sucrose content (Pol) varied among treatments (F=14.66, P<0.0001). The lowest Pol level was observed in stalks infested by both pests and was 8.37% lower than the level noted in non-infested uncaged stalks.

Table 1—Biometric parameters, soluble solids (Brix), apparent sucrose (Pol) and sucrose yield per area under *Diatraea saccharalis* and *Mahanarva fimbriolata* infestations.

Treatment	Diameter of stalk	Length of stalk	Stalk yield	Brix	Pol	Sucrose yield per area
	(cm)	(cm)	(t/ha)	(%)	(%)	(t pol/ha)
Sugarcane borer (high Infestation)	2.43 ab	258.63 a	116.85 ab	21.93 b	19.63 bc	22.96 bc
Sugarcane borer (low Infestation)	2.41 ab	261.86 a	116.85 ab	22.30 b	20.08 b	23.44 abc
Spittlebug	2.32 b	245.44 a	103.41 b	22.22 b	20.08 b	20.79 c
Spittlebug + sugarcane borer	2.36 b	248.47 a	106.04 b	21.78 b	19.27 c	20.42 c
Control (caged)	2.49 a	272.82 a	125.54 a	21.73 b	19.50 bc	24.50 ab
Control (uncaged)	2.49 a	267.29 a	125.85 a	23.51 a	21.03 a	26.46 a
P	0.034	0.0965	0.0284	0.0002	< 0.0001	0.0077
F_{Trat}	3.27*	2.30^{NS}	3.45*	10.64**	14.66**	4.86**
CV	3.17	5.39	8.8	1.82	1.64	8.94

Means within a column indicated by different letters are significantly different (LSD test, P<0.05).
**P<0.01; *P<0.05; ^{NS}, non-significant at P=0.05

Pol was not significantly different between stalks infested by either pest separately. Stalks infested by spittlebug, either individually or combined with the sugarcane borer, resulted in a lower sucrose yield per unit area than stalks without any pest infestation (F = 4.86, P = 0.0077). Spittlebug infestation caused a 15.14% to 16.65% reduction in sucrose yield per hectare.

Overall, plants infested by spittlebug, either associated with or without the sugarcane borer, were severely damaged. On the other hand, the sugarcane borer did not seem to affect the yield. However, the sucrose yield was affected and may be related to the influence of fungi (*Colletotrichum* and *Fusarium* spp.) associated with the sugarcane borer and different infestation levels. Severe infestations of the sugarcane borer result in longer galleries in the stalk, and a greater likelihood of fungal occurrence. These fungi are responsible for sucrose inversion and production of metabolite inhibitors (McGuire *et al.*, 1965; Stupiello & Moraes, 1974; Blumer, 1992) which can lead to even greater yield reductions. Technological parameters such as sugar production and quality should also be evaluated. This information will be very important to enhance the current threshold levels adopted to control these pests in Brazil.

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REFERENCES

Blumer, E. (1992). Efeito do complexo broca/podridões na fermentação etanólica. Tese de Mestrado – Escola Superior de Agricultura Luís de Queiroz, Universidade de São Paulo, Piracicaba. 66 p.

CTC (2007). Controle biológico da broca da cana-de-açúcar *Diatraea saccharalis*. Boletim do fornecedor.

Dinardo-Miranda, L.L., Ferreira, J.M.G. and Carvalho, P.A.M. (2001). Influência da época de colheita e do genótipo de cana-de-açúcar sobre a infestação de *Mahanarva fimbriolata* (Stal) (Hemiptera: Cercopidae). Neotropical Entomol., 30: 145–49.

Dinardo-Miranda, L.L. (2003). Cigarrinha-das-raízes em cana-de-açúcar. Campinas: Instituto Agronômico, 70 p.

Gagliumi, P. (1973) Pragas da cana-de-açúcar: Nordeste do Brasil. Rio de Janeiro, 1973. (Coleção Canavieira, 10).

Madaleno, L.L., Ravaneli, G.C., Presotti, L.E., Mutton, M.A., Fernandes, O.A. and Mutton, M.J.R. (2008). Influence of *Mahanarva fimbriolata* (Stål) (Hemiptera: Cercopidae) injury on the quality of cane juice. Neotropical Entomol., 37(1): 68–73.

McGuire, J.U., Mathes, R. and Charpentier, L.J. (1965). Sugarcane yields affected by borer infestation and position of injury on the stalk. Proc. Int. Soc. Sugar Cane Technol., 12: 1368–1372.

Mendonça, A.F., Barbosa, G.V.S. and Marques, E.J. (1996). As cigarrinhas da cana-de-açúcar no Brasil, p.171–192. In: Mendonça, A. F. (ed.), Pragas da cana-de-açúcar. Maceió: Edição do autor, 239 p.

Peterson, R.K.D. and Higley, L.G. (2001). Illuminating the black box: the relationship between injury and yield. In: Biotic Stress and yield loss. Boca Raton: CRC Press, 1–12.

Scheneider, F. (1979). Sugar Analysis ICUMSA Methods. Peterborough: ICUMSA. 265 p.

Stupiello, J.P. and Moraes, R.S. (1974). Prejuízos causados pelo complexo broca-podridão vermelha. In: Jornada científica da Faculdade de Ciências Médicas Biológicas de Botucatu, 4., Resumo. Botucatu, FCMBB, 42 p.

Tanimoto, T. (1964). The press method of cane analysis. Hawaian Planter's Record., 57: 133–150.

White, W.H., Viator, R.P., Dufrene, E.O., Dalley, C.D., Richard, Jr., E.P. and Tew, T.L. (2008) Re-evaluation of sugarcane borer (Lepidoptera: Crambidae) bioeconomics in Louisiana. Crop Protection, 27: 1256–1261.

REPONSE DE LA CANNE À SUCRE A DEUX BIOAGRESSEURS: *DIATRAEA SACCHARALIS* ET *MAHANARVA FIMBRIOLATA*

Par

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MOTS CLÉS: Foreur de la Canne, Cicadelle Ecumeuse, Relation Plante-Insecte, Rendement.

Résumé

LE FOREUR de la tige (*Diatraea saccharalis*) et la cicadelle écumeuse (*Mahanarva fimbriolata*) sont considérés comme les ravageurs majeurs de la canne à sucre en Amérique du Sud. Les dégâts causés ont déjà été étudiés séparément pour les deux espèces. Toutefois, nos connaissances sur la réaction de la canne à sucre à l'infestation simultanée par ces deux ravageurs et leur effet sur le rendement ne sont pas connues. L'objectif de cette étude a été d'évaluer la réponse de la canne à l'infestation de ces deux bioagresseurs. Les traitements comprenaient les niveaux faibles et élevés d'infestation du foreur, l'infestation par la cicadelle écumeuse, une combinaison des infestations de ces deux bioagresseurs, et un témoin (plantes non-infestées). Les parcelles comportaient des tiges

de canne sur 2 m^2, encagées et non-encagées. Les dégâts attribués uniquement aux nymphes de la cicadelle écumeuse ou en combinaison avec une attaque du foreur, ont occasionné une réduction du diamètre de la tige. Par rapport au témoin (tiges encagées), ces dégâts ont eu un effet significatif sur le rendement avec les résultats suivants: tiges attaquées par les nymphes de la cicadelle écumeuse : 17.6%, effets combinés des nymphes de la cicadelle écumeuse + foreur de la tige: 15.5% et foreur de la tige seulement: 6.9%. Aucune différence parmi les traitements n'a été observée au niveau des sucres solubles et du saccharose apparent. Toutefois, la cicadelle écumeuse a significativement affecté le rendement en sucre par unité de surface (seul ou en combinaison avec le foreur). Par conséquent, l'infestation due à ces deux ravageurs peut affecter le rendement de la canne à sucre.

LA RESPUESTA DE LA CAÑA DE AZÚCAR A DOS FACTORES DE ESTRÉS BIÓTICO: *DIATRAEA SACCHARALIS* Y *MAHANARVA FIMBRIOLATA*

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PALABRAS CLAVE: **Barrenador del Tallo, Salivazo, Relación Planta-Insecto, Producción.**

Resumen

EL BARRENADOR de la caña de azúcar (*Diatraea saccharalis*) y salivazo (*Mahanarva fimbriolata*) son considerados plagas importantes de la caña de azúcar en América del Sur. Los daños causados por estas plagas ya ha sido estudiado para cada especie por separado, sin embargo, el conocimiento de la respuesta a los ataques de estas dos plagas en forma combinada, así como el efecto sobre la producción en la caña de azúcar no se tienen resultados. El objetivo de este trabajo fue evaluar la respuesta de la planta a las infestaciones de estos dos factores de estrés biótico. Los tratamientos comprendieron altas y bajas infestaciones del barrenador de la caña de azúcar y del salivazo, solos y como combinados y los controles (plantas no infestadas). Las parcelas comprendieron tallos en jaulas de 2 m^2 y tallos sin enjaular. El daño atribuido al ataque de las ninfas de salivazo, solo o en combinación con el ataque del barrenador, disminuyó el diámetro de los tallos. Cuando se compararon estos resultados con el control (tallos en jaulas), los daños ocasionaron disminuciones significativas de la producción: (17.6%), cuando los tallos fueron atacados únicamente por las ninfas del salivazo; (15.5%) cuando las ninfas de salivazo y barrenador de la caña de azúcar en combinado y (6.9%) cuando fue solo el barrenador de la caña de azúcar. No hubo diferencias significativas entre los tratamientos en los niveles de sólidos solubles y sacarosa aparente. Sin embargo, al evaluar la producción de sacarosa por unidad de área, se encontró que el salivazo afectó la producción de azúcar (individualmente y en combinación con el barrenador). Por tanto, la infestación por estas plagas se traduce en la reducción de productividad en el cultivo de caña de azúcar.