

MAHANARVA FIMBRIOLATA INFESTATION IN SUGARCANE: IMPACTS ON ETHANOL PRODUCTION

By

M.J.R. MUTTON*, G.C. RAVANELI, D.B. GARCIA, L.L. MADALENO,
J.P. STUPIELLO and M.A. MUTTON

São Paulo State University – UNESP – Brazil

* mjrmut@fcav.unesp.br

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Abstract

The spittlebug (*Mahanarva fimbriolata*) has become an important pest of sugarcane in Brazil, causing stalk yield and cane quality losses. This research was conducted to evaluate the effects of spittlebug damage levels on ethanol production. The experiment was set in a sugarcane field with no trash burn, using the variety SP80-1842 (4th ratoon), four stalk damage levels (0, 15%, 30% and 60%) and two harvest dates (May/June and October). Batch fermentation was conducted with baker's yeast, *Saccharomyces cerevisiae*, with 10 fermentation cycles. There was a reduction in juice sucrose content, total reducing sugars, purity and pH and an increase in total juice and volatile acidity. It was also observed that pest attack damage in sugarcane negatively influenced the fermentation process, with higher levels of acidity and residual reducing sugars and lower alcohol content in wines. Distillates presented higher acetaldehyde and lower ethanol concentration with increasing spittlebug stalk damage levels.

Introduction

The spittlebug *Mahanarva fimbriolata* (Stal, 1854) (Hemiptera: Cercopidae) has become a key pest of sugarcane in Brazil, because of the conditions resulting from mechanical harvesting with no trash burn. Nymphs suck roots resulting in nutrient deficiency and dry stalks, affecting both stalk and sugar yield.

Metabolic alterations take place in sugarcane in response to spittlebug infestation, producing a wide variety of biomolecules, which interfere with cane quality and processing, yeast metabolism inhibition during fermentative process, and alcoholic yield losses (Ravaneli *et al.*, 2006).

The damages may be severe on most genotypes, especially in middle and end-of-season varieties (Dinardo-Miranda *et al.*, 1999).

This research was conducted to determine the effects of *M. fimbriolata* damage levels in sugarcane on cane quality and on ethanol production.

Materials and methods

The variety used was SP 80-1842 (4th ratoon). The mean infestation observed was 5.32 nymphs/m. Cane was harvested at the end of the rainy season (May/June) and after the dry season (October). The stalk damage levels (15%, 30% and 60%) were compared to uninfested control (Gonçalves *et al.*, 2003).

Juice extraction was performed as described by Tanimoto (1964). Total soluble solids (T.S.S.) and sucrose content analyses were performed as recommended by Schneider (1979); pH, total Reducing Sugars (T.R.S) through Lane & Eynon's (1934) method; Total Acidity by juice titration with NaOH 0.05N, Volatile Acidity as indicated by Vilella *et al.* (1973) and Total Phenolic Compounds through Folin and Ciocalteu's (1927) colorimetric protocol.

To conduct ethanolic fermentation, juice was submitted to a clarification process. In the first harvest date, juice purity was diluted to 13° Brix. In the second harvest time, juice purity was diluted to 14° Brix, and pH 3.5 (± 0.3). Fresh baker's yeast (*Saccharomyces cerevisiae*) was used at a concentration of 30g per liter of must. Batch fermentations were conducted in 1 L erlenmeyers, in a BOD incubator set at 32°C, monitoring the process with the help of a Brix densimeter. Ten fermentative cycles were conducted. Total residual reducing sugars (T.R.R.S.) (Lane and Eynon, 1934) and alcohol content were determined in wines. The distillates were submitted to volatile compounds analyses by gas chromatography.

Statistical analyses

For juice analyses, the experiment was arranged in a completely randomised design in a 4 x 2 factorial. Treatments corresponded to the spittlebug stalk damage levels (0, 15%, 30% and 60%) and harvesting times (May/June and October/2007). Analyses were performed in fifteen replications.

Wine and distillate data were analysed in completely randomised design in a 4 x 10 x 2 factorial. Treatments corresponded to the spittlebug stalk damage levels, fermentative cycles and harvesting times. Analyses were performed in three replications. Data were submitted to an ANOVA, and means were compared by Tukey test at 5%.

Results and discussion

M. fimbriolata infestation levels affected cane quality. Sucrose content, T.R.S. and juice purity were lower at higher damage levels. Losses were 8.76%, 3.14% and 6.95%, respectively (Table 1).

As spittlebugs attack sugarcane roots, limiting water, nutrient uptake, photosynthesis is expected to be affected, reducing sucrose accumulation (Dinardo-Miranda *et al.*, 2002; Ravaneli *et al.*, 2006). In addition, the reduction in sucrose levels may be a consequence of the biosynthesis of plant defence compounds, such as phenols (Buchanan *et al.*, 2000) and the attempt to produce new vegetative parts. Juice pH, total and volatile acidity were also affected by higher damage levels (Table 1), which indicates that cane was in a deterioration process.

Table 1—Effects of *Mahanarva fimbriolata* damage levels on technological parameters of sugarcane juice.

	TSS	Sucrose	Purity	TRS	pH	Total acidity	Volatile acidity
	%					gH ₂ SO ₄ /L	mg acetic acid/L
Damage levels (A)							
0%	20.16A	17.33A	85.41A	18.66A	5.27A	1.09B	13.53B
15%	20.04A	17.15A	85.16A	18.38AB	5.26AB	1.13AB	15.52AB
30%	19.86A	16.78A	84.11AB	17.96B	5.20B	1.19AB	17.14AB
60%	19.06B	15.89B	82.66B	17.39C	5.09C	1.25A	18.76A
F test	5.46**	11.50**	5.06**	13.97**	18.84**	4.45**	3.62*
LSD (Tukey)	0.78	0.7	2.05	0.55	0.07	0.12	4.34
Harvest times (B)							
May/June	15.23B	11.96B	79.41B	12.97B	5.26A	1.23A	19.23A
October	24.33A	21.61A	89.26A	23.22A	5.15B	1.11B	13.25B
F test	1841.07**	2596.62**	315.12**	4743.77**	30.11**	13.81**	25.84**
LSD (Tukey)	0.42	0.37	1.09	0.29	0.04	0.06	2.33
F test A x B	0.18ns	0.19ns	1.01ns	1.99ns	8.28**	2.56ns	0.05ns
CV	5.87	6.18	3.6	4.5	2.02	15.11	39.66

ns = non-significant; * = significant at 5% probability; ** = significant at 1% probability.

The damage levels of *M. fimbriolata* resulted in higher levels of total residual reducing sugars in the wine, reflected in alcohol yield decrease (Figure 1). The highest T.R.R.S. levels were found in the October harvest. This behaviour may be occurring as a result of yeast stress because of cane quality, which presents high levels of acidity and phenolic compounds (data not shown).

There were losses of 13.82% in alcohol content in wines at higher damage levels (Figure 1). Similar results were described in Ravanelli *et al.* (2006), which observed reduction of 7.2% in alcohol content when spittlebug infestation levels were higher than 2.5 nymphs/m. In distillates, there was higher acetaldehyde concentration when infested cane stalks were used. This behaviour is evident in the October harvest, although the highest means were found in the first harvesting season (Figure 2).

The opposite was observed in ethanol levels (Figure 2), which corroborates the juice quality results. Also, acetaldehyde levels indicate that the fermentation process itself may have been affected, because acetaldehydes are precursors to ethanol in the fermentation pathway. Therefore, *M. fimbriolata* attack results in incomplete fermentations because it affects cane quality and the fermentation process.

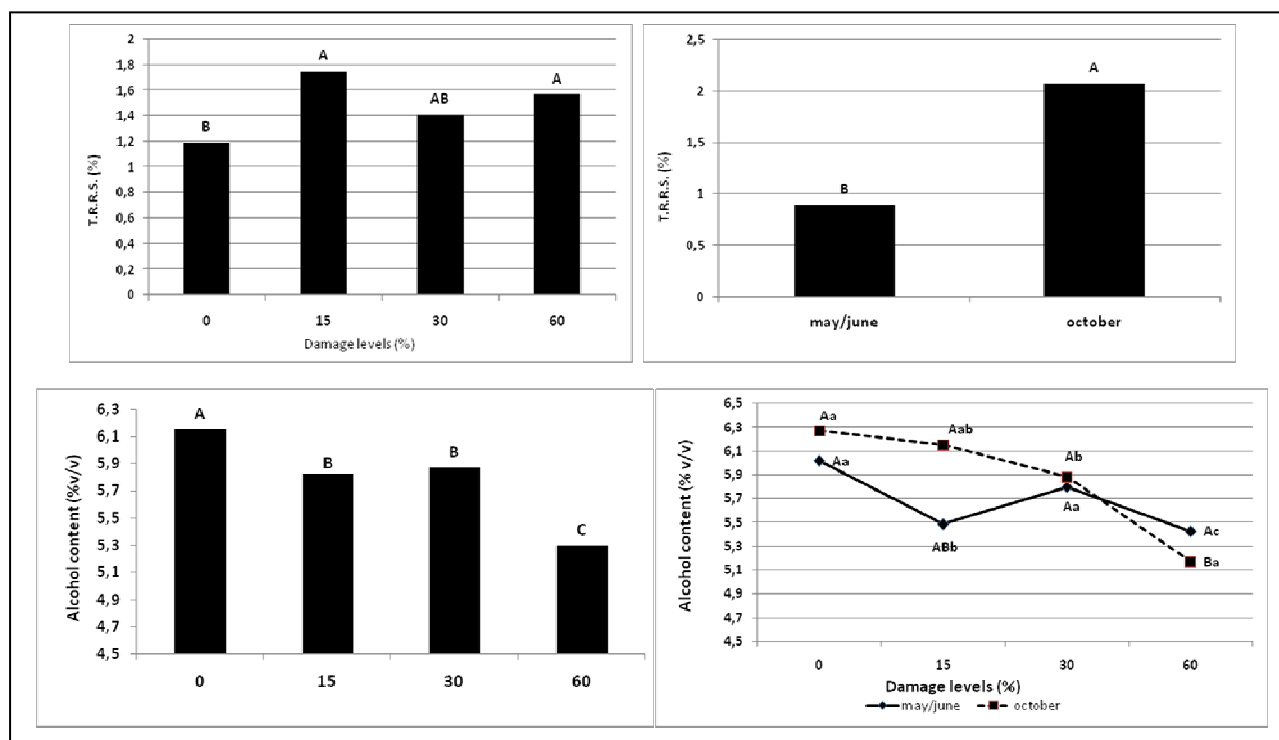


Fig. 1—Effect of *M. fimbriolata* damage levels on residual reducing sugars (T.R.R.S.) and alcohol content in wines.

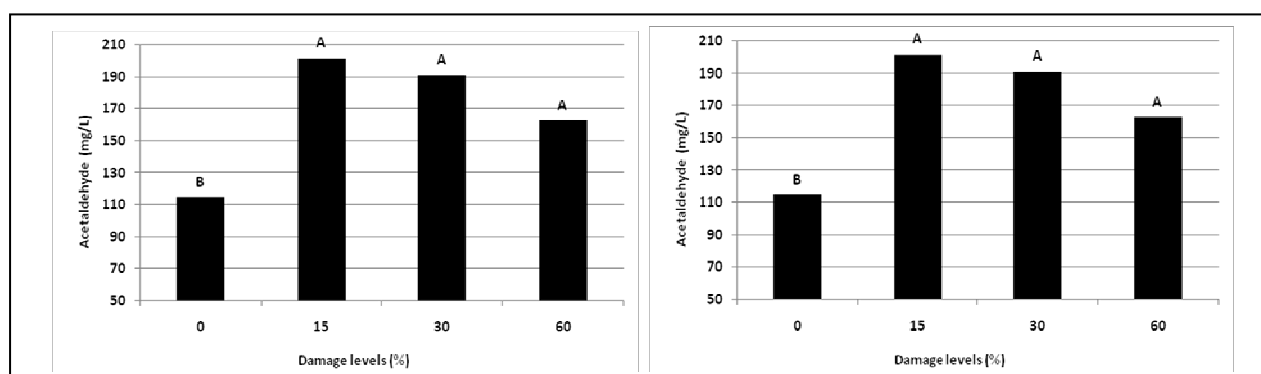


Fig. 2—Effect of *M. fimbriolata* damage levels on acetaldehyde and ethanol contents in distillates.

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L'IMPACT D'UNE INFESTATION DE *MAHANARVA FIMBRIOLATA* SUR LA PRODUCTION D'ETHANOL

Par

M.J.R. MUTTON*, G.C. RAVANELI, D.B. GARCIA, L.L. MADALENO,
J.P. STUPIELLO et M.A. MUTTON

São Paulo State University – UNESP – Brazil

* mjrmut@fcav.unesp.br

MOTS-CLÉS: *Saccharum spp.*, Cercope,
Qualité de la Canne à Sucre, Fermentation d'Éthanol.

Résumé

MAHANARVA FIMBRIOLATA de la famille des Cercopidae, est devenu un ravageur important de la canne à sucre au Brésil, où il induit des pertes de rendements et de qualité. Cette étude a été réalisée pour évaluer les effets de différents niveaux d'infestations de *Mahanarva fimbriolata* sur la production d'éthanol. L'expérience a été réalisée dans un champ de canne à sucre sans brûlis, avec la variété SP80-1842 (4ème repousse), quatre niveaux de dommage des tiges (0, 15 %, 30 % et 60 %) et deux dates de récolte (mai / juin et octobre). Des fermentations en discontinues ont été menées avec de la levure boulangère, *Saccharomyces cerevisiae*, avec 10 cycles de fermentation. Il y avait une réduction de la teneur en saccharose du jus, des sucres réducteurs, de la pureté, du pH et une augmentation en jus total et des acides volatils. Il a également été observé que les dommages causés par l'infestation du ravageur ont une influence négative sur le processus de fermentation, avec des niveaux plus élevés de l'acidité ; des sucres réducteurs résiduels et une plus faible teneur en alcool dans les vins. Les distillats présentaient une plus forte concentration en acétaldéhyde et une plus faible concentration en éthanol, pour des dommages de niveaux croissants.

INFECCIÓN POR *MAHANARVA FIMBRIOLATA* EN LA CANA DE AZÚCAR: IMPACTO EN LA PRODUCCIÓN DE ETANOL

Por

M.J.R. MUTTON*, G.C. RAVANELI, D.B. GARCIA, L.L. MADALENO,

J.P. STUPIELLO y M.A. MUTTON

São Paulo State University – UNESP – Brazil

* mjrmut@fcav.unesp.br

PALABRAS CLAVE: *Saccharum sp.*, Spittlebug,
Calidad de Caña, Fermentación Etanólica.

Resumen

EL SPITTLEBUG (*Mahanarva fimbriolata*) se ha convertido en una importante plaga de la cana de azúcar en Brasil, provocando pérdidas en el rendimiento de tallos de cana y en la calidad de la caña. Esta investigación se realizó para evaluar los efectos de los niveles del daño de este insecto en la producción de etanol. El experimento se localizó en un campo de caña sin quema de la paja, usando la variedad SP 80-1842 (4° retoño), cuatro niveles de daño en los tallos (0, 15%, 30% y 60%) y dos fechas de cosecha (Mayo/Junio y Octubre). Se realizaron fermentaciones en batch empleando levadura de panificación, *Saccharomyces cerevisiae*, con 10 ciclos de fermentación. Hubo una reducción en el contenido de sacarosa del jugo, en los azúcares reductores totales, la pureza y el pH, y un incremento en el jugo total y la acidez volátil. Se observó también que los daños por el ataque de la plaga en la caña de azúcar influye negativamente el proceso fermentativo, con más altos niveles de acidez y azúcares reductores residuales, así como menores contenidos de alcohol en los vinos. Los destilados presentan mayores aldehídos y menores concentraciones de etanol con el incremento de los daños de la plaga en los tallos de caña.