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EFFICIENCY OF BORIC ACID TO CONTROL PASTURE SPITTLEBUGS *Deois flavopict*a AND *Notozulia entreriana* (HEMIPTERA: CERCOPIDAE)

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ABSTRACT

The *Urochloa* spp. (sin. *Brachiaria* spp.) is an important grass cultivated in Brazil. However, the pasture spittlebugs pest attack can limited this forage plant supply and animal production. In search of alternative pest control methods, this research evaluated the boric acid efficiency to control spittlebugs *Deois flavopicta* and *Notozulia entreriana* (Hemiptera: Cercopidae). The experiment was carried out under completely randomized design with six treatments and four replications. The treatments were boric acid at concentrations of 0.1, 0.2 and 0.4% and insecticides permethrin 50 CE (0.005%) and imidacloprid 700 WG (0.02%). The number of surviving insects after pulverization of treatments to pasture spittlebugs pest control efficiency were performed. Boric acid at the concentration 0.4% showed 100% of efficiency to control spittlebugs *D. flavopicta* and *N. entreriana* species. Thus, boric acid at 0.4% can be used to integrated pest management programs of forage grasses.

Keywords: Pasture pests, IPM, pasture fertilization, boron, signal grass.

EFICIÊNCIA DO ÁCIDO BÓRICO NO CONTROLE DA CIGARRINHA-DAS-PASTAGENS *Deois flavopicta* E *Notozulia entreriana* (HEMIPTERA: CERCOPIDAE)

RESUMO

O capim *Urochloa* spp. (sin. *Brachiaria* spp.) é uma importante gramínea cultivada no Brasil. No entanto, o ataque de cigarrinhas-das-pastagens pode limitar o fornecimento desta planta forrageira e a produção animal. Buscando métodos alternativos de controle de pragas, esse trabalho avaliou a eficiência do ácido bórico no controle das cigarrinhas-das-pastagens *Deois flavopicta* e *Notozulia entreriana* (Hemiptera: Cercopidae). O experimento foi conduzido sob o delineamento inteiramente casualizado com seis tratamentos e quatro repetições. Os tratamentos foram ácido bórico nas concentrações de 0,1, 0,2 e 0,4%, e os inseticidas permetrina 50 CE (0,005%) e imidacloprido 700 WG (0,02%). Foram avaliados o número de insetos sobreviventes após a pulverização dos tratamentos e a eficiência do controle. O ácido bórico na concentração de 0,4% apresentou 100,00% de eficiência no controle das cigarrinhas-das-pastagens *D. flavopicta* e *N. entreriana*. O ácido bórico na concentração de 0,4% pode ser utilizado em programas de manejo integrado de pragas de culturas forrageiras.

Palavras-chave: Pragas de pastagem, MIP, adubação de pastagens, boro, capim braquiária.

INTRODUCTION

Brazil has around 100 million hectares of cultivated pasture (IBGE, 2017), which *Urochloa* spp. (sin. *Brachiaria* spp.) forage grasses have predominance in 70% of these areas (ZIMER et al., 2012). The *Urochloa* spp. is widely used for animal feeding in extensive and intensive pasture production systems. However, issues related with attacks of pest-insects and soil fertility management have been reducing the biomass production and limiting the viability of livestock activity (VALÉRIO, 2009; ZIMER et al., 2012). *Deois flavopicta* Stal and *Notozulia entreriana* Berg (Hemiptera: Cercopidae) stand out among the main pasture pests (GUSMÃO et al., 2016). The behavior of pasture spittlebugs during the nymphal phase is characterized by feed primarily from the xylem of plants on ground level and adults attack the foliar layer of plants. The damaged plants have unnatural vegetative development, which decreases the capacity of pasture to tolerate animal densities and the system of extensive production (VALÉRIO, 2009). In addition, the pasture spittlebugs also affect the forage grasses quality by reducing the proportion of crude protein, phosphorus, magnesium, calcium, and potassium, as well as the fiber levels that affect the animal digestibility, weight gain and the cattle feed efficiency (VALÉRIO & NAKANO, 1988). In worldwide, the economic damages caused by pasture spittlebugs attacks range from U$ 840 million to U$ 2.1 billion per year (THOMPSON, 2004). In this way, the traditional methods of control have been used in order to avoid these damages (PEREIRA et al., 2018). Rocha & Ribeiro (2016) evaluated the efficiency of different doses and interactions of the entomopathogenic fungus *Metarhizium anisopliae* Metschnikoff (Hypocreales: Moniliaceae) and the active ingredients of fipronil, chlorpyrifos, and carbaryl insecticides. The authors found that fipronil (10 mL ha^{-1}) associated with *M. anisopliae* (900 g ha^{-1}) showed better performance to control *Mahanarva fimbriolata* (Stal) (Hemiptera: Cercopidae) and *D. flavopicta*. Although the high control efficiency to pasture spittlebugs, fipronil has been affecting negatively most of the natural enemies in agroecosystems (OLIVEIRA et al., 2013). Besides that, reports in literature revealed that fipronil insecticide can also reduce the diameter and number of conidium produced by *M. anisopliae*, an important agent in biological control pest with natural occurrence in the fields (MOINO & ALVES, 1998). Thus, alternative and economically viable strategies of integrated pest management (IPM) have been proposed poorly to control pasture spittlebugs associate with potential agronomic benefits to forage grasses.

Boron is a scarce micronutrient in Brazilian soils, but when available for forage grasses can improve the root development and tillering, as well as increase the plant biomass production (SILVA, 2015; ALMEIDA, 2015). In parallel, the boric acid (commercial product of boron) has insecticidal properties. On insects, boric acid acts primarily on insect midgut affecting the process of digestion and nutrient absorption. Besides that, by physical contact, boric acid can affect their target-pest by abrade the exoskeletons of insects (QUARLES, 2001). In literature, there are satisfactory results of the boric acid in the control of *Atta sexdens rubropilosa* Forel (Hymenoptera: Formicidae) and *Nasutitermes corniger* Motschulsky (Isoptera: Termitidae: Nasutitermitinae) (QUARLES, 2001; SUMIDA et al., 2010; CALEGARI et al., 2014), as well as *Blattella germanica* Linnaeus (Blattodea: Ectobiidae) (HABES et al, 2006). However, although the insecticide action boric acid has been discovered at the end of the decade 40 to pest control, currently there are no studies approaching the efficiency of boron to control pasture spittlebugs (QUARLES, 2001). In the face of this scenario, was hypothesized double benefits from the foliar application of boric acid to control pasture spittlebugs and forage grasses nutritional supplementation. The objective of this study was to evaluate the boric acid efficiency in the control of pasture spittlebugs *D. flavopicta* and *N. entreriana* and provide practical information to IPM programs for pasture grass.

MATERIAL AND METHODS

The experiment was carried out under completely randomized design with six treatments and four replications. The treatments were fertilizer boric acid (99.5%) at concentrations of 0.1, 0.2 and 0.4%, Ambush 50 CE® (permethrin) at concentration of 0.005% and Confidor® 700 WG (imidacloprid) at concentration of 0.02%. Each 10 adults of pasture spittlebugs from species *D. flavopicta* and *N. entreriana* were considered as replication. The individuals of spittlebugs were collected in *Urochloa* spp. forage grass after pulverization with Guarany® costal atomizer. The sprayer machine was calibrated to the rate of 800 L ha^{-1}.

The treatments were sprayed on area of 5x40 m (200 m^2). On these treated areas, four groups of 10 spittlebugs of *D. flavopicta* and *N. entreriana* were collected, which later were placed inside of iron cages with 0.30x0.50 m of dimensions that were screened and externally sealed. The number of surviving insects after application of the products and the efficiency E (%) of treatments to control the pasture spittlebugs were calculated according to Abbott (1925) formula.

The data of treatments efficiency were submitted to variance analysis (ANOVA) using SISVAR 5.6 (FERREIRA, 2010) software and means were compared by Tukey's test ($P< 0.05$).

RESULTS AND DISCUSSION

Pasture spittlebugs are considered the most important pests of forage grasses, which reinforce the need of adopting alternative and sustainable methods of control instead of traditional chemical strategy (VALÉRIO, 2009). In agriculture, boric acid has been used as insecticide against several pests, as well as fertilizer to pastures (SUMIDA et al., 2010; LOPES et al., 2017). In the present study, were found significant differences between treatments in relation to mortality of *D. flavopicta* (F = 274,516; df model = 5; df residue = 18; $P < 0.0001$) and *N. entreriana* (F = 306,440; df model = 5; df residue = 18; $P < 0.0001$) (Table 1). The number of surviving spittlebugs ranged from 7.50 ± 0.47 to 0.00 ± 0.00 for *D. flavopicta* and 6.50 ± 0.28 to 0.00 ± 0.00 to *N. entreriana*, according to the increase of boric acid concentration. Permethrin 50 CE insecticide showed 0.50 ± 0.28 of mean to *D. flavopicta* surviving individuals, while *N. entreriana* showed mean of 0.25 ± 0.25 individuals. In relation to imidacloprid 700 WG, this insecticide did not allow the survival of any insect to both spittlebug species assessed (Table 1).

Besides that, all treatments showed significant differences in relation to the control treatment regarding the efficiency to pasture spittlebugs (Figure 1). For species *D. flavopicta*, the boric acid at concentrations of 0.1% and 0.2% presented 27.50 and 55% control efficiency, respectively. However, for the same concentrations, boric acid showed efficiency to control *N. entreriana* between 35.00 and 65.00%. At the highest concentration, boric acid showed 100.00% of efficiency to control both species of pasture spittlebugs (Figure 1). The insecticide permethrin 50 CE at the same concentration presented 95.00 and 97.50% of efficiency to control *D. flavopicta* and *N. entreriana*, respectively, while imidacloprid 700 WG demonstrated, 100.00% of efficiency for both pasture spittlebugs species (Figure 1).

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Table 1. Average of surviving insects (mean ± standard error) after pulverization of treatments on adult pasture spittlebugs.

Treatments	*D. flavopicta* [1]	*N. entreriana*[1]
Boric acid (0.1%)	7.50 ± 0.47 c	6.50±0.28 c
Boric acid (0.2%)	4.50 ± 0.28 b	3.50±0.28 b
Boric acid (0.4%)	0.00 ± 0.00 a	0.00±0.00 a
Permethrin 50 CE	0.50 ± 0.28 a	0.25±0.25 a
Imidacloprid 700 WG	0.00 ± 0.00 a	0.00±0.00 a
Control	10.00±0.00 d	9.50±0.28 d
P	<0.0001	<0.0001
F	274.516	306.440
df model	5	5
df residue	18	18
CV (%)	13.85	13.87

[1]Numbers followed by the same letter did not statistically differ in the column at 5% of probability according with Tukey's test.

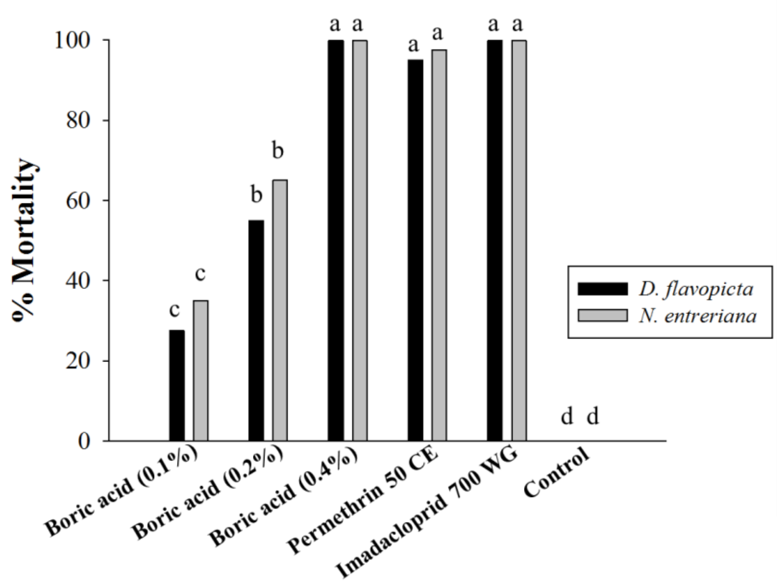

Figure 1. Efficiency (E%) of treatments to control pasture spittlebugs species.

*Column followed by the same letter did not statistically differ according Tukey's test at 5% of probability. (*D. flavopicta*: F = 274.516; df model = 5; df residue = 18; P < 0.0001; *N. entreriana*: F = 306.440; df model = 5; df residue = 18; P < 0.0001).

In general, boric acid at the concentration of 0.4% (4 kg/ha) showed efficiency of 100.00% to control *D. flavopicta* and *N. entreriana*. This high efficiency to kill pasture spittlebugs species can be related with ingestion and neurotoxic boric acid mode of action (QUARLES et al., 2001). In parallel, the sodium salts boric acid composition (decahydrate sodium tetraborate, pentahydrate sodium tetraborate, sodium tetraborate, tetrahydrate disodic octaborate, disodic octaborate) can support the improvement of insecticide performance in the control of pasture spittlebugs, since the abrasiveness effect on insects cuticle can lead them to dehydration and destruction of midgut cells (EBELING et al., 1975; QUARLES et al., 2001).

Studies with cockroach *B. germanica* demonstrated the destruction of midgut cells after the ingestion of contaminated baits with different concentrations of boric acid (HABES et al., 2006). In this same study, the authors cited that the intoxicated insects showed uncoordinated movement followed by trembling, paralysis and death, which was hypothesized the same effects in the present study. In literature, boric acid toxicity to insects haas been compared to natural spinosyns insecticides from soil actinomycetes *Saccharopolyspora spinosa* Mertz and Yao (Actinomycetales: Pseudonocardiaceae) mode of action (HABES et al., 2006). Spinosyns cause hyperexcitation, involuntary muscular contractions and muscular fatigue in contaminated insects (SALGADO et al., 1998).

In this study, besides the satisfactory performance of boric acid at a concentration of 0.4%, the synthetic insecticides permethrin 50 CE and imidacloprid 700 WG were also efficiently to control the pasture spittlebugs *D. flavopicta* and *N. entreriana*. However, when compared with boric acid at 0.4% to permethrin 50 CE and imidacloprid 700 WG, boric acid has economic and environmental advantages in function of the low-toxicity and human safe, as well as relatively harmless profile to natural enemies (MOINO & ALVES, 1998; OLIVEIRA et al., 2013). Reports on literature have demonstrated that boron acid acts as bactericide and fungicide, which can indirectly support the benefits to grasses roots when it damaged by pathogenic microorganisms from direct feed attacks of pasture spittlebugs.

It is important to highlight that the forage grasses fertilizations play important role to forage production, quality and cattle fattening (ZIMER et al., 2012; MENEZES et al., 2015; LOPES et al., 2017). Thus, since that most cultivated pastures in Brazil are featured by extensive animal system production and low investment, efficient and economic viable spittlebugs methods of control are widely desirable instead of traditional chemical control (VALÈRIO & KOLLER, 1992).

Therefore, the use of boric acid reveals interesting scenario to control pastures spittlebugs in function of extra potential benefits by mineral nutrition of plants when applied to control *D. flavopicta* and *N. entreriana*. However, to ensure reasonable foliar coverage and boric acid control effectiveness, is suggested enough rate of volume sprayed per area in function of the feed behavior of pasture spittlebugs during the nymphal phase and the foams physical protection.

CONCLUSION

Boric acid at concentration of 0.4% showed efficiency to control the pasture spittlebugs *D. flavopicta* and *N. entreriana*, and can be used as part of IPM strategy to forage grasses.

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