Seed treatment with insecticides was not effective on reducing *Dalbulus maidis* incidence and further occurrence of Maize rayado fino and Maize bushy stunt diseases

Rodolfo Vargas Castilhos[1*], Maria Cristina Canale[1]

ABSTRACT

In this work we evaluated seed treatment using different insecticides on *Dalbulus maidis* natural infestation and the further incidence of Maize bushy stunt phytoplasma (MBSP) and Maize rayado fino virus (MRFV) diseases, in a field experiment. The experiment was conducted in second growing season of 2020/21 agricultural year in Chapecó, SC, with the P4285 VYHR maize genotype, sown in plots of 24m^2 in a density of 62.500 plants ha^{-1}. The insecticides evaluated were thiametoxam, imidacloprid, imidacloprid + thiodicarb and clothianidin, all at the maximum dosage recommended for *D. maidis* management. A control treatment (absence of insecticides) was also evaluated. For each treatment it was used five replicates (plots). The number of leafhopper.plant^{-1} was counted at 3, 7, 10, 14 and 17 days after emergence. At 90 days after emergence the incidence of MBSP and MRFV diseases was evaluated. The number of leafhoppers.plant^{-1} in the plots subjected to seed treatment did not differ significantly from control in all evaluation dates, showing that perhaps the chemical protection of seeds was not effective in suppress *D. maidis* incidence in early stages of the crop. Also, there was no significant difference in MBSP and MRFV incidence among treatments, suggesting that seed treatment as a single practice may be ineffective in *D. maidis* management and stunt disease prevention, especially in cases of high infestation.
Keywords: corn leafhopper; insect-transmitted pathogens, chemical control.

INTRODUCTION

In 2020/21 agricultural year the scenario for corn production in Santa Catarina was quite unfavorable due to high incidence of the corn leafhopper *Dalbulus maidis* (DeLong & Wolcott) (Hemiptera: Cicadellidae). This insect can transmit the maize rayado fino virus (MRFV), and the mollicutes *Spiroplasma kunkelii*, responsible for corn stunt disease, and '*Candidatus* Phytoplasma asteris', responsible for maize bushy stunt (MBS) disease (Lee et al., 2004; Waquil, 2004). Those diseases have potential to reduce grain yield in up to 70%, which brings out the need to realize an efficient control of the vector *D. maidis* (Virla et al., 2004; Oliveira et al., 2005)

The most critical period for occurrence of *D. maidis* in maize crops is from emergence to V5, and the earlier plants are inoculated with the corn stunt pathogens, the more severe are the symptoms of stunt complex diseases. Usually, the incidence of *D. maidis* in the early stages of maize is more intense in second growing season due to migration of residual population from first growing season crops. Given this, the protection of maize plants against *D. maidis* in the initial vegetative stages is crucial, especially in second growing season, and the seed treatment with registered insecticides is a recommended practice in the integrated management of this pest (Cota et al., 2021).

This work aimed to evaluate the efficiency of different insecticides recommended for seed treatment on the control of *D. maidis* and mitigation of maize rayado fino and maize bushy stunt diseases in a second growing season crop with high pressure of leafhopper population.

MATERIAL AND METHODS

Field assay was carried out at the experimental station of Epagri in Chapecó, SC (27°05'04"S; 52°38'12"W), in 2020/21 crop year. The insecticides active ingredient (Commercial product –

[1]*Epagri - Centro de Pesquisa para Agricultura Familiar, Chapecó, SC.* *rodolfocastilhos@epagri.sc.gov.br.

recommended dosage) evaluated were thiametoxam (Cruiser® 350 FS - 80 mL 60.000 seeds^{-1}); imidacloprid (Sombrero® - 800 mL 100 kg of seeds^{-1}); imidacloprid + thiodicarb (Cropstar® - 1.75 L 100 kg of seeds^{-1}) and clothianidin (Poncho® - 80 mL 60.000 seeds^{-1}). A control treatment without insecticides was used. Seeds from the hybrid P4285 VYHR were treated with the aforementioned insecticides and sowed in plots of 24 m^2 (4.8 x 5 m) in a density of 62.500 plants ha^{-1}. Five plots were used for each genotype, in a randomized block design.

At 3, 7, 10, 14 and 17 days after emergence (DAE), 10 plants in the center of the plots from the two central rows were visually analyzed and the number of leafhoppers in each plant was counted. At 90 days after emergence, all plants from the two central rows in the plot were visually evaluated and based on typical symptoms (short chlorotic stripes along the leaf veins for rayado fino and leaf reddening for MBS disease), the incidence rate (%) of rayado fino and MBS disease was calculated using the formula: Incidence (%) = (n. of symptomatic plants / total n. of plants) x 100.

For data analysis, the normal distribution of residues was verified by Shapiro-Wilk test, and the homoscedasticity of variance between treatments was verified by Bartlett's test. When these assumptions were attended, ANOVA was performed and if insecticide effect was significant, averages were compared by Tukey's test ($p<0.05$). In cases that ANOVA assumptions were not met, data were subjected to Kruskal-Wallis non-parametric test. The statistical analyses were performed with the software R version 4.1.0 (R Core Team, 2021).

RESULTS AND DISCUSSION

At 3 DAE, the lowest number of leafhoppers.plant^{-1} (0.68) was observed for the treatment with imidacloprid + thiodicab, while in the other treatments, the number of leafhoppers was >1.2 per plant. Despite the significant difference among treatments, the number of *D. maidis*.plant^{-1} in all insecticides did not differ significantly from control at 3 DAE (Figure 1). The number of leafhoppers.plant^{-1} ranged from 1.98 to 2.76 at 7 DAE; 5.06 to 6.46 at 10 DAE; 4.34 to 5.18 at 14 DAE and 4.40 to 4.96 at 17 DAE, with no significant difference among treatments on these evaluation dates (Figure 1).

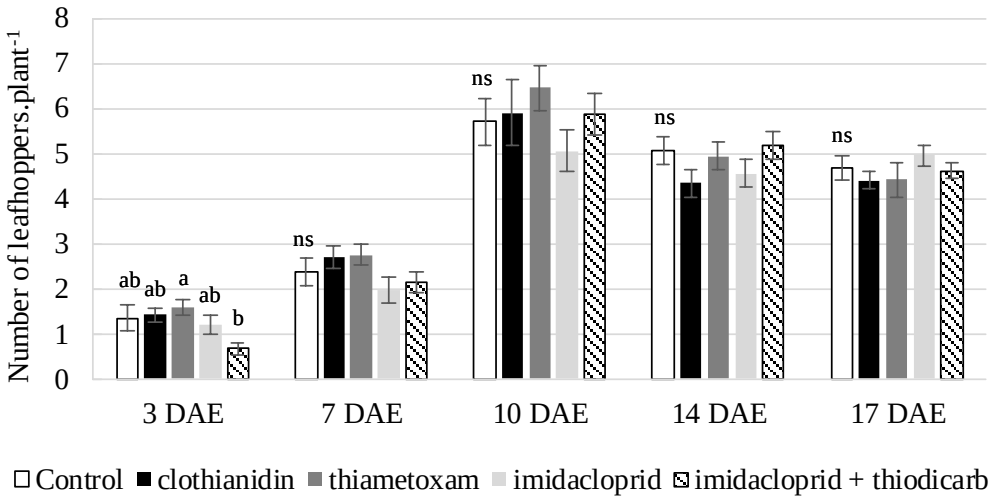

Figure 1. Number of *D. maidis* plant^{-1} in maize treated with different insecticides.
DAE=days after emergence
Means followed by different letters differ significantly by Tukey ($p<0.05$). ns= not significant difference.
3DAE (F=3.12, p=0.038); 7DAE (F=1.64, p=0.20); 10DAE (F=0.84, p=0.51); 14DAE (F=0.54, p=0.70); 17DAE (F=0.81, p=0.53).

The insecticides evaluated did not reduce the occurrence of rayado fino disease, since the incidence rate was equivalent in all treatments, ranging from 29.41% for imidacloprid to 39.86% for thiametoxam (Table 1). The incidence of MBS disease was lower in comparison to rayado fino, however, no significant difference was observed among treatments, with rates ranging from 9.38% in control to 14.55% in imidaclorpid + thiametoxam. In face of drought condition along the study and invasion of capybaras in the experimental area, it was not possible to obtain grain yield.

Table 1. Incidence rate (± SE) of maize rayado fino (MRF) and maize bushy stunt (MBS) diseases in maize subjected to seed treatment with different insecticides.

Insecticides	**MRF(%)**	**MBS(%)**
control	35.92 ± 2.29 ^{ns}	9.38 ± 1.33 ^{ns}
clothianidin	33.63 ± 5.06	10.41 ± 2.74
thiametoxam	39.86 ± 3.11	11.59 ± 2.85
imidacloprid	29.41 ± 2.19	11.09 ± 1.47
imidacloprid + thiodicarb	31.45 ± 1.32	14.55 ± 2.94

ns= no significant difference. MRF: H=8.72, *p*=0.06; MBS: F=0.66, *p*= 0.62

The chemical control of *D. maidis* may be hampered due to high migration capacity of this insect from maize adjacent crops, resulting in low efficacy of some insecticides, especially in conditions of high infestation. According to Cota et al. (2021), for an efficient management of *D. maids* in initial vegetative stages, the seed treatment must be complemented with foliar spray of insecticides. In a study carried by Oliveira et al. (2007), the neonicotinoids imidacloprid and thiametoxam reduced *D. maidis* population and mollicutes contamination in greenhouse condition, nonetheless, in field conditions, the insecticides did not assure the reduction in stunt disease incidence, what comes in agreement with findings from our study.

In field conditions, Ribeiro et al. (2018), found no significant effect of insecticides via seed treatment on reducing *D. maidis* populations at 21 DAE. Despite in some cases the seed treatment is not fully effective, this practice is highly recommended as part of an integrated management, which includes complementary practices such as elimination of voluntary maize, synchronization of sowing dates, use of tolerant hybrids and foliar spray of insecticides

CONCLUSION

Seed treatment, as a single practice, was not effective on reducing *D. mai*dis population and the incidence of Maize rayado fino and Maize bushy stunt diseases in a high infestation condition.

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