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MANEJO DE PERCEVEJOS E MOSCA-BRANCA EM SOJA

Santa Maria, RS
2021

Alberto Rohrig

Manejo de percevejos e mosca-branca em soja

Dissertação apresentada ao Curso de Pós-Graduação em Agrobiologia, da Universidade Federal de Santa Maria (UFSM, RS), como requisito parcial para obtenção do grau de **Mestre em Agrobiologia.**

Orientador: Prof. PhD. Jonas Andre Arnemann

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RESUMO

Dissertação de Mestrado
Programa de Pós-Graduação em Agrobiologia
Universidade Federal de Santa Maria

MANEJO DE PERCEVEJOS E MOSCA-BRANCA EM SOJA

AUTOR: Alberto Rohrig ORIENTADOR:
Prof. PhD. Jonas André Arnemann
Santa Maria, 04 de dezembro de 2021.

Os percevejos e a mosca-branca compõem uma das principais preocupações para o manejo de pragas na produção de soja brasileira, pois causam grandes perdas econômicas aos produtores de soja e, muitas vezes, os levam à diversas aplicações de inseticidas durante o mesmo ciclo da cultura. Apesar das diferenças biológicas, essas duas pragas sugadoras de seiva costumam ocorrer concomitantemente em campos de soja e podem ser manejadas com sucesso com a aplicação de inseticida que atinja as duas pragas, reduzindo custos operacionais para os produtores. Sendo assim, o objetivo deste trabalho foi avaliar a eficácia de onze inseticidas químicos no controle de percevejos e de mosca-branca em condições de campo, em duas safras. O delineamento experimental foi realizado por meio de blocos casualizados, efetivando-se quatro repetições. Duas pulverizações de inseticidas foram feitas com intervalo de 14 dias entre elas. Quanto aos resultados da ANOVA e do teste de Tukey ($P \leq 0,05$), pontua-se que revelaram diferença significativa entre os tratamentos para o controle de percevejos e mosca-branca. O tratamento inseticida Acetamiprido + bifentrina (75 + 75 g ia ha $^{-1}$) foi o que apresentou a maior eficiência no controle de percevejos, atingindo 97,8% de mortalidade do inseto. O tratamento inseticida Ciantraniliprole + bifentrina (50 + 50 g ia ha $^{-1}$) foi o mais eficiente para o controle da mosca-branca, atingindo 78,8% de mortalidade de insetos. Este tratamento, também, apresentou o maior controle combinado de percevejos e mosca-branca, atingindo 83,5% da mortalidade média dos insetos. Deste modo, o tratamento inseticida Ciantraniliprole + bifentrina (50 + 50 g ia ha $^{-1}$) pode ser recomendado para o manejo conjunto de percevejos e mosca-branca em soja.

Palavras-chave: Redução de produtividade. Manejo. *Euschistus heros*. *Bemisia tabaci*. *Glycine max*. +

ABSTRACT

Master's Thesis
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MANEJO DE PERCEVEJOS E MOSCA-BRANCA EM SOJA

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Stink bugs and whiteflies are major concerns for pest management in Brazilian soybean production, causing severe economic losses to soybean growers and leading to excessive application of insecticides per crop cycle. Despite biological differences, these two sap-sucking or feeding pests often occur together in soybeans fields and can be successfully managed with the same insecticide spray, reducing operational costs to the growers. The aim of this work was to evaluate the efficacy of eleven chemical insecticides in the control of stink bugs and whiteflies under field conditions, in two crop seasons. The experimental design was randomized blocks with four replicates. Two insecticide sprays were made with an interval of 14 days apart. The results from ANOVA and Tukey post-hoc test ($P \leq 0.05$) revealed significant difference among the treatments for the control of stink bugs and whiteflies. Acetamiprid + bifenthrin (75 + 75 g a.i. ha^{-1}) was the most efficient treatment for the control of stink bugs, reaching 97.8% of insect mortality. Cyantraniliprole + bifenthrin (50 + 50 g a.i. ha^{-1}) was the most efficient treatment for the control of whiteflies, reaching 78.8% of insect mortality. This treatment also presented the highest combined control of stink bugs and whiteflies, reaching 83.5% of insect mortality. This, the insecticide treatment can be recommended for the combined management of stink bugs and whiteflies in soybean.

Key-words: Yield losses. Management. *Euschistus heros*. *Bemisia tabaci*. *Glycine max.*

LISTA DE ILUSTRAÇÕES

ARTIGO: FIGHTING OFF THE SUCKING PESTS: MANAGING STINK BUGS AND WHITEFLIES IN SOYBEAN

Figura 1. Average means and standard deviation for control efficacy (%) of stink bug and whiteflies, in response to the first (1st) and second (2nd) insecticide sprays on soybean plants, under field conditions, in two summer cropping seasons (2019/20 and 2020/21). Same active ingredients in the two sprays are indicated by: (2x). Standard deviation for stink bug control not showed due to low infestation in the second cropping season. Abbreviations: cyant. (cyantraniliprole), bifent. (bifenthrin) and carbos. (carbosulfan). Santa Maria, RS, Brazil.

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LISTA DE ABREVIATURAS

UFSM	**Universidade Federal de Santa Maria**
mtDNA - COI	**DNA mitocondrial, subunidade citocromo-oxidase**
Biótipo Q	**Mediterranean (MED)**
Biótipo B	**Middle East-Asia Minor 1” (MEAM1)**
Biótipo A	**New World” (NW), “New World 2” (NW2)**
CPMMV	**Cowpea mild mottle virus**
ANOVA	**Análise da variancia**
DA1S	**Dias após a primeira aplicação**
DA2S	**Dias após a segunda aplicação**

SUMÁRIO

1 INTRODUÇÃO

As pragas sugadoras de seiva são uma grande preocupação no manejo depragas em lavouras de soja, no Brasil. Dentre elas, estão os percevejos (Hemiptera:Pentatomidae) e a mosca-branca (Hemiptera: Aleyrodidae), os quais se destacam emimportância econômica. A expansão da área cultivada com soja e o uso de inseticidasnão seletivos (VIEIRA et al., 2012) têm permitido que esses insetos se tornem cadavez mais dispersos e difíceis de controlar, causando graves perdas econômicas aosprodutores de soja em todo o país (MARQUES et al., 2019; ARNEMANN et al., 2019).O percevejo-marrom (*Euchistus heros* [F.]) e o percevejo barriga-verde (*Diceraeus furcatus* [F.]) são as principais espécies de percevejos encontrados noscampos de soja brasileiros. No entanto, o percevejo verde-pequeno (*Piezodorusguildinii* [WESTWOOD]) e o percevejo verde-grande (*Nezara viridula* [L.]) também sãocomuns (GUEDES et al., 2016). Esses insetos se alimentam das vagens de soja,afetando tamanho e peso dos grãos: são menores e com peso reduzido (CORRÊA-FERREIRA et al., 2009).

Os inseticidas neonicotinóides, organofosforados e piretróides são a principal estratégia de controle dessa praga, no Brasil. Em muitos casos, são combinados para aumentar a eficácia do controle (SOSA-GÓMEZ E OMOTO, 2012; MARQUES et al., 2019). No entanto, falhas de controle de *E. heros* foram relatadas, no Brasil, para os seguintes ingredientes ativos beta-ciflutrina, imidaclopride, endosulfan, monocrotofos e metamidofós (SOSA-GÓMEZ E SILVA, 2010; TUELHER et al., 2017), de modo que as populações de campo se tornam cada vez menos suscetíveis a piretróides (SOMAVILLA et al., 2020). Diante desse cenário, atualmente, os produtores de soja brasileiros utilizam de duas a quatro pulverizações de inseticidas foliares por ciclo dacultura para controlar os percevejos (BUENO et al., 2015).

Enquanto os percevejos causam injúrias às plantas de soja apenas na fase reprodutiva, a mosca-branca (*Bemisia tabaci* [GENNADIUS]) pode atacar a cultura ao longo de todo o seu ciclo (LIMA, LARA, & BARBOSA 2002). Atualmente, mais de 38 espécies crípticas são reconhecidas dentro do complexo de espécies de *B. tabaci* (ELFEKIH et al., 2021), muitas delas eram anteriormente chamadas de biótipos, haja vista que são morfologicamente indistinguíveis (DE BARRO et al., 2011).

A espécie MEAM1 ('Middle-East Asia Minor 1', anteriormente, conhecida como 'Biótipo B') predomina nos campos de soja brasileiros (DE MORAES et al., 2018), mas a espécie MED ('Mediterrâneo', anteriormente conhecido como 'Biótipo Q') também foi detectada recentemente no país. Apesar de ser mais comum em culturas de casas de vegetação, a espécie MED transmite o vírus do feijão-caupi (CPMMV; carlavírus) de forma mais eficiente (BELLO et al., 2021). Além disso, desenvolveu resistência aos novos inseticidas mais rapidamente em comparação à MEAM1 (MCKENZIE et al., 2012; POZEBON et al., 2020).

A mosca-branca causa injúrias às plantas de soja, tanto direta (devido à sucção de seiva e injeção de toxina) quanto indiretamente (atuando como vetor de vírus e precursor para o crescimento de fungos fuliginosos) (HIROSE et al., 2015). Quando não manejada adequadamente, a mosca-branca pode causar perdas de produção de até 31 kg ha^{-1} para uma densidade populacional de uma mosca-branca por trifólio (PADILHA et al., 2021). Embora os adultos da mosca-branca sejam mais facilmente controlados, as ninfas permanecem abrigadas nos terços médio e inferior do dossel das plantas de soja, diminuindo a sua exposição aos inseticidas. Isso permite o crescimento populacional logo após as aplicações foliares de inseticidas (POZEBON et al., 2019), exigindo até seis pulverizações de inseticidas para interromper a infestação de mosca-branca (PETROLI, 2017).

Nesse sentido, cabe frisar que falhas de controle e a falta de informações atualizadas sobre o manejo de pragas sugadoras de seiva levaram os produtores de soja brasileiros a aumentar excessivamente o número de pulverizações de inseticidas por ciclo da cultura, aumentando os custos de controle e comprometendo a sustentabilidade dessa estratégia de manejo (ARNEMANN et al., 2019; POZEBON et al., 2020; SOMAVILLA et al., 2020). Apesar das diferenças no ciclo biológico e no comportamento, os percevejos e a mosca-branca costumam ocorrer juntos nos campos de soja e podem ser manejados conjuntamente com o mesmo inseticida, reduzindo os custos operacionais para os produtores.

Assim, o objetivo deste trabalho foi avaliar a eficácia de inseticidas químicos no controle de percevejos e de mosca-branca, visando conhecer a estratégia mais eficiente para o manejo conjunto, quando as populações atingem os níveis decontrole.

2 REFERENCIAL TEÓRICO

2.1 A MOSCA-BRANCA

2.1.1 Bioecologia e injúrias em soja

A mosca-branca é um inseto pertencente à ordem Hemiptera, subordem Sternorryncha, e, devido ao seu hábito alimentar e alta polifagia, é capaz de atacar mais de 600 espécies de plantas (POLSTON; DE BARRO; BOYKIN, 2014). Quanto ao seu ciclo de vida, a mosca-branca apresenta, ao longo dele, as fases de ovo, quatro instares ninfais e adulto. Os adultos fazem suas posturas de ovos na face abaxial da folha e apenas as ninfas do primeiro instar apresentam movimentação. Isso acontece por aproximadamente 11 dias, após essa fase, fixam-se na folha, permanecendo até a emergência do adulto (SUMMERS; NEWTON JR.; ESTRADA, 1996).

O ciclo varia de acordo com as condições ambientais, principalmente a temperatura (ALBERGARIA; CIVIDANES, 2002). Contudo, geralmente dura entre 15 e 25 dias em temperatura de 25° à 27° (TOSCANO et al., 2016). As fêmeas podem ovipositar de 100 a 300 ovos durante o seu ciclo de vida e, em condições favoráveis, a espécie pode ter de 11 a 15 gerações por ano (BROWN; BIRD, 1992). A região superior das plantas de soja são preferenciais para oviposição e, portanto, as fêmeas acompanham o crescimento da planta: ninfas de 1º e 2º instares se alojam na região mediana das plantas, ao passo que as ninfas de 3º e 4º instares se fixam no terço inferior (POZEBON et al., 2019).

Por sugar a seiva, a mosca-branca compromete a fisiologia funcional da planta atacada, além de atuar na disseminação de 300 viroses, contemplando os gêneros: Begomovírus, Carlavírus, Crinivírus, Ipomovírus e Torradovírus (GILBERTSON et al., 2015). Outro problema causado pela praga invasiva em questão é decorrente da seiva extravasada durante a sua alimentação, pois essa ação favorece o aparecimento do fungo *Capnodium* sp. (fumagina), o que acarreta a redução da superfície fotossintética da planta (NAVAS-CASTILLO; FIALLO-OLIVÉ; SÁNCHES-CAMPOS, 2011).

Descrita em território brasileiro pela primeira vez, na Bahia, por Bondar (1928), e registrada na maioria dos estados da federação (MORAES et al., 2018), a *B. tabaci* é representada por um complexo de espécies crípticas, gerindo grupos morfologicamente indistinguíveis, mas que são distinguíveis ecológica e geneticamente (KANAKALA; GHANIM, 2015). No que tange à ecologia comportamental desse inseto-praga, supõe-se que espécies apresentam certa preferência por determinadas plantas. Contudo a diferenciação de espécies, de forma coesa, demanda a realização de análises moleculares com base no DNA mitocondrial, subunidade citocromo-oxidase (mtDNA - COI) (BOYKIN et al., 2013). Nesse viés, como parte do complexo de espécies crípticas que ocorrem no Brasil, tem-se: "*Mediterranean*" (MED), "*Middle East-Asia Minor 1*" (MEAM1), *"New World"* (NW), *"New World 2*" (NW2), descritas como biótipos Q, B e A, respectivamente (DE BARRO et al., 2011).

As espécies crípticas de *B. tabaci* são pragas de diversos cultivos agrícolas, haja vista que conseguem sobreviver em uma mesma área durante todo ano. Por essa razão e por possuir um ciclo relativamente curto, é comum encontrar diversas fases de vida do inseto no mesmo cultivo, o que dificulta seu controle e, por conseguinte, implica em um número alto de aplicações de moléculas químicas por cultivo (ERDONGAN et al., 2008). Desse modo, na figura, a seguir, pode se observar características morfológicas de *Bemisia tabaci.*

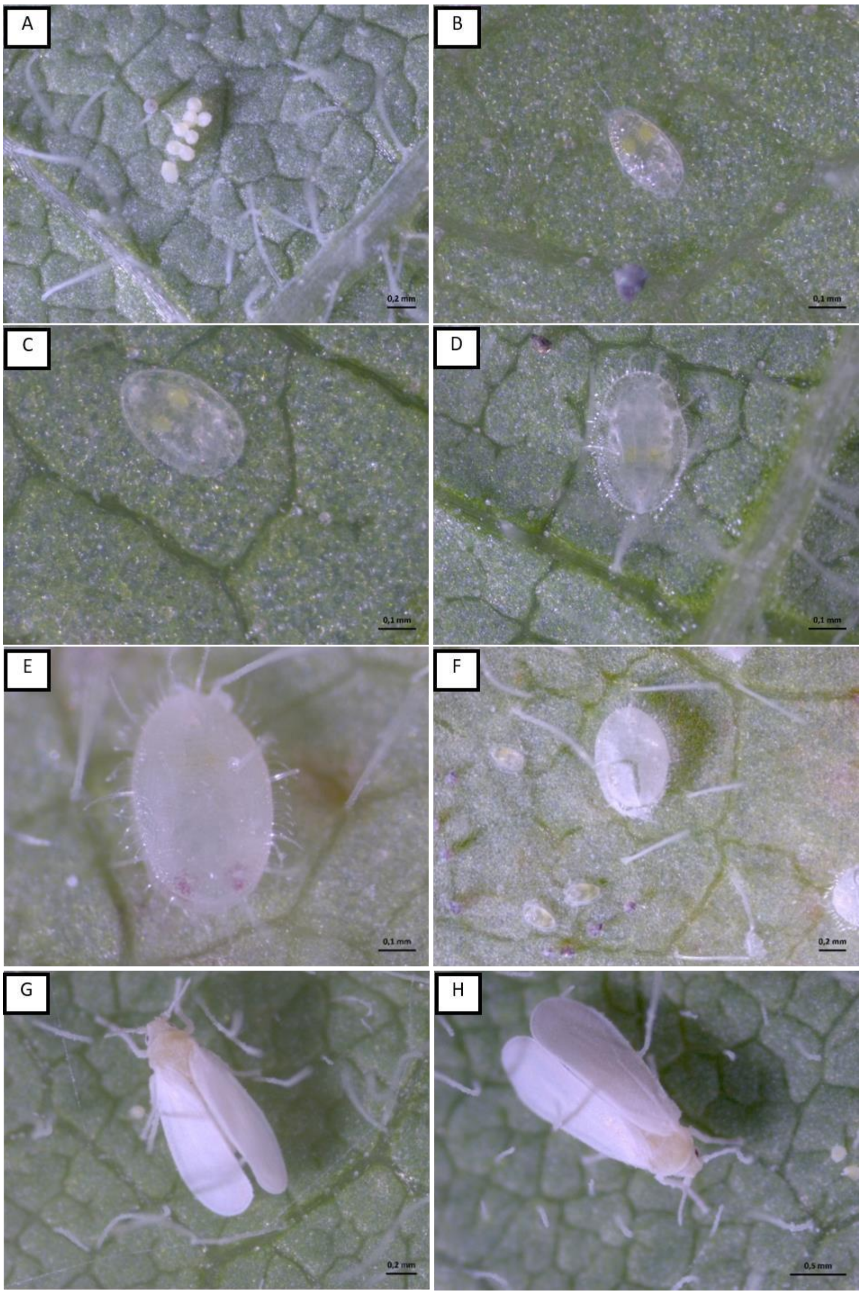


Figura 1 Características morfológicas de *Bemisia tabaci*: Ovos (A), ninfa N1(B), ninfaN2 (C), ninfa N3 (D), ninfa N4 (E), exúvia (F), adultos (G, H). Fonte: (POZEBON, 2020)

A *B. tabaci* era considerada praga ocasional em cultivos de soja, mas com o aumento da expansão da fronteira agrícola da soja e, principalmente, com o emprego frequente do controle químico da praga, a mosca-branca passou a ser considerada praga de grande importância no cultivo da soja (ARNEMANN et al., 2019; OLIVEIRA et al., 2018), podendo causar perdas de produção de até 31 kg ha^{-1} para uma densidade populacional de uma mosca-branca por trifólio (PADILHA et al., 2021). Essa frequência de aplicação aliada ao uso repetitivo do mesmo princípio ativo pode estar potencializando o aparecimentode resistência do inseto ao inseticida (SHADMANY, 2013).

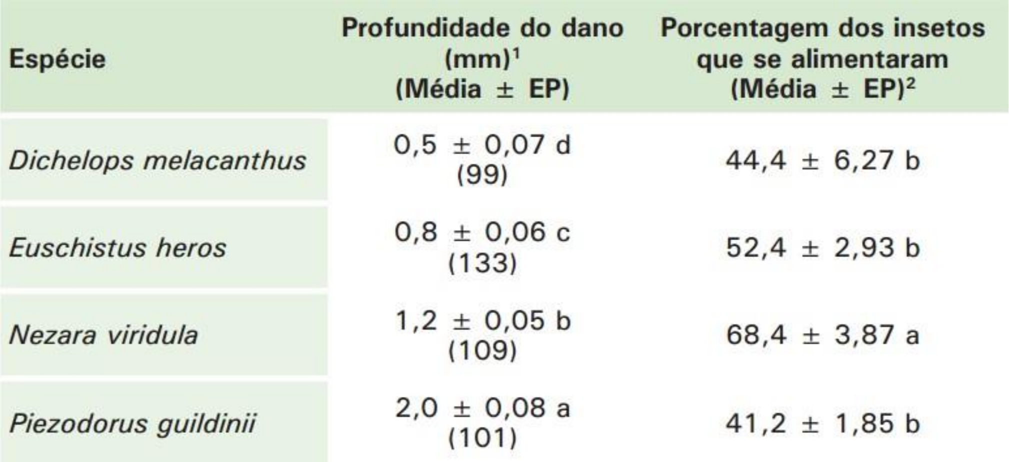
2.2 COMPLEXO DE PERCEVEJOS DA SOJA

2.2.1 Bioecologia e injúrias dos percevejos pentatomídeos em soja

Dentre as várias espécies de percevejos que atacam a soja, os pentatomídeos *Euschistus heros* (FABRICIUS, 1798), *Piezodorus guildinii* (WESTWOOD, 1837), *Nezara viridula* (LINNAEUS, 1758), *Diceraeus furcatus* (FABRICIUS, 1775) e *Diceraeus melacanthus* (DALLAS, 1851) se destacam pela sua capacidade de dano (HOFFMANN-CAMPO et al., 2000; GALLO et al., 2002; SOSA-GÓMEZ et al., 2010). Essas espécies apresentam cinco ínstares ninfais, sendo as duas primeiras ápteras e as três seguintes providas de tecas alares. As ninfas se movimentam pouco, ao passo que os adultos realizam um processo de dispersão, durante a senescência da cultura (CORRÊA-FERREIRA; PANIZZI, 1999). Dessa forma, os cultivos de entressafra e plantas hospedeiras no entorno da lavoura contribuem para a sobrevivência dos percevejos, além de influenciarem a densidade de adultos colonizadores no início da safra subsequente.

Os percevejos fitófagos, ao se alimentarem dos grãos de soja, injetam saliva contendo enzimas digestivas e sugam o conteúdo liquefeito. Essas enzimas alteram a fisiologia e a bioquímica dos tecidos próximos à punção, podendo causar morte celular dos tecidos vegetais mesmo sem envolvimento de danos mecânicos causados pelos estiletes (TODD; HERZOG, 1980; HORI, 2000). Ademais, ainda pode provocar aborto de grãos e vagens, redução da germinação e vigor das sementes, distúrbios fisiológicos, como “haste verde”, e retardamento da maturação. Nesse viés, estudos demonstram que a profundidade média de punctura varia de acordo com a espécie de percevejo (Tabela 1). Outros fatores, como densidade populacional, estádio de desenvolvimento das plantas e suscetibilidade dos genótipos de soja, também influenciam no potencial de dano (PANIZZI et al., 2012).

Tabela 1. Profundidade média (± EP) do dano em sementes de soja causado pela alimentação de quatro espécies de percevejos após 60 minutos (número inicial de insetos = 250). Entre parênteses consta o número de insetos observados.



Espécie	Profundidade do dano (mm)[1] (Média ± EP)	Porcentagem dos insetos que se alimentaram (Média ± EP)[2]
Dichelops melacanthus	0,5 ± 0,07 d (99)	44,4 ± 6,27 b
Euschistus heros	0,8 ± 0,06 c (133)	52,4 ± 2,93 b
Nezara viridula	1,2 ± 0,05 b (109)	68,4 ± 3,87 a
Piezodorus guildinii	2,0 ± 0,08 a (101)	41,2 ± 1,85 b

[1] Médias em cada coluna seguidas pela mesma letra não diferem significativamente pelo teste de Tukey (P = 0,05).[2] Média de cinco repetições de 50 insetos. **Fonte:** Adaptada de Depiere e Panizzi (2011) e Panizzi et al. (2012).

O percevejo-marrom, *E. heros*, é uma espécie Neotropical, registrada pela primeira vez, no Brasil, por Williams et al. (1973). Apesar de completar menor número de gerações em soja (geralmente três), o percevejo-marrom é a espécie mais abundante, sobretudo, em regiões mais quentes (DEGRANDE; VIVAN, 2005). Os adultos apresentam coloração marrom escura e dois espinhos no pronoto, que são mais longos e escuros no verão em comparação a adultos coletado no inverno (MOURÃO; PANIZZI, 2000). Os ovos são amarelados e depositados em pequenas massas, contendo entre cinco e oito ovos. As ninfas de primeiro ínstar medem 1,3 mm e têm o corpo alaranjado e a cabeça preta, permanecendo sobre os ovos até atingir o segundo ínstar, quando iniciam sua alimentação. As ninfas de terceiro a quinto ínstar têm coloração variável: de cinza a marrom. Os danos às sementes de soja ocorrem a partir do terceiro ínstar, quando as ninfas atingem tamanho médio de 3,6 mm (GRAZIA et al., 1980). A duração média do estado de ovo até inseto adulto é de 28,4 dias (sob 25 ºC) e a longevidade média dos adultos é de 116 dias (CIVIDANES, 1992).

O percevejo-verde-pequeno, *P. guildinii,* também é uma espécie Neotropical, encontrada desde o sul dos Estados Unidos até a Argentina. A frequência dessa espécie oscila regional e sazonalmente, além de ser o percevejo com maior facilidade de adaptação alimentar, utilizando para tal plantas em florescimento (PANIZZI, 2002). *P. guildinii* geralmente atinge o pico populacional mais cedo do que as demais espécies e causa maior dano à soja, devido ao seu comportamento de inserção e retirada dos estiletes, os quais podem causar maior lesão às paredes celulares da planta (BELORTE et al., 2003; CORRÊA-FERREIRA; AZEVEDO, 2002; SOSA-GÓMEZ; MOSCARDI, 1995). Os adultos medem cerca de 9 mm e apresentam coloração verde clara, com uma listra transversal marrom-avermelhada próxima à cabeça. Os ovos são pretos, cilíndricos e depositados em fileiras duplas (11 a 15 ovos por postura). As ninfas recém-eclodidas medem cerca de 1 mm e permanecem próximas à postura (hábito gregário). Elas apresentam coloração preta e avermelhada, tornando-se esverdeada ao longo do ciclo de desenvolvimento. A duração média do ciclo de ovo à adulto é de 24,4 dias (sob 25 ºC), com as fases ninfais variando de três a seis dias no primeiro e quinto ínstar, respectivamente (CIVIDANES, 1992).

O percevejo-verde, *N. viridula*, é uma espécie cosmopolita, ocorrendo nas regiões tropicais e subtropicais das Américas, Austrália, Ásia, África e Europa (PANIZZI et al., 2000). Nesse escopo, pontua-se que as sementes de soja danificadas por *N. viridula* se tornam altamente suscetíveis ao ataque por pragas de grãos armazenados e à contaminação por organismos patogênicos (TODD; WOMACK, 1973). Os adultos medem de 10 a 17 mm e apresentam coloração verde, com antenas avermelhadas. As fêmeas depositam até 200 ovos em agrupamentos hexagonais, com coloração amarelada no início e rosada próximo à eclosão (GALLO et al., 2002). As ninfas de primeiro e segundo ínstares são pretas com manchas brancas no dorso, medindo entre 1,3 a 3,1 mm. Elas permanecem agrupadas até o terceiro ínstar, quando passam a se alimentar dos grãos de soja e ocasionar danos à cultura. No último ínstar, adquirem coloração verde com manchas brancas, amarelas e vermelhas na parte dorsal do abdômen, podendo atingir até 9 mm. O período ninfal varia de 20 a 31 dias, enquanto a longevidade total do inseto é de aproximadamente 117 dias(CIVIDANES, 1992).

Por fim, registra-se que o termo percevejo-barriga-verde engloba as espécies do gênero *Diceraeus* (anteriormente classificado como *Dichelops*), os quais são exclusivamente Neotropicais e se encontram distribuídos pela América do Sul. No Brasil, *D. melacanthus* abrange uma extensão territorial maior e se concentra nas regiões mais quentes, enquanto *D. furcatus* é mais encontrado na região subtropical. Os adultos medem de 9 a 11 mm e sua coloração varia entre castanho-amarelado e acinzentado, apresentando o abdômen verde. Essa espécie possui duas projeções pontiagudas na cabeça e expansões laterais espinhosas no pronoto (GRAZIA, 1978). Os ovos são verde-claros, depositados em três ou mais fileiras. As ninfas têm coloração marrom-acinzentada na região dorsal e verde na abdominal. Os percevejos dessa espécie tendem a permanecer na palhada após a colheita da soja, tornando-se pragas de sistema e causando prejuízos às culturas do trigo e milho. Nesses casos, ocorrem, também, ataques no início da safra de soja, entretanto com pouco impacto na produtividade (PANIZZI; CHOCOROSQUI, 1999).

3 OBJETIVOS

3.1 Objetivo principal

Avaliar o manejo químico de percevejos e mosca-branca, visando determinar a estratégia mais eficiente para o manejo conjunto dessas pragas sugadoras em soja.

3.2 Objetivos especíifícos

Determinar os inseticidase combinações com maior eficiência de controle para o manejo conjunto de percevejos e mosca-branca em soja.

Determinar os inseticidas e combinações com maior eficiência de controle para o manejo de percevejos em soja.

Determinar os inseticidas e combinações com maior eficiência de controlepara o manejo de mosca-branca em soja.

4 ARTIGO

Fighting off the sucking pests of soybean: managing stink bugs and whiteflies

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Keywords: *Bemisia tabaci*; control efficacy; *Euschistus heros*; *Glycine max*; pest management.

Abstract: Stink bugs and whiteflies are major concerns for pest management in Brazilian soybean fields, causing severe economic losses to soybean growers and leading to excessive insecticide applications per crop cycle. Despite biological differences, these two sap-sucking pests often co-occur in soybeans fields and can be successfully managed with the same insecticide spray, reducing operational costs to the growers. The aim of this work was to evaluate the efficacy of eleven insecticides in the control of stink bugs and whiteflies. Two insecticide sprays were made with an interval of 14 days between them. The results from ANOVA and Tukey post-hoc test ($P \leq 0.05$) revealed significant differences among

treatments. Acetamiprid + bifenthrin (75 + 75 g a.i. ha^{-1}) was the most efficient treatment for the control of stink bugs, reaching 97.8% of insect mortality. Cyantraniliprole + bifenthrin (50 + 50 g a.i. ha^{-1}) was the most efficient treatment for the control of whiteflies, reaching 78.8% of insect mortality. This treatment also presented the highest combined control of stink bugs and whiteflies, reaching 83.5% of insect mortality.

4.1 Introduction

Sap-sucking pests are a major concern for pest management in soybean fields in Brazil. Stink bugs (Hemiptera: Pentatomidae) and whiteflies (Hemiptera: Aleyrodidae) stand out in economic importance. Expansion of land area grown with soybeans and abusive use of non-selective insecticides (Vieira et al., 2012) have enabled these insects to become increasingly dispersed and difficult to control, causing severe economic losses to soybean growers throughout the country (Marques et al., 2019; Arnemann et al., 2019).

The neotropical brown stink bug (*Euchistus heros* [F.]) and the green-belly stink bug (*Diceraeus furcatus* [F.]) are the main stink bug species found in Brazilian soybean fields, but the red-banded stink bug (*Piezodorus guildinii* [Westwood]) and the southern green stink bug (*Nezara viridula* [L.]) are also common (Guedes et al., 2016). These insects feed on soybean pods, leading to smaller seeds and reduced yield (Corrêa-Ferreira et al., 2009). Neonicotinoid, organophosphate and pyrethroid insecticides are the main control strategy for these pests in Brazil, often combined to enhance control efficacy (Sosa-Gómez and Omoto, 2012; Marques et al., 2019). Nonetheless, control failures of *E. heros* have been reported in Brazil (Sosa-Gómez and Silva, 2010; Tuelher et al., 2017), with field populations becoming increasingly less susceptible to pyrethroids (Somavilla et al., 2020). Brazilian soybean growers currently use two to four foliarinsecticide sprays to manage stink bugs (Bueno et al., 2015).

The whitefly (*Bemisia tabaci* [Gennadius]) can injury soybeans throughout its whole cycle (Lima et al., 2002). Currently, over 38 cryptic species are recognised within the *B. tabaci* species complex (Elfekih et al., 2021), many of which were previously referred to as biotypes due to being morphologically indistinguishable (de Barro et al., 2011). The MEAM1 species (‘Middle-East Asia Minor 1’, previously known as ‘B-biotype’) predominates in Brazilian soybean fields (de Moraes et al., 2018), but the MED species (‘Mediterranean’, previously known as ‘Q-biotype’) has been recently detected in the country as well. Although more common in greenhouse crops, the MED species transmits the cowpea mild mottle virus (CPMMV; carlavirus) more efficiently (Bello et al., 2021) and has evolved resistance to novel insecticides more rapidly than MEAM1 (McKenzie etal., 2012; Pozebon et al., 2020).

Whiteflies damage soybean plants both directly (due to sap sucking and toxin injection) and indirectly (acting as vector for viruses and precursor for the growth of sooty mold fungi) (Hirose et al., 2015). When left unmanaged, whiteflies can result in yield losses as high as 31 kg ha^{-1} for a population density of one whitefly trifoliate^{-1} (Padilha et al., 2021). Although whitefly adults are easily controlled, the nymphs remain sheltered in the middle and lower segments of the soybean canopy, preventing direct contact with insecticides. This allows population growth shortly after foliar insecticide applications (Pozebon et al., 2019), requiring up to six insecticide sprays to halt whitefly infestation (Petroli, 2017).

Control failures and lack of updated information regarding the management of sap-sucking pests have led Brazilian soybean growers to raise excessively the number of insecticide sprays per crop cycle, increasing control costs and compromising the long-term sustainability of this management strategy (Arnemann et al., 2019; Pozebon et al., 2020; Somavilla et al., 2020). We evaluated the efficacy of chemical insecticides in the control of stink bugs and whiteflies in two crop seasons. Our results will help farmers to establish the most efficient strategy for the management of sap-sucking pests when populations reach the economic threshold levels.

4.2 Results and Discussion

4.2.1First cropping season (2019/20)

Stink Bug Control

The population of stink bugs infesting the soybean plants in the first cropping season was composed of *E. heros* (71 %), *P. guildinii* (20 %), *N. viridula*

(8 %) and other species (1 %). The treatments were sprayed at a population density of 4.4 stink bugs m^{-2}. Adults and nymphs were evaluated as a single variable.

All treatments where the combination of cyantraniliprole + bifenthrin (50 + 50 g a.i. ha^{-1}) or cyantraniliprole + bifenthrin + carbosulfan (50 + 30 + 90 g a.i. ha^{-1}) were used in the first spray presented stink bug mortality (adults + nymphs) >90 % at 3 days after the first spray (DA1S), and maintained satisfactory control efficacy (> 80 %) until 14 days (Table 1). With the exception of acetamiprid + pyriproxyfen (20 + 40 g a.i. ha^{-1}) and sulfoxaflor + lambda-cyhalothrin (30 + 45 g a.i. ha^{-1}), all treatments kept the population density below two stink bugs m^{-2} until 14 DA1S, which is considered the control threshold for stink bugs in soybeans (Corrêa-Ferreira and Panizzi, 1999).

Control efficacy for stink bugs at 3 days after the second spray (DA2S) was >80 % in all treatments, with the exception of acetamiprid + pyriproxyfen (20 + 40 g a.i. ha^{-1}), which controlled only 50 % of the infesting population (Table 1). This lack of knockdown effect is probably related to the absence of a pyrethroid given that they are extremely fast-acting insecticides (Salgado, 2013).

Two sprays of cyantraniliprole + bifenthrin + carbosulfan (50 + 30 + 90 g a.i. ha^{-1}) and two sprays of acetamiprid + bifenthrin (75 + 75 g a.i. ha^{-1}) reduced the infesting population to zero stink bugs m^{-2} at 3 DA2S, maintaining 100% of control efficacy until 14 DA2S. Acetamiprid + bifenthrin (two sprays) presented the highest level of stink bug mortality across all evaluations (97.8 %). All treatments containing cyantraniliprole + bifenthrin (50 + 50 g a.i. ha^{-1}) or cyantraniliprole + bifenthrin + carbosulfan (50 + 30 + 90 g a.i. ha^{-1}) in the first spray also presented high control efficacy for stink bugs (near 90 % or higher; see Table 1). Cyantraniliprole is a second-generation anthranilic diamide (ryanodine receptor modulator) that offers cross-spectrum foliar and systemic activity against chewing and sucking insects (Salgado, 2013). However, its use in Brazil is still limited by its high costs (Benevia®; US$ 90.00 ha^{-1} on average; Arnemann et al., 2019).

The highest control efficacies considering all treatments were obtained at 14 DA2S, when six treatments reduced the infesting population to zero stink bugs m^{-2}. Similar results were observed by Marques et al. (2019), with 84.8 % mortality after two sprays of lambda-cyhalothrin + thiamethoxam (35.25 + 26.5 g a.i. ha^{-1}).

The same treatment provided 86.5 % of control efficacy in our study (Table 1) and is cheaper (US$ 10.00 ha^{-1} on average) than products containing cyantraniliprole, for instance. Thiamethoxam is a highly systemic neonicotinoid whose absorption by plants peaks around 72 h after the application (Gazzoni, 2008), providing high mobility within soybean plants and long residual activity (Cui et al., 2010), whereas lambda-cyhalothrin presents faster knockdown effect when compared to other pyrethroids (Marques et al., 2019).

Whitefly control

Whitefly population in the first cropping season averaged 2.6 adults $trifoliate^{-1}$ and 8.0 nymphs $trifoliate^{-1}$ at the moment of the first spray (Table 2). Adults and nymphs were evaluated as separate variables and presented susceptibility to different active ingredients.

Significant differences among the treatments were observed for whitefly adults. Sulfoxaflor + lambda-cyhalothrin (two sprays) presented the lowest control efficacy (average 72.3 %), and the highest infesting population (average 3.4 adults $trifoliate^{-1}$) among the insecticide treatments. Cyantraniliprole + bifenthrin (two sprays) presented the highest control percentage (90.8 %) with populations below 1.0 adult $trifoliate^{-1}$ at all evaluations (Table 2).

None of the treatments reached 60 % of control efficacy at 14 DA1S for whitefly nymphs, with the infesting populations increasing rather than decreasing in several treatments (Table 2). Control levels increased only at 10 DA2S, when all treatments surpassed 70 % of nymph mortality. Average control efficacy across all evaluations was <70 %. Cyantraniliprole + bifenthrin+ carbosulfan (two sprays) provided 66.7 % of insect mortality and reduced whitefly population to less than 1.0 nymph $trifoliate^{-1}$, which is considered the control threshold for whiteflies in soybean (Padilha et al., 2021). Arnemann et al. (2019) also pointed out cyantraniliprole is an efficient tool for whitefly control. Nymph mortality for treatments containing cyantraniliprole + bifenthrin increased when carbosulfan was added to the first spray (see the evaluation at 14 DA2S in Table 2).

Overall, all treatments presented higher control efficacy for whitefly adults than whitefly nymphs. The reason for this discrepancy lies in the feeding behaviour of both life stages. Whitefly nymphs are commonly found in the middle and lower segments of the soybean plants, in the underside of the leaflets (Czepak et al., 2018; Pozebon et al., 2019), while adults feed and oviposit in the upper (i.e. younger) leaves of soybean plants, remaining more exposed to direct contact with insecticide sprays. Thus, adults can be easily controlled by sequential sprays of fast-acting pyrethroids, whereas the control of nymphs relies on the long residual action and plant systemicity of neonicotinoids (Stamm et al.,2016, Arnemann et al., 2019).

Combined control

For the growing conditions of the first cropping season (2019/20), the highest combined control of stink bugs and whiteflies (adults + nymphs) was provided by two sprays of cyantraniliprole + bifenthrin + carbosulfan (50 + 30 + 90 g a.i. ha^{-1}), with an average of 83.2 % of insect mortality. Two sprays of cyantraniliprole + bifenthrin (50 + 50 g a.i. ha^{-1}), one spray of cyantraniliprole + bifenthrin + carbosulfan (50 + 30 + 90 g a.i. ha^{-1}) followed by one spray of bifenthrin + carbosulfan (30 + 90 g a.i. ha^{-1}), and two sprays of acetamiprid + bifenthrin (75 + 75 g a.i. ha^{-1}) also reached 80 % of average control efficacy for stink bugs and whiteflies. The lowest combined control was provided by two sprays of sulfoxaflor + lambda-cyhalothrin (30 + 45 g a.i. ha^{-1}; average 58.9 %).

The three treatments containing cyantraniliprole + bifenthrin + carbosulfan (50 + 30 + 90 g a.i. ha^{-1}) in the first spray presented the highest yields, differing significantly from the others (Supplementary Table 4). The untreated control presented yield reduction of 326.7 kg ha^{-1} due to damage by stink bugs and whiteflies, when compared to the highest-yielding treatment (two sprays of cyantraniliprole + bifenthrin + carbosulfan). Although not reaching 80 % of control efficacy, two sprays of thiamethoxam + lambda-cyhalothrin (35.25 + 26.5 g a.i. ha^{-1}) resulted in yield similar to the treatments with highest insect mortality. This might be related to the bioestimulation properties of thiametoxam, as described by Gazzoni (2008).

4.2.2 Second cropping season (2020/21)

The population of whiteflies in the second cropping season reached the same control level of the first cropping season (≥10 whiteflies trifoliate^{-1}) before stink bugs could naturally infest the experimental plots. Insecticide sprays maintained stink bug infestation negligible, and it was not quantified in the second cropping season. The insecticide treatments were first sprayed when whitefly populations reached 4.4 adults and 6.4 nymphs trifoliate^{-1}, respectively (Supplementary Table 2).

Similarly, to the first cropping season, all treatments presented control efficacy of whitefly adults near or higher than 80 % (Supplementary Table 2). When considering all evaluations, only cyantraniliprole + bifenthrin + carbosulfan (followed by one spray of cyantraniliprole) presented <80 % of average adult mortality, differing significantly from the other treatments ($P \leq 0.05$). Two sprays of thiamethoxam + lambda-cyhalothrin (35.2 + 26.5 g a.i. ha^{-1}) resulted in the highest mean of control efficacy for whitefly adults (90.2 %).

The overall mortality of whitefly nymphs in the second cropping season (2020/21) was lower than observed for adults, although higher than observed for nymphs in the first cropping season (2019/20). Suitable climatic conditions for this pest during the 2020/21 summer season (i.e. low air humidity and high mean temperatures; Sharma et al., 2013), allowed whitefly populations to grow as high as 49.3 nymphs trifoliate^{-1} in the untreated control (Supplementary Table 2 at 10 DA2S). All insecticide treatments kept nymph population <3.0 nymphs trifoliate^{-1} at 10 DA2S, surpassing 95 % of control efficacy. The highest mean of control efficacy for whitefly nymphs considering all evaluations was provided by two sprays of cyantraniliprole + bifenthrin (50 + 50 g a.i. ha^{-1}; average 79.3 %).

As observed in the first cropping season (2019/20), the treatments containing cyantraniliprole were among the most efficient in controlling whitefly nymphs. The satisfactory performance of this active ingredient is probably related to its physicochemical characteristics, such as low Log Pow and high solubility in water (Barry et al., 2014), providing great mobility within soybean plants (Pes et al., 2020). Cyantraniliprole presents upward translocation through xylem tissues when applied via seed treatment or in the soil (Selby et al., 2016) and translaminar and acropetal movements when applied as a foliar spray (Barry et al., 2014). This mobility within the plant may reach whitefly nymphs located in the underside of soybean leaves. While few treatments presented satisfactory control of whitefly nymphs after the first spray, all reached 90 % of insect mortality at 10 DA2S. Sequential sprays are particularly important for the performance of pyrethroids, which rely on fast knockdown effect and provide little to none residualaction (Salgado, 2013).

The untreated control presented yield reduction of 1281.7 kg ha^{-1} when compared with the highest-yielding treatment (one spray of cyantraniliprole + bifenthrin, followed by one spray of bifenthrin). This substantial yield loss is related to the high pressure of whiteflies in the second cropping season (reaching 20.5 adults trifoliate^{-1} and 49.3 nymphs trifoliate^{-1} in the untreated plots; Supplementary Table 2) and the high potential to cause damage in soybeans (31 kg ha^{-1} of yield reduction for a population density of one whitefly trifoliate^{-1}; Padilha et al., 2021).

4.2.3 Two-season analysis

The variations observed in the infestation levels of stink bugs and whiteflies between the two cropping seasons offered a chance to evaluate the performance of the same insecticide treatments under two distinct field conditions: high pressure of stink bugs with moderate presence of whiteflies in the first season (2019/20), and high pressure of whiteflies with absence of stink bugs in the second season (2020/21). The population growth of whiteflies in the untreated control plot illustrates this difference in pressure between the two seasons (see Tables 3 and 5). The absence of stink bugs in the second cropping season might be linked to a late migration of the first colonizing insects into the soybean plots, when compared to the previous season; thus, when the insecticide treatments were applied to control the already established whitefly population, the first stink bug settlers were also suppressed, indirectly preventing the establishment of the infesting population.

The results from the first season support this hypothesis, as all treatments provided stink bug mortality >80 %. The only exception (two sprays of acetamiprid + pyriproxyfen 20 + 40 g a.i. ha^{-1}) includes the active ingredient pyriproxifen in its composition, which knowingly controls whiteflies but has little effect upon stink bugs and other pests (Salgado, 2013). This juveline hormone mimic provides an antimetamorphic effect, preventing the insect to reach its adult stage; as such, it does not control adult insects or early stages, requiring a precise spray timing to reach satisfactory control efficacy.

Considering the averages between the two seasons, all insecticide treatments provided mortality of adult whiteflies ≥80 %, whereas nymph mortality did not reach 70 % (Supplementary Table 3 and Figure 1). This outcome reinforces the conclusion that whiteflies nymphs are much harder to control than adults. Aside from the treatments containing cyantraniliprole, the only treatment to reach 60 % or more of average nymph mortality was thiamethoxam + lambda-cyhalothrin (two sprays).

When stink bugs and whiteflies were analysed together as a single variable, all treatments presented control efficacy equal or higher than 70 % in the average between the two seasons (Supplementary Table 3). Cyantraniliprole + bifenthrin (two sprays) provided the highest combined control of whitefly adults and nymphs and stink (up to 83.5 %). However, two sprays of cyantraniliprole + bifenthrin + carbosulfan (50 + 30 + 90 g a.i. ha^{-1}) also provided high combined control of both pest species (82.7 %), and had the highest yield among all treatments and seasons (Supplementary Table 4). Marques et al. (2019) and Arnemann et al. (2019) also highlighted the importance of sequential sprays to reach satisfactory mortality levels of stink bugs and whiteflies, respectively.

Therefore, for conditions of high population pressure such as those under which these two experiments were carried out, two sprays of cyantraniliprole + bifenthrin (50 + 50 g a.i. ha^{-1}) or two sprays of cyantraniliprole + bifenthrin + carbosulfan (50 + 30 + 90 g a.i. ha^{-1}) beginning when infestation levels by each pest reach their respective economic threshold levels. Insecticide sprays in conditions of low infestation could unnecessarily increase control costs and indirectly affect natural enemies, potentially jeopardizing the management strategy as a whole. Future efforts should be focused on including novel formulations of chemical and biological insecticides to provide an economically efficient and environmentally sustainable management program for sap-sucking pests in soybeans.

4.3 Materials and Methods

Experiment conditions and plant material

Two field experiments were carried out in Santa Maria-RS/Brazil (29º42′48″ S, 53º43′59″ W, 119 meters a.s.l.) over two summer cropping seasons (2019/20 and 2020/21). We used the soybean cultivar TMG 7063 IPRO with a population density of 300,000 plants ha^{-1}, and a row spacing of 0.5 meters. The sowing dates were January 1st, 2020 (first cropping season) and December 10th, 2020 (second cropping season). In both cropping seasons, 250 kg hectare^{-1} of fertilizer NPK 00-20-20 were used. Weeds were controlled prior to sowing (glyphosate 1,040 g a.e. ha^{-1} + 2,4-D 1,005 g of a.e. ha^{-1}), and at V3 soybean growth stage with a foliar spray of glyphosate (1,040 g of a.e. ha^{-1}). Seeds were treated with carbendazim + thiram (30 + 70 g a.i. ha^{-1}) and three foliar sprays of azoxystrobin (60 g a.i. ha^{-1}) + cyproconazole (24 g a.i. ha^{-1}) were made for disease control at the reproductive stages R1, R4 and R5.4. Defoliating caterpillars were controlled by the expression of insecticide Cry proteins in the Btsoybean plants.

Treatments

The experimental design was randomized blocks with four replicates, including eleven insecticide treatments and one untreated control plot (Supplementary Table 1). Each plot consisted of 12 rows 12 m long (72 m²). Treatments were chosen based on the insecticides commonly used by soybean growers and recommended by field technicians in Brazil to control stink bugs and whiteflies on soybeans. Two insecticide sprays were made with an interval of 14 days between them, using a spraying volume of 150 L ha^{-1}. The sprays were carried out using a CO_2-pressurized backpack sprayer, TJ XR-110015 nozzles, with a spray boom of 2 meters long and 0.5 meters between nozzles. The soybean plants were at growth stage R1 at the moment of the first insecticide spray, in both cropping seasons.

Evaluations

Infestation by stink bugs and whiteflies occurred naturally in both experiments. Evaluations were made at 3, 10, 14 days after the first spray (DA1S) and at 3, 7, 10, 14 days after the second spray (DA2s), in the first cropping season; at 3, 5, 7, 10, 14 DA1S and at 3, 7, 10, 14 DA2S, in the second cropping season. Stink bugs (adults and nymphs) were quantified using a vertical beat sheet (Guedes et al., 2006), with a sampling area of 1 m² per experimental unit, followed by morphological identification of the stink bug species.

Whitefly adults were counted on site in the underside of 20 trifoliate leaves plot^{-1}, randomly selected in the upper canopy segment of soybean plants from the five central rows of each plot. Whitefly nymphs were quantified by sampling five leaflets plot^{-1} (20 leaflets treatment^{-1}), randomly selected in the middle and lower canopy segments of soybean plants. The choice for sampling whitefly adults in the upper segment and nymphs in the middle and lower segments of the canopy was based on the distribution pattern of *B. tabaci* in soybean plants (Pozebon et al., 2019). Harvest was performed in 6 m² plot^{-1}, and was used to estimate yield ha^{-1}.

Statistical analysis

Whitefly adults and nymphs were analysed separately due to differences in their biology and behaviour. Stink bug adults and nymphs were combined as a single variable due to similarities between the two life stages. Control efficiency for each insecticide treatment was assessed through the equation of Abbott (1925):

$$\text{C.E.}\,(\%) = (1 - \frac{Pt}{Pc}) \times 100$$

where C.E. is the control efficiency or corrected insect mortality (%) in each treatment, P_c is the mean number of individuals alive in the control plot, and P_t is the mean number of individuals alive in the treatment plot. Data were submitted to analysis of variance (ANOVA), and Tukey post-hoc test ($P \leq 0.05$) was conducted. All statistical analyses were carried out using the Software SASM- Agri (Canteri et al., 2001).

4.4 Conclusion

(1) Acetamiprid + bifenthrin (75 + 75 g a.i. ha^{-1}) was the most efficient treatment for the control of stink bugs in soybeans, reaching 97.8 % of insect mortality;

(2) Cyantraniliprole + bifenthrin (50 + 50 g a.i. ha^{-1}) was the most efficient treatment for the control of whiteflies in soybeans, reaching 78.8 % of insect mortality;

(3) Cyantraniliprole + bifenthrin (50 + 50 g a.i. ha^{-1}) presented the highest combined control of stink bugs and whiteflies with 83.5 % of insect mortality.

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4.6 Figures and Tables

Table 1. Mean number (M) of living stink bug adults and nymphs m^{-2} and control efficacy (CE%), in the first summer cropping season (2019/20).The active ingredients used in each treatment are presented in Supplementary Table 1. Santa Maria, RS, Brazil

Treatment	**0 DA1S**[1]	**3 DA1S**		**10 DA1S**		**14 DA1S**		**3 DA2S**		**7 DA2S**		**10 DA2S**		**14 DA2S**		**Mean CE%**
	M[2]	**M**	**CE%**	**M**	**CE%**	**M**	**CE%**	**M**	**CE%**	**M**	**CE%**	**M**	**CE%**	**M**	**CE%**	
1	4.7 a	0.5 b	93.5	0.5 c	91.3	0.7 b	88.5	0.5 b	90.9	0.5 b	92.0	0.2 b	93.3	0.0 c	100.0	92.8 a
2	5.7 a	0.7 b	90.3	0.7 bc	87.0	0.5 b	92.3	1.0 b	81.8	2.0 b	68.0	0.0 b	100.0	0.0 c	100.0	88.5 a
3	4.0 a	0.2 b	96.8	0.2 c	95.7	0.7 b	88.5	0.2 b	95.4	0.2 b	96.0	0.0 b	100.0	0.2 c	95.8	95.4 a
4	4.0 a	0.7 b	90.3	0.5 c	91.3	0.7 b	88.5	0.0 b	100.0	0.0 b	100.0	0.0 b	100.0	0.0 c	100.0	95.7 a
5	5.0 a	0.5 b	93.5	0.2 c	95.7	0.2 b	96.1	0.5 b	90.9	1.7 b	72.0	0.7 b	80.0	0.2 c	95.8	89.2 a
6	6.5 a	0.0 b	100.0	0.2 c	95.7	0.2 b	96.1	0.0 b	100.0	0.5 b	92.0	0.2 b	93.3	0.0 c	100.0	96.7 a
7	4.7 a	1.7 b	77.4	1.7 bc	69.6	2.5 ab	61.5	2.7 ab	50.0	1.0 b	84.0	1.0 b	73.3	3.2 ab	45.8	66.0 b
8	2.5 a	2.2 b	71.0	0.5 c	91.3	2.7 ab	57.7	0.7 b	86.34	0.5 b	92.0	0.0 b	100.0	1.0 bc	83.3	83.1 a
9	3.0 a	0.2 b	96.8	0.7 bc	87.0	1.2 b	80.8	0.0 b	100.0	0.0 b	100.0	0.2 b	93.3	0.0 c	100.0	94.0 a
10	4.7 a	0.2 b	96.8	0.5 c	91.3	0.2 b	96.1	0.0 b	100.0	0.0 b	100.0	0.0 b	100.0	0.0 c	100.0	97.8 a
11	2.7 a	1.0 b	87.1	2.5 b	56.5	1.5 b	76.9	0.0 b	100.0	0.0 b	100.0	0.2 b	93.3	0.5 c	91.7	86.5 a
12	5.0 a	7.7 a	—	5.7 a	—	6.5 a	—	5.5 a	—	6.2 a	—	3.7 a	—	6.0 a	—	—
CV (%)[3]	18.3	31.5	—	22.0	—	38.0	—	77.7	—	40.1	—	27.8	—	35.2	—	10.4

Note. [1]DAS = Days after first (1) and second (2) spray.[2]Means followed by the same letter in the column do not differ among themselves by the Tukey test ($P \leq 0.05$). [3]CV (%) =Coefficient of variation.

Table 2. Mean number (M) of living adults and nymphs per soybean trifoliate and control efficacy (CE%) of whitefly adults and nymphs in the first summer cropping season (2019/20). The active ingredients used in each treatment are presented in Supplementary Table 1. Santa Maria, RS, Brazil

Treatment	**0 DA1S**[1]	**3 DA1S**		**10 DA1S**		**14 DA1S**		**3 DA2S**		**7 DA2S**		**10 DA2S**		**14 DA2S**		**Mean CE%**
	M[2]	**M**	**CE%**	**M**	**CE%**	**M**	**CE%**	**M**	**CE%**	**M**	**CE%**	**M**	**CE%**	**M**	**CE%**	
Adults																
1	2.8 a	0.2 b	90.2	0.4 c	87.8	0.5 bc	83.6	0.1 c	98.6	0.1 c	98.5	0.6 b	86.2	0.9 f	90.8	90.8 a
2	2.6 a	0.1 b	96.1	0.5 c	85.1	0.5 bc	82.0	0.4 c	89.2	0.3 bc	91.1	1.8 ab	60.6	1.3 cdef	86.1	84.3 ab
3	2.5 a	0.2 b	92.2	0.8 bc	78.4	0.3 bc	88.5	0.8 bc	78.4	0.6 bc	80.6	3.2 ab	31.9	1.7 bcdef	82.1	76.0 ab
4	2.5 a	0.2 b	92.2	0.6 c	82.4	0.3 bc	88.5	0.1 c	98.6	0.2 bc	94.1	1.3 b	72.3	0.9 f	90.8	88.4 ab
5	2.5 a	0.1 b	96.1	0.6 c	82.4	0.5 bc	82.0	0.3 c	90.5	0.2 bc	94.1	1.1 b	77.7	1.1 def	88.2	87.3 ab
6	2.6 a	0.2 b	92.2	0.8 bc	78.4	0.6 bc	80.3	0.3 c	91.9	0.7 bc	79.1	0.7 b	84.1	1.0 ef	89.7	85.1 ab
7	2.4 a	0.3 b	86.3	0.6 c	82.4	0.6 bc	78.7	0.2 c	94.6	0.1 c	98.5	0.5 b	88.3	2.8 bc	70.8	85.6 ab
8	2.8 a	0.5 b	78.4	0.6 c	82.4	0.8 b	72.1	1.8 ab	51.3	1.1 b	67.1	0.5 b	89.4	3.4 b	65.1	72.3 b
9	2.7 a	0.1 b	98.1	0.6 c	83.8	0.3 bc	88.5	0.5 c	86.5	0.6 bc	82.1	2.0 ab	57.4	2.5 bcd	74.4	81.5 ab
10	2.5 a	0.0 b	100.0	0.8 c	78.4	0.1 c	96.7	0.4 c	89.2	0.4 bc	86.6	1.1 b	76.6	1.7 bcdef	82.6	87.1 ab
11	2.8 a	0.5 b	78.4	1.8 b	51.3	0.7 bc	75.4	0.6 bc	83.8	0.8 bc	76.1	0.5 b	89.4	2.4 bcde	74.9	75.6 ab
12	2.7 a	2.5 a	—	3.7 a	—	3.1 a	—	3.7 a	—	3.3 a	—	4.7 a	—	9.8 a	—	—
CV (%)[3]	7.4	36.4	—	19.2	—	24.6	—	30.5	—	27.9	—	40.8	—	15.6	—	12.2
Nymphs																
1	5.2 a	2.7 cde	72.4	2.9 a	60.1	7.7 a	0.0	2.8 a	54.1	2.3 ab	70.9	0.1 a	98.3	0.8 ab	89.0	63.5 a
2	19.5 a	4.1 bcde	58.2	5.2 a	29.1	6.3 a	0.0	6.1 a	2.4	1.4 ab	81.6	2.3 a	73.9	1.1 ab	84.1	47.0 b
3	11.9 a	10.8 ab	0.0	5.9 a	20.3	6.6 a	0.0	2.4 a	61.3	7.8 a	1.3	0.4 a	95.0	1.7 ab	75.9	36.2 b
4	4.8 a	1.9 e	80.6	5.6 a	23.6	5.5 a	0.0	1.2 a	80.6	0.3 b	96.2	1.1 a	87.2	0.1 b	98.6	66.7 a
5	3.7 a	2.6 cde	73.5	4.0 a	45.9	3.3 a	35.9	5.0 a	19.3	2.8 ab	64.6	2.2 a	75.0	0.2 ab	97.2	58.8 a
6	4.0 a	5.8 abcde	40.9	3.6 a	51.3	5.1 a	1.9	2.3 a	62.1	1.7 ab	77.8	0.7 a	91.7	0.1 ab	97.9	60.5 a

7	6.8 a	11.5 a	0.0	6.3 a	14.2	3.1 a	39.8	4.1 a	34.7	2.8 ab	63.9	0.3 a	96.1	0.7 ab	90.3	48.4 b
8	3.4 a	4.9 abcde	50.0	11.4 a	0.0	5.8 a	0.0	6.8 a	0.0	7.1 a	10.1	2.2 a	75.6	0.6 ab	91.1	32.4 b
9	7.3 a	7.3 abcd	25.5	8.0 a	0.0	2.1 a	59.2	2.8 a	54.1	5.9 ab	24.7	1.3 a	85.0	4.6 ab	35.9	40.6 b
10	10.9 a	2.3 de	76.5	7.4 a	0.0	2.8 a	44.7	2.9 a	53.2	1.6 ab	79.1	1.6 a	82.2	0.1 ab	97.9	61.9 a
11	8.9 a	8.0 abc	18.4	5.8 a	20.9	2.5 a	51.5	5.2 a	15.3	0.9 ab	88.6	0.3 a	96.7	0.4 ab	93.8	55.0 a
12	9.5 a	9.8 ab	—	7.4 a	—	5.1 a	—	6.2 a	—	7.9 a	—	9.0 a	—	7.2 a	—	—
CV (%)	26.8	22.2	—	31.2	—	48.7	—	43.7	—	45.4	—	84.9	—	76.2	—	44.5

Note. [1]DAS = Days after first (1) and second (2) spray.[2]Means followed by the same letter in the column do not differ among themselves by the Tukey test ($P \leq 0.05$). [3]CV (%) =Coefficient of variation.

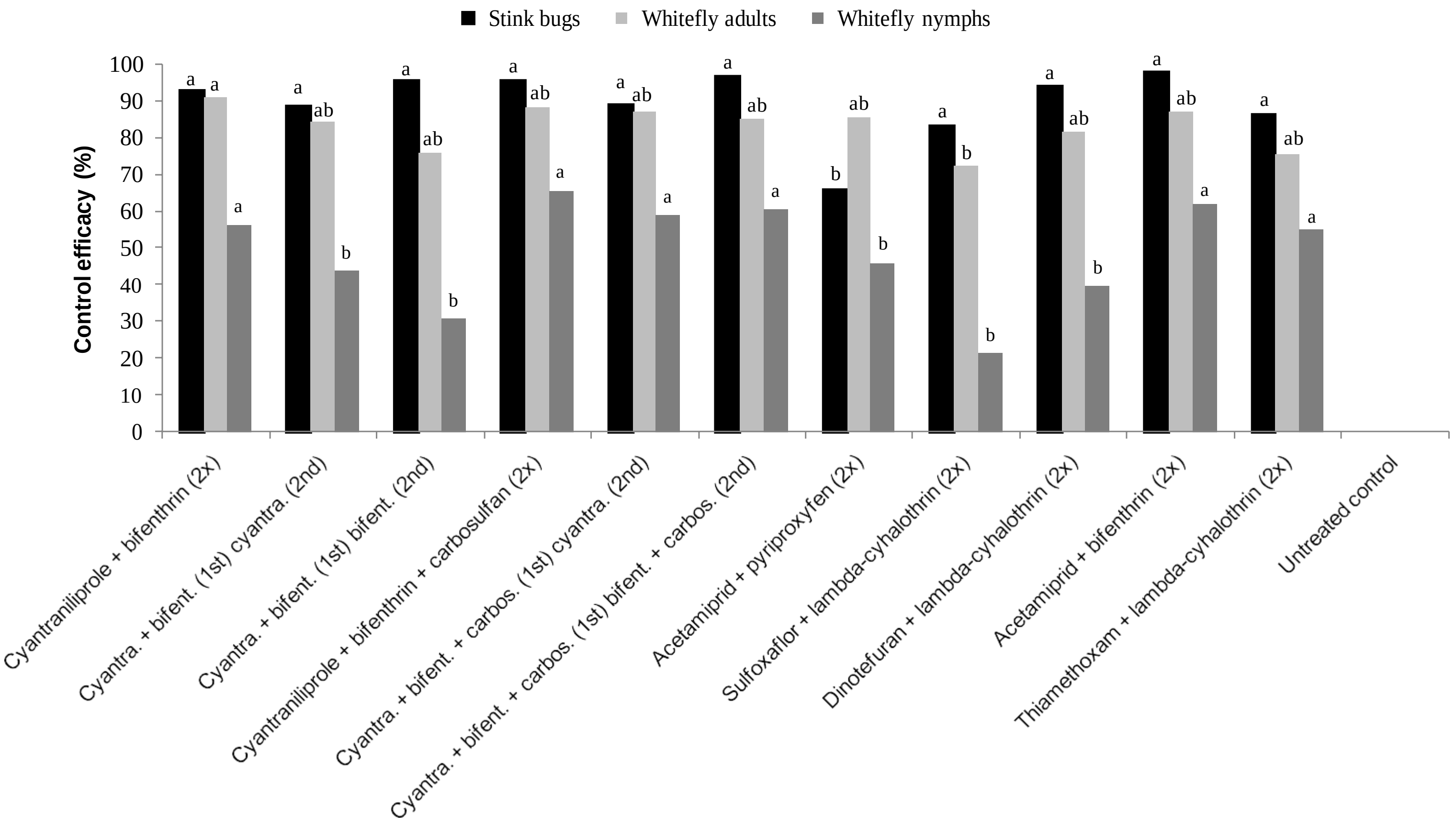

Figure 1. Average control efficacy (CE ± SD) of stink bug and whiteflies, in the first (1st) and second (2nd) insecticide sprays on soybeans (summer cropping season 2019/20). Same active ingredients in the two sprays are indicated by: (2x). Cyantra. (cyantraniliprole), bifent. (bifenthrin) and carbos. (carbosulfan). Santa Maria, RS, Brazil.

Supplementary Table 1. Active ingredient, trade name, dose of active ingredient ha^{-1} and dose of commercial product ha^{-1} of the insecticidesevaluated for the control of stink bugs and whiteflies on soybean plants under field conditions in two cropping seasons. Santa Maria, RS, Brazil.

Treatment ID	**Active ingredient (trade name)**		**Chemical group (mode of action)**		**Dose a.i. ha^{-1} (c.p.)[1]**	
	1st spray	**2nd spray**	**1st spray**	**2nd spray**	**1st spray**	**2nd spray**
1	Cyantraniliprole (10%) + bifenthrin (10%) (Benevia® + Talstar®)	Cyantraniliprole (10%) + bifenthrin (10%) (Benevia® + Talstar®)	Diamide (ryanodine receptor modulator) + pyrethroid (sodium channel modulator)	Diamide (ryanodine receptor modulator) + pyrethroid (sodium channel modulator)	50 + 50 (500 + 500)	50 + 50 (500 + 500)
2	Cyantraniliprole (10%) + bifenthrin (10%) (Benevia® + Talstar®)	Cyantraniliprole (10%) (Benevia®)	Diamide (ryanodine receptor modulator) + pyrethroid (sodium channel modulator)	Diamide (ryanodine receptor modulator)	50 + 50 (500 + 500)	50 (500)
3	Cyantraniliprole (10%) + bifenthrin (10%) (Benevia® + Talstar®)	Bifenthrin (10%)(Talstar®)	Diamide (ryanodine receptor modulator) + pyrethroid (sodium channel modulator)	Pyrethroid (sodium channel modulator)	50 + 50 (500 + 500)	50 (500)
4	Cyantraniliprole (10%) + bifenthrin (5%) + carbosulfan (15%) (Benevia® + Talisman®)	Cyantraniliprole (10%) + bifenthrin (5%) + carbosulfan (15%) (Benevia® + Talisman®)	Diamide (ryanodine receptor modulator) + pyrethroid (sodium channel modulator) + carbamate (AChE inhibitor)	Diamide (ryanodine receptor modulator) + pyrethroid (sodium channel modulator) + carbamate (AChE inhibitor)	50 + 30 + 90 (500 + 600)	50 + 30 + 90 (500 + 600)
5	Cyantraniliprole (10%) + bifenthrin (5%) + carbosulfan (15%) (Benevia® + Talisman®)	Cyantraniliprole (10%) (Benevia®)	Diamide (ryanodine receptor modulator) + pyrethroid (sodium channel modulator) + carbamate (AChE inhibitor)	Diamide (ryanodine receptor modulator)	50 + 30 + 90 (500 + 600)	50 (500)
6	Cyantraniliprole (10%) + bifenthrin (5%) + carbosulfan (15%) (Benevia® + Talisman®)	Bifenthrin (5%) + carbosulfan (15%) (Talisman®)	Diamide (ryanodine receptor modulator) + pyrethroid (sodium channel modulator) + carbamate (AChE inhibitor)	Pyrethroid (sodium channel modulator) + carbamate (AChE inhibitor)	50 + 30 + 90 (500 + 600)	30 + 90 (600)
7	Acetamiprid (20%) + pyriproxyfen (10%) (Privilege®)	Acetamiprid (20%) + pyriproxyfen (10%) (Privilege®)	Neonicotinoid (nAChR agonist) + pyriproxyfen (juvenile hormone mimic)	Neonicotinoid (nAChR agonist) + pyriproxyfen (juvenile hormone mimic)	20 + 40 (200)	20 + 40 (200)
8	Sulfoxaflor (10%) + lambda-	Sulfoxaflor (10%) + lambda-	Sulfoximine(nAChR agonist)	Sulfoximine(nAChR agonist)	30 + 45	30 + 45

	cyhalothrin (15%) (Expedition®)	cyhalothrin (15%) (Expedition®)	+ pyrethroid (sodium channel modulator)	+ pyrethroid (sodium channel modulator)	(300)	(300)
9	Dinotefuran (8.4%) + lambda-cyhalothrin (4.8%) (Zeus®)	Dinotefuran (8.4%) + lambda-cyhalothrin (4.8%) (Zeus®)	Neonicotinoid (nAChR agonist) + pyrethroid (sodiumchannel modulator)	Neonicotinoid (nAChR agonist) + pyrethroid (sodiumchannel modulator)	58.8 + 33.6 (700)	58.8 + 33.6 (700)
10	Acetamiprid (25%) + bifenthrin (25%) (Sperto®)	Acetamiprid (25%) + bifenthrin (25%) (Sperto®)	Neonicotinoid (nAChR agonist) + pyrethroid (sodiumchannel modulator)	Neonicotinoid (nAChR agonist) + pyrethroid (sodiumchannel modulator)	75 + 75 (300)	75 + 75 (300)
11	Thiamethoxam (14.1%) + lambda-cyhalothrin (10.6%) (Engeo Pleno S®)	Thiamethoxam (14.1%) + lambda-cyhalothrin (10.6%) (Engeo Pleno S®)	Neonicotinoid (nAChR agonist) + pyrethroid (sodiumchannel modulator)	Neonicotinoid (nAChR agonist) + pyrethroid (sodiumchannel modulator)	35.2 + 26.5 (250)	35.2 + 26.5 (250)
12	Untreated control	—	—	—	—	—

Note. [1]a.i. = active ingredient (g hectare^{-1}). c.p. = commercial product (mL hectare^{-1}).

Supplementary Table 2. Mean number (M) of living adults and nymphs per soybean trifoliate and control efficacy (CE%) of whitefly adults andnymphs in response to the insecticide treatments sprayed on soybean plants, under field conditions, in the second summer cropping season (2020/21). The active ingredients used in each treatment are presented in Supplementary Table 1. Santa Maria, RS, Brazil

Treatment	0 DA1S[1]	3 DA1S		5 DA1S		7 DA1S		10 DA1S		14 DA1S		3 DA2S		7 DA2S		10 DA2S		14 DA2S		Mean
	M[2]	M	CE%	M	CE%	M	CE%	M	CE%	M	CE%	M	CE%	M	CE%	M	CE%	M	CE%	CE%
									Adults											
1	5.0 a	2.2 b	84.3	2.1 de	80.9	2.7 b	85.6	1.3 bcd	89.4	3.1 b	85.2	0.8 bc	87.6	0.4 c	93.7	0.5 b	94.2	0.4 b	97.6	88.7 ab
2	6.1 a	2.4 b	83.2	2.4 cde	78.2	1.9 b	90.1	1.2 cd	90.2	2.1 b	89.8	1.5 bc	76.0	0.5 c	91.3	0.8 b	90.2	0.5 b	96.9	87.3 ab
3	4.1 a	3.1 b	78.0	4.2 bc	62.7	2.5 b	86.7	1.9 bcd	84.5	2.5 b	87.8	1.1 bc	82.2	0.9 bc	85.0	0.5 b	94.2	0.9 b	94.4	84.0 ab
4	3.1 a	3.3 b	76.6	4.0 bcd	64.4	2.4 b	87.5	3.2 bcd	73.6	3.2 b	84.2	1.1 bc	83.7	1.0 bc	84.2	1.3 b	84.5	1.6 b	90.6	81.0 bc
5	3.2 a	4.0 b	72.0	4.4 b	60.9	2.2 b	88.2	4.0 bc	67.5	4.6 b	77.6	2.2 b	65.9	2.1 b	66.9	1.1 b	87.9	1.2 b	93.0	75.5 c
6	2.7 a	3.2 b	77.6	3.4 bcde	69.3	2.5 b	86.7	2.2 bcd	82.1	2.9 b	85.6	1.0 bc	84.5	0.7 c	89.0	0.5 b	93.7	1.1 b	93.5	84.7 ab
7	2.6 a	3.2 b	77.6	2.4 cde	78.2	2.0 b	89.6	0.6 d	95.1	1.7 b	91.5	1.1 bc	83.7	0.5 c	92.1	0.9 b	89.7	0.8 b	95.2	88.1 ab
8	3.9 a	2.4 b	83.2	3.0 bcde	73.3	1.5 b	91.9	1.8 bcd	85.0	2.8 b	86.1	0.7 bc	89.1	0.5 c	91.3	0.7 b	91.4	1.0 b	94.2	87.3 ab
9	4.0 a	2.6 b	81.5	3.5 bcde	68.4	2.4 b	87.5	5.5 b	54.9	3.9 b	81.0	1.1 bc	82.9	0.5 c	91.3	0.8 b	90.8	1.2 b	92.7	81.2 bc
10	6.2 a	1.8 b	87.1	2.7 bcde	76.0	1.2 b	93.5	2.1 bcd	83.3	2.7 b	86.9	0.3 c	94.6	0.4 c	92.9	0.6 b	93.1	1.9 b	88.6	88.4 ab
11	5.8 a	2.1 b	85.0	1.8 e	84.0	1.2 b	93.5	0.9 cd	92.7	1.2 b	93.9	0.9 bc	85.3	0.6 c	89.8	0.8 b	90.8	0.5 b	96.8	90.2 a
12	5.9 a	14.3 a	—	11.2 a	—	19.1 a	—	12.3 a	—	20.5 a	—	6.4 a	—	6.3 a	—	8.7 a	—	16.5 a	—	—
CV(%)[3]	15.6	26.7	—	10.1	—	13.8	—	24.5	—	27.6	—	17.7	—	16.6	—	13.2	—	25.5	—	6.0
									Nymphs											
1	6.1 a	5.2 a	42.6	1.7 b	80.2	0.5 c	86.2	4.1 c	68.7	1.3 b	81.8	1.2 b	92.9	3.4 b	71.1	1.4 b	97.2	2.1 b	92.9	79.3 a
2	6.8 a	5.6 a	38.8	3.5 ab	60.4	1.0 bc	75.0	4.1 c	68.0	1.3 b	81.8	1.6 b	90.9	3.7 b	68.5	0.6 b	98.8	1.1 b	96.2	75.4 a
3	6.9 a	6.8 a	25.14	3.7 ab	57.6	0.8 bc	78.7	5.5 abc	57.1	2.5 b	64.3	1.6 b	90.6	3.1 b	73.6	1.9 b	96.1	1.4 b	95.4	71.0 ab
4	6.5 a	6.9 a	24.1	2.9 b	66.7	1.7 abc	56.2	5.7 abc	56.0	2.6 b	63.6	1.8 b	89.5	1.9 b	83.4	3.0 b	93.9	2.3 b	92.5	69.5 ab
5	5.7 a	7.1 a	22.9	3.2 ab	63.3	1.7 abc	57.5	6.3 abc	51.0	3.6 ab	48.9	1.5 b	91.5	4.3 b	63.4	1.4 b	97.2	3.9 b	87.2	64.7 ab

6	6.9 a	5.2 a	43.2	3.2 ab	63.3	3.1 ab	21.2	6.2 abc	52.1	2.9 ab	58.7	2.7 b	84.4	1.5 b	87.2	2.3 b	95.3	1.8 b	94.1	66.6 ab
7	5.7 a	6.6 a	27.9	2.1 b	75.7	0.8 c	80.0	5.3 bc	59.1	3.4 ab	51.7	1.6 b	90.6	1.8 b	84.	1.1 b	97.9	1.1 b	96.6	73.7 ab
8	6.8 a	7.7 a	15.3	1.4 b	84.2	0.4 c	90.0	3.3 c	74.5	2.2 b	69.2	1.9 b	89.2	4.3 b	63.0	0.9 b	98.1	1.7 b	94.4	75.3 a
9	5.2 a	9.5 a	0.0	4.1 ab	53.1	1.3 abc	66.2	6.5 abc	49.8	4.1 ab	43.4	1.9 b	89.2	2.5 b	78.7	1.8 b	96.3	2.4 b	92.1	63.2 ab
10	6.6 a	9.3 a	0.0	6.2 ab	29.9	2.1 abc	47.5	11.8 ab	8.8	2.1 b	71.3	3.4 b	80.7	2.2 b	80.8	2.4 b	95.0	3.7 b	87.9	55.8 b
11	6.4 a	8.4 a	8.2	2.2 b	75.1	1.6 abc	58.7	4.4 c	66.0	1.1 b	84.6	2.1 b	87.8	2.0 b	83.0	1.5 b	97.0	4.8 b	84.3	71.6 ab
12	6.9 a	9.1 a	—	8.8 a	—	4.0 a	—	12.9 a	—	7.1 a	—	17.6 a	—	11.7 a	—	49.3 a	—	30.5 a	—	—
CV(%)	14.1	14.7	—	26.1	—	23.8	—	19.9	—	22.9	—	34.9	—	25.5	—	25.2	—	40.5	—	16.6

Note. [1]DAS = Days after first (1) and second (2) spray.[2]Means followed by the same letter in the column do not differ among themselves by the Tukey test ($P \leq 0.05$). [3]CV (%) =Coefficient of variation.

Supplementary Table 3. Average means of control efficacy (CE%) of stink bug and whitefly adults and nymphs in response to the first (1st) and second (2nd) insecticide sprays on soybean plants, under field conditions, in two summer cropping seasons (2019/20 and 2020/21). Same active ingredients in the two sprays are indicated by: (2x). Statistics for stink bug control not showed due to low infestation in the second cropping season. Cyantra. (cyantraniliprole), bifent. (bifenthrin) and carbos. (carbosulfan). Santa Maria, RS, Brazil.

Treatments	**Stinkbugs (CE%)[1]**	**Whitefly adults (CE%)[2]**	**Whitefly nymphs (CE%)**	**Whitefly adults + nymphs (CE%)[3]**	**Stinkbugs + whiteflies (CE%)[4]**
Cyantraniliprole + bifenthrin (2x)	92.8	89.8 a	67.8 a	78.8 a	83.5 a
Cyantra. + bifent. (1st) cyantra. (2nd)	88.5	85.8 a	59.5 a	72.7 ab	77.9 a
Cyantra. + bifent. (1st) bifent. (2nd)	95.4	80.0 a	50.9 a	65.4 ab	75.4 a
Cyantraniliprole + bifenthrin + carbosulfan (2x)	95.7	84.7 a	67.6 a	76.1 ab	82.7 a
Cyantra. + bifent. + carbos. (1st) cyantra. (2nd)	89.2	81.4 a	61.8 a	71.6 ab	77.4 a
Cyantra. + bifent. + carbos. (1st) bifent. + carbos. (2nd)	96.7	84.9 a	63.6 a	74.2 ab	81.7 a
Acetamiprid + pyriproxyfen (2x)	66.0	86.9 a	59.8 a	73.4 ab	70.9 a
Sulfoxaflor + lambda-cyhalothrin (2x)	83.1	79.8 a	48.3 a	64.1 b	70.4 a
Dinotefuran + lambda-cyhalothrin (2x)	94.0	81.4 a	51.3 a	66.4 ab	75.6 a
Acetamiprid + bifenthrin (2x)	97.8	87.8 a	58.9 a	73.3 ab	81.5 a
Thiamethoxam + lambda-cyhalothrin (2x)	86.5	82.9 a	63.3 a	73.1 ab	77.6 a
Untreated control	—	—	—	—	—
CV(%)[5]	—	6.9	21.1	4.9	8.1

Note. [1] Stink bugs not quantified in Experiment II (2020/21 cropping season) due to low infestation in the experimental plots. [2] Means followed by the same letter in the column do not differ among themselves by the Tukey test ($P \leq 0.05$). [3] Average between the third and fourth columns. [4] Average between the second, third and fourth columns. [5] CV (%) = Coefficient of variation.

Supplementary Table 4. Soybean yield (kg hectare^{-1}) in response to the first (1st) and second (2nd) insecticide sprays to control stink bugs and whiteflies on soybeans in two summer cropping seasons (2019/20 and 2029/21). Same active ingredients in the two sprays are indicated by: (2x).Santa Maria, RS, Brazil.

Treatments	First cropping season (2019/20)¹	Second cropping season (2020/21)	Average between seasons
Cyantraniliprole + bifenthrin (2x)	3562.0 abcd	3925.4 ab	3743.7 a
Cyantraniliprole + bifenthrin (1st) cyantraniliprole (2nd)	3516.5 abcd	4082.9 ab	3799.7 a
Cyantraniliprole + bifenthrin (1st) bifenthrin (2nd)	3290.8 d	4261.7 ab	3776.3 a
Cyantraniliprole + bifenthrin + carbosulfan (2x)	3791.7 a	4208.3 ab	4000.0 a
Cyantraniliprole + bifenthrin + carbosulfan (1st) cyantraniliprole (2nd)	3698.3 ab	3738.3 ab	3718.3 a
Cyantraniliprole + bifenthrin + carbosulfan (1st) bifenthrin + carbosulfan (2nd)	3763.3 a	3888.3 ab	3825.8 a
Acetamiprid + pyriproxyfen (2x)	3380.8 cd	3820.0 ab	3600.4 a
Sulfoxaflor + lambda-cyhalothrin (2x)	3583.3 abcd	4147.5 ab	3865.4 a
Dinotefuran + lambda-cyhalothrin (2x)	3513.7 abcd	3826.7 ab	3670.2 a
Acetamiprid + bifenthrin (2x)	3561.7 abcd	3622.5 bc	3592.1 a
Thiamethoxam + lambda-cyhalothrin (2x)	3667.5 abc	3605.8 bc	3636.7 a
Untreated control	3465.0 def	2980.0 c	3222.5 a
CV(%)²	3.3	7.7	7.1

Note. ¹Means followed by the same letter in the column do not differ among themselves by the Tukey test (P≤0.05). ² CV (%) = Coefficient of variation.

5 CONCLUSÕES

Com base no trabalho realizado conclui-se:

O tratamento inseticida mais eficiente no controle de percevejos em soja foi o Acetamiprido + Bifentrina (75 + 75 g ia ha $^{-1}$), atingindo em média 97,8% de mortalidade de insetos;

O tratamento inseticida Ciantraniliprole + Bifentrina (50 + 50 g ia ha $^{-1}$) foi o eficiente para o controle da mosca-branca em soja, atingindo em média 78,8% de mortalidade de insetos;

O tratamento inseticida Ciantraniliprole + Bifentrina (50 + 50 g ia ha $^{-1}$, duas aplicações) apresentou maior controle combinado de percevejos e mosca-branca em soja, atingindo em média 83,5% de mortalidade de insetos;

Diante do exposto, acentua-se que os objetivos da presente dissertação foram alcançados, sendo que foi observado o controle das pragas percevejos e mosca- branca em soja com o uso conjunto de inseticida em duas aplicações sequenciais para o controle concomitante das pragas, assim como alternativas para o controle em isolado. Estes resultados demonstram haver opções para o manejo integrado de pragas, para a rotação de inseticidas com o uso de produtos mais modernos, com princípios ativos menos tóxicos e que controlam mais de uma praga ao menos tempo.

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