Capture of thrips in semi-hydroponic strawberry cultivation using Moericke traps with different tones of blue

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Abstract – Traps configure a practical and economical method to capture and monitor thrips in strawberry cultivations. This study aimed to evaluate the thrips capture efficiency of Moericke traps with different tones of blue (light, intermediate, and dark). Thrips were collected from October 2022 to October 2023 in a conventional semi-hydroponic cultivation of San Andreas and Monterrey strawberry cultivars. The traps were randomly distributed and arranged at the same height as the cultivation bench, with four replicates per tone of blue. To count the thrips, 20mL water samples were collected weekly from the bottom of each basin. The data were subjected to analysis of variance using the F test and the means were compared by the Tukey's test (p≤0.05). The light blue Moericke trap more effectively captured thrips in semi-hydroponic strawberry cultivation.

Index terms: *Fragaria* x *ananassa*; Thysanoptera; Integrated pest management.

Captura de tripes em morangueiro semi-hidropônico utilizando armadilhas do tipo Moericke de diferentes tonalidades de azul

Resumo – O uso de armadilhas é um método prático e econômico para realizar a captura e o monitoramento de tripes em cultivos de morangueiro. Este estudo objetivou avaliar a eficiência de captura de tripes em armadilhas do tipo Moericke de diferentes tonalidades de azul (clara, intermediária e escura). As coletas dos tripes ocorreram de outubro de 2022 a outubro de 2023, em cultivo convencional semi-hidropônico de morangueiro dos cultivares San Andreas e Monterrey. As armadilhas foram distribuídas completamente ao acaso, dispostas na mesma altura da bancada de cultivo, com quatro repetições por tonalidade de azul. Para a contagem dos tripes, amostras de 20mL de água foram coletadas semanalmente do fundo de cada bacia. Os dados foram submetidos à análise de variância pelo teste F e as médias comparadas pelo teste de Tukey (p≤0,05). A armadilha Moericke de coloração azul-clara foi mais eficaz na captura de tripes em cultivo semi-hidropônico de morangueiro.

Termos para indexação: *Fragaria* x *ananassa*; Thysanoptera; Manejo integrado de pragas.

Introduction

Brazil leads strawberry production in South America (Faostat, 2021). However, pest attacks remain still one of the main obstacles to strawberry cultivation in the country (*Fragaria x ananassa* Duch.), as they often cause economic damage, requiring integrated control measures (Michereff Filho *et al*., 2020).

Thrips damage stems from nymphs and adults, which feed on the flowers, resulting in brownish stains and necrotic spots on the stamens and floral receptacle at the feeding site. This damage leads to flower withering and abortion, reducing productivity (Liburd and Arévalo, 2005; Nondillo *et al*., 2010). Fruits show tanning in their achene region (Nondillo *et al*., 2010), reducing strawberries production and quality and increasing post-harvest perishability (Santos *et al*., 2023).

The most efficient way to avoid damage to strawberry crops refers to detecting pest populations at the beginning of infestations, which enables implementing the appropriate integrated management (Michereff Filho *et al*., 2020). Traps configure one the most practical and cheapest methods for capturing and monitoring insects (Dearden *et al*., 2023), especially those that are attracted by color, such as thrips, which can be monitored with blue colored traps (Cruz-Esteban *et al*., 2020; Cruz-Esteban, 2023; Dearden *et al*., 2023; Santos *et al*., 2023).

Moericke traps type are very efficient in capturing thrips. In this method the insects are attracted by the trap's color. After falling into it, insects are trapped and die in the aqueous medium within the trap (Santos *et al*., 2023). As the color of the trap influences its attractiveness to thrips, the optimal tone or even the contrast between two

Received on 12/03/2024. Accepted for publication on 10/06/2024. Doi: https://doi.org/10.52945/rac.v37i2.1832
Section editor: Joatan M. da Rosa

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colors increase capture rates (Dearden *et al*., 2023). In strawberry cultivation, it has been proven that blue Moericke traps more efficiently capture thrips than yellow and white ones (Santos *et al*., 2023). However, in the literature has no information on whether the tone of blue can influence the capture of these insect pests. Thus, this study aimed to evaluate the capture efficiency of Moericke traps depending on three tones of blue (light, intermediate and dark) in a semi-hydroponic strawberry cultivation in Caçador, Santa Catarina, Brazil.

Material and methods

The study was conducted in a greenhouse, located at 26°49'03.1"S and 50°59'24.9"W, in a conventional semi-hydroponic cultivation of San Andreas and Monterrey strawberry cultivars. Because the San Andreas cultivar reached the end of its productive cycle, it was replaced by the Monterrey cultivar. The evaluations for San Andreas were carried out from 10/13/2022 to 04/20/2023 and for Monterrey, from 04/28 to 10/26/2023. Thrips were collected every seven days, totaling 55 sampling occasions.

The experiment consisted of eight 6m long benches spaced 90cm apart. Each bench had two rows of slabs with a 30cm spacing between them. Planting density totaled 94,815 plants per hectare.

The slabs were filled with 50L of a substrate composed of Sphagnum peat, roasted rice husks, expanded perlite, and vermiculite. A hydraulic system was used in the fertigation that consisted of a deposit for the nutrient solution, non-draining and self-compensating drippers with a nominal flow rate of $8Lh^{-1}$, a manifold distributor with four outlets, four 4x6mm microtubes; and one dripper stake per plant.

The thrips were captured in basins with a 2.5L capacity that had come internally and externally colored from the factory, in light (RGB code: 0, 133, 168) (trap model a), intermediate (RGB code: 32 , 93, 145) (trap model b) and dark blue (RGB code: 58, 71, 124) (trap model c). Round basins (22cm diameter, 10cm height, $375cm^2$ area) were used in traps models a (Figure 1A) and c (Figure 1B). The trap model b (Figure 1C) was handmade, consisting of empty liquid laundry soap packaging (34cm diameter, 9cm height, $380cm^2$ area) that was colored from the factory in the chosen tone and cut on its side to make an opening for water storage and insect capture.

The traps were randomly distributed (with four replications per tone) and placed on a support mounted at the same height as the cultivation bench (80cm from the ground). In each trap, 2L of water, mixed with 5mL of neutral detergente, were added to break the surface tension of the water, thus avoiding the exit of captured insects. With a pipette, 20mL samples of water containing the insects were collected from the bottom of each trap every seven days. The water and detergent were replaced after sample collection. Additionally, every 14 days, the traps were washed and randomly repositioned within the cultivation area.

The thrips were counted with a stereomicroscope (6.4× magnification). The specimens were mounted on microscope slides using Canada balsam (Mound and Kibby, 1998), and identified by the appropriate dichotomous keys (Mound and Marullo, 1996; Cavalleri and Mound, 2012). Part of the specimens was deposited at the entomological collection of the Federal University of Rio Grande, in Rio Grande (Rio Grande do Sul) and the other part, at the Epagri Entomological Museum, at the Caçador Experimental Station (EECD) in Caçador (Santa Catarina).

The experiment was analyzed as a factorial completely randomized design, with factor A = trap color and factor B = sampling time. Statistical analyses were performed on the "R" environment (R Core Team, 2021), considering a 5% level of significance. The data were subjected to analysis of variance using the F test and the means were compared using the Tukey's test ($p \leq 0.05$).

Pests were monitored weekly and control was implemented during population peaks using the following pesticides: Abamex® (Abamectin) for spider mites; Boveril® (*Beauveria bassiana*) for whiteflies and spider mites; Delegate® (Spinetoram) for thrips and drosophilids and Actara® (Thiamethoxam) for aphids (Figure 2).

Results and discussion

Frankliniella occidentalis (Pergande) (Thysanoptera: Thripidae) was the predominant species of thrips in semi-

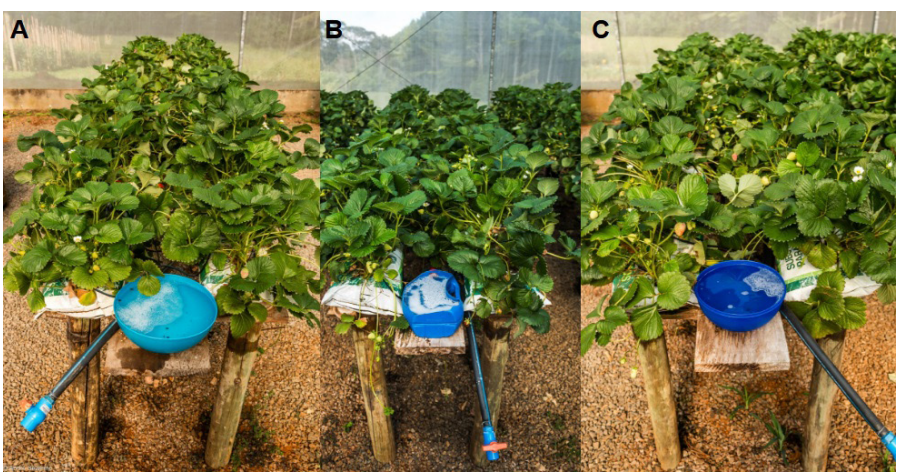

Figure 1. Moericke traps of different tones of blue to capture thrips in a semi-hydroponic strawberry cultivation: (A) light blue (RGB code: 0, 133, 168); (B) intermediate blue (RGB code: 32, 93, 145) and (C) dark blue (RGB code: 58, 71, 124)
Photos: André Amarildo Sezerino.
Figura 1. Armadilhas Moericke de diferentes tonalidades de azul utilizadas para a captura de tripes em cultivo semihidropônico de morangueiro: (A) azul-clara (código RGB: 0, 133, 168); (B) azul-intermediária (código RGB: 32, 93, 145) e (C) azul-escura (código RGB: 58, 71, 124)
Fotos: André Amarildo Sezerino.

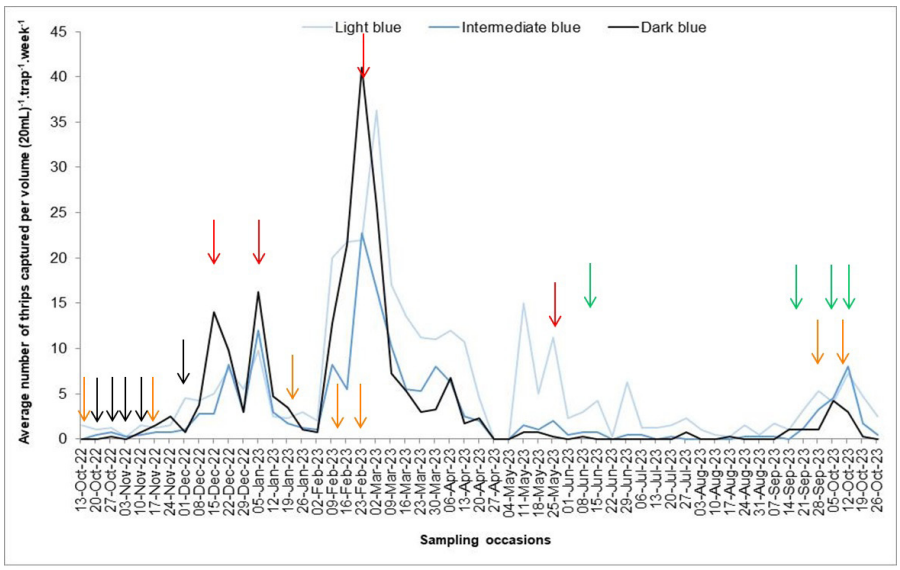

Figure 2. Average number of thrips captured per sampled volume (20mL)-1.trap-1. week-1 in a semi-hydroponic strawberry cultivation. Arrows indicate the application of insecticides for pest control, in which: red refers to spinetoram; orange to abamectin; green to thiamethoxam and black to Beauveria bassiana in Caçador, SC – October 13, 2020 to October 26, 2021

Figura 2. Número médio de tripes capturados por volume amostrado (20mL)-1. armadilha-1.semana-1, em cultivo semi-hidropônico de morangueiro. As setas indicam a aplicação de inseticidas para o controle de pragas, onde: laranja (abamectina); preta (Beauveria bassiana); vermelha (espinetoram) e verde (tiametoxam) em Caçador, SC – 13 de outubro de 2020 a 26 de outubro de 2021

hydroponic San Andreas and Monterrey strawberry cultivation, representing 78.6% of the collected specimens. This result corroborates the findings in the literature, which indicate this species as the most frequent and abundant in strawberry cultivations in southern Brazil (Nondillo *et al*., 2010; Pinent *et al*., 2011; Santos *et al*., 2023). In this study collected six other Thripidae species: *Caliothrips phaseoli* (Hood) (19.2%); *Frankliniella schultzei* (Trybom) (2.0%); *Heliothrips haemorrhoidalis* (Bouché) (0.07%); *Holopothrips* sp. (0.04%); *Holothrips* sp. (0.04%), and *Carathrips mediamericanus* (Hood) (0.04%). *Frankliniella occidentalis* and *C. phaseoli* are considered polyphagous, and occurred throughout the studied period. The former species is primarily phytophagous on flowers but it can also feed on fruits and leaves. *Caliothrips phaseoli* feeds exclusively on leaves, which can cause leaf tissues silvering and necrosis (Mound and Kibby, 1998). *Frankliniella schultzei* is considered the main thrips pest species in Caçador and in the tomato-producing region in Alto Vale do Rio do Peixe, in Santa Catarina (Santos, 2016). In this research it collected it from November 2022 to March 2023, a period coinciding with the tomato cultivation adjacent to the greenhouse in which this experiment was conducted. The three tones of blue significantly differed regarding thrips capture. Light blue traps showed the most efficient capture rate, followed by dark blue ones. Intermediate blue traps captured thrips the least (Table 1). The average number of thrips captured per volume sampled^{-1} trap^{-1} week^{-1} totaled 5.9, 3.7 and 2.9 for light, dark and intermediate blue traps, respectively (Table 1). For semi-hydroponic San Andreas strawberry cultivation, Santos *et al.* (2023) found that blue Moericke traps more efficiently captured thrips than yellow and white ones. In Mexico, Cruz-Esteban (2023) studied sticky traps with different tones of yellow and blue to determine their *F. occidentalis* capture efficiency in blackberry cultivations. The authors found that bright blue traps (59% reflectance at 548nm) were the most efficient.

Thrips population fluctuation, determined by periodically sampling Moericke traps with different tones of blue, proved to be seasonal, varying throughout the year of this study (Figure 2). This research captured thrips consistently throughout its duration, with the first population peaks occurring in December 2022. The highest thrips population peak occurred in February, decreasing during the winter (Figure 2). These data corroborate a previous study in the same location, that found that thrips populations on strawberry cultivation decrease in July and increase in early spring due to rising daily temperatures (Santos *et al*., 2023).

The use of colored traps aids the field monitoring of pests and thus control decision making. This method is based on the principle that the wavelengths some colored surfaces emit attract different insects species (Prokopy and Boller, 1971). Since photoreceptor responses act as sensory inputs that drive insect behavior (Cruz-Esteban *et al*., 2020; Cruz-Esteban, 2023). Therefore, the results of this study indicate that using light blue Moericke traps enhances attractiveness, optimizes thrips capture rates, and improves pest monitoring in strawberry crops.

Table 1. Mean (±SE) thrips captured per Moericke traps-1.week-1 in a semi-hydroponic strawberry cultivation (n=55) in Caçador, SC - October 13, 2022 to October 26, 2023

Tabela 1. Valor médio (±EP) de tripes capturados por armadilhas Moericke-1.semana-1 em cultivo semi-hidropônico de morangueiro (n=55) em Caçador, SC - 13 de outubro de 2022 a 26 de outubro de 2023

Blue tone of the trap	Number of thrips captured per sampled volume (20mL)$^{-1}$.trap^{-1}.week^{-1}
Light	5.9 ± 0.43 a
Intermediate	2.9 ± 0.12 c
Dark	3.7 ± 0.11 b

Means followed by the same letter fail to differ from each other by the Tukey's test at 5% probability of error.

Médias seguidas pela mesma letra não diferem entre si pelo teste de Tukey a 5% de probabilidade de erro.

Conclusions

Light blue Moericke traps show the greatest efficient in capturing thrips over time in semi-hydroponic strawberry cultivations, especially *F. occidentalis*, considered the main pest in strawberry crops in the Alto Vale do Rio do Peixe region in Santa Catarina.

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