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COLOUR PREFERENCE AND RESPONSE OF THRIPS TO DIFFERENT PETUNIA VARIETIES IN WESTERN ROMANIA

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Abstract

Thrips are a common pest in most horticultural and ornamental crops. They are particularly common in greenhouses in western Romania. In the present study, we investigated thrips preference for different coloured traps as well as specific structure and abundance in Petunia hybrida varieties in greenhouses. Thrips attraction to colour was assessed using three commercially available coloured sticky traps: yellow, orange and blue. Taxonomically, the diversity of thrips is reflected in the relatively large number of species, identified in Petunia, 6 species: Frankliniella intonsa, Frankliniella occidentalis, Frankliniella schultzei, Scirtothrips dorsalis, Thrips palmi and Thrips tabaci. Of these species, 2 are the most common and abundant: Frankliniella occidentalis (n= 172) and Thrips tabaci (n= 163). In the Petunia varieties, significant differences were observed depending on the colour of the trap, these were found between yellow-blue (p = 0.000) and yellow-orange (p = 0.000) and it is observed that there are no significant differences between blue-orange (p = 0.434). Most of the thrips species were caught with the yellow sticky traps (F=39.398, p=0.000<0.05).

***Key words**:colour preference, Petunia hybrida, thrips, western Romania.*

INTRODUCTION

The current world checklist of thrips contains approximately 7700 species (Tang et al., 2023), grouped in 2 suborders and 9 families (Mound, 2007; Diffie et al., 2008). The suborder *Tubulifera* comprises a single family, *Phlaeothripidae*, with 3500 species (Morse & Hoddle, 2006; Tipping, 2008). The suborder *Terebrantia* comprises 8 families: *Thripidae* (≈2201 species), *Aeolothripidae* (≈222 species), *Heterothripidae* (93 species), *Melanthripidaea* (79 species); *Stenurothripidae* (24 species); *Merothripidae* (20 species), *Fauriellidae* (5 species) and *Uzelothripidae* (2 species) (Buckman et al. 2013).

The most common species associated with ornamental plants as hosts are mainly from three of the nine families of the *Thysanoptera*, with the majority of species from the family *Thripidae* (He et al., 2020). Species in this family are among the most highly evolved of the *Thysanopter*a (Ebratt-Ravelo et al., 2019). They are also the most common and difficult phytophagous insects to control in commercial ornamental production, feeding on a wide range of plant species including bedding plants, potted plants and cut flowers (Parker et al., 1995).

Petunias (*Petunia hybrida*) are among the most popular bedding plants in the world due to their versatility, variety and range of flower colours (Kessler, 1999). In Romania, petunias have been among the top five selling bedding plants for the last 20 years (Popescu & Popescu, 2015), and in this case the popularity and demand for petunias is increasing, leading to the expansion of this plant's cultivation area. However, it has been reported that the aesthetic and ornamental value of petunias can suffer significant economic losses due to thrips infestation.

Four species: *Frankliniella occidentalis* Pergande, *Thrips tabaci* Lindeman, *Thrips palmi* Karny and *Scirtothrips dorsalis* Hood, all of the family *Thripidae*, are the most economically important species in nurseries because of their widespread distribution, highly polyphagous life cycle, strong ability to transmit viruses and severe damage to crops. (Morse & Hoddle, 2006; Wu et al., 2018, 2021; Vîrteiu et al., 2022).

Damage caused by their feeding can have a negative impact on world trade due to the quarantine risks associated with some of the species (Kumar et al., 2012). In order to apply the most effective control strategy, it is important to know which thrips species are present in the nursery. So, the aim of this study was to determine the preference for different coloured traps of *Thripidae* assemblages present in *Petunia hybrida* varieties in Timiș County, Western Romania nurseries, as well as their structure and abundance.

MATERIALS AND METHODS

Sampling of thrips for species identification was carried out at commercial bedding plant greenhouses near Timișoara, Western Romania (latitude: 45°50'16"N; longitude: 21°06'02"E; altitude: 99 m above sea level). The greenhouse was managed conventionally and ornamental plants were grown on tabletops in small pots covering a total of 98 m^2, of which *Petunia hybrida* plants covered 21 m^2.

Crop management included the use of bio-stimulants and fertilizers such as Algaren Twin (25 ml/10 l water) mixed with MagicP Star (10 ml/10 l water) at transplanting; King Life 12 - 48 - 8 + Mg (10 g/10 l water) and Calfomyth (35 ml/10 l water) at 10-15 days after transplanting; two further treatments with Drin (15 ml/10 l water), Foliacon 22 (25 ml/10 l water) and King Life 30 - 10 - 10 + Mg (7-10 ml/10 l water) at 10-15 days after the first treatment; King Life 20 - 20 - 20 (7-10 g/l water) and Calfomyth (35 ml/10 l water) at bud burst; King Life 8 - 5 - 40 + Mg (10 ml/10 l water); Algaren Twin (15 ml/10 l water) and Calfomyth (35 ml/10 l water) at flowering; while no chemical pest control was applied.

Seasonal and temporal sampling of thrips adults and larvae was used. Thrips samples were taken from the leaves and flowers of 12 varieties of *Petunia hybrida*, namely: 'Tropical', 'Beautical Mix 2', 'Calipetite Mix 1', 'Calipetite Mix 2', 'Contrast Mix 1', 'Purple Picotee', 'Double Red', 'Cream Picotee', 'Cherry Pop', 'Bicolor Yellow Red', 'Orange Bouquet' and 'Pink Bouquet'. Three double-sided sticky traps of different colours: blue, yellow and orange (10.2 × 20.5 cm in size) were placed at a distance of 0.5 m from each other in the middle of each plot/petunia variety. Each plot consisted of 30 petunias (Parnea et al., 2018; Vîrteiu et al., 2018; Muntean & Grozea, 2021; Vîrteiu et al., 2021). As the thrips species spread differently in the nursery, 3 traps (one trap/colour) per petunia variety were evenly distributed around the perimeter of a plot (Figure 1).

Figure 1. Sampling by the sticky trap method

The traps were attached to a cable so that their lower edge was 10-15 cm below the tops of the plants (Vîrteiu et al., 2022). Traps were monitored and replaced every 10-15 days (all over sampling period) and repeated seven times between February and May 2023 (sampling dates: 20 February, 6 March, 22 March, 8 April, 24 April, 8 May and 22 May). After removing the coloured sticky traps, they were wrapped in clear plastic cling film and transported to the laboratory for thrips count (Pobozniak et al., 2020).

All specimens of thrips were identified to the species level according to the standard identification keys provided by Mound and Marullo (1996), Cluever & Smith (2017). Once the data had been processed, the insects were preserved by preparing slides as follows: 50 specimens were randomly selected from each trap, 25 from each side of the trap (a solvent was used to remove the specimens - HistoClear II - so as not to damage them), and then mounted on slides using Canada balsam as a mounting medium. If less than 50 thrips were present per trap, as in the first part of the collection, all were removed and identified.

RESULTS AND DISCUSSIONS

Thrips populations collected from petunia plants, under controlled conditions, were not very high in comparison to other open ecosystems (agricultural crops, pastures, groves). Virteiu et al. (2015) highlighted the presence of 12 thrips species on rose flowers, and Bărbuceanu & Vasiliu - Oromuru (2002) also collected a number of 12 thrips species on ornamental plants in the southern part of the country. In the climatic conditions of the western part of the country, other authors (Parnea et al., 2018; Virteiu et al., 2018) highlighted between 8 and 15 thrips species on oat and winter wheat. Some experimental parameters, such as: plant density, plot size and plot type had an important role in the development of thrips populations. The research carried out by Alvi et al (2021) showed that increasing row spacing leads to an increase in the density and number of thrips species, while the research carried out by Belder et al (2002) on a series of 43 agricultural landscape plots showed that the number of different thrips species was significantly lower in agricultural fields with a larger total area compared to woodland, which reduces the density of thrips and their symptoms.

Due to the specific microclimate, the taxonomic spectrum of thrips species was relatively rich and diverse. Thus, the collected material revealed a numerical abundance of 498 specimens: 394 of these were adults and 144 were larvae of different ages. From a taxonomic point of view, the diversity of the thrips species was reflected in the relatively high number of species identified on petunias - 6 species: *Frankliniella intonsa* (Hinds), *Frankliniella occidentalis* (Pergande), *Frankliniella schultzei* (Trybom), *Scirtothrips dorsalis* Hood, *Thrips palmi* Karny and *Thrips tabaci* Lindeman.

Of these species, 2 were the most abundant in the sample: *Frankliniella occidentalis* with an average of 5.11 specimens/traps and *Thrips tabaci* with average specimens/traps of 4.86, while *Frankliniella schultzei* presented the fewest specimens (0.083 specimens/traps). The remaining 3 species (*Frankliniella intonsa, Scirtothrips dorsalis* and *Thrips palmi*) were moderately abundant with an average of 2.13, 1.55 and 0.75 specimens/ traps. This particular climate had an impact on the specific structure of the thrips species. *Thrips dorsalis* Hood and *Thrips palmi* Karny, mesophile species, were collected for the first time from petunias in western Romania in early May, when temperatures in the greenhouse increased considerably.

Table 1. Thrips species structure in relation to *Petunia hybrida* plants

Thrips species	N*	Mean*	Std. Deviation	95% Confidence Interval for Mean		Min. *	Max. *	H'*
				Lower Bound	Upper Bound			
Frankliniella occidentalis	36	5.1111	4.01979	3.7510	6.4712	0.00	14.00	2.39
Frankliniella intonsa	36	2.1389	3.22626	1.0473	3.2305	0.00	12.00	0.00
Frankliniella schultzei	36	0.0833	0.36839	-0.0413	0.2080	0.00	2.00	0.00
Thrips tabaci	36	4.8611	4.49859	3.3390	6.3832	0.00	17.00	2.43
Thrips palmi	36	0.7500	1.85742	0.1215	1.3785	0.00	8.00	0.00
Scirtothrips dorsalis	36	1.5556	1.90405	0.9113	2.1998	0.00	6.00	0.00
Total	216	2.4167	3.53882	1.9421	2.8913	0.00	17.00	1.46

ANOVA	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	801.944	5	160.389	17.816	.000
Within Groups	1890.556	210	9.003		
Total	2692.500	215			

* N - number of samples analysed; Mean - mean number of specimen/ sample; Min. - minimum number of specimens/ sample; Max - maximum number of specimen/ sample; H' - Shannon Diversity Index

The data in Table 1 underline the existence of significant differences between number of specimens and thrips species ($F=17.816$, $p=0.000<0.05$).

Analysis of thripsofauna composition revealed the constant presence of *Frankliniella occidentalis* and *Thrips tabaci* in all samples, with different population sizes and the highest structural index values. *Thrips tabaci* and *Frankliniella occidentalis* had the highest values (2.43-2.39). This high index highlights the significant differences between the species constituting the thrips fauna. The species *Frankliniella schultzei, Thrips palmi, Scirtothrips dorsalis, Frankliniella intonsa* had the lowest value. This highlights the sporadic occurrence of these species in the samples and also reflects a dynamic fauna, as these polyphagous species do not only attack the petunias, but also the other plant species present in the greenhouse.

The negative binomial distribution of this group of insects was also evidentiated by the numerical values of the comparative indices between the species that make up the associations of thrips on petunia inflorescences.

From an ecological point of view, the fauna of the *Thripidae* on petunia inflorescences was dominated by species that are typically floriphagous, among which *Frankliniella occidentalis, F. intonsa* and *Thrips tabaci* stand out. *Frankliniella schultzei* was present accidentally, probably because the associated plants growing around the greenhouse allowed this species to develop.

Vîrteiu et al. (2022) reported that all 6 thrips species were associated with *Petunia hybrida* varieties in nurseries in the western part of Romania. All the six species were affiliated to: three species with *Frankliniella* genus (*F. occidentalis, F. intonsa, F. schultzei*), two species with the genus *Thrips* (*T. tabaci* and *T. palmi*), one species with the *Scirtothrips* genus and, considering the survey reported by Funderburk et al. (2007), they were collected from almost all ornamental greenhouses.With regard to *Frankliniella occidentalis* being the most abundant species in petunias in greenhouses, Bărbuceanu & Vasiliu-Oromulu (2012) highlighted that this species is now present in most greenhouses in Romania, eliminating another thrips species from these protected areas, as *Heliothrips haemorrhoidalis* (Heeger), *Thrips dianthi* (Priesner), *Parthenothrips dracaenae* (Heeger), *Heliothrips feromoralis* (Renter). *T. tabaci* has been described to be a polyphagous and cosmopolitan species (Vîrteiu et al., 2015), with the second highest occurrence in the petunia studied and in all 12 varieties. *Scirtothrips dorsalis* and *Thrips palmi* are also reported to be present on the flowers of ornamentals (Vasiliu-Oromulu, 2002). With the exception of one species, *Frankliniella intonsa*, which is strongly xerophilic, the fauna of this group of insects is dominated by mesophilic species in terms of climatic preferences. The increased temperatures in early May did not affect the mesophilic species that continued to occur in the samples, although some of them occurred sporadically.

Table 2. Analysis of multiple comparisons between different species of thrips

	Thrips species	Number of samples analysed	Subset	
			1	2
Tukey HSD[a,b]	*Frankliniella schultzei*	36	0.0833	
	Thrips palmi	36	0.7500	
	Scirtothrips dorsalis	36	1.5556	
	Frankliniella intonsa	36	2.1389	
	Thrips tabaci	36		4.8611
	Frankliniella occidentalis	36		5.1111
	Sig.		0.069	0.999

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 9.935.
a. Uses Harmonic Mean Sample Size = 36.000.
b. Alpha = 0.05.

A statistically significant relationship between the thrips species was found using the Tukey HSD test (Table 2). Therefore, any numerical change in thrips species composition was causally related to a change in one of the individual species values.

When analysing the abundance of thrips species in the 12 varieties of petunia included in the study, it was found that the variety with the highest abundance of thrips species was 'Calipetite Mix 2' with an average of 3.77 and a standard deviation of 4.023, followed by 'Double Red' with an average of 3.38 and a standard deviation of 4.81 (Table 3). The varieties with the least thrips infestation were

'Pink Bouquet' with an average of 1.33 individuals and a standard deviation of 2.72 and 'Cream Picotee' with an average of 0.88 individuals and a deviation of 2.16. The analysis of the variation in the number of thrips individuals caught did not show any significant differences in relation to the petunia variety (f=1.301, p=0.226>0.05).

Table 3. Average number of thrips (±SE) specimens in relation to petunia varieties

Petunia varieties	N*	Mean	Std. Deviation	95% Confidence Interval for Mean		Min. *	Max. *	D'*
				Lower Bound	Upper Bound			
Tropical	18	3.6667	4.39251	1.4823	5.8510	0.00	14.00	0.267
Beautical Mix 2	18	2.7222	3.17723	1.1422	4.3022	0.00	11.00	0.246
Calipetite Mix 1	18	1.7778	2.62467	0.4726	3.0830	0.00	7.00	0.271
Calipetite Mix 2	18	3.7778	4.02281	1.7773	5.7783	0.00	14.00	0.199
Contrast MIx 1	18	2.7778	3.65506	0.9602	4.5954	0.00	12.00	0.216
Purple Picotee	18	1.6667	2.80755	0.2705	3.0628	0.00	8.00	0.209
Double Red	18	3.3889	4.81589	0.9940	5.7838	0.00	17.00	0.247
Cream Picotee	18	0.8889	2.16629	-0.1884	1.9662	0.00	9.00	0.053
Cherry Pop	18	1.6667	2.40098	0.4727	2.8606	0.00	7.00	0.204
Bicolor Yellow Red	18	2.5000	3.79241	0.6141	4.3859	0.00	11.00	0.330
Orange Bouquet	18	2.8333	4.34200	0.6741	4.9926	0.00	11.00	0.298
Pink Bouquet	18	1.3333	2.72246	-.0205	2.6872	0.00	9.00	0.222
Total	216	2.4167	3.53882	1.9421	2.8913	0.00	17.00	0.263

ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	176.500	11	16.045	1.301	.226
Within Groups	2516.000	204	12.333		
Total	2692.500	215			

* N - number of samples analysed; Mean - mean number of specimen/ sample; Min. - minimum number of specimens/sample; Max - maximum number of specimen/ sample; D' - Simpson's Index

Possible causal relationships between thrips and petunia plants were revealed by Simpson's index analysis using the observed thrip-flower associations in petunia (n = 2.4167), which we considered as potential explanatory variables (Table 3 and Figure 2). for the abundance of the major thrips species in petunia.

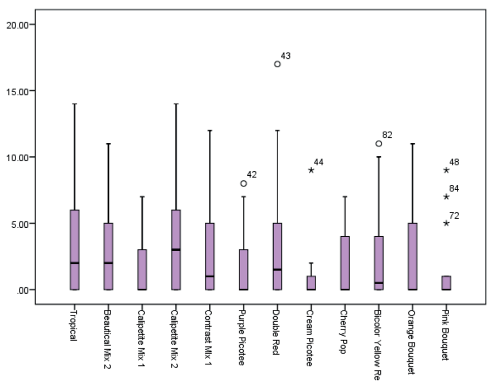

Figure 2. Graphical representation of the average thrips number related to petunia variety

All six thrips species were observed in all 12 *Petunia hybrida* varieties studied, but at different frequencies, suggesting that thrips prefer different petunia plant varieties. The value of Simpson's D ranges from 0 to 1, with 0 representing infinite diversity and 1 representing no diversity, so the larger the value of D, the lower the diversity (Mound, 2018). The results of calculating the diversity index (D) of thrips species were found to be 0.263 (D close to 0). These results suggest that thrips diversity is moderate to high in examined petunia varieties. The highest diversity values were recorded for 'Cream Picotee' (D= 0.053) and the lowest for 'Bicolor Yellow Red' (D= 0.330). The most suitable host varieties or those with moderate diversity of thrips pests were 'Calipetite Mix 2', 'Cherry Pop' and 'Purple Picotee'.

A further - and most important - aim of the research was to highlight the colour preferences of the different species of thrips. Coloured sticky traps are one of the most useful and effective tools available for the collection of insect pests, including thrips. Colour attractiveness and the rate at which thrips are captured depend on the type of plant (Kirk, 1984) and the colours of the traps (Beckham, 1969; Cho et al., 1995). In 2023, more than 48.93% of the specimens were attracted by the yellow traps, the remaining were attracted by orange - 17.6% and blue - 33.47%.

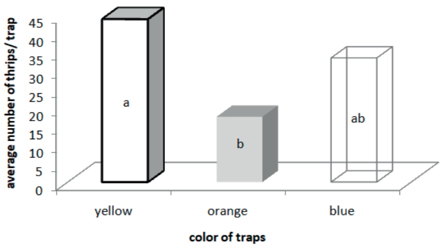

Figure 3. Average number of thrips specimens caught by the colour traps
(Columns denoted by different letters are significantly different at a significant level $p < 0.05$)

Although the yellow traps attracted the highest number of specimens ($F=39.398$, $p=0.000<0.05$), followed by the blue traps, significant differences were observed depending on the colour of the trap; these differences were found between the yellow-blue ($p=0.000$) and the yellow-orange ($p=0.000$) traps. The blue traps and the orange traps attracted the specimens to a certain degree in different ways. No significant difference was found between the attractions of the two colours (Figure 3). Thrips show a greater phototactic response to yellow colour compared to other colours (Thongjua et al., 2015). The effective attraction of thrips to yellow traps in this study is in line with studies conducted by researchers on a number of crops (Jenser et al., 2001; Vîrteiu et al., 2022).

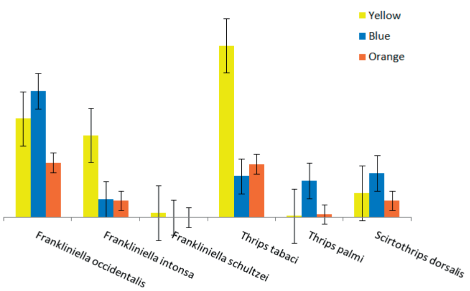

Figure 4. Mean proportions (± SE) of different thrips species caught on petunia plants with coloured sticky traps

Yellow sticky trap at 15 cm attracted more thrips, including *Thrips tabaci*, the species considered to be an economically important pest of ornamentals and vegetables. The greatest attraction of the thrips to the yellow sticky trap was observed for two other species of thrips: *Frankliniella intonsa* and *Frankliniella schultzei* (Figure 4).
Other reports (Cho et al., 1995; Elekçioğlu, 2013) have also shown that the average number of adult thrips caught in blue sticky traps was usually higher than that in yellow sticky traps. Three species preferred blue sticky traps: *Frankliniella occidentalis*, *Thrips palmi* and *Scirtothrips dorsalis*. Our results under conditions of relatively high densities of *F. occidentalis* are consistent with those of Robb (1989) and Seo et al. (2006), who found that blue traps attracted more *Frankliniella occidentalis* than other colors (like green or white) in an ornamental glasshouse. The present research is partially similar to that of Cho et al. (1995), who indicated that blue sticky traps were preferred by *Frankliniella occidentalis* and *Thrips tabaci*, followed by white sticky traps; and contrasts with the results obtained by Hoddle et al. (2002), who indicated that white sticky traps were preferred by *Frankliniella occidentalis*. The orange traps were the least effective.

CONCLUSIONS

With 6 species identified, the study revealed a high taxonomic diversity.
The most abundant species were *Frankliniella occidentalis* and *Thrips tabaci*.
Structural indices show a dynamic fauna, most species collected being polyphagous.
The *Thripidae* fauna hosted by the petunia inflorescences was dominated by species that are typically floriphagous and, at the same time, dominated by species that are mesophilic.
'Calipetite Mix 2' variety was preferred by thrips among the petunias studied, at the same time, 'Cream Picotee' variety was the least affected by thrips species.
The yellow proved to be the most reliable colour for monitoring thrips populations.
Orange and blue could be used with weaker, but still reasonable effectiveness.

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