

# Optimizing monitoring strategies for *Lamprodila festiva* L. (Buprestidae, Coleoptera): Insights from a two-year field study

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**Toma D. Tötös Ş., Vasian I., Bălăţenoiu F., 2026.** Optimizing monitoring strategies for *Lamprodila festiva* L. (Buprestidae, Coleoptera): Insights from a two-year field study. Ann. For. Res. 69(1):171-182.

**Abstract** Recent studies have shown that the cypress jewel beetle, *Lamprodila festiva* L. (Buprestidae, Coleoptera), a species native to the Mediterranean region, has significantly expanded its range and become a major pest of ornamental Cupressaceae species in many urban areas and nurseries. Often, new outbreaks of this pest are identified based on damage caused by the larvae on host plants. However, this type of identification can be lethal for the host species, which often dries up partially or completely. Therefore, the development of effective detection and monitoring methods, as well as a better understanding of adult flight dynamics, is essential for pest management. To monitor this pest of Cupressaceae species, a two-year field experiment was conducted in a nursery located near Bucharest, Romania, using sticky traps (coated on both sides with adhesive) in green and yellow colours, together with dispensers containing host volatile compounds. The trapping schemes were as follows: green unbaited, green baited, yellow unbaited and yellow baited. A total of 2,231 *L. festiva* specimens were captured, revealing differences in trap performance among treatments. Females represented a very small proportion of the total catch (approximately 3%) in both study years. Green traps were the most effective in capturing adults, while the use of host volatile-based lures did not affect the mean number of individuals captured per trap. Both sexes showed clear responses to trap colour, with males being more strongly attracted to green traps, while females exhibited a preference for yellow traps. Under the climatic conditions of the study area, adult flight activity began at the end of May and lasted until the first decade of August. The main flight activity occurred in June in both years, while from late July onwards a marked decline in the mean number of adults captured per day was observed. The results contribute to a better understanding of *L. festiva* flight dynamics and support the use of green sticky traps as a practical monitoring tool in ornamental nurseries and urban plantings of Cupressaceae.

**Keywords:** *Lamprodila festiva*, visual cues, olfactory cues, host volatiles, sticky traps.

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**Manuscript:** received February 6, 2025; revised June 29, 2026; accepted June 30, 2026.

## Introduction

Urban green spaces play essential ecological, economic, aesthetic, and social roles (Nowak & Crane 2002, Nowak et al. 2007, Bowler et al. 2010, Maes et al. 2019, Raum et al. 2023), contributing significantly to improving human health (Jackson 2003, Wolf et al. 2020). However, urban conditions such as pollution, the heat island effect, insufficient irrigation, soil compaction, and climate change subject trees and shrubs to high levels of stress, reducing their ability to provide aforementioned services (Gunawardena et al. 2017, Maes et al. 2019, Czaja et al. 2020, Ordóñez et al. 2023). Additionally, insect pests can cause severe damage through defoliation, leaf discoloration, tunnelling beneath the bark or within the wood, and pathogen transmission, often leading to partial or total dieback of urban trees (Dreistadt et al. 1990, Sjöman & Östberg 2019, Raum et al. 2023).

The Cupressaceae family, the most widespread group of gymnosperms globally (Brown 2018), is extensively planted for ornamental purposes in many European urban areas (Monroy-Colín et al. 2020, Ciani et al. 2021, Popovych 2023). Beyond their aesthetic importance, certain Cupressaceae species demonstrate a higher capacity to capture particulate matter, unsafe to human health (Lin et al. 2017, Baesso Moura et al. 2024), compared to broadleaf species due to their complex foliar structures, acting as natural filters (Beckett et al. 1998, Beckett et al. 2000, Freer-Smith et al. 2005). However, recent studies highlight that the pollen of some Cupressaceae species is a major source of respiratory allergies in winter, particularly in the Mediterranean region (Charpin et al. 2019, Gomes et al. 2019, Velasco-Jiménez et al. 2020). Nonetheless, certain Cupressaceae species, such as *Thuja occidentalis* L., exhibit significant resilience to urban stress conditions due to their adaptability to diverse environmental and climatic factors (de Blois & Bochar 1995, Yezhezhepova et al. 2024).

Recently, *Lamprodila festiva* (Linnaeus, 1767) has caused considerable damage to ornamental Cupressaceae species in various European urban areas (Razinger et al. 2013, Schmidt et al. 2014, Volkovitsh & Karpun

2017, Jendek et al. 2018, Ruicănescu & Stoica 2019, Ruseva et al. 2020, Kereši 2020, Musolin et al. 2022, Vîrteiu et al. 2022, Khachikov et al. 2023) as well as in nurseries (Nitzu et al. 2016, Ruseva et al. 2020, Toma et al. 2023) and arboreta (Shiryaeva 2019, Ruseva et al. 2020).

This buprestid is naturally common in Mediterranean countries, where it develops on native Cupressaceae species (Bily 2002, Volkovitsh & Karpun 2017, Keszthelyi & Somfalvi-Tóth 2024). Its shift to ornamental Cupressaceae species has facilitated its range expansion, largely through trade in ornamental plants (Nitzu et al. 2016, Musolin et al. 2022), reaching Central and Eastern Europe (Volkovitsh & Karpun 2017, Królik et al. 2023, Keszthelyi & Somfalvi-Tóth 2024). Currently, *L. festiva* is regarded as a significant pest of Cupressaceae species in many countries (Keszthelyi & Somfalvi-Tóth 2024) and is included in the EPPO Global Database (EPPO 2026). In Romania, its presence was first recorded in the 1950s–1960s in Mehedinți County (Ruicănescu & Stoica 2019). The first report of the insect in urban areas occurred in 2014 in two nurseries near Bucharest (Nitzu et al. 2016). Since then, dieback of ornamental Cupressaceae species caused by *L. festiva* has become increasingly frequent in urban areas and nurseries (Bunescu & Florian 2019, Ruicănescu & Stoica 2019, Vîrteiu et al. 2022, Toma et al. 2023, Bunescu et al. 2024). These reports indicate a progressive expansion of the species in Romania, highlighting the need for effective detection and monitoring methods, as well as a better understanding of the seasonal flight activity of the species under local climatic conditions.

Currently, the detection of the pest relies on identifying damage to host species, including larval galleries beneath the bark and the characteristic oval exit holes of adults (Musolin et al. 2022, Toma et al. 2023). However, detection based on visible damage is often too late to save the host tree, which frequently dries partially or entirely. Early identification of the pest provides critical time to implement measures that reduce infestation impact (Imrei et al. 2020, Liebhold et al. 2023). Determining

the onset and flight period of adults is equally crucial for timing control efforts (Duan et al. 2024). Numerous studies have demonstrated that Buprestidae species are attracted to specific visual and olfactory cues (Oliver et al. 2004, Lelito et al. 2007, Domingue et al. 2011, Poland et al. 2011, Domingue et al. 2013, Petrice & Haak 2015, Santoiemma et al. 2024). Matula et al. (2023) tested *L. festiva*'s response to different visual cues, achieving promising results using sticky traps. Nevertheless, several studies indicate that combining visual and olfactory attractants can increase captures of Buprestidae species (Poland et al. 2011, Crook et al. 2012, Domingue et al. 2013, Ryall et al. 2015).

In this context, given the increasing importance of *L. festiva* as a pest of ornamental Cupressaceae species in nurseries and urban green spaces, the present study aimed to evaluate the response of adults to four trapping schemes based on visual and olfactory cues. In addition to assessing trap performance, the flight dynamics of *L. festiva* were investigated

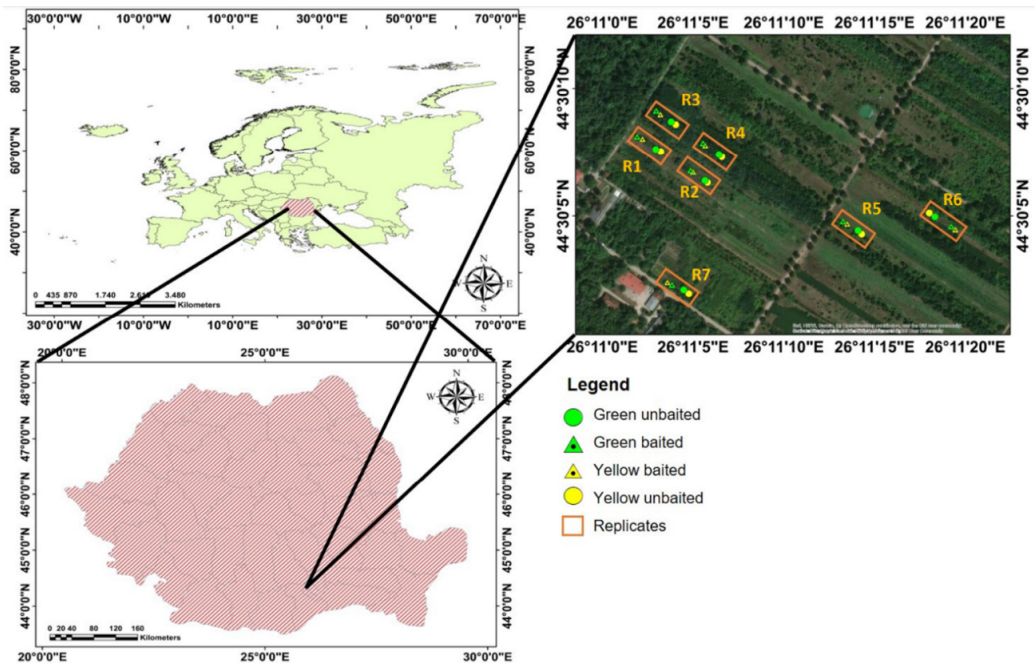
under the climatic conditions of southeastern Romania, as this varies with climatic conditions (Ruicănescu & Stoica 2019, Keszthelyi & Somfalvi-Tóth 2024).

## Materials and Methods

### Study area

The study was conducted during two consecutive years (2024–2025) in the Ștefănești Nursery, Voluntari, Ilfov County (GPS Coordinates: 44°30'7"N, 26°11'14"E) (Figure 1).

The nursery lies in the Romanian Plain and is characterized by an average annual temperature of 10.3°C, annual precipitation of 555.1 mm, and 66% air humidity (Ionescu et al. 2017). Here are hosted numerous ornamental plant species and varieties, and the presence of *L. festiva* was first recorded in 2021, subsequently causing significant damage to Cupressaceae ornamental species, particularly those of the genus *Thuja* (Toma et al. 2023).



**Figure 1** Location of the study area in southeastern Romania. The figure illustrates the geographical position of the Ștefănești Nursery, Voluntari, Ilfov County, where the experiment was conducted during 2024–2025.

## Trapping schemes and beetles sampling

To assess the response of *L. festiva* to visual stimuli, yellow and green colours were used, as these have proven effective in capturing other Buprestidae species (Crook et al. 2009, Francese et al. 2010a, Petrice & Haack 2015). For olfactory cues, chemical compounds were selected based on Bozsik et al. (2022), who analysed *L. festiva* antennae responses to various host volatiles emitted by *Thuja occidentalis*. These compounds were selected because electrophysiological studies demonstrated antennal responses of *L. festiva* adults to host volatiles, suggesting a potential role as attractants or synergists enhancing responses to visual stimuli. Unbaited traps relied exclusively on visual cues, whereas baited traps combined visual stimuli with host volatile compounds.

Based on the observations reported by Keszthelyi and Somfalvi-Tóth (2024) regarding the onset of adult flight, traps were deployed at the end of May in both study years. In 2024, traps were installed on 21<sup>st</sup> of May, whereas in 2025 deployment took place on 30<sup>th</sup> of May. A total of seven replicates, 28 traps in total, were established in 2024. In 2025, the number of replicates was reduced to five (R1–R5) (Fig. 1), corresponding to 20 traps, due to the removal of a portion of the heavily infested host trees. In both years, each replicate consisted of four trap variants: (i) green unbaited, (ii) green baited, (iii) yellow unbaited, and (iv) yellow baited.

The traps and dispensers used in the experiment were supplied by the "Raluca Ripan" Institute for Research in Chemistry in Cluj-Napoca. The coloured sticky panels measured 420 x 297 mm and were coated with adhesive on both sides. The dispensers consisted of a heat-sealed, semi-permeable polyethylene bag (115 x 50 mm, 0,05 mm wall thickness) with a piece of PES filter (40 x 60 mm) inserted as the carrier substrate. The sachet lures were loaded with 1,2 ml of a mixture of (-)- $\beta$ -pinene, (-)- $\alpha$ -pinene, (-)-limonene, (+)-limonene, terpinen-4-ol, and (-)-fenchone in proportion of 2:1:1:1:1:2. The average release rate was 52 mg/day for 21 days and was determined by measuring weight loss at room temperature (22 °C). All the chemicals used were purchased from Sigma Aldrich and their purity was >98%.

According to Matula et al. (2023) method and the preference of the adults to fly in the upper sunny canopy of the host species (Ruicănescu & Stoica 2019), the coloured sticky traps were placed on the branches of Cupressaceae species at approximately 2 m from the ground with a south orientation.

To ensure that the pheromones from baited variants would not interfere with the unbaited ones, the variants were grouped in pairs per replicate: yellow unbaited with green unbaited and yellow baited with green baited. The distance between baited and unbaited variants was at least 25 m (Figure 2), and the distance between the seven replicate was at least 50 m.

The coloured sticky traps were replaced every 6 weeks and the dispensers were replaced every 3 weeks until the end of the experiment. These replacement intervals were chosen to maintain adhesive efficiency and ensure a relatively constant release rate of volatile compounds throughout the monitoring period.

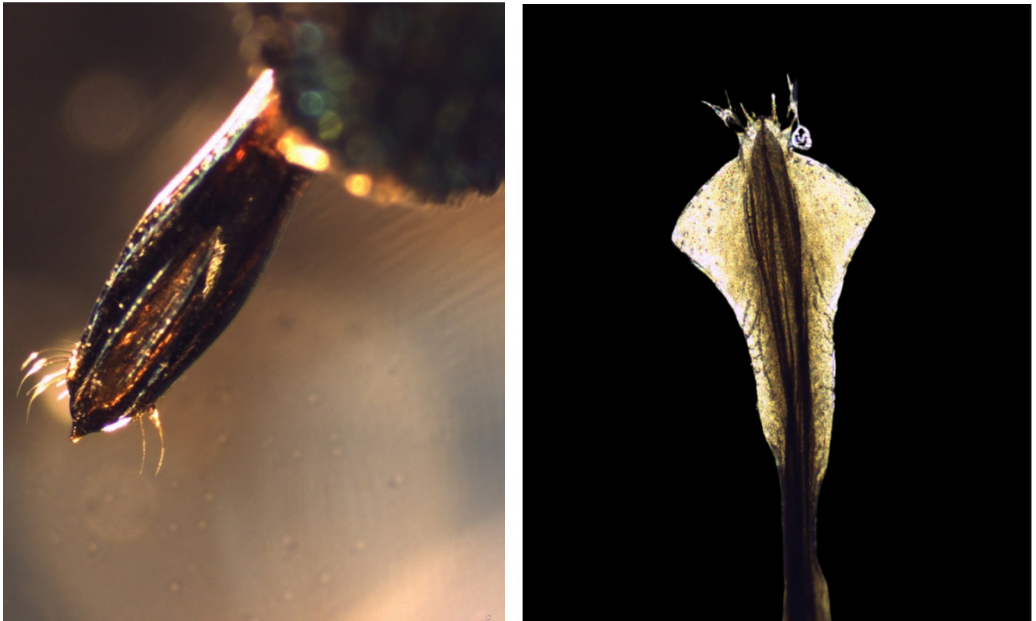
Considering that the adult insect's activity period varies, with some studies suggesting May–June (López-Pérez 2016, Pedersoli 2016, Jendek et al. 2018), and others observing adults in July (Bily 2002, Matula et al. 2023), or even August (Nitzu et al. 2016, Kereši 2020), all traps were inspected 3 weeks after the last recorded capture.

Specimens caught in the four variants were collected every 6–10 days after the experiments were set up. Collections were carried out after 18:00, when flight activity ceases (Ruicănescu & Stoica 2019). All Buprestidae individuals captured in each variant were gathered, placed in labeled containers, and stored in a freezer at a constant temperature of -5 °C until laboratory analysis. Other insect species trapped on the traps were removed during each inspection.

In the laboratory, the entomological material was first cleaned of adhesive using gasoline. Subsequently, target species *L. festiva* specimens were sexed based on their genitalia (Ruicănescu & Stoica 2019) (Fig. 3) and inventoried based on variant, replicate, and collection date. The identification and sexing of *L. festiva* specimens were performed using a Leica MZ6 stereo zoom microscope.



**Figure 2** Experimental arrangement of sticky traps used to evaluate the response of *Lamprodila festiva* adults to visual and olfactory cues: (I) green and yellow unbaited traps relying exclusively on visual stimuli, (II) green and yellow traps baited with host volatile compounds.



**Figure 3** Sex determination of *Lamprodila festiva* adults: male aedeagus (I) and female ovipositor (II).

## Data analysis

Considering that the collections were conducted at irregular intervals, the daily average number of captures was calculated to provide a more accurate representation of the insect's flight intensity over time. This was done by dividing the total number of specimens identified by the number of days corresponding to each interval. To evaluate the efficiency of the different types of traps used, the average number of captures recorded on each collection date was analysed for each trap type.

Flight activity was analysed separately for each study year due to differences in trap deployment dates and sampling schedules. In contrast, trap performance analyses were conducted using the combined dataset from both years, as the same trap designs, colours, attractants, and study site were used throughout the experiment.

Initially, data normality was assessed using the Shapiro–Wilk test, while homogeneity of variances was evaluated with Levene's test. As the data did not meet the assumptions of normality and homogeneity required for parametric analyses, non-parametric statistical methods were applied. Differences between treatments were therefore evaluated using the Mann–Whitney U test. Primary data processing was conducted using Excel (Microsoft Corp., Redmond, Washington, WA, USA). Normality, homogeneity, and statistical differences were tested with STATISTICA 8.0 software (Weiß, 2007).

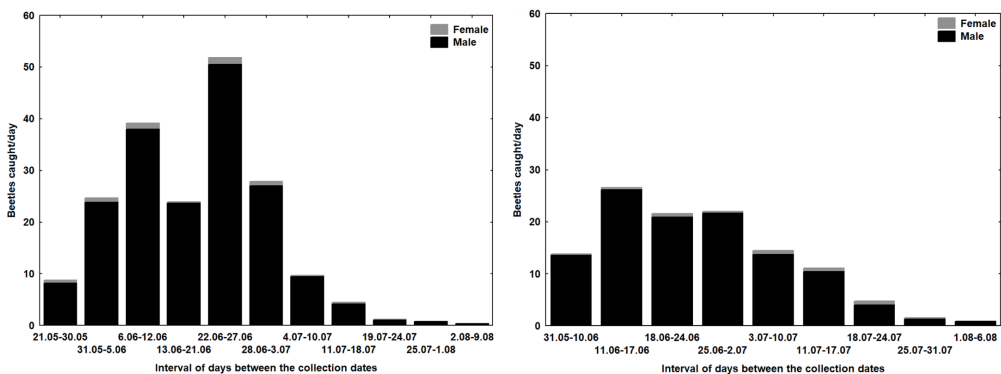
## Results

### Dynamics of insect flight

Over the two-year study period, a total of 2,231 *L. festiva* adults were captured using the trapping schemes employed. Specifically, 1,323 individuals were collected in 2024, whereas 908 adults were captured in 2025, despite the lower number of replicates used during the second year. In both years, captures were strongly male-biased, with females accounting for only 3% of the total catch. A total of 40 females were recorded in 2024 and 32 in 2025.

The mean number of adults captured per day varied throughout the flight season in both years (Figure 4). In 2024, the most intense flight activity was recorded between 31<sup>st</sup> of May and 3<sup>rd</sup> of July, accounting for more than 80% of all individuals captured on sticky traps. Two distinct flight peaks were identified. The first occurred between 6<sup>th</sup> and 12<sup>th</sup> of June, with an average of 39 adults captured per day, while the second and most pronounced peak was recorded between 22<sup>nd</sup> and 27<sup>th</sup> of June, with an average of 52 adults captured daily. From late July onwards (24<sup>th</sup> of July), flight activity declined markedly, with fewer than one individual captured per day.

Although the sampling dates differed slightly between years, a similar seasonal pattern was observed in 2025. Approximately 86% of all



**Figure 4** Seasonal flight activity of *Lamprodila festiva* adults recorded on sticky traps during the 2024 (I) and 2025 (II) monitoring seasons. Values represent the mean number of adults captured per day between consecutive sampling dates.

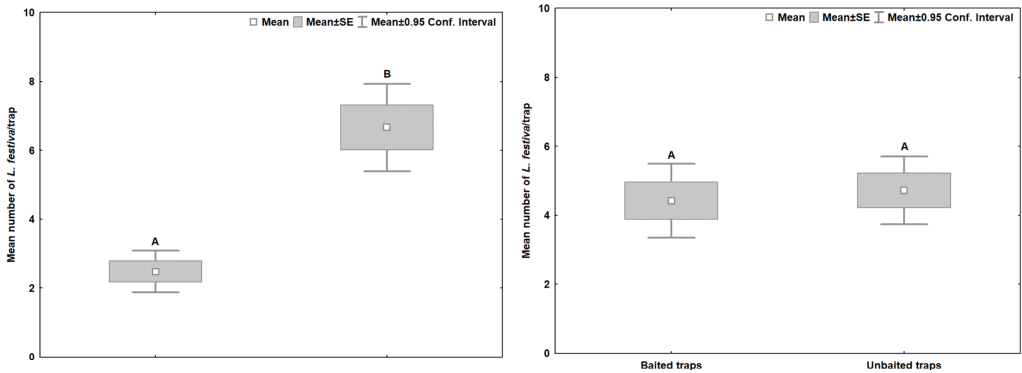
captured adults were recorded by the first half of July (10<sup>th</sup> of July). Likewise, captures declined sharply from late July, when the mean number of adults captured per day dropped to approximately one individual. However, unlike in 2024, no clearly defined flight peaks were observed. The highest capture rates were recorded during mid and late June, specifically between 11<sup>th</sup> and 17<sup>th</sup> of June with an average of 26.5 adults per trap and between 25<sup>th</sup> of June and 2<sup>nd</sup> of July with an average with 22 adults per trap.

**Influence of trap design on *Lamprodila festiva* captures**

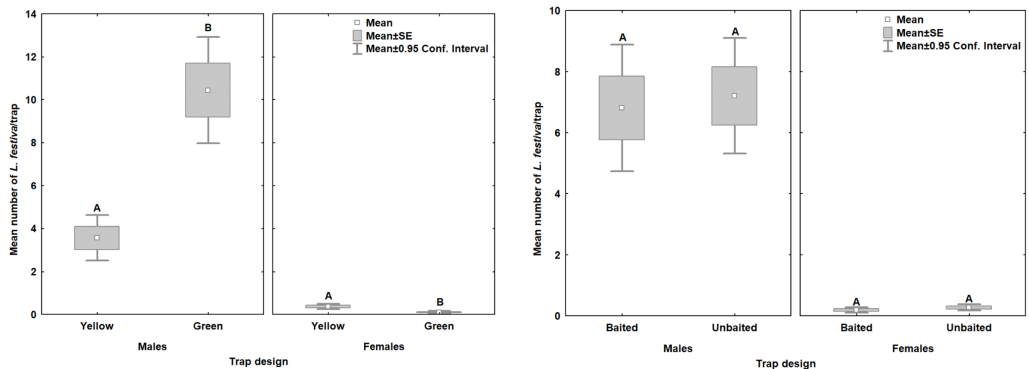
The average number of *L. festiva* adults captured was influenced by trap design (Figure 5). Regarding trap colour, the mean number of insects captured

on green traps ( $6.66 \pm 0.65$ ) was significantly higher ( $U = 23045.50, p < 0.05$ ) than that recorded on yellow traps ( $2.48 \pm 0.31$ ) (Figure 5a). While colour played an important role in the capture of *L. festiva* adults, the same cannot be said for the dispenser used in this study (Figure. 5b). Although no statistically significant differences were observed ( $U = 27182.50, p = 0.08$ ), the results indicate that baited panels recorded a lower mean number of captures ( $4.42 \pm 0.55$ ) compared to unbaited traps ( $4.72 \pm 0.50$ ).

Both male and female *L. festiva* responded significantly to trap colour ( $U = 8991, p < 0.05, U = 10068, p < 0.05$ ) (Figure 6I), whereas no significant response to host volatile dispensers was detected ( $U = 11460, p = 0.601, U = 11226, p = 0.418$ ) (Figure 6II). The two sexes showed



**Figure 5** Mean number of *Lamprodila festiva* adults captured according to trap colour (I) and the presence or absence of host volatile attractants (II) during the 2024–2025 monitoring period. Means followed by different letters differ significantly ( $p < 0.05$ ).



**Figure 6** Mean number of male and female *Lamprodila festiva* adults captured according to trap colour (I) and the presence or absence of host volatile attractants (II). Means followed by different letters differ significantly ( $p < 0.05$ ).

different preferences for trap colors. Males were more attracted by green traps, with a mean of 10.45 ( $\pm$  1.26) males per trap, significantly higher than 3.56 ( $\pm$  0.53) mean males recorded on yellow traps. Females, although fewer in number, showed a preference for yellow traps, with a mean of 0.36 ( $\pm$  0.06) females per trap, significantly higher than the mean on green traps (0.10  $\pm$  0.03).

## Discussion

Over the past two decades, *L. festiva* has undergone significant range expansion in Europe, particularly due to its adaptation to ornamental Cupressaceae species (Keszthelyi & Somfalvi-Tóth 2024). The insect's life cycle and flight period vary depending on climatic conditions. In its natural habitat, *L. festiva* completes one generation in 1–2 years (Bily 2002), and its flight period generally extends from April to August (Keszthelyi & Somfalvi-Tóth 2024). However, in colder climates, development can take up to four years (Nitzu et al. 2016), with a correspondingly shorter flight period (Keszthelyi & Somfalvi-Tóth 2024).

Under the climatic conditions of the study area, the first adults were observed on sticky traps at the end of May in both years, with flight activity lasting until the first decade of August. In both 2024 and 2025, the peak flight activity of the insect was recorded in June, findings that align with the results of Keszthelyi & Somfalvi-Tóth (2024), who reported similar patterns in terms of flight onset, duration, and peak in the climatic niche of this region. The observed flight period is consistent also with the observation made by Nitzu et al. (2016). However, it differs from the findings of Bunesco et al. (2024), who reported peak flight activity during July–August, and Jendek et al. (2018), who recorded peak activity from May to June. It is worth noting that previous studies primarily relied on visual observations of adults flying near host species. However, it should be noted that the flight activity of species belonging to the family Buprestidae

is strongly influenced by temperature, with maximum dispersal occurring at the highest daily temperatures (Bonsignore & Bellamy 2007). Therefore, differences between the flight patterns observed in the present study and those reported in previous investigations may be explained, at least in part, by differences in temperature during the monitoring periods. Furthermore, in addition to the lower number of traps employed in 2025, climatic conditions, particularly temperature, may also have contributed to the absence of clearly defined flight peaks during the second monitoring season.

Regarding the traps used, in this experiment, green unbaited traps proved to be the most effective, capturing the highest number of *L. festiva* adults throughout the study period. Green traps have generally been more efficient in capturing Buprestidae species compared to other colors, a finding corroborated by studies in Europe (Domingue et al. 2013, Brown et al. 2017, Rhainds et al. 2017, Santoiemma et al. 2024) and North America (Francese et al. 2010, Francese et al. 2013, Santoiemma et al. 2024). Matula et al. (2023) also reported similar results over two years, with green sticky traps capturing more *L. festiva* adults than multifunnel traps. However, transparent sticky traps outperformed green ones in the first year of their study.

Interestingly, most of the captures in the present study were males (approximately 97%), primarily on green traps. Females, though fewer in number, showed a preference for yellow traps. A different response to visual stimuli in males and females has been observed in the invasive North American species *Agrius planipennis* Fairmaire, where males are more attracted to green traps, and females to purple ones (Francese et al. 2010a, Francese et al. 2010b, Francese et al. 2013, Poland et al. 2019). Poland et al. (2019) suggested that females prefer purple because its spectrum resembles ash tree bark, where eggs are laid, while males are drawn to green as it mimics the leaves of host species.

Likewise, fertilized females of *L. festiva* search for suitable sites to lay eggs, while males spend more time flying to locate mates (Ruicănescu & Stoica 2019). While it cannot be conclusively stated that the yellow hue used mimics the bark of Cupressaceae species to attract females, the high number of males captured could result from their increased activity during the flight period. Additionally, the significantly higher number of males on green traps may be due to the green color resembling the elytra of females, potentially misleading males searching for mates.

It is noteworthy that neither males nor females exhibited a preference for pheromone-baited sticky traps. Although not statistically significant, the average number of males and females was higher on unbaited traps of both colors. For *Agrilus planipennis*, the addition of host volatile compounds to traps significantly increased captures (Crook et al. 2008, Marshall et al. 2010, Poland et al. 2011, Crook et al. 2012, Ryall et al. 2012). Duan et al. (2024) suggested that *Agrilus* species rely on plant-produced volatile compounds for host selection over long distances, while visual cues become dominant at shorter ranges when the host is in proximity.

Similarly, *L. festiva* may exhibit comparable host-selection behavior. Given that the sticky traps were placed on host branches, the lack of increased attraction to host volatiles suggests the need to explore alternative combinations or identify a specific sex pheromone, as in the case of *A. planipennis* (Silk et al. 2015, Silk et al. 2019). Host volatile-based lures are generally less effective than pheromone-based ones for target species (Liebhold et al. 2023). Nevertheless, exploiting the visual sensitivity of *L. festiva* by using green sticky traps can be an efficient method for capturing adult stages of this pest. However, only two trap colours were evaluated in the present study, and it cannot be excluded that other colors may provide even greater attraction.

Future research should therefore investigate

a broader range of visual stimuli to optimize detection methods. In addition, further studies should evaluate other semiochemical attractants, including potential sex pheromones, which may improve the effectiveness of monitoring programs. The incorporation of climatic variables, particularly temperature-based degree-day models, may also contribute to a more accurate characterization of adult flight phenology and help optimize the timing of trap deployment and control measures. Furthermore, although the study was conducted over two consecutive years, long-term monitoring would improve our understanding of the influence of annual climatic variability on adult flight activity and trap performance.

## Conclusions

This study highlighted significant differences in the response of the pest *Lamprodila festiva* to various trap designs.

The green traps were found to be the most effective in detecting *Lamprodila festiva* adults. However, this result was influenced by the predominance of males (97% of the total captures), which preferred green traps to yellow ones. In contrast, yellow traps were more effective for capturing females.

The addition of host volatile-based pheromones did not increase the capture levels, the baited traps recording fewer captures than unbaited ones.

Under the environmental conditions of the study area, adult activity began in late May and lasted until early August, with maximum flight intensity in June.

## Acknowledgments

This research was supported by the Ministry of Research, Innovation and Digitalization of Romania through the National Core Programme, project PN 23090102, and by a grant of the Ministry of Research, Innovation and Digitalization, CNCS/CCCDI-UEFISCDI, project number PN-IV-P8-8.1-PRE-HE-ORG-2025-0339, within PNCDI IV.

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