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RESEARCH ARTICLE

Efficiency of Using LED Traps in Phytosanitary Monitoring of the Pyraustidae (Insecta, Lepi-Doptera) Family Representatives

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ABSTRACT

Several species of the Pyraustidae family are widespread phytophagous insects that cause significant damage to agricultural crops worldwide. Among them, the European corn borer (Ostrinia nubilalis (Hb.)) and the meadow moth (Loxostege sticticalis L.) are particularly harmful and are found in many regions, including the Russian Federation. Effective control of these pests requires reliable monitoring tools to assess population dynamics and predict outbreaks. This study evaluated the efficiency of light traps for monitoring key Pyraustidae pests. The research was conducted from 2021 to 2023 on three farms in the central zone of Krasnodar Krai, a region where economically important phytophages threaten crops such as maize, soybean, sunflower, tomato, and pepper. During peak reproduction periods, pest infestations in this area can result in crop losses exceeding 60%. Light traps designed by the Federal Research Center of Biological Plant Protection (FSBSI FRCBPP) were deployed throughout the growing seasons, and data were processed and analyzed in 2024–2025. The results confirmed the high efficiency of light traps in attracting Pyraustidae species, particularly O. nubilalis. The abundance of these species was closely linked to the intensity of maize crop rotations, while overall population dynamics were influenced by prevailing weather conditions. These findings highlight the importance of integrating light traps into pest monitoring systems to support timely decision-making and crop protection strategies. In conclusion, light traps based on super-bright LEDs proved to be an effective tool for faunistic and ecological monitoring of Pyraustidae species, offering valuable prospects for improving integrated pest management in crop production.

INTRODUCTION

A number of agricultural crops (soybeans, sunflowers, corn and others) are susceptible to damage by a complex of phytophages and polyphages, including representatives of the superfamily Pyraloidea, which numbers about 9,000 species in the world fauna and about 200 species in Russia. The superfamilies Pyraloidea constitute a group of small to medium-sized butterflies of various colors and include five families: Galleriidae, Crambidae, Phycitidae, Pyralididae and Pyraustidae (Mathew, Menon, 1984). In the southern regions of Russia, 56 species from the family Pyraustidae (Shchurov, Lagoshina, 2013) have been identified so far. The most dangerous pests of the Pyraustidae family include the European corn borer (*Ostrinia nubilalis* (Hb.)) and the meadow moth (*Loxostege sticticalis* L.), which can lead to yield losses of up to 60% (Malysh et al., 2021; Tărău et al., 2024) and lead to plants mortality of up to 100% (Kacar et al., 2023). In addition to Russia (Afonin et al., 2014), these species cause harm all over the world: in Africa (Kacar et al., 2023; Massoud et al., 2016), Europe (Anderbrant et al., 2024; Runno-Paurson et al., 2024), Asia, Australia (Cheng et al., 2023; Zhang et al., 2023,) and in America (Al-Danoon, Mohanty, 2023).

Taking into account the high prevalence and harmfulness of these butterflies and modern achievements in various fields of science and production, the work is underway to find the most

effective means of monitoring and control of these species (Frolov et al., 2020; Grushevaya et al., 2019; Nowinszky et al., 2018), including using remote sensing from orbiting satellites (Kara et al., 2023). The conducted research using light traps designed by the FSBSI FRCBPP on various crops in Krasnodar Territory revealed their high efficiency in attracting a number of species of the Pyraustidae family, made it possible to assess their numbers and study the dynamics of development (Pachkin et al., 2022a; 2022b; 2022c; Moghavvemi et al., 2025).

The European corn borer or the corn moth – *Ostrinia nubilalis* (Hübner, 1796) inhabits large-stemmed cultivated, wild and weed plants, such as *Artemisia* spp., *Xanthium* spp., *Echinochloa crusgalli*, *Bidens* spp., *Ambrosia artemisiifolia*, etc. The caterpillars damage corn, millet, hemp, hops, pepper, sorghum, soybeans, cotton, etc.

The meadow moth – *Loxostege sticticalis* (Linnaeus, 1761) belongs to a group of particularly dangerous polyphagous pests that become especially harmful during the periods of increased numbers and mass reproduction, which occur in cycles of 10-12 years. It inhabits more than 200 species of wild and weed plants, on which populations persist and develop in phases of population decline and depression (Temreshev et al., 2023; Jam et al., 2025: Mansoor et al., 2025; Abbas et al., 2025). The greatest damage is caused to sugar beet, perennial legumes, sunflower, pea, hemp, corn, and vegetable crops.

The study is aimed at the efficiency assessment of the light traps of a conical design, developed by the FSBSI FRCBPP for attracting the Pyraustidae family representatives. It is also of interest to study the dependence of the distribution and preservation of various Pyraustidae species in the agroecosystem depending on crop rotation, as well as their flight and abundance depending on weather conditions.

MATERIALS AND METHODS

The research was carried out on three farms in the central zone of Krasnodar Territory of Russia during the growing seasons of corn, soybean, and sunflower during 2021 - 2023. The processing of the obtained data and analysis were carried out in 2024-2025. The studies used light traps made by the Federal State Budgetary Scientific Institution "Federal Research Center of Biological Plant Protection" (FSBSI FRCBPP) (Pachkin et al., 2019; 2021a; 2021b). The device is an autonomous mobile system for monitoring and mass trapping of insects that respond to light (Figure 1). The design of the device uses LED strips with ultraviolet radiation (UVA) with the 400 nm wavelength and 360 illumination angles (Pachkin et al., 2021a)

At night, the source of ultraviolet light attracts crepuscular and nocturnal insect fauna. Insects collide with smooth transparent plates, fall onto the inner surface of the cone and into the cavity of the cylinder, and then into the insect receptacle. To obtain reliable results, three light traps were used, which were installed at a distance of 100 meters from each other. Counts were carried out once a week throughout the entire growing season of the crops under study. Identification of insects was carried out using the morphological method with the participation of the staff of the Department of Phytopathology, Entomology and Plant Protection of the Kuban State Agrarian University (Russia, Krasnodar) using special guidelines (Bey-Bienko, 1965; Gornostaev, 1990; Klyuchko et al., 2003; Ler, 1992; Mamaev, 1972; Mamaev et al., 1972; Negrobov, Chernenko, 1990).

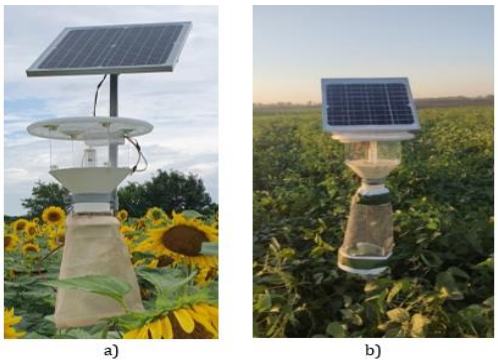

Figure 1: Light trap of conical design: a) – with a fine-mesh insect receptacle, b) – with a separating insect receptacle (FSBSI FRCBPP, Krasnodar, 2023 orig.)

Weather conditions during the research period (2021-2023) were different (Figure 2). The analysis shows a particularly strong excess of the average precipitation in 2022 in the central zone of Krasnodar Krai: in the third part of July, with an average annual norm of 10 mm, 144 mm were recorded; in the second part of August – 70 mm compared to the norm of 16 mm. During the same period, a decrease in precipitation was observed, in comparison with the long-term average data, from the second part of March to the second part of May. The amount of precipitation in 2023 corresponded to the long-term average values, except for the first and third parts of July, where an increase in precipitation was noted (Figure 2).

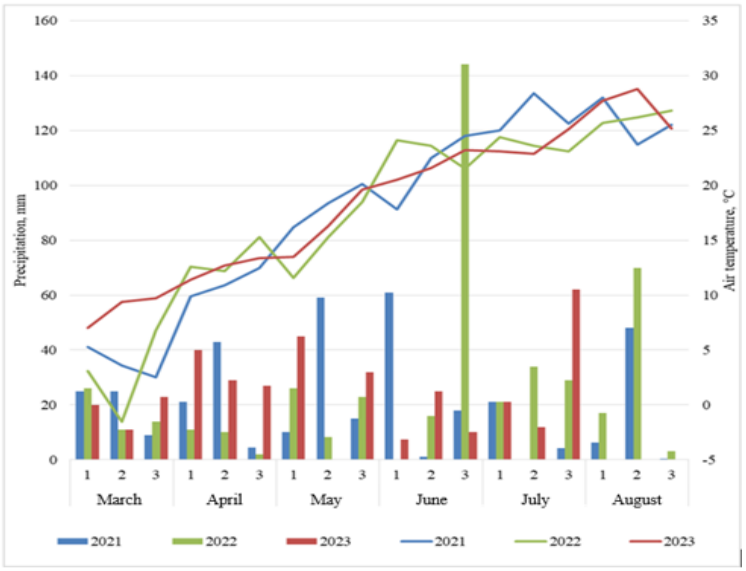

Figure 2: Weather conditions in the central part of Krasnodar Krai during the research period 2021-2023

RESULTS AND DISCUSSION

The study of the agroecosystem's fauna using light traps made it possible to note the stable and effective attraction of representatives of the Pyraustidae family living in agrocenoses. As a result of the research, the phenology of such economically important species as the European corn borer *Ostrinia nubilalis* (Hubner, 1796), the meadow moth *Loxostege sticticalis* (Linnaeus, 1761), as well as indifferent phytophages – *Sitochroa verticalis* (Linnaeus, 1758) and *Nomophila noctuella* (Denis & Schiffermuller, 1775).

In 2021, maximum flight peaks of *L. sticticalis* were noted in soybean crops in the second part of July and the second part of August, when the number of butterflies reached an average of 785 individuals per trap (Figure 3). The maximum abundance of *S. verticalis* reached 245 individuals per trap, *O. nubilalis* – 172 individuals per trap, *N. noctuella* – up to 44 individuals per trap. The high abundance of *O. nubilalis* on soybeans is due to the saturation of crop rotations with corn crops (Figure 3).

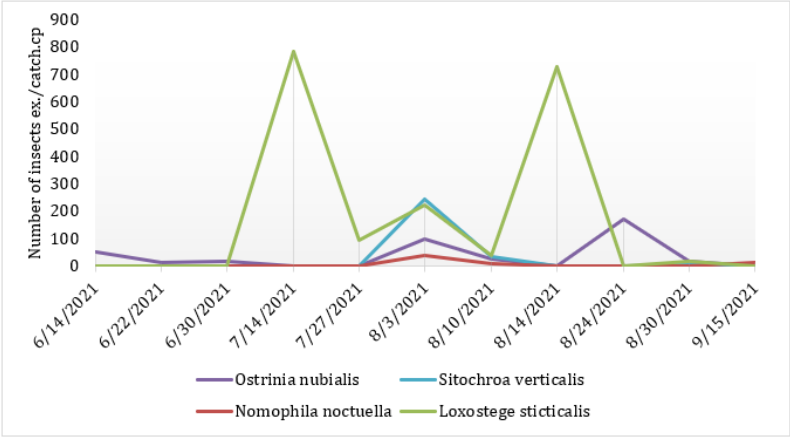

Figure 3: Dynamics of the number of Pyraustidae representatives in soybean crops in 2021

The obtained data revealed the high efficiency of attracting these species of Pyraustidae and allowed us to consider this type of light trap as a successful monitoring tool.

In 2022, the research aimed at determining the effectiveness of light traps in attracting Pyraustidae was continued in sunflower crops (Figure 4).

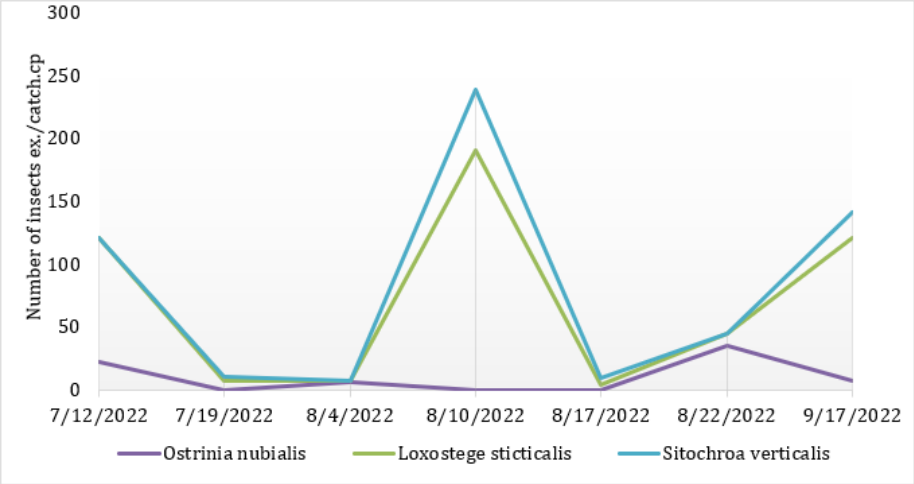

Figure 4: Flight dynamics of Pyraustidae representatives in sunflower crops in 2022

In 2022, a peak in the abundance of *L. sticticalis* was observed on sunflower at the end of the first part of August, which is associated with the peculiarities of weather conditions that influence all development stages of this species. The number of butterflies at the peak of flight reached more than 190 ind./trap in average. The peak flight of *S. verticalis* - up to 250 ind./trap was noted in the same period, which confirms the conclusions about the predominant influence of abiotic factors. The maximum number of insects of the species L. sticticalis up to 35 specimens/trap was noted in the second ten days of August.

In 2023, the research on soybean and sunflower was continued. A significant decrease in the number of *L. sticticalis* in sunflower crops was noted - up to 12 ind./trap in the third part of August in comparison with the data from 2021-2022, which amounted to slightly more than 1.5% of the number in previous years. The number of *S. verticalis* and *O. nubilalis* was also reduced, while the number of *N. noctuella* increased significantly in the first peak of abundance - up to 26 ind./trap (Figure 5).

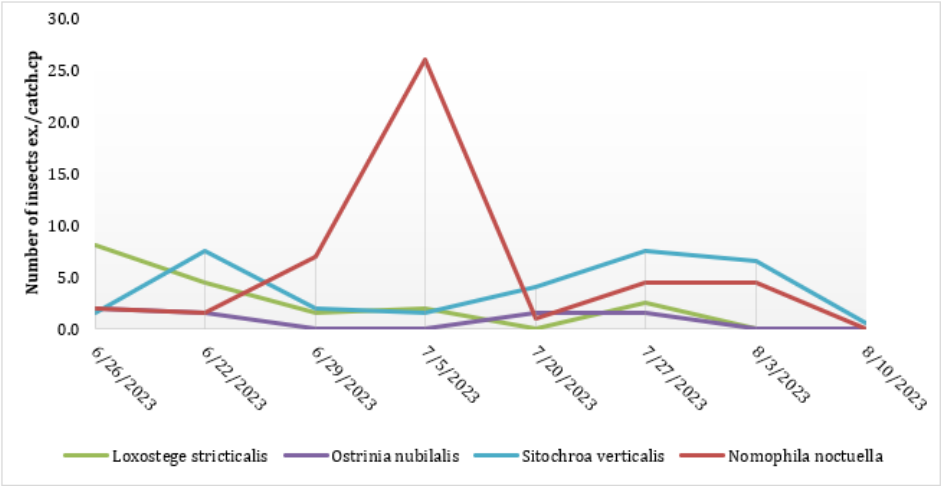

Figure 5: Dynamics of the number of Pyraustidae representatives in sunflower crops in 2023

During the same period, the same trend towards a decrease in the abundance in traps of *L. sticticalis*, *S. verticalis* and *N. noctuella* was noted on soybean - less than 10 ind./trap relative to *O. nubilalis* - up to 840 ind./trap, but we explain this phenomenon by migration of butterflies from adjacent corn crops (Figure 6).

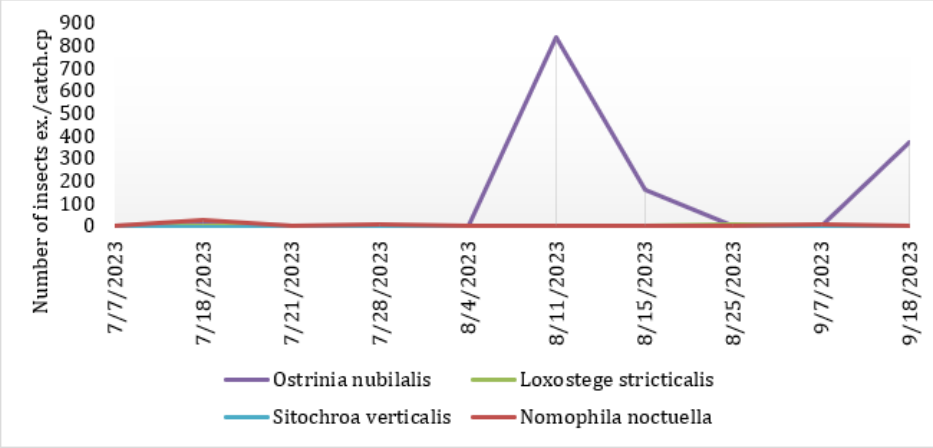

Figure 6: Dynamics of the number of Pyraustidae representatives in soybean crops in 2023

The reasons for the low number of Pyraustidae representatives in 2023 compared to 2021-2022, in our opinion, were unfavorable weather conditions, which not only significantly affected the development time of all generations of butterflies, but also significantly reduced the number of each generation, practically eliminating the peaks.

CONCLUSIONS

To summarize, it can be concluded that light traps are highly effective for faunal and environmental monitoring of Pyraustidae. A species such as *O. Nubilalis* is dependant on its main forage crops; its numbers are highly dependent on the saturation of the crop rotation with corn. The remaining species, as wider polyphagers that can also develop on weeds, are much less dependant on crop rotation. A serious dependence of all Pyraustidae species on weather conditions has been revealed. Moreover, it manifests itself not only directly in the year of influence, shifting the timing of the development of generations, but also the next year after abnormal weather conditions.

Abbreviations Used

Federal State Budgetary Scientific Institution (FSBSI), Federal Research Center of Biological Plant Protection (FRCBPP), Ultraviolet A (UVA), light-emitting diode (LED).

Authors Contributions

PIB: conceptualization, research, writing the manuscript, data analysis and interpretation; KOYu: managerial work, investigation, funding acquisition; PAA: research, data analysis and interpretation, writing the manuscript; LDO: research, analysis.

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Competing Interests

The authors have declared that no competing interests exist.

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