MEALYBUGS (*HEMIPTERA: PSEUDOCOCCIDAE*) – MAJOR PESTS OF INDOOR BELGIAN MUMS

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Abstract. *The citrus mealybug (Planococcus citri, Hemiptera: Pseudococcidae) is one of the most economically important pests of indoor plants worldwide. Due to the optimal conditions for mealybugs in greenhouses, they can overwinter at all stages of development, causing particular problems for growers. The attack of Planococcus citri affects the quality of Belgian mums through sap extraction and contamination with honeydew secretions. Feeding by citrus mealybug results in wilted, distorted and yellowed chlorotic leaves, premature leaf drop, stunted growth and, occasionally, death of the infested plants or parts of plants. In this context, the suitability of the Belgian mum as a host for the citrus mealy bug was investigated in this study. At Sânmihaiul Român (Timiș County, Romania), between September and October 2024, the abundance and damage levels, as well as some morphological characteristics (original images are shown) of this pest species were recorded. A magnifying lens was used to examine infested plants in the greenhouse. Infested branches, leaves and flowers were collected from the Belgian mums over a period of 45 days in the autumn months of the years 2024. For further examination in the laboratory, the samples were placed separately in paper bags. The taxa were then identified according to the methods described in the literature, by examination of the adult citrus mealybug. Mealybug populations per leaf were lower at the beginning of the trial (first ten days of September) than during the rest of the trial. There was a gradual increase in the mealybug population, which peaked in the second decade of September and continued into October in the first decade. The moderately hot and humid climate in the greenhouse during the collecting period was favourable for the pest to develop.*

Keywords*: mealybugs, Planococcus citri, Belgian mums, attack, greenhouse*

INTRODUCTION

The ornamental horticulture industry has been through a period of dramatic change as a result of the growth in global trade. Ornamental plants are widely used for cut flowers, in landscaping, for potted flowers and in the home garden (VILLAGRAN et al., 2023). Roses, chrysanthemums, carnations, orchids, gerberas, freesias, lilies, gladioluses and ranunculus are among the major ornamental flowers that dominate the global flower market (MEKAPOGU et al., 2022).

As ornamental plants are highly valued for their visual appearance, every effort is made to obtain a quality product. One of the main problems associated with loss of quality during cultivation is pests such as mealybugs (CARVALHO et al., 2013).

Mealybugs (*Hemiptera: Coccoidea: Pseudococcidae*) are a diverse group of plant sap-sucking insects with major economic impact worldwide (FRANCO et al., 2001; WANG et al., 2016; LOPES et al., 2019), infesting a variety of horticultural, ornamental and agricultural crops (GARCIA MORALES et al, 2016; SUBRAMANIAN et al., 2021; PIRITHIRAJ et al., 2021). With approximately 2,012 described species in more than 273 genera belonging to 74 families, it is the second largest family of scale insects worldwide (BEN-DOV et al., 1993; CHOI & LEE, 2022; OLIVEIRA et al., 2023). They are direct pests that feed by sucking on almost any part of the plant, from roots to fruit. By transmitting plant diseases, mealybugs also damage plants indirectly (WILLIAMS, 2004; SOYSOUVANH et al., 2015; HERRBACH et al., 2016; MANI & SHIVARAJU, 2016).

The mealybugs comprise about 140 species in Europe, most of which are polyphagous (BEN-DOV et al., 2006, 2015). In Romania the mealybug fauna is poorly known, TEODORESCU (2018) mentions the presence of 15 species of invasive mealybugs in Romania between 1859 and 2018.

According to research by MAROCICO et al. (2021), 3 new species have been reported in Western Romania, accidentally introduced into greenhouses as a result of the trade in ornamental trees, shrubs and flowers. Of these, *Planococcus citri* has been reported on over 200 host plant species belonging to 191 genera and 82 botanical families (TEODORESCU & MATEI, 2010; ÖZTÜRK et al., 2022). New shoots and leaves of a wide range of indoor plants are attacked, including: C*itrus limon*, *Citrus aurantifolia "aranciata"*, *Strelitzia reginae*, *Anthurium andraeanum*, *Ficus microcarpa*, *Ficus benjamina*, *Ficus americana* subsp. *guianensis* (MAROCICO et al., 2021).

The presence of *Planococcus citri* on Belgian mums (*Chrysanthemum indicum*) in Romania is reported for the first time. Due to the optimal conditions for citrus mealybugs in greenhouses, they can overwinter at all stages of development, causing particular problems for growers. The attack of *Planococcus citri* affects the quality of Belgian mums through sap extraction and contamination with honeydew secretions. Feeding by citrus mealybug results in wilted, distorted and yellowed chlorotic leaves, premature leaf drop, stunted growth and, occasionally, death of the infested plants or parts of plants (NOHA & SHAABAN, 2010; DAANE et al., 2012).

Considering the destructive nature of citrus mealybugs, the aim of this study was to identify the most prevalent mealybug species in Western Romanian greenhouses on the basis of morphological characteristics and to obtain new biological information on their impact on Belgian mum plants (the abundance and damage levels).

MATERIAL AND METHODS

Survey and data collection

The research was carried out in a 1600 m² greenhouse located in Sânmihaiu Roman, in the western part of Romania (latitude: 45°43'12"N; longitude: 21°06'48"E; altitude: 85 meters above sea level), where Belgian mums were grown in hanging pots. Within this area, 320 m² exhibited signs of pest infestation.

To manage the crop effectively, a variety of fertilizers were utilized: Osmocote, Peters Excel, Universol Blue, Peters Professional, and Cropmax. Osmocote was used during planting to ensure a controlled release of nutrients. During the vegetative growth phase, Peters Excel (15-5-15 at 100 ppm) was administered weekly via irrigation, while Universol Blue (18-11-18 at 150 ppm) was applied every two weeks to enhance root and leaf growth. At the stage of bud development, Peters Professional (20-20-20 at 100 ppm) was introduced, and Cropmax (10 ml per 10 liters of water) was utilized as a foliar spray every two to three weeks to boost the overall vitality of the plants.

In the greenhouse of Sânmihaiul Român, samples of citrus mealybugs were collected throughout the season compress between September and October 2024 (over a period of 35 days), by visual sampling on three plants/20 branches with leaves and flowers, using a magnifying lens. Three sampling areas have been set up. While the attack was localized in the first module of the greenhouse, which consisted of 3 rows and was therefore represented by the 3 sampling areas, from each row were randomly selected, each time other Belgian mum plants.

Specimens and parts of infested plants (branches, leaves and flowers) were collected in labeled plastic bags. The weekly observations made in each area were focused on the following aspects: quantifying the mealybugs colonies present, framing the population level at each observation and finally establishing the level and abundance curve. A quantification survey method was adopted following Muntean & Grozea (2021). In addition, male/female adults and nymphs were measured separately for number of specimens/colonies. A total of ten colonies were the subject of each analysis.

Slide mounting and identification

In the laboratory, for preparation of slides and scanning light microscopy, the specimens were individually picked from the host plants using a very fine brush moistened with 70% alcohol and preserved in 70% alcohol. Specimen preparation methods were in accordance with Bahder et al. (2015).

For the morphological identification, the main taxonomic characters of the adult and the nymphus were evaluated and quantified according to the following determination key of COX & BEN-DOV (1986), WILLIAMS (2004) and KAYDAN & GULLAN (2012).

Descriptive notes

Planococus citri - the most important morphological characteristics and original pictures:

Male: All male species under study were represented by macropterous forms. The body consists of a well-defined head, thorax and abdomen, covered with fleshy setae. In general, males are narrow and slender, 0.9 - 1.23 mm long, 0.2 - 0.3 mm wide at the mesothorax and 0.2 - 0.3 mm wingspan; light brown in colour, with a much darker thorax and a blackish tinge to the wings. Short waxy filaments are visible around the edges of their body, with a slightly longer pair of filaments present at the rear end of their body. The antennae are filiform, usually 10-segmented, but sometimes two or more adjacent segments of the flagellum are fused together or are incompletely separated. Forewings membranous, large and elongate, rounded distally and narrow basally; the entire wing surface (except for the alar lobe area) is uniformly covered with minute hairs, microtrichia. Hind wings modified into small, elongated, membranous hamulohalterae, supported along their anterior margin by a weak, slender hamulohalteral ridge (figure 1 A - D). There are three pairs of well developed legs, which are of variable length and stoutness (AFIFI, 1968).

Female: The adult female has an oval body; white, pinkish colored, wingless, dorsum covered with white cottony wax and has a fringe of elongated wax filaments running around the periphery of the body (18 pairs of distinct cerarii); length 2.63 mm and width 1.6 mm. Antennae 8-segmented. Dorsal setae stout; circulum quadrate; ventral oral collar with tubular canals between the antennae, more than five. Normally developed legs (figure 1 E - H), with tarsus and claws without denticles, hind coxae and tibia with translucent pores (ELHAM et all., 2019).

Nymphs: the nymphs resembles the female, but are smaller. The first instar is a very active one and is called a crawler. Nymphs are pinkish-yellow in color (figure 1 I - J) and are often found clustered on the egg sac or around porous glands on plants (KERNS et al., 2004).

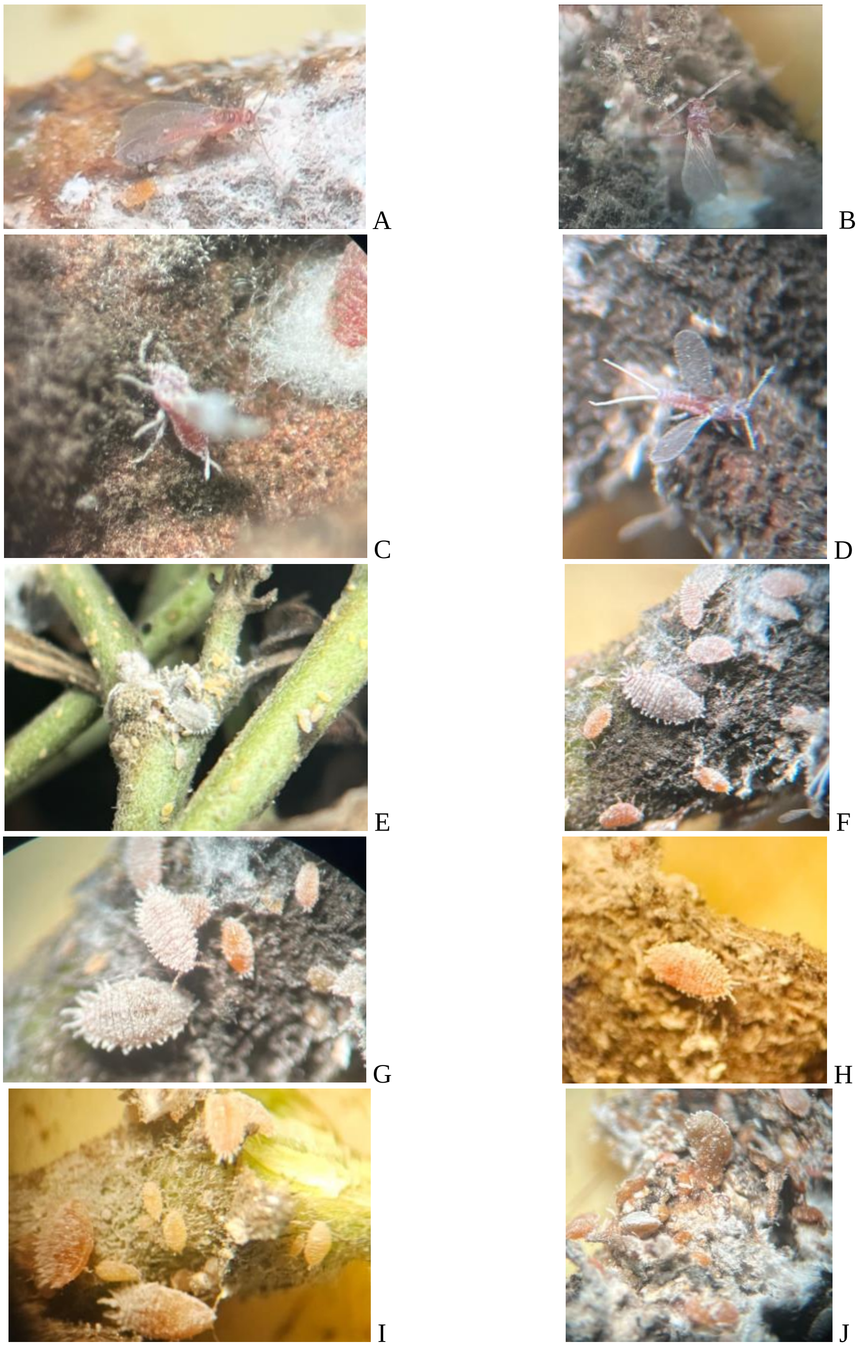

Fig. 1. *Planococcus citri* – A – D – male; E – H – female; I – J - nymph colonies on Belgian mums in Sânmihaiu Roman greenhouse
(orginal photos by Julean & Virteiu, 2024)

RESULTS AND DISCUSSIONS

During this study, a total of 1645 *Planococcus citri* colonies were collected from Belgian mums. Of these colonies, only ten were analysed and a total of 196 adults (male and female) (sex ratio ♂:♀=1: 0.87) and 252 nymphs were counted and identified (table 1).

Table 1.

The number of *Planococcus citri* detected on Belgian mums in Sânmihaiu Roman greenhouse, September/ October 2024

Planococcus citri	**∑X**	**Mean ± SD**	***P-value***	***Lower 95.0%***	***Upper 95.0%***
Male	105	10.5 ± 0.26	0.742874	-0.71048	0.531238
Female	91	9.1 ± 1.44	0.091928	-0.59597	6.230805
Nymphs	252	25.2 ± 13.69	0.971764	-31.8922	32.8972

In each of the ten colonies analyzed, the analysis of the variation in the number of adults (male and female) and nymphs caught showed no significant differences in relation to the Belgian mum plants (f=1.905, p=0.091 – 0.971>0.05).

Favourable conditions for reproduction and expansion of *Planococcus citri* colonies are indicated by the presence of a large number of nymphs and an almost equal sex ratio.

Although only 10 colonies were analysed, an extension of the study to a larger number of colonies would have a clearer picture of the overall population structure.

Table 2.

The sex ratio and its effect on the offspring (nymphs)

Pairwise Comparisons		$\mathbf{HSD_{.05} = 15.1569}$ $\mathbf{HSD_{.01} = 19.4294}$	$\mathbf{Q_{.05} = 3.5064}$ $\mathbf{Q_{.01} = 4.4948}$
Male:Female	$M_1 = 10.50$ $M_2 = 9.10$	1.40	Q = 0.32 (*p* = 0.97153)
Male: Nymphs	$M_1 = 10.50$ $M_3 = 25.20$	14.70	Q = 3.40 (*p* = 0.05864)
Female: Nymphs	$M_2 = 9.10$ $M_3 = 25.20$	16.10	Q = 3.72 (*p* = 0.03568)

Using the Tukey HSD test, a statistically significant relationship was found between *Planococcus citri* females and nymphs (Table 2). Therefore, any numerical change in citrus mealybugs composition was causally related to a change in one of the individual species values. The variation in the number of females had a low to moderate effect on the development of the nymphs and the relationship was linear.

Thus, nymph abundance in the samples had a positive low to moderate correlation with female number (r=0.323), meaning that 32.3% of the variation in nymph abundance is explained by female number variation (Fig. 2).

The results were in agreement with the results of other authors. MARTINEZ FERRER ET AL. (2023) mention that when flights are consecutive, there is always a significant relationship between the abundance of adults (male and female) among each other. Between 25% and 40% of the variability in the abundance of adults corresponds to common factors, while the rest is due to specific factors related to the particulate crops and to the year.

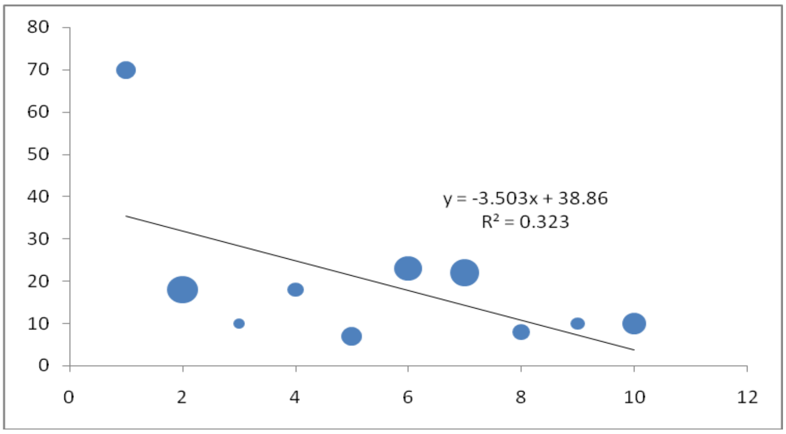

Fig. 2. Liniar regression between number of adults (male and female) and nymphs

The climatic conditions and the availability of food over a short period of time may have favored the rapid establishment of this species in the greenhouse. The main species captured were adults (both male and female) and the first and second instar nymphs, and a few third instar nymphs were also found. Figure 3 shows the average number of nymphs and adult colonies caught per day. This is an indication of the clear prevalence of nymphal stages and a slight similarity between the capture profile of adults and nymphs.

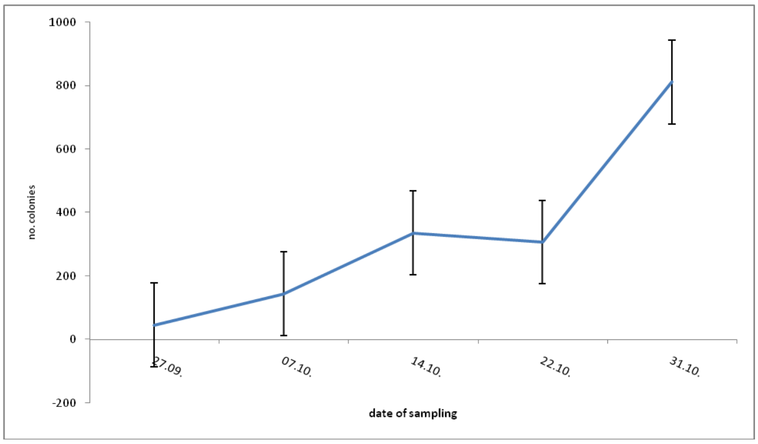

Fig. 3. Seasonal variation of adult and nymphal colonies collected from Belgian mums in the Sânmihaiu Roman greenhouse

The period of *P. citri* movement lasted from beginning September to end October. Thus, mealybug populations per leaf were lower at the beginning of the trial (first ten days of September) than during the rest of the trial. There was a gradual increase in the mealybug population, which peaked in the second decade of September and continued into October in the first decade. The moderately hot and humid climate in the greenhouse during the collecting period was favorable for the pest to develop.

CID ET AL. (2010) showed that a significant increase in mealybug abundance, in case of grapevines is related to climate change. Our results are in agreement with BENTLEY ET AL.

(2006), who showed that the activity period of *P. citri* during the annual cycle is from early July to December, and that some activity can be detected throughout the winter, especially in the greenhouse.

Infestation of indoor belgian mums in Western Romania greenhouse

Out of a total of 1600 square metres planted with Belgian mums, only 320 m² showed signs of Planococcus citri infestation. The infestation rate varied between 35 and 80% at each collection date, with an average of 57% of the branches being infested (table 1). This suggests that factors such as microclimatic conditions, localised pest migration or an uneven distribution of plants may influence the spread of the pest.

Table 3.

Number of Belgian mum branches infested by *Planococcus citri* and the number of mealybug colonies on the branches in the Sânmihaiu Român greenhouse in the autumn of 2024

Sampling date	No of belgian mums plants/ 20 branches	No of İnfested branches	Infestation levels %	No of mealybugs colonies	Attack levels %
27.09.2024	3/ 20 branches	7	35	46	2.80
07.10.2024	3/ 20 branches	9	45	144	8.75
14.10.2024	3/ 20 branches	12	60	336	20.43
22.10.2024	3/ 20 branches	13	65	307	18.66
31.10.2024	3/ 20 branches	16	80	812	49.36
Average		11.4	57%	329	20

There is a correlation between plant condition and susceptibility to pest attack, with large colonies of *Planococcus citri* observed predominantly on less developed and weakened plants. Infestations were also localized to groups of 5-10 adjacent plants, with other areas of the greenhouse showing no signs of infestation, suggesting concentrated rather than uniform distribution.

During the period analyzed, an average of 329 mealybug colonies were found on Belgian mum plants; this high level of infestation, ranging from 2.80% to 49.36%, with an average of 20%, is an alarm signal, as a significant infestation rate can affect plant development and crop quality, requiring rapid intervention.

CONCLUSIONS

A total of 1645 colonies of *Planococcus citri* were collected from Belgian mums during the period between September and October 2024.

The majority of individuals in the analysed colonies are nymphs, which is an indication of population growth and intense reproductive activity.

The lifecycle of the pest indicates a critical period of increasing population between the second decade of September and the first decade of October.

The average infestation rate of 20% highlights the urgent need for intervention.

By applying the appropriate treatments and preventive measures, the impact on the crop can be significantly reduced and damage to the crop can be prevented.

Interventions should be planned before and during the peak of the population (the second ten days of September). This is the time when the pest is at its most active and most susceptible to treatment.

It is essential that systemic or contact treatments are applied in September, followed by maintenance treatments in October.

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