

INVESTIGATION INTO THE MONITORING AND MANAGEMENT OF SPECIFIC DEFOLIATING SPECIES AFFECTING THE ECOLOGICAL BLACK CURRANT PLANTATION IN RECEA-CRISTUR, CLUJ COUNTY

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Abstract

Recently, Romania has experienced a consistent rise in the acreage dedicated to fruit bush cultivation. The black currant (*Ribes nigrum* Linné) is a fruit-bearing shrub whose cultivated areas are consistently expanding, owing to the nutritional and therapeutic value of its fruits. As the cultivated regions of black currant expanded, the populations of defoliating species also increased. During the 2021-2022 period, in the blackcurrant plantation (cultivated with Tiben, Tisel, and Ruben varieties) located in Recea-Cristur, Cluj County, defoliating species were identified, and the frequency and intensity of the infestation were evaluated based on the efficacy of chemical treatments. The identified species include *Epiblema uddmanniana* Linné, *Archips crataegana* Hübner, *Aphelia paleana* Hübner, *Pandemis heparana* Denis & Schiffermüller, and *Lampronia capitella* Clerck.

In 2021, the attack intensity at the untreated variant was 5.07% for the Tisel variety, 6.57% for the Tiben variety, and 7.28% for the Ruben variety. In 2022, the intensities were 6.85% for the Ruben variety, 7.54% for the Tisel variety, and 9.72% for the Tiben variety. However, in both years, applying chemical treatments with products sanctioned for organic agriculture resulted in a significant reduction in attack intensity across all varieties compared to control, demonstrating the potential of these treatments in managing defoliating species.

Key words: blackcurrant, defoliators, attack, control.

INTRODUCTION

Blackcurrant (*Ribes nigrum* Linné) is cultivated for its precious fruits from both a nutritional and therapeutic perspective (Oczkowski, 2021). (Ikuta et al., 2012; Tabart et al., 2012; Cortez & Gonzalez de Mejia, 2019; Kendir et al., 2019; Ejaz et al., 2023). Fruits are primarily consumed fresh; however, they are also valued in processed forms, including juices, syrups, liqueurs, compotes, jams, marmalades, and tonic wines (Allai et al., 2020; Wójciak et al., 2022). Blackcurrant plantations face persistent threats from indigenous pest species and those that have broadened their geographical distribution (Ionescu-Mălăncuș et al., 2011; Tanasković, 2012). Numerous species have been introduced from other continents and emerged as significant pests of various plants. The hairy oak caterpillar, *Lymantria dispar* Linné, serves as a classic example, having entered Europe in 1866 and remaining on the phytosanitary quarantine lists of numerous European countries today (Cargnus et al., 2013).

The mulberry shoot moth, *Epiblema uddmanniana* Linné, belongs to the family Tortricidae within the order Lepidoptera. Its distribution includes Western Europe and regions surrounding the Mediterranean Sea, extending to the Caucasus, Kazakhstan, Iran, and China (Boyes & Holland, 2021).

The adult exhibits a wingspan ranging from 15 to 20 mm, characterized by a light gray-brown coloration with olive green hues, each wing featuring a subtriangular reddish-brown spot, while the hindwings are gray. The larva measures up to 15 mm in length and exhibits a matte run-dark coloration, with the prothoracic and anal plates being black or brownish-black (David, 2007; Tiberi, 1981).

It produces one generation annually. The insect overwinters in the third-instar larval stage within a silky cocoon located beneath exfoliated bark or at the base of buds (Boyes & Holland, 2021; Dicker, 1939).

Larvae consume brambles (*Rubus* spp.), frequently found in these species' habitats, and may damage cultivated varieties (Gordon et al.,

1997). During spring, hibernating larvae infest flower buds, causing twisting of leaves and subsequently affecting the growth of the shoot tip (David, 2007).

The hawthorn moth, *Archips crataegana* Hübner, belongs to the family Tortricidae within the order Lepidoptera. It is found in Europe, Asia Minor, and northwestern Africa (Balachowsky, 1968). In Romania, it is frequently observed (Popescu-Gorj, 1974) and is present in the plantations of Moldova and Transylvania (Peiu, 1984).

The adult exhibits a 19-26 mm wingspan and a gray-brown coloration, with males featuring yellowish hues. The dark brown pattern features an oval spot with a rounded apex. The fully developed larva, classified as a true caterpillar, measures 20-23 mm long and exhibits a dark gray or blackish-green hue (Perju, 2002).

Monovoltine species. It hibernates in the egg stage within the fissures of the tree bark (Vasiliev, 1974). Polyphagous species infest the fruiting organs of apples, pears, plums, and cherries. Cork oak, sorghum, hawthorn, and dovecot can be infested. It frequently damages oak, poplar, elm, linden, willow, hazel, maple, and birch trees. Larvae consume swelling buds, subsequently targeting flower buds, flowers, and foliage; the affected leaves exhibit distinctive twisting (Perju, 2002).

Timothy tortrix, *Aphelia paleana* Hübner, is a moth belonging to the family Tortricidae within the order Lepidoptera, found in Europe and the Palearctic region extending to China and the Russian Far East (Byun et al., 2003).

The adult's wingspan ranges from 17 to 24 mm. The forewings are yellow-ochre pale or ochre-whitish, while the hindwings are dark gray. The larva exhibits a dark green to black coloration adorned with prominent white spots; the head and thorax are black with white anterior borders. It produces a single generation annually. It undergoes hibernation during the larval stage.

The larvae consume a variety of plants. The brown apple moth, *Pandemis heparana* Denis & Schifferrmüller, belongs to the family Tortricidae and the order Lepidoptera and is prevalent throughout Europe (Balachowsky, 1966). It is a prevalent species in Romania (Popescu-Gorj, 1984). The adult possesses 20-22 mm forewings, exhibiting a yellow-brown to reddish-brown hue adorned with a reticulated

blackish-brown pattern. The hindwings are a dark chestnut color (Perju, 2002). The larva, a genuine caterpillar, reaches a length of 25 mm when fully developed, exhibiting a light green hue and warty texture; the lateral-posterior cephalic capsule features a small dark spot, while the prothoracic tergite appears yellowish (Castellari, 1990). Because it is a bivoltine species, it hibernates as a second and third instar larva within the crevices of the tree bark, protected by a silky cocoon (Castellari, 1990; Vilajeliu, 1999).

The species exhibits polyphagy (Giacomuzzi et al., 2016). The larvae consume the leaves of diverse woody plants, specifically fruit and ornamental trees, and shrubs, feeding on the epidermis and parenchyma, which causes the leaves to twist. Caterpillars frequently infest flowers with silk threads and devour floral components, damaging the skin of developing fruits and thereby creating entry points for pathogenic organisms (Castellari, 1990; Vasiliev, 1974; Vilajeliu, 1999).

The currant fruit moth, *Lampronia capitella* Clerck, belongs to the family Tortricidae and the order Lepidoptera and is prevalent in Central European countries (Beirne, 1943; Hellqvist et al., 2006). It is documented as a faunal component in Romania (Kovács, 2002; Popescu-Gorj, 1984). The adult possesses a wingspan ranging from 13 to 17 mm. The forewings are yellowish-brown with a purple hue; each wing features prominent yellow spots. The hind wings exhibit a gray hue (Perju, 2002). The larva, a genuine caterpillar, reaches a length of 9-12 mm when fully developed; young larvae exhibit a reddish-brown coloration, which subsequently transitions to a dirty-green hue (Kovács, 2002; Vasiliev, 1974).

Monovoltine species. It hibernates as an underdeveloped larva, encased in a white silky cocoon beneath the host shrubs' vegetative layer at the buds' base (Bohm Helene, 1971). It is an oligophagous species that infests currant bushes (Kovács, 2002). The larvae feed on the contents, leaf, and flower buds, then consume the green fruits of the white and rarely red currant species. Before the buds open, the larvae laterally bore one entry hole and bore the contents of the buds. Until fully developed, a larva can destroy all the buds on a shoot. The larvae of the new generation consume the seeds of the developing

fruits; the attacked fruits shrivel, dry, and fall, the shoots remaining bare (Bohm Helene, 1971; Yarchakovskaya, 1991).

MATERIALS AND METHODS

The research was conducted in the blackcurrant plantation located in Recea-Cristur, Cluj County, Romania (47°04'29.0"N 23°30'13.6"E) from 2021 to 2022.

The farm specializes in producing and selling forest fruits, including raspberries, black currants, red currants, blueberries, and gooseberries. It encompasses a total area of 3 hectares, comprising 2 hectares dedicated to blackcurrant cultivation, featuring the varieties Tisel, Tiben, and Ruben, and 1 hectare allocated to raspberry cultivation, including the varieties Willamette, Polka, and Glen Ample. Since 2017, the farm has been certified organic for the cultivated fruit bushes.

The blackcurrant plantation was established on land cleared from a hayfield in the autumn of 2014. No crops or orchards exist in the vicinity of the plantation.

The multiannual average temperature is 8.5°C, and the multiannual average precipitation is 573 mm.

In 2021, the mean annual temperature was 9.8°C, with July being the warmest month, averaging 22.3°C (Table 1). This year's recorded precipitation was 538.21 mm, with the highest monthly total in July at 131.06 mm (Table 2).

In 2022, the mean annual temperature was 10.5°C, with July being the warmest month, averaging 22.2°C (Table 1). This year's recorded precipitation was 452.07 mm, with the highest monthly total in May at 95.25 mm (Table 2).

This study identified the defoliating species, evaluated the frequency and intensity of their attacks, and assessed the efficacy of chemical treatments.

The experiment was conducted to attain the specified objectives, incorporating the following factors.

Factor A - experimental years: 2021 and 2022.

Factor B - cultivated blackcurrant varieties: Tisel, Tiben and Ruben.

Factor C - treatment: V₁-treated; V₂-untreated.

Table 1. Average air temperature during the period 2021-2022

Experimental years	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2021	Average temperature	-0.2	2	3.3	8.1	14.1	19.7	22.3	19.3	14.6	7.9	4.2	1.5
	Maximum temperature	2.9	6.2	9.3	13.7	20.1	26.5	29.1	25.9	21.3	15.2	9.8	3.9
	Minimum temperature	-4	-1.7	-2.8	2.4	8	12.7	15.4	12.8	8.4	1.5	-0.7	-1.5
2022	Average temperature	-1	1.7	3.5	8.8	15.7	20.5	22.2	21.9	14.4	10.4	5.6	2
	Maximum temperature	3	7.3	10.3	14.9	22.7	27.5	29.8	29.3	19.8	17.3	9.1	5.8
	Minimum temperature	-5.5	-3.4	-3.7	2.1	8.2	12.5	14.4	15	9.8	4.9	2.2	-2.1

Source: <https://en.tutiempo.net/climate/romania.html>

Table 2. The amount of precipitation for the period 2022-2023

Experimental years	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2021	Average relative humidity (%)	85.5	84	66.1	66.9	70.5	67.3	69.8	72.6	73.1	71.1	85.1	86.5
	Total rainfall and/or snowmelt (mm)	26.39	25.15	42.93	32.50	75.70	30.99	131.06	59.43	18.79	11.93	23.37	59.97
	Average relative humidity (%)	79.8	74.8	49.4	64.9	63.3	59.1	51.7	62.9	78.1	81.7	89.5	87
2022	Total rainfall and/or snowmelt (mm)	15.73	11.41	9.9	49.27	95.25	19.55	8.63	86.1	50.03	34.8	49.77	23.63

Source: <https://en.tutiempo.net/climate/romania.html>

Table 3. Treatments with insecticides applied in the blackcurrant plantation, Recea-Cristur (Cluj County), 2021-2022

Nr.	Period	Phenophase	Product	Active substance	%
1.	10.03.21 12.03.22	Vegetative dormancy	Ovipron Top	paraffin oil 96.5 g/kg, formulation ingredients	1.5
2.	24.03.21 26.03.22	Foliage beginning	Ovipron Top	paraffin oil 96.5 g/kg, formulation ingredients	0.1
3.	20.04.21 21.04.22	All bud free	Konflic Laser 240 SC	50% potassium salt from vegetable oil extract; 50% <i>Quassia amara</i> extract spinosad 240 g/l	0.3 0.05
4.	27.04.21 28.04.22	50% flowering	Microcat Flic	Potassium oxide (K ₂ O) - 6% w/w	0.15
5.	11.05.21 16.05.22	50% of fruits formed	Laser 240 SC	spinosad 240 g/l	0.05
6.	25.05.21 27.05.22	100% of fruits formed	Bactospeine DF Oleorgan	54% <i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i> (tulpina ABTS – 351) extract of saponified oil from the Neem tree - 40%	0.1 0.3
7.	04.06.21 10.06.22	First fruit coloring	Konflic	50% potassium salt from vegetable oil extract; 50% <i>Quassia amara</i> extract	0.3
8.	13.08.21 22.08.22	Post-harvesting	Oleorgan	extract of saponified oil from the Neem tree - 40%	0.2

To assess the severity of the defoliator assault, on September 8, 2021, and September 7, 2022, 100 plants were randomly selected from each variety or variant (V₁ - treated and V₂ - untreated). One hundred leaves from each respective variety were collected from the infested plants to determine the attack frequency. Leaves were scanned and analyzed utilizing the WinDIAS 3 image analysis system which offers rapid and precise measurement of leaf surface area and attributes, rendering it suitable for plant pathology applications. The intensity of the assault was determined after the analysis. Products sanctioned for organic agriculture were utilized to address defoliators. Eight treatments were conducted each year. The implemented treatments are presented in Table 3. The results were statistically analyzed using the ANOVA program.

RESULTS AND DISCUSSIONS

During the 2021-2022 period, the impact of defoliating species on three blackcurrant varieties was assessed on the plantation. In both years, eight treatments were administered, and subsequent to fruit harvesting, the frequency and intensity of the attack on the treated variant (V₁) were analyzed in comparison to the untreated control (V₂). From the 100 leaves collected from each variant, both the total leaf surface area and the area affected by defoliators were measured, subsequently allowing for the calculation of attack intensity.

In 2021, the average leaf surface area for V₁, which underwent chemical treatments, ranged from 38.69 cm² (with fluctuations between 13.8-

108.5 cm²) in the Tiben variety to 40.56 cm² (with fluctuations between 11.6- 88.8 cm²) in the Tisel variety. In 2022, V₁ and V₂ (the variant without chemical treatments) exhibited a significant reduction in leaf surface area across all varieties. This year's climatic conditions reveal a temperature increase of 2°C relative to the multi-year average, alongside a precipitation decrease of 121 mm. The temperature rose by 0.7°C, while precipitation decreased by 86.14 mm compared to the previous year. In 2022, the average leaf surface area for the Tisel variety was 15.06 cm², with a range of 5.4 to 34.5 cm², while the Tiben variety averaged 16.52 cm², with a range of 5.3 to 34.9 cm² (Table 4).

In 2021, at V₁, the intensity of the attack was measured at 2.72% for the Tisel variety, exhibiting fluctuations between 0.44% and 11.7%. For the Ruben variety was 3.17%, with variations ranging from 0.32% to 11.6%. In 2022, the intensity of the attack diminished relative to the prior year, recorded at 2.14% (oscillating between 0.49-12.9%) for the Tiben variety and 2.5% (oscillating between 0.33-12.8%) for the Tisel variety (Table 4).

In 2021, at V₂, the attack intensity ranged from 5.07% for the Tisel variety (oscillating between 0.64% and 18.3%) to 7.28% for the Ruben variety (oscillating between 0.1% and 19.5%). In the subsequent year, the intensity of the attack escalated in the Tisel and Tiben varieties, while it diminished in the Ruben variety. The attack intensity ranged from 6.85% in the Ruben variety (oscillating between 0.19% and 18.3%) to 9.72% in the Tiben variety (oscillating between 0.35% and 19.7%).

In both years, the application of chemical treatments with products approved for organic agriculture reduced attack intensity across all varieties compared to V₂, which did not receive any chemical treatments (Table 4).

Table 5 shows the effectiveness of chemical treatments in reducing the degree of attack determined by defoliating species.

In 2021, the degree of attack in V₂ was between 0.76% (for the Tisel variety) and 1.31% (for the Ruben variety). However, the attack produced by defoliating species is generally reduced. Applying chemical treatments reduced the degree of attack in all varieties. The effectiveness of the applied treatments was between 46.4% (for the Tisel variety) and 56.5%

(for the Ruben variety). In 2022, at V₂, the degree of attack was between 0.82% (for the Ruben variety) and 1.28% (for the Tisel variety). Compared to the previous year, the degree of attack increased in the Tisel and Tiben varieties but decreased in the Ruben variety. This year, the effectiveness of chemical treatments was between 67.1% (for the Ruben variety) and 77.9% (for the Tiben variety).

Statistically, significantly negative differences were determined compared to the untreated variant (V₂) regarding the interaction between year, variety, and treatment on the intensity of the attack produced by the defoliating species (Table 6).

Table 4. Intensity of defoliation caused by defoliating species in the blackcurrant plantation Recea-Cristur (Cluj County), 2021-2022

Variety	Variant	2021			2022		
		The leaf surface (cm ²)	The surface attacked (cm ²)	Intensity of attack (%)	The leaf surface (cm ²)	The surface attacked (cm ²)	Intensity of attack (%)
Tisel	V ₁	40.56 (11.6-88.8)	1.10 (0.16-4.19)	2.72 (0.44-11.7)	15.06 (5.4-34.5)	0.37 (0.08-2.47)	2.50 (0.33-12.8)
	V ₂	39.03 (9.5-77.6)	1.98 (0.1-5.09)	5.07 (0.64-18.3)	16.17 (6.2-31.8)	1.22 (0.1-3.35)	7.54 (0.15-17.2)
Tiben	V ₁	38.69 (13.8-108.5)	1.17 (0.1-4.29)	3.02 (0.26-9.19)	16.52 (5.3-34.9)	0.35 (0.1-1.53)	2.14 (0.49-12.9)
	V ₂	35.90 (11.3-91.2)	2.36 (0.1-8.14)	6.57 (0.16-12.9)	15.02 (4.9-37.3)	1.46 (0.1-4.22)	9.72 (0.35-19.7)
Ruben	V ₁	38.91 (16.1-95.4)	1.23 (0.1-6.25)	3.17 (0.32-11.6)	15.57 (5.9-29.5)	0.35 (0.08-1.31)	2.26 (0.27-14.2)
	V ₂	39.13 (12.2-85.6)	2.85 (0.1-8.05)	7.28 (0.1-19.5)	17.95 (6.8-31.4)	1.23 (0.2-3.76)	6.85 (0.19-18.3)

Table 5. Effectiveness of treatments in control defoliating species in the blackcurrant plantation, Recea-Cristur (Cluj County), 2021-2022

Variety	Variant	2021				2022			
		F %	I %	G.A. %	E %	F %	I %	G.A. %	E %
Tisel	V ₁	7	2.72	0.19	46.4	6	2.50	0.15	66.8
	V ₂	15	5.07	0.76	n.a.	17	7.54	1.28	n.a.
Tiben	V ₁	6	3.02	0.18	54.1	3	2.14	0.06	77.9
	V ₂	12	6.57	0.79	n.a.	14	9.72	1.36	n.a.
Ruben	V ₁	9	3.17	0.28	56.5	8	2.26	0.18	67.1
	V ₂	18	7.28	1.31	n.a.	12	6.85	0.82	n.a.

Notes: n.a. - not available

Table 6. Influence of interaction between the 3 factors on the attack intensity produced by defoliators Recea-Cristur (Cluj County), 2021-2022

Experimental variant	Intensity of attack	%	Difference ±	Significance
V ₂ -untreated x 2021 x Tisel	5.07	100.0	0.00	Ct.
V ₁ -treated x 2021 x Tisel	2.72	53.3	-2.38	⁰⁰⁰
V ₂ -untreated x 2021 x Tiben	6.57	100.0	0.00	Ct.
V ₁ -treated x 2021 x Tiben	3.02	45.7	-3.58	⁰⁰⁰
V ₂ -untreated x 2021 x Ruben	7.28	100.0	0.00	Ct.
V ₁ -treated x 2021 x Ruben	3.17	43.7	-4.11	⁰⁰⁰
V ₂ -untreated x 2022 x Tisel	7.54	100.0	0.00	Ct.
V ₁ -treated x 2022 x Tisel	2.50	33.2	-5.02	⁰⁰⁰
V ₂ -untreated x 2022 x Tiben	9.72	100.0	0.00	Ct.
V ₁ -treated x 2022 x Tiben	2.14	21.8	-7.59	⁰⁰⁰
V ₂ -untreated x 2022 x Ruben	6.88	100.0	0.00	Ct.
V ₁ -treated x 2022 x Ruben	2.26	33.2	-4.60	⁰⁰⁰
LSD (p 5%)			0.04	
LSD (p 1%)			0.06	
LSD (p 0.1%)			0.10	

Notes: Ct - control; ⁰⁰⁰ - very significantly negative difference; LSD - last significant difference

During the field observations, the collection of some lepidopteran larvae was followed, and in laboratory conditions, the adults appeared and were identified. From the material taken from the blackcurrant plantation, the adults of five lepidopteran species were identified, of which four species from the Tortricidae family: *Epiblema uddmanniana* Linné (Figure 1), *Archips crataegana* Hübner (Figure 3.a.), *Aphelia paleana* Hübner (Figure 2), *Pandemis heparana* Denis & Schifferrmüller (Figure 3.b.) and a species from the Prodoxidae family, *Lampronia capitella* Clerck (Figure 4).

In 2021, from larvae collected on May 5, *Epiblema uddmanniana* Linné adults emerged on May 27. From the biological material taken on May 19, the adults of *Archips crataegana* Hübner, *Aphelia paleana* Hübner, *Pandemis heparana* Denis & Schifferrmüller appeared on May 30. From the biological material taken on June 2, the adults of *Aphelia paleana* Hübner, *Pandemis heparana* Denis & Schifferrmülle, and *Lampronia capitella* Clerck appeared on June 14.

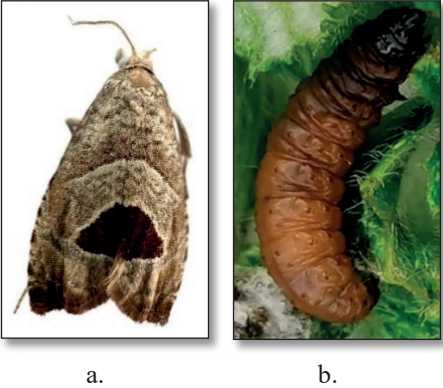


Figure 1. *Epiblema uddmanniana* Linné: a. adult; b. larvae

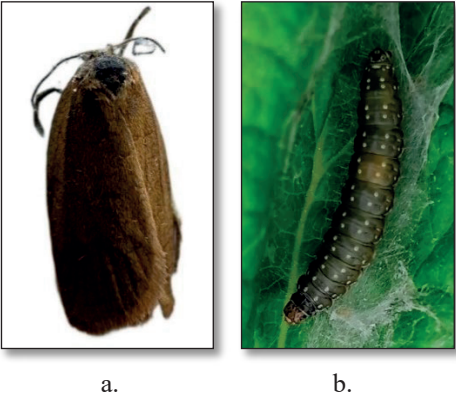


Figure 2. *Aphelia paleana* Hübner: a. adult; b. larvae

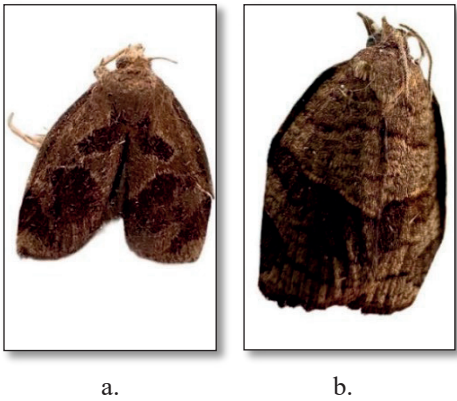


Figure 3. a. *Archips crataegana* Hübner
b. *Pandemis heparana* Denis & Schifferrmüller



Figure 4. *Lampronia capitella* Clerck

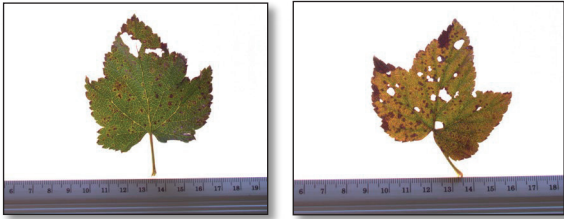


Figure 5. Symptoms of defoliation caused by defoliating insects in the blackcurrant plantation, Recea-Cristur (Cluj County), 2021-2022

The Tortricidae family includes polyphagous species whose larvae feed on buds that begin to swell and then feed on flower buds, flowers, and foliage. *Lampronia capitella* Clerck, of the family Prodoxidae, is an oligophagous species that attacks black currant bushes. The symptomatology of the attack produced by defoliators in the blackcurrant plantation is presented in Figure 5.

CONCLUSIONS

In V₂, the intensity of the attack by defoliators was recorded at 5.07% for the Tisel variety, 6.57% for the Tiben variety, and 7.28% for the Ruben variety in 2021. In 2022, the figures were

6.85% for the Ruben variety, 7.54% for the Tisel variety, and 9.72% for the Tiben variety.

In both years, the application of chemical treatments with products approved for organic agriculture reduced defoliator attack intensity across all varieties compared to V₂. In 2021, the attack intensity was recorded at 2.72% for the Tisel variety, 3.02% for the Tiben variety, and 3.17% for the Ruben variety. In 2022, the intensities were 2.14% for the Tiben variety, 2.26% for the Ruben variety, and 2.5% for the Tisel variety.

The effectiveness of chemical treatments against defoliators in 2021 was 46.4% for the Tisel variety, 54.1% for the Tiben variety, and 56.5% for the Ruben variety. In 2022, the effectiveness increased to 66.8% for the Tisel variety, 67.1% for the Ruben variety, and 77.9% for the Tiben variety. Following an analysis of the adults derived from larvae collected in the blackcurrant plantation located in Recea Cristur, Cluj County, species from the family Tortricidae were identified: *Epiblema uddmanniana* Linné, *Archips crataegana* Hübner, *Aphelia paleana* Hübner, and *Pandemis heparana* Denis & Schiffermüller, as well as *Lampronia capitella* Clerck from the family Prodoxidae.

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