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RESEARCH ON THE PROTECTION OF RAPESEED CROP AGAINST DISEASES, WEEDS AND PESTS

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Abstract

Rapeseed (Brassica napus L.) is an important oilseed crop in Europe and in Romania because of their ability to germinate and grow at low temperatures in the temperate regions. Rapeseed is primarily used to produce edible vegetable oil and meal for animal feed. Rapeseed production is negatively influenced by several diseases, arthropod pests and weeds. Chemical control is still an indispensable method in effective rapeseed protection against these harmful organisms in Romania. The work falls into integrated management strategy for rapeseed harmful organisms based on risk assessment, monitoring and management of the rapeseed crop that can be used as a framework by growers to manage rapeseed bioaggressors with reduced plant protection products inputs is required. The research was carried out during the vegetation period of 2021 and 2022 in Poșta Câlnău commune, Buzău county.

***Key words**: rapeseed, protection, diseases, weeds, pests.*

INTRODUCTION

Rapeseed (*Brassica napus* L.) is a vegetable oil crop, widely used as a source of oil and protein for food and industrial applications (Raboanatahiry et al., 2021).

About 70 million tons of rapeseed are produced per year around the world, involving 66 countries: 34 countries in Europe, 15 countries in Asia, 9 countries in America, 6 countries in Africa, and 2 countries in Oceania (http://www.fao.org/faostat/en/#search/Rapeseed%20).

Rapeseed is the second most important oilseed crop of the world, and it is also a favourite plant for basic and breeding research (Friedt et al., 2018).

Winter-type rapeseed grows well in the climatic conditions of the Poșta Câlnău area.

Known for its production of high-quality vegetable oil, rapeseed competes with other crops in Romania, respectively soybean and sunflower.

In agricultural production, rapeseed is an indispensable component of crop rotations in our country.

If the introduction of high-yielding and hybrid cultivars and the opening of new markets in the food and feed sector have steadily increased rapeseed production since the 1980s, since the 1990s, however, the average growth rate of yields has declined in Europe, which has been associated with a less effective control of biotic stresses (Zheng et al., 2020).

Diseases, weeds and insect control largely relies on plant protection products, because crop rotation, soil management, resistant cultivars or biocontrol are often ineffective.

Chemical control is still an indispensable method in the effective protection of rapeseed in Romania against diseases, weeds and pests.

In heavily weed-infested soils, managing summer weeds plays an important role to avoid seeding delays, conserve nutrients and moisture for the rapeseed crop to use during the growing season.

Weed control in winter rapeseed has always been challenging. Yield loss from poor broad-leaved weed control can range from 3% up to 73% depending on the vigour of the crop and this does not take into account contamination of harvested crop with weed seed which can reduce marketability of the sample (https://ahdb.org.uk/new-approaches-to-weed-control-in-oilseed-rape).

In rapeseed growing regions revealed 16 diseases and 37 insect pests, as well as nematodes, slugs and snails. This biotic stresses predominantly affect leaves (10 diseases and 22 insect pests) and stems (7 diseases and 12 insect pests), while only 2 diseases and 11 insect pests affect pods and seeds of oilseed rape (Zheng et al., 2020).

Identification of rapeseed pathogens and pests in different areas of Romania is a permanent goal for phytopathological and entomological scientific activity in our country (Grozea et al., 2007; Paraschivu et al., 2011; Radu et al., 2011; Zală et al., 2012; 2023).

Several diseases negatively impact rapeseed production. Diseases caused by soil-borne pathogens, pose a risk of substantial yield loss since crop rotation schemes have become narrow as the time lapse between rapeseed crops in a field has been shortened (Wallenhammar et al., 2022).

Sclerotinia sclerotiorum, whose sclerotia can survive in the soil for more than 4 years, is able to infect more than 400 plant species (Mizubuti, 2019).

Pollen beetle (*Meligethes aeneus*), cabbage aphid (*Brevicoryne brassicae*), rape stem weevil (*Ceutorhynchus napi*), rape seed weevil (*Ceutorhynchus assimilis*), rape flea beetle (*Phyllotreta atra*), striped flea beetle (*Ph. nemorum*) are important insect pests that affect European. Eastern Europe has the highest number of pest species: 15, where damage by insect pests is a significant yield reducing factor in rapeseed production, with an average annual yield loss of 15% (Milovac et al., 2017).

Due to environmental concerns and concern for human health, the sustainable use of pesticides is required by promoting the integrated management of diseases, weeds and pests according to the European directive 2009/128/CE.

MATERIALS AND METHODS

The research was carried out in the rapeseed experimental fields from Poșta Câlnău-Buzău at 45°14′ latitude and 26°51′ longitude, in conditions of natural infection during the vegetation period of 2021 and 2022. The land belongs to the BioVitAgro farm.

Correct diagnosis of rapeseed pathogens, weeds and pest is the primary requirement in any integrated management practice.

Diseases, pests and weeds was detected under conditions of natural infection under the influence of climatic conditions during the vegetation period of the two years of studies.

The observations were made on the rape hybrid PT234. This hybrid with semi-early maturity, has a fast development in autumn and a very good tolerance to drought and low temperatures (https://www.corteva.ro/).

Visual observation is the fastest method to identify diseases based on symptoms shown by infected rape plants and identification pests and weeds based on their morphological characters.

The abundance of the species *Meligethes aeneus* was determined in the phenophase of maximum flowering (BBCH 65) with the entomological net both in the variants treated with the two insecticides, as well as in the control variant. The collected material (one thread/ total surface area variant, was placed in a 720 ml jar, which had pieces of paper soaked in acetone).

The attack value is represented by frequency (disease incidence)-F%, intensity (severity)-I% and attack degree (AD%). Frequency is the percentage of leaves or siliques attacked out of 100 examined leaves or siliques. The intensity, visually estimated, indicates the degree to which the leaf or siliques are attacked. The intensity was noted directly in percentage. The attack degree present severity of disease or pest in the crop and was calculated with the formula:

$$\text{AD } (\%) = \frac{\text{F } (\%)\text{xI}(\%)}{100}$$

The effectiveness of treatments with fungicides and insecticides applied was calculated according to the Abbott (1925) formula, based on the recorded attack degrees:

$$\text{E } (\%) = \frac{\text{AD control} - \text{AD treated}}{\text{AD control}} \text{x } 100$$

The harvestable surface of one variant was 20 m^2.

The experiments were arranged according to the method of randomized blocks, in 4 repetitions.

A standard technology was applied: plowing executed at 25 cm, sowing of a treated seed with Scenic Gold 375 FS (fluopicolid 200 g/l +

fluoxastrobin 150 g/l) - 1 l/100 kg of seed and Lumiposa (cyantraniliprol 625 g/l) - 1.14 l/ 100 kg of seed; NH_4NO_3-120 kg/ha (1/3 of the dose in autumn and 2/3 of the dose in early spring) and complex fertilizer NPK 18: 46: 0-100 kg/ha (applied to prepare the land for sowing). Regarding the preceding plant, this was autumn barley. Sowing in the two years of research was carried out in the first decade of September.

In the experiment with fungicides, 3 treatments with insecticides were also applied (one in autumn and 2 in spring). In the experiment with insecticides (V1-untreated, V2-Inazuma, V3-Decis Expert 100 EC) 2 treatments with fungicides were also applied (both in spring). In the herbicide experience (V1-untreated, V2-Salsa) 3 treatments with insecticides were applied (one in autumn and 2 in spring) and 2 treatments with fungicides were also applied (both in spring). The experiences with fungicides against powdery mildew included 3 experimental variants: V1 - untreated control, V2 - 1 treatment applied (Final: boscalid - 200 g/l + dimoxistrobin - 200 g/l - 0.5 l/ha; respectively Custodia 320 SC (azoxistrobin-120 g/l + tebuconazol – 200 g/l - 1.0 l/ha) in the stem elongation phenophase: BBCH 31; V3 - 2 treatments: one applied in the stem elongation phenophase (Final), and the second (Custodia) in the “yellow bud” phenophase: BBCH 59. Observations on the effectiveness of fungicides were carried beginning of ripening: BBCH 80 (Weber and Bleiholder, 1990). The insecticides applied were: Inazuma (acetamiprid-100 g/kg + lambda-cihalotrin - 30 g/kg) - 0.2 kg/ha and Decis Expert 100 EC (deltametrin) - 0.75 l/ha. A single treatment with each of the two insecticides was applied when pests (*Brevicoryne brassicae* and *Ceutorhynchus assimilis*) were detected on the plants, and efficacy scoring took place after 3 days. To combat the *Meligethes aeneus* species, insecticide treatment was applied in the “yellow bud” phenophase, in combination with the second fungicide treatment.

The notations regarding the attack of diseases and the presence of pests were performed on 100 leaves and siliques of each 4 plants/variant.

The herbicide applied were Salsa (etamet-sulfuron-metil 75%) - 25 g/ha + trend (adjuvant) - 250 ml/ha postemergence-BBCH 10-18. We used the numerical quantitative method for mapping the weeds, which consists in counting, by species, the weeds/m^2 using the metric frame (Chirilă, 2009); 2 determinations/variant with 3 days before herbicid application and efficacy scoring took place after 30 days.

For the observation of the climatic conditions necessary for the appearance and development of the disease, precipitation and temperatures were taken into account (Cotuna et al., 2022). The temperature recorded values slightly lower than the multi-year average only in April of 2021, otherwise the values were higher (Figure 1).

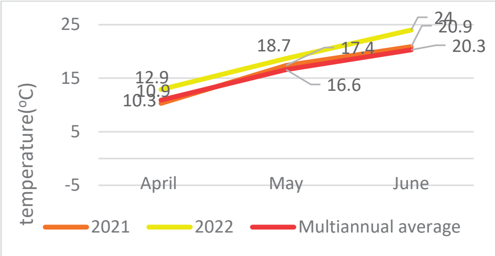

Figure 1. Average monthly temperatures (°C), Poșta-Câlnău, Buzău (source:https://www.meteoblue.com/en/weather/week/poșta-câlnău_romania)

As for the rainfall recorded in April, May and June, it was below the multi-year average values in each of the two years (Figure 2).

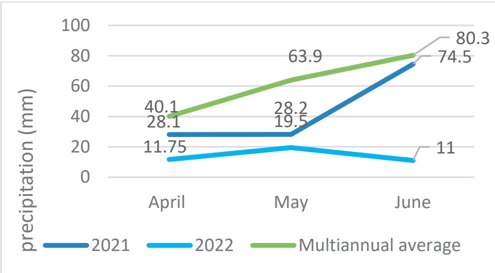

Figure 2. Average monthly precipitation (mm), Poșta-Câlnău, Buzău (source:https://www.meteoblue.com/en/weather/week/poșta-câlnău_romania)

RESULTS AND DISCUSSIONS

The attack of *Ceutorhynchus assimilis* larvae (Figure 3.) consists in consuming the newly formed seeds in siliques.

Figure 3. Observation of *C. assimilis* larvae
(foto: Lipianu S.)

The greatest damage caused by the pollen beetle is caused by the adults that cause reddening of the buds, which is why they will drop before they can produce flowers. Once the flowers have opened, damage by *Meligethes aeneus* adults (Figure 4) or larvae is negligible, and the pest will help pollinate the crop.

Figure 4. Observation of *Meligetes aeneus* adult
(foto: Istrate R.)

Continued feeding by cabbage aphid (Figure 5) causes yellowing, wilting and stunting of plants (Istrate and Roşca, 2009).

Figure 5. Observation of *Brevicoryne brassicae* colony
(foto: Zală C.R.)

The treatment with insecticides against *Brevicoryne brassicae* species (Table 1) was applied in the phenophase first flowers opening (BBCH 60). The efficacy of Inazuma insecticide was 96.3% in 2021 and 96.1% in 2022. The efficacy of Decis Expert 100 EC insecticide varied between 94.8% in 2022 and 94.9% in 2021, which resulted in an important decrease in the number of colonies/plant.

Table 1. Results regarding the efficacy of insecticide treatments against *Brevicoryne brassicae* species (colonies/plant)

Variants	**Years**	**Average density**		**E (%)**
		before	after	
		treatment		
Untreated	2021	21.7	-	
	2022	22.9	-	
Inazuma	2021	-	0.8	96.3
	2022	-	0.9	96.1
Decis Expert	2021	-	1.1	94.9
	2022	-	1.2	94.8

The treatment with insecticides against *Ceutorhynchus assimilis* species (Table 2) was applied at the end of the development of siliques stage. The effectiveness of the Inazuma insecticide was the highest, 97.5%, in 2021, when we recorded a decrease in the number of larvae/silique from 47.3 in the untreated variants to 1.2. The efficacy of Decis Expert 100 EC insecticide was average over the two years of 96.0%.

Table 2. Results regarding the efficacy of insecticide treatments against *Ceutorhynchus assimilis* species (larvae/silique)

Variants	**Years**	**Average density**		**E (%)**
		before	after	
		treatment		
Untreated	2021	47.3	-	
	2022	49.7	-	
Inazuma	2021	-	1.2	97.5
	2022	-	1.4	97.2
Decis Expert	2021	-	1.8	96.2
	2022	-	2.1	95.8

Regarding the effect of applying a single treatment with insecticides against the species Meligethes aeneus, we mention that in the control variant we captured (Figure 6) a total number of 483 adults (2021) during one week (one threading/day/total variant surface) and 514 adults in 2022.

Compared to the untreated control variant, the total number of specimens collected was 116 adults in the variant with the Inazuma insecticide (which represents a decrease of

76%) and in the variant with Decis Expert 126 adults were captured (a decrease of 74%).

In 2022, 139 specimens were captured (which represents a decrease of 73% compared to the untreated control variant) in the variant with Inazuma, and 152 specimens (the decrease being 70.5%) in the variant with Decis Expert.

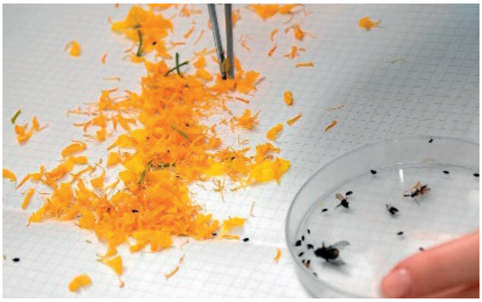

Figure 6. Counting pollen beetle captured following a threading (foto: Lipianu S.)

Alternaria appears on the siliques in the form of small light brown lesions that soon turn black (Figure 7, left) and these lesions on silique cause infection in the seed. Infected silique may ripen and shatter prematurely. while the crop is standing or in the swath.

Powdery mildew symptoms appeared as white colonies on both leaf surfaces and on siliques (Figure 7, central and right).

Figure 7. left): Alternaria on the siliques and Powdery mildew: central) on leafs, right) on siliques (foto: Zală C.R.)

Sclerotinia stem rot develops lesions greyish white, and infected tissues tend to shred easily. When the bleached stems of diseased plants are split sclerotia are visible (Figure 8).

From the data presented in Table 3, it can be seen that *Erysiphe cruciferarum* had more favorable conditions for its manifestation in 2022. The application of a single phytosanitary treatment against powdery mildew recorded the highest effectiveness in 2022, respectively 71.2% for Final fungicide and 69.6% for Custodia fungicide. The efficacy of the two treatments (the first with Final and the second with Custodia fungicide) was 98.5%.

Figure 8. Sclerotinia stem rot and some species of weeds (foto: Zală C.R.)

Table 3. Results regarding the efficacy of fungicide treatments against *Erysiphe cruciferarum*

Variants	Years	F (%)	I (%)	A.D. (%)	E (%)
Untreated	2021	42.2	52.5	22.2	-
	2022	43.6	59.6	26.0	-
Final	2021	22.1	29.8	6.6	70.3
	2022	23.8	31.5	7.5	71.2
Custodia	2021	23.4	30.4	7.1	68.0
	2022	24.5	32.1	7.9	69.6
T1-Final T2-Custodia	2021	6.3	5.5	0.34	98.5
	2022	6.5	6.2	0.4	98.5

From the data presented in Table 4, it can be seen that also alternaria had more favorable conditions for its manifestation in 2022. Since the alternaria manifested itself only at the level of siliques, only the effect of a single treatment in the "yellow bud" phenophase. Treatment effectiveness ranged around 92.0% in both years.

Table 4. Results regarding the efficacy of fungicide *treatments* against *Alternaria brassicae*

Variants	Years	F (%)	I (%)	A.D. (%)	E (%)
Untreated	2021	32.81	61.5	20.2	-
	2022	34.95	63.4	22.2	-
Final	2021	6.35	25.2	1.6	92.0
	2022	6.75	25.4	1.71	92.3
Custodia	2021	6.5	25.3	1.64	91.9
	2022	7.1	25.7	1.82	91.8

The nine species encountered in the non-herbicided rapeseed variants were (%-2021/2022): *Amaranthus retroflexus* (12/11), *Tripleurospermum inodorum* (18/17), *Chenopodium album* (11/10), *Echinochloa crus-galli* (8/7), *Convolvulus arvensis* (11/11), *Veronica hederifolia* (13/12), *Stellaria media* (12/11), *Sonchus arvensis* (8/11) and *Sinapis arvensis* (7/10). The average number of weeds was 265.2/m^2 in 2021 and 211.7/m^2 in 2022.

The average number of weeds in the variants herbicided with Salsa after 30 days from the application of the treatment was 6.63/m^2 in 2021, which represents an effectiveness of 97.5%; and at the level of 2022 the average number of weeds was 9.9/m^2, which represents an effectiveness of 95.3%.

CONCLUSIONS

The occurrence of diseases, pests and weeds reported in the rapeseed crop can be influenced by the geographical position of Romania.

The insects found in our experience are: pollen beetle (*Meligethes aeneus*), rape seed weevil (*Ceutorhynchus assimilis*) and the cabbage aphid (*Brevicoryne brassicae*).

Colonies of *Brevicoryne brassicae* are found on upper and lower leaf surfaces, in leaf folds, along the leafstalk, and near leaf axils.

Against the backdrop of higher temperatures and less precipitation in 2022 compared to 2021, the efficacy of insecticide treatment against *Brevicorine brassicae* was only 0.1-0.2% lower in 2022 compared to the previous year, a fact attributed to volatilization faster of the spray solution.

The diseases of the autumn rapeseed crop found in our experience are: powdery mildew (*Erysiphe cruciferarum*), alternaria (*Alternaria brassicae*) and sclerotinia stem rot (*Sclerotinia sclerotiorum*); powdery mildew and alternaria being the most common while the attack of sclerotinia stem rot was sporadic.

The severity of powdery mildew and alternaria it varied between the two years, based largely on the moisture and temperature situation.

The weeds control allows the rapeseed crop to be competitive, and controls early emerging weeds before they take up excessive nutrients and moisture. For this reason, the control and management of the weeding condition plays an important role in the technological links of rapeseed.

The average number of weeds and the effectiveness of the treatment were influenced by the climatic conditions at the level of the two years of research, water stress and higher temperatures decreased the number of weeds/m^2, but also caused a decrease in the effectiveness of the Salsa herbicide, at the level of the year 2022.

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