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RESEARCH ON THE EFFECTIVENESS OF SOME FUNGICIDES AND INSECTICIDES IN COMBATING OF SOME DISEASES AND PESTS OF RAPE IN CRISTIAN COMMUNE - BRAŞOV COUNTY

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ABSTRACT

In Romanian agricultural production, autumn rape is in present an indispensable component of crop rotations because helps to maintain soil fertility and contributes to sustainable production therefore. Behavior against fungal diseases and insect pests for modern rape varieties represents an essential agronomic property. Rape pest and disease control is a priority to minimize quantitative and qualitative production losses. In plant protection, fungicides and insecticides must to be used only when is necessary and at optimal times and doses. The notations were made during the vegetation period of 2020, 2021 and 2022.

Both fungicides applied (125 g/l azoxistrobin + 125 g/l difenoconazol and 125g/l fluopiram + 125 g/l protioconazol) showed high efficacy against alternaria, black leg and powdery mildew, and in the variants where both fungicides were applied, the highest efficacy was 98.8% against black leg and 98.9% anti powdery-mildew. The effectiveness of the two insecticides applied (240 g/l tiacloprid and 5% lambda-cihalotrin) varied between 87.2 and 97.3 against *Ceutorhynchus napi*, *C. assimilis*, *Phyllotreta atra*, *Ph. nemorum* and *Brevicoryne brassicae*.

Keywords: rape, diseases, pests, effectiveness.

INTRODUCTION

Rape, one of oilseed crops are grown across the globe for the valuable edible oil that they produce (Mailer, 2016).

Rape is the second most important oilseed crop of the world (Friedt et al., 2018).

The area cultivated with rape in Romania increased from 342,600 ha in 2020 to 438,000 ha in 2021 (https://insse.ro/).

Rape (*Brassica napus* L.) was domesticated as an oilseed crop in Europe in the early Middle Ages. Because of its ability to germinate and grow at low temperatures, rape are one of the few oil crops that can be grown in the temperate regions of the world (McVetty and Lukow, 2004).

The rape plant is exclusively grown for production of oil and the residue obtained after oil extraction process is assumed to be highly nutritious and are utilized as livestock feed in the growing regions. The rape oil encompasses high amount of omega-3 and omega-6 fatty acids. The oil is deemed to reduce cholesterol levels, lower serum triglyceride levels, and keep the blood platelets from sticking together. Additionally, glucosinolate compounds present in the oil are popularly believed to prevent cancer (Bhat and Reddy, 2017).

In Romania, the areas cultivated with autumn rape predominate over those cultivated with spring rape.

Identification of pathogens and pests in different areas of Romania is a permanent goal for phytopathological and entomological scientific activity in our country (Paraschivu et al., 2015; Zală, 2021).

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Rape culture is very vulnerable to diseases and pests, which is why phytosanitary treatments are extremely necessary, sometimes also during flowering.

The application of insecticides can harm bees because the toxicity of the carried insecticide into the hive through pollen or nectar from treated crops is so striking that, over time, it can destroy the entire bee colony (Jivan et al., 2012).

The main diseases of the autumn rape crop in Romania are: leaf spot, black leg, canker, and dry rot (*Plenodomus lingam* anamorph *Phoma lingam*), powdery mildew (*Erysiphe cruciferarum*), alternaria (*Alternaria brassicae*) and sclerotinia stem rot (*Sclerotinia sclerotiorum*); powdery mildew and alternaria being the most common. Thus, previous studies emphasized that autum rape requires special phytosanitary protection against biotic constrainers (Grozea et al., 2007; Paraschivu et al., 2011; Grosz et al., 2012; Zală et al., 2012; Georgescu et al., 2020).

Black leg or stem canker of oilseed rape is an internationally important disease of rape, causing serious losses in Europe (Rouxel and Balesdent, 2005; Fitt et al., 2006). The disease is distributed worldwide, and it is one of the main causes of considerable decrease in seed yield and quality (Kaczmarek et al., 2016). Epidemics of phoma stem canker are initiated by airborne ascospores (Hall, 1992), the speed and spore release depends on weather conditions to a great extent (Dawidziuk et al., 2012).

Alternaria has been reported from all the continents of the world affects most cruciferous crops (Meena et al., 2010). The pathogen *Alternaria brassicae* is greatly influenced by weather, the highest disease incidence were reported in wet seasons and in areas with relatively high rainfall (Humpherson-Jones and Phelps, 1989).

In Romania, rape is attacked by a wide variety of insects: rape stem weevil (*Ceutorhynchus napi*), rape seed weevil (*Ceutorhynchus assimilis*), rape flea beetle (*Phyllotreta atra*), striped flea beetle (*Phyllotreta nemorum*) and the rape aphid (*Brevicoryne brassicae*). The orifices caused by the weevils represent entrance gates for new pathogen agents.

Ceutorhynchus napi occurs during April, extending until the end of May, and *Ceutorhynchus assimilis* species occurs along with formation of floral button at the end of April and is present in culture until beginning of changing into brown color of seeds (Bucur and Roșca, 2011).

Larvae of *Phyllotreta atra* and *Phyllotreta nemorum* are leaf-miners. In strong attacks, the leaves dry up.

Often, aphids feed on the underside of the leaves and on the center of the rape head (Istrate and Roșca, 2009).

Because of the environmental concerns the choice and effective application of agrochemicals such as fungicides and insecticides is of particular importance in the European Union and beyond. Application of fungicides and insecticides, along with the observance of the other technological links in rape, ensure high yield potential, combined with good stability. Chemical control is still an indispensable method in effective rape protection against disease and pests in Romania.

MATERIAL AND METHODS

The research was carried out in the rape experimental fields from Cristian - Brașov at 45°37′43″ latitude and 25°29′00″ longitude, in conditions of natural infection during the vegetation period of 2020, 2021 and 2022. The land belongs to a farmer.

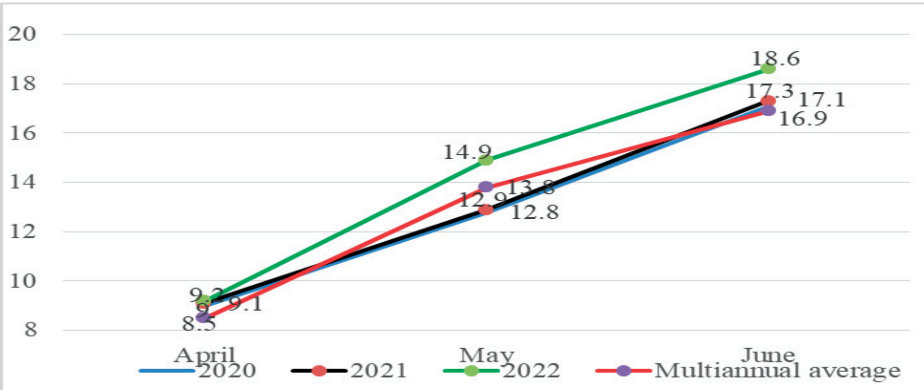
The observations were made on the rape hybrid PT234. This hybrid with semi-early maturity, has a fast development in autumn and a very good tolerance to drought and low temperatures (https://www.corteva.ro/). The notations regarding the attack of diseases and the presence of pests were performed on 100 leaves and siliques and the stems of each 4 plants/variant (16 plants/repetition in the experiment with fungicides and 12 plants/repetition in the experiment with insecticides).

Visual observation is the fastest method to identify diseases based on symptoms shown by infected rape plants and and identification pests based on their morphological characters. Scouting for diseases and pests attack has a particular importance in rape culture to establishing the attack value during the vegetation season.

The attack value is represented by frequency (F%), intensity (I%) and attack degree (AD%). Frequency is the percentage of leaves or siliques attacked out of 100 examined leaves or fruits. 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 using the frequency (disease incidence) and intensity (severity). Attack degree was calculated using the formula:

$$AD\ (\%) = \frac{F\ (\%) x I(\%)}{100}$$

For scouting optimization and for the observation of the climatic conditions necessary for the appearance and development of the diseases and pests, precipitation and temperatures were taken into account (Paraschivu et al., 2022). The abiotic factors have an important role during the fungus development and pathogenicity that cause diseases in rape, which is sensitive over the growing season (Radu et al., 2011). Regarding the variability of the climatic conditions in the three years of experimentation, it can be observed that in the commune Cristian the average temperature recorded was slightly below the multiannual average only in the months May 2020 and 2021 (Figure 1).

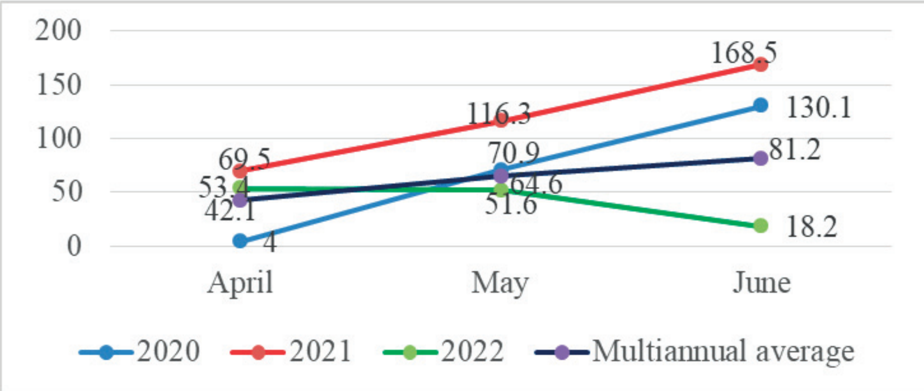


(source: https://www.meteoblue.com/ro/vreme/weatherarchive/cristian_românia)

Figure 1. Average monthly temperatures (°C), Cristian - Brașov

Regarding the rainfall, it can be seen that the amount recorded was below the multiannual average in the months of April 2020, May 2021 and June 2022 (Figure 2).

Fertilization consisted of 120 kg/ha N (1/3 of the dose in autumn and 2/3 of the dose in early spring) and complex fertilizer NPK 18:46:0 applied to prepare the land for sowing. Sowing in the three years of research was carried out in the first decade of September. The harvestable surface of one variant was 20 m^2. The harvestable area of a repetition was 80 m^2 in the fungicide experiment and 60 m^2 in the insecticide experiment.



(source: https://www.meteoblue.com/ro/vreme/weatherarchive/cristian_românia)

Figure 1. Average monthly precipitation (mm), Cristian - Brașov

The experiments were arranged according to the method of randomized blocks, in 4 repetitions. We researched and registering, from early April until late May, the number of larvae/plant of *Ceutorhynchus napi* and *C. assimilis*.

As we know, in agriculture, the material that is worked with, by its nature, is very variable and subject to a significant number of uncontrollable influences of the environment, which can produce important fluctuations from one repetition to another, which means that in the interpretation experimental results to take statistics into account. We used the analysis of variance, an ingenious procedure, founded by the English statistician Fisher (1926).

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

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

A standard technology was applied regarding the preceding plant, this was wheat, plowing (executed at 25 cm), sowing of a treated seed (fungicid: fluopicolid 200 g/l + fluoxastrobin 150 g/l and insecticid: cyantraniliprol 625g/l), fertilizer (ammonium nitrate and NPK 18:46:0) and herbicide (etametsulfuron-metil 75% - 25 g/ha postemergence-BBCH 10-18). In the experiment with fungicides, 3 treatments with insecticides were also applied (one in autumn and 2 in spring). In the experiment with insecticides, 2 treatments with fungicides were also applied (both in spring). The experiences with fungicides included 3 experimental variants: V1 - untreated control, V2 - 1 treatment applied in the stem elongation phenophase: BBCH 31; V3 - 2 treatments: one applied in the stem elongation phenophase, and the second in the “yellow bud” phenophase: BBCH 59. The fungicides used were: 125 g/l azoxistrobin + 125 g/l difenoconazol and 125g/l fluopiram + 125 g/l protioconazol - 1 l/ha each. Observations on the effectiveness of fungicides were carried beginning of ripening: BBCH 80 (Weber and Bleiholder, 1990). The insecticides applied were: 240 g/l tiacloprid - 0.3 l/ha and 5% lambda-cihalotrin - 0.15 kg/ha. A single treatment with each of the two insecticides was applied when pests were detected on the plants, and efficacy scoring took place after 3 days.

RESULTS AND DISCUSSION

Stem spots were observed on some rape plants as specific symptoms of black leg. On diseased stems *Plenodomus lingam* pathogen produced broad, elongated greyish-necrotic lesions wich containing numerous small, black pycnidia (Figure 3). The disease manifestsed itself also on the leafs throu grayish spots with numerous fine black convex pycnidia appear on their surface (Figure 4).

(foto: Mirela Paraschivu)

Figure 3. Stems lesion due to black leg

(foto: Otilia Cotuna)

Figure 4. Leaf canker (*Phoma lingam*) lesions

First powdery mildew symptoms appeared as circular to irregular white colonies, which subsequently developed into abundant growth on both leaf surfaces. Powdery mildew was manifested both on leaves and on siliques (Figure 5).

Alternaria appears on the siliques in the form of small light brown lesions that soon turn black (Figure 6) due to the appearance of spore masses, under humid conditions, and act as a source of infection for other siliques of the plant.

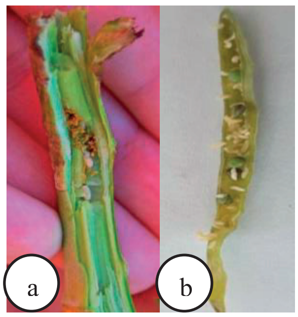
(foto: Cristinel Relu Ză)

Figure 5. Powdery mildew on the leafs and silique

(foto: Mali-Sanda Manole)

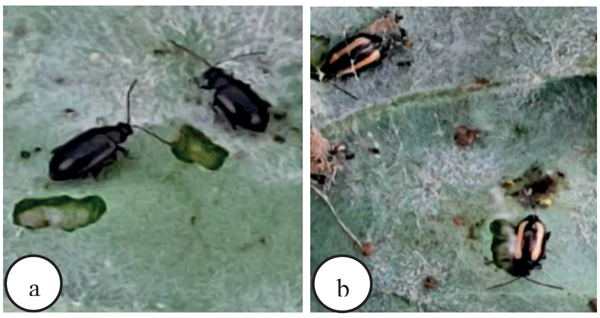
Figure 6. Alternaria on the siliques

The attack of the two weevils *Ceutorhynchus napi* (Figure 7a), and *Ceutorhynchus assimilis* (Figure 7b) stop plants and siliquaes growing, or if siliquaes do form, these have low quality seeds. The attack risk of *C. napi* appears at the beginning of the stem growth. Adults of the species *Phyllotreta atra* (Figure 8a) and *Phyllotreta nemorum* (Figure 8b) bore the upper epidermis of the leaves, in the form of small holes, especially on the edges. *Brevicoryne brassicae* (Figure 9) feed by sucking sap from their rape plants. Continued feeding by aphids causes yellowing, wilting and stunting of plants.



(foto: Rada Istrate)

Figure 7. Larvae of:
a) *Ceutorhynchus napi*;
b) *C. assimilis.*



(foto: Cristinel Relu Ză)

Figure 8. Adults of:
a) *Phyllotreta atra;*
b) *Phyllotreta nemorum.*

(foto: Cristinel Relu Ză)

Figure 9. Colonies of
Brevicoryne brassicae

From the data presented in Table 1, it can be seen that rapeseed 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 with fungicides was followed, namely the one applied with 125g/l fluopiram + 125 g/l protioconazol. Thus, the effectiveness of the treatment varied between 92.7% in 2021 and 93.1% in 2022.

The highest efficacy of 125 g/l azoxistrobin + 125 g/l difenoconazol fungicide, 78.2%, against black leg was recorded in 2020, while the highest efficacy of 86.6% was recorded for 125g/l fluopiram + 125 g/l protioconazol fungicide in the same year.

The application of a single phytosanitary treatment against powdery mildew recorded the highest effectiveness in 2022, respectively, 74.6% for 125 g/l azoxistrobin + 125 g/l difenoconazol and 75.4% for 125g/l fluopiram + 125 g/l protioconazol.

The efficacy of the two treatments (the first with 125 g/l azoxistrobin + 125 g/l difenoconazol and the second with 125g/l fluopiram + 125 g/l protioconazol) was at least 98.7% against black leg and at least 98.6% against powdery mildew.

Table 1. Results regarding the effectiveness of fungicide treatments, years 2020, 2021, 2022

Variants	Disease	Years	F (%)	I (%)	A.D. (%)	E (%)
Untreated control	Alternaria	2020	32.47	58.5	19.0	-
		2021	32.67	60.00	19.6	-
		2022	34.57	66.75	23.07	-
	Blackleg	2020	21.15	19.75	4.17	-
		2021	17.63	18.25	3.22	-
		2022	12.95	17.8	2.3	-
	Powdery mildew	2020	39.8	50.0	19.9	-
		2021	41.4	55.25	22.87	-
		2022	43.28	67.5	29.21	-
125 g/l azoxistrobin + 125 g/l difenoconazol	Blackleg	2020	9.35	9.77	0.91	78.2
		2021	8.15	9.1	0.74	77.0
		2022	7.43	8.82	0.66	71.3
	Powdery mildew	2020	21.5	27.3	5.9	70.4
		2021	23.3	29.8	6.94	69.7
		2022	24.2	30.7	7.42	74.6
125g/l fluopiram + 125 g/l protioconazol	Blackleg	2020	7.27	7.85	0.56	86.6
		2021	6.86	7.08	0.49	84.8
		2022	5.31	6.93	0.37	83.9
	Powdery mildew	2020	20.7	26.8	5.55	72.1
		2021	22.3	28.25	6.3	72.5
		2022	22.6	31.75	7.2	75.4
T1- azoxistrobin + 125 g/l difenoconazol T2 - 125g/l fluopiram + 125 g/l protioconazol	Alternaria (just 125g/l fluopiram + 125 g/l protioconazol)	2020	5.49	24.5	1.34	92.9
		2021	5.74	25.1	1.44	92.7
		2022	6.27	25.4	1.6	93.1
	Blackleg	2020	1.6	3.00	0.05	98.8
		2021	1.47	2.5	0.04	98.76
		2022	1.25	2.5	0.03	98.7
	Powdery mildew	2020	5.5	5.0	0.28	98.6
		2021	6.15	5.25	0.32	98.6
		2022	6.2	5.4	0.33	98.9

Regarding the influence of fungicide treatments on the level of yield (Table 2), it is observed that the application of a single treatment: 125 g/l azoxistrobin + 125 g/l difenoconazol (T1) or 125 g/l fluopiram + 125 g/l protioconazol (T2) contributes to a significant increase in two of the three years of research, while the yield increase (+200 kg/ha) was distinctly significant in the variant in which 125 g/l fluopiram + 125 g/l protioconazol fungicide was applied at the level of 2022.

In the variants where only one treatment was applied, in the case of the 125 g/l fluopiram + 125 g/l protioconazol, increases were recorded between 28 and 57 kg/ha compared to the 125 g/l azoxistrobin + 125 g/l difenoconazol fungicide.

Production increases were very significant (between 267 and 370 kg/ha) in the variants where two treatments were applied.

Table 2. Results regarding the influence of fungicide treatments on yield of PT 234 hybrid

Years	Variants	Yield (kg/ha)	Difference		Significance
			%	kg/ha	
2020	Untreated	2815	100	-	-
	T1	2935	104.3	120	*
	T2	2992	106.3	177	*
	T1 + T2	3116	110.7	301	***
2021	Untreated	3018	100	-	-
	T1	3121	103.4	103	*
	T2	3149	104.3	131	*
	T1 + T2	3285	108.8	267	***
2022	Untreated	2571	100	-	-
	T1	2733	106.3	162	*
	T2	2771	107.8	200	**
	T1 + T2	2941	114.4	370	***

	2020	2021	2022
LSD 5%	117.3 kg/ha	101.9 kg/ha	129.5 kg/ha
LSD 1%	196.7 kg/ha	162.6 kg/ha	199.8 kg/ha
LSD 0.1%	282.2 kg/ha	228.8 kg/ha	315.1 kg/ha

The density of harmful insects detected in the rape crop was the highest in 2022, and the lowest in 2020 (Table 3).

Insecticide treatments against the species *Phyllotreta atra* and *Phyllotreta nemorum* were applied at the beginning of the stem elongation growth stage. The efficacy of the insecticide 240 g/l tiacloprid varied between 87.8% in 2022 and 89.2% in 2021, which resulted in a decrease in the number of adults/plant from 60.8 to 7.4 (2022) and, respectively, from 56.4 at 6.1 in 2021. The efficacy of 5% lambda-cihalotrin insecticide varied between 86.7% in 2022 and 87.9% in 2020, which resulted in a decrease in the number of adults/plant from 60.8 to 8.1 in 2022 and, respectively, from 51.9 to 6.3 in 2020.

The treatment with insecticides against *Brevicoryne brassicae* species was applied in the phenophase first flowers opening (BBCH 60). The efficacy of 240 g/l tiacloprid insecticide was 95.7% in 2021 and 2022, and 96.3% in 2020. The efficacy of the insecticide 5% lambda-cihalotrin varied between 94.7% in 2022 and 95.2% in 2021, which resulted in a decrease in the number of colonies/plant from 20.8 to 1.1 (2022) and respectively from 18.6 to 0.9 in 2021.

The treatment with insecticides against *Ceutorhynchus napi* species was applied at the end of the stem elongation growth stage. The greatest decrease in the number of larvae occurred in the case of the application of the insecticide 240 g/l tiacloprid, from 7.1 larvae/stem to 0.3 larvae/stem in 2020, which resulted in the highest effectiveness recorded, of 95.8%. The efficacy of 5% lambda-cihalotrin insecticide ranged from 93.5% (2022) to 94.4% (2020).

The treatment with insecticides against *Ceutorhynchus assimilis* species was applied at the end of the development of siliques stage. Both insecticides showed the highest efficacy against this pest, compared to the other species against which they were applied. The effectiveness of the 240 g/l tiacloprid insecticide was the highest, 97.3%, in 2020, when we recorded a decrease in the number of larvae/silique from 41.4 in the untreated variants to 1.1. The efficacy of 5% lambda-cihalotrin insecticide was slightly above the value of 96.0%.

Table 3. Results regarding the effectiveness of insecticide treatments, years 2020, 2021, 2022

Species	Variants	Years	Average density		E (%)
			before treatment	after treatment	
Phyllotreta atra and *Phyllotreta nemorum*	Untreated	2020	51.9 adults/plant	-	-
		2021	56.4 adults/plant	-	-
		2022	60.8 adults/plant	-	-
	240 g/l tiacloprid	2020	-	5.8 adults/plant	88.8
		2021	-	6.1 adults/plant	89.2
		2022	-	7.4 adults/plant	87.8
	5% lambda-cihalotrin	2020	-	6.3 adults/plant	87.9
		2021	-	7.2 adults/plant	87.2
		2022	-	8.1 adults/plant	86.7
Brevicoryne brassicae	Untreated	2020	16.4 colonies/plant	-	-
		2021	18.6 colonies/plant	-	-
		2022	20.8 colonies/plant	-	-
	240 g/l tiacloprid	2020	-	0.6 colonies/plant	96.3
		2021	-	0.8 colonies/plant	95.7
		2022	-	0.9 colonies/plant	95.7
	5% lambda-cihalotrin	2020	-	0.8 colonies/plant	95.1
		2021	-	0.9 colonies/plant	95.2
		2022	-	1.1 colonies/plant	94.7
Ceutorhynchus napi	Untreated	2020	7.1 larvae/stem	-	-
		2021	8.7 larvae/stem	-	-
		2022	9.2 larvae/stem	-	-
	240 g/l tiacloprid	2020	-	0.3 larvae/stem	95.8
		2021	-	0.4 larvae/stem	95.4
		2022	-	0.5 larvae/stem	94.6
	5% lambda-cihalotrin	2020	-	0.4 larvae/stem	94.4
		2021	-	0.5 larvae/stem	94.3
		2022	-	0.6 larvae/stem	93.5
Ceutorhynchus assimilis	Untreated	2020	41.4 larvae/silique	-	-
		2021	45.2 larvae/silique	-	-
		2022	48.6 larvae/silique	-	-
	240 g/l tiacloprid	2020	-	1.1 larvae/silique	97.3
		2021	-	1.3 larvae/silique	97.1
		2022	-	1.5 larvae/silique	96.9
	5% lambda-cihalotrin	2020	-	1.5 larvae/silique	96.3
		2021	-	1.7 larvae/silique	96.2
		2022	-	1.9 larvae/silique	96.1

CONCLUSIONS

The main biotic factors, which play a limiting role in rape culture, are represented by a series of pathogenic agents and harmful insects, which under conditions favorable to the attack (abiotic factors are favorable), lead to a decrease in production and a decrease in its quality. Environmental conditions favor the growth and development of phytopathogenic agents, the evolution of diseases and the response of rape plants to various pathogen infections.

Alternaria was manifested only on siliques, powdery mildew occurred on leaves and stems, and blackleg occurred on leaves and stems. The application of fungicide treatments against alternaria, powdery mildew and black leg in rape was more effective in years more favorable to them.

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

Both insecticides applied showed very good efficacy against the respective harmful insects; the insecticide 240 g/l tiacloprid registering in all variants a slightly higher effectiveness compared to the insecticide 5% lambda-cihalotrin.

The fungicides 125 g/l azoxistrobin + 125 g/l difenoconazol and 125 g/l fluopiram + 125 g/l protioconazol together with the insecticides 240 g/l tiacloprid and 5% lambda-cihalotrin can be successfully used in the rapeseed pest control scheme. The application of fungicides together with the results obtained on the biology, epidemiology and genetic diversity of rape pathogens contribute to the development of disease management strategies.

In the complex of measures to combat various pathogens and pests, treatments with fungicides and insecticides are of particular importance due to their effectiveness, accessibility and widespread use. An integrated management strategy for rape diseases and pests based on risk assessment, monitoring, and crop management, to reduce the impact of agrochemicals on the environment, which will contribute toward the sustainability and profitability of rape production.

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