PhD THESIS

Research on the protection of rapeseed crops in north-eastern Moldova against pest attack

(SUMMARY OF Ph.D. THESIS)

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INTRODUCTION

The rapeseed has a particularly important place in the world economy, as a source of vegetable oils (METSPALU *et al*., 2015). Rapeseed oil has extensive food uses and can be used directly in food or used in other products. Rapeseed is also an excellent early honey plant, ensuring the collection of pollen and nectar since may, honey production can reach up to 50 kg of honey/ha. In the increase of areas cultivated with rape, a unique contribution has the fact that this plant is used to obtain biofuel used for cars being cheaper and less polluting (Del GATTO *et al*., 2015; KAISER *et al*., 2020). The multiple advantages justify the increase of the areas cultivated with winter rape.

Rapeseed crops are attacked by pests starting the autumn, but the most massive attacks are reported in the spring-summer period caused by a great diversity of species. In the local literature, it is shown that in rapeseed, the pest complex has a total of 48 species of the Insecta class (RĂILEANU, 2014; URSACHE *et al*., 2017).

The chemical method is the most used to control these pests, applying mainly insecticides from the group of synthetic pyrethroids and neonicotinoids (BRANDES *et al*.,2018) and it also determined the emergence of the resistance phenomenon (ERBAN *et al*., 2017; SKELLERN and COOK, 2018; STARÁ and KOCOUREK, 2018). For the application of chemical treatments, it is recommended to monitor the density of the pest population and to apply if exceed the PED (STRATONOVITCH *et al*., 2014). On the other hand, insecticides have also affected useful entomofauna (VINATIER *et al*., 2012; PALAGACHEVA and KEHAYOV, 2017; ŠAFÁŘ and SEIDENGLANZ, 2018). The concept of integrated control promotes the use of entomopathogenic microorganisms, protection of useful entomofauna as well as the use of semi-chemical products, especially in organic crops (COOK *et al*., 2007; HERVÉ *et al*., 2014; YAŞAR and SAĞDAŞ, 2014; KAISER *et al*., 2020).

The activity of plant protection is an important link in the development of a sustainable agriculture, which is why it is imperative to know all the factors that contribute to limiting the damage caused by pathogens and the damage of winter rape.

1. Structure of the doctoral thesis

The PhD Thesis includes a total of 148 pages and has been structured in two parts:

- Current State of Knowledge – 1st part (42 pages)
- Personal Contribution - 2nd part (106 pages)

The second part of the thesis summarizes a number of 108 pages, structured in 6 chapters, presenting the objectives pursued, meterial and methor, the particularities of the natural environment, the results obtained and discussions, conclusions and recommendations based on the obtained results, as well as its originality and innovative contributions. The thesis comprises a total of 44 tables, 37 figures and 194 bibliographic titles.

2. Research objectives

The subject of winter rape protection has been in the spotlight for several years in our country. Thus, following several researches, the best phytosanitary protection methods have been identified and recommended with the lowest impact on the environment. By integrating pest management into the development of crop technologies that will enhance the traits of increased resistance to the attack of pests, it was intended that this research project should support agricultural practice in the north-eastern Moldova.

The research objectives were:

- Monitoring and control of fleas in rapeseed culture
  - monitoring and control rapeseed fleas during the period of emergence and formation of the rosette depending on the treatments applied.
  - establishing the entomofauna structure of rapeseed fleas.
  - calculation of ecological indicators for rapeseed fleas.
- Testing the efficacy of some semi-chemical products synthesized at the "Raluca Ripan" Institute of Chemistry from UBB Cluj-Napoca in monitoring the pests in rapeseed culture.
  - efficacy of semi-chemical products in monitoring the species *Meligethes* (*Brassicogethes*) *aeneus* F.
  - efficacy of semi-chemical products in monitoring the species *Epicometis* (*Tropinota*) *hirta* Poda.
- Monitoring and control pests of rapeseed
  - monitoring of pests that attack in the spring-summer period in correlation with the applied chemical treatments.
  - calculation of ecological indicators for rapeseed pests according to the applied control technology.

3. Material and methods

The research objectives included in the project of the doctoral thesis were pursued in the experimental fields from Pomârla, Botoşani county.

3.1. Monitoring and control of rapeseed fleas

Monitoring the density of rapeseed flea populations was performed in three experimental variants:

- V1 = untreated
- V2 = variant with the application of a single treatment
- V3 = variant with the application of two chemical treatments

In V2 a single treatment with a systemic insecticide was using (Calypso 480 SC in 2015 şi 2018, Mospilan 20 SG in 2016, Actara 25 WG in 2017).

In V3 about two weeks after the first treatment, the second treatment was performed using a synthetic pyrethroid (Karate Zeon in 2015, 2017 and 2018, Decis 2,5 EC in 2016).

In each variant, the density of flea populations and the degree of attack were established to calculate the efficacy of the applied control scheme. The catches made on the sticky panels were analyzed in the laboratory to determine the structure of rapeseed flea species in each experimental year and in each experimental variant, for which a series of ecological indicators were established, such as: abundance, dominance, constancy and significance index green.

3.2. Testing the effectiveness of semi-chemical products in monitoring pests in rapeseed culture

In the period 2016-2018, we tested the functionality of some semiochemical formulations to be used for monitoring two species of pests in autumn rapeseed crops: *Meligethes* (*Brassicogethes*) *aeneus* F. şi *Epicometis* (*Tropinota*) *hirta* Poda.

For *Meligethes* (*Brassicogethes*) *aeneus* F. three economical formulations were tested:

- V1 = izotiocianat of alil + nonan;
- V2 = 2-fenil-etil izotiocianat + nonan; .
- V3 = izotiocianat of alil + 2-fenil-etil izotiocianat + nonan.

For *Epicometis* (*Tropinota*) *hirta* Poda. were tested trans-anetol (4-propenylanisole, trans-1-methoxy-4-(1-propenyl) benzene), verified in two ways of use.

3.3. Monitoring and control of rapeseed pests

In the period 2016-2018, an experiment with three variants was organized in which we proceeded to monitor the pests according to the applied chemical control scheme.

The experimental variants were:

- V1 = untreated
- V2 = variant with the application of a single treatment
- V3 = variant with the application of two chemical treatments

4. Results and discussions

4.1. Results regarding the monitoring and control of fleas in rapeseed

In the rapeseed culture in the investigated area, the numerical density of rapeseed flea populations is closely correlated with the climatic characteristics of each year. With the sticky traps, the lowest catches were made in 2016, the year in which the lowest temperatures and the most precipitations during the five years of study were registered during the eastern rapeseed period, and the most catches were in 2018, which was the hottest and driest in September-October.

In the untreated variant, the degree of the attack had values between 17.8% (in 2016) and 24.9% (in 2018), with a multi-annual average of 21%.

By applying a single treatment, the degree of attack ranged between 1.1% (in 2016) and 1.8% (in 2018),with a multi-annual average of 1.4%, the effectiveness of this treatment being between 92,3% (in 2015) and 94.1% (in 2017), with a multi-year average of 93.3%.

In the variant with the application of two chemical treatments, the degree of attack was between 0.5% (in 2016) and 1.2% (in 2018), with a multi-annual average of 0.9%, which represents a reduction of the degree of attack compared to the untreated witness with a proportion between 95.2% (in 2018) and 97.2% (in 2016), with a multi-annual average of 95.7%.

In rapeseed culture, the structure of rapeseed fleas was composed of the following species: *Phyllotreta atra* Fabricius, *Phyllotreta nemorum* L., *Phyllotreta undulata* Kutschera and *Psylliodes chrypocephala* L. Each species had a differentpercentage of participation in the entomofauna structure from one year to another. During the four years, the species *Phyllotreta atra* represented 52.5% of the total catches. *Phyllotreta nemorum* participated with 29.5% in the structure of the entomofauna, *Phyllotreta undulata* with 8.3%, and the species *Psylliodes chrysocephala* with 9.7%.

4.2. Results regarding the testing of the efficacy of some semi-chemical products in the monitoring of rapeseed pests

● efficacy of semi-chemical products in monitoring the species *Meligethes (Brassicogethes) aeneus* F.

In Pomârla, Botoşani county, the species *Meligethes* (*Brassicogethes*) *aeneus* F. is a frequently encountered pest, with a tendency to increase the numerical density. The total catch made in the four experimental variants on the monitoring interval was 5585 adults, of which: 1656 specimens in 2016, 1746 catches in 2017 and 2183 catches in 2018.

In the control variant, 629 adults were captured, representing 11.3% of the total catches. In this variant of the simple yellow panels, which are used by farmers in monitoring the species *Meligethes* (*Brassicogethes*) *aeneus* F. in the period 2016-2018 made a total of 482 catches, representing 13.7% of the total catches made in the experimental plot. During three weeks of testing, the catches made on a panel ranged from 21 to 82 specimens. Delta white traps are not recommended to be used, the catches made by them are meagre, representing only 7.1%.

By using semi-chemical products synthesised at the "Raluca Ripan" Institute of Chemistry at UBB Cluj-Napoca, during the experimental period, an increase in catches was achieved regardless of the type of trap on which the dispenser was placed. All variants with dispensers had differences from the control, which were statistically assured.

Dispenser 1 (allyl isothiocyanate + nonan) made 23.6% of the total catches. Compared to the control variant, it achieved an increase of catches over the three experimental years 1.7 times higher on the yellow panels and 3.4 times higher on the white Delta type traps, the difference being distinctly significant positive.

Dispenser 2 (2-phenyl-ethyl isothiocyanate + nonan) made 27.6% of the total catches. Compared to the control variant, it made 1.9 times more catches on the yellow

panels and 4.2 times more on the Delta traps, the difference being very significantly positive.

At dispenser 3 (allyl isothiocyanate + 2-phenyl-ethyl isothiocyanate + nonan) 37.5% of the total catches were made. Compared to the control variant, the increase in catches was 2.7 times more catches on the yellow panels and 5.5 times more on the Delta traps, the difference being very significantly positive. The components have a synergistic effect; the catches on both types of traps are numerically superior to those made in the previous pheromone variants. The differences between dispenser 3 and dispenser 1, as well as between dispenser 3 and dispenser 2 are statistically assured.

● efficacy of semi-chemical products in monitoring the species *Epicometis (Tropinota) hirta* Poda.

In the three years of study, 2552 adults were captured in the three variants.

In the control variant (the blue vessel with water) in the three years 375 adults of *Epicometis* (*Tropinota*) *hirta* Poda were captured (representing 14.7% of the total catches), of which 126 adults in 2016, in 2017 year 84 adults were captured, and in 2018 year 165 adults were captured.

In variant (V1) with trans-anetol and cinamil alcool in proportion 2:1, is impregnated on the felt in a polyethylene bag with 150 mg/trap, in the three years 818 adults of *Epicometis* (*Tropinota*) *hirta* Poda were captured (representing 31.9% of the total catches), of which: 230 adults in 2016, in 2017, 194 adults were captured, and in in 2018, 391 adults were captured.

Compared to the control, the catches are 183% higher in 2016, by 231% in 2017 and 237% in 2018.

In variant (V2) in which the semi-chemical product was placed in water in a blue vessel placed on the ground, in the three years 1362 adults of *Epicometis (Tropinota) hirta* Poda (representing 53,4% of the total catches), of which 458 adults in 2016, in 2017, 337 adults were captured, and in 2018, 567 adults were captured.

Compared to the control, the catches are higher by 363% in 2016, by 401% in 2017 and by 444% in 2018.

Compared to variant (V1) the catches are higher by 199% in 2016, by 174% in 2017 and by 145% in 2018.

In this variant, the increase in the number of catches compared to V1 is also explained by the fact that there is a phenomenon of synergism between the semiochemical product, the color of the vessel and the fact that adults also look for a source of water, water that is in the trap vessel.

4.3. Results regarding the monitoring and control of rapeseed pests

In the three years of pest monitoring in the three variants, 5313 adults were captured, of which 71.2% in the untreated control variant, 20% in the variant with the application of a single chemical treatment and 8.8% in the variant with the application of two chemical treatments.

From the untreated control variant in the period 2016-2018, through the 10 threads, 3780 insects were collected, of which: 1267 specimens in 2016, in 2017 996 specimens were collected, and in 2018 1517 specimens were collected . Each year most specimens were from the species *Meligethes aeneus* and *Epicometis hirta*.

In the variant with the application of a single chemical treatment, 1062 insects were collected, of which: 344 specimens in 2016, in 2017 283 specimens were collected, and in 2018 435 specimens were collected.

Compared to the untreated control variant, the total number of collected specimens decreased in a proportion of about 73% in 2016, by 72% in 2017 and 2018.

In the variant with the application of two chemical treatments, 469 insects were collected, of which: 183 specimens in 2016, in 2017 134 specimens were collected, and in 2018 152 specimens were collected.

Compared to the untreated control variant, the total number of collected specimens decreased in a proportion of about 86% in 2016, by 87% in 2017 and 90% in 2018.

The species *Meligethes aeneus* F. and *Epicometis hirta* Poda have a large number of specimens in both variants with the application of chemical treatments, this phenomenon being determined by the continuous migration of these species from the spontaneous vegetation existing in the vicinity of rapeseed fields.

The analysis of the values of ecological indices shows the species *Epicometis hirta* Poda and *Meligethes aeneus* F. in each variant have the highest abundance, are eudominant species with a value of over 10% (D5), are euconstant species with the value of the index between 75.1 - 100% (C4), respectively characteristic species, with the value of over 10% (W5).

In order to effectively control pests in rapeseed cultivation, it is necessary to apply two treatments during the vegetation period of the crop.

The average yields obtained for the three years in the production plots in which two treatments were applied were the following: for the Alonzo hybrid - 3.5 t/ha, for the Olano hybrid - 4.2 t/ha, and for the ES Neptune hybrid - 3 , 8 t/ha.

5. Conclusions and recommendations

1. Since 2015, a strong impact of global warming on the structure of rapeseed pests in the northeastern part of Moldova has been observed.
2. The importance of rapeseed pests has been growing in 2016 and 2018, especially for rapeseed fleas that attack autumn from sunrise to the rosette stage, as well as *Ceuthorrrynchus* species that attack in spring, mainly the leaf, stem, flowers and siliceous. These pests require a professional study of the dynamics and an adequate integrated control.

3. The species *Epicometis hirta* Poda and *Meligethes aeneus* F. have the highest abundance every year, and their chemical control is difficult, their attack overlapping with the flowering period of rapeseed.
4. The integrated pest control system, appropriate to climate change and cross-cutting factors, shall include the application of selective insecticides and the promotion of alternative methods of prevention and control.

Recommendations

In rapeseed crops, continuous monitoring of species that attack the vegetative and generative organs is required in order not to allow the accumulation of a high biological reserve of them.

To control the pest complex, it is recommended to apply two treatments in autumn, and in spring-summer, depending on the density of pests, it is recommended to apply 2-3 treatments.

To monitor the dynamics of the numerical density of the pests *Meligethes aeneus* F. and *Epicometis hirta* Poda, i recommend the use of yellow traps and / or semi-chemical products produced by the "Raluca Ripan" Institute of Chemistry at UBB Cluj-Napoca.

6. Originality and innovative contributions of the thesis

- Monitoring studies were performed for the first time of the phytophagous entomofauna from rapeseed crops from Dorohoi area, Botoşani county.
- The effectiveness of sticky panels in monitoring rapeseed flea species was tested.
- The values of the ecological indices of the rapeseed flea species were calculated.
- To monitor and possibly control the hairy beetle, *Epicometis* (*Tropinota*) *hirta* Poda, and the glossy rapeseed beetle, *Meligethes* (*Brassicogethes*) *aeneus* F. from rapeseed crops, the first studies were performed in our country on the effectiveness of some semi-chemical products which have the chance to be approved.

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