RESEARCH IN CONTROL OF RAPESEED FLEAS

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Abstract. During the emergence of winter rapeseed, the crop can be attacked by many species of pests, rapeseed fleas being the most important. This paper presents the results obtained in combating these pests as well as the participation of rapeseed flea species in the structure of the entomofauna collected using glued panels. The effectiveness of two control strategies over the period 2015-2018 was verified. By applying a single treatment with systemic insecticides, the degree of attack decreased compared to the untreated control in a proportion between 92.3% and 94.1%. The second variant was by applying the second treatment with a synthetic pyrethroid, at an interval of 14 days after the first treatment. In this variant, the degree of attack was reduced in a proportion between 95.2% and 97.2%. Every year and in every variant, *Phyllotreta atra* was the dominant species followed by *Phyllotreta nemorum*. The lowest catches were in *Phyllotreta undulata* and *Psylliodes chrypocephala*.

Keywords: *Phyllotreta atra*, *Phyllotreta nemorum*, *Phyllotreta undulata, Psylliodes chrypocephala*, degree of attack.

INTRODUTION

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. Systematically these insects belong to the following orders: Coleoptera 25 species; Lepidoptera 9 species; Diptera 6 species; Heteroptera 4 species; Hymenoptera 1 species; Homoptera 3 species (Răileanu, 2014).

Rapeseed fleas (*Phyllotreta atra* F., *Phyllotreta nemorum* L., *Phyllotreta undulata* Kutschera and *Psylliodes chrypocephala* L.) are among the most common pests found in rapeseed culture and widespread in our country (Trotuş *et al.*, 2009; Manole *et al.*, 2009; Talmaciu *et al.*, 2010; Buburuz *et al.*, 2012; Popovici and Tălmaciu, 2013; Răileanu and Tălmaciu, 2013; Răileanu, 2014; Bucurean and Marnea, 2015; Ursache *et al.*, 2017). They are oligophagous species that have one generation per year. *Phyllotreta species* overwinter in the adult stage and Psylliodes chrypocephala in the egg or larval stage (Hiiesaar *et al*., 2003; Tancik and Dúlanský, 2013; Metspalu *et al*., 2014; Nilsson *et al*., 2015; Stankevych *et al*., 2019). Adults attack the leaves on which the characteristic "sieve" appears, and if the plants are attacked in the emergent phase, and the weather is dry, they will die.

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. 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 (Büchs and Nuss, 2000; Oberholzer *et al*., 2003; Veromann et al., 2006; Vinatier et al., 2012; Šafář and Seidenglanz, 2018). The concept of integrated control promotes the use of entomopathogenic microorganisms (*Beauveria bassiana* Bals., *Metarhizium anisopliae* Metsch, *Nosema phyllotretae* Weiser, *Gregarina phyllotretae* Hoshide and *Unikaryon phyllotretae*), especially in organic crops (Yaman *et al*., 2010; Carreck *et al*., 2007; Kaiser *et al*., 2020).

MATERIAL AND METHODS

In autumn, the plants are attacked by many species of pests, but among them, the rapeseed fleas stand out. In terms of attack degree, there is a direct correlation between the numerical density of the population and the climatic condition.

In the period 2015-2018 in Pomârla, Botoşani county, the rapeseed fleas were monitored according to the applied treatment scheme. Three experimental variants were placed: untreated control, the variant with the application of a single treatment and variant with the use of two chemical treatments (Table 1). The surface of the control variant was of 1000 sq.m areas, and for the variants, with the application of chemical treatments, it was of 1 ha. In each year, in the variant with the application of a single treatment, was used an insecticide with systemic action (Calypso 480 SC in 2015 and 2018; Mospilan 20 SG in 2016; Actara 25 WG in 2017). The second treatment was applied after 14 days. In the version with the application of two treatments, we used a synthetic pyrethroid (Karate Zeon in 2015, 2016 and 2018; Decis 2.5 EC in 2016).

Table 1.

Tratamente aplicate la rapiţa de toamnă

Year	No. treat.	Date of treatment	The product	Active substance	Dose
2015	1	24.09.2015	Calypso 480 SC	Tiacloprid	0.1 l/ha
	2	8.10.2015	Karate Zeon	Lambda-cyhalotrin	0.15 l/ha
2016	1	25.09.2016	Mospilan 20 SG	Acetamiprid	0.15 kg/ha
	2	10.10.2016	Decis 2,5 EC	Deltametrin	0.15 l/ha
2017	1	28.09.2017	Actara 25 WG	Thiametoxam	0,1 kg/ha
	2	13.10.2017	Karate Zeon	Lambda-cyhalotrin	0.15 l/ha
2018	1	21.09.2018	Calypso 480 SC	Tiacloprid	0.1 l/ha
	2	5.10.2018	Karate Zeon	Lambda-cyhalotrin	0.15 l/ha

To evaluate the effectiveness of the applied treatments, in each experimental variant were placed ten white sticky panels, with a size of 30/30 cm. Placing was made the day after the first treatment on the diagonal of the experimental plot. The catches were read twice a week for 18 days. The four species were identified on each trap: *Phyllotreta atra*, *Phyllotreta nemorum*, *Phyllotreta undulata* and *Psylliodes chrypocephala* to determine the contribution of each species in the structure of the collected entomofauna. Also, in each variant, the degree of attack was checked to establish the effectiveness of the applied treatment schemes.

RESULTS AND DISCUSSION

In 2015, with the sticky panels, 539 specimens were captured in the three experimental variants, of which: 442 in the untreated control, 67 in the version with a single treatment and 30 in the version with the application of two treatments (Table 2).

Table 2.

Number of catches of fleas depending on the treatments applied (2015-2018)

Variant	Year				
	2015	2016	2017	2018	2015-2018
Untreated	442	317	436	686	1881
1 treatment	67	53	52	87	259
2 treatments	30	15	36	32	113
Total	539	385	524	805	2253

Comparing the total number of catches made in each experimental variant, we find that the number of scores decreased by 84.8% by applying one treatment and by 93.2% by using two treatments (Fig. 1).

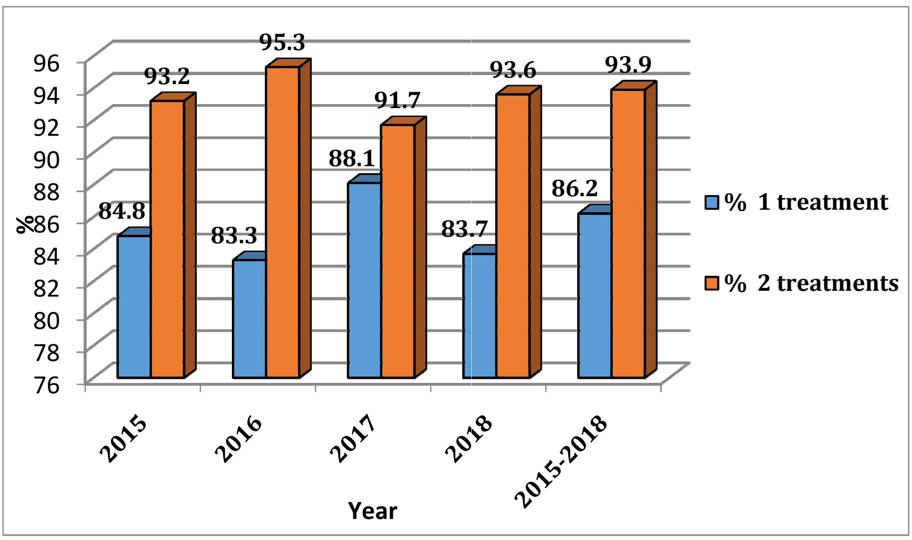

Fig. 1. The contribution of treatments in reducing catches (%) (2015-2018)

In the untreated control variant, the number of catches/panel was between 21 individuals and 89 individuals. By applying a single treatment, this parameter ranged between 1 and 13 individuals, and by applying two treatments, the catches made on a panel were between 0 and 9 individuals. We found that in the single-treatment variant, compared to the two-treatment variant, more specimens of *Psylliodes chrysocephala* L. were reported, this species being favoured by the decreasing temperature trend.

In 2016, 385 specimens were captured in the three experimental variants. This year, the lowest number of catches in the four years of monitoring was achieved. This phenomenon was determined by the climatic conditions in September and especially in October. October had the lowest temperatures, the monthly average being 7.1°C, compared to 8.9°C in 2015, 10.4°C in 2017, and 12.3°C in 2018. Also, October was with the most monthly precipitations, these being 133 mm, compared to 8.4 mm in 2015, 34.7 mm in 2017 and 12 mm in 2018. It can be concluded that the numerical density of rapeseed fleas is lower in the years when after the emergence of rapeseed and until the rosette is formed, it is a colder and rainy period. Also, the sensitivity of plants to flea attack is lower, because in hot and dry years the plants lose a lot of water through the wounds caused by the attack, which can enter an irreversible water imbalance that can cause plant death and thus reduce crop density. This year, of the 385 catches: 317 were made in the untreated control, 53 in the variant with the application of a single treatment and 15 in the variant with the use of two treatments (Table 2). The number of catches decreased by 83.3% by applying one treatment and by 95.3% by applying two treatments (Fig. 1). It was the year in which the highest percentage reduction in catches was achieved by applying two treatments. In the untreated control the number of scores made on a panel was between 16 and 44 individuals, in the single treatment variant between 0 and 11 specimens were captured, and by applying two treatments between 0 and 4 samples.

During the monitoring period of the catches made in 2017 with the sticky panels, 524 specimens were captured in the three experimental variants, of which: 436 in the untreated control, 52 in the version with a single treatment and 36 in the version with the application of two treatments. In the untreated control variant, the number of catches/panel was between 24 and 72 individuals, in the variant with use of a single treatment between 1 and 9 specimens, and by the application of two treatments between 0 and 8 samples. If we analyze the total number of catches made in each experimental variant, we find that the number of scores decreased by 88.1% by applying one treatment and by 91.7% by applying two treatments (Fig. 1).

In 2018, a total of 805 specimens were captured, being the year in which the largest number of catches in the four years of monitoring rapeseed fleas was made. This phenomenon was determined by the climatic conditions in September and especially in October. This year, October was the warmest of the entire experimental period, with a monthly average temperature of 12.3°C. Also, September and October had the lowest monthly rainfall, which was 16, 9 mm in September and 12 mm in October, respectively. Therefore, dry and hot autumns are very favourable for rapeseed flea populations, as they can cause a high degree of plant attack. Of the 805 catches: 686 were made in the untreated control, 87 in the variant with the application of a single treatment and 32 in the variant with the use of two treatments (Table 2). The number of catches decreased by 83.7% by applying one treatment and by 93.6% by applying two treatments (Fig. 1). In the untreated control variant, the number of catches made on a panel was between 47 and 112 individuals, this being the highest number of scores made by a sticky panel throughout the experimental period. By applying a single treatment, this parameter ranged between 1 and 21 individuals, and by applying two treatments, the catches made on a panel were between 0 and 9 specimens.

By averaging the decrease in catches over the four experimental years, it can be seen that by applying chemical treatments the number of catches decreased by 86.2% by applying a single treatment and by 93.9% by applying two treatments (Fig. 1). In the four experimental years, 2253 rapeseed fleas were captured from the three variants. If we express the annual percentage of catches from the total made during the monitoring period, this is 23.9% in 2015; of 17.1% in 2016; of 23.3% in 2017; and 35.7% in 2018 (Fig. 2).

In the three variants, we proceeded to evaluate the degree of attack produced by rapeseed fleas. The results obtained are presented in table 3.

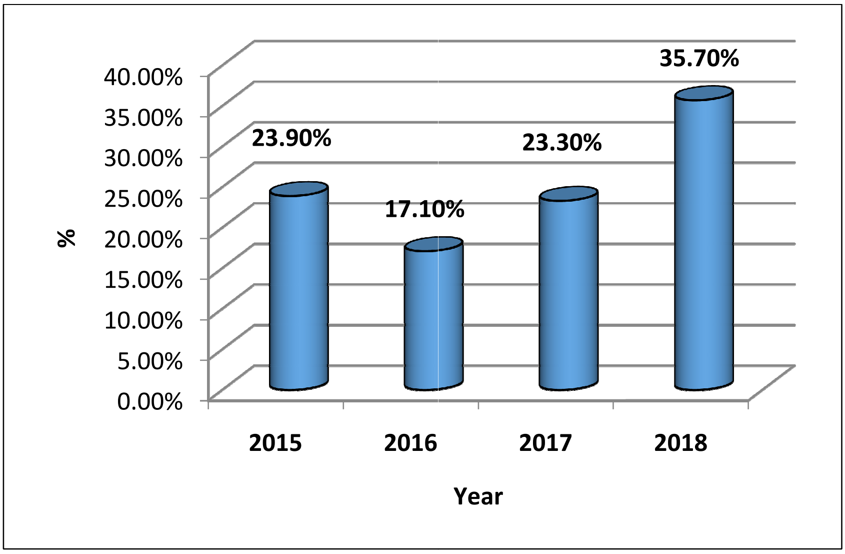

Fig. 2. % of annual catches in the total experimental period (2015-2018)

Table 3.

The degree of attack produced by fleas depending on the experimental variant (%)

Variant	Year				
	2015	**2016**	**2017**	**2018**	**2015-2018**
untreated	19,6	17,8	21,8	24,9	21,0
1 treatment	1,5	1,1	1,3	1,8	1,4
2 treatments	0,8	0,5	1,0	1,2	0,9

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%. Chemical treatments have substantially reduced the degree of flea attack. Thus, 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%. By applying two treatments, the degree of attack was between 0.5% (in 2016) and 1.2% (in 2018), with a multi-annual average of 0.9%.

Figure 3 is a graphical representation of the effectiveness of applied chemical treatments. By applying a single treatment, the degree of attack was reduced in a proportion between 92.3% (in 2015) and 94.1% (in 2017), with a multi-annual average of 93.3%. The application of two treatments reduced the degree of attack compared to the untreated control with a proportion between 95.2% (in 2018) and 97.2% (in 2016), with a multi-annual average of 95.7%. In both variants with chemical treatments, the intensity of the attack was reduced.

The application of the second treatment determined an increase in efficacy by 3.6 percentage points in 2015, by 3.4 percentage points in 2016, by 1.2 percentage points in 2017 and by 2.4 percentage points in the year 2018, and the multiannual average by 2.4 percentage points.

It can be seen that the application of the second chemical treatment has led to a slight decrease in the degree of attack, so it may be that from an economic point of view this treatment would not be justified, but if we consider the whole complex of pests that attack in autumn (especially aphids, some species of Lepidoptera, giant fleas of rapeseed and other beetles) this treatment is valid on the entire phytophagous entomofauna.

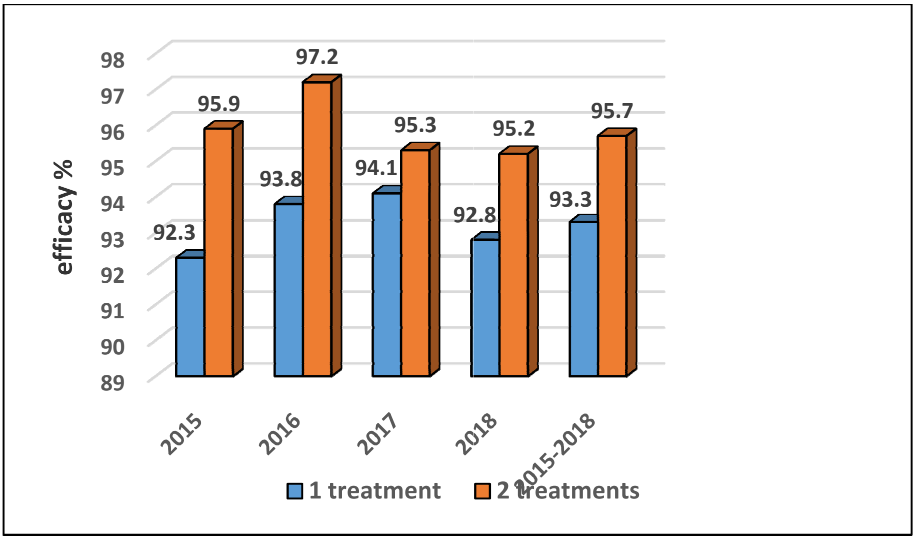

Fig. 3. Efficacy of applied chemical treatments (%) (2015-2018)

The captures made on the sticky panels were analyzed in the laboratory to determine the structure of the flea species in each experimental year.

Table 4 shows the number of specimens of the four species of rapeseed fleas collected each year, and Table 5 the percentage of participation of each species in the structure of the entomofauna collected.

Table 4.

The structure of the entomofauna collected in 2015-2018 year

Species	Year				Total
	2015	2016	2017	2018	
Phyllotreta atra Fabricius	346	218	252	366	1182
Phyllotreta nemorum L.	109	119	183	254	665
Phyllotreta undulata Kutschera	38	19	45	84	186
Psylliodes chrysocephala L.	46	29	44	101	220
Total	539	385	524	805	2253

In 2015, of the 539 specimens collected, most belong to the species *Phyllotreta atra*, of which 346 specimens were collected (representing 64.2% of total catches, being the highest percentage of the four experimental years), followed of the species *Phyllotreta nemorum* with 109 specimens (representing 20.2% of the total catches, being the lowest percentage of the four experimental years) The other two species had a much smaller number of catches, *Phyllotreta undulata* with 38 specimens (representing 7.1 %) and *Psylliodes chrysocephala* with 46 catches (representing 8.5%) (Tables 4 and 5.).

In 2016, the year in which the fewest catches were made, again the species *Phyllotreta atra* and *Phyllotreta nemorum* had the highest percentage of participation in the structure of the collected entmofauna. *Phyllotreta atra* accounted for 56.6% of total catches, and *Phyllotreta nemorum* accounted for 30.9% of overall scores. The other two species had the lowest percentage of participation in the research period. *Phyllotreta undulata* with 19 catches accounted for 4.9% of total catches, and *Psylliodes chrysocephala* with 29 catches accounted for 7.75% of total catches.

Table 5.

Percentage of participation of each species in the structure of the collected entomofauna

Species	Year				Total
	2015	2016	2017	2018	
Phyllotreta atra Fabricius	64.2	56.6	48.1	45.5	52.5
Phyllotreta nemorum L.	20.2	30.9	34.9	31.6	29.5
Phyllotreta undulata Kutschera	7.1	4.9	8.6	10.4	8.3
Psylliodes chrysocephala L.	8.5	7.6	8.4	12.5	9.7
Total	539	385	524	805	2253

In 2017, 252 catches were made at *Phyllotreta atra*, with a percentage of participation in the entmofauna structure of 48.1%. *Phyllotreta nemorum* accounted for 34.9% of total catches, the highest rate in experimental years. The other two species had the lowest percentage of participation in the entomofauna structure. *Phyllotreta undulata* with 45 catches accounted for 8.6% of total catches, and *Psylliodes chrysocephala* with 44 catches accounted for 8.4% of total catches. It is the only year in which *Phyllotreta undulata* had a slightly higher percentage compared to *Psylliodes chrysocephala*.

The year 2018 was particularly favourable for the monitored species, being the year with the most catches, a total of 805 specimens. *Phyllotreta atra* maintained its tendency to decrease the percentage participation in the entmofauna structure. 366 catches were made in this species, with a percentage of participation in the structure of the entomofauna of 45.5%, being the lowest percentage of the four years. *Phyllotreta nemorum* accounted for 31.6% of total catches, with 254 catches. The other two species had the highest rate of participation in the entomofauna structure during the research period. *Phyllotreta undulata* with 84 catches accounted for 10.4% of total catches, and *Psylliodes chrysocephala* with 101 scores accounted for 12.5% of total catches.

During the four years, 2253 specimens were collected from the experimental plots. During this interval, there were 1182 catches of *Phyllotreta atra*, representing 52.5% of the total catches. *Phyllotreta nemorum* participated with 29.5% in the structure of the entomofauna, capturing 665 specimens. Of the species *Phyllotreta undulata*, 186 samples were captured, representing 8.3% of the total catches, and the species *Psylliodes chrysocephala* with 220 catches represented 9.7% of the entomofauna collected.

CONCLUSIONS

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 different percentage 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%.

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