Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2021, 11(2), 417-42x, doi: 10.15421/2021_131

ORIGINAL ARTICLE

Harmfulness of cruciferous bugs

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Received: 01.03.2021. Accepted 08.04.2021

The complex of cruciferous bugs includes such species as painted or harlequin (cabbage) bug (*Eurydema ventralis* Kol), pentatomid rape bug (*E. oleraracea* L.), and mustard bug (*E. ornata* L.). They belong to a line Hemiptera, the family Shield bugs (Pentatomidae), and the genus Cruciferous bugs (*Eurydema*). The dominant species is the cabbage bug. The mustard bug dominated only in 2007, and since 2012 it has not been detected in the records. They are widespread throughout the whole territory of Ukraine. Both adult bugs and larvae cause damage to the crops; they pierce the leaf skin or floriferous shoots with the proboscis and suck out the juice. The light spots appear at the puncture points, the tissue dies, falls out, and the holes of the irregular form are formed. When the seeds are damaged, the flowers and ovary fall off, and the quality of the seeds deteriorates. The harmfulness of the bugs increases dramatically in dry and hot weather.

It is established that the weight of 1000 seeds of spring rape damaged by the cruciferous bugs is 36.27–53.52% less than that of the undamaged ones; for white mustard, these figures are 33.05–33.48%, and the weight of 1000 seeds of white cabbage damaged by the cruciferous bugs is 30.48–30.83 % less than the weight of the undamaged ones. The germination rate of the damaged spring rape seeds is 5.7-9.4% lower than that of the undamaged ones, the germination rate of white mustard is lower by 10.6%, and the germination rate of white cabbage seeds is lower by 37.1-38.1%. The oil content in the damaged seeds of spring rape is reduced by 14.45% on average, and the estimated oil yield at an average yield capacity of 0.495 t/ha is 0.071 t/ha lower.

Key words: spring rape**,** mustard, pests, harmfulness, cruciferous bugs.

Introduction

The complex of cruciferous bugs includes such species as painted or harlequin (cabbage) bug (*Eurydema ventralis* Kol), pentatomid rape bug (*E. oleraracea* L.), and mustard bug (*E. ornata* L.). They belong to a line Hemiptera, the family Shield bugs (Pentatomidae), and the genus Cruciferous bugs (*Eurydema*). The cruciferous bugs are a common species and are spread throughout the Palaearctic. They are widespread throughout the whole territory of Ukraine (Puchkov, 1961; Yevtushenko, Vilna, Stankevych, 2016).

The imago of the cabbage bug is 6-10 mm long; its body is flattened, the prothorax is red with six black spots, on the shield and elytra there are black spots and stripes (Figure 1); the antennae are 5-segmented; a triangle scutellum covers a larger part of the abdomen, the legs are 3-segmented. The imago of the mustard bug is 6-10 mm in size; the body is flattened, the prothorax is yellow with six black spots, on the shield and elytra, there are black spots and stripes (Figure 1). The imago of the rape bug is 6-10 mm in size; the body is flattened, the prothorax is white with six black spots; on the shield and elytra, there are black spots and stripes (Figure 1). The egg is 0.6–0.8 mm in size, cylindrical; the bottom is rounded, the top is covered by a convex lid that opens when the larvae hatch (Figure 1). The larva of the imago is similar (Figure 1). The immature bugs overwinter under the fallen leaves at the edge of forest belts, in gardens and parks, on the beams slopes and roadsides. In April and May, they leave the wintering places. Besides, they feed on the cabbage weeds, and with the emergence of the cultivated cabbage plants, sprouts, and seedlings transplanting, the bugs' mass flies over to them. The female lays 12 eggs in a group, placing them in two rows, more often on the underside of the leaves. The fertility is up to 300 eggs. The embryonic development lasts for 6–12 days. The larvae feed on the plants for 25–40 days turning into an adult insect. After the extra feeding, the bugs give birth to the second generation, which develops in July and August. Both the adult bugs and larvae cause damage to the crops; they pierce the leaf skin or floriferous shoots with the proboscis and suck out the juice. The light spots appear at the puncture points, the

tissue dies, falls out, and the irregular form holes are formed. When the seeds are damaged, the flowers and ovary fall off, and the seeds' quality deteriorates. The economic threshold of harmfulness is 2–3 bugs per plant (Belyaev et al., 2017; Puchkov, 1961; Yevtushenko et al., 2009; Stankevych, Vilna, 2012; Vilna, 2013; Vilna, Stankevych, 2013; Stankevych, Kava, 2013; Yevtushenko, Vilna, 2014; Vilna et al., 2015; Stankevych, 2015; Yevtushenko et al., 2016).

Fig. 1. Cruciferous bugs: 1) oviposition; 2) reappearance of larvae; 3) larva and signs of damage; 4) rape bug; 5) mating of cabbage bugs; 6) mustard bugs (photo by the author, Educational, Research and Production Centre "Research Field" of Kharkiv National Agrarian University named after V.V. Dokuchaiev, 2018)

Materials and methods

The development of the cruciferous bugs was observed in the entomological insulators (sweep nets) made from agricultural fiber. The pests were counted according to the generally accepted method (Omeliuta, 1986; Stankevych, Zabrodina, 2016). The correlation analysis and the analysis of variance (Dospiekhov, 1985) were performed.

The influence of the cabbage crops seeds damaged by the cruciferous bugs on the sowing quality of the seeds was determined following the State Standard of Ukraine 4138-2002 (National Standard, 2003) at the laboratory of the Zoology and Entomology Department of Kharkiv National Agrarian University named after V.V. Dokuchaiev and at the Educational and Scientific Centre of the Soil Science and Agro-Chemistry Institute named after O.N. Sokolovskyi of the National Academy of Agrarian Sciences of Ukraine. For this purpose, under the laboratory conditions, the seed material was placed in Petri dishes (100 seeds of each variant) at a temperature of 20 °C, the seeds were moistened daily to maintain a constant humidity level. The seed germination indices were recorded on the 3rd, 5th, 7^{th,} and 9th days.

The biochemical analysis of the purified seeds as for the fat and protein content was carried out according to Kjeldahl and Rushkovskyi (Kostromitin, 1975) laboratory at the laboratory of the Seed Quality of the Plant Growing Institute named after V.Ya. Yuriev.

Results and discussion

In 2012 after harvesting the crops of spring rape of Ataman variety, we cleaned the crops and thoroughly analyzed them. With the help of the binocular, the seeds of spring rape damaged by the bugs, and the healthy seeds without any signs of damage were selected. Under the laboratory conditions, the weight of 1000 undamaged and damaged seeds was determined. From the data given in Table 1, the weight of 1000 healthy seeds is 2.6996 g., and that of the damaged ones is 1.4454 g. Thus the mass of 1000 seeds damaged by a sucking mouthpart of the bugs is reduced by 46.5% compared to the undamaged seeds; that is, it is reduced almost two times.

Table 1. Influence of damage to seeds of spring rape of Ataman variety caused by cruciferous bugs on quantitative and qualitative indices in 2012 (Educational, Research and Production Centre "Research Field")

Variants of research (seed fractions)	Weight of 1000 seeds		Fat content		Protein content	
	g.	percentage to undamaged	%	at a ratio to undamaged	%	at a ratio to undamaged
Undamaged	2.6996	100.0	35.92	—	30.97	—
Damaged	1.4454	53.5	27.98	– 7.94	30.44	– 0.53
HIP05	0.39		2.57		0.77	

From the data given in Table 2, the undamaged seeds of spring rape contain 35.92% of fat, and the damaged ones contain 27.98% of fat, which is 1.3 times less. The protein content in the undamaged seeds was 30.97%, and in the damaged ones, it was 30.44%, which is only 0.53% less. The biochemical analysis data indicate that the damage caused by the cruciferous bugs significantly reduces the fat content in the seeds.

As a result of the germination of spring rape seeds under laboratory conditions, the damage caused by the cruciferous bugs on the laboratory germination rate of seeds has been established. From Table 2, it is seen that on the first day after sowing, no germination was observed in either of the variants. On the second day, the germination rate of the undamaged seeds was 6.3%, and that of the damaged seeds was 4.0%. On the third day, the germination rate of the undamaged seeds of spring rape was 74.2%, and that of the damaged seeds was 57.6%.

On the fourth day after sowing, the seed germination rate of the undamaged seeds was 86.0%, and that of the damaged seeds was 75.5%. On the fifth day after sowing, the seed germination rate of the undamaged seeds was 87.3%, and that of the damaged seeds was 77.3%. On the sixth day after sowing, the seed germination rate of the undamaged seeds was 89.3% vs. 79.5% as for the damaged ones. On the seventh day after sowing the laboratory, the germination rate of the undamaged seeds of spring rape was 90.0%, and that of the damaged ones was 81.0%. The final germination rate of spring rape seeds under the laboratory conditions was recorded on the eighth day, as no further germinated seeds were observed. The final germination rate of the undamaged spring rape seeds was 90.0%, and that of the damaged seeds was 84.3% (Fig. 2).

Table 2. Influence of damage to seeds of spring rape of Ataman variety caused by cruciferous bugs on laboratory germination rate in 2012 (Educational, Research and Production Centre "Research Field")

Variants of research (day)	Seed germination rate, %		
	undamaged	damaged	at a ratio to undamaged
first	0	0	–
second	6.3	4,0	– 2,3
third	74.2	57,6	– 16,6
fourth	86.0	75,5	– 10,5
fifth	87.3	77,3	–10,0
sixth	89.3	79,5	– 9,8
seventh	90.0	81,0	– 9,0
eighth	90.0	84,3	– 5,7
HIP 05		1.89	

In 2013 after harvesting the oilseeds cabbage crops and the cabbage seeds and after cleaning and analyzing the crops with the help of the binocular, the seeds of spring rape, white mustard, and white cabbage damaged by the bugs as well as the healthy seeds without any signs of damage were selected (Table 3).

Fig. 2. Sprouts obtained under laboratory conditions from undamaged (black) (1), undamaged (brown) (2), and damaged (3) spring rape seeds, 2013

Table 3. Influence of damage to cabbage crops caused by cruciferous bugs on quantitative and qualitative indices in 2013 (Educational, Research and Production Centre "Research Field")

Crop, variety	Variants of research (seed fractions)	Weight of 1000 seeds		Oil content		Protein content	
		g.	percentage to undamaged	%	at a ratio to undamaged	%	at a ratio to undamaged
Spring rape of Ataman variety	Undamaged	3.2161	100.0	47.84	—	14.66	—
	Damaged	1.2313	38.28	26.93	–20.91	31.44	16.78
White mustard of Carolina variety	Undamaged	3.9911	100.0	20.57	—	37.91	—
	Damaged	1.3194	33.05	18.77	–1.80	36.39	–1.52
White cabbage of Kharkivska 105 variety	Undamaged	5.2099	100.0	37.44	—	31.03	—
	Damaged	1.6067	30.83	15.72	–21.72	38.30	7.27

The weight of 1000 yielded spring rape seeds of Ataman variety undamaged by the bugs amounted to 3.2161 g, and the weight of the damaged seeds amounted to 1.2313 g, which is 2.6 times less. The weight of 1000 undamaged seeds of white mustard of Carolina variety was 3.9911 g, and that of white cabbage of Kharkivska 105 variety was 5.2099 g, and the weights of the damaged seeds were 1.3194 g and 1.6067 g, or 3.0 and 3.2 times less. The undamaged seeds of spring rape have an oil content of 47.84%, and the damaged seeds have an oil content of 26,93%, which is 1,8 times less. The protein content in the undamaged seeds is 14.66%, while in the damaged, it is 31.44%. The undamaged seeds of white mustard contain 20.57% of oil, and the damaged ones contain 18.77% or 0.1 times less. The protein content in the undamaged seeds is 3.91%, and in the damaged, it is 36.39%. In the undamaged seeds of white cabbage, the oil content amounts to 37.44%, and in the damaged, it is 15.72%, which is almost 2.4 times less. The protein content in the undamaged seeds is 31.03%, and in the damaged, it is 38%. The biochemical analysis data shows that the damage to the seeds caused by the cruciferous bugs in 2013 also caused a decrease in the oil content in it and an increase in the protein content in the seeds of spring rape and white cabbage. As a result of the spring rape seeds germination under the laboratory conditions, the influence of damage to seeds caused by the cruciferous bugs on the laboratory germination rate was established (Table 4).

Table 4. Influence of damage to seeds of spring rape of Ataman variety caused by cruciferous bugs on laboratory germination rate in 2013

Variants of research (day)	Seed germination rate, %		
	undamaged	damaged	at a ratio to undamaged
first	6.4	4.0	-2.4
second	59.2	31.1	-28.1
third	71.0	62.6	-8.4
fourth	86.8	73.5	-13.3
fifth	89.4	75.3	-14.1
sixth	90.3	78.5	-11.8
seventh	91.1	80.0	-11.1
eighth	92.0	83.3	-8.7

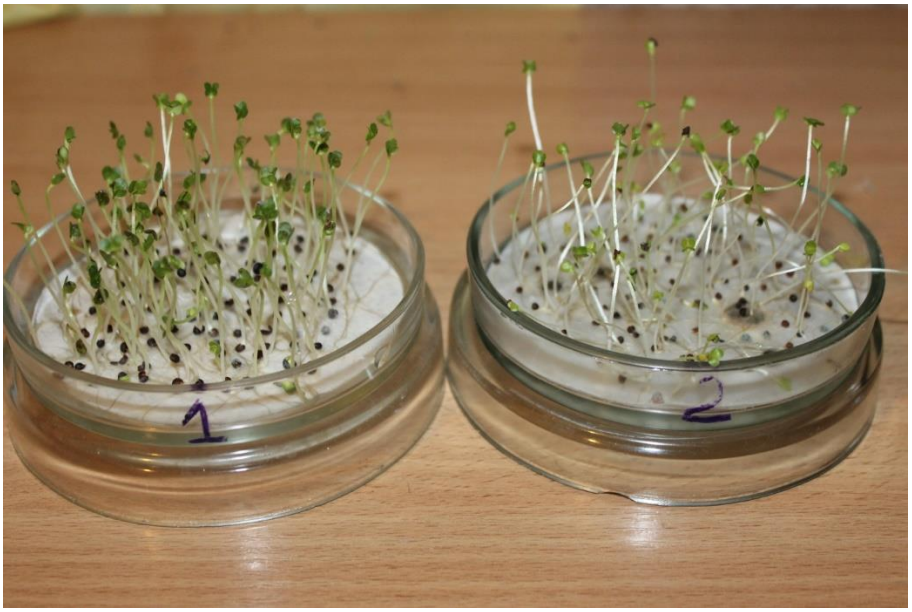

Fig. 3. Sprouts obtained under laboratory conditions from undamaged (1) and damaged (2) spring rape seeds, 2013

From the data given in Table 4, it is seen that on the first day after sowing, the germination rate of the undamaged seeds of spring rape of Ataman variety was 6.4%, and that of the damaged seeds was 4.0%; on the second day the germination rate of the undamaged seeds was 59.2%, and that of the damaged seeds was 31.1%. On the third day, the germination rate of the undamaged seeds of spring rape was 71.0%, and that of the damaged seeds was 62.6%. On the fourth day after sowing, the germination rate of the undamaged seeds was 86.8%, and that of the damaged seeds was 73.5%. On the fifth day after sowing, the germination rate of the undamaged seeds was 89.4%, and that of the damaged seeds was 75.3%. On the sixth day after sowing, the germination rate of the undamaged seeds was 90.3% versus 78.5% as for the damaged ones.
On the seventh day after sowing, the laboratory germination rate of the undamaged spring rape seeds was 9.1%, and the germination rate of the damaged ones was 80.0%. The final germination rate of spring rape seeds under the laboratory conditions (Fig. 3) was recorded on the eighth day, as no further germinated seeds were observed. The final germination rate of the undamaged spring rape seeds was 92.0%, and that of the damaged seeds was 83.3%.

Table 5. Influence of damage to seeds of white mustard of Carolina variety caused by cruciferous bugs on laboratory germination rate in 2013 (Educational, Research and Production Centre "Research Field")

Variants of research (day)	Seed germination rate, %		
	undamaged	damaged	at a ratio to undamaged
first	8.2	3.0	-5.2
second	68.4	10.1	-58.3
third	73.2	55.6	-17.6
fourth	84.0	66.5	-17.5
fifth	87.7	74.3	-13.4
sixth	89.3	79.5	-9.8
seventh	92.1	82.0	-10.1
eighth	97.0	86.4	-10.6

From the data given in Table 5, it is seen that on the first day after sowing, the germination rate of the undamaged seeds of white mustard of Carolina variety was 8.2%, and that of the damaged seeds was 3.0%; on the second day, the germination rate of the undamaged seeds was 68.4%, and that of the damaged seeds was 10.1%. On the third day, the germination rate of the undamaged seeds of white mustard was 73.2%, and that of the damaged seeds was 55.6%. On the fourth day after sowing, the germination rate of the undamaged seeds was 84.0%, and that of the damaged seeds was 66.5%. On the fifth day after sowing, the germination rate of the undamaged seeds was 87.7%, and that of the damaged seeds was 74.3%. On the sixth day after sowing, the germination rate of the undamaged seeds was 89.3% versus 79.5% as for the damaged ones. On the seventh day after sowing the laboratory, the germination rate of the undamaged seeds of white mustard was 92.1%, and that of the damaged ones was 82.0%. The final germination rate of white mustard seeds under the laboratory conditions was recorded on the eighth day (Fig. 4). The final germination rate of the undamaged white mustard seeds was 97.0%, and that of the damaged seeds was 86.4%.

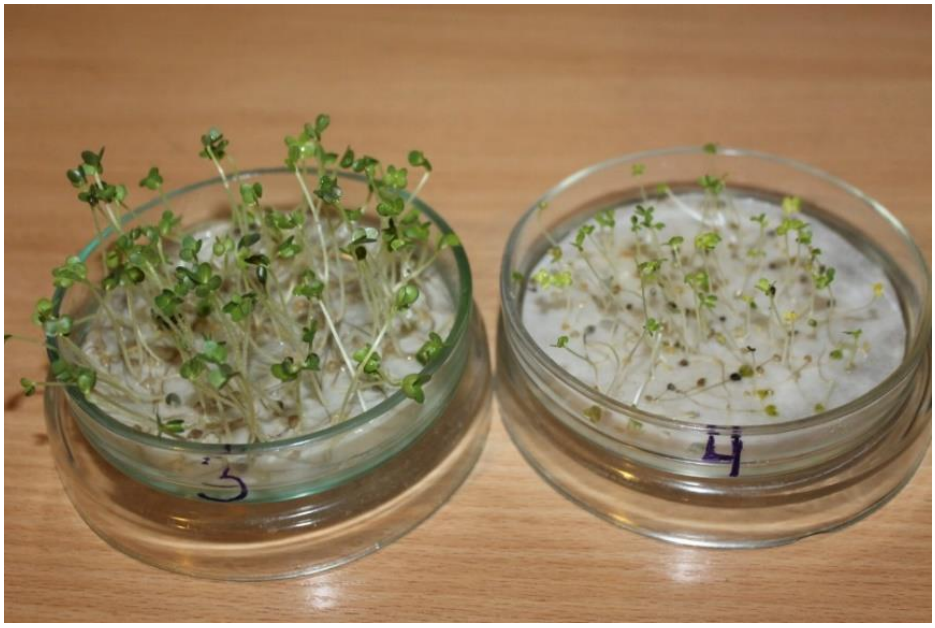

Fig. 4. Sprouts obtained under laboratory conditions from undamaged (3) and damaged (4) white mustard seeds, 2013

From the data given in Table 6, it is seen that on the first day after sowing, the germination rate of the undamaged seeds of white cabbage of Kharkivska 105 variety was 4.1%, and that of the damaged seeds was 2.0%; on the second day the germination rate of the undamaged seeds was 26.6%, and that of the damaged seeds was 19.1%. On the third day, the germination rate of the undamaged seeds of white cabbage was 71.0%, and that of the damaged seeds was 21.3%. On the fourth day after sowing, the germination rate of the undamaged seeds was 82.4%, and that of the damaged seeds was 43.7%. On the fifth day after sowing, the germination rate of the undamaged seeds was 86.8%, and that of the damaged seeds was 47.3%. On the sixth day after sowing, the germination rate of the undamaged seeds was 88.7% versus 49.5% as for the damaged ones. On the seventh day after sowing, the laboratory germination rate of the undamaged cabbage seeds was 92.5%, and that of the damaged ones was 51.7%. The final germination rate of the cabbage seeds under the laboratory conditions was recorded on the eighth day as no further germinated seeds were observed (Fig. 5). The final germination rate of the undamaged white cabbage seeds was 94.0%, and that of the damaged seeds was 56.9%.

Table 6. Influence of damage to seeds of white cabbage of Kharkivska 105 variety caused by cruciferous bugs on laboratory germination rate in 2013 (Educational, Research and Production Centre "Research Field")

Variants of research (day)	Seed germination rate, %		
	undamaged	Damaged	at a ratio to undamaged
first	4.1	2.0	-2.1
second	26.6	19.1	-7.5
third	71.0	21.3	-49.7
fourth	82.4	43.7	-38.7
fifth	86.8	47.3	-39.5
sixth	88.7	49.5	-39.2
seventh	92.5	51.7	-40.8
eighth	94.0	56.9	-37.1

The weight of 1000 yielded spring rape seeds of Ataman variety undamaged by the bugs amounted to 3.3251 g, and the weight of the damaged seeds amounted to 1.2061 g, which is 2.8 times less. The weight of 1000 undamaged seeds of white mustard of Carolina variety was 3.9981 g, and that of white cabbage of Kharkivska 105 variety was 5.3128 g, and the weights of the damaged seeds were 1.3386 g and 1.6192 g respectively, or 3.0 and 3.3 times less.

The undamaged seeds of spring rape have an oil content of 49.23%, and the damaged seeds have an oil content of 34.71%, which is 1.4 times less. The protein content in the undamaged seeds is 18.60%, while in the damaged ones, it is 26.72%. The undamaged seeds of white mustard contain 34.19% of oil, and the damaged ones contain 45.59% or 1,3 times more. The protein content in the undamaged seeds was 25.53%, and in the damaged, it was 23.36%. In the undamaged seeds of white cabbage, the oil content amounted to 35.25%, and in the damaged, it was 34.43%, which is 1.0 less. The protein content in the undamaged seeds was 29.41%, and in the damaged, it was 30.38% (Table 7).

Fig. 5. Sprouts obtained under laboratory conditions from undamaged (5) and damaged (6) seeds of white cabbage, 2013

Table 7. Influence of damage to cabbage crops caused by cruciferous bugs on quantitative and qualitative indices, 2014

Crop, variety	Variants of research (seed fractions)	Weight of 1000 seeds		Oil content		Protein content	
		g.	percentage to undamaged	%	at a ratio to undamaged	%	at a ratio to undamaged
Spring rape of Ataman variety	Undamaged	3.3251	100.0	49.23	—	18.60	—
	Damaged	1.2061	36.27	34.71	–14.52	26.72	8.12
White mustard of Carolina variety	Undamaged	3.9981	100.0	34.19	—	25.53	—
	Damaged	1.3386	33.48	45.59	11.40	23.36	–2.17
White cabbage of Kharkivska 105 variety	Undamaged	5.3128	100.0	35.35	—	29.41	—
	Damaged	1.6192	30.48	34.43	–0.92	30.38	0.97

The biochemical analysis data shows that the damage to the seeds of spring rape and white cabbage caused by the cruciferous bugs is the reason of the decrease in the oil content in it and an increase in the protein content in the seeds of spring rape and white cabbage.

As a result of the spring rape seeds germination under the laboratory conditions, the influence of damage to seeds caused by the cruciferous bugs on the laboratory germination rate was established (Table 8).

Table 8. Influence of damage to seeds of spring rape of Ataman variety caused by cruciferous bugs on laboratory germination rate in 2014

Variants of research (day)	Seed germination rate, %		
	undamaged	damaged	at a ratio to undamaged
first	3.8	2.1	-1.7
second	28.4	16.1	-12.3
third	36.2	28.6	-7.6
fourth	53.6	41.9	-11.7
fifth	73.1	59.7	-13.4
sixth	84.7	75.2	-9.5
seventh	89.4	79.5	-9.9
eighth	91.8	82.4	-9.4

From the data given in Table 8, it is seen that on the first day after sowing, the germination rate of the undamaged seeds of spring rape of Ataman variety was 3.8%, and that of the damaged seeds was 2.1%; on the second day, the germination rate of the undamaged seeds was 28.4%, and that of the damaged seeds was 16.1%. On the third day, the germination rate of the undamaged seeds of spring rape was 36.2%, and that of the damaged seeds was 28.6%. On the fourth day after sowing, the

germination rate of the undamaged seeds was 53.6%, and that of the damaged seeds was 41.9%. On the fifth day after sowing, the germination rate of the undamaged seeds was 73.1%, and that of the damaged seeds was 59.7%. On the sixth day after sowing, the germination rate of the undamaged seeds was 84.7% versus 75.2% as for the damaged ones. On the seventh day after sowing the laboratory, the germination rate of the undamaged seeds of spring rape was 89.4%, and that of the damaged ones was 79.5%. The final germination rate of the spring rape seeds under the laboratory conditions was recorded on the eighth day as no further germinated seeds were observed. The final germination rate of the undamaged spring rape seeds was 91.8%, and that of the damaged seeds was 82.4% (Fig. 6).

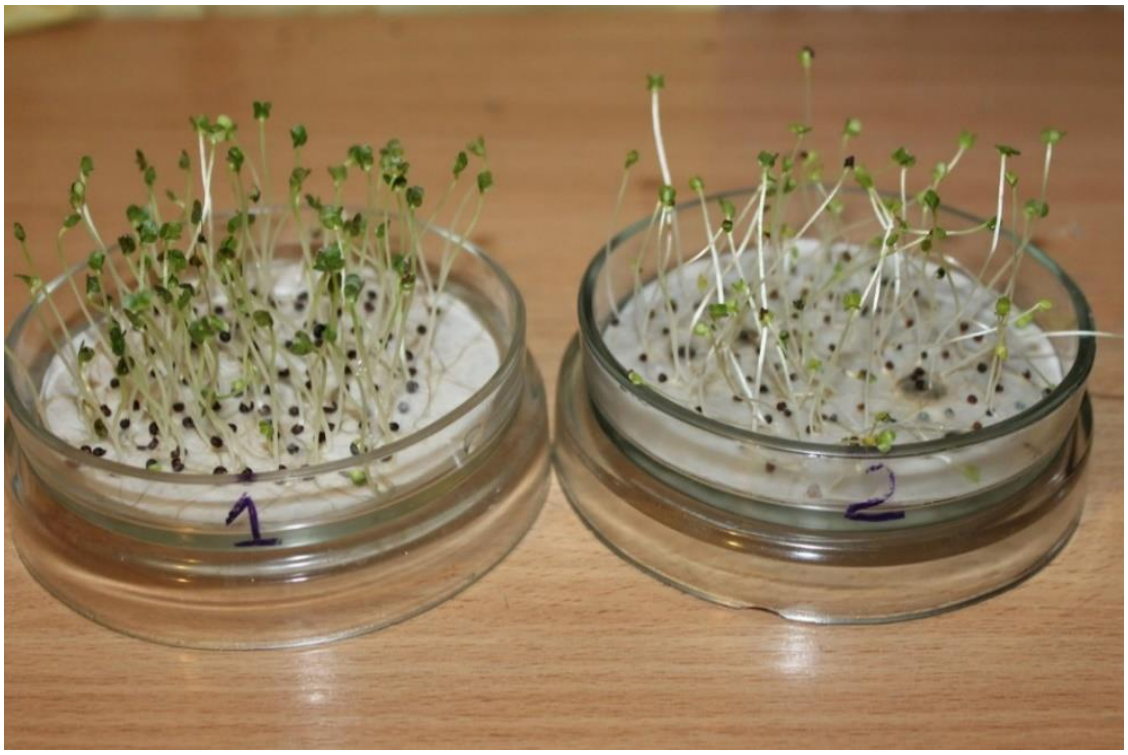

Fig. 6. Sprouts obtained under laboratory conditions from undamaged (1) and damaged (2) seeds of spring rape, 2014

Table 9. Influence of damage to seeds of white mustard of Carolina variety caused by cruciferous bugs on laboratory germination rate in 2014

Variants of research (day)	Seed germination rate, %		
	undamaged	damaged	at a ratio to undamaged
first	6.1	2.8	-3.3
second	29.5	15.4	-14.1
third	59.1	38.7	-20.4
fourth	72.6	54.1	-18.5
fifth	82.4	69.2	-13.2
sixth	88.7	72.8	-15.9
seventh	91.3	80.9	-10.4
eighth	95.2	84.6	-10.6

From the data given in Table 9, it is seen that on the first day after sowing, the germination rate of the undamaged seeds of white mustard of Carolina variety was 6,1%, and that of the damaged seeds was 2,8%; on the second day, the germination rate of the undamaged seeds was 29.5%, and that of the damaged seeds was 15.4%. On the third day, the germination rate of the undamaged seeds of white mustard was 59.1%, and that of the damaged seeds was 38.7%. On the fourth day after sowing, the germination rate of the undamaged seeds was 72.6%, and that of the damaged seeds was 54.1%. On the fifth day after sowing, the germination rate of the undamaged seeds was 82.4%, and that of the damaged seeds was 69.2%. On the sixth day after sowing, the germination rate of the undamaged seeds was 88.7% versus 72.8% as for the damaged ones. On the seventh day after sowing the laboratory, the germination rate of the undamaged seeds of white mustard was 91.3%, and that of the damaged ones was 80.9%. The final germination rate of the white mustard seeds under the laboratory conditions was recorded

on the eighth day. The final germination rate of the undamaged white mustard seeds was 95.2%, and that of the damaged seeds was 84.6% (Fig. 7).

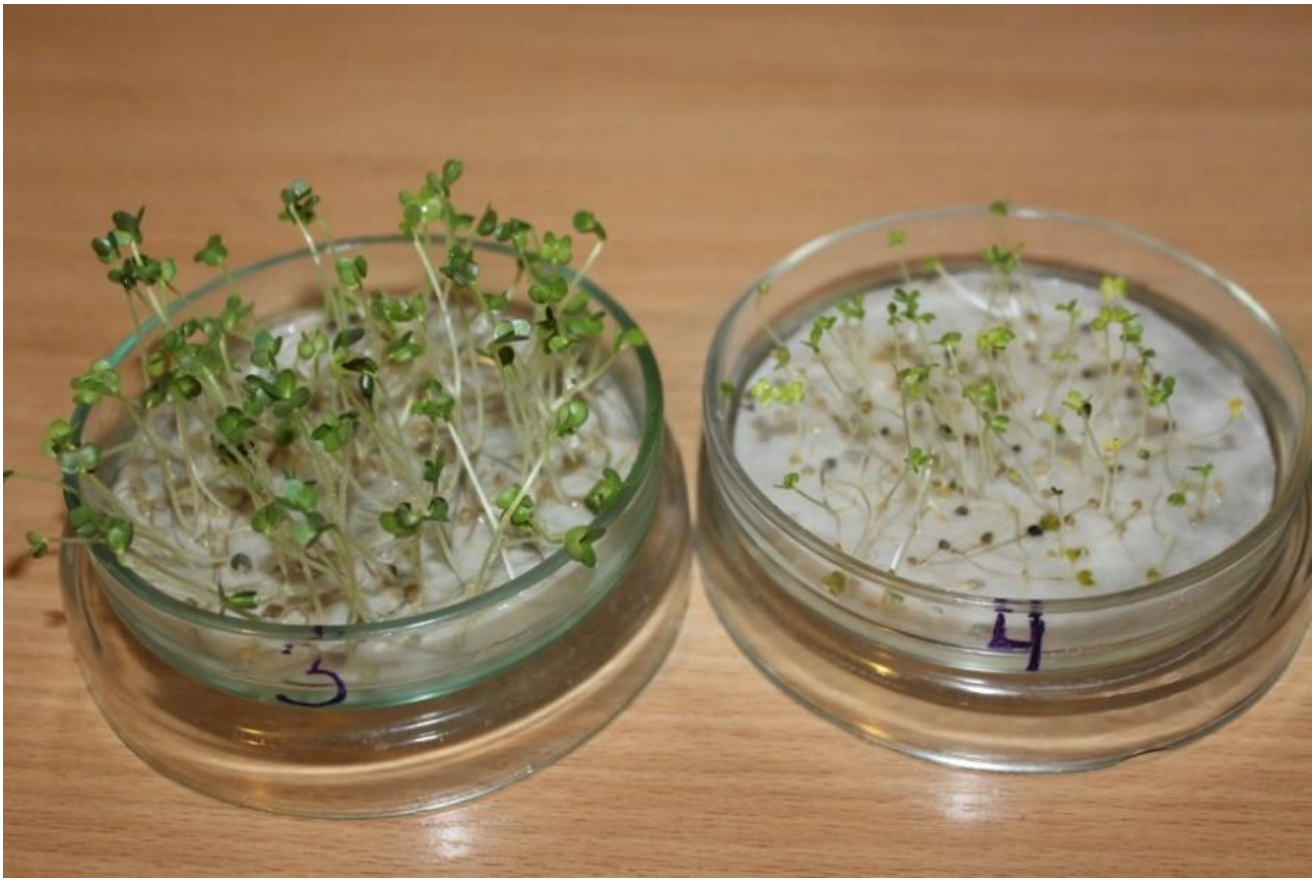

Fig. 7. Sprouts obtained under laboratory conditions from undamaged (3) and damaged (4) seeds of white mustard, 2014

Table 10. Influence of damage to seeds of white cabbage of Kharkivska 105 variety caused by cruciferous bugs on laboratory germination rate in 2014

Variants of research (day)	Seed germination rate, %		
	undamaged	damaged	at a ratio to undamaged
first	4.4	2.7	-1.7
second	22.8	16.5	-6.3
third	43.6	22.1	-21.5
fourth	68.1	39.4	-28.7
fifth	79.9	42.4	-37.5
sixth	86.3	48.4	-37.9
seventh	92.7	52.2	-40.5
eighth	93.9	55.8	-38.1

From the data given in Table 10, it is seen that on the first day after sowing, the germination rate of the undamaged seeds of white cabbage of Kharkivska 105 variety was 4.4%, and that of the damaged seeds was 2.7%; on the second day the germination rate of the undamaged seeds was 22.8%, and that of the damaged seeds was 16.5%. On the third day, the germination rate of the undamaged seeds of white cabbage was 43.6%, and that of the damaged seeds was 22.1%. On the fourth day after sowing, the germination rate of the undamaged seeds was 68.1%, and that of the damaged seeds was 39.4%. On the fifth day after sowing, the germination rate of the undamaged seeds was 79.9%, and that of the damaged seeds was 42.4%. On the sixth day after sowing, the germination rate of the undamaged seeds was 86.3% versus 48.4% as for the damaged ones. On the seventh day after sowing the laboratory, the germination rate of the undamaged cabbage seeds was 92.7%, and that of the damaged ones was 52.2%. The final germination rate of the cabbage seeds under the laboratory conditions was recorded on the eighth day as no further germinated seeds were observed. The final germination rate of the undamaged white cabbage seeds was 93.9%, and that of the damaged seeds was 55.8% (Fig. 8).

Fig. 8. Sprouts obtained under laboratory conditions from undamaged (5) and damaged (6) seeds of white cabbage, 2014

Over the three years of the research, with an average yield of spring rape of Ataman variety of 0.455 t/ha, the average oil content in the damaged seeds was lower by 14.45%, and the estimated oil losses were 0.071 t/ha (Fig. 9).

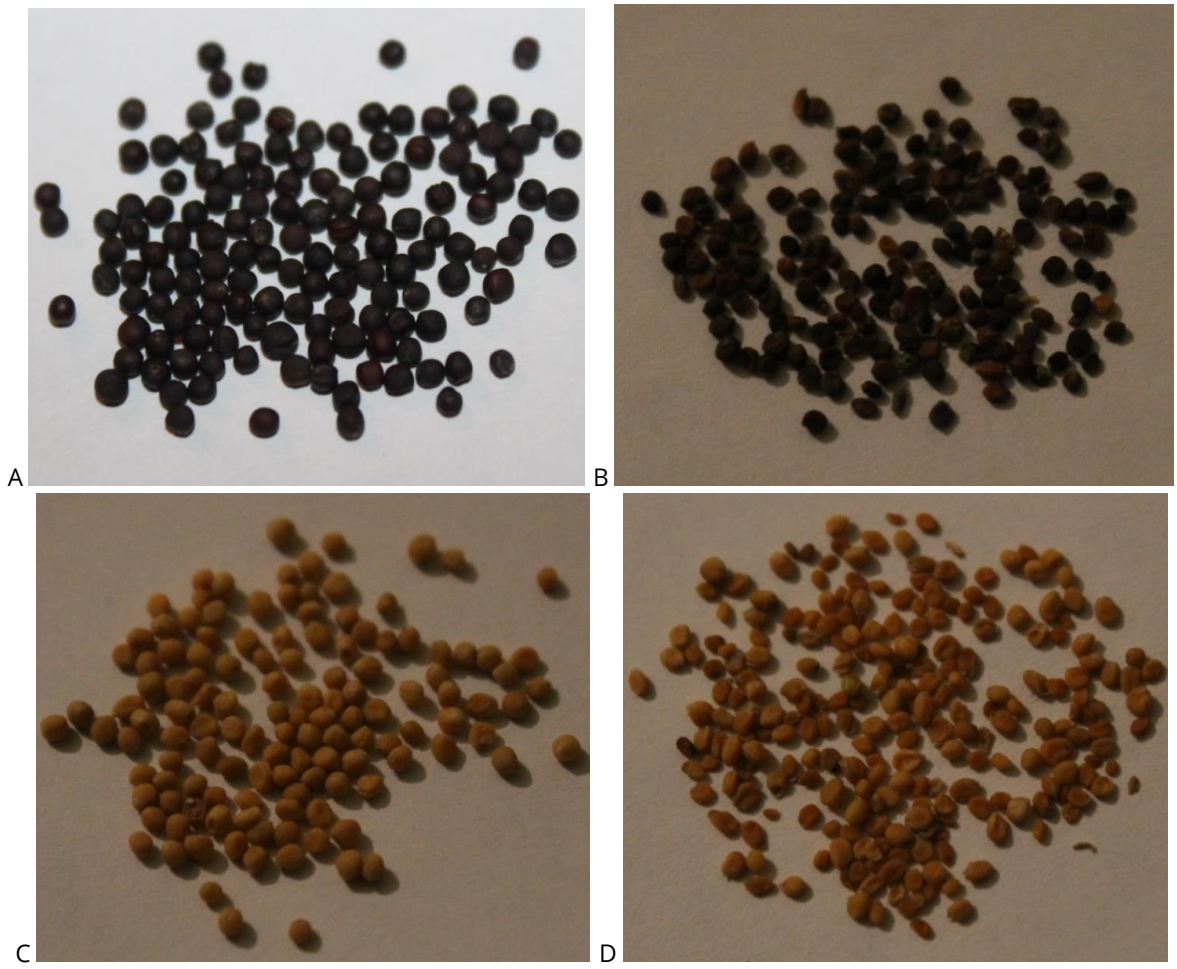

Fig. 9. Seeds of spring rape of Ataman variety: undamaged (A), damaged (B) and seeds of white mustard of Carolina variety: undamaged (C) and damaged (D)

Conclusions

The cruciferous bugs (*Eurydema* spp.) are a counterpart of the complex of the main pests of the cabbage crops generative organs in the Eastern Forest-Steppe of Ukraine. three species present the cruciferous bugs: painted or harlequin (cabbage) bug (*Eurydema ventralis* Kol), pentatomid rape bug (*E. oleraracea* L.) and mustard bug (*E. ornata* L.).

The weight of 1000 seeds of spring rape damaged by the cruciferous bugs is 36.27–53.52% less than that of the undamaged ones; for white mustard, these figures are 33.05–33.48%, and the weight of 1000 seeds of white cabbage damaged by the cruciferous bugs is 30.48–30.83 % less than the weight of the undamaged ones.

The germination rate of the damaged spring rape seeds is 5.7-9.4% lower than that of the undamaged ones, the germination rate of white mustard is lower by 10,6%, and the germination rate of white cabbage seeds is lower by 37.1-38.1%.

The oil content in the damaged seeds of spring rape is reduced by 14.45% on average, and the estimated oil yield at an average yield capacity of 0.495 t/ha is 0.071 t/ha lower.

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Citation:

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