Ministry of Education and Science of Ukraine
Kharkiv V.V. Dokuchaiev National
Agrarian University

S.V. STANKEVYCH, M.D. YEVTUSHENKO, V.V. VILNA

DOMINANT PESTS OF SPRING RAPE AND MUSTARD IN THE EASTERN FOREST-STEPPE OF UKRAINE AND ECOLOGIC PROTECTION FROM THEM

Monograph

PUBLISHING HOUSE I. IVANCHENKA
KHARKIV
2020

Міністерство освіти і науки України
Харківський національний аграрний
університет ім. В.В. Докучаєва

С.В. СТАНКЕВИЧ, М.Д. ЄВТУШЕНКО, В.В. ВІЛЬНА

ДОМІНУЮЧІ ШКІДНИКИ РІПАКА ЯРОГО Й ГІРЧИЦІ У СХІДНОМУ ЛІСОСТЕПУ УКРАЇНИ ТА ЕКОЛОГІЗОВАНИЙ ЗАХИСТ ВІД НИХ

Монографія

Видавництво Іванченка І.С.
Харків
2020

UDC 632.7 : [633.853.49«321» + 633.844] (477.52/.6)
S11

Recommended for publication by the Academic council
Kharkiv V.V. Dokuchaiev National Agrarian University
(the proceeding № 14 of December, 2019)

Reviewers:

Ye.M. Biletskyi, Ph.D. in Biology, academician of the Academy of Higher Education of Ukraine, professor of the Department of Ecology and Biotechnology of *Kharkiv V.V. Dokuchaiev National Agrarian University*;

H.I. Yarovyi, Ph.D. in Agriculture, professor, Head of the Department of Fruit and Vegetable Growing of *Kharkiv V.V. Dokuchaiev National Agrarian University*;

M.M. Dolia, Ph.D. in Agriculture, professor, corresponding member of the National Academy of Agricutural Sciences of Ukraine, Dean of the Department of Plant Protection of *National University of Life and Environmental Sciences of Ukraine*

S11 **Stankevych S.V.** Dominant pests of spring rape and mustard in the eastern Forest-Steppe of Ukraine and ecologic protection from them: monograph / S.V. Stankevych, M.D. Yevtushenko, V.V. Vilna; Publishing House I.Ivanchenko – 140 p.
ISBN 978-617-7879-04-5

The species composition of spring rape and mustard pests in the Eastern Forest-Steppe of Ukraine is specified. For the first time the seasonal dynamics in the number of cruciferous fleas, bugs and rape blossom beetle on the spring rape and mustard crops was determined in the Eastern Forest-Steppe of Ukraine; the main host plants as reservoirs for these species of harmful insects were identified. The high efficiency of spring rape crops protection against the cruciferous fleas by the method of pre-sowing toxicity of seeds with the systemic insecticides based on imidacloprid and thiamethoxam with the subsequent ground spraying with the insecticides based on lambda-cyhalothrin against the background with the fertilizers ($N_{30}P_{30}K_{30}$) was proved. The influence of treatment the spring rape seed with the insectofungicidal mixtures on the laboratory and field germination was determined. The expediency and effectiveness of application of the microbiological preparation Actophyte, 0,25 % of emulsion concentrate in combination with the systemic insecticide Biscaya, 24 % of oily dispersion against the rape blossom beetle and cruciferous bugs on spring rape and mustard crops by the method of spraying the plants in the phenophase of the yellow bud were proved.

The monograph will be useful for the plant protection experts, researchers and agronomists, teachers, graduate students and students of biological and agricultural specialties of higher education institutions and for all those interested in increasing the yield capacity and quality of spring rape and mustard seeds.

UDC 632.7 : [633.853.49«321» + 633.844] (477.52/.6)

ISBN 978-617-7879-04-5

CONTENT

PREFACE

The monograph is the result of many years' researches conducted by the authors on the farms of the Eastern Forest-Steppe of Ukraine during 2007–2019.

For the first time the authors specified the species composition of the pests of oil producing cabbage crops in the Eastern Forest-Steppe of Ukraine. 54 species of harmful insects were found on the oil producing cabbage crops which belong to 8 orders and 22 families. Among them 29 species are the specialised pests and 25 species are multi-faceted ones. 8 species belong to those that populate the crops on a mass scale, 4 species of which belong to the Coleoptera order. The seasonal dynamics in the number of the cruciferous fleas, bugs and rape blossom beetle as the species that have an economic importance during the years of mass reproduction was determined.

By means of careful surveys the main host plants as reservoirs for the dominant pests of oil producing cabbage crops in the Eastern Forest-Steppe of Ukraine were identified.

The authors economically substantiated and proved the high efficiency of protection of spring rape sprouts from the cruciferous fleas by the method of pre-sowing toxicity of seeds with the systemic insecticides based on imidacloprid and thiamethoxam with the subsequent ground spraying with the insecticides based on lambda-cyhalothrin against the background with the fertilizers ($N_{30}P_{30}K_{30}$) and without them. The expediency and effectiveness of application of the microbiological preparation Actophyte, 0,25 % of emulsion concentrate in combination with the systemic insecticide Biscaya, 24 % of oily dispersion against the rape blossom beetle and cruciferous bugs on spring rape and mustard crops by the method of spraying the plants in the phenophase of the yellow bud were proved.

The influence of spring rape seeds treatment with the insectofungicidal mixtures on the laboratory and field germination was determined.

The authors were the first who determined and proved the effect of oil producing cabbage crops seeds damaged by the rape blossom beetle and cruciferous bugs on protein and fat content as well as on the seed germination energy.

PART 1. PESTS OF OIL PRODUCING CABBAGE CROPS IN THE EASTERN FOREST-STEPPE OF UKRAINE

The identification of conditions that contribute to the reproduction of the harmful insects in one place or another in many cases makes it possible to scientifically substantiate and implement the measures in order to limit their harmful activity and even completely eliminate the danger.

It is well known that the insects, both geographically and locally, are extremely unevenly distributed. This unevenness is caused by the differences in the natural and economic conditions of the particular regions, the differences on which both the possibility of existence and the intensity of the insect reproduction depend. Such biotic factor as the vegetation distribution, which is the forage base for most insects, influences their spreading greatly. This connection is strongly expressed among the harmful herbivorous insects (Dobrovolskyi, 1959).

To a greater extent this connection is inherent in the insects feeding on a single kind of food or monophagous pests as well as in the insects feeding on a limited variety of food or oligophagous pests (Kozhanchikov, 1955).

The presence and distribution of the plants which are cultivated or used by humans and on which the insects are fed is certainly the first and basic condition for the emergence of a zone or a breeding ground of harmfulness. The presence of the most preferred by the insects fodder plants often leads to the formation of a zone or a centre of the greatest damage (in the presence of other favourable conditions for the existence and reproduction of the pest) (Dobrovolskyi, 1959).

The monophagous pests that feed and reproduce on the crops which occupy a restricted area have the most sharply restricted zones or the breeding grounds with the greatest harmfulness. At the same time the ecological connections which are based on a high degree of physiological and ecological adaptation to the feeding on the certain plants and to the conditions of growth and agricultural techniques of cultivation of the insect nourishing crops are revealed (Kozhanchikov, 1955).

In the first turn the human economic activity leads to the change of the natural vegetation cover and replacement it by a few new species of plants and this fact is extremely strongly reflected in the quantitative and qualitative indices of the entomofauna (Buch, 1998, Wachowiak, 1999). The pure crops in nature do not occupy the large areas, but they can occupy 100 or more hectares in the agroceonoses and much more heavily populated by the pests (Tachvanainen, Root, 1972).

As B.V. Dobrovolskyi (Dobrovolskyi, 1959) notes the first and the main condition for the emergence of the harmful zones of any kind of insects is the presence and distribution of their fodder crops (in the presence of other favourable conditions for their reproduction and spreading). Under natural conditions the insects feed on the wild growing plant species and weeds; this fact greatly regulates their number. Therefore the anthropic factor begins to play a significant role. In the first turn the human economic activity leads to the change of the natural vegetation cover and replacement it by a few new species of plants which is extremely strongly reflected in the quantitative and qualitative indices of the entomofauna. New relationships are formed between the species; the trophic chains are restructured and the adaptations to exist in a changed environment are arisen. Certain species of the pests also become dominant under favourable weather and biological conditions (Buch, 1998, Wachowiak, 1999).

A striking example of this is the pests of the cabbage crops. According to the data of M.M. Bogdanov-Katkov (Bogdanov-Katkov, 1920) the pests of the cabbage crops under natural conditions feed on the following plants: field shepherd's purse (*Capsella bursa-pastoris* Moench.), field pennycress (*Thlaspi arvense* L.), yellow rocket (*Barbarea vulgaris* R. Br.), field pepper weed (*Cardaria campestre* R. Br.), pepper grass (*Cardaria draba* L.), camelina (*Camelina dentata* Pers.), wild radish (*Raphanus rapanistrum* L.) and others. Timely destruction of these weeds in all crop rotation fields limits the development of the pests.

The number of weeds in the natural biocoenosis is not significant and therefore the cultivated plants from the Brassicaceae family play the decisive trophic role for the insects; the acreage under these crops is constantly increasing. Their species and variety composition is very diverse. In 2018 according to the State Register of Plants Varieties Suitable for Distribution in Ukraine the following number of the cabbage crops varieties is indicated: white cabbage – 242 varieties, cauliflower – 77 varieties, red cabbage – 33 varieties, Pe-tsai cabbage – 27 varieties, broccoli cabbage – 22 varieties, Savoy cabbage – 10 varieties, turnip-rooted cabbage – 9 varieties, Brussels sprouts – 6 varieties, small radish – 76 varieties, garden radish – 10 varieties, perennial wall-rocket – 3 varieties, turnips –2 varieties, green mustard – 2 varieties, field mustard – 2 varieties, rocket salad – 1 variety, black radish – 1 variety, field turnip – 1 variety, winter rape – 257 varieties and 114 parent components, spring rape – 54 varieties and 16 parent components, spring leaf mustard – 11 varieties, white mustar – 10 varieties, spring false flax – 9 varieties, oily radish – 5 varieties, winter leaf mustard – 7 varieties, field mustard – 3 varieties, annual turnip rape – 2 varieties, black mustard 2 varieties, green mustard –2 varieties and colza – 1 variety.

Today the main oil producing crops from the Brassicaceae family in the world and in Ukraine are winter rape (*Brassica napus oleifera bienis* D. C.) and spring rape (*Brassica napus oleifera annua* Metzg.). Currently the acreage of these crops in the world is over 40 million hectares, and in Ukraine there are more than 1 million hectares. Less common crops are white mustard (*Sinapis alba* L.) and Chinese mustard (*Brassica juncea* Gzem.). The world acreage under mustard is about 3,0 million hectares (in Ukraine there are about 100 thousand hectares). Other oil producing crops from the Brassicaceae family such as spring winter cress (*Brassica campestris* L.), winter rape (*Brassica rapa oleifera* DC), winter false flax (*Camelina sativa subsp. pilosa* N. Zinge), spring false flax (*Camelina sativa var. Glabrata* (DC.), oily radish (*Raphanus sativus* L. *var. oleiformis* Pers) and black mustard (*Brassica nigra* (L.) Koch) occupy only a small area, while the Abyssinian mustard (*Crambe abyssinica* Hosts. ex. RE Fr.) is not grown in our country at all. In addition the new fodder crops from the Brassicaceae family such as perko and cow cabbage that are new for our country, are being tested at the research stations.

Such amount of high quality fodder crops contributes to the migration of the insects from their natural habitats to the agricultural land. The insect habitat begins to expand and coincides with the areas of the cultivated plants growing.

To obtain the high and sustainable yields of all agricultural crops is impossible without protection of the plants from the harmful insects. The loss of the crops due to pests is huge, especially during their reproduction on a mass scale. The entomocomplex of agroceonoses of the oil producing cabbage crops is extremely rich and contains several hundred species. As a result of their vital functions more than 50% of the crops can be lost and as far as 25-55% growth increase in the yield can be reached due to the pollinating insects (Prushynsky, 1995).

Despite the short-term existence of the agroceonoses of the spring oil producing cabbage crops (90–120 days) their entomofauna is characterised by a considerable diversity of the species composition (Zhuravskyi, 2008).

According to V.P. Fedorenko (Fedorenko, 2008) in recent years the number of pests in the spring and winter rape agroceonoses has been increasing rapidly in Ukraine.

In the countries of the former USSR the cabbage pest complex is characterised by the large species diversity (more than 300 species) (Kostromitin, 1980). Maksymov M.P. (Maksymov, 1990) names 80 species of insects that damage the oil producing cabbage crops in Ukraine. According to O.A. Ivantsova (Ivantsova, 2010) 103 species of pests were registered on the brown mustard in the Volga region. Velychko V.V. (Velychko, 1951) indicates that about 86 species of insects damage the crops of mustard in the Non-Black Zone of the Russian Federation. In Uzbekistan (Burda, 1970) 82 insect species damage the cabbage crops. Minkevych O.I. (Minkevych, 1949) names 61 species of insects that damage the mustard crops in Russia. According to the data of L.O. Kanter (Kanter, 1980) 45 species of the harmful insects of cabbage crops were recorded in Western Trans-Baikal. In Latvia about 50 insect species damage the cabbage crops (Cinitis, 1972). Lhagwa Zh. (Lhagwa, 1971) lists 25 insect species that cause damage to the cabbage crops in Mongolia. According to various data from 34 (Ovchinnikova, 1971, 1972) to 40 (Gortlevskii, 1983) species of insects (Gortlevskii, 1983) damage the cabbage crops in the Moscow region. G.A. Moskaliova (Moskaliova, 1985) names about 30 species of pests in the Leningrad region. Antsupova T.Ye. (Antsupova, 1984) names 19 species of pests in the Kuban. Amosov Yu.M. (Amosov, 1980) describes 25 species that damage the cabbage crops in Yakutia. Semakov V.V. (Semakov, 1966) names 22 species of harmful insects in Kamchatka. Osipov V.G. (Osipov, 1986) notes that 19 species of pests are harmful to the cabbage crops in Belarus.

The most complete faunistic description of the cabbage crops pests under the conditions of Forest-Steppe and Polissia of Ukraine is given in the monographic work of A.P. Kryshtal (Kryshtal, 19590. He described 211 species of the insects that damage these crops that constitute 14% of all insect pests; among them 56 species are specialised.

Such scientists as M.P. Sekun (Sekun, 2009), M. Krut (Krut, 2011), and L.P. Kava (Kava, 2013) indicate that about 50 species of the pests damage the spring and winter rape crops in Ukraine. V.P. Vasiliev (Vasiliev, 1989) and Yu.H. Krasylovets name 47 specialised insect species that damage the rape crops in Ukraine. Z.I. Hurova (Hyrova, 1963) and L.I. Kolesnik (Kolesnik, 2007) name 40 species, and V.S. Zhuravskyi (Zhuravskyi, 2007) lists 27 species of the insect that are harmful for the rape crops. According to R.V. Yakovliev (Yakovliev, 2008, 2010, 2012) 32 species of phytophagous pests damage the mustard crops in the Forest-Steppe of Ukraine. Laba Yu. R. (Laba, 2009, 2012) indicates that 46 harmful insect species damage the spring and winter rape crops in the Central Forest-Steppe of Ukraine.

In the Forest-Steppe of Ukraine the most harmful species are the cruciferous fleas (*Phyllotreta spp*.), rape blossom beetle (*Meligethes aeneus* F.), cruciferous bugs (*Eurydema spp*.), seed-eating ceuttorrhync beetle ((*Ceuthorrhynchus quadridens* Panz.), turnip fly (*Athalia rosae* L.) and cabbage aphids (*Brevicoryne brassicae* L.) (Yakovliev, 2008; 2009).

Chervonenko M.H. (Chervonenko, 2003) says that the most dangerous pests of the rape crops are a complex of cruciferous fleas, rape blossom beetle, turnip fly, cabbage aphid, seed-eating ceutorrhynchus beetle, diamond black moth (*Plutella maculipennis* Curt.), cabbage moth (*Mamestra brassicae* L.), bright-line brown-eye moth (*Mamestra oleraceae* L.), common silvery moth (*Autographa gamma* L.), cabbage butterfly (*Pieris brassicae* L.) and turnip white butterfly (*P. rapae* L.).

Gordieieva O.F. (Gordieieva, 2003) indicates that under the conditions of the left-bank Forest Steppe of Ukraine 42 species of the phytophagous pests belonging to 8 orderss and 19 families were found on the rape crops. The most dangerous species are the cruciferous fleas, rape blossom beetle and cabbage aphid.

According to I. Tarushkin (Tarushkin, 2006) the most dangerous pests of the rape crops in the territory of Ukraine are the rape blossom beetle, seed-eating ceutorrhynchus beetle, turnip fly, and the brassica pod midge.

In Belgium, Bulgaria, Germany, Slovakia and France the most harmful species of the rape crops pests are the cruciferous fleas, ceutorrhynchus, rape blossom beetle, turnip fly, brassica pod midge and cabbage aphids (Hoffman, 1983, Knoll, 1997, Volker, 2003, Johnen, 2006). The main pests of the rape crops in Switzerland (Carrel, 1995) are the rape blossom beetle, ceutorrhynchus and the cruciferous fleas. In Hungary the most harmful species of the oil producing cabbage crops are the rape blossom beetle and ceutorrhynchus (Marczali, 2006). In Poland the greatest losses to the winter rape crops are caused by the rape blossom beetle, ceutorrhynchus and the pod midge (Mrowczynski, 1992, 2003, 2007). Recently the diamond black moth and the cabbage aphid (Mrowczynski, 2006, 2007) deserve the special attention. The rape blossom beetle, pod midge, cruciferous fleas, cabbage root fly and turnip fly cause the greatest damage to the spring rape crops in Poland (Vilinskiy, 1974; Mrówczyński, 2007; Walkowski, 2002). Shpaar D. (Shpaar, 2007) points out that the rape blossom beetle is the most dangerous pest of the cabbage crops in Germany, Poland and France. In Norway one of the main pests of the oil producing cabbage crops is the rape blossom beetle (Andersen, 2008).

M. Krut notes that different species of pests cause unequal harm in the different regions of Ukrain. (Krut, 2003). In such oblasts as the Kyivska, Sumska, Vinnytska, Khmelnytska, Cherkaska, Chernivetska, Ivano-Frankivska, Chernihivska, Odeska and Khersonska the complex of the cruciferous fleas is the most dangerous one. In the Kyivska, Sumska, Vinnytska, Chernivetska, Ivano-Frankivska, Chernihivska and Lvivska oblasts the most dangerous pest is the rape blossom beetle. The turnip fly causes damage in the Kyivska, Sumska, Khmelnytska, Chernivetska, Cherkaska, Vinnytska, Kharkivska, Rivnenska and Khersonska oblasts. The seed-eating ceutorrhynchus beetle is especially dangerous in the Kyivska, Sumska, Volynska, Lvivska, Rivnenska and Ivano-Frankivska oblasts.

Tsybulko V.I. (Tsybulko, 1975) notes that in the Eastern Forest-Steppe of Ukraine the cabbage crops are damaged by about 60 species of multi-faceted and specialised insects.

Materials and methods of researches

In 2007–2019 the species composition of the oil producing cabbage crops pests was investigated throughout the whole vegetation period by mowing with the entomological catching net, using the soil traps, the Petliuk box and hand collection. The number of pests was recorded according to the generally accepted methods (Omeliuta 1986; Stankevych, Zabrodina, 2016). The researches were carried out on the crops of the oil producing cabbage plants in the fields of the Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University and the state enterprise "Research Farm "Elitne" of the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine. The collected entomological material was analysed and systematised; and the species composition of the insects was determined at the Zoology and Entomology Department named after B.M. Lytvynov of Kharkiv V.V. Dokuchaiev National Agrarian University . The accuracy of the identification of certain harmful species of insects was confirmed by PhD in Biology V.M. Hramma, the head of the Laboratory of Insect Ecology of Kharkiv V.V. Dokuchaiev National Agrarian University .

Results of researches and discussion

During the vegetation periods of 2007–2019 in the fields of the Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University and the state enterprise "Research Farm "Elitne" of the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine we have identified 54 species of specialised and multi-faceted pests of the oil producing cabbage crops belonging to 8 orderss and 22 families (Tables 1.1, 1.2). Among them 29 species are specialised pests and 25 species are multi-faceted ones (Figure 1.1) (Yevtushenko, Stankevych, Vilna, 2014; Stankevych, 2015; Yevtushenko, Vilna, Stankevych, 2017; Stankevych, 2018).

The frequency of the pest species occurrence on the rape and mustard crops (Table 1.1) is the following: species that populate the crops on a mass scale – 8 (14,8%), the moderately spread species – 6 (11,1%), species that have the insignificant population density – 40 (74,1%). The cabbage bug, mustard bug, cabbage aphid, rose chafer, rape blossom beetle, mesographe flea beetle, flea beetle and diamond black moth belong to the species that populate the crops on a mass scale. Among them 4 species belong to the Coleoptera order, 2 species belong to the Hemiptera order, 1 species belong to the Homoptera order and 1 species belong to the Lepidoptera order.

From Table 1.2 it is seen that the representatives of the Coleoptera order are the dominant species; their part in the entomocomplex structure is 48% (26 species).

The economic importance of these pests is not the same and greatly depends on the population density, phenophase of the crop (Table 1.3) as well as on weather conditions. For example hot and dry weather is favourable for the cruciferous fleas when the plants are more weakened and the fleas are more voracious. The cabbage aphids like warm weather.

In the phase of sprouting (up to 4 true leaves) the complex of the cruciferous fleas, tenebrionid beetle and earth-boring dung beetle are the most dangerous pests. The latter can be found along the perimeter of the field.

Table 1.1

Species composition of oil producing cabbage crops pests in the fields of the Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University and the state enterprise "Research Farm "Elitne" of the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine (2007–2019)

Order	Family	Species		Specialization	Frequency of occurrence
		Latin name	English name		
Orthoptera	Acrididae	*Locusta migratoria Rossica* L.	Migratory locust	M	+
		Calliptamus italicus L.	Italian locust	M	+
	Tettigoniidae	*Tettigonia viridissima* L.	Large green grasshopper	M	+
	Gryllidae	*Gryllus campestris* L.	Field cricket	M	+
	Gryllotalpidae	*Gryllotalpa gryllotalpa* L.	Mole cricket	M	+
Homoptera	Aphididae	*Brevicoryne brassicae* L.	Cabbage aphid	S	+++
Hemiptera	Pentatomidae	*Eurydema ventralis* Kol.	Cabbage bug	S	+++
		Eurydema oleraracea L.	Pentatomid rape bug	S	++
		Eurydema ornata L.	Mustard bug	S	+++
		Graphosoma italicum L.	Striped shield bug	M	+
		Dolicoris baccarum L.	Sloe bug	M	+
		Syromastes marginatus L.	Dock bug	M	+
	Miridae	*Lygus pratensis* L.	Tarnished plant bug	M	+
		Adelphocoris lineolatus Goeze.	Alfalfa plant bug	M	+
		Lygus rugulipennis Popp.	European tarnished plant bug	M	+
		Polimerus cognatus Fied.	Beet bug	M	+
Thysanoptera	Thripidae	*Thrips tabaci* Lind.	Tobacco thrips	M	+

Coleoptera	Silphidae	*Aclypaea opaca* L.	Black carrion beetle	M	+
	Tenebrionidae	*Opatrum sabulosum* L.	Tenebrionid beetle	M	++
		Pedinus femoralis L.	Tenebrionid beetle	M	++
	Scarabeidae	*Tropinota (Epicometis) hirta* L.	Rose chafer	M	+++
		Oxythyrea funesta Poda.	White spotted rose beetle	M	+
		Cetonia aurata L.	Green rose chafer	M	+
		Lethrus apterus Laxm.	Scarab beetle	M	+
	Meloidae	*Meloe proscarabaeus* L.	Meloid beetle	M	+
	Nitidulidae	*Meligethes aeneus* F.	Rape blossom beetle	S	+++
	Chrysomelidae	*Phyllotreta atra* F.	Mesographe flea beetle	S	+++
		Phyllotreta nigripes F.	Flea beetle	S	+++
		Phyllotreta nemorum L.	Large striped flea beetle	S	++
		Phyllotreta undulata Kutsch.	Undulating flea beetle	S	++
		Phyllotreta vitata Redt.	Cabbage beetle	S	++
		Phyllotreta armoracie Koch.	Horseradish flea beetle	S	+
		Entomoscelis adonidis Pall.	Rape-leaf beetle	S	+
		Colaphellus höfti Men.	Oriental mustard leaf beetle	S	+
		Colaphellus sophiae Schall.	*No English name*	S	+
		Phaedon cochleariae L.	Horse-radish leaf beetle	S	+
	Curculionidae	*Ceuthorrhynchus quadridens* Panz.	Seed-eating ceutorrhynchus beetle	S	+
		Ceuthorrhynchus assimilis Payk.	Cabbage seed-pod beetle	S	+
		Ceuthorrhynchus napi Gyll.	Rape stem weevil	S	+
		Ceuthorrhynchus syrites Germ.	*No English name*	S	+
		Baris coerulesces Scop.	Rutabaga barid	S	+
		Baris chlorizans Germ.	Rape barid	S	+
		Lixus ascanii L.	*No English name*	S	+

Hymenoptera	Tenthredinidae	*Athalia rosae* L.	Turnip fly	S	+
Lepidoptera	Yponomeutidae	*Plutella maculipennis* Curt.	Diamond black moth	S	+++
	Pyraustidae	*Evergestis extimalis* Scop.	Cabbage worm	S	+
		Margaritia sticticalis L.	Webworm beetle	M	+
	Noctuidae	*Baratra (Mamestra) brassicae* L.	Cabbage moth	M	+
		Autographa gamma L.	Gamma moth	M	+
		Scotia (Agrotis) segetum Schiff.	Turnip moth	M	+
	Pieridae	*Pieris brassicae* L.	Cabbage butterfly	S	+
		Pieris rapae L.	Turnip white butterfly	S	+
Diptera	Tipulidae	*Tipula paludosa* Ng.	European cranefly	S	+
	Cecidomyiidae	*Dasyneura brassicae* L.	Brassica pod midge	S	+

Conventional signs: M – multi-faceted species; S – specialised species; +++ – species that populate the crops on a mass scale; ++ – moderately spread species; + – insignificant population density.

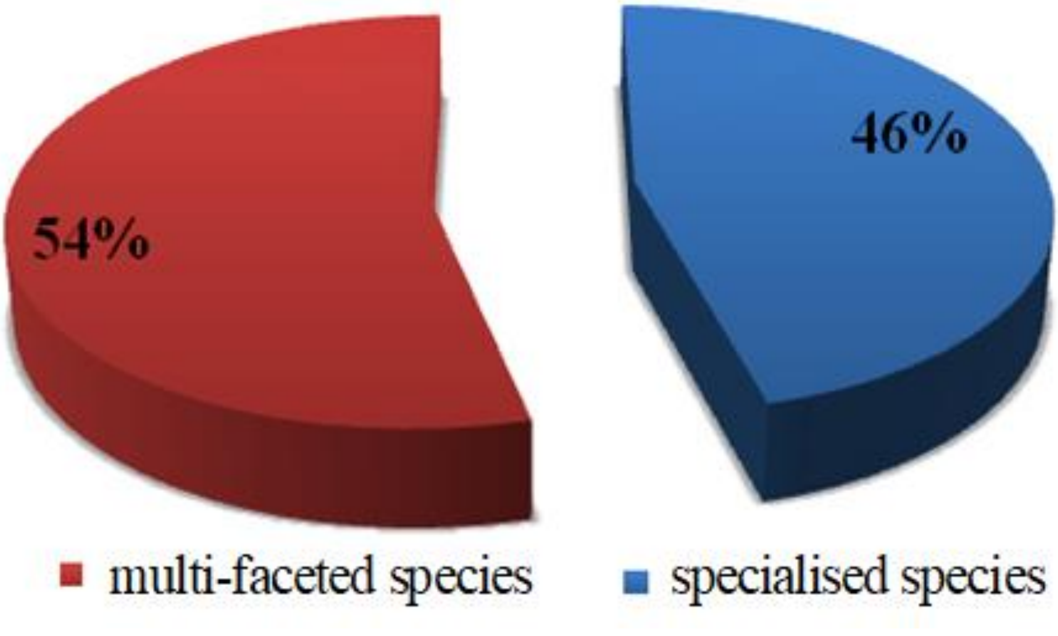


Figure1.1. Trophic structure of oil producing cabbage crops pests in the fields of the Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University and the state enterprise "Research Farm "Elitne" of the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine (2007–2019)

Table 1.2

Taxonomic structure of oil producing cabbage crops pests in the fields of the Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University and the state enterprise "Research Farm "Elitne" of the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine (2007–2019)

Orders	Species number	Order part in entomocomplex, %
Sheath-winged (Coleoptera)	26	48
True bugs (Hemiptera)	10	18
Scale-winged (Lepidoptera)	8	15
Straight-winged (Orthoptera)	5	9
Two-winged (Diptera)	2	4
Membrane-winged (Hymenoptera)	1	2
Uniform-winged (Homoptera)	1	2
Fringe-winged (Thysanoptera)	1	2

In the phase of the rosette formation the cruciferous bugs (Figure 1.3), other multi-faceted species of bugs, cabbage aphids, cruciferous fleas (Figure 1.4), leaf beetles, the caterpillars of butterflies and moths (Figure 1.7) as well as the larvae of turnip fly cause the greatest damage to the crops. The ceutorrhynchus, barids and *Lixus ascanii* L. are especially dangerous during the period of the stalk formation

In the phase of budding the rape blossom beetle and cabbage aphid cause the considerable damage.

During the stage of plant flowering the especial damage is caused by the rape blossom beetle (Figure 1.5), chafers (Figure 1.6) and cabbage aphid (Figure 1.2).

The cabbage seed-pod beetle, Brassica pod midge, cruciferous bugs and cabbage aphid are especially dangerous in the phases of the pod formation and ripening.

The oil producing cabbage crops have 2 critical periods, they are the phenophases of sprouting and flowering. The complex of the cruciferous fleas and rape blossom beetle are especially dangerous in these phenophases. This thesis is devoted to studying the biological and ecological peculiarities of the pests, their harmfulness as well as the effective ways in order to protect the spring rape and mustard crops from the harmful insects.

Table 1.3

Harmful entomofauna of oil producing cabbage crops in the fields of the Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University and the state enterprise "Research Farm "Elitne" of the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine (2007–2019)

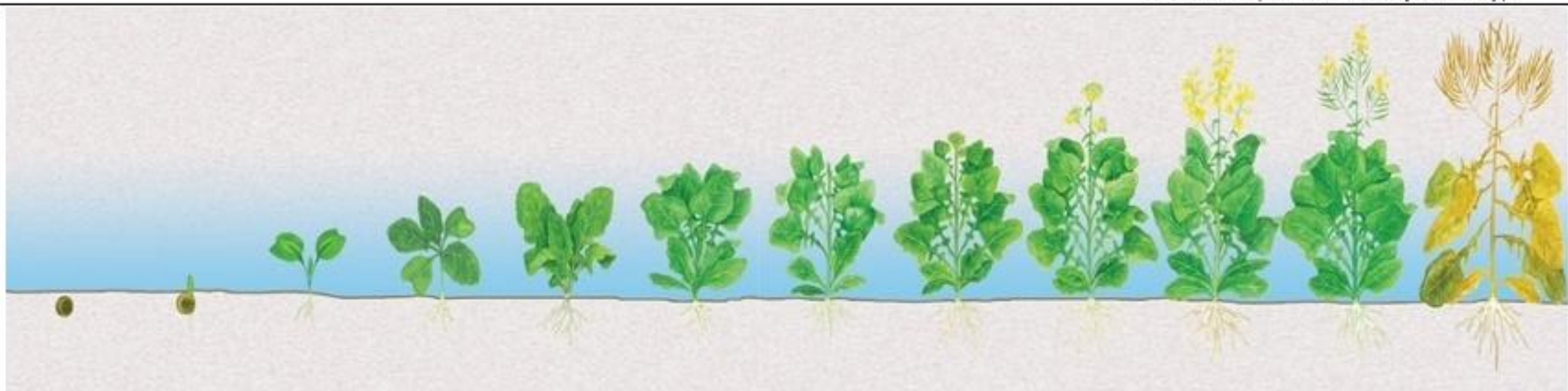
Species of pests	Cruciferous fleas and earth-boring dung beetle; Tenebrionid beetles and earth-boring dung beetle; Cruciferous bugs and other multi-faceted species of bugs; Cabbage aphid, leaf beetles, moths, butterflies and sawflies; Ceuthorrhynchuses, barids and weevils; Rape blossom beetle and chafers; Ceuthorrhynchuses and pod midge											
Graphic representation of the phenophase of the crops development												
Pheno-phases	Sowing	Sprouting	Cotyledons of 2 true leaves	3-4 true leaves	Rosette formation	9 and more true leaves	Stalk growing	Budding	Beginning of flowering	Flowering	Pods formation and growth	Complete ripeness
Approximate dates	25th of April – 1st of May	31st of April – 5th of May	6th – 11th of May	12th – 16th of May	16th– 20th of May	20th– 25th of May	26th of May – 13th of June	14th of June – 23rd of June	24th – 26th of June	26th of June – 5th of July	5th – 10th of July	20th – 25th of July

Figure 1.2. Colony of cabbage aphid on spring rape stalk, Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University , 1st decade of June 2016 (photo by the author)

Figure 1.3. Cabbage bugs on spring rape crop, Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University , 2nd decade of June 2017 (photo by the author)

Figure 1.4. Mass of cruciferous fleas on spring rape leaves, Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University, 1st decade of June 2009 (photo by the author)

Figure 1.5. Rape blossom beetle on spring rape flower, Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University , 3rd decade of June 2010 (photo by the author)

Figure 1.6. Rose chafer and larva of rape blossom beetle on white mustard flower, Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University , 3rd decade of June 2017 (photo by the author)

Figure 1.7. Caterpillar of diamond black moth on spring rape plant, Educational, Research and Production Centre "Experimental Field" of Kharkiv V.V. Dokuchaiev National Agrarian University , 2nd decade of June 2016 (photo by the author)

Conclusions:

1. 54 species of harmful insects were found on the oil producing cabbage crops which belong to 8 orders and 22 families. Among them 29 species are the specialised pests and 25 species are multi-faceted ones. 8 species belong to those that populate the crops on a mass scale, 4 species of which belong to the Coleoptera order.

2. In the phase of sprouting (up to 4 true leaves) the complex of cruciferous fleas, tenebrionid beetle and earth-boring dung beetle are the most dangerous pests. The latter can be found along the perimeter of the field.

3. In the phase of the rosette formation the greatest damage to the crops is caused by the cruciferous bugs, other multi-faceted species of bugs, cabbage aphids, cruciferous fleas, leaf beetles, the caterpillars of butterflies and moths as well as the larvae of the turnip fly.

4. The ceutorrhynchus, barids and Lixus ascanii L. are especially dangerous during the period of the stalk formation

5. In the phase of budding the rape blossom beetle and cabbage aphid cause the considerable damage.

6. During the stage of plant florescence the especial damage is caused by the rape blossom beetle, chafers and cabbage aphid.

7. The cabbage seed-pod beetle, Brassica pod midge, cruciferous bugs and cabbage aphid are especially dangerous in the phases of the pod formation and ripening.

PART 2. HOST PLANTS AS RESERVOIRS OF MAIN OIL PRODUCING CABBAGE CROPS PESTS IN THE EASTERN FOREST-STEPPE OF UKRAINE

The identification of conditions that contribute to the reproduction of the harmful insects in one place or another in many cases makes it possible to scientifically substantiate and implement the measures in order to limit their harmful activity and even completely eliminate the danger.

It is well known that the insects, both geographically and locally, are extremely unevenly distributed. This unevenness is caused by the differences in the natural and economic conditions of the particular regions, the differences on which both the possibility of existence and the intensity of the insect reproduction depend. Such biotic factor as the vegetation distribution, which is the forage base for most insects, influences their spreading greatly. This connection is strongly expressed among the harmful herbivorous insects (Dobrovolskyi, 1959).

To a greater extent this connection is inherent in the insects feeding on a single kind of food or monophagous pests as well as in the insects feeding on a limited variety of food or oligophagous pests (Kozhanchikov, 1955).

The presence and distribution of the plants which are cultivated or used by humans and on which the insects are fed is certainly the first and basic condition for the emergence of a zone or a breeding ground of harmfulness. The presence of the most preferred by the insects fodder plants often leads to the formation of a zone or a centre of the greatest damage (in the presence of other favourable conditions for the existence and reproduction of the pest) (Dobrovolskyi, 1959).

The monophagous pests that feed and reproduce on the crops which occupy a restricted area have the most sharply restricted zones or the breeding grounds with the greatest harmfulness. At the same time the ecological connections which are based on a high degree of physiological and ecological adaptation to the feeding on the certain plants and to the conditions of growth and agricultural techniques of cultivation of the insect nourishing crops are revealed (Kozhanchikov, 1955).

In the first turn the human economic activity leads to the change of the natural vegetation cover and replacement it by a few new species of plants and this fact is extremely strongly reflected in the quantitative and qualitative indices of the entomofauna (Buch, 1998, Wachowiak, 1999). The pure crops in nature do not occupy the large areas, but they can occupy 100 or more hectares in the agroceonoses and much more heavily populated by the pests (Tachvanainen, Root, 1972).

As B.V. Dobrovolskyi (Dobrovolskyi, 1959) notes the first and the main condition for the emergence of the harmful zones of any kind of insects is the presence and distribution of their fodder crops (in the presence of other favourable conditions for their reproduction and spreading). Under natural conditions the insects feed on the wild growing plant species and weeds; this fact greatly regulates their number. Therefore the anthropic factor begins to play a significant role. In the first turn the human economic activity leads to the change of the natural vegetation cover and replacement it by a few new species of plants which is extremely strongly reflected in the quantitative and qualitative indices of the entomofauna. New relationships are formed between the species; the trophic chains are restructured and the adaptations to exist in a changed environment are arisen. Certain species of the pests also become dominant under favourable weather and biological conditions (Buch, 1998, Wachowiak, 1999).

A striking example of this is the pests of the cabbage crops. According to the data of M.M. Bogdanov-Katkov (Bogdanov-Katkov, 1920) the pests of the cabbage crops under natural conditions feed on the following plants: field shepherd's purse (*Capsella bursa-pastoris* Moench.), field pennycress (*Thlaspi arvense* L.), yellow rocket (*Barbarea vulgaris* R. Br.), field pepper weed (*Cardaria campestre* R. Br.), pepper grass (*Cardaria draba* L.), camelina (*Camelina dentata* Pers.), wild radish (*Raphanus rapanistrum* L.) and others. Timely destruction of these weeds in all crop rotation fields limits the development of the pests.

The number of weeds in the natural biocoenosis is not significant and therefore the cultivated plants from the Brassicaceae family play the decisive trophic role for the insects; the acreage under these crops is constantly increasing. Their species and variety composition is very diverse. In 2018 according to the State Register of Plants Varieties Suitable for Distribution in Ukraine the following number of the cabbage crops varieties is indicated: white cabbage – 242 varieties, cauliflower – 77 varieties, red cabbage – 33 varieties, Pe-tsai cabbage – 27 varieties, broccoli cabbage – 22 varieties, Savoy cabbage – 10 varieties, turnip-rooted cabbage – 9 varieties, Brussels sprouts – 6 varieties, small radish – 76 varieties, garden radish –10 varieties, perennial wall-rocket – 3 varieties, turnips –2 varieties, green mustard – 2 varieties, field mustard – 2 varieties, rocket salad – 1 variety, black radish – 1 variety, field turnip – 1 variety, winter rape – 257 varieties and 114 parent components, spring rape – 54 varieties and 16 parent components, spring leaf mustard – 11 varieties, white mustard – 10 varieties, spring false flax – 9 varieties, oily radish – 5 varieties, winter leaf mustard – 7 varieties, field mustard – 3 varieties, annual turnip rape – 2 varieties, black mustard – 2 varieties, green mustard –2 varieties and colza –1 variety.

Today the main oil producing crops from the Brassicaceae family in the world and in Ukraine are winter rape (*Brassica napus oleifera bienis* D. C.) and spring rape (*Brassica napus oleifera annua* Metzg.). Currently the acreage of these crops in the world is over 40 million hectares, and in Ukraine there are more than 1 million hectares. Less common crops are white mustard (*Sinapis alba* L.) and Chinese mustard (*Brassica juncea* Gzem.). The world acreage under mustard is about 3,0 million hectares (in Ukraine there are about 100 thousand hectares). Other oil producing crops from the Brassicaceae family such as spring winter cress (*Brassica campestris* L.), winter rape (*Brassica rapa oleifera* DC), winter false flax (*Camelina sativa subsp. pilosa* N. Zinge), spring false flax (*Camelina sativa var. Glabrata* (DC.), oily radish (*Raphanus sativus* L. *var. oleiformis* Pers) and black mustard (*Brassica nigra* (L.) Koch) occupy only a small area, while the Abyssinian mustard (*Crambe abyssinica* Hosts. ex. RE Fr.) is not grown in our country at all. In addition the new fodder crops from the Brassicaceae family such as perko and cow cabbage that are new for our country, are being tested at the research stations.

It is impossible to obtain high and sustainable yields of all agricultural crops without protecting the plants from the harmful insects. The losses of the crops because of the pests are enormous, especially during their mass reproduction. The entomocomplex of the rape agrocenosis consists of several hundred species. As a result of the vital activity of the insect pests up to 50% of the crops (and even more) can be lost, and the yield increase at the level of 25-55% can be ensured due to the activity of the insect pollinators (Pruszynski, 1995).

According to a number of the authors (Kryshtal, 1959; Vasyliev, 1989; Yevtushenko, Stankevych, Vilna, 2014; Yevtushenko, Vilna, Stankevych, 2017) the cruciferous bugs from the *Eurydema* genus, the cruciferous fleas from the *Phyllotreta* genus, the rape blossom beetle (*Meligethes aeneus* F) and the rose chafer (*Epicometis (Tropinota) hirta* Poda.) cause the annual significant losses of the oil producing cabbage crops in the Forest-Steppe zone of Ukraine.

In the studied literature we have found sometimes quite contradictory information as for the wild plants on which the pests of the oil cruciferous crops can feed. Even less data on this issue can be found regarding the Eastern Forest Steppe of Ukraine and the Kharkiv region in particular.

Therefore the purpose of our research was to identify the main host plants as reservoirs of the oil producing cabbage crops pests under the conditions of the Kharkiv district of the Kharkiv region as well as to identify the stations where such plants are concentrated in large quantities, which promotes the mass reproduction of the pests which then populate the agrocenoses.

Materials and methods of researches

The researches regarding the identification of the host plants as reservoirs of the main oil producing cabbage crops pests were carried out in 2011–2014 in the biocoenoses in the territory of the settlement Rogan, villages Mala Rogan, Elitne, Vilkhivka, Biskvitne and Koropy of the Kharkiv district of the Kharkiv region. The meadows (the valley of the Roganka river), the perimeters of the fields and the roadsides of highways where the species of the researched host plants as reservoirs of the main oil producing cabbage crops pests grew were chosen as the stations for conducting the researches. From each of the studied stations a section of about 1 km in length was chosen and in hundreds plants of one species were inspected and visually counted the detected pests, and then their density per plant was calculated.

Results of researches and discussion

The cruciferous fleas on the farms of the Eastern Forest-Steppe of Ukraine appear in early spring (I-II decades of April). The beetles cause harm to all species of plants, but initially they feed mainly on different cabbage weeds. According to the literary data among the wild growing cabbage plants the beetles prefer Indian cress, hedge mustard, hoary alyssum, tansy mustard, pepper weed, sea kale, garlic mustard, erysimum, yellow rocket, wild radish, gillyflower, pennycress, etc. Undulating flea beetle and mesographe flea beetle feed on the leaves of field shepherd’s purse and flea beetle feeds on the leaves of candytuft. When the sprouts of spring rape appear most beetles migrate to them and within 2-3 days completely destroy the sprouts during the reproduction on a mass scale. The beetles scrape the epidermis from the leaves and eat out the terminal bud. Hot and dry weather favours the increasing of the cruciferous fleas' harmfulness. On the one hand it is explained by the increased activity and voracity of the beetles connected with restoring the water balance of their bodies, and on the other hand it is explained by the fact that in dry weather the plants are more weakened and vulnerable to damage by the insects. The beetles cause damage beginning from the phase of sprouting and up to the crops harvesting. The larvae of the large striped flea beetle penetrate the leaf, mine it and stay there until turning into a pupa, and the larvae of the horseradish flea beetle develop inside the leaf stalk and in the medial vein of horseradish and cabbage leaves (Yevtushenko, Stankevych, Vilna, 2014).

One of the most dangerous pests of the cabbage crops in all areas of their cultivation is the rape blossom beetle (*Meligethes aeneus* F.); it can damage the plants in the budding and flowering phenophases. At first the beetles populate the flowers of dandelion, tall buttercup and yellow rocket and later they appear on the flowers of fruit trees (cherry-tree, apple-tree, etc.). Te beetles appear on the cultivated cabbage crops with the emergence of the first green buds. The beetles feed on the inner parts of the flowers (pistils, stamens, pollen and petals). The damaged buds turn yellow and fall down. Feeding mainly on the pollen of the opened flowers the rape blossom beetles are less harmful during the friendly and rapid flowering. However the mass appearance of the beetles can also cause the significant damage during the period of flowering (Yevtushenko, Stankevych, Vilna, 2014).

The cruciferous bugs actively populate the crops of oil producing cabbage crops beginning from the stemming phase. According to the literary data among all wild growing plants the bugs prefer different types of hedge mustard. The damage is caused by the adult bugs and their larvae; they pierce the skin of the leaves or the flower-bearing shoots with the proboscis and suck the juice from them. The light spots appear at places of piercing, the tissue dies, falls out and the irregular holes are formed. When the seeds are damaged, the flowers and ovary fall down and the quality of the seeds deteriorates. The harmfulness of the bugs increases significantly in dry and hot weather (Yevtushenko Vilna, Stankevych, 2017).

The mustard bug (*Eurydema ornata* L.) damages the seeds of the cruciferous crops, especially cabbage, garden radish, black radish as well as the oil producing crops, namely mustard, false flax, rape, sea kale, etc. It is also closely associated with the wild growing cruciferous plants on which the bugs are often numerous (Puchkov, 1961).

The cabbage bug (*Eurydema ventralis* Kol.) damages almost all cabbage plants as well as the caper plants. It is dangerous for the cabbage seedlings and causes severe weakening or complete death of the plants (Puchkov, 1961).

Pentatomid rape bug (*Eurydema oleracea* L.) damages different varieties of cabbage, radish, Russian turnip, common turnip, horseradish, rape, false flax and sea kale; and during the period of the additional feeding it also damages sunflower, sugar beet transplants, ears of rye, wheat, barley, leaves of potato and other plants on which the larvae can develop (Puchkov, 1961).

Rose chafer (*Epicometis hirta* Poda.) is a dangerous pest of almost all agricultural crops in the budding and flowering phases. In recent years the pest has gained the economic importance not only for the fruit, but also for the field crops including the oil producing cabbage crops. The damage is caused by the beetles which gnaw out the flowers of fruit trees, rose, rose-bush, rowan tree, June berry, almond, lemon, tangerine, grapes (buds, ovaries and young leaves), horse chestnut, snowball-tree, lilac, privet, beetroot, elderberries, golden currant, black currant (young leaves and flowers), Elea gnus, peony, poppy, black radish, rocket salad, rape, mustard, cabbage (seeds), beet (transplants), common flax, rhubarb, cucumbers, watermelons, melons, pumpkin, ambary hemp, cotton, castor-oil plant, strawberries, holy clover, peas (leaves and sprouts), clover, vetch, beans, soybeans, haricot, alfalfa, gram chick-peas, sunflower, safflower, tomato, daisy, tulip, ears of rye, wheat, barley, panicles of millet, corn and other plants (Rozova, 2011; Chernii, 2011).

The population density of the main pest species of oil producing cabbage crops on the host plants as reservoirs at the researched stations in 2011–2014 is presented in Tables 2.1 and 2.2. The researches have shown that among all host plants as reservoirs dandelion (*Taraxacum officinale* Wigg.) and caustic buttercup (*Ranunculus acris* L.) are the first plants that appear in spring. These species of plants are the typical representatives of meadow vegetation. Dandelion is also spread along the highways and around the perimeters of the fields, but buttercup only occurs on the meadows under the conditions of high humidity. Their main role is to be the host plants as reservoirs for the insects that feed on the pollen of flowers; these insects are the rape blossom beetle and rose chafer. These plants begin to bloom in late March, but feeding of the cruciferous fleas has not been noted on them.

Other five plant species, namely field mustard (*Sinapis arvensis* L.), hedge mustard (*Sisymbrium Loeselii* L.), tansy mustard *(Descurainia Sophia* (L.), Webb. ex Prantl.), yellow rocket (*Barbarea vulgaris* R. Br.) and common shepherd's purse (*Capsella bursa-pastoris* Moench.) are the plants of the Brassicaceae family and serve as a forage base for the specialised cabbage pests and multi-faceted pests. They can be found at two other investigated stations: on the roadsides of highways and along the perimeters of the fields.

In early April we have found the rape blossom beetle and rose chafer on the flowering plants of buttercup and dandelion. The imagoes of these pests' species feed on the pollen of flowers, stamens and pistils. Caustic butter cup only occurred on the meadows; its population density during the years of the researches ranged from 16 to 29 plants/m². On the average each plant had 0,2-0,4 specimens of the rape blossom beetle and rose chafer (Tables 2.1, 2.2).

Dandelion occurred at all three investigated stations. On the meadows its population density was 22–29 plants/m², along the perimeters of the fields it was 14–18 plants/m², and on the roadsides of highways it was 13–18 plants/m². The population density of the rape blossom beetle ranged from 1,9 specimens/plant on the roadsides of highways to 3,6 specimens/plant on the meadows, and that of the rose chafer was 0,3-0,8 specimens/plant. This fact makes it possible to suggest that most rape blossom beetles hibernate in the ground litter in the areas close to the meadows (Tables 2.1, 2.2).

Field mustard grows on the roadsides of highways (2–3 plants/m²) and along the perimeters of the fields (2–4 plants/m²). It was populated by all the investigated pest species. The population density of the cruciferous fleas on this weed species ranged from 10,7 to 20,1 specimens/plant. With the beginning of budding the rape blossom beetles and the cruciferous bugs began to populate the plants. The population density of the rape blossom beetle reached 3,1–5,4 specimens/plant, and that of the bugs was 2,1–2,6 specimens/plant (Tables 2.1, 2.2). In the flowering phase the population density of the rose chafer was about 0,1–0,4 specimens/plant (Tables 2.1, 2.2).

Hedge mustard is found on the roadsides of highways and along the perimeters of the fields. Its average population density is about 3–6 plants/m². All the investigated species of pests were noted on this plant.

Table 2.1

Population density of main pests of oil producing cabbage crops on host plants as reservoirs at researched stations of Eastern Forest-Steppe of Ukraine in 2011–2012

Variant		Year of research									
		2011					2012				
		population density at station, pieces/m²	pests population density, specimens/plant				population density at station, pieces/m²	pests population density, specimens/plant			
plants species	stations		*Phyllotreta spp.*	*Meligethes aeneus* F.	*Eurydema spp.*	*Epicometis (Tropinota) hirta* Poda.		*Phyllotreta spp.*	*Meligethes aeneus* F.	*Eurydema spp.*	*Epicometis (Tropinota) hirta* Poda.
Taraxacum officinale Wigg.	meadows	22	0	2,6	0	0,4	25	0	3,1	0	0,6
	roadsides of highways	15	0	2,2	0	0,3	13	0	1,9	0	0,5
	fields perimeters	16	0	2,3	0	0,3	18	0	2,8	0	0,6
Ranunculus acris L.	meadows	29	0	0,2	0	0,3	24	0	0,4	0	0,4
	roadsides of highways	0	0	0	0	0	0	0	0	0	0
	fields perimeters	0	0	0	0	0	0	0	0	0	0
Sinapis arvensis L.	meadows	0	0	0	0	0	0	0	0	0	0
	roadsides of highways	3	15,3	5,2	2,1	0,1	2	14,2	4,8	2,6	0,1
	fields perimeters	4	18,5	5,4	2,0	0,1	2	20,1	5,1	2,3	0,1
Sisymbrium Loeselii L.	meadows	0	0	0	0	0	0	0	0	0	0
	roadsides of highways	4	14,2	4,1	2,4	0,1	4	13,8	3,4	1,7	0,1
	fields perimeters	4	16,8	4,3	2,4	0,1	3	19,9	3,7	2,1	0,1

Descurainia Sophia (L.) Webb. ex Prantl.	meadows	0	0	0	0	0	0	0	0	0	0
	roadsides of highways	3	7,6	1,6	1,4	0,1	4	5,4	1,1	1,8	0,1
	fields perimeters	3	7,8	1,5	1,4	0,1	3	6,3	1,3	2,6	0,1
Barbarea vulgaris R.Br.	meadows	0	0	0	0	0	0	0	0	0	0
	roadsides of highways	6	17,1	6,1	1,8	0,2	5	17,4	9,1	2,8	0,1
	fields perimeters	7	19,4	5,3	1,9	0,2	8	23,2	12,3	3,2	0,2
Capsella bursa-pastoris Medic.	meadows	0	0	0	0	0	0	0	0	0	0
	roadsides of highways	18	0,2	0	0	0	15	0,1	0	0	0
	fields perimeters	17	0,4	0	0	0	13	0,6	0	0	0

Table 2.2

Population density of main pests of oil producing cabbage crops on host plants as reservoirs at researched stations of Eastern Forest-Steppe of Ukraine in 2013–2014

Variant		Year of research									
		2013					2014				
		population density at station, pieces/m²	pests population density, specimens/plant				population density at station, pieces/m²	pests population density, specimens/plant			
plants species	stations		*Phyllotreta spp.*	*Meligethes aeneus* F.	*Eurydema spp.*	*Epicometis (Tropinota) hirta* Poda.		*Phyllotreta spp.*	*Meligethes aeneus* F.	*Eurydema spp.*	*Epicometis (Tropinota) hirta* Poda.
Taraxacum officinale Wigg.	meadows	28	0	2,9	0	0,6	29	0	3,6	0	0,8
	roadsides of highways	18	0	2,3	0	0,5	15	0	2,8	0	0,6
	fields perimeters	14	0	2,6	0	0,4	17	0	3,1	0	0,8

Ranunculus acris L.	meadows	16	0	0,3	0	0,4	18	0	0,2	0	0,3
	roadsides of highways	0	0	0	0	0	0	0	0	0	0
	fields perimeters	0	0	0	0	0	0	0	0	0	0
Sinapis arvensis L.	meadows	0	0	0	0	0	0	0	0	0	0
	roadsides of highways	2	12,1	3,3	2,1	0,3	3	10,7	3,1	2,2	0,3
	fields perimeters	3	13,3	3,7	2,2	0,3	2	12,5	3,3	2,4	0,4
Sisymbrium Loeselii L.	meadows	0	0	0	0	0	0	0	0	0	0
	roadsides of highways	5	10,4	2,2	2,3	0,1	6	9,2	1,7	2,1	0,2
	fields perimeters	6	11,7	2,6	2,5	0,2	6	9,8	1,9	2,2	0,2
Descurainia Sophia (L.) Webb. ex Prantl.	meadows	0	0	0	0	0	0	0	0	0	0
	roadsides of highways	3	5,6	0,9	1,6	0,1	3	4,4	0,7	1,3	0,1
	fields perimeters	4	5,8	1,2	1,7	0,1	3	4,9	1,0	1,4	0,1
Barbarea vulgaris R.Br.	meadows	0	0	0		0	0	0	0	0	0
	roadsides of highways	6	15,3	4,2	1,6	0,4	6	13,1	3,3	1,7	0,5
	fields perimeters	7	17,1	3,1	1,9	0,4	10	18,3	4,6	1,8	0,6
Capsella bursa-pastoris Medic.	meadows	0	0	0	0	0	0	0	0	0	0
	roadsides of highways	12	0,1	0	0	0	16	0,1	0	0	0
	fields perimeters	15	0,2	0	0,1	0	14	0,3	0	0,1	0

The population density of the cruciferous fleas ranged from 9,2 to 19,9 specimens/plant. The rape blossom beetles and the cruciferous bugs began to populate the plants at the beginning of the budding phase. The population density of the rape blossom beetle ranged from 1,7 to 4,3 specimens/plant, and that of the bugs was 1,7–2,5 specimens/plant. During the flowering phase the population density of the rose chafer was within the limits of 0,1–0,2 specimens/plant (Tables 2.1, 2.2).

Tansy mustard is found on the roadsides of highways and the outskirts of the fields. At the given stations the population density of this species of weed was 3–4 plants/m². Due to its small leaves and smaller size of the flowers tansy mustard is less populated by the cruciferous fleas, rape blossom beetle and rose chafer. The average population density of the cruciferous fleas was 4,4–7,8 specimens/plant. At the beginning of the budding phase the plants are populated by the rape blossom beetles and cruciferous bugs. The population density of the rape blossom beetle ranged from 0,7 to 2,6 specimens/plant and that of the bugs was 1,3–2,6 specimens/plant. The population density of the rose chafer in the phase of flowering was no more than 0,1 specimens/plant (Tables 2.1, 2.2)

Yellow rocket is one of the most common weeds from the Brassicaceae family. Along the highways and the perimeters of the fields we have noted the density population of yellow rocket at the level of 5–10 plants/m². The highest population density of the cruciferous fleas was noted on yellow rocket; it was from 13,1 to 23,2 specimens/plant. The rape blossom beetle populated yellow rocket most often in comparison with all the investigated weeds. Its population density ranged from 3,1 to 12,3 beetles per plant, and the population density of the bugs reached 1,6–3.2 specimens/plant. In the flowering phase the rose chafer also feeds on yellow rocket; its population density was 0,1–0,5 specimens/plant (Tables 2.1, 2.2).

Common shepherd’s purse was found on the roadsides of highways and along the perimeters of the fields with a population density of 12–18 plants/m², which is 3,0–3,5 times higher in comparison with other weeds from the Brassicaceae family. However we observed feeding of the cruciferous fleas on shepherd’s purse with an average beetle population density of only 0,1–0,6 specimens/plant (Tables 1, 2). This can probably be explained by the fact that the leaf rosette of shepherd’s purse lies on the surface of the soil and is always covered with dust; this fact may not attract the insects and prevents them from feeding (Tables 2.1, 2.2).

Conclusions:

1. The host plants as reservoirs for the dominant pests of the oil producing cabbage crops in 2011–2014 were dandelion, caustic buttercup, field mustard, hedge mustard, tansy mustard, yellow rocket and field shepherd's purse. The largest number of species of host plants as reservoirs was found on the roadsides of highways and along the perimeters of fields (6 species) and on the meadows (2 species).

2. The cruciferous fleas, rape blossom beetles and cruciferous bugs visited such crops as field mustard, hedge mustard and yellow rocket most often.

3. Field shepherd's purse was the least significant among the identified host plants as reservoirs. Only a small amount of the cabbage fleas fed on this crop. This fact can be explained by the small white flowers that do not attract the rape blossom beetle and rose chafer as well as by a ground flat leaf rosette which is always covered with dust and prevents the fleas and bugs from feeding.

PART 3. PROTECTION OF SPRING RAPE FROM UNDULATING FLEA BEETLES

The flora invariably remains the main source of food for a man. As a result of the agricultural activity a man can obtain 88 % of food products and together with the livestock products this figure can reach 99 % (Bardin, 2000; Yakovenko, 2005).

Against the background of a stable deficit the world's growing needs for vegetable oil are constantly increasing. Ukraine has every chance to become one of the leaders at the oil market because the areas under the rape crops as well as the average yields are growing year after year (Yevtushenko, Vilna, Stankevych, 2016).

Unlike sunflower rape can be successfully cultivated in all regions of Ukraine (Abramyk, Haidash, Hurynovych, 2003).

Rape is a source of vegetable oil used in many industries such as metallurgy, paint and varnish, textile, food, etc. The oil obtained during its processing is extremely useful for humans because it contains a significant part of glycerides of unsaturated fatty acids which effectively counteract the cardiovascular diseases, reduce the chances of thrombosis and regulate the content of cholesterol in the blood (Havryliuk, 2008).

In addition rape is a good melliferous herb (90 kg/ha). Rape seeds contain up to 50 % of fat, 20 % of protein and 5,0–5,6 % of cellulose. This crop is also a valuable fodder for livestock because winter rape is the very first crop in the green conveyor. About 180 kg of straw can be obtained from every 100 kg of grain yields. It is rich in proteins (3,5 %), fats (1,5 %) and ash (5,3 %). In addition the rape straw contains 39,5 % of cellulose and 34,2 % of REM. Its ash contains a lot of potassium (27,3 %) and calcium (2,4 %). When processing rape into the oil the output of oilcake is about 54 %. The oilcake contains 32,0 % of protein, 29,8 % of REM, 11,0 % of cellulose and 7,2 % of ash (Haidash, 1998). Every 100 kg of the green rape mass contain 3 kg of digestible protein and 15,7 % of fodder units. It is rich in protein (up to 31 %), ascorbic acid (100 mg. per 100 g. and even more) and carotene (4,0–7,11 mg. per 100 g.) (Husiev, Kokovikhin, Pelykh, 2011).

The introduction of rape into the field crop rotations reduces their saturation with cereals and sunflowers, increases the area of the best preceding crops and significantly improves the soil fertility and its phyto–sanitary condition. Besides in the absence of organic fertilizers on the farms rape is widely used as a green fertilizer. In addition rape can remove the radionuclides from the soil, which is relevant for Ukraine. It is not generally known that rape crops have a beneficial effect on the ecological situation. For example one hectare of rape crops educes 10,6 million liters of oxygen while 1 hectare of forest educes only 4 million liters of this gas. And perhaps the most important thing is that rape has become the basis for the production of ecologically pure fuel (Sekun, Lapa, Markov, 2008).

At the World Congress devoted to rape cultivation which was held in Cambridge in 1995 rape was identified as the most promising oil producing crop and its oil was considered to be the most valuable among all other oils (Supikhanov, Petrenko, 2008).

In China and India rape was known as an agricultural crop before 4,000 BC. It has spread to Central Asia from the Mediterranean countries and in the XIV century it appeared in Western Europe (Holland and England). In the XVI century rape spread across the Rhine to Germany. From there through Poland in the middle of the eighteenth century rape got into Western Ukraine. As oil producing crop it has being cultivated since the middle of the XIX century (Orobchenko, 1959; Kuznetsova, 1975).

Rape is cultivated in Poland, Italy, Sweden, Holland, France, England, India, Pakistan, and Canada, in the USA, Chile, Ethiopia, Algeria, Australia and other countries. In 28 countries of the world it is cultivated as the main oil producing crop. In general about 25 million hectares in the world are devoted to the rape crops and the average yield capacity amounts to 1,4 t./ha. The share of rape in the world production of oil producing crops is about 13 % (over 37 million tons) and the share of rape oil production is over 14 million tons. In Ukraine the main areas under the rape crops are located in the left–bank part of the Forest–Steppe and they are constantly increasing (Shpaar, 2007; Husiev, Kokovikhin, Pelykh, 2011).

According to the Ministry of Agrarian Policy of Ukraine the area of agricultural land in Ukraine under rape should become about 2,2 million hectares and its gross production at a yield capacity of 2,5 t./ha should reach 5,5 million tons, which will make it possible to produce 1,8 million tons of biological fuel annually (Yevtushenko, Stankevych, Vilna, 2014).

The financial costs on rape cultivation are covered with the yield capacity of 1,1–1,5 t./ha (Yeshchenko, Karychkovska, Novak, 2014).

The main reasons for the poor yield of rape are an inobservance of agricultural technology and large losses from harmful organisms. The shortage of yield caused by the harmful organisms is 30–40 % or even more. That is why the development of an effective and scientifically grounded system of winter rape protection under modern growing technology takes the first place.

One of the most dangerous pests of winter rape is a complex of the undulating flea beetles that can do harm to the plants from the phase of sprouting and until the harvest ripening.

Undulating flea beetles are a complex of species, namely *Phyllotreta atra* F., *Phyllotreta nigripes* F, *Phyllotreta nemorum* L., *Phyllotreta undulata* Kutsch., *Phyllotreta vitata* Redt. and *Phyllotrta armoracie* Koch which belong to the genus of *Phyllotreta*.

The species are very widely spread. The most harmful pests have been found in the North Caucasus, the Lower Volga region and other places characterised by early, friendly and warm spring. They cause a great harm in Eastern and Western Siberia and in the Upper Volga region. In Ukraine they can be found everywhere; but the most numerous number of these pests is found in the south of the Forest–Steppe zone and in the Steppe region (Palyi, 1962).

Undulating flea beetles are small (2–5 mm) jumping beetles with the thickened hips of the back legs and single–coloured or striped elytra (Figure 3.1). Their eggs are pale yellow, sometimes with a light pink tint, translucent and elongated oval. Their length is 0,3–0,4 mm. The larvae are vermiform with 3 pairs of thoracic legs; the colour of the body is whitish–yellow, the head and legs are darker, and the length of the adult larva is up to 4 mm. The pupa is 2–3 mm long and it is light yellow in colour (Vasyliev, 1989; Fedorenko, Sekun, Markov, 2008).

Sexually immature beetles spend the winter under the plant remains and in the upper layer of soil in the field, on the roadside, in the lawns and in the forest belts. The active life of various species of the undulating flea beetles begins not at the same time; the later spring comes, the later the beetles appear (Sakharov, 1934).

At the end of March and in April they leave the wintering places and settle on the cabbage weeds. In the case of the cabbage seedlings emergence or after planting the seedlings in the soil the mass of the fleas migrates to these plants and continues the additional feeding. The beetles feed most intensively in the afternoon from 10 a.m. to 1 p.m. and then from 4–6 p.m. In May and June they mate. The female lays a group of 20–40 eggs into the soil at the roots of the cabbage plants (some species lay eggs into the leaf blade or leaf nerves). The development of an egg lasts 3–12 days, the development of a larva lasts 15–30 days and the development of a pupa lasts 7–17 days depending on the weather conditions. The larvae pupate in the soil

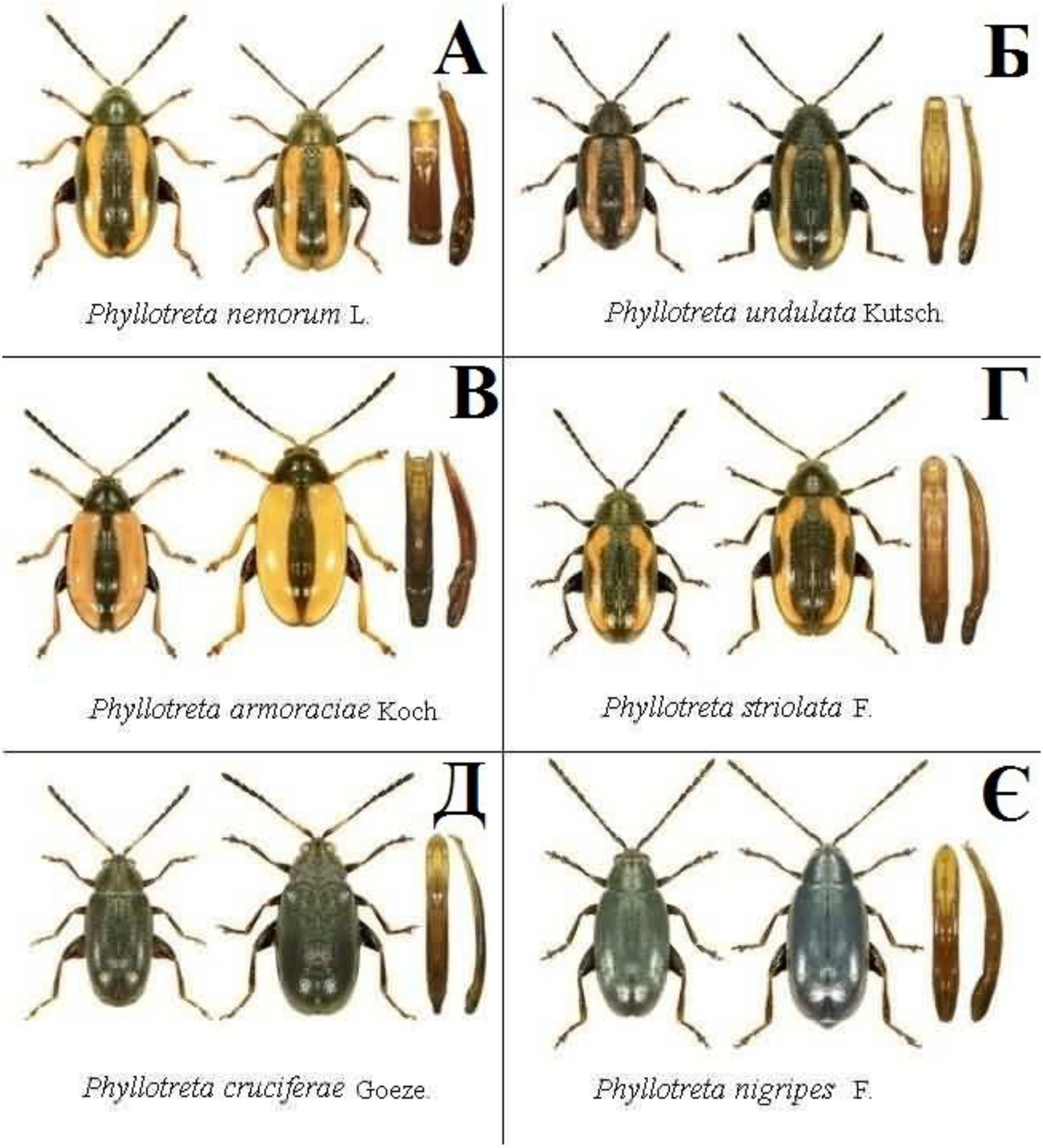


Figure 3.1. Undulating flea beetles and male genitals: a) *Phyllotreta nemorum* L.; b) *Phyllotreta undulata* Kutsch.; c) *Phyllotreta armoracie* Koch.; d) *Phyllotreta vitata* Redt.; e) *Phyllotreta atra* F.; f) *Phyllotreta nigripes* F.

Figure 3.2. **Sprouts of spring cruciferous crops damaged by undulating flea beetles to weak and heavy degrees**

Figure 3.3. A mass of young generation of undulating flea beetles which can also cause significant damage on spring rape leaves after flowering

Figure 3.4. Damage to spring rape caused by undulating flea beetles of the young generation: A) damage to flowers; B) damage to juicy stems; C) damage to young pods

at a depth of 5–8 cm, and then the beetles go to the surface and feed on the plants until the migration to wintering. In July there is a new generation of the fleas which can damage the late rape crops. The beetles feed only on the cabbage crops; they can survive without food no more than 10–12 days. The higher the air temperature is, the faster they die out because of the starvation. In wet and rainy weather the beetles are not mobile. The fleas can destroy the sprouts in 3–4 days especially if the weather is hot and dry (Palyi, 1962; Kostromitin, 1980).

The beetles are most active and harmful in hot and dry weather. According to the observations 10 undulating flea beetles ate 430 mm^2 of the leaf surface for 10 days at a temperature of 14,3 °C; and at a temperature of 20,6 °C they ate 720 mm^2 of the leaf surface for the same period of time (Piatakova, 1928).

The beetles peel the leaf and eat away a growth point. The small holes in the form of ulcers appear on the leaves as a result of the damage, and later the openings also appear (Figures 3.2–3.4). The damaged leaves are gradually turning yellow. At high temperatures the heavily damaged sprouts perish within two to three days (Kostromitin, 1980).

The economic threshold of harmfulness of the undulating flea beetles on the cabbage crops sprouts is only 3–5 specimens per m^2 (Stankevych, Zabrodina, 2016).

At the beginning of the XXI century plant protection becomes more ecologically oriented. The advantage is given to less toxic preparations with low rates of applying. The presowing protection becomes especially relevant; and if the economic threshold of harmfulness in the phase of sprouting is exceeded then it will be recommended to spray the crops with the insecticides authorised to use (Fedorenko, Luhovskyi, 2011, Stankevych, Yevtushenko, Krasylovets, 2014; Stankevych, 2015; Stankevych, Kava, 2015).

Materials and methods of researches

The seasonal dynamics of the undulating flea beetles number was determined on the crops at the Educational, Research and Production Centre “Experimental Field” of Kharkiv V.V. Dokuchaiev National Agrarian University . The pest calculations were carried out according to the generally accepted methods. The species composition of the undulating flea beetles complex was established according to the determinants (Palyi, 1975).

To establish the seasonal dynamics of the undulating flea beetles number the calculations were conducted every five days beginning from the time of the sprouts appearance by visual counting, mowing with the entomological catching net, and using the Petliuk box. When mowing with the entomological catching net at the Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University 25 double sweeps were made on each crop; and at the state enterprise "Research Farm "Elitne" of the Institute of Plant Growing named after V.Ya. Yuryev of the National Academy of Agrarian Sciences of Ukraine 100 double sweeps of the net along two diagonals of the field were made. Using the Petliuk box 16 equidistant places with an area of 0,25 m^2 were chosen in the field, and then the density of the beetles' population per 1 m^2 was determined (Nykyforov, Bezdenko, 1951; Mehalov, 1968; Fassulati, 1971; Omeliuta et al., 1986; Chaika, Polishchuk, 2010; Yevtushenko, Stankevych, Vilna, 2014; Stankevych, Zabrodina, 2016).

According to the agreements concluded by Kharkiv V.V. Dokuchaiev National Agrarian University and the Institute of Plant Growing named after V.Ya. Yuryev of the National Academy of Agrarian Sciences of Ukraine on conducting of mutual researches on the cabbage oil producing crops in the fields of the state enterprise "Research Farm "Elitne" of the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine a mutual research as for the influence of different seed treatment agents on the quantity and quality of the spring rape crop against the background with the fertilizers ($N_{30}P_{30}K_{30}$) and without them was carried out.

The researches were carried out in 2010–2012. The soil was typical chornozem with a content of humus in the arable layer of about 5,3 %. After the preceding crop of winter wheat spring rape of Ataman variety was sown at a rate of 2,5 million of germinating seeds per 1 hectare in two blocks: without the fertilizers and with the applying of a complex of the mineral fertilizers ($N_{30}P_{30}K_{30}$). The agrarian equipment was common for the cultivation zone.

The seeds of spring rape were sprayed with the preparations of insecto-fungicide and fungicide actions on the day before sowing according to the List of the pesticides and agrochemicals authorized for use in Ukraine.

During the phase of sprouting (not later than 4 true leaves appeared) the crops of spring rape were sprayed with Karate Zeon insecticide, 5 % of microcapsule water suspension with a rate of consumption of 0,15 L./ha.

The scheme of the research in 2010:

1. Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting);

2. Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting);

3. Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0+6,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting);

4. Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting).

The scheme of the research in 2011–2012:

1. Control, water (H2O) (10,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting);

2. Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting);

3. Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting);

4. Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting);

5. Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting).

After harvesting the test sheaves were threshed with the help of MZ–1 machine and cleaned with the help of SM–015 machine. The yield analysis was carried out at the laboratory of Plant Growing and Variety Studying of the V.Yu. Yuryev Institute Plant Growing, the National Academy of Agrarian Sciences of Ukraine. The obtained data as for the influence of various treatment agents on the growth and development of the crops as well as the protective properties of the preparations as for their reliability were analysed; and the technical and economic efficiencies were determined.

When spraying the crops the technical efficiency of the preparations against the main rape pests was determined by the formula:

$$T = \frac{a - b}{a} \times 100, \qquad (3.1)$$

where *T– technical efficiency, %;*

a – density of the pests population before spraying,

b – density of the pests population in 3, 7 or 14 days after spraying (Recommendations, 1975; Methods of calculation, 1976; Triebel and others, 2001).

The economic efficiency or increase in the yield was determined according to the following formula:

$$I = \frac{a - b}{a} \times 100, \qquad (3.2)$$

where *I – increase in the yield, %;*

a – average yield from a calculated unit on a cultivated plot, t.;

b – average yield from a calculated unit on a plot under control, t. (Recommendations, 1975; Methods of calculation, 1976; Triebel and others, 2001).

The degree of spring rape sprouts damaged by the undulating flea beetles was determined on a scale of 0 to 5: mark 0 – no damage; mark 1 – damage up to 25%; mark 2 – 26–50 % of damage; mark 3 – 51–75 % of damage; mark 4 – more than 75 % of the leaf surface of the plant are damaged.

The average degree of the damaged spring rape sprouts was determined by the formula:

$$D = \frac{\Sigma n - b}{\Sigma n},$$

(3.3)

where *D – average degree of damage;*

∑(n × b) – sum of damaged plants of the corresponding damage degree;

n – total number of plants in the test.

The coefficient of the damaged spring rape sprouts was determined by the formula:

$$C = \frac{a - b}{100}, \qquad (3.4)$$

where *C – coefficient of damage;*

a – proportion of damaged plants, %;

b – average degree of damage.

The influence of the seed treatment agents on the sowing quality of seeds was determined in accordance with the State Standard of Ukraine 4138–2002 in the laboratory of the Phytopathology Department of Kharkiv V.V. Dokuchaiev

National Agrarian University 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. In order to determine the influence of the seed treatment agents on the seed germination under the laboratory conditions the seed material was placed into Petri dishes (100 seeds of each variant) which were then placed into a thermostat at a temperature of 20 °C; further the seed material was moistened every day to maintain a constant level of 60 % moisture. The seed germination rates were fixed on the 3rd, 5th, 7th and 9th days.

Results of researches and discussion

According to the data of our researches all 6 species of the undulating flea beetles which are common for Ukraine can be found in the Eastern Forest–Steppe of Ukraine. They are *Phyllotreta atra* F., *Phyllotreta nigripes* F., *Phyllotreta nemorum* L., *Phyllotreta undulate* Kutsch., *Phyllotreta vittata* Redt. *and Phyllotreta armoracie* Koch. Together they form a complex of the undulating flea beetles that cause harm to all cabbage crops.

However not all species are equally represented. The most numerous species are *Phyllotreta atra* (about 71 %) and *Phyllotreta nigripes* (about 16 %), the latter is less numerous. Other 4 species make up from 0,4 to 8,8 % in the structure of the population (Table 3.1).

Table 3.1

Correlation of species in a complex of undulating flea beetles at Educational, Scientific and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2007–2012

Species proportion in a complex of undulating flea beetles, %					
Phyllotreta atra	*Phyllotreta nigripes*	*Phyllotreta undulata*	*Phyllotreta nemorum*	*Phyllotreta vittata*	*Phyllotreta armoracie*
70,8	15,8	8,8	1,9	2,3	0,4

According to the calculations of the undulating flea beetles carried out in the beginning of spring during 2007–2012 we found out that the first beetles appeared on the early cabbage weeds (first of all on colza, hedge mustard and field mustard) when the average daily temperature was set at the level of 7–11 °C. Usually (in 2007, 2008, and in 2010) the fleas appeared on the fodder plants at the beginning of the first decade of April. In 2011 the latest period of the beetles' appearance was marked at the beginning of the third decade of April (Table 3.2).

Table 3.2

The terms of beginning and mass appearance of undulating flea beetles on fodder crops at Educational, Scientific and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2007–2012

Years	Beginning of beetles mass appearance on fodder crops		Mass appearance of beetles		
	decade	average daily air temperature, °C	decade	average daily air temperature, °C	sum of effective temperatures, °C
2007	beginning of the1st decade of April	10,8	end of the 3rd decade of April	11,0	130,3
2008	beginning of the 1st decade of April	10,1	end of the 2nd decade of April	12,0	101,6
2009	beginning of the 2nd decade of April	7,6	middle of the 3rd decade of April	10,9	103,1
2010	beginning of the 1st decade of April	9,7	end of the 2nd decade of April	11,6	108,1
2011	beginning of the 3rd decade of April	9,3	middle of the 3rd decade of April	12,3	105,9
2012	middle of the 1st decade of April	8,5	middle of the 2nd decade of April	13,5	117,0

The mass appearance of the undulating flea beetles took place when the average daily temperatures were above 11 °C, and the sum of the effective temperatures above 5 °C was 101–130 °C. The data given in Table 3.2 show that in 2009 and 2011 the mass of the flea beetles left the wintering places in the middle of the third decade of April and it was the latest for the period of our researches. In 2012 the beetles appeared in the middle of the second decade of April and it was the earliest period of their appearance.

The seasonal dynamics of the undulating flea beetles number on spring rape is reflected in the form of a diagram in Figure 3.5.

Analysing the data given in Figure 3.5 it is seen that the greatest number of the undulating flea beetles on spring rape in 2007–2011 was from the end of May to the middle of June. In 2012 as a result of the early and warm spring there was an early outbreak of the wintered undulating flea beetles from the wintering places and their mating periods also began early. The dry and hot conditions of that year contributed to the fact that the sprouts of oil producing cabbage crops were obtained in 15–20 days after sowing (usually in 5–7 days). As a result there were such conditions when the undulating flea beetles of the new generation appeared during the period of the formation and growth of the pods of the oil producing crops, but not during the period of the seeds ripening as it was in the previous (2007–2011) years. Thus there was the second peak of the undulating flea beetles number on spring rape which fell on the third decade of June. As a result the undulating flea beetles of the new generation have significantly damaged the young pods of spring rape in which the future harvest was being formed at that time.

The necessity to conduct the presowing treatment and spraying of the plants in the phase of sprouting is explained by the fact that for the years of the researches the density of the undulating flea beetles population on the spring rape sprouts reached 81,4 specimens per m^2 which exceeded the economic threshold of harmfulness (3 specimens per m^2) 27,1 times. Such a number of pests can lead to the loss of crops within a few hours.

When treating the seeds with the tank mix of the fungicide treatment agent Royal FLO, 48 % of water and suspension concentrate together with the insecticide treatment agent Taboo, 50% of suspension concentrate the density of the fleas population on the sprouts was 8,9 specimens per m^2 and exceeded the economic threshold of harmfulness almost 3 times. When treating the seeds with the tank mix of the fungicide treatment agent Maxim XL 035 FS together with Cruiser, 35 % of liquid suspension concentrate the density of the fleas population on the sprouts was 8,2 specimens per m^2 and exceeded the economic threshold of harmfulness 2,7 times. Thus the presowing toxicity of spring rape seeds does not provide a reduction in the density of the undulating flea beetles population during their mass reproduction to the level of the economic threshold of harmfulness (Table 3.3).

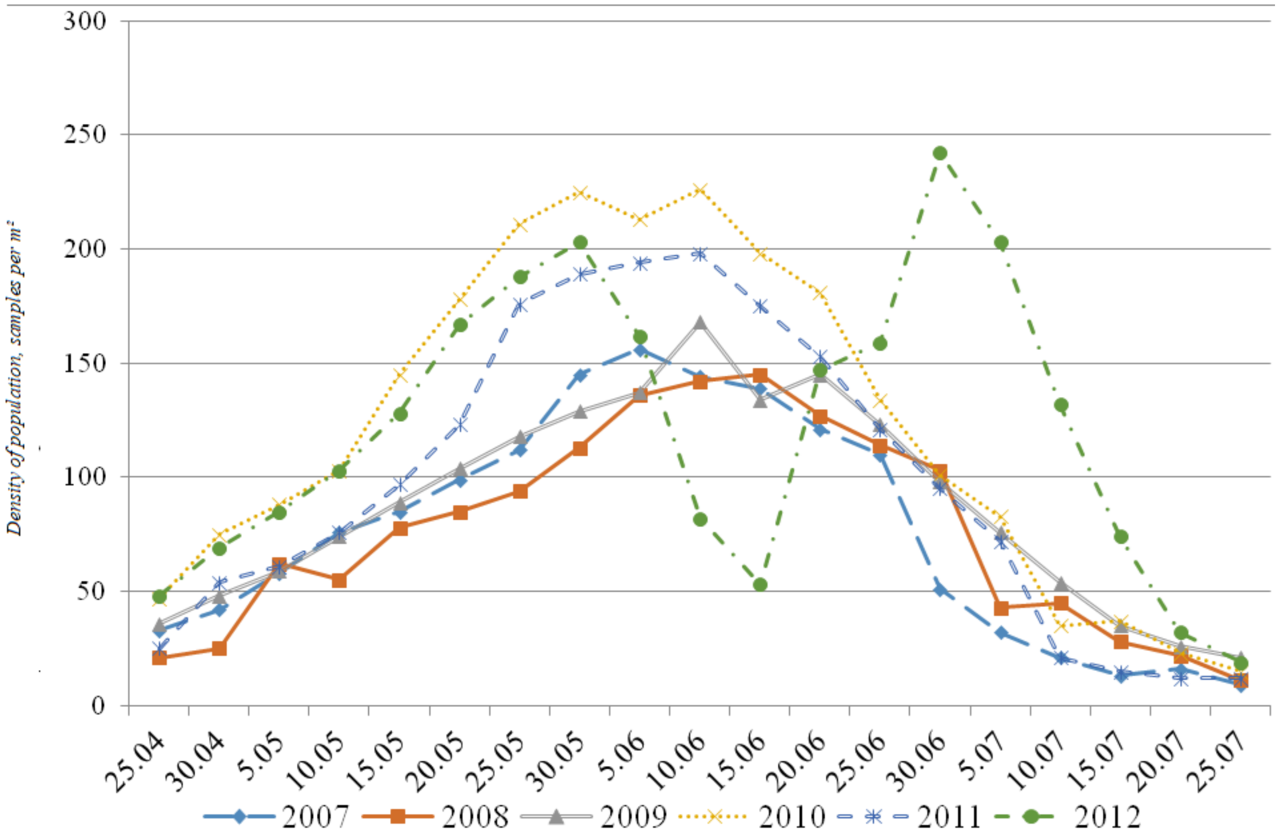


Figure 3.5. Seasonal dynamics of undulating flea beetles number on spring rape at Educational, Scientific and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2007–2012

The efficiency of protection from the undulating flea beetles on the spring rape crops by the method of the ground spraying with the insecticide Karate Zeon, 5 % of microcapsule water suspension was determined in the phenophase of 2 true leaves (the beginning of the first decade of May). The population density of the undulating flea beetles before spraying amounted to 81,4 specimens per m² and exceeded the economic threshold of harmfulness (3 specimens per m²) 27,1 times. In 3 days after spraying their population density under control was 102,3 specimens per m² and exceeded the economic threshold of harmfulness 34,1 times. In the variant with the crops spraying with the insecticide Karate Zeon, 5% of microcapsule and water suspension the density of the fleas population in 3 days after spraying was 5,7 specimens per m² and exceeded the economic threshold of harmfulness 1,9 times. So the spraying of rape crops in the phase of sprouts (2 true leaves) does not provide a reduction in the density of the undulating flea beetles population during their mass reproduction to the level of the economic threshold of harmfulness (Table 3.4).

The efficiency of controlling the undulating flea beetles on the spring rape crops by the method of the presowing seeds treatment with the insecticide seed treatment agents Taboo, 50 % of suspension concentrate and Cruiser, 35 % of liquid suspension concentrate and spraying the crops in the phase of sprouting with the insecticide Karate Zeon, 5 % of microcapsule water suspension was noted in the phase of sprouting, namely in the phase of 2 true leaves of spring rape (the beginning of the first decade of May).

Table 3.3

Efficiency of spring rape sprouts protection from undulating flea beetles by the method of presowing seeds treatment with insecticide seed treatment agents. State Enterprise "Research Farm "Elitne", the V.Ya. Yuryev Institute of Plant Growing named of the National Academy of Agrarian Sciences of Ukraine, 2011–2012

Variants of research	Rate of preparations expenditure per 1 t. of seeds, L.	Density of fleas population, specimens per m²	Technical efficiency, %
Control (H_2O)	0	81,4	–
Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate	6,0 + 5,0	8,9	89,1
Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate	4,0 + 5,0	8,2	89,9
HIP_{05}		4,8	

From the data given in Table 3.5 it can be seen that in the variant with the seeds treatment with a tank mix of the fungicide treatment agent Royal FLO, 48 % of water and suspension concentrate with the insecticide treatment agent Taboo, 50 % of suspension concentrate the density of the flea population on the sprouts amounted to 8,9 specimens per m² and exceeded the economic threshold of harmfulness almost 3 times; and after the ground spraying with the insecticide Karate Zeon, 5 % of microcapsule water concentrate the density of the fleas population in 3 days after spraying was 0,4 specimens per m² and it was 7,5 times less than the economic threshold of harmfulness. In the variant when treating the seeds with a tank mix of the fungicide treatment agent Maxim XL 035 FS, 35 % of liquid suspension concentrate together with the insecticide treatment agent Cruiser, 35 % of liquid suspension concentrate the density of the fleas population on the sprouts amounted to 8,2 specimens per m² and exceeded the economic threshold of harmfulness 2,7 times; but after spraying with the insecticide Karate Zeon, 5% of microcapsule water concentrate the density of the fleas population in 3 days after spraying was 0,3 specimens per m² and it was 10 times less than the economic threshold of harmfulness (Table 3.5).

Table 3.4

Efficiency of spring rape sprouts protection from undulating flea beetles in phenophase of 2 true leaves by ground spraying. State Enterprise "Research Farm "Elitne", the V.Ya. Yuryev Institute of Plant Growing named of the National Academy of Agrarian Sciences of Ukraine, 2011–2012

Variants of research	Rate of expenditure per 1 ha of crops, L.	Density of fleas population, specimens per m²		Technical efficiency, %
		before spraying	in 3 gays after spraying	
Control (H_2O)	0	81,4	102,3	–
Karate Zeon, 5 % of microcapsule water suspension	0,15	81,4	5,7	92,0
HIP_{05}			2,8	

That is the presowing toxicity of spring rape seeds with the subsequent ground spraying of crops in the phase of sprouts (2 pairs of true leaves) provides a decrease in the density of the undulating fleas population 7,5–10 times below the level of the economic threshold of harmfulness.

The field germination of the seeds was determined and the inspection as for the damage of the sprouts by the leaf pests was carried out when the spring rape sprouts appeared. Before harvesting the test sheaves were selected and the average height of the plants, the number of productive branches, the number of productive and unproductive pods, the number of pods damaged by the sucking pests, the average number of seeds in each pod and the number of frail seeds were determined. The yield purification, the moisture content determination, the weight of 1000 seeds, the actual yield capacity and the determination of other indices were carried out after harvesting the crops.

As it can be seen from the data in Table 3.6 for the years of the researches the average field germination of spring rape seeds against the background without the fertilizers was the best in the variants when applying Royal FLO, 48 % of water and suspension concentrate + Taboo, 50% of suspension concentrate (5,0 + 6,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and ammounted to 185 and 221 plants per m² respectively. In the variants of Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.) + Karate Zeon, 5% of microcapsule water suspension (0,15 L./ha in the phase of sprouting) the field germination was 151 and 167 plants per m² respectively. In the variant under control (the seeds were treated with water) the field germination of spring rape seeds was only 120 plants per m².

The number of spring rape sprouts damaged by the leaf pests including the undulating flea beetles was the least one in the variants when applying the insecticide seed treatment agents Royal FLO, 48 % of water suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.) + Karate Zeon, 5% of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35% of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and amounted to 40 and 42 % in both variants (Table 3.7). The plants of spring rape in the variant under control were damaged most of all; the damage was 96 %. In the variants with the fungicide seed treatment agents Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) the number of damaged plants was somewhat lower than in the variant under control and amounted to 88 % that can be explained by a more friendly and better germination of the plants since the given seed treatment agents belong to the fungicides and do not have an insecticide action.

Table 3.5

Efficiency of spring rape crops protection from undulating flea beetles by presowing toxicity and ground spraying in phenophase of sprouting. State Enterprise “Research Farm “Elitne”, the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine, 2011–2012

Variants of research	Rate of expenditure per 1 t. of seeds or per 1 ha of crops, L.	Density of fleas population, specimens per m²		Technical efficiency, %
		before spraying	in 3 gays after spraying	
Control (H_2O)	10,0 L./t.	81,4	102,3	–
Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate + Karate Zeon, 5 % of microcapsule water suspension (in phase of sprouting)	6,00 + 5,00+ 0,15	8,9	0,4	95,5
Maxim XL 035 FS, 35 % of liquid suspension concentrate + Karate Zeon, 5 % of microcapsule water suspension (in phase of sprouting)	4,00 + 5,00+ 0,15	8,2	0,3	96,3
HIP_{05}			0,04	0,01

Table 3.6

Influence of seed treatment agents on germination and damage of sprouts caused by leaf pests, quantitative and qualitative indices of rape crop yield capacity against the background without fertilizers in the field of State Enterprise "Research Farm "Elitne", the Institute of Plant Growing named after V.Ya. Yuriev of the National Academy of Agrarian Sciences of Ukraine, (2011–2012)

Years	Variants of research	Plants in a test, specimens per m²	Damaged plants,%	Average degree of damage	Damage coefficient	Yield capacity, t./ha	Weight of 1000 seeds, gm	Plants height, m	Number of productive branches, pieces	Total number of pods on a plant, pieces	,Number of undeveloped pods, pieces	Number of pods damaged by sucking pests, pieces	Length of pods, cm.	Number in pods, pieces	Number of frail seeds, pieces
Average in 2010 – 2012.	Control, water (H_2O) (10,0 L./t.)	**120**	**96**	**3,19**	**3,06**	**0,044**	**2,45**	**0,72**	**3,1**	**44,5**	**9,4**	**22,3**	**5,0**	**11,5**	**3,7**
	Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.)	**151**	**88**	**2,75**	**2,43**	**0,170**	**2,70**	**0,80**	**3,4**	**54,2**	**9,6**	**21,2**	**5,4**	**13,4**	**4,4**
	Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.)	**167**	**88**	**2,74**	**2,42**	**0,175**	**2,89**	**0,80**	**3,4**	**58,0**	**9,3**	**21,0**	**5,2**	**13,3**	**4,2**
	Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.)	**185**	**40**	**1,34**	**0,44**	**0,261**	**2,97**	**0,85**	**3,7**	**64,8**	**8,2**	**19,9**	**5,3**	**15,5**	**3,3**
	Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.)	**221**	**42**	**1,39**	**0,47**	**0,271**	**2,89**	**0,85**	**3,7**	**62,4**	**8,4**	**20,5**	**5,3**	**14,7**	**3,6**

Table 3.7

Influence of seed treatment agents on germination and damage of sprouts caused by leaf pests, quantitative and qualitative indices of rape crop yield capacity against the background with fertilizers ($N_{30}P_{30}K_{30}$) in the field of State Enterprise "Research Farm "Elitne", the Institute of Plant Growing named after V.Ya. Yuriev of the National Academy of Agrarian Sciences of Ukraine, (2011–2012)

Years	Variants of research	Plants in a test, specimens per m²	Damaged plants,%	Average degree of damage	Damage coefficient	Yield capacity, t./ha	Weight of 1000 seeds, gm	Plants height, m	Number of productive branches, pieces	Total number of pods on a plant, pieces	Number of undeveloped pods, pieces	Number of pods damaged by sucking pests, pieces	Length of pods, cm.	Number in pods, pieces	Number of frail seeds, pieces
Average in 2010 – 2012.	Control, water (H_2O) (10,0 L./t.)	**129**	**94**	**3,2**	**3,01**	**0,071**	**2,79**	**0,74**	**3,2**	**45,5**	**9,0**	**22,0**	**5,3**	**11,9**	**3,4**
	Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.)	**170**	**85**	**2,7**	**2,30**	**0,205**	**2,97**	**0,81**	**3,9**	**66,6**	**8,4**	**19,9**	**5,4**	**15,6**	**3,2**
	Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.)	**164**	**85**	**2,71**	**2,35**	**0,229**	**2,97**	**0,83**	**4,2**	**68,9**	**8,5**	**20,3**	**5,4**	**16,1**	**3,2**
	Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.)	**209**	**37**	**1,29**	**0,48**	**0,307**	**3,20**	**0,92**	**4,7**	**76,8**	**7,0**	**18,5**	**5,6**	**16,8**	**2,9**
	Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.)	**213**	**37**	**1,4**	**0,50**	**0,322**	**3,18**	**0,98**	**4,6**	**73,8**	**6,4**	**18,8**	**5,7**	**16,7**	**3,0**

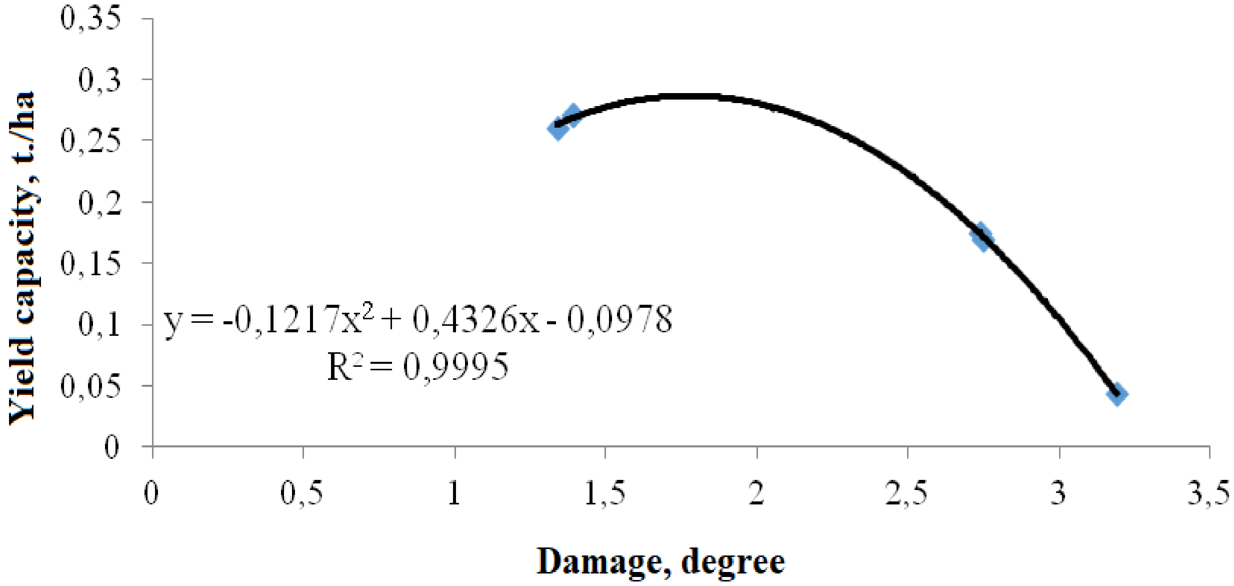


Figure 3.6. Dependence of spring rape yield capacity in the phase of sprouting on the level of damage caused by undulating flea beetles (background without fertilizers). State Enterprise "Research Farm "Elitne", the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine (2010–2012)

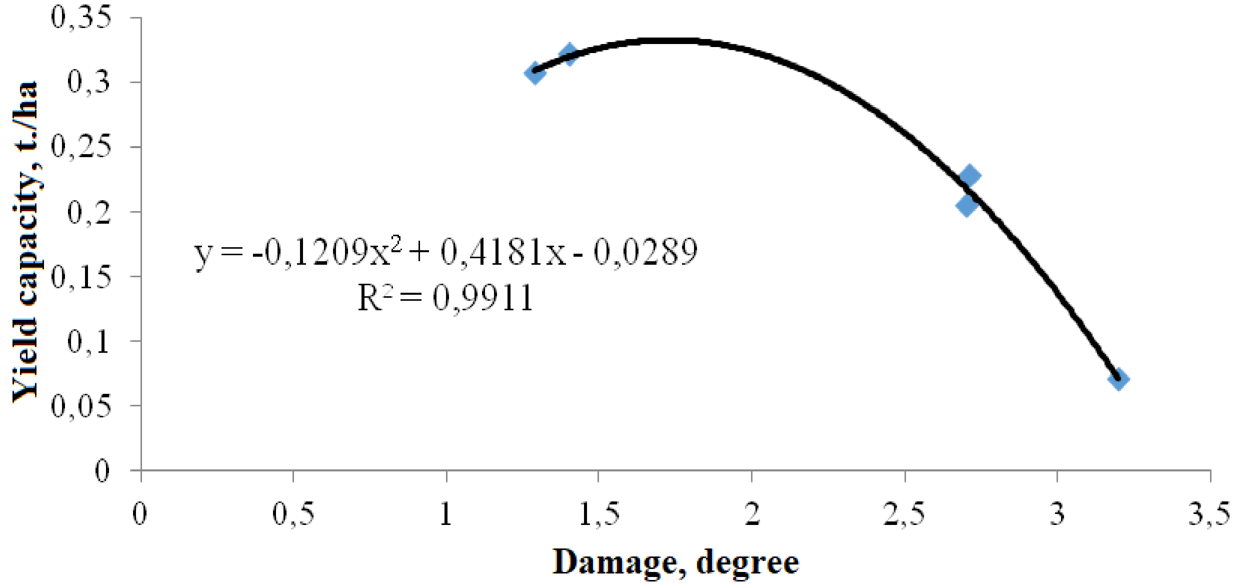


Figure 3.7. Dependence of yield capacity of spring rape crops in the phase of sprouting on the level of damage caused by undulating flea beetles (background $N_{30}P_{30}K_{30}$). State Enterprise "Research Farm "Elitne", the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine (2010–2012)

Analysing the data from Figure 3.6 and Figure 3.7 it can be seen that the yield capacity of spring rape both against the background with the fertilizers ($N_{30}P_{30}K_{30}$) and against the background without applying the fertilizers significantly depends on the degree of the sprouts damaged by the leaf pests. It is slightly higher against the background without applying the fertilizers, R^2 = 0,9995 vs. R^2 = 0,9911 against the background with the fertilizers. From the data given in the diagrams it is seen that the critical point after which there is a rapid decrease in the yield capacity is the plants damage from two degrees and more.

Analysing the data from Figure 3.8 and Figure 3.9 the conclusion can be made that the damage of the spring rape sprouts by leaf pests both against the background with the fertilizers ($N_{30}P_{30}K_{30}$) and against the background without applying the fertilizers significantly influences the weight of 1000 seeds. It is slightly lower against the background without applying the fertilizers, R^2 = 0,875 vs. R^2 = 0,9986 against the background with the fertilizers. From the data given in the diagrams it is seen that the critical point after which there is a rapid decrease in the weight of 1000 seeds against the background with the fertilizers is the plants damage from 1,5 degrees and more; and against the background without the fertilizers the weight of 1000 seeds is decreasing beginning from two degrees and more.

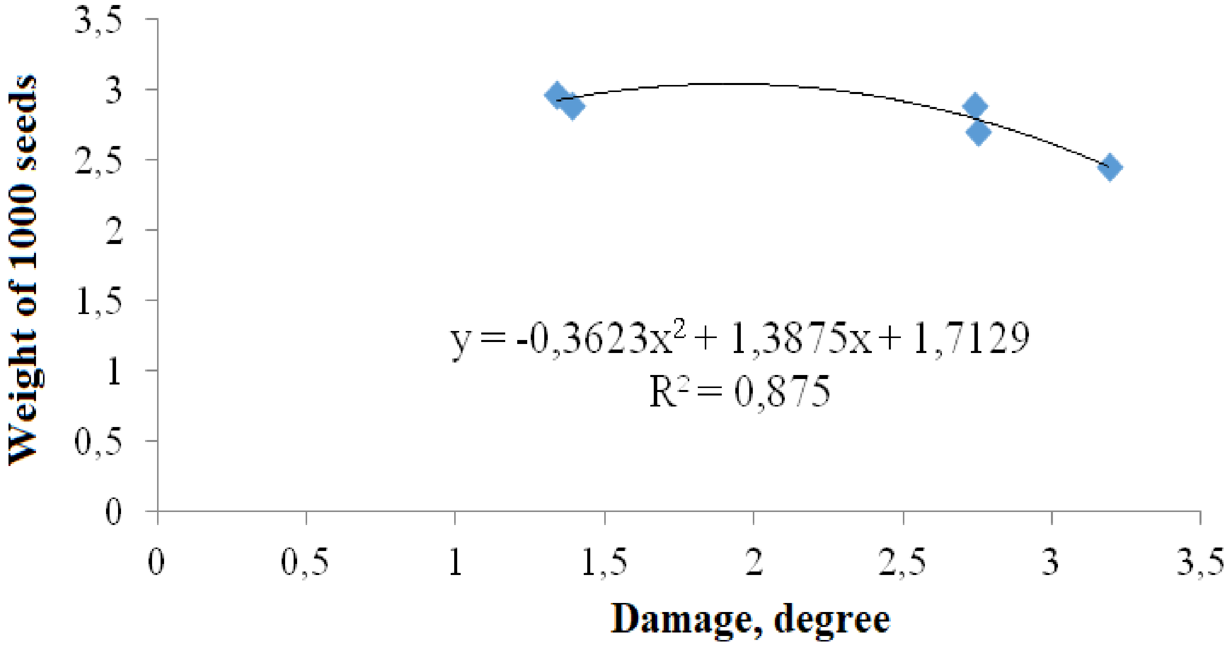


Figure 3.8. Dependence of weight of 1000 spring rape seeds on the level of damage caused by undulating flea beetles in the phase of sprouting (background without fertilizers). State Enterprise “Research Farm “Elitne”, the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine (2010–2012)

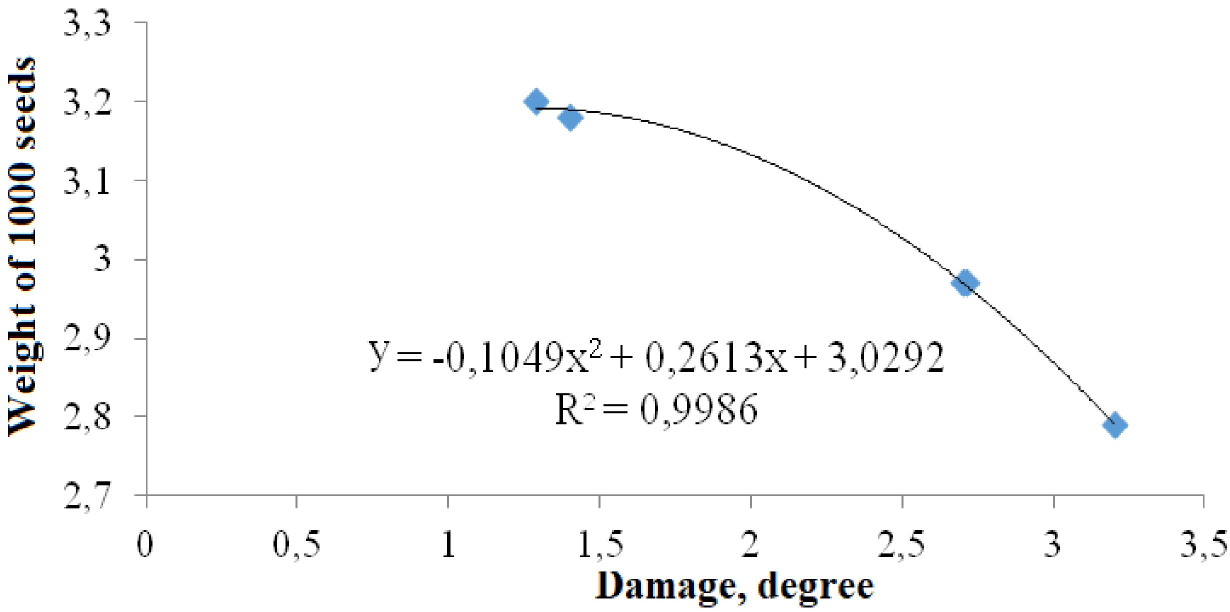


Figure 3.9. Dependence of weight of 1000 spring rape seeds on the level of damage caused by undulating flea beetles in the phase of sprouting (background $N_{30}P_{30}K_{30}$). State Enterprise "Research Farm "Elitne", the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine (2010–2012)

For the years of the researches the highest average yield against the background without the fertilizers was noted in the variants of Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and it ammounted to 0,261 and 0,271 t./ha respectively (Table 3.7). In the variants of the fungicide seed treatment agents Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) the yield was at the level of 0,170 and 0,175 t./ha. In the variant under control the yield was the lowest one and amounted only to 0,044 t./ha.

As it can be seen from Table 3.7 for the years of the researches the average field germination of spring rape seeds against the background with the fertilizers ($N_{30}P_{30}K_{30}$) was the best in the variants of Royal FLO, 48 % of water suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and amounted to 209 and 213 plants per m^2 (Table 3.8). In the variants of Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) the field germination was 170 and 164 plants per m^2. In the variant under control the field germination of spring rape seeds was only 129 plants per m^2.

Against the background with the fertilizers ($N_{30}P_{30}K_{30}$) the damage of the spring rape sprouts caused by the leaf pests was the least in the variants of applying the insecticide seed treatment Royal FLO, 48 % of water suspension concentrate + Taboo, 50% of suspension concentrate (5,0 + 6,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and on the average it amounted to 37 % in both variants (Table 3.7). The most damaged crops of spring rape were in the variant under control; the damage was 94 %. In the variants with the fungicide seed treatment agents Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) the damage of plants was slightly less than in the variant under control and amounted to 85 %; this fact can be explained by a more friendly and better plants germination since the given preparations do not exhibit the insecticide action.

For the years of the researches on the average the highest yield against the background with the fertilizers ($N_{30}P_{30}K_{30}$) was in the variants of Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 %

of suspension concentrate (5,0 + 6,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and it amounted to 0,307 and 0,322 t./ha (Table 3.8). In the variants with the fungicide seed treatment agents Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.) + Karate Zeon, 5% of microcapsule water suspension (0,15 L./ha in the phase of sprouting) the yield was at the level of 0,205 and 0,229 t./ha. In the variant under control the yield was the lowest one and amounted only to 0,071 t./ha.

As it can be seen from Table 3.8 in 2011–2012 the highest increase in the yield capacity of spring rape crop against the background with the fertilizers was in the variants of Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and it amounted to 0,190 and 0,223 t./ha respectively or to 268 and 314 %; and against the background without the fertilizers the increase in the yield capacity was 0,157 and 0,178 t./ha or 357 and 404 % respectively. In the variants of Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) against the background with the fertilizers there was an increase in the yield of 0,066 and 0,072 t./ha or 93 and 101 % respectively; and against the background without the fertilizers the increase in the yield was 0,055 and 0,065 t./ha respectively or 125 and 148 %.

When treating the seeds the insecticides not only protect the sprouts of the agricultural crops from the pests, but being the biologically active substances, they certainly influence the initial growth and development of plants. With the introduction of organic insecticides this problem has acquired

Table 3.8

Economic efficiency of treating spring rape seed material in the phase of sprouting with insecto–fungicides and spraying them with insecticides at the State Enterprise "Research Farm "Elitne", the V.Ya. c Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine (2010–2012)

Back–ground	Variants of research	Yield capa–city, t./ha	Yield saved	
			t./ha	%
Without fertilizers	Control, water (H_2O) (10,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting)	0,044	–	–
	Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting)	0,099	0,055	125
	Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting)	0,109	0,065	148
	Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0+6,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting)	0,201	0,157	357
	Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0+4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting)	0,222	0,178	404
Average in a block without fertilizers		**0,135**	–	
$N_{30}P_{30}K_{30}$	Control, water (H_2O) (10,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting)	0,071	–	–
	Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting)	0,137	0,066	93
	Maxim XL 035 FS, 35 % of liquid suspension concentrate (5,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting)	0,143	0,072	101
	Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0+6,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting)	0,261	0,190	268
	Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0+4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting)	0,294	0,223	314
Average in a block with fertilizers		**0,181**	–	
HIP_{05} according to research variants (factor A) – 90,26 HIP_{05} according to background (factor B) – 8,58				

a great practical and theoretical importance in the chemical protection of plants. The scientific literature data indicate the negative influence of the insecticides on the processes of vital functions of the plants treated with the preparations during the vegetative period. However there is almost no information about the influence of such insecticides on the seeds treated with them, although they are decisive when applying the preparations according to this technology. The reaction of cereals and other crops to the biologically active insecticides has been experimentally proven in the case of organic and chlorine and organic and phosphorus compounds. The data of the authors show that the nature of the plants reaction to the insecticides depends on the class of the toxicant chemical compounds, the norms of expenditure and the conditions of the crop cultivation.

Table 3.9

Influence of insecto–fungicide seed treatment agents on laboratory germination of spring rape seed material of Ataman variety

Variants of research	Rate of expenditure, L./t.	Years of researches	Seed germination, %			
			3rd day	5th day	7th day	9th day
Control, water (H2O)	10,0	2011	0	81	88	91
		2012	0	78	86	93
		average	0	79,5	87	92
Royal FLO, 48 % of water and suspension concentrate	5,0	2011	0	48	70	78
		2012	0	52	71	76
		average	0	50	70,5	77
Maxim XL 035 FS, 35 % of liquid suspension concentrate	5,0	2011	0	82	86	87
		2012	0	73	80	84
		average	0	77,5	83	85,5
Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate	5,0 + 6,0	2011	0	50	68	79
		2012	0	53	57	74
		average	0	51,5	62,5	76,5
Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate	5,0 + 4,0	2011	0	67	76	84
		2012	0	63	78	86
		average	0	65	77	85
HIP_{05} according to research variants (factor A) – 96,49 HIP_{05} according to the years of researches (factor B) – 1,32						

As a result of the researches concerning the influence of the seed treatment agents on the rape seeds germination under the laboratory conditions we obtained the data given in Table 3.9.

From the data given in Table 3.9 it is evident that on the 3rd day there were no germinated seeds. On the 5th, 7th and 9th days the best indices of the seeds germination were noted in the variant under control; these indices were 79,5 %, 87,0 % and 92,0 % respectively. The worst indices were in the variants of Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) and Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.); on the 5th day these indices were 50,0 % and 51,5 % respectively, on the 7th day they were 70,5 % and 62,5 % and on the 9th day the indices were 77,0 % and 76,5 %. From the data obtained we can conclude that all the investigated insecticides suppress the germination of seeds, but this action is the strongest one in the variants of Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) and Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.).

Conclusions

1. A complex of undulating flea beetles which consists of six species was found on the crops of oil producing cabbage crops. The dominant species are *Phyllotreta atra* F. (about 72 %) and *Phyllotreta nigripes* F. which is less numerous (about 16 %). In the spring the first undulating flea beetles appear on the early cabbage weeds (first of all on colza), when the average daily temperature is at the level of 7–11 °C; it is the beginning of the first and third decades of April. The mass appearance of the undulating flea beetles occurs when the average daily temperatures exceed 11 °C and the sum of the effective temperatures above 5 °C is 101–130 °C, and it is the middle of the second and the third decades of April.

2. The damage of spring rape sprouts caused by the leaf beetles both against the background with the fertilizers (N30P30K30) and against the background without the fertilizers significantly influences the weight of 1000 seeds. Against the background without the fertilizers it is a little less and $R^2 = 0{,}875$ while against the background with the fertilizers $R^2 = 0{,}9986$. The critical point after which there is a rapid decrease in the weight of 1000 seeds against the background with the fertilizers is the plants damage from 1,5 degrees and more; against the background without

applying the fertilizers the weight of 1000 seeds is decreasing beginning from the damage of two degrees and more.

3. The yield capacity of spring rape both against the background with the fertilizers ($N_{30}P_{30}K_{30}$) and against the background without applying the fertilizers significantly depends on the degree of the sprouts damaged by the leaf pests. It is slightly higher against the background without applying the fertilizers, R^2 = 0,9995 vs. R^2 = 0,9911 against the background with the fertilizers. The critical point after which there is a rapid decrease in the yield capacity is the plants damage from two degrees and more.

4. The presowing toxicity of spring rape seeds with the subsequent ground spraying of crops in the phase of sprouting (2 pairs of true leaves) provides a decrease in the density of the undulating fleas population 7,5–10 times less than the level of the economic threshold of harmfulness. The best field germination of spring rape seeds both against the background without the fertilizers and against the background with the fertilizers was in the variants when applying Royal FLO, 48 % of water suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and amounted to 185 and 221 plants per m² respectively against the background without the fertilizers; against the background with the fertilizers the field germination was 209 and 213 plants per m² respectively. The least number of spring rape sprouts damaged by the leaf pests against both backgrounds was in the variants when applying the insecticide seed treatment agents Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and ammounted to 40 and 42 % respectively against the background without the fertilizers and to 37 % in both variants against the background with the fertilizers. The highest yield capacity of spring rape was in the variants of Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.) + Karate Zeon, 5 % of microcapsule water

suspension (0,15 L./ha in the phase of sprouting) and Maxim XL 035 FS, 35 % of liquid suspension concentrate + Cruiser, 35 % of liquid suspension concentrate (5,0 + 4,0 L./t.) + Karate Zeon, 5 % of microcapsule water suspension (0,15 L./ha in the phase of sprouting) and ammounted to 0,307 and 0,322 t./ha respectively against the background with the fertilizers and to 0,261 and 0,271 t./ha against the background without the fertilizers.

5. The applied insecto–fungicide seed treatment agents have a negative influence on the laboratory germination of spring rape seed material. The worst indices of germination were in the variants when applying Royal FLO, 48 % of water and suspension concentrate (5,0 L./t.) and Royal FLO, 48 % of water and suspension concentrate + Taboo, 50 % of suspension concentrate (5,0 + 6,0 L./t.); on the 9th day these indices were 77,0 % and 76,5 % respectively.

PART 4. EFFICIENCY OF CHEMICAL PROTECTION OF SPRING RAPE AND MUSTARD FROM CRUCIFEROUS BUGS

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 order 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 6 black spots, on the shield and elytra there are black spots and stripes (Figure 4.1); 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 6 black spots, on the shield and elytra there are black spots and stripes (Figure 4.1). The imago of the rape bug is 6–10 mm in size, the body is flattened, the prothorax is white with 6 black spots, on the shield and elytra there are black spots and stripes (Figure 4.1). 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 4.1). The larva of the imago is similar (Figure 4.1). 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. In addition they feed on the cabbage weeds, and with the emergence of the cultivated cabbage plants sprouts and the 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 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 economic threshold of harmfulness is 2–3 bugs per plant

Figure 4.1. Cruciferous bugs:
1. oviposition; 2. reappearence 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 V.V. Dokuchaiev National Agrarian University, 2018)

(Puchkov, 1961; Yevtushenko, Fedorenko, Stankevych, 2009; Stankevych, Vilna, 2012; Vilna, 2013; Vilna, Stankevych, 2013; Stankevych, Kava, 2013; Yevtushenko, Vilna, 2014; Vilna, Yevtushenko, Stankevych, 2015; Stankevych, 2015; Yevtushenko, Vilna, Stankevych, 2016).

Materials and methods of researches

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

The collected entomological material was analysed and systematised and the species of the insects were determined at the Zoology and Entomology Department of Kharkiv V.V. Dokuchaiev National Agrarian University **.**

To establish the seasonal dynamics of the cruciferous bugs' number the calculations were conducted every five days beginning from the time of the sprouts appearance by mowing with the entomological catching net and visual counting. At the Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University the mowing with the entomological catching net was made by 25 double sweeps on each crop; and at the state enterprise "Research Farm "Elitne" of the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine 100 double sweeps of the net along two diagonals of the field were made (Mehalov, 1968; Nikiforov, 1951; Omeliuta, 1986; Fassulati, 1971; Chaika, 2010; Stankevych, Zabrodina, 2016).

The settling of the overwintered bugs was determined in the field № 1 of the central forage crop rotation at the State Enterprise "Research Farm "Dokuchaievske" of Kharkiv V.V. Dokuchaiev National Agrarian University in spring 2013. In autumn the field was sown with winter rape; there was little snow in winter and the crops were almost completely lost. In the spring the entire field was overgrown with the weeds, the predominant species were hedge mustard of Lozeliiv and common winter cress. The mowing with the entomological catching net (three routes) was carried in the direction of the forest belt which was stretched from the east to the west. There were three routes for the inspection. The first one was parallel to the forest belt which was directed from the north to the south and was at a distance of 40–50 m from it, the second route was in the middle of the field, and the third one was parallel to the ring highway at a distance of 40–50 m from it.

In order to determine the priority of spring rape and mustard crops populating, the experimental plot under spring oilseed cabbage crops was divided in half across the crops. The plots were separated by a defensive strip of 1,5 m wide. The seedlings were removed from it beginning from the first days of their appearance and this plot was kept without the plants. After the emergence of the rape and mustard seedlings the seed cabbage crops were planted on this plot.

The influence of the cabbage crops seeds damaged by the cruciferous bugs on the sowing quality of the seeds was determined in accordance with the State Standard of Ukraine 4138-2002 (National Standard, 2003) at the laboratory of the Zoology and Entomology Department of Kharkiv V.V. Dokuchaiev National Agrarian University 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, and further the seeds were moistened daily to maintain a constant level of humidity. The seed germination indices were recorded on the 3rd, 5th, 7th and 9th days.

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

To analyse the weather conditions and their influence on the harmfulness and the pests' development the data of the Rogan meteorological observation station which is located directly on the territory of the Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University were used.

The insecticides that we used during the vegetation period to control the cruciferous bugs had been tested under the conditions of the Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University on the plots where the number of the pests exceeded the economic threshold of harmfulness; the insecticides were applied against the same agro-technical background and in the same phase of the plant development (Dospiekhov, 1985; Triebel, 2001).

Spraying of the plots was carried out with a knapsack sprayer of the "Lemira – SP – 202–01" brand at the rate of consumption of about 250 L./ha: 1. Control (H2O); 2. Biscaya, 24% of oily dispersion (0,25 L./ha). The variants of the research in 2014 are the following: 1. Control (H_2O); 2. Biscaya, 24% of oily dispersion (0,25 L./ha); 3. Mospilan 20% of soluble powder (0,05 kg); 4. Nurelle D, 55% of emulsion concentrate (1,0 L./ha).

The acreage of the experimental plots where the insecticides controlling the cruciferous bugs were tested accounted to 5 m² in triplicate. After 3, 7, and 14 days the areas of 1 m² on each plot were examined and the density of the bugs' population was determined.

When spraying the crops the technical efficiency of the preparations against the main rape pests was determined by the formula:

$$T = \frac{a-b}{a} \times 100, \qquad (4.1)$$

where *T– technical efficiency, %;*

a – density of the pests population before spraying,

b – density of the pests population in 3, 7 or 14 days after spraying (Recommendations, 1975; Methods of calculation, 1976; Triebel and others, 2001; Stankevich, Zabrodina, 2016).

The economic efficiency or increase in the yield was determined according to the following formula:

$$I = \frac{a-b}{a} \times 100, \qquad (4.2)$$

where *I – increase in the yield, %;*

a – average yield from a calculated unit on a cultivated plot, t.;

b – average yield from a calculated unit on a plot under control, t. (Recommendations, 1975; Methods of calculation, 1976; Triebel and others, 2001; Stankevich, Zabrodina, 2016).

Results of researches and discussion

Species ratio in the complex of the cruciferous bugs and seasonal dynamics of the population number. According to our researches in Kharkiv region there are all 3 types of the cruciferous bugs common in Ukraine; they are the cabbage, rape and mustard bugs. In the fields of the Educational, Research and Production Centre "Research Field" of

Kharkiv V.V. Dokuchaiev National Agrarian University the ratio between the species of the cruciferous bugs' population on the crops of spring rape and mustard was not equivalent. Most often (in 2008–2010 and in 2012–2014) the cabbage bug was the dominant species while the mustard bug dominated only in 2007; the rape bug was less numerous in all the years. During the seven-year studies more or less cabbage and rape bugs annually populated spring rape and mustard. In the records of the Educational, Research and Production Centre "Research Field" the mustard bug on spring oilseed cabbage crops and on white cabbage seedlings has not been found since 2012, though the overwintered cruciferous bugs usually populate these crops in the first turn (Table 4.1).

Table 4.1

Species ratio of cruciferous bugs on spring rape and mustard at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2007-2010 and 2012-2014

Years	Crop	Species share in the complex of cruciferous bugs,%		
		mustard bug	cabbage bug	rape bug
2007	Spring rape	83,8	12,2	4,0
	Mustard	69,6	19,3	11,1
2008	Spring rape	13,2	82,6	4,2
	Mustard	27,5	67,1	5,4
2009	Spring rape	40,4	55,3	4,3
	Mustard	28,1	63,8	8,1
2010	Spring rape	24,3	66,8	8,9
	Mustard	9,1	78,7	12,2
2012	Spring rape	0	85,2	14,8
	Mustard	0	89,1	10,9
2013	Spring rape	0	81,3	18,7
	Mustard	0	91,4	8,6
2014	Spring rape	0	87,1	12,9
	Mustard	0	90,6	9,4
∑ average		21,14	69,32	9,54

Both in Kharkiv and in the Kharkiv region the cruciferous bugs at the stage of the immature imago overwinter under the fallen leaves, in the parks, in the forest edges, on the beam slopes, on the roadsides and in the gardens.

On the 13th of April 2012 during the inspections of the forest plantations the first bugs after their awakening were found around the experimental field in the forest floor and on the wild cabbage plants; their number was about 1specimen/m² of the inspected area of the forest floor. In the experimental field they first populated the cabbage saplings and on the 4th of May the bugs emerged on the rape and mustard crops in the phase of sprouting; the imagines of the cabbage bug (*Eurydema ventralis* Kol.) were the first to populate the plants.

In 2013 the density of the bugs in the forest floor was 1,4 specimens/m², and the emergence of the cabbage and rape bugs imagines from the wintering places began on April 19; on the 1st of May the imagines populated the cabbage seeds despite the fact that there have already been 70% of rape and mustard seedlings (Tables 4.2, 4.3).

In 2014 in the course of the wintering places of the cruciferous bugs' inspection about 2 specimens per m² were found on the inspected area of the forest floor. The cruciferous bugs began to emerge on April 10 (Table 4.3).

Table 4.2

Development of cruciferous bugs on cabbage seeds at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012–2013

Bugs development	Dates for years of researches	
	2012	2013
Beginning of bugs emergence from wintering places	13.04	19.04
Beginning of populating cabbage seedlings by bugs	2.05	1.05
Bugs mating on cabbage seedlings	6.05	3.05
Emergence of the first oviposition of bugs on cabbage seedling	11.05	8.05
Mass oviposition of bugs	18.05	10.05
Beginning of bugs larvae reappearance	20.05	14.05
Mass reappearance of bugs larvae	26.05	19.05

From the data given in Table 4.2 it is seen that in 2012 the cruciferous bugs have been populating the cabbage seedlings since May 2; and on May 6 they have already been mating, that is, they have been feeding on cabbage for four days. The first ovipositions on the cabbage seeds were found in the records on May 11, and in the mass they were found on May 18. A single larval reappearance began on May 20, and the mass one was on May 26.

Table 4.3

Development of cruciferous bugs on spring rape of Ataman variety at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012–2014

Bugs development	Dates for years of researches		
	2012	2013	2014
Beginning of bugs emergence from wintering places	13.04	19.04	10.04
Beginning of populating spring rape by bugs	20.05	26.05	30.04
Bugs mating on spring rape	28.05	5.06	12.05
Emergence of the first oviposition of bugs	5.06	14.06	23.05
Mass oviposition of bugs	9.06	20.06	2.06
Beginning of bugs larvae reappearance	13.06	23.06	6.06
Mass reappearance of bugs larvae	18.06	28.06	13.06

In 2013 the cruciferous bugs have been populating the cabbage seedlings since May 1 and on May 3 the bugs mating was observed and on May 8 the first oviposition was revealed. The mass oviposition has been taking place since May 10. In the second decade of May the larvae of the bugs began to reappear, and since May 19 there has been mass reappearance. In 2013 the cabbage and rape bugs were found on the crops of spring rape only on May 26 while on the cabbage seedlings the bugs' larvae of the first and second generations have been already developing; in 2012 at the same time the mass reappearance of the cruciferous bugs' larvae on the cabbage seeds has been taking place.

Judging by these data we can conclude that despite the large assortment of the fodder vegetation the bugs prefer the cabbage seedlings. This is evidenced by the priority of their populating, mating, oviposition, reappearance of larvae and further development of the young generation, which does not pass on to the seedlings and young plants of the oilseed cabbage crops. Thus by planting in fives and tens plants of seed cabbage on four sides of the field of spring rape and mustard it is possible to determine the beginning of the buds emergence, their extra feeding and further development which is important in the organization and conducting spraying of the oilseed cabbage crops with the insecticides if the economic threshold of harmfulness is exceeded.

The density of the cruciferous bugs on spring rape and mustard crops varied significantly in 2012–2014. This may be due to the fact that in 2013 the cabbage seedlings were planted near the rape and mustard crops, and in 2012 they were planted at a distance of about 1 km from these crops (Table 4.4).

Table 4.4

Density of cruciferous bugs on spring rape and mustard crops according to main phenophases of their development at Educational, Research and Production Centre “Research Field” of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012–2014

Phenophases of plants development	Density of cruciferous bugs population (specimens/m²) for the years of researches		
	2012	2013	2014
Sprouts emergence	1,0–1,1	0,9–1,0	0,9–1,1
Phenophase of rosette	2,3–3,1	1,9–2,1	2,1–2,8
Budding and flowering	6,5–6,9	3,3–3,6	4,8–5,1
Pods formation and their growth	10,2–12,1	5,9–6,3	4,7–5,3
Ripening	11,1–12,6	6,1–6,9	P4,6–5,1

From the data given in Table 4.4 it is seen that in 2012–2014 in the phase of the sprouts emergence the density of the cruciferous bugs on spring rape and mustard crops did not exceed 1,0 specimen/m². In 2021, beginning from the rosette phenophase, the density of the bugs on spring rape and mustard crops was within the range of 2,3–3,1 specimens/m², in 2013 the density was 1,9–2,1 specimens/m², and in 2014 it was 2,1–2,8 specimens/m². In 2012 in the phenophases of budding and flowering their density was 6,5–6,9 specimens/m², in 2013 it was 3,3–3,6 specimens/ m², and in 2014 it was 4,8–5,1 specimens/m². In 2012 during the above–mentioned phenophases the number of the bugs was higher and they had nothing to feed on because the plants had become physiologically old. In 2012 in the phenophases of pod formation and growth the density of the cabbage bugs was already 10,2–12,1 specimens/ m², and in 2013 it was 5,9–6,3 specimens/m², which is almost 2 times less compared with 2012, and in 2014 the density of the bugs was 4,7–5,3 specimens/m².

In 2012 the larvae of the cruciferous bugs of the second generation reappeared in the phenophase of pod formation and partial ripening. Despite the fact that the pods of spring rape and mustard were already almost 90% dry, the bugs and their larvae continued to stay on the plants almost until harvesting, but most larvae of the cruciferous bugs of the second generation did not have time to complete their development on the rape and mustard before harvesting. Beginning from July 25, after harvesting the crops of spring rape and mustard in the experimental field, the inspections of wild weeds from the cabbage family and the sprouts of the mustard seeds fall have been continued

In the second half of September as a result of the poorly harvested mustard crops the sprouts of mustard seeds fall appeared on the plot, which in due course were populated by the bugs and they were continuing the development and feeding until October 3, 2012. On this plot the mustard plants were developing till the phenophase of the flowering beginning and then were buried into the soil with a disc harrow. It was found that further the cruciferous bugs continued their development on common winter cress until the first strong frosts.

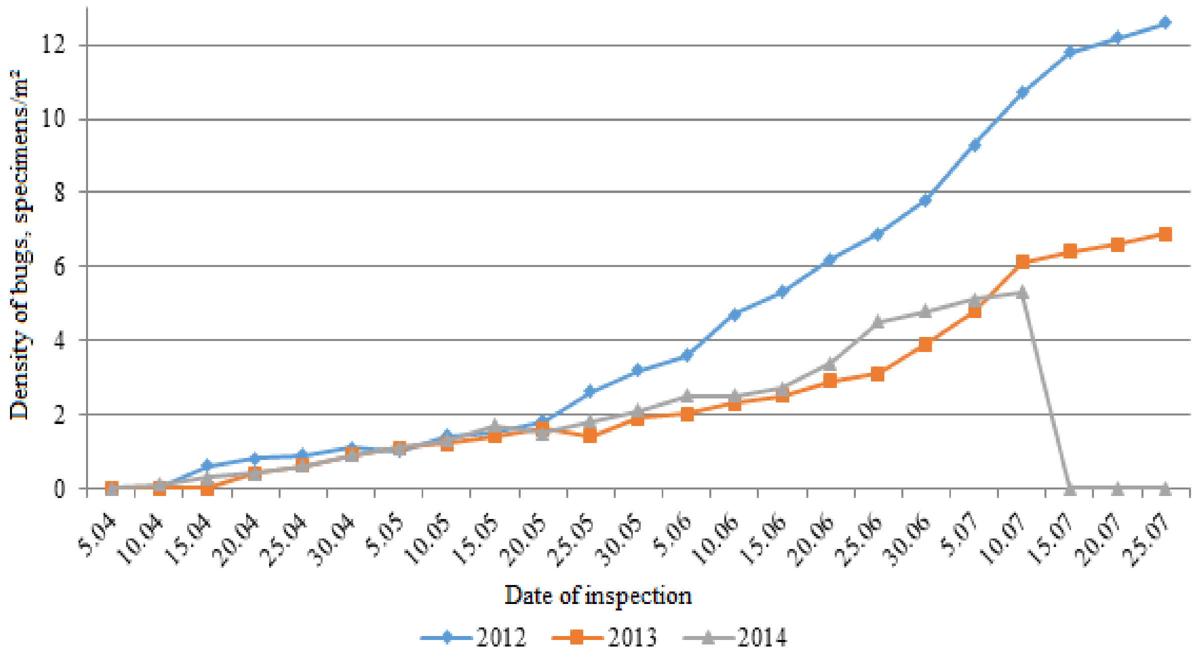


Figure 4.2. Seasonal dynamics of cruciferous bugs' number on spring rape at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012–2014

In 2013 the larvae of the cruciferous bugs almost entirely completed their development on the cabbage seeds and after burying the plant residues into the soil the bugs continued to develop on the sprouts of the mustard seeds fall and on common winter cress plants even at 0 °C at night. The feeding of the bugs on the mustard seeds fall was observed until October 22 when the daily average temperature already had fallen to 0 °C.

The seasonal dynamics of the cruciferous bugs' number for the years of the research is presented in the form of diagrams in Figures 2, 3 and 4. It can be concluded that the lowest density of the bugs was observed during all the years in April and in the first decade of May. Further the density gradually increased, and from the third decade of June until the beginning of the crops ripening there was a gradual increase in the number regardless of the year and the crop; it was mainly due to the reappearance of the larvae.

Analysing the data from Figure 4.2 it can be seen that in 2012–2014 the peak of the cruciferous bugs' number on spring rape was observed from the middle of June to the second decade of July.

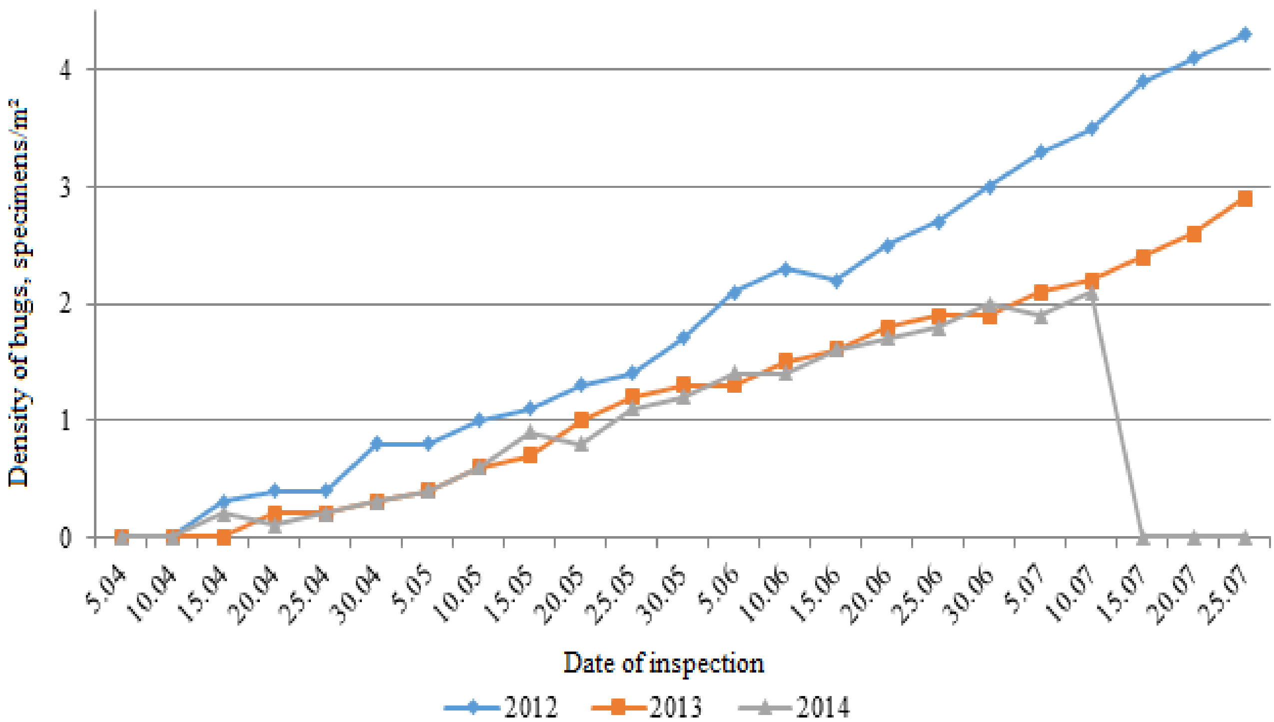


Figure 4.3. Seasonal dynamics of cruciferous bugs' number on white mustard at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012–2014

During 2012–2014 the peak of the cruciferous bugs number on white mustard was between the middle of the first decade of May and the end of the first decade of July (Figure 4.3).

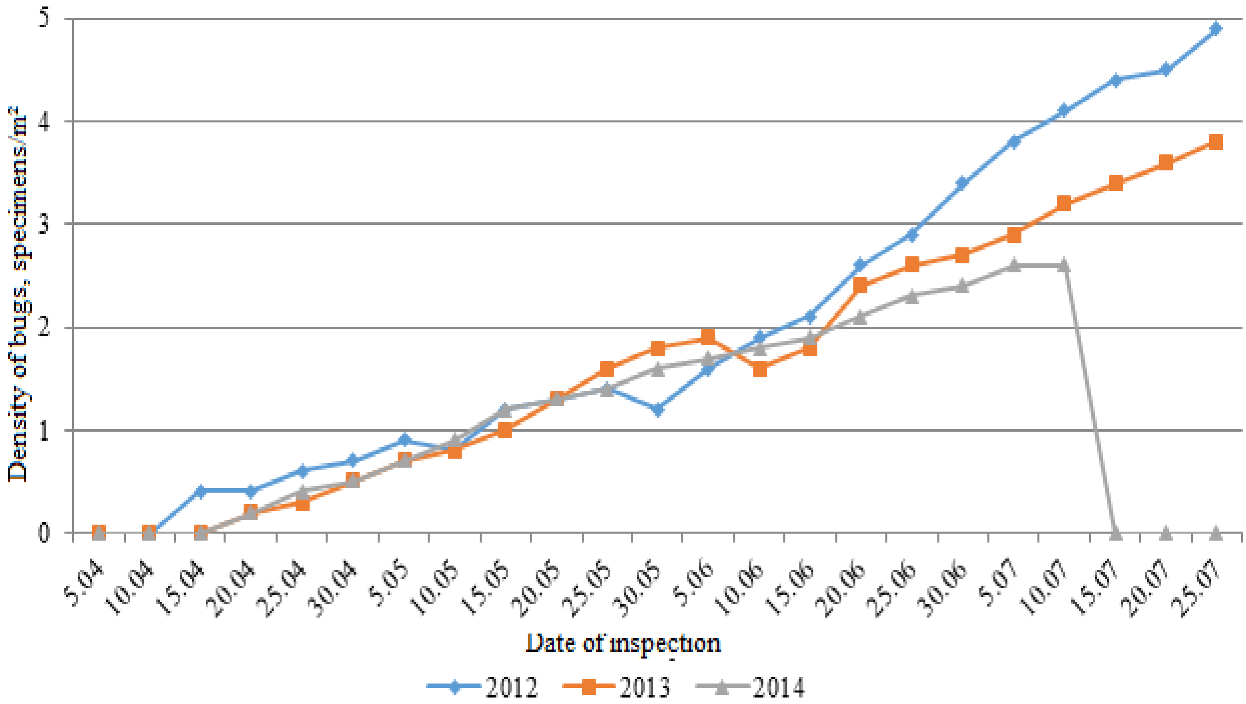


Figure 4.4. Seasonal dynamics of cruciferous bugs' number on Chinese mustard at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012–2014

Table 4.5

Density of cruciferous bugs in hibernation places at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012–2014

Species	Number of bugs by the years, specimens/m²					
	2012		2013		2014	
	forest belt	forest edge	forest belt	forest edge	forest belt	forest edge
Cabbage bug	1,0	0,7	3,0	1,4	2,1	1,8
Rape bug	0,4	0,5	1,2	0,6	1,6	0,7
Mustard bug	0	0	0	0	0	0
Total number of bugs per m²	1,4	1,2	4,2	2,0	3,7	2,5

The peak of the cruciferous bugs' number on Chinese mustard (Figure 4.4) lasted 20 days, from the beginning of the third decade of June to the end of the first decade of July.

In the Kharkiv region the cruciferous bugs at the stage of the immature imago overwinter under the fallen leaves, in the parks, at the forest edges, on the beam slopes, on the roadsides and in the gardens. In the course of the autumn and spring inspections in 2012–2014 the density of the cruciferous bugs in the forest belts around the experimental field and at the edge of the dendrological park was determined (Table 4.5). Based on the data from Table 4.5 it can be noted that the highest density of the cruciferous bugs in the hibernation places is concentrated in the forest belts and is amounted to about 3,1 specimens/m². There are much less bugs at the forest edge and their number is about 1,9 specimens/m².

Harmfulness of cruciferous bugs. In 2012 after harvesting the crops of spring rape of Ataman variety we cleaned the crops and thoroughly analysed them. With the help of the binocular the seeds of spring rape damaged by the bugs as well as the healthy seeds without any signs of damage were selected. Under the laboratory conditions the weight of 1000 both undamaged and damaged seeds was determined. From the data given in Table 4.6 it is seen that 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% in comparison with the undamaged seeds, that is, it is reduced almost 2 times.

Table 4.6

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
HIP_{05}	0,39		2,57		0,77	

From the data given in Table 4.6 it is seen that the undamaged seeds of spring rape contain 35,92% of fat, and the damaged ones contain 27,98% of fat, that is 1,3 times less. The protein content in the undamaged seeds was 30,97%, and in the damaged ones it was 30,44%, that is only by 0,53% less. The data of the biochemical analysis 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 the laboratory conditions the influence of the damage caused by the cruciferous bugs on the laboratory germination rate of seeds has been established. From the data given in Table 4.7 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%.

Table 4.7

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		

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 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% (Figure 4.5).

In 2013 after harvesting of the oilseeds cabbage crops and the cabbage seeds and after cleaning and analysing 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 4.8).

Figure 4.5. Sprouts obtained under laboratory conditions from undamaged (black) (1), undamaged (brown) (2) and damaged (3) spring rape seeds, 2013

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 ones 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 ones it is 36,39%. In the undamaged seeds of white cabbage the oil content amounts to 37,44%, and in the damaged ones 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 ones it is 38%.

Table 4.8

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 data of the biochemical analysis shows that the damage to the seeds caused by the cruciferous bugs in 2013 also caused a decrease in the oil content in it as well as 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 4.9).

Table 4.9

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

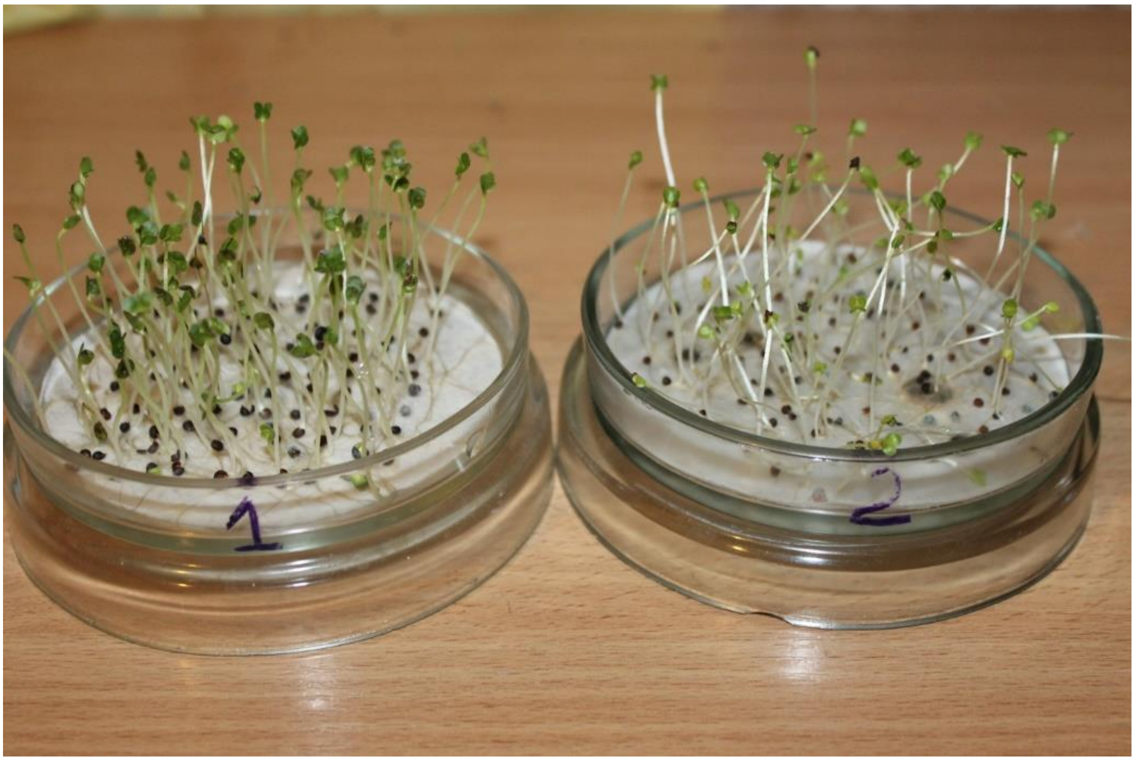


Figure 4.6. Sprouts obtained under laboratory conditions from undamaged (1) and damaged (2) spring rape seeds, 2013

From the data given in Table 4.9 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 (Figure 5.2) 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 4.10

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 4.10 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 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 (Figure 4.7). The final germination rate of the undamaged white mustard seeds was 97,0 %, and that of the damaged seeds was 86,4 %.

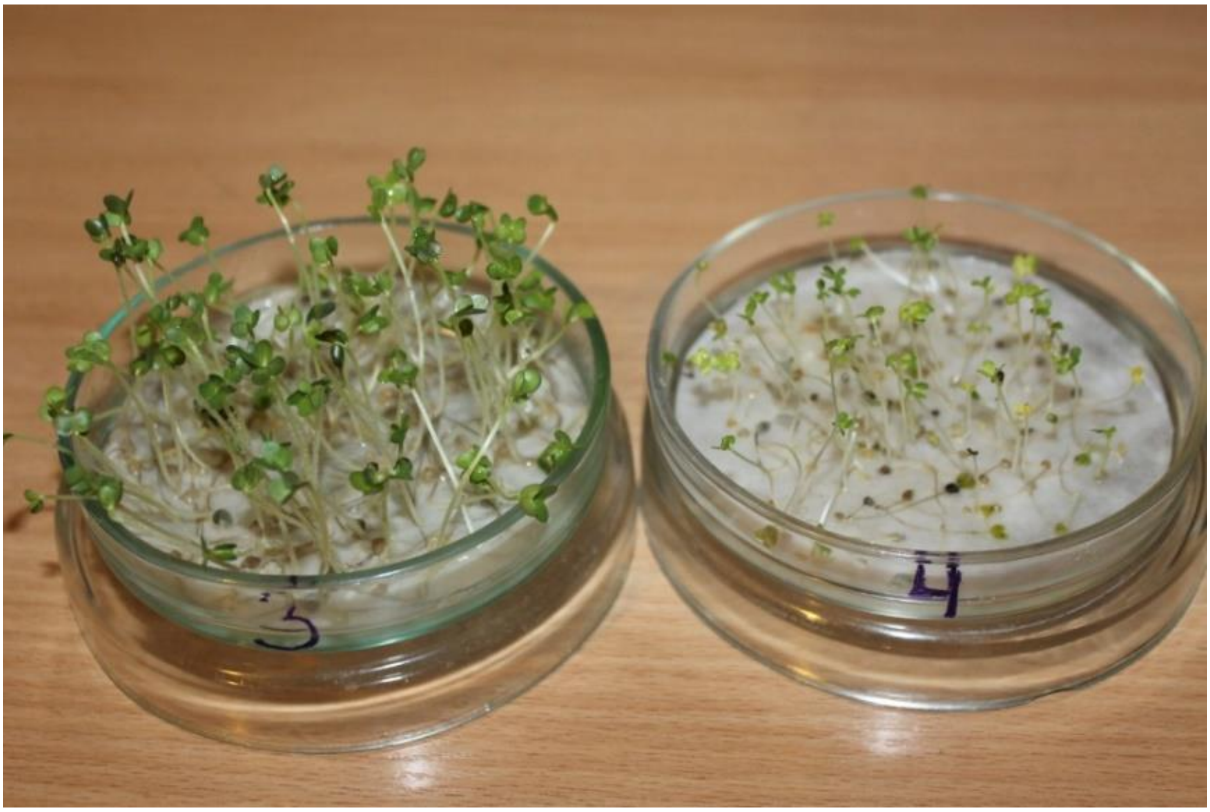


Figure 4.7. Sprouts obtained under laboratory conditions from undamaged (3) and damaged (4) white mustard seeds, 2013

From the data given in Table 4.11 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 seeds of cabbage 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 (Figure 4.8). The final germination rate of the undamaged white cabbage seeds was 94,0 %, and that of the damaged seeds was 56,9 %.

Table 4.11

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 1,3386g. and 1,6192 g. respectively, or 3,0 and 3,3 times less.

Figure 4.8. Sprouts obtained under laboratory conditions from undamaged (5) and damaged (6) seeds of white cabbage, 2013

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 ones it was 23,36 %. In the undamaged seeds of white cabbage the oil content amounted to 35,25 %, and in the damaged ones it was 34,43 %, which is 1,0 time less. The protein content in the undamaged seeds was 29,41 %, and in the damaged ones it was 30,38 % (Table 4.12).

The data of the biochemical analysis 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 as well as 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 4.13).

Table 4.12

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

Table 4.13

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 4.13 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 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 % (Figure 4.9).

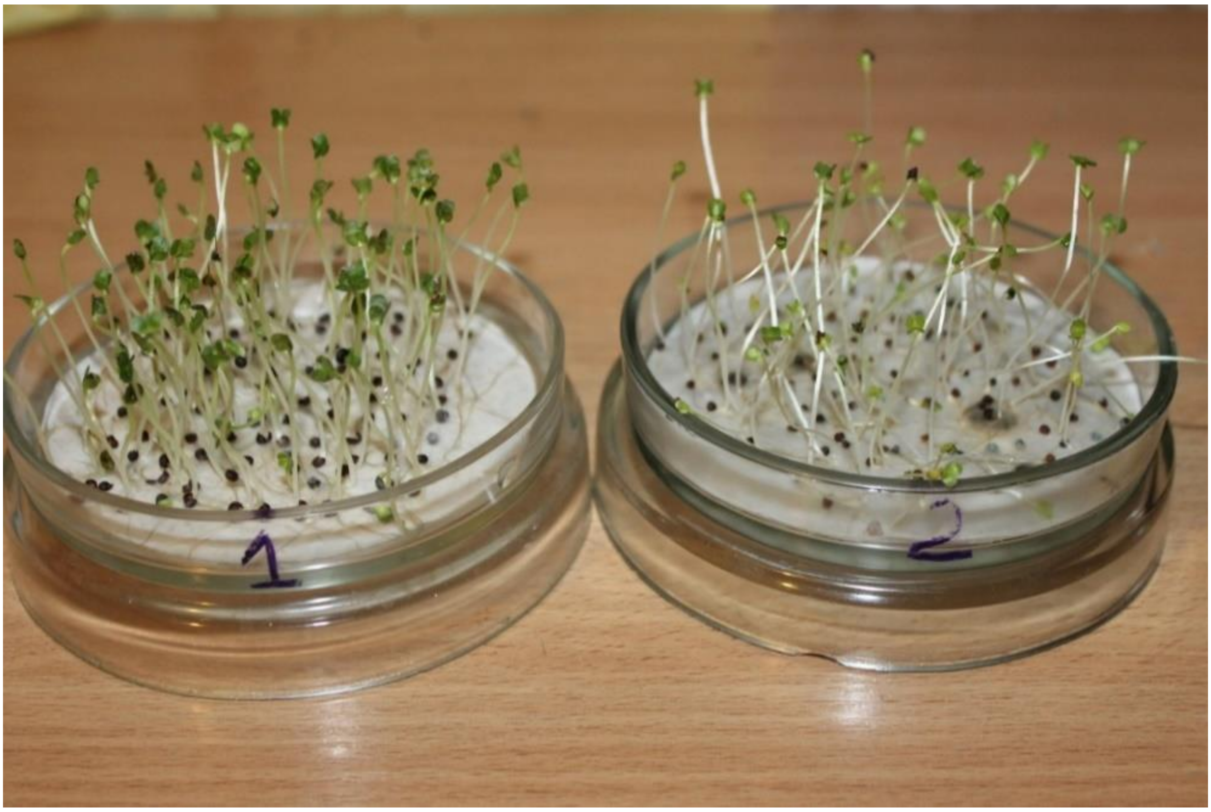


Figure 4.9. Sprouts obtained under laboratory conditions from undamaged (1) and damaged (2) seeds of spring rape, 2014

Table 4.14

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 4.14 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 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 % (Figure 4.10).

From the data given in Table 4.15 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 germination rate of the undamaged seeds of cabbage 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 % (Figure 4.11).

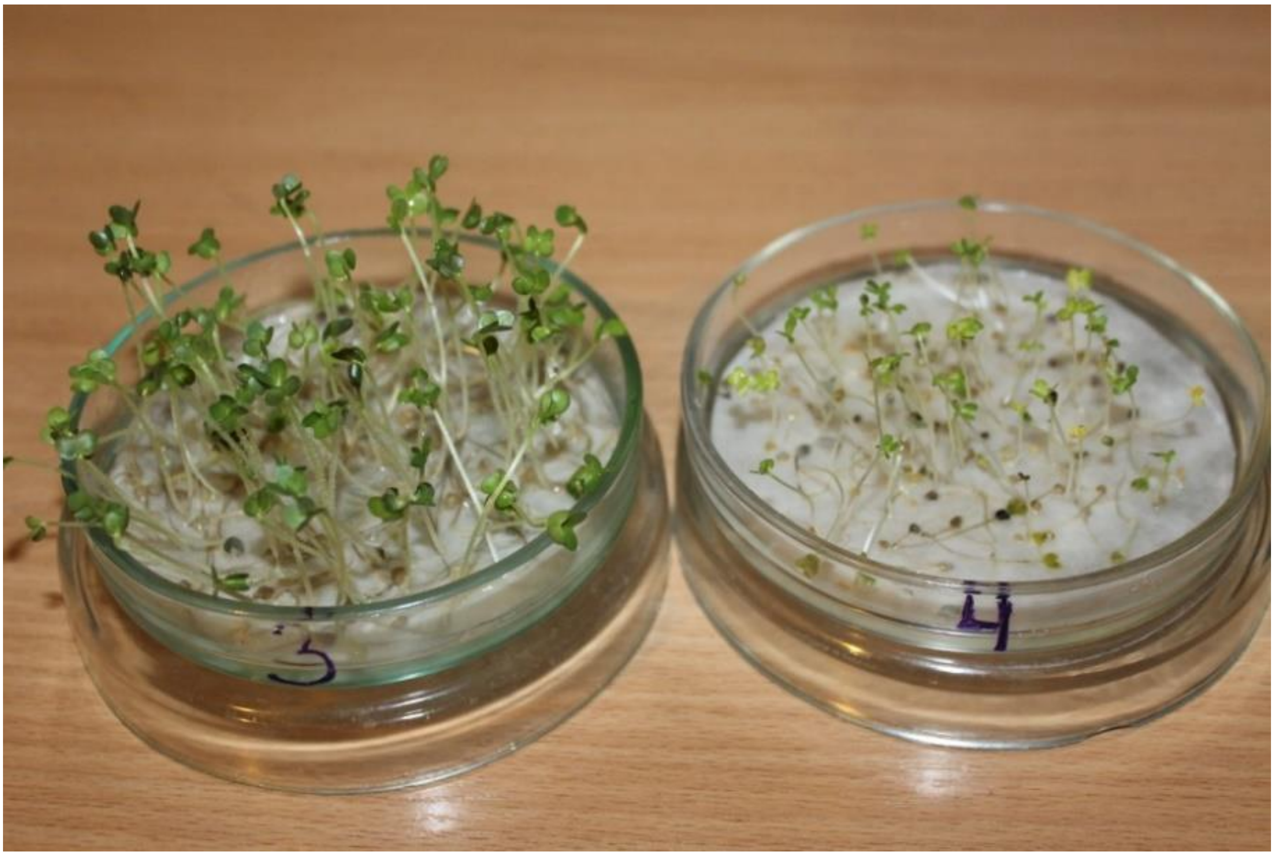


Figure 4.10. Sprouts obtained under laboratory conditions from undamaged (3) and damaged (4) seeds of white mustard, 2014

Figure 4.11. Sprouts obtained under laboratory conditions from undamaged (5) and damaged (6) seeds of white cabbage, 2014

Over the three years of the researches with an average yield of spring rape of Ataman variety of 0,455 t./ha the average content of oil in the damaged seeds was lower by 14,45 % and the estimated oil losses were 0,071 t./ha (Figure 4.12).

Table 4.15

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

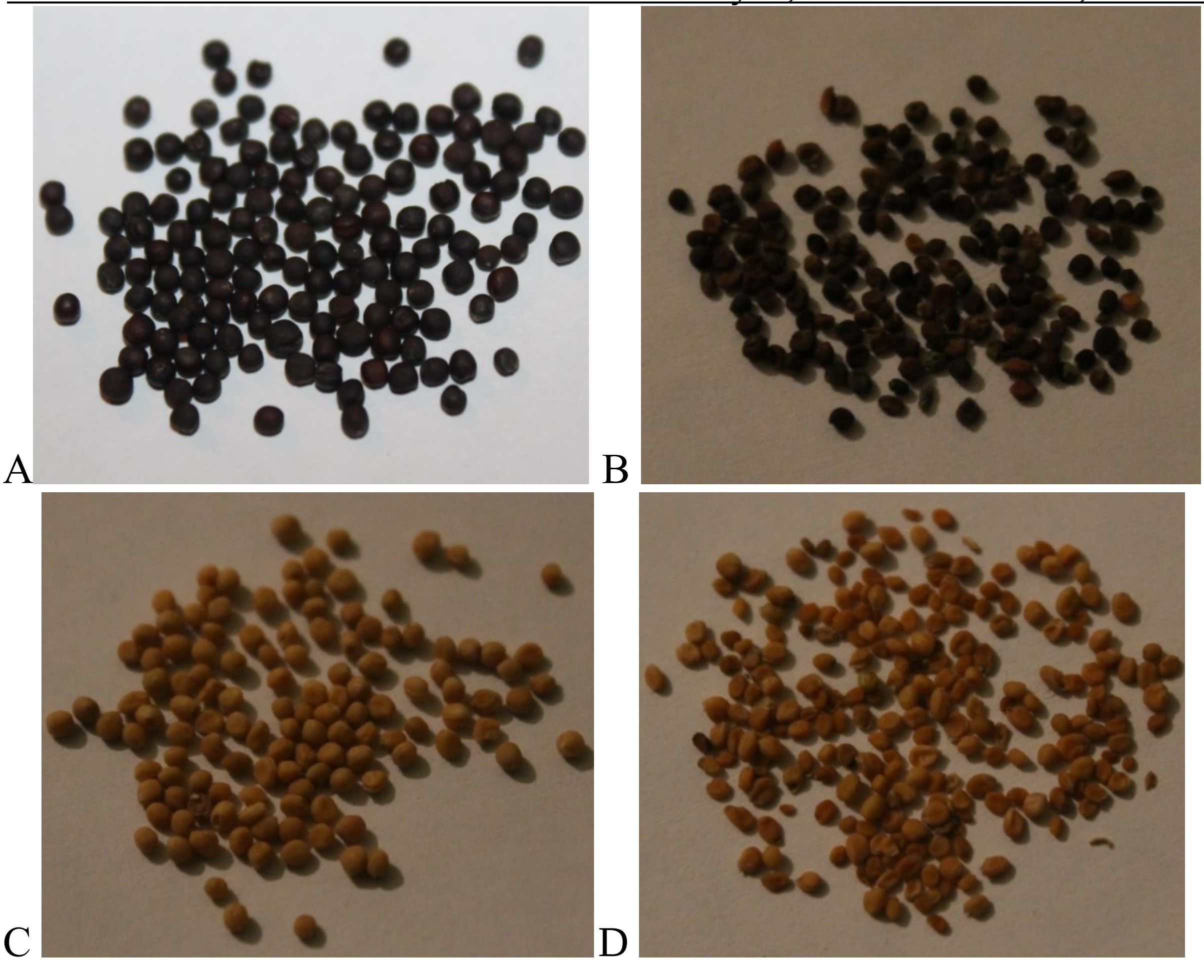


Figure 4.12. Seeds of spring rape of Ataman variety: undamaged (A), damaged (B) and seeds of white mustard of Carolina variety: undamaged (C) and damaged (D)

Technical efficiency of insecticides in controlling cruciferous bugs. In 2012–2013 in order to protect the plants of spring oilseed cabbage crops from the damages caused by the cruciferous bugs on the experimental crops of the Educational, Research and Production Centre “Research Field” the spraying of crops in the phenophase of the yellow bud with the systemic Biscaya insecticide, 24% of oily dispersion was carried out. The plot under control was sprayed with water. Such spraying was used against the cabbage and rape bugs, cabbage aphids and rape blossom beetle which, depending on the year, caused a decrease in the yield capacity and its quality. The acreage of the experimental plots under spring rape and mustard where the insecticide controlling the cruciferous bugs was tested accounted to 5 m^2 in triplicate. After 3, 7, and 14 days after spraying the area of 1 m^2 on each plot was examined and the population density of the bugs per 1 plant was determined.

As a result of spraying the crops of oilseed cabbage with the insecticide of systemic action Biscaya, 24 % of oily dispersion at the rate of consumption of 0,25 L./t in the phenophase of the yellow bud we have found out that spraying of the spring rape and mustard crops provided the protection from the cruciferous bugs.

In the course of the researches the data regarding the technical efficiency of spraying were obtained (Tables 4.16–4.18). They indicate that the preparation Biscaya, 24 % of oily dispersion has quite enough toxic effect on the cabbage and rape bugs.

Table 4.16

Technical efficiency of insecticide Biscaya, 24 % of oily dispersion when protecting spring rape of Ataman variety from cruciferous bugs in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012-2014

Variants of research	2012			2013			2014			Average in 2012–2014		
	Technical efficiency (%) in 3, 7 and 14 days after spraying											
	3	7	14	3	7	14	3	7	14	3	7	14
Control (H_2O)	–	–	–	–	–	–	–	–	–	–	–	–
Biscaya, 24% of oily dispersion (0,25 L./ha)	88,9	57,6	47,2	84,1	55,4	43,3	90,2	62,4	53,4	87,7	58,4	47,9
HIP_{05}	3,52											

Table 4.17

Technical efficiency of insecticide Biscaya, 24 % of oily dispersion when protecting white mustard of Carolina variety from cruciferous bugs in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012-2014

Variants of research	2012			2013			2014			Average in 2012–2014		
	Technical efficiency (%) in 3, 7 and 14 days after spraying											
	3	7	14	3	7	14	3	7	14	3	7	14
Control (H_2O)	–	–	–	–	–	–	–	–	–	–	–	–
Biscaya, 24% of oily dispersion (0,25 L./ha)	90,4	81,2	68,3	92,4	83,7	69,8	93,8	84,2	70,4	92,2	83,0	69,5
HIP_{05}	2,22											

For the years of the researches the average technical efficiency in 3 days after spraying constituted 87,7 % on spring rape, on white mustard it was 92,2 % and on Chinese mustard it was 92,4 % (Tables 4.16–4.18). In 7 days after spraying the technical efficiency constituted 58,4% on spring rape, on white mustard it was 83,0 % and on Chinese mustard it was 83,1 %. In 14 days after spraying the technical efficiency amounted to 47,9 % on spring rape, on white mustard it was 69,5 % and on Chinese mustard it was 66,7 %. A little lower technical efficiency of the Biscaya insecticide, 24 % of oily dispersion on the crops of spring rape can be explained by the fact that this crop was populated by the cruciferous bugs much more than mustard.

In 2014 in order to protect the crops of spring rape, white mustard and Chinese mustard the insecticides Mospilan, 20 % of soluble powder (0,1 kg/ha) and Nurelle D, 500 emulsion concentrate (1 L./ha) were also used. The data obtained (Table 4.19) indicate a sufficient toxic effect on the cruciferous bugs. Thus after 3 days the technical efficiency of the Mospilan preparation on the crops of spring rape of Ataman variety was 77,4 %, after 7 days it was 52,8 % and after 14 days the efficiency was 49,1 %. The preparation Nurelle D showed a little more toxicity; when applying this preparation the technical efficiency on the 3rd, 7th and 14th days was 81,6 %, 75,5 % and 49,0 % respectively.

Table 4.18

Technical efficiency of insecticide Biscaya, 24 % of oily dispersion when protecting Chinese mustard of Tavrychanka variety from cruciferous bugs in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012-2014

Variants of research	2012			2013			2014			Average in 2012–2014		
	Technical efficiency (%) in 3, 7 and 14 days after spraying											
	3	7	14	3	7	14	3	7	14	3	7	14
Control (H_2O)	–	–	–	–	–	–	–	–	–	–	–	–
Biscaya, 24% of oily dispersion (0,25 L./ha)	91,2	85,3	65,7	92,7	81,1	66,9	93,5	82,9	67,6	92,4	83,1	66,7
HIP_{05}	3,26											

The opposite tendency of the toxic effects of the Nurelle D and Mospilan preparations is observed in the cultivation of white and Chinese mustards. When applying Mospilan on the crops of white mustard of

Carolina variety the technical efficiency on the 3rd, 7th and 14th days was 83,6 %, 74,5 % and 65,5 % respectively. A little lower technical efficiency was when applying the Nurelle D insecticide; in 3 days the efficiency was 82,0 %, in 7 days it was 68,0 %, and in 14 days the efficiency was 62,0 %.

Table 4.19

Technical efficiency of insecticides Mospilan, 20 % of soluble powder (0,1 kg/ha) and Nurelle D 500 emulsion concentrate (1,0 L./ha) when protecting spring rape of Ataman variety, white mustard of Carolina variety and Chinese mustard of Tavrychanka variety from cruciferous bugs in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2014

Variants of research	Technical efficiency (%) in 3, 7 and 14 days after spraying								
	Spring rape			White mustard			Chinese mustard		
	3	7	14	3	7	14	3	7	14
Control (H_2O)	–	–	–	–	–	–	–	–	–
Mospilan, 20% of soluble powder (0,1 kg/ha)	77,4	52,8	49,1	83,6	74,5	65,5	80,8	67,3	55,8
Nurelle D, 55% of emulsion concentrate (1,0 L./ha)	81,6	75,5	49,0	82,0	68,0	62,0	78,4	68,6	56,9
HIP_{05}	2,68								

Spraying of Chinese mustard crops of Tavrychanka variety with Mospilan showed a rather high technical efficiency against the cruciferous bugs, which amounted to 80,8 % on the 3rd day, 67,3 % on the 7th day and 55,8 % on the 14th day. When applying Nurelle D, the technical efficiency was slightly lower than that of Mospilan and was 78,4 %, 68,6 % and 56,9 % on the 3rd, 7th and 14th days respectively. Therefore the use of the preparations Mospilan and Nurelle D has a quite high toxic effect on the bugs, but their toxic effect is lower than that of the Biscaya preparation.

Economic efficiency of insecticides in controlling cruciferous bugs. The stabilization of the phytosanitary condition of agrocoenosis of spring oilseed cabbage crops and its ecological safety are the final result of the integrated protection of these crops. The stable functioning of agrocenosis and phytosanitary stability are achieved by selection of the appropriate varieties, minimization of the insecticides application, preservation of the useful entomofauna, strengthening of the biocoenosis regulation and prevention of mass reproduction of the harmful insect species. The crucial importance in reducing the harmful effects of the cruciferous bugs belongs to the chemical method.

To protect the crops of spring rape and mustard from the cruciferous bugs at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University we have carried out the spraying with the Biscaya insecticide 24% of oily dispersion at the consumption rate of 0,25 L./ha in the phenophase of the yellow bud before flowering, which provided quite high technical as well as the economic efficiency in controlling the cruciferous bugs and rape blossom beetles, the main pests of the generative organs of the oilseed cabbage crops in the Eastern Forest-Steppe of Ukraine.

Spraying with the insecticide Biscaya, 24% of oily dispersion with the consumption rate of 0,25 L./ha in controlling the cruciferous bugs contributed to saving the yield of spring rape crops of Ataman variety by more than 0,117 t./ha in 2012, in 2013 the yield was saved by more than 0,103 t./ha and in 2014 it was saved by more than 0,528 t./ha (Table 4.20). For the three-years researches the saved yield amounted to 0,249 t./ha on the average.

Table 4.20

Economic efficiency of insecticide Biscaya, 24 % of oily dispersion when protecting spring rape of Ataman variety from cruciferous bugs in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012-2014

Variants of research	Years of researches						Average in 2012–2014	
	2012		2013		2014			
	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved. t./ha	Yield capacity t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved, t./ha
Control (H_2O)	0,085	–	0,091	–	0,563	–	0,246	–
Biscaya, 24 % of oily dispersion (0,25 L./ha)	0,202	0,117	0,194	0,103	1,091	0,528	0,495	0,249
HIP_{05}	0,005	-	0,003	-	0,068	-	-	-

In 2012 when protecting white mustard of Carolina variety from the cruciferous bugs the yield capacity was 0,107 t./ha higher than that one without spraying with the insecticide; in 2013 the yield capacity was 0,135 t./ha higher and in 2014 it was 0,156 t./ha higher (Table 4.21).

When spraying the crops of Chinese mustard of Tavrychanka variety with the Biscaya insecticide, 24% of oily dispersion and ensuring the protection from the cruciferous bugs, we have obtained the significantly higher yield than the yield obtained without chemical protection (Table 4.22).

Thus in 2012 in the variant with the insecticide the yielded crops were at the level of 0,214 t./ha, which is 2,2 times higher than in the control variant; in 2013 the yielded crops were at the level of 0,223 t./ha (2,18 times higher) and in 2014 the yielded crops were at the level of 0,853 t./ha (1,75 times higher). 0,201 t./ha on the average was saved in 2012–2014.

Thus depending on the crop for the years of the researches the average economic efficiency of spraying the crops with the systemic insecticide Biscaya, 24% of oily dispersion at the rate of consumption of 0,25 L./ha was 0,133–0,249 t./ha (Tables 4.20–4.22).

Table 4.21

Economic efficiency of insecticide Biscaya, 24 % of oily dispersion when protecting white mustard of Carolina variety from cruciferous bugs in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012-2014

Variants of research	Years of researches						Average in 2012–2014	
	2012		2013		2014			
	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved. t./ha	Yield capacity t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved, t./ha
Control (H_2O)	0,103	–	0,121	–	0,162	–	0,128	–
Biscaya, 24% of oily dispersion (0,25 L./ha)	0,210	0,107	0,256	0,135	0,318	0,156	0,261	0,133
HIP_{05}	0,011	-	0,016	-	0,004	-	-	-

Table 4.22

Economic efficiency of insecticide Biscaya, 24 % of oily dispersion when protecting Chinese mustard of Tavrychanka variety from cruciferous bugs in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2012-2014

Variants of research	Years of researches						Average in 2012–2014	
	2012		2013		2014			
	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved. t./ha	Yield capacity t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved, t./ha
Control (H_2O)	0,096	–	0,102	–	0,488	–	0,228	–
Biscaya, 24% of oily dispersion (0,25 L./ha)	0,214	0,118	0,223	0,121	0,853	0,365	0,430	0,201
HIP_{05}	0,010	-	0,016	-	0,012	-	-	-

Table 4.23

Economic efficiency of insecticides Mospilan and Nurelle D 500 when protecting spring rape of Ataman variety, white mustard of Carolina variety and Chinese mustard of Tavrychanka variety from cruciferous bugs in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2014

Variants of research	Spring rape		White mustard		Chinese mustard	
	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved. t./ha	Yield capacity t./ha	Yield saved, t./ha
Control (H_2O)	0,563	–	0,162	–	0,488	–
Mospilan, 20% of soluble powder (0,1 kg/ha)	0,880	0,317	0,287	0,125	0,761	0,273
Nurelle D, 55% of emulsion concentrate (1,0 L./ha)	0,907	0,344	0,255	0,093	0,749	0,261
HIP_{05}	0,010	-	0,011	-	0,011	-

The use of Mospilan on the crops of spring rape of Ataman variety contributed to saving the yield at the level of 0,317 t./ha, the yield of white mustard of Carolina variety was saved at the level 0,125 t./ ha and the yield of Chinese mustard of Tavrychanka variety was saved at the level of 0,273 t./ha (Table 4.23). Spraying of spring rape, white mustard and Chinese mustard crops with the preparation Nurelle D ensured saving the yield at the level of 0,344 t./ha, 0,093 t./ha and 0,261 t./ha respectively. In the whole the use of the insecticides Mospilan and Nurelle D provided a yield capacity 1,53-1,77 times higher than the yield capacity without spraying the crops with the insecticides.

Conclusions:

1. 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. The cruciferous bugs are presented by three species: painted or harlequin (cabbage) bug (*Eurydema ventralis* Kol), pentatomid rape bug (*E. oleraracea* L.) and mustard bug (*E. ornata* L.). The dominant species is a cabbage bug. The mustard bug dominated only in 2007, and since 2012 it has not been detected in the records.

2. The largest number of wintering bugs was concentrated in the forest belts, near which there were the crops of spring oilseeds and cabbage plants and the seeds of white cabbage. In 2012−2014 the density of wintering imagines of the cabbage bug was 1,7–4,4 specimens/m² and the density of the rape bug was 0,9–2,3 specimens/m² of the forest floor.

3. The imagines of the overwintered bugs populated the cabbage seeds as a trap crop and then they populated the sprouts of spring rape and mustard. At the Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University the density of the cruciferous bugs on the seeds of white cabbage of Kharkivska 105 variety was 19,0–30,7 specimens per plant at the beginning of the populating of spring oilseed cabbage crops. The maximum density of the cruciferous bugs in the phenophase of the yellow bud on the crops of spring oilseed cabbage plants was the following: 4,5 ± 1,45 specimens/m² of cabbage bug was found on spring rape of Ataman variety, 4,0 ± 1,83 specimens/m² on white mustard of Carolina variety and 3,5±2,65 specimens/ m² on the Chinese mustard of Tavrychanka variety; and the density of the rape bug was 0,7 ± 0,23 specimens/m², 0,5 ± 0,23 specimens/m² and 0,5 ± 0,3 specimens/m² respectively.

4. At the state enterprise "Research Farm "Elitne" the maximum density of the cruciferous bugs in the phenophase of the yellow bud on spring rape of Ataman variety was 6,0 ± 0,9 specimens/ m^2, on white mustard of Carolina variety it was 5,7 ± 0,85 specimens/m^2 and on Chinese mustard of Tavrychanka variety the average density was 5,3 ± 0,9 specimens/m^2.

5. In 2015 the highest number of the cabbage and rape bugs is concentrated on the seeds of white cabbage plants at 12 o'clock in the afternoon at a density of 22,3–30,7 specimens/plant and the lowest number of them was found at 8 o'clock in the morning and it was 17,9–28,5 specimens/plant. The maximum density of 51-60 specimens/plant was at 12 o'clock in the afternoon.

6. At the Educational, Research and Production Centre "Research Field" the beginning of populating spring rape of Ataman variety by the bugs at took place in the phenophases of 3−4 pairs of true leaves, namely during the rosette formation. In 2012 it was May 20, in 2013 it was May 26 and in 2014 it was April 30 when the sum of the active temperatures was 411,8; 299,2 and 106°C according to the years. The beginning of the larval reappearance took place at the sum of the active temperatures of 687,9; 668,5 and 520,3°C respectively. Depending on the climatic conditions of the year the peak of the cruciferous bugs' number was observed in the period from the second and third decades of June to the third decade of July. The highest density of the bugs was observed before harvesting.

7. 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 then 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 the average, and the estimated oil yield at an average yield capacity of 0,495 t./ha is 0,071 t./ha lower.

8. In 2012−2014 the average technical efficiency of the Biscaya preparation, 24% of oily dispersion on spring rape in 3 days after spraying was 87,7%, in 7 days it was 58,4%, and in 14 days it was 47,9%; on white mustard the technical efficiency was 92,2; 83,0 and 69,5% respectively.

As for Chinese mustard the efficiency was 92,4; 83,1 and 66,7%. The technical efficiency of the insecticides Mospilan, 20% of soluble powder and Nurelle D, 55% of emulsion concentrate is quite lower than that of the Biscaya insecticide, 24% of oily dispersion, and, depending on the cultivated crop, in 3 days the technical efficiency was 77,4–83,6% and 78,4–82,0% respectively, in 7 days it was 52,8–74,5% and 68,0–75,5%, in 14 days the efficiency was 49,1−65,5% and 49,0−62,0% respectively.

9. At the Educational, Research and Production Centre "Research Field" spraying with the Biscaya insecticide ensured saving of the spring rape yield up to 0,249 t./ha, the yield of white mustard was saved at the level of 0,133 t./ha, and the yield of Chinese mustard was saved at the level of 0,201 t./ha. The applying of the Mospilan insecticide, 20% of soluble powder on spring rape crops contributed to saving the yield at the level of 0,317 t./ha, the yield of white mustard was saved at the level of 0,125 t./ha and the yield of Chinese mustard was saved at the level of 0,273 t./ha. Spraying with the preparation Nurelle D, 55% of emulsion concentrate ensured saving of the yield up to 0,344; 0,093 and 0,261 t./ha respectively.

PART 5. EFFICIENCY OF CHEMICAL PROTECTION OF SPRING RAPE AND MUSTARD FROM RAPE BLOSSOM BEETLE

Rape blossom beetles *(Meligethes aeneus*) belong to the species Coleoptera or Beetles, a Sap-feeding (*Nitidulidae)* family, a genus of *Meligethes* (Yevtushenko, Stankevych, Vilna, 2014; Yevtushenko, Vilna, Stankevych, 2016). They can be found everywhere. The beetles are 1,5–2,7 mm in length and have a flat elongated body, black top with metallic green or blue tint, their antennae are mace like and the legs are black and brown (Figures 5.1, 5.2, 5.3). The egg is 0,3 mm in size, it is white, smooth and elongated-oval. The larva is up to 4 mm; it is worm-like, light gray in colour and covered with small black warts, its head is brown (Figure 5.4). The pupa is about 3 mm in length, it has a flattened-ovate form, and it is of a light yellow colour (Yevtushenko, Stankevych, Vilna, 2014).

Figure 5.1. Rape blossom beetle (imago), Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University, 3rd decade of June 2018 (photo by the author)

Figure 5.2. Imago of rape blossom beetle in its mass, Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University, 3rd decade of June 2018 (photo by the author)

Figure 5.3. Imago of rape blossom beetle in a rape flower, Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University, 3rd decade of June 2018 (photo by the author)

Figure 5.4. Larvae of rape blossom beetle of younger and older ages, Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University, 3rd decade of June 2018 (photo by the author)

The imagines hibernate on the surface of the soil under the fallen leaves or plant remains on the edges of forests, in gardens and parks. In April and early May the beetles settle on the flowers of wild growing plants (buttercup, dandelion, etc.), then they move to the seeds of cabbage crops (Evtushenko, Stankevych, 2011; Stankevych, 2012). In addition they feed on the inner parts of buds and flowers, gnawing out the anthers, stamens, pistils and petals. The female lays 1 or 2 eggs into the unblown buds and flowers. The fertility is 50-60 eggs. The larvae regenerate after 5–9 days and feed on the inner parts of the buds and flowers, mostly on anthers and sometimes on young pods (Stankevych, 2014). The larval development lasts 15–25 days. After the development the larvae get 2–5 cm deeper into the topsoil and pupate. The pupae develop during 10–12 days. The imagines, which appear in June and July, for some time feed on the flowers of different plants and then fly to the wintering places. In the Eastern Forest-Steppe of Ukraine one generation is developing for a year (Evtushenko, Stankevych, 2012; Yevtushenko, Stankevych, Vilna, 2014; Stankevych, 2015).

According to the literary data the rape blossom beetle yields one generation a year in the northern regions of Russia, and it yields two or three generations in the central and southern regions (Osmolovskyi, 1972). According to other data the rape blossom beetle yields 1–3 generations a year in the Volga region (O.A. Ivantsova (2010). In Sweden (Wivstad, 2010) and Norway (Andersen, 2008) the pest yields one generation a year.

According to the vast majority of the authors the rape blossom beetle yields two generations in Ukraine (Hurova, 1963; Horodnii, 1970), and according to other data it yields only one generation (Kovalchuk, 1987) or as many as 3–4 generations (Orobchenko, 1959). According to Academician Fedorenko V.P. (Fedorenko, Sekun, Markov et al., 2008) in Ukraine the rape blossom beetle yields 1 or 2 generations a year, and according to Z.I. Hurova (1963) in the Eastern Forest-Steppe of Ukraine the complete cycle of the first generation of the rape blossom beetle development lasts 36–42 days, and the development of the second generation lasts 26–29 days.

In the cold and rainy spring the rape blossom beetle becomes less active and its harmfulness is significantly reduced (Yevtushenko, Stankevych, Vilna, 2014.

The economic threshold of harmfulness of the rape blossom beetle is 5–6 specimens per plant (Stankevych, Zabrodina, 2016).

The data given by I.V. Kozhanchikov (Kozhanchikov, 1929) and N.L. Sakharov (Sakharov, 1934) are interesting. They emphasise that the presence of the rape blossom beetle does in no way prevent the formation of the high yields of the cabbage crops seeds.

It should be noted that the rape blossom beetle is not new to our country and as a pest of rape and other crops from the cabbage family has been mentioned since 1845 (About Harmful Insects, 1945).

The protective measures include the soil cultivation during the period of the pest mass pupation and spraying the crops at the stage of budding with the insecticides or biological preparations authorised to use if the number of the beetles exceeds the economic threshold of harmfulness (Stankevych, 2012; Stankevych, 2018).

The rape blossom beetle is widespread throughout the territory of Ukraine. It causes the significant damage to the crops every year and reduces the seed yields. The species habitat covers the whole Europe, the Caucasus, Asia Minor and North Africa; as for the countries of Central Asia, the beetle is widespread only in Turkmenistan. The rape blossom beetle is the most dangerous pest of cabbage crops in Germany, Poland and France (Shpaar, 2007).

Materials and methods of researches

To establish the seasonal dynamics of the rape blossom beetle number the calculations were carried out every five days beginning from the budding phase. The beetles were shaken down from the plants into the plastic bags (10 plants in 10 equidistant places of the field). Then the density was converted to an average per 1 plant.

On the experimental plots of the Educational, Research and Production Centre “Research Field” of Kharkiv V.V. Dokuchaiev National Agrarian University 500 buds were chosen in order to determine the number of the rape blossom beetle eggs in the buds of spring rape and mustard and to clarify the number of the eggs laid into 1 bud. On each plot from 5 diagonally located places we chose 20 buds from each of 5 plants (100 buds from each plot). The buds were placed into the plastic bags and then the buds were opened with a knife and the total number of the eggs of the rape blossom beetle and the number of the eggs in each bud were calculated.

The content of fats and protein in the seeds of spring rape was determined at the laboratory of the Seed Quality of the V.Ya. Yuryev Institute Plant Growing of the National Academy of Agrarian Sciences of Ukraine and the seed germination was determined at the laboratory of the Zoology and Entomology Department in Kharkiv V.V. Dokuchaiev National Agrarian University . The influence of the seed treatment agents on the seed germination was evaluated at the laboratory of the Phytopathology Department of Kharkiv V.V. Dokuchaiev National Agrarian University and at the laboratory of the O.N. Sokolovskyi Institute of Agrochemistry and Soil Science.

The germination intensity of the purified seeds harvested in 2012 which had been damaged by the larvae of the rape blossom beetle was determined at the laboratory of the Zoology and Entomology Department in Kharkiv V.V. Dokuchaiev National Agrarian University .

The biochemical analysis of the spring rape purified seeds harvested in 2012 as for the fat and protein content was carried out according to the methods of Kjeldahl and Rushkovskyi (Kostromitin, 1975) at the laboratory of the Seed Quality of the V.Ya. Yuryev Institute Plant Growing of the National Academy of Agrarian Sciences of Ukraine

In order to protect the crops of spring rape and mustard from the rape blossom beetle the experiment as for the influence of the insecticides and their tank mixtures on the quantity and quality of oily cabbage crops yield capacity was laid on the experimental plots of the Educational, Research and Production Centre “Research Field” of Kharkiv

V.V. Dokuchaiev National Agrarian University . The plants were sprayed in the phenophase of a yellow bud (before the emergence of the first flowers). The experiments were carried out in 2010–2012 according to the generally accepted method. The variants of the experiment are the following: 1. Control (H_2O); 2. Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha); 3. Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha); 4. Biscaya, 24 % of oily dispersion (0,25 L./ha); 5. Actophyte, 0.25 % of emulsion concentrate (2,4 L./ha) + Biscaya, 24 % of oily dispersion (0,25 L./ha); 6. Actophyte, 0.25 % of emulsion concentrate (4,8 L./ha) + Biscaya, 24 % of oily dispersion (0,25 L./ha).

The acreage of the experimental plots under rape and mustard where the insecticides controlling the rape blossom beetle were tested accounted to 5 m² in triplicate. After 3, 7, and 14 days 25 plants were examined on each plot and the population density of the beetles per 1 plant was determined. Spraying of the crops was carried out with a knapsack sprayer of the "Lemira–SP–202–01" brand at a rate of consumption of about 250 L./ha.

When spraying the crops the technical efficiency of the preparations against the main rape pests was determined by the formula:

$$T = \frac{a-b}{a} \times 100, \quad (5.1)$$

where *T– technical efficiency, %;*

a – density of the pests population before spraying,

b – density of the pests population in 3, 7 or 14 days after spraying (Recommendations, 1975; Methods of calculation, 1976; Triebel and others, 2001; Stankevich, Zabrodina, 2016).

The economic efficiency or increase in the yield was determined according to the following formula:

$$I = \frac{a-b}{a} \times 100, \quad (5.2)$$

where *I – increase in the yield, %;*

a – average yield from a calculated unit on a cultivated plot, t.;

b – average yield from a calculated unit on a plot under control, t. (Recommendations, 1975; Methods of calculation, 1976; Triebel and others, 2001; Stankevich, Zabrodina, 2016).

Results of researches and discussion

In the Eastern Forest-Steppe of Ukraine the rape blossom beetle in the imago stage hibernates on the surface of the soil under the fallen leaves or plant remains on the edges of forests, in gardens and parks. In the course of the inspection and calculations conducted in 2007–2012 in the experimental fields of the Educational, Research and Production Centre “Research Field” of Kharkiv V.V. Dokuchaiev National Agrarian University and the state enterprise “Research Farm “Elitne” of the V.Ya. Yuryev Institute of Plant Growing of the National Academy of Agrarian Sciences of Ukraine we have found out that the first individuals of the rape blossom beetle appear on the flowering plants (first of all dandelion and buttercup) when the average daily temperature passes through the mark 8°C. The earliest emergence of the beetles on these plants was observed in 2008, 2010 and 2012. The beetles emerged already in the middle of the first decade of April. In 2007 and 2011 the latest period of the beetles’ emergence was observed, it was the beginning of the third decade of April (Table 5.1).

The mass emergence of the rape blossom beetle took place when the average daily temperatures fluctuated within 9–13 °C and the sum of the effective temperatures above 5 °C was 100–113 °C. From the data given in Table 5.1 it is seen that in 2008 the mass emergence of the rape blossom beetles from the hibernation places was in the middle of the second decade of April and it was the earliest during the research period; and in 2009 the beetles emerged at the end of the third decade of April and it was the latest period oh their emergence.

After the hibernation the rape blossom beetles feed on the pollen of the flowering vegetation, first on dandelion and buttercup, then on the fruit trees (apricot, plum, cherry and apple) and on the weeds from the cabbage family (colza, hedge mustard and field mustard). According to our observations the active populating of spring oily cabbage crops by the rape blossom beetle took place at the very beginning of the budding phenophase (about the second decade of June), although the solitary individuals have been found since the beginning of the rosette formation (in the second decade of May). With the beginning of the budding phase the population density of the rape blossom beetle in the fields under the oily cabbage crops dynamically increases and reaches its peak before flowering. We noted the beginning of the beetles mating in the third decade of May and at the beginning of the first decade of June; and the laying of eggs was noted beginning from the second decade of June.

At the end of the second and at the beginning of the third decade of June the reappearance of the rape blossom beetle larvae was observed; they fed for about 25–30 days and pupated at the end of the third decade of June and at the beginning of the first decade of July. At the end of the first decade of July the emergence of a new generation of the beetles was noted. In the third decade of June, when the plants are in the phase of the pods formation, the beetles begin to leave the field.

The seasonal dynamics of the rape blossom beetle number on spring rape and mustard are shown in the form of diagrams in Figures 5.5, 5.6, and 5.7.

Table 5.1

Terms of beginning and mass emergence of rape blossom beetles on flowering plants at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2007-2012

Year	Beginning of beetles emergence on flowering plants		Mass emergence of beetles on flowering plants		
	decade	average daily air temperature, °C	decade	average daily air temperature, °C	sum of effective temperatures, °C
2007	beginning of the 3rd decade of April	9,1	middle of the 3rd decade of April	9,1	103,9
2008	middle of the 1st decade of April	11,0	middle of the 2nd decade of April	11,5	112,9
2009	end of the 2nd decade of April	8,6	end of the 3rd decade of April	11,5	101,0
2010	middle of the 1st decade of April	9,1	end of the 2nd decade of April	10,9	110,0
2011	beginning of the 3rd decade of April	11,7	middle of the 3rd decade of April	10,6	105,9
2012	middle of the 1st decade of April	9,7	middle of the 2nd decade of April	13,5	103,5

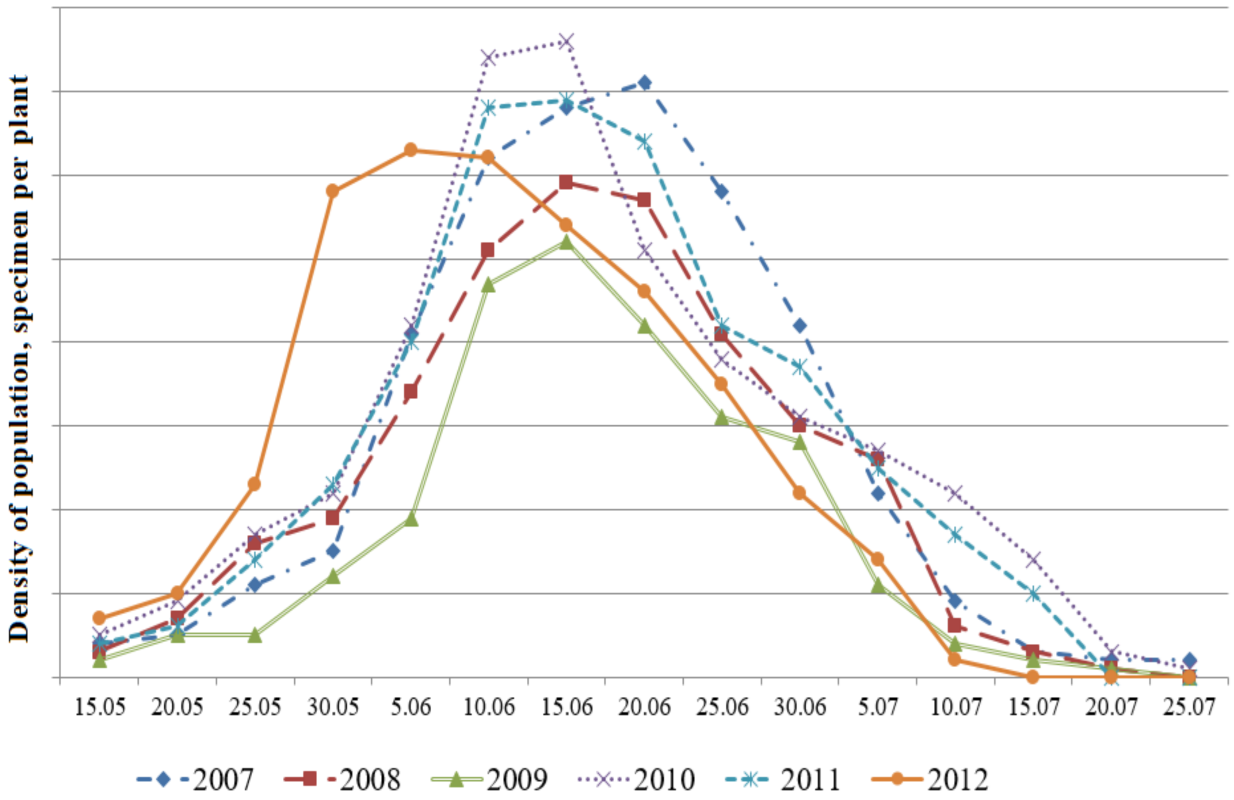


Figure 5.5. Seasonal dynamics of rape blossom beetle number on spring rape crops in Eastern Forest-Steppe of Ukraine in 2007–2012

Analysing the data from Figures 5.5, 5.6 and 5.7 it can be seen that at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University the first individuals of the rape blossom beetle begin to populate the crops of spring oily cabbage crops in the middle of the second decade of May. During the years of the researches the peak of the rape blossom beetle number on the oily cabbage crops was noted from the end of the third decade of May to the end of the second decade of June when the plants are in the phenophases of budding and flowering. Beginning from the third decade of June during the phenophase of the pods growth the beetles begin to leave the field; only some larvae, which have not finished feeding on the buds and flowers and are still feeding on the young pods and seeds, remain on the plants.

In order to determine the number of the spring rape buds populated by the eggs of the rape blossom beetle and to clarify the number of the eggs laid into one bud on the experimental plots of the Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University we chose 500 buds.

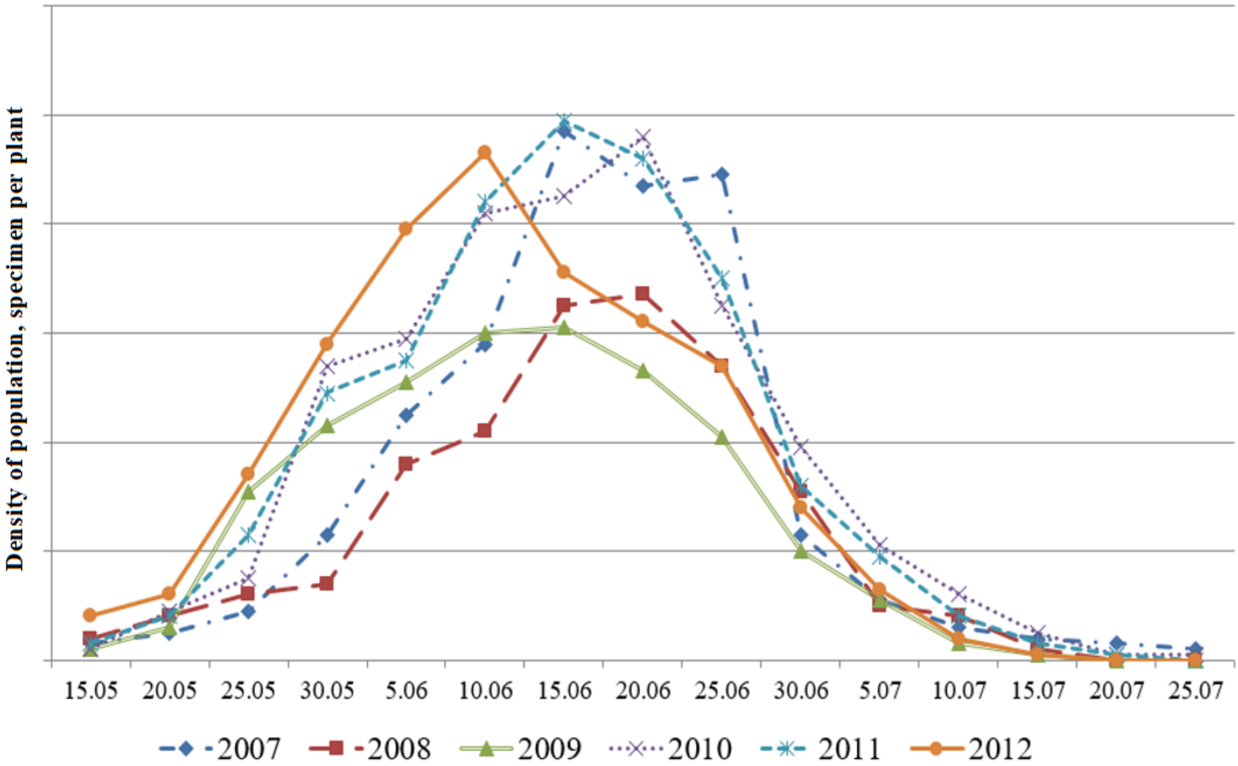


Figure 5.6. Seasonal dynamics of rape blossom beetle number on white mustard crops in Eastern Forest-Steppe of Ukraine in 2007–2012

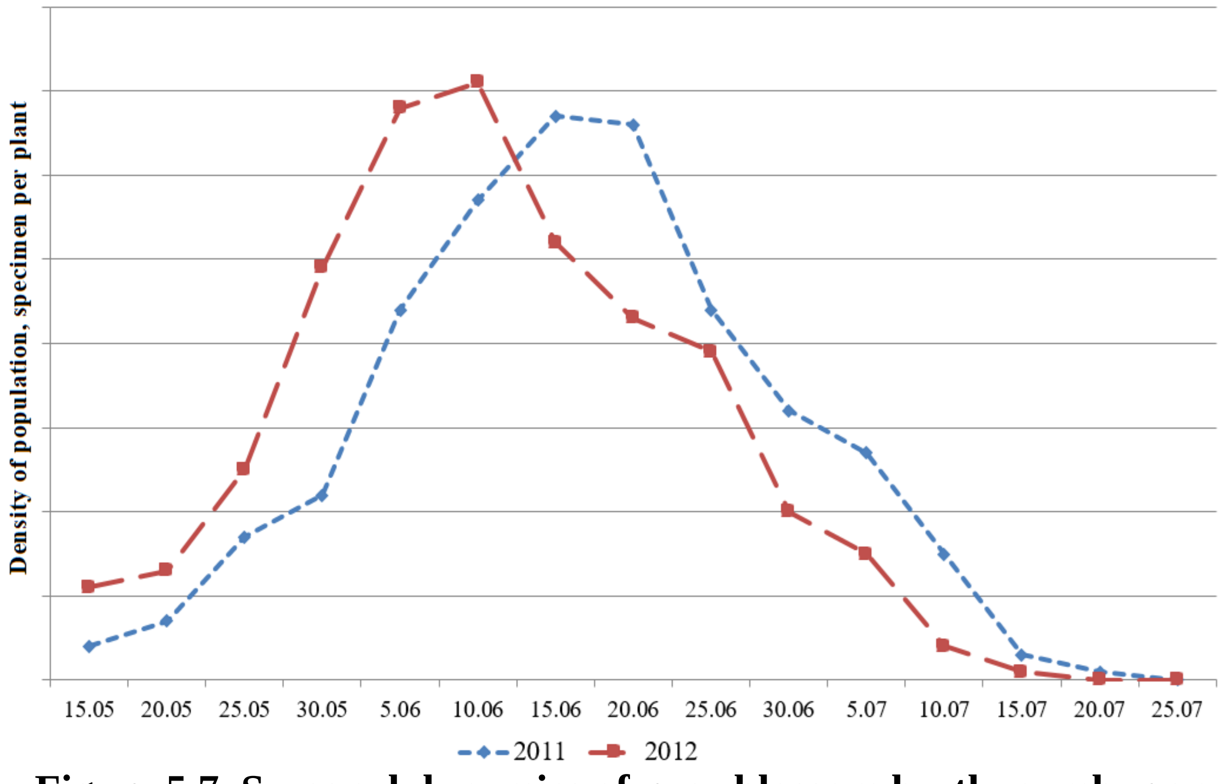


Figure 5.7. Seasonal dynamics of rape blossom beetle number on Chinese mustard crops in Eastern Forest-Steppe of Ukraine in 2011–2012

On each plot from 5 diagonally located places we chose 20 buds from each of 5 plants (100 buds from each place). The buds were placed into the plastic bags and then the buds were opened with a knife and the total number of the eggs of the rape blossom beetle and the number of the eggs in each bud were calculated. The obtained data are shown in Table 5.2.

Table 5.2

Number of rape blossom beetle eggs in the buds of spring rape and mustard at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2010-2012

Crops	Years of researches	Number of eggs in the buds							
		0	1	2	3	4	5	total	
								populated	unpopulated
Spring rape	2010	303	29	53	75	23	17	39,4	60,2
	2011	321	32	41	89	12	5	35,8	64,2
	2012	319	29	47	82	14	9	36,8	63,8
White mustard	2010	314	26	49	67	29	15	37,2	62,8
	2011	330	35	48	60	15	12	34,0	66,0
	2012	327	29	44	73	19	8	34,6	65,4
Chinese mustard	2011	307	38	56	68	22	9	38,6	61,4
	2012	315	23	49	87	15	11	37,0	63,0

From the data given in Table 5.2 it is seen that the total populating of spring rape buds with the eggs of the rape blossom beetle was 39,4 % in 2010, in 2011 it was 35,8 % and in 2012 it was 36,2 %. The populating of white mustard buds with the eggs of the rape blossom beetle was 37,2% in 2010, in 2011 it was 34,0 %, and in 2012 it was 34,6 %. The populating of Chinese mustard buds with the eggs of the rape blossom beetle amounted to 38,6 % in 2011, and in 2012 it was 37,0 %. We noted from 1 to 5 eggs laid into the populated buds, but most often there were 2–3 eggs (Table 5.2). Six or more eggs in one bud were not found.

Usually the mass populating of the plants with the rape blossom beetles takes place during the period of oily cabbage crops budding. At this time it is important to use the protective measures in the shortest possible time, namely it is necessary to spray the plants before flowering (in the phenophase of a yellow bud) since spraying during the flowering will cause harm to the beneficial entomofauna and insect pollinators. This is extremely important because the insects pollinate 85% of flower plants (95% of which are the bees).

Taking into account the fact that most insecticides have a negative influence on the number of the entomophages and pollinators which in their mass populate the crops of white mustard during the phase of flowering and in order to expand the range of the insecticides that are effective in protecting oily cabbage crops from the rape blossom beetle we have examined the influence of a new microbiological preparation Actophyte, 0,25 % of emulsion concentrate on the rape blossom beetle by spraying the plants before flowering.

The biological preparations are not harmful to birds, warm-blooded animals, beneficial entomofauna and humans. The microbiological preparation Actophyte, 0,25 % of emulsion concentrate (active substance aversectin) has been applied by us at different rates of consumption and in a combination with the insecticide of systemic action Biscaya, 24 % of oily dispersion (active substance thiacloprid) on the crops of spring rape of Ataman variety, white mustard of Carolina variety and Chinese mustard of Tavrychanka variety.

Actophyte, 0,25 % of emulsion concentrate is a microbiological preparation which has an insectoacaricide action. The dry and clear weather is a necessary condition for its application. The active substance of the preparation is a complex of natural avermectins which are produced by the non-pathogenic soil radiant fungus (*Streptomyces avermitilis)*.

Biscaya, 24 % of oily dispersion is a systemic insecticide which due to its preparative forms (oily dispersion) is very well kept on the leaves of the cabbage crops abundantly covered with a bloom and does not require the additional use of the adhesions. The preparation is not toxic to the bees and bumble-bees.

As a result of spraying the crops in the phase of the yellow bud we have found that spraying of spring rape and mustard is a reliable way to protect them from the rape blossom beetle.

In the course of the researches the following data (Tables 5.3, 5.4, 5.5 and Figure 5.8) regarding the technical efficiency of the preparations action were obtained. As it can be seen from the data given in Tables 5.3, 5.4, and 5.5 the preparations have a toxic effect on the rape blossom beetle. However the binary mixture of the microbiological preparation Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha) and the systemic insecticide Biscaya, 24 % of oily dispersion (0,25 L./ha) turned to be the best one.

Table 5.3

Technical efficiency of preparations Actophyte, 0,25 % of emulsion concentrate and Biscaya, 24 % of oily dispersion when protecting white mustard of Carolina variety from rape blossom beetle in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2010-2012

Years of researches	Variants of research																	
	Control (H_2O)			Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha)			Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha)			Biscaya, 24 % of oily dispersion (0,25 L./ha)			Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha)+ Biscaya, 24 % of oily dispersion (0,25 L./ha)			Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha) + Biscaya, 24 % of oily dispersion (0,25 L./ha)		
	Technical efficiency (%) in 3, 7 and 14 days after spraying																	
	3	7	14	3	7	14	3	7	14	3	7	14	3	7	14	3	7	14
2010	–	–	–	69,3	47,1	22,3	74,1	52,2	28,5	91,5	85,7	69,2	93,4	89,8	71,1	98,7	93,6	76,4
2011	–	–	–	65,4	50,1	25,9	76,2	53,5	30,1	90,6	84,4	66,2	94,8	90,1	70,4	97,4	92,9	75,8
2012	–	–	–	70,1	48,9	18,1	76,1	55,1	26,2	90,4	81,2	68,3	91,2	88,7	72,3	98,4	93,1	77,7
Average	–	–	–	**68,3**	**48,7**	**22,1**	**75,5**	**53,6**	**28,3**	**90,8**	**83,8**	**67,9**	**93,1**	**89,5**	**71,3**	**98,2**	**93,2**	**76,6**

HIP_{05} according to research variants (factor A) – 99,87
HIP_{05} according to research years (factor B) – 0,02

Table 5.4

Technical efficiency of preparations Actophyte, 0,25 % of emulsion concentrate and Biscaya, 24 % of oily dispersion when protecting Chinese mustard of Tavrychanka variety from rape blossom beetle in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2011-2012

Years of researches	Variants of research																	
	Control (H_2O)			Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha)			Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha)			Biscaya, 24 % of oily dispersion (0,25 L./ha)			Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha)+ Biscaya, 24 % of oily dispersion (0,25 L./ha)			Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha) + Biscaya, 24 % of oily dispersion (0,25 L./ha)		
	Technical efficiency (%) in 3, 7 and 14 days after spraying																	
	3	7	14	3	7	14	3	7	14	3	7	14	3	7	14	3	7	14
2011	–	–	–	66,2	52,3	23,6	73,7	51,1	29,9	90,2	84,1	68,8	93,4	88,3	72,2	97,2	92,9	75,6
2012	–	–	–	67,9	51,4	25,1	74,4	52,3	27,6	91,1	85,3	65,7	93,9	87,3	70,1	98,3	92,4	71,2
Average	–	–	–	**67,1**	**51,9**	**24,4**	**74,1**	**51,7**	**28,8**	**90,7**	**84,7**	**67,3**	**93,7**	**87,8**	**71,2**	**97,8**	**92,7**	**73,4**
HIP_{05} according to research variants (factor A) – 99,95 HIP_{05} according to research years (factor B) – 0,01																		

Table 5.5

Technical efficiency of preparations Actophyte, 0,25 % of emulsion concentrate and Biscaya, 24 % of oily dispersion when protecting spring rape of Ataman variety from rape blossom beetle in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2011-2012

Years of researches	Variants of research																	
	Control (H_2O)			Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha)			Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha)			Biscaya, 24 % of oily dispersion (0,25 L./ha)			Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha)+ Biscaya, 24 % of oily dispersion (0,25 L./ha)			Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha) + Biscaya, 24 % of oily dispersion (0,25 L./ha)		
	Technical efficiency (%) in 3, 7 and 14 days after spraying																	
	3	7	14	3	7	14	3	7	14	3	7	14	3	7	14	3	7	14
2011	–	–	–	68,8	50,3	19,1	75,3	49,7	25,4	90,3	83,2	69,9	94,7	87,9	70,7	98,3	93,4	76,9
2012	–	–	–	69,3	52,8	18,2	76,2	53,1	26,7	91,4	84,9	66,4	93,1	88,2	68,6	96,9	91,3	75,4
Average	–	–	–	**69,1**	**51,6**	**18,7**	**75,8**	**51,4**	**26,1**	**90,9**	**84,1**	**68,2**	**93,9**	**88,1**	**69,7**	**97,6**	**92,4**	**76,2**

HIP_{05} according to research variants (factor A) – 99,95
HIP_{05} according to research years (factor B) – 0,01

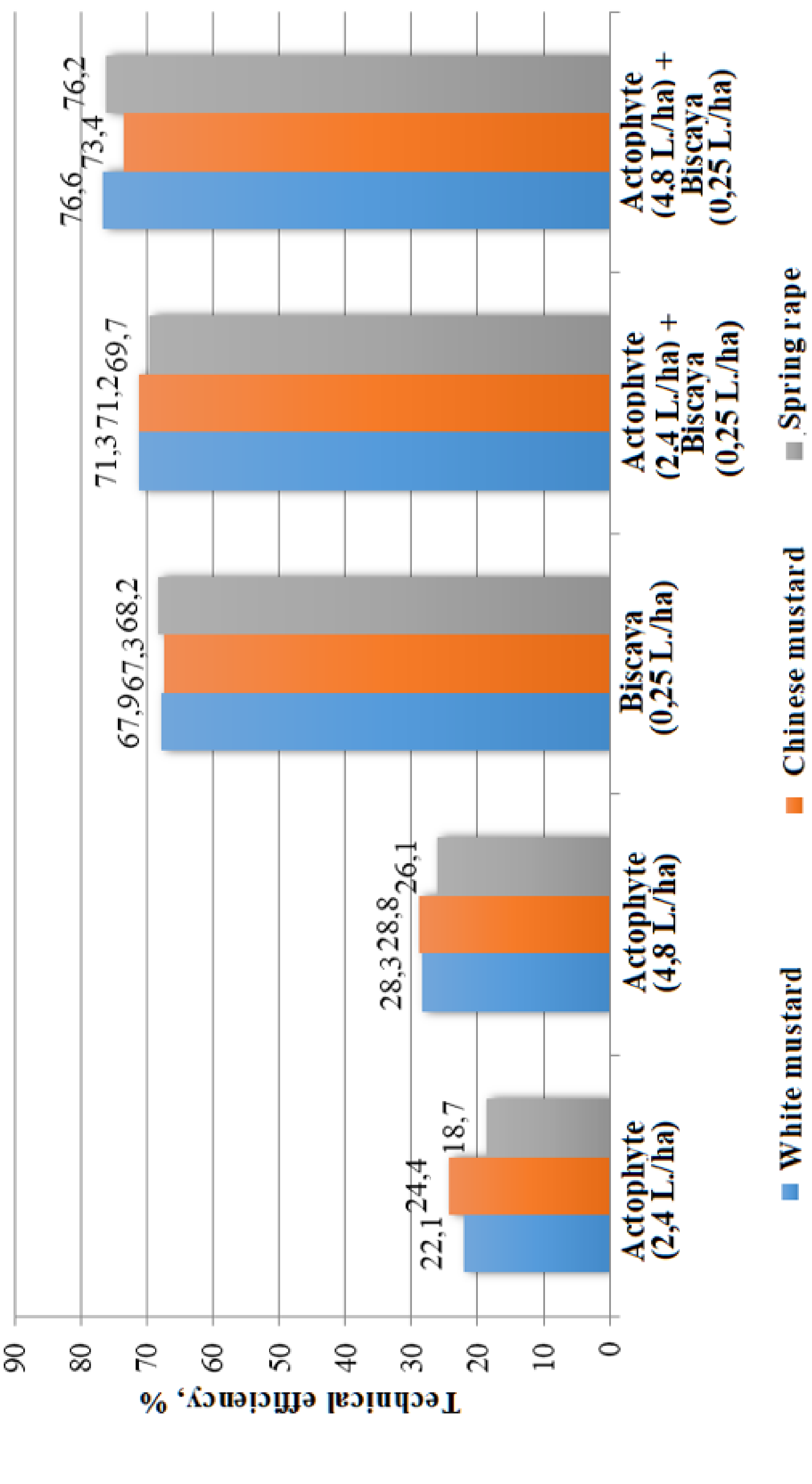


Figure 5.8. Technical efficiency of preparations Actophyte, 0,25% of emulsion concentrate and Biscaya, 24% of oily dispersion in 14 days after spraying spring rape and mustard against rape blossom beetle in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2010–2012

Table 5.6

Economic efficiency of preparations Actophyte, 0,25 % of emulsion concentrate and Biscaya, 24 % of oily dispersion when protecting white mustard of Carolina variety from rape blossom beetle in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2010-2012

Years of researches	Variants of research											
	Control (H2O)		Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha)		Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha)		Biscaya, 24 % of oily dispersion (0,25 L./ha)		Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha)+ Biscaya, 24 % of oily dispersion (0,25 L./ha)		Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha) + Biscaya, 24 % of oily dispersion (0,25 L./ha)	
	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved. t./ha	Yield capacity t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved, t./ha
2010	0,521	–	0,734	0,213	0,759	0,248	1,078	0,557	1,161	0,64	1,213	0,692
2011	0,273	–	0,406	0,133	0,454	0,181	0,532	0,259	0,621	0,348	0,672	0,399
2012	0,103	–	0,146	0,043	0,169	0,066	0,21	0,107	0,282	0,179	0,305	0,202
Average	**0,299**	–	**0,429**	**0,13**	**0,461**	**0,162**	**0,607**	**0,308**	**0,688**	**0,389**	**0,73**	**0,431**

HIP_{05} according to research variants (factor A) – 0,19
HIP_{05} according to research years (factor B) – 0,13

Table 5.7

Economic efficiency of preparations Actophyte, 0,25% of emulsion concentrate and Biscaya, 24% of oily dispersion when protecting Chinese mustard of Tavrychanka variety from rape blossom beetle in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2011-2012

Years of researches	Variants of research											
	Control (H2O)		Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha)		Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha)		Biscaya, 24 % of oily dispersion (0,25 L./ha)		Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha) + Biscaya, 24 % of oily dispersion (0,25 L./ha)		Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha) + Biscaya, 24 % of oily dispersion (0,25 L./ha)	
	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved. t./ha	Yield capacity t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved, t./ha
2011	0,302	–	0,465	0,163	0,471	0,169	0,492	0,19	0,569	0,267	0,655	0,353
2012	0,096	–	0,135	0,39	0,148	0,052	0,214	0,118	0,237	0,141	0,273	0,177
Average	**0,199**	–	**0,3**	**0,101**	**0,31**	**0,111**	**0,353**	**0,154**	**0,403**	**0,204**	**0,464**	**0,265**
HIP_{05} according to research variants (factor A) – 0,11 HIP_{05} according to research years (factor B) – 0,06												

Table 5.8.

Economic efficiency of preparations Actophyte, 0,25 % of emulsion concentrate and Biscaya, 24 % of oily dispersion when protecting spring rape of Ataman variety from rape blossom beetle in phenophase of a yellow bud at Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2011-2012

Years of researches	Variants of research											
	Control (H_2O)		Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha)		Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha)		Biscaya, 24 % of oily dispersion (0,25 L./ha)		Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha) + Biscaya, 24 % of oily dispersion (0,25 L./ha)		Actophyte, 0,25 % of emulsion concentrate (4,8 L./ha) + Biscaya, 24 % of oily dispersion (0,25 L./ha)	
	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved. t./ha	Yield capacity t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved, t./ha	Yield capacity, t./ha	Yield saved. t./ha	Yield capacity t./ha	Yield saved, t./ha
2011	0,167	–	0,289	0,122	0,314	0,147	0,397	0,23	0,468	0,301	0,522	0,355
2012	0,085	–	0,132	0,047	0,144	0,059	0,202	0,117	0,252	0,167	0,284	0,199
Average	**0,126**	–	**0,21**	**0,084**	**0,229**	**0,103**	**0,3**	**0,174**	**0,36**	**0,234**	**0,403**	**0,277**
HIP_{05} according to research variants (factor A) – 0,10												

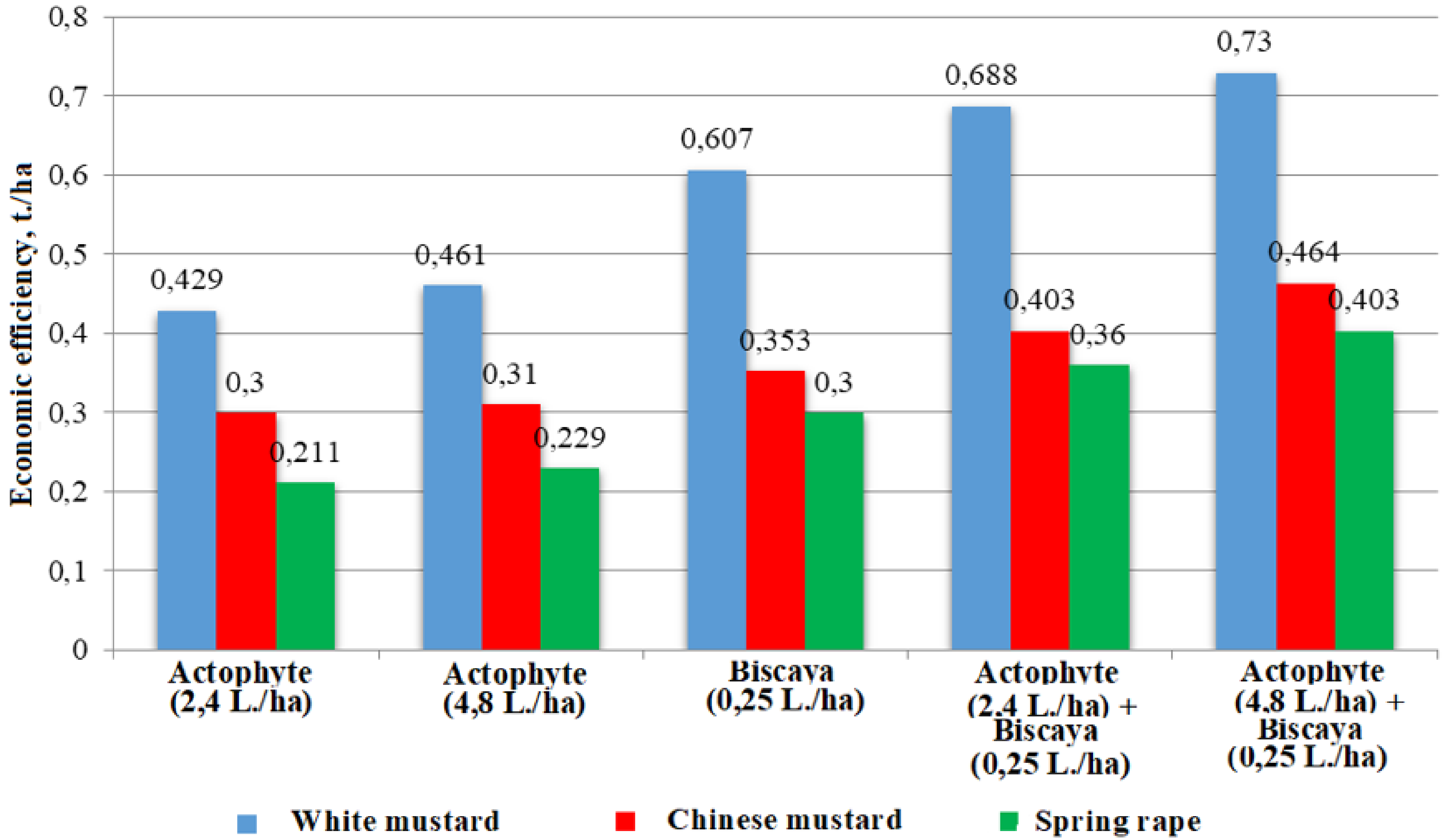


Figure 5.9. Economic efficiency of preparations Actophyte, 0,25 % of emulsion concentrate and Biscaya, 24 % of oily dispersion when protecting mustard and spring rape from rape blossom beetle in phenophase of a yellow bud under the conditions of Educational, Research and Production Centre "Research Field" of Kharkiv V.V. Dokuchaiev National Agrarian University in 2010-2012

After harvesting, cleaning and analysing the crops of spring rape and mustard we obtained the following data (Tables 5.6, 5.7 and 5.8; Figure 5.9) as for the economic efficiency of the used preparations and their mixtures. As it is seen from the data given in Tables 5.6, 5.7 and 5.8 in all variants of the experiment the increase in the yield capacity was noted, however the binary mixture of the microbiological preparation Actophyte, 0,25 % of emulsion concentrate (4,8 L//ha) and systemic insecticide Biscaya, 24 % of oily dispersion (0,25 L./ha) was the best one.

The increase in the yield capacity of white mustard accounted to 0,431 t./ha, the growth increase in Chinese mustard was 0,265 t./ha and spring rape gave the increase of 0,277 t./ha. The increase in the yield capacity when applying the binary mixture of the microbiological preparation Actophyte, 0,25 % of emulsion concentrate (2,4 L./ha) and systemic insecticide Biscaya, 24 % of oily dispersion (0,25 L./ha) was slightly lower. The increase in the yield capacity of white mustard was 0,389 t./ha, the increase in Chinese mustard was 0,204 t./ha, and spring rape gave the increase of 0,234 t./ha. The application of the systemic insecticide Biscaya, 24 % of oily dispersion at the rate of consumption of 0,25 L./ha provided the saved yield of white mustard at the level of 0,308 t./ha, the yield of Chinese mustard was saved at the level of 0,154 t./ha, and the yield of spring rape was saved at the level of 0,174 t./ha.The variants when applying the microbiological preparation Actophyte, 0,25 % of emulsion concentrate at the consumption rate of 2,4 and 4,8 L./ha were the least effective ones. When applying the microbiological preparation Actophyte, 0,25 % of emulsion concentrate at the consumption rate of 2,4 L./ha the increase in the yield capacity of white mustard was 0,130 t./ha on the average, the increase in the yield of Chinese mustard was 0,101 t./ha and spring rape gave the increase of 0,084 t./ha. At the consumption rate of 4,8 L./ha the saved yield of white mustard was 0,162 t./ha, the saved yield of Chinese mustard at the level of 0,111 t./ha and the saved yield of spring rape was at the level of 0,103 t./ha.

At the end of the third decade of June spring rape is in the phenophase of the pods formation and the rape blossom beetles are beginning to leave the fields but the larvae of the rape blossom beetle are still finishing feeding on the rape crops. Since there are no more flowers on the rape crops the larvae feed on the young pods and the seeds that are forming in the pods. As a result the undeveloped pods of the ugly shape are forming and the seeds are damaged by the gnawing mouths of the larvae (Figure 5.10).

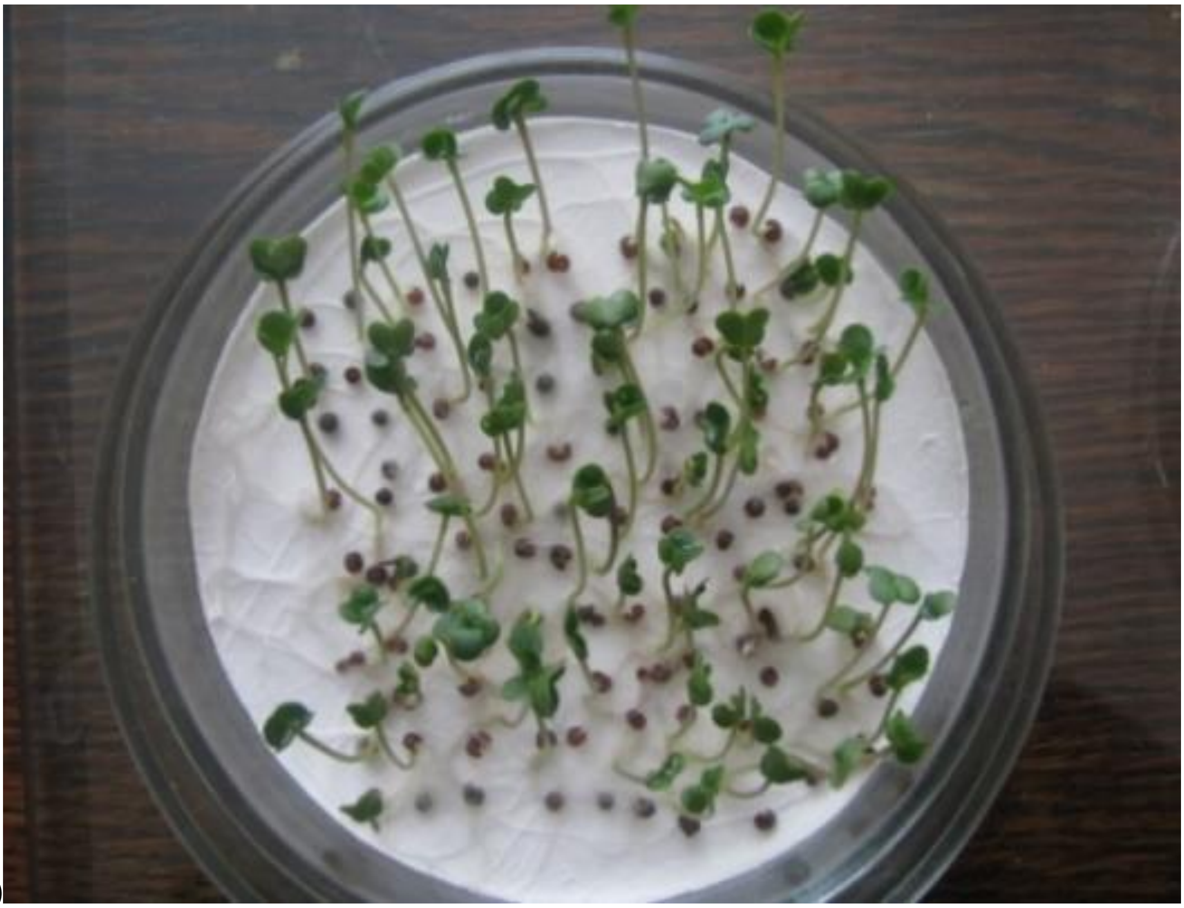
In 2012 after harvesting the crops of spring rape we cleaned and thoroughly analysed them and selected the seeds of spring rapes gnawed by the larvae of the rape blossom beetle as well as the healthy seeds without any signs of damage. Under the laboratory conditions a weight of 1000 both undamaged and damaged seeds and the filling, that is a number of seeds per unit of volume, were determined (Table 5.9).

From the data given in Table 5.9 it is seen that the weight of 1000 healthy seeds is 2,6996 g., and the weight of the damaged ones is 0,4213 g. So the weight of 1000 seeds damaged by the gnawing mouth of the larvae is less by 84,4 % in comparison with the undamaged seeds; and the filling of the damaged seeds is 6,8 times more, which indicates their smaller size and frailness.

A)

B)

Figure 5.10. Spring rape seeds, undamaged (A) and damaged by the larvae of rape blossom beetle (B) (photo by the author)

A) 

B) 

Figure 5.11. Spring rape seedlings obtained at the laboratory on the 8th day from undammed seeds (A, B) (photo by the author)

A) 

B) 

Figure 5.12. Spring rape seedlings obtained at the laboratory on the 8th day from seeds damaged by the larvae of rape blossom beetle (A, B) (photo by the author)

At the laboratory of the Seed Quality of the V.Ya. Yuryev Institute Plant Growing of the National Academy of Agrarian Sciences of Ukraine the biochemical analysis of the undamaged seeds of spring rape and the seeds damaged by the larvae of the rape blossom beetle was carried out. The mass fraction of fat was determined according to the method of Rushkovskyi and the protein content in the seeds was determined by the Kjeldahl method.

Table 5.9

Influence of spring rape seeds of Ataman variety damaged by larvae of rape blossom beetle on quantitative and qualitative indices

Variants of research (seed fractions)	Weight of 1000 seeds		Filling		Fat content		Protein content	
	g.	in % to undamaged	pieces/ cm^3	in ratio to undamaged	%	in ratio to undamaged	%	in ratio to undamaged
Undamaged	2,6996	100,0	220	100,0	35,92	–	30,97	–
Damaged	0,4213	15,6	1500	681,8	17,48	- 18,44	32,23	+ 1,26
HIP_{05}	0,27		153,92		5,46		9,91	

From the data given in Table 5.9 it is seen that the undamaged seeds of spring rape contain 35,92 % of fat, and the damaged seeds contain only 17,48 % of fat, that is 2,05 times less. The protein content in the undammed seeds was 30.97 % and in the damaged ones it was 32,23 %, that is 1,04 times more. The data of biochemical analysis indicate that the larvae of the rape blossom beetle first of all gnaw out those parts of the seeds that contain the fat substances.

As a result of the germination of spring rape seeds under the laboratory conditions the influence of the seeds damaged by the larvae of the rape blossom beetle on the laboratory germination was established (Table 5.10).

From the data given in Table 5.10 it is seen that on the first day after sowing no germination was observed in any variant. On the second day the germination rate of the undamaged seeds was 6,3 % and that of the damaged seeds was 0; on the third day the germination rate of the undamaged spring rape seeds was 74,2 % vs. 15,8 % in the variant with the damaged seeds. The seed germination on the fourth day after sowing was 8,0 % for the undamaged seeds and 33,3 % for the damaged ones. On the fifth day after sowing the germination rate of the undamaged seeds was 87,3 % and that of the damaged ones was 47,0%. On the sixth day after sowing the germination rate of the undamaged seeds was 89,3 % vs. 54,3 % of the damaged ones. On the seventh day after sowing the laboratory germination of the undamaged spring rape seeds was 90,0 % vs. 56,7 % of the damaged ones. The final germination of spring rape seeds under the laboratory conditions was recorded on the eighth day because no new germinated seeds were observed. For the undamaged spring rape seeds it was 90,0 % and for the damaged seeds it was 58,0 %, that is by 32,0 % lower (Figure 5.11).

Table 5.10

Influence of spring rape seeds of Ataman variety damaged by the larvae of rape blossom beetle on the laboratory germination

Variants of research (day)	Seed germination, %		
	undamaged	damaged	in ratio to undamaged
first	0	0	-
second	6,3	0	- 6,3
third	74,2	15,8	- 58,4
fourth	86,0	33,3	- 52,7
fifth	87,3	47,0	- 40,3
sixth	89,3	54,3	- 35,6
seventh	90,0	56,7	- 33,3
eighth	90,0	58,0	- 32,0
HIP_{05}	17,02		

Figure 5.11 shows that when germinating the spring rape seeds under the laboratory conditions the seedlings obtained from the undamaged seeds are much more developed, have a healthy dark green colour; and the seedlings obtained from the damaged seeds are weak, have a thin stem and the cotyledons of light greenish colour.

Conclusions

1. In the Eastern Forest-Steppe of Ukraine the first individuals of the rape blossom beetle appear on the flowering wild growing plants (first of all on dandelion and buttercup) when the average daily temperature exceeds 8 °C, it is the middle of the first decade of April and the beginning of the third decade of April. The mass emergence of the rape blossom beetles takes place when the daily average temperatures are at the range of 9–13 °C and the sum of the effective temperatures above 5 °C is at the range of 100–113 °C, it is the middle of the second decade of April and the end of the third decade of April. The females of the rape blossom beetle usually lay 2–3 eggs into one bud of spring rape or mustard.

2. When protecting the crops from the rape blossom beetle the highest technical efficiency was noted when applying the binary mixture of the microbiological preparation Actophyte, 0.25 % of emulsion concentrate in the dose of 4,8 L./ha and systemic insecticide Biscaya, 24 % of oily dispersion (0,25 L./ha) and in 14 days after spraying it was 76,6 % on white mustard, 74,3% on Chinese mustard and 76,2% on spring rape. The highest growth increase in the yield capacity was observed in the same variant; for white mustard it was 0,431 t./ha, for Chinese mustard it was 0,265 t./ha and for spring rape the growth increase amounted to 0,277 t./ha.

3. It is established that the weight of 1000 healthy seeds is 2,6996 g., and the weight of seeds damaged by the larvae of the rape blossom beetle is 0,4213 g., so it is reduced by 84,4 %. The filling of the damaged seeds is 6,8 times higher, which indicates that they are smaller in diameter and frail. The undamaged seeds of spring rape contain 35,92 % of fat, and the damaged seeds contain only 17,48 %, which is 2,05 times less. The protein content in the undamaged seeds was 30,97 % and in the damaged ones it was 32,23 %, that is 1,04 times more. The germination rate of the undamaged seeds of spring rape under the laboratory conditions on the eighth day was 90,0 %, and the germination rate of the damaged ones amounted to 58,0 % and was lower by 32,0 %.

REFERENCES

1. Abramik M.I., Gajdash V.D., Gurinovich S.J.et al. (2003). Ripak yarij, Ivano–Frankivsk, 82. (in Ukrainian).

2. Ammosov Yu.N., Bagachanova A.K. & Vinokurov N.N et al. (1980). Nasekomye – vrediteli kapusty belokachannoj v Centralnoj Yakutiiyu Yakutsk, Yakutskoe kn-e uzd-vo, 110. (in Russian).

3. Ancupova T.E. (1984). Osnovnye vrediteli yarovogo rapsa v Centralnoj zone Krasnodarskogo kraya. Tez. dokl. IH sezda vsesoyuz. entomol. o-va. Kiev, Naukova dumka, 27–28. (in Russian).

4. Andersen A. Kjos Ø. & Nordhus E. et al. (2008). Resistens mot pyretroider hos rapsglansbille – hva nå? Plantemotet, 3 (1), 94–95.

5. Bardin Ya.P. (2000). Ripak: vid sivbi – do pererobki, Bila Cerkva, Svit, 107. (in Ukrainian).

6. Beleckij E.N. & Stankevich S.V. (2018). Policiklichnost', sinhronnost' i nelinejnost' populjacionnoj dinamiki nasekomyh i problemy prognozirovanija, Vienna, Premier Publishing s.r.o. Vienna, 138. (in Russian).

7. Beleckij E.N., Stankevich S.V. & Nemerickaja L.V. (2017). Sovremennye predstavlenija o dinamike populjacij nasekomyh: proshloe, nastojashhee, budushhee. Sinergeticheskij podhod. Vesti HNAU im. V. V. Dokuchaeva. Ser. «Fitopatologija i jentomologija», vv. 1–2, 22–33. (in Russian).

8. Bogdanov-Katkov N.N. (1920). Ogorodnye blohi ili bloshki. Petrograd, Pyataya gosudarstvennaya tipografiya, 21. (in Russian).

9. Buch W. (1998). Tierische Schädlinge und ihre Antagonisten in Rapskulturen – Arbeiten zu Biologie, Epidemiplogie, natürlicher Regulation und chemischer Bekämpfung in Der 100-jährigen Geschichte der Biologiscen Bundesanstalt für Landß und Forstwirschaft. Mitt. Biol. Bundesanst. Landß und Forstwirt. Berlin. ß Dahnev., 340, 86–106.

10. Burda Yu. N. (1970). Osnovnye vrediteli kapusty i tomatov v Samarkandskoj oblasti: avtoref. dis. kand. biol. nauk. Dushanbe, 24. (in Russian).

11. Carrel K., Schmid J. E. & Stamp P. (1995). Bedeutung gentechnisch veränderter Krankheits- und schädlingsresistenter Kulturpflanzen für Pflanzenbau und Pflanzenzüchtung. Zürich, Institut für Pflanzenwissenschaften Bereich Ackerbau, 95.

12. Chajka V.M. & Polishuk A.A. (2010). Na posivah ozimogo ripaku. Efektivnist riznih metodiv obliku chiselnosti dlya monitoringu entomofauni. Karantin i zahist roslin, № 3, 5–7. (in Ukrainian).

13. Chernij A.M. (2011). Olenka volohata. Karantin i zahist roslin, 6, 5. (in Ukrainian).

14. Chervonenko M. G., Tereshenko N. M. & Ishenko I. V. (2003). Shkidniki hrestocvitih kultur. Zahist roslin, 9, 19. (in Ukrainian).

15. Cinitis R.Ya. (1972). Biologicheskie i agrotehnicheskie meropriyatiya po borbe s vreditelyami kapusty v Latvijskoj SSR. Biologicheskie metody borby s vreditelyami ovoshnyh kultur. Moskva, Kolos, 59–64. (in Russian).

16. Cybulko V.I. (1975). Integrirovannaya borba s listogryzushimi vreditelyami kapusty v usloviyah Harkovskoj oblast. Zashita selskohozyajstvennyh kultur ot vreditelej, boleznej i sornyakov: tr, 208, 61–71. (in Russian).

17. Derzhavnij reyestr sortiv roslin pridatnih dlya poshirennya v Ukrayini na 2018 r. (2018), 447. (in Ukrainian).

18. Dobrovolskij B.V. (1959). Rasprostranenie vrednyh nasekomyh. Ochagi i zony naibolshej vredonosnosti. Moskva, Sov. nauka, 215. (in Russian).

19. Dospehov B.A. Metodika polevogo opyta (s osnovami statisticheskoj obrabotki rezultatov issledovanij). Mlskva: Kolos, 1985. 416 (in Russian).

20. Evtushenko N.D. & Stankevich S.V. (2012). Sezonnaya dinamika chislennosti rapsovogo cvetoeda, Meligethes aeneus (F., 1775) (Coleoptera: Nitidulidae) na yarovom rapse i gorchice v Harkovskom rajone Izvestiya Harkovskogo entomologicheskogo obshestva, T. XX. Vyp. 2, 65–68. (in Russian).

21. Fasulati K.K. (1971). Polevoe izuchenie nazemnih bespoz-vonochnyh, Moskva, 421. (in Russian).

22. Fedorenko V.P. & Lugovskij K.P. (2011). Kontrol hrestocvitih blishok u posivah ozimogo ta yarogo ripaku. Karantin i zahist roslin, № 10, 7–9. (in Ukrainian).

23. Fedorenko V.P., Sekun N.P. & Markov I.L. i dr. (2008). Zashita rapsa. Zashita i karantin rastenij, 3, 69–93. (in Russian).

24. Gajdash V.D. (1998). Ripak, Ivano–Frankivsk, Siversiya LTD, 224. (in Ukrainian).

25. Gavrilyuk M.M., Chehov V.A. & Fedorchuk M.I. (2008). Olijni kulturi v Ukrayini, Kiyiv, Osnova, 420. (in Ukrainian).

26. Gordyeyeva O.F. (2003). Dinamika chiselnosti hrestocvitih blishok (Phyllotreta spp.) na posivah yarogo ripaku v umovah livoberezhnogo Lisostepu Ukrayini. Visnik Polt. derzh. agrar. Akad, 8, 35–38. (in Ukrainian).

27. Gorodnij M. G. (1970). Olijni ta efiroolijni kulturi. Kiyiv, Urozhaj, 276.

28. Gortlevskij A.A. & Makeeva V.A. (1983). Ozimyj raps. Moskva, Rosselhozizdat, 135. (in Russian).

29. Gurova Z.I. (1963). Vrediteli semennikov ovoshnyh kresto-cvetnyh kultur rajona vostochnoj chasti Lesostepi Ukrainy i mery borby s nimi: avtoref. dis. kand. biol. nauk. Harkov, 24.

30. Gusyev M.G., Kokovihin S.V. & Pelih I.Ya. (2011). Ripak – perspektivna kormova j olijna kultura na pivdni Ukrayini, Vinnicya, FOP Rogalska I. O., 208. (in Ukrainian).

31. Hoffman G.M. & Schmutterer H. (1983). Parasitäre Krankheiten und Schädlinge an landirtschaftlichen Kulturpflancen. Stuttgart, Verlag Eugen Ulmer, 488.

32. Ivancova E.A. (2010). Vrediteli gorchicy i rapsa. Pole deyatelnost, 2010, 6, 8–11. (in Russian).

33. Johnen A. (2006). Der Rapserdfloh ist wieder ein Thema! Raps, 1, 10–15.

34. Johnen A. (2006). Schedlingskontrolle im Raps. Bekämpf-ungsstrategien und Entscheidungshifiten Raps, 18–23.

35. Kanter L.A., Imyhelova C.D. C. & Sanzhimitupova R.D. (1980). Vrediteli kapusty Zapadnogo Zabajkalya. Fauna i ekologiya nasekomyh Zabajkalya sb.st. Ulan-Ude, BF SO AN SSSR, 4–17. (in Russian).

36. Kava L. & Stankevich S. (2013). Shkidniki ripaku gotuyutsya do novogo sezonu. Propoziciya, 3 (218), 120–122. (in Ukrainian).

37. Knoll D. (1997). Pflanzenschutz im Raps Erfahrungen und Empfehlungen aus schleswig-holstcinischer Sicht. Raps, 36–38.

38. Kolesnik L.I. (2007). Osnovni shkidniki kapusti bilogolovoyi u shidnomu lisostepu Ukrayini. Ekologiya i prognoz rozvitku: avtoref. dis. kand. biol. nauk. Harkiv, 20. (in Ukrainian).

39. Kost E.A. (1975). Spravochnik po klinicheskim laboratornym metodam issledovaniya. Moskva, Medicina, 360. (in Russian).

40. Kostromitin V.B. (1980). Krestocvetnye bloshki. Moskva, Kolos, 62. (in Russian).

41. Kovalchuk G.M. (1987). Ripak ozimij – cinna olijna i kormova kultura. Kiyiv, Urozhaj, 112.

42. Kozhanchikov I.V. (1929). K biologii Meligethus aeneus Fabr. Zashita rastenij ot vreditelej. Byull. Byuro Vserossijskih entomo-fitopatologicheskih sezdovov. Leningrad, Izd-vo zashita rastenij ot vreditelej, 560–562.

43. Kozhanchikov I.V. (1955). Osobennosti i prichiny geografi-cheskogo rasprostraneniya vrednyh nasekomyh. Sb. rabot In-ta prikl. zoologii i fitopatologii. Leningrad, ZIN AN SSSR, 3, 3–15. (in Russian).

44. Krasilovec Yu.G. (2010). Naukovi osnovi fitosanitarnoyi bezpeki polovih kultur. Harkiv, Magda LTD, 416. (in Ukrainian).

45. Krishtal O.P. (1959). Komahi-shkidniki silskogospodarskih roslin v umovah Lisostepu ta Polissya Ukrayini. Kiyiv, Vidavnictvo Kiyivskogo universitetu, 358. (in Ukrainian).

46. Krut M. (2003). Kompleksnij zahist ripaku vid shkidnikiv. Propoziciya, 10, 70–71. (in Ukrainian).

47. Krut M. (2011). Na ozimomu ta yaromu ripaku meshkaye blizko 50 vidiv shkidnikiv. Zerno i hlib, 3, 60–61. (in Ukrainian).

48. Kuznecova R.Ya. (1975). Raps – vysokourozhajnaya kultura, Leningrad, Kolos, 84. (in Russian).

49. Laba Yu.R. (2012). Obgruntuvannya zahistu ripaku vid shkidnikiv u Centralnomu Lisostepu Ukrayini: avtoref. dis. kand. s.-g. nauk. Kiyiv, 20. (in Ukrainian).

50. Laba Yu.R. (2009). Shkidniki ripaku. Vidovij sklad v umovah centralnogo ta zahidnogo Lisostepu Ukrayini. Nasinnictvo, 2, 11–13. (in Ukrainian).

51. Lhagva Zh. (1971). Osnovnye vrediteli kapusty v usloviyah Lesostepnoj zony MNR i sistema meropriyatij po borbe s nimi: avtoref. dis. kand. s.-h. nauk. Leningrad-Pushkin, 21. (in Russian).

52. Maksimov N.P. (1990). Zagotovka i hranenie semyan maslichnyh kultur. Kiev, Urozhaj, 200. (in Russian).

53. Marczali Z. (2006). A termesztett keresztesvirágú növényeken élő Meligethes és Ceutorhynchus fajok elterjedése és ökológiája | Distribution and ecology of Melighetes and Ceutorhynchus species on cultivated cruciferous plants. PhD thesis, Veszprémi Egyetem, 129.

54. Megalov V.A. (1968). Vyyavlenie vredietlej polevyh kultur, Moskva, Kolos, 176. (in Russian).

55. Metodika uchyota i prognoza razvitiya vredietelej i boleznej polevyh kultur v Centralno–Chernozyomnoj polose. Izd. 2–e, ispr. i dop. (1976). Voronezh, Centralno–chernozyomnoe kn. izd., 136. (in Russian).

56. Minkevich I.A., Borisovskij V.E. (1949). Maslichnye kultury. Moskva, Selhozgiz, 200. (in Russian).

57. Moskalyova A. A. (1985). Vidovoj sostav vreditelej rapsa, mery borby s nimi (Leningradskaya oblast). Integrirovannaya zashita rastenij ot vreditelej i boleznej: sb. nauch. tr. Leningrad, LSHI, 24–26. (in Russian).

58. Mrówczyński M. & Pruszyński S. (2007). Metodyka integrowanej produkcji rzepaku ozimego i jarego. Warszawa, 96.

59. Mrowczynski M. & Wachowiak H. (1999). Ochorona rzepaku ozimego pized szkodnikami w Polsce i w innich krajach Europy. Post. Ochr. Rosl, 39, 2, 917–922.

60. Mrówczyński M. (1992). Uszkadzanie typów i odmian rzepaku ozimego przez szkodniki. Część III. Szkodniki kwiatostanów i łuszczyn. Prace Nauk. Inst. Ochr. Roślin, 34 (1/2), 45–62.

61. Mrówczyński M. (2003). Studium nad doskonaleniem ochrony rzepaku ozimego przed szkodnikami. Rozpr. Nauk. Inst. Ochr. Roślin, 10, 61.

62. Mrówczyński M., Praczyk T. & Wachowiak H. et al. (2006). Integrovaná ochrana řepky před škůdci, chorobami a plevely v Polsku. Sborník konference s mezinárodní účastí «Řepka, mák, hořčice 2006». Praha, 103–116.

63. Mrówczyński M., Pruszyński G. & Wachowiak H. (2007). Nowe zagrożenia upraw rolniczych przez szkodniki ze szczególnym uwzględnieniem kukurydzy. Progress in Plant Protection / Postępy w Ochronie Roślin, 47 (1), 323–330.

64. Nacionalnij standart Ukrayini (2003). Nasinnya silsko-gospodarskih kultur. Metodi viznachennya yakosti: DSTU 4138–2002. Kiyiv, Derzhspozhivstandart Ukrayini, 173. (in Ukrainian).

65. Nikiforov A.M. & Bezdenko T.G. (1951). Metodicheskie ukazaniya po vyyavleniyu vreditelej i boleznej selskohozyajstvennyh rastenij, Minsk, Izd. AN BSSR, 96. (in Russian).

66. O vrednyh nasekomyh (1845). Izdano uchyonym komitetom ministerstva gosudarstvennyh imushestv. Sankt-Peterburg, Tipografiya Ministerstva Gosimushestv, 278.

67. Omelyuta V.P. ta in. (1986). Oblik shkidnikiv i hvorob silskogospodarskih kultur, Kiyiv, Urozhaj, 274. (in Ukrainian).
68. Orobchenko V.P. (1959). Raps ozimyj, Moskva, Selhozgiz, 160. (in Russian).
69. Osipov V.G. (1986). Mery borby s krestocvetnymi bloshkami na kormovih krestocvetnyh kultura. Zashita rastenij: sb. nauch. tr. Minsk, Uradzhaj, III, 17–22. (in Russian).
70. Osmolovskij G.E. (1972). Vrediteli kapusty. Leningrad, Kolos, 79.
71. Ovchinnikova L.M. (1971). Glavnejshie vrediteli krestocvetnyh semennikov i opredelenie koefficienta ih vrednosti. Konf. po biocenologii i metodam uchyota chislennosti vreditelej s/h kultur i lesa: tezisy dokladov. Leningrad, Nauka, 23–25. (in Russian).
72. Ovchinnikova L.M. & Voskresenskaya V.N. (1972). Rol mestnyh entomofagov v kompleksnoj zashite krestocvetnyh semennikov ot vreditelej. Biologicheskie metody borby s vreditelyami ovoshnyh kultur. Moskva, Kolos, 85–98. (in Russian).
73. Palij V.F.(1962). Rasprostranenie, ekologiya i biologiya zemlyanyh bloshek fauny SSSR, Frunze, Izd–vo AN Kirgiz. SSR, 118. (in Russian).
74. Palij V.F. & Avanesova G.A. (1975). Zemlyanye bloshki Coleoptera, Chrysomelidae, Halticinae: opredelitel rodov i vrednyh vidov, Tashkent, Fan, 111. (in Russian).
75. Prushinski S., Palosh T. & Mruvchinski M. (1995). Integrirovannaya zashita ozimogo rapsa v Polshe. Zashita rastenij, 6, 16–17. (in Russian).
76. Puchkov V.G. (1961). Fauna Ukrayini. Shitniki. Vip. 1. T. 21. Kiyiv, Vid-vo AN URSR, 1961. 338. (in Ukrainian).
77. Pyatakova V.D. (1928). Ogorodnye bloshaki, Mleev, 75. (in Russian).
78. Rekomendacii po obsledovaniyu selskohozyajstvennyh ugodij na zaselyonnost vreditelyami i zaselyonnost boleznyami (1975). Kiev, Urozhaj, 60. (in Russian).
79. Rozova L.V. (2011). Olenka volohata (*Epicometis hirta* Poda.) v nasadzhennyah plodovih kultur. Karantin i zahist roslin. 8, 12–13 (in Ukrainian).
80. Saharov N.L. (1934). Vrediteli gorchicy i borba s nimi, Saratov, Saratovskoe kraevoe gos. izd–vo, 120. (in Russian).

81. Sekun M.P. (2009). Zahist posiviv yarogo ripaku vid shkidnikiv. Agronom, 2, 80–84. (in Ukrainian).

82. Sekun M.P., Lapa O.M. & Markov L.I. (2008). Tehnologiya viroshuvannya i zahistu ripaku, Kiyiv, Globus–Print 116. (in Ukrainian).

83. Semakov V.V. (1966). Vrediteli krestocvetnyh kultur Kamchatki i borba s nimi. Petropavlovsk-Kamchatskij, Dalnevost-e kn-e izd-vo, 38. (in Russian).

84. Shpaar D. (2007). Chrezvychajnaya situaciya s rapsovym cvetoedom v Evrope. Zashita i karantin rastenij, 12, 26–27. (in Russian).

85. Shpaar D. i dr. (2007). Raps i surepica (Vyrashivanie, uborka, ispolzovanie), Moskva, DLV Agrodelo, 320. (in Russian).

86. Stankevich S. (2015). Shkidniki hrestocvitih. The Ukrainian Farmer, 5 (65), 74−75. (in Ukrainian).

87. Stankevich S.V. & Kava L.P. (2013). Shkidniki ripakiv ozimogo i yarogo u Shidnomu ta Centralnomu Lisostepu Ukrayini. Visnik HNAU im. V. V. Dokuchayeva. Seriya "Fitopatologiya ta entomologiya", 10, 163–168. (in Ukrainian).

88. Stankevich S.V. & Kava L.P. (2015). Zalezhnist urozhajnosti ripaka yarogo vid poshkodzhenosti shodiv zhukami hrestocvitih blishok. Naukovi dopovidi NUBiP Ukrayini, № 8 (57). Rezhim dostupu: http://nd.nubip.edu.ua/2015_8/20.pdf (in Ukrainian).

89. Stankevich S.V. & Vilna V.V. (2012). Vidovij sklad kompleksu hrestocvitih klopiv v umovah Harkivskogo rajonu. Dinamika bioriznomanittya. Lugansk, LNU im. T. G. Shevchenka, 110. (in Ukrainian).

90. Stankevich S., Yevtushenko M., Krasilovec Yu. ta in. (2014). Zahist shodiv ripaku yarogo vid hrestocvitih blishok. Visnik SNAU. Ser. "Agronomiya i biologiya", Vip. 9 (28), 161–165. (in Ukrainian).

91. Stankevich S.V. & Zabrodina I.V. (2016). Ekonomichni porogi shkidlivosti osnovnih shkidnikiv silskogospodarskih kultur, Harkiv, HNAU, 24. (in Ukrainian).

92. Stankevich S.V. & Zabrodina I.V. (2016). Monitoring shkidnikiv silskogospodarskih kultur, Harkiv, FOP Brovin O.V., 216. (in Ukrainian).

93. Stankevich S.V. (2012). Rasteniya-rezervatory vreditelej maslichnyh krestocvetnyh kultur. Byuleten nauchnyh rabot BelSHA, 32, 22–32. (in Russian).

94. Stankevich S.V. (2012). Zastosuvannya mikrobiopreparatu aktofit v poyednanni z insekticidom biskajya proti ripakovogo kvitkoyidu u fenofazu zhovtogo butonu. Visnik HNAU im. V. V. Dokuchayeva. Ser. "Fitopatologiya ta entomologiya", 12, 115–122. (in Ukrainian).

95. Stankevich S.V. (2014). Yakisni pokazniki nasinnya ripaku yarogo zalezhno vid protruyuvannya ta poshkodzhennya lichinkami ripakovogo kvitkoyida. Visnik HNAU im. V. V. Dokuchayeva. Ser. "Fitopatologiya ta entomologiya", 8, 114–120. (in Ukrainian).

96. Stankevich S.V. (2015). Zmina paradigmi u zahisti olijnih kapustyanih kultur vid hrestocvitih blishok za ostanni 130 rokiv. Visnik HNAU im. V. V. Dokuchayeva. Ser. "Fitopatologiya ta entomologiya", № 1–2, 156–180. (in Ukrainian).

97. Stankevich S.V. (2015). Sezonnaya dinamika chislennosti rapsovogo cvetoeda na yarovom rapse i gorchice v vostochnoj lesostepi Ukrainy. Zashita rastenij. Sbornik nauchnyh trudov, 39, 197–203. (in Russian).

98. Stankevich S.V. (2018). Zmina paradigmi u zahisti olijnih kapustyanih kultur vid ripakovogo kvitkoyida za ostanni 140 rokiv. Visnik HNAU im. V.V. Dokuchayeva. Ser. "Fitopatologiya ta entomologiya", 1–2, 127–145. (in Ukrainian).

99. Stankevich S.V., Beleckij E.N. & Zabrodina I.V. (2019). Ciklicheski-nelinejnaya dinamika prirodnyh sistem i problemy prognozirovaniya. Vankuver, Accent Graphics Communications & Publishing. Vankuver, 232. (in Russian).

100. Stankevych S.V., Yevtushenko M.D. & Zabrodina I.V. et al. (2019). V.V. Dokuchaiev Scientific school of Kharkiv National Agrarian University and development agricultural entomology in XIX-XXI centuries. Ukrainian Journal of Ecology, 9 (2), 156–169.

101. Stankevych S.V., Yevtushenko M.D. & Zabrodina I.V. et al. (2019). V.V. Dokuchaiev Scientific school of Kharkiv National Agrarian University and development agricultural entomology in XIX-XXI centuries. Ukrainian Journal of Ecology, 9 (2), 156–169.

102. Stankevych S.V., Yevtushenko M.D. & Vilna V. V. et al. (2019). Integrated pest management of flea beetles (Phyllotreta spp.) in spring oilseed rape (*Brassica napus* L.). Ukrainian journal of ecology, №9 (3), 198–207.

103. Stankevych S.V., Yevtushenko M.D. & Vilna V.V. et al. (2019). Efficiency of chemical protection of spring rape and mustard from rape blossom beetle. Ukrainian Journal of Ecology, №9 (4), 584–598

104. Stankevych S.V., Vasylieva Yu.V. & Golovan L.V. et al. (2019). Chronicle of insect pests massive reproduction. Ukrainian Journal of Ecology, 9 (1), 262–274.

105. Stankevych S.V., Vasylieva Yu.V. & Golovan L.V. et al. (2019). Chronicle of insect pests massive reproduction. Ukrainian Journal of Ecology, 9 (1), 262–274.

106. Supihanov B.K. & Petrenko N.I. (2008). Olijni kulturi: istoriya, sorti, virobnictvo, torgivlya, Kiyiv, NNC IAE UAAN, 126. (in Ukrainian).

107. Tachvanainen J.O. & Root R.B. (1972). The influence of vegetational diversity on population ecology of a spezialized herbivore, Phyllotreta cruciferae (Coleoptera: Chrysomelidae). Oecologia, 4, 321–346.

108. Tarushkin I. (2006). Glavnye vrediteli rapsa v usloviyah Ukrainy. Himiya. Agronomiya. Servis, 21–22, 12. (in Russian).

109. Tribel S.O. ta in. (2001). Metodiki viprobuvannya i zastosuvannya pesticidiv, Kiyiv, Svit, 448. (in Ukrainian).

110. Vasilev V.P. (1989). Vrediteli selskohozyajstvennyh kultur i lesnyh nasazhdenij. T. 3. Metody i sredstva borby s vreditelyami, sistemy meropriyatij po zashite rastenij. Kiev, Urozhaj, 408. (in Russian).

111. Vasilev V.P. i dr. (1989). Vrediteli selskohozyajstvennyh kultur i lesnyh nasazhdenij. T. 3. Metody i sredstva borby s vreditelyami, sistemy meropriyatij po zashite rastenij, Kiyiv, Urozhaj, 408. (in Russian).

112. Velichko V.V. (1951). Belaya gorchica v nechernozyomnoj polose. Moskva, Selhozgiz, 1951, 72. (in Russian).

113. Vilinskiy T.V. (1974). Zasady jarrneho osetro vania repky Ozimnej. Poda Uroda, 21, 1, 16–18.

114. Vilna V.V. & Stankevich S.V. (2013). Hrestocviti klopi ta obmezhennya yih shkidlivosti u NNVC «Doslidne pole» HNAU im. V.V. Dokuchayeva. Visnik HNAU im. V.V. Dokuchayeva. Seriya "Fitopatologiya ta entomologiya", 10, 64−70. (in Ukrainian).

115. Vilna V.V. & Stankevich S.V. (2014). Hrestocviti klopi ta ripakovij kvitkoyid – osnovni shkidniki generativnih organiv olijnih kapustyanih kultur u Shidnomu Lisostepu Ukrayini. Visti Harkivskogo entomologichnogo tovaristva, XXII, 1−2, 5−11. (in Ukrainian).

116. Vilna V.V. (2013). Dinamika chiselnosti klopiv rodu Eurydema (Hemiptera: Pentatomydae) na posivah kapustyanih kultur u NNVC «Doslidne pole» HNAU im. V.V. Dokuchayeva. Visti Harkivskogo entomologichnogo tovaristva, XXI, 2, 63−66. (in Ukrainian).

117. Vilna V.V., Yevtushenko M.D. & Stankevich S.V. (2015). Rasteniya-rezervatory hrestocvetnyh klopov. Zemledelie i zashita rastenij, 1 (98), 43−45. (in Ukrainian).

118. Volker H.P. (2003). Raps. Krankheiten, Schädlinge, Schadpflanyen. Gelsenkirchen-Buer, Verlag Th. Mann, 200.

119. Walkowski T. (2002). Rzepak jary. Poznan, 67.

120. Wivstad M. (2010). Klimatforandringarna – en utmaning for jordbruket och Giftfri miljo. Uppsala: Kemikalieinspektionen, 94.

121. Yakovenko T.M. (2005). Olijni kulturi Ukrayini, Kiyiv, Urozhaj, 404. (in Ukrainian).

122. Yakovlyev R.V. (2012). Entomokompleks girchichnogo agrocenozu ta zahodi regulyuvannya jogo chiselnosti v Lisostepu Ukrayini: avtoref. dis. kand. s.-g. nauk. Kiyiv, 20. (in Ukrainian).

123. Yakovlyev R.V. (2008). Osoblivosti formuvannya strukturi entomofauni agrocenozu girchici u Pivdenno-Shidnomu Lisostepu Ukrayini. Zahist i karantin roslin: mizhvid. temat. zb. Kiyiv, Kolobig, 54, 376–380. (in Ukrainian).

124. Yakovlyev R.V. (2009). Shkidlivist fitofagiv na posivah girchici v umovah Lisostepu Ukrayiniye Sb. tezisov mezhdunar. konf. «Sovremennye nauchnye problemy sozdaniya sortov i gibridov maslichnyh kultur i tehnologi ih vyrashivaniya». Zaporizhzhya, Divo, 89–90. (in Ukrainian).

125. Yakovlyev R.V. & Ruban M.B. (2010). Osnovni fitofagi girchici ta yih shkidlivist u Lisostepu Ukrayini. Nauk. visnik NUBiP Ukrayini, 145, 154–161. (in Ukrainian).

126. Yeshenko V.O., Karichkovska G.I. & Novak A.V. ta in. (2010). Tehnologiya viroshuvannya ripaka yarogo v Lisostepu Ukrayini, Uman, Vidavec «Sochinskij», 276. (in Ukrainian).

127. Yevtushenko M.D. & Vilna V.V. (2014). Vidovij sklad sisnih shkidnikiv ripaku yarogo i girchici ta osoblivosti biologiyi hrestocvitih klopiv. Visnik HNAU im. V.V. Dokuchayeva. Seriya "Fitopatologiya ta entomologiya", 1−2, 70−80. (in Ukrainian).

128. Yevtushenko M.D., Fedorenko N.V. & Stankevich S.V. (2009). Efektivnist insekticidiv pri zahisti yarogo ripaku vid blishok (Phylotretta Spp.) ta klopiv (Eurydema Spp.) do cvitinnya. Visnik HNAU im. V. V. Dokuchayeva. Seriya "Entomologiya ta fitopatologiya", 8, 39−43. (in Ukrainian).

129. Yevtushenko M.D., Stankevych S.V. & Vilna V.V. (2014). Hrestocviti blishki, ripakovij kvitkoyid na ripaku yaromu j girchici u Shidnomu Lisostepu Ukrayini, Harkiv, 170. (in Ukrainian).

130. Yevtushenko M.D., Vilna V.V. & Stankevych S.V. (2016). Hrestocviti klopi na ripaku yaromu j girchici u Shidnomu Lisostepu Ukrayini, Harkiv, FOP Brovin O.V., 184. (in Ukrainian).

131. Yevtushenko N.D. & Stankevych S.V. (2011). Roslini-rezervatori osnovnih shkidnikiv olijnih kapustyanih kultur. Visti Harkivskogo entomologichnogo tovaristva. T. XIX. Vip. 2, 71–76. (in Ukrainian).

132. Zhukova L. V., S. V. Stankevych, & V. P. Turenko et al. (2019). Root rots of spring barley, their harmfulness and the basic effective protection measures. Ukrainian Journal of Ecology, 9 (2), 232–238.

133. Zhuravskij V.S. (2008). Vidova riznomanitnist komah na posivah yarogo ripaku u centralnomu Lisostepu Ukrayini. Zahist i karantin roslin: mizhvid. temat. nauk. zb. Kiyiv, Kolobig, 54, 197–202. (in Ukrainian).

134. Zhuravskij V.S., Sekun M.P. & Skripnik O.V. (2007). Insekticidi proti hrestocvitih blishok na yaromu ripaku. Zahist i karantin roslin: mizhvid. temat. nauk. zb. Kiyiv, Kolobig, 53, 59–63. (in Ukrainian).

135. Zhuravskij V.S., Sekun M.P. (2007). Himichnij metod obmezhennya chiselnosti osnovnih shkidnikiv yarogo ripaku. Nauk.-tehn. byul. In-tu olijnih kultur UAAN. Zaporizhzhya, 12, 188–192. (in Ukrainian).

Scientific edition

Stankevych Sergij
Yevtushenko Mykola
Vilna Victoria

Уточнено видовий склад шкідників ріпака ярого й гірчиці у Східному Лісостепу України. Уперше для регіону досліджень встановлено сезонну динаміку чисельності хрестоцвітних блішок, клопів та ріпакового квіткоїда на посівах ріпака ярого й гірчиці; виявлено основні рослини-резерватори зазначених видів шкідливих комах. Доведено високу ефективність захисту сходів ріпака ярого й гірчиці від хрестоцвітних блішок способом передпосівної токсикації насіння інсектицидами системної дії на основі імідаклоприду та тіаметоксаму з подальшим наземним обприскуванням інсектицидами на основі лямбда-цигалотрину на фоні з добривами ($N_{30}P_{30}K_{30}$). Установлено вплив обробки насіннєвого матеріалу ріпака ярого інсектофунгіцидними сумішами на лабораторну та польову схожість. Доведено доцільність і ефективність застосування мікробіопрепарату Актофіт, 0,25 % к. е. у поєднанні з інсектицидом системної дії Біская, 24 % о. д. проти ріпакового квіткоїда та хрестоцвітних клопів на посівах ріпака ярого й гірчиці способом обприскування рослин у фенофазі жовтого бутона.

Монографія буде корисною для фахівців із захисту рослин, наукових співробітників та агрономів, викладачів, здобувачів біологічних і сільськогосподарських спеціальностей вищих навчальних закладів та для всіх тих, кого цікавить підвищення врожайності і якості насіння ріпака ярого й гірчиці.

DOMINANT PESTS OF SPRING RAPE AND MUSTARD IN THE EASTERN FOREST-STEPPE OF UKRAINE AND ECOLOGIC PROTECTION FROM THEM

Monograph

Editor V.L. Chorna
Proof-reader V.L. Chorna
Designer S.V. Stankevych
Makeup S.V. Stankevych

Signed for printing 14.01.2020. Format 60 × 84 1/16. Paper offset. Font Times. Offset printing. Conventional printed sheet 10,0; Publisher’s sheet copy 8,0. Circulation 100 copies.

Editorial and publishing department of Kharkiv V.V. Dokuchaiev National Agrarian University. Post address 62483, Kharkiv region, Kharkiv district, post-office “Dokuchaievske-2”, student campus. Phone 99-72-70.
E-mail: office@knau.kharkov.ua

Видавник: Publishing House I.Ivanchenko пр. Тракторобудівників,89-а/62, м. Харків, 61135, тел.: +38 (050/093) 40-243-50. Свідоцтво про внесення суб`єкта видавничої справи до державного реєстру видавців, виготівників та розповсюджувачів видавничої продукції ДК № 4388 від 15.08.2012 р.

Manufacturer KhNAU operational printing station