MODERN TRENDS IN THE DEVELOPMENT OF AGRICULTURAL PRODUCTION

PROBLEMS AND PERSPECTIVES

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The monograph presented for review is a collection of the results of actual achievements of domestic agricultural scientists, obtained directly in real conditions. The authors are recognized experts in their fields, as well as young scientists and postgraduate students of Ukraine. Research is conceptually grouped into 5 sections: modern technologies in crop production and fodder production; economy of the agro-industrial complex; breeding and breeding in the 21th century; protection and quarantine of plants; agrochemistry and soil science. The monograph will be interesting for experts in plant breeding, economics, plant protection, selection, agrochemistry, soil science, scientific workers, teachers, graduate students and students of agricultural specialties of higher education institutions, and for all those who are interested in increasing the quantity and quality of agricultural products.

Keywords: modern technologies, crop production, fodder production, plant protection, quarantine, agrochemistry, soil science, economy of agro-industrial complex.

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PESTS OF OIL PRODUCING CABBAGE CROPS IN THE FOREST-STEPPE OF UKRAINE

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During the vegetation periods in 2007–2021 in the fields of the Educational, Research and Production Centre "Research Field" of Kharkiv National Agrarian University named after V.V. Dokuchaiev and the State Enterprise "Research Farm "Elitne" of the Institute of Plant Growing named after V.Ya. Yuriev of the National Academy of Agrarian Sciences of Ukraine we have found 54 species of specialised and multi-faceted pests of oil producing cabbage crops that belong to 8 lines and 22 families. Among them 29 species are the specialised pests and 25 are multi-faceted ones. The frequency of the pest species occurrence on the crops is the following: 8 species (14,8%) populate the crops on a mass scale, 6 species (11,1%) are moderately spread, and 40 species (74, 1%) have a low population density. The cabbage bug, mustard bug, ground 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 line, 2 species belong to the Hemiptera line, 1 species belong to the Homoptera line and 1 species belong to the Lepidoptera line. The representatives of the Coleoptera line dominate; their proportion 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 and phenophase of the crop development as well as on weather conditions.

Key words: *pests, harmful entomofauna, species composition, oil producing cabbage crops.*

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, Walkowski, 2002). 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, Walkowski, 2002).

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.

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 (Prushinski, Palosh & Mruvchinski, 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.

Materials and methods. In 2007–2021 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 National Agrarian University named after V.V. Dokuchaiev and the state enterprise "Research Farm "Elitne" of the Institute of Plant Growing named after V.Ya. Yuryiev 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 National Agrarian University named after V.V. Dokuchaiev. 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 National Agrarian University named after V.V. Dokuchaiev.

Results of the research. During the vegetation periods of 2007–2019 in the fields of the Educational, Research and Production Centre "Experimental Field" of Kharkiv National Agrarian University named after V.V. Dokuchaiev and the state enterprise "Research Farm "Elitne" of the Institute of Plant Growing named after V.Ya. Yuryiev 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 lines and 22 families (Tables 1). Among them 29 species are specialised pests and 25 species are multi-faceted ones (Figure 1) (Yevtushenko, Stankevych & Vilna, 2014; Yevtushenko, Vilna & Stankevych, 2017; Stankevych, S.V., et al.б 2019; Stankevych, S.V., et al., 2020; Stankevych, Yevtushenko & Vilna, 2020; Stankevych, S.V., et al., 2021): Migratory locust (*Locusta migratoria Rossica* L.), Italian locust (*Calliptamus italicus* L.), Large green grasshopper (*Tettigonia viridissima* L.), Field cricket (*Gryllus campestris* L.), Mole cricket (*Gryllotalpa gryllotalpa* L.), Cabbage aphid (*Brevicoryne brassicae* L.), Cabbage bug (*Eurydema ventralis* Kol.), Pentatomid rape bug (*Eurydema oleraracea* L.),

Mustard bug (*Eurydema ornata* L.), Striped shield bug (*Graphosoma italicum* L.), Sloe bug (*Dolicoris baccarum* L.), Dock bug (*Syromastes marginatus* L.), Tarnished plant bug (*Lygus pratensis* L.), Alfalfa plant bug (*Adelphocoris lineolatus* Goeze.), European tarnished plant bug (*Lygus rugulipennis* Popp.), Beet bug (*Polimerus cognatus* Fied.), Tobacco thrips (*Thrips tabaci* Lind.), Black carrion beetle (*Aclypaea opaca* L.), Tenebrionid beetle (*Opatrum sabulosum* L.), Tenebrionid beetle (*Pedinus femoralis* L.), Rose chafer (*Tropinota (Epicometis) hirta* L.), White spotted rose beetle (*Oxythyrea funesta* Poda.), Green rose chafer (*Cetonia aurata* L.), Scarab beetle (*Lethrus apterus* Laxm.), Meloid beetle (*Meloe proscarabaeus* L.), Rape blossom beetle (*Meligethes aeneus* F.), Mesographe flea beetle (*Phyllotreta atra* F.), Flea beetle (*Phyllotreta nigripes* F.), Large striped flea beetle (*Phyllotreta nemorum* L.), Undulating flea beetle (*Phyllotreta undulata* Kutsch.), Cabbage beetle (*Phyllotreta vitata* Redt.), Horseradish flea beetle (*Phyllotreta armoracie* Koch.), Rape-leaf beetle (*Entomoscelis adonidis* Pall.), Oriental mustard leaf beetle (*Colaphellus höfti* Men.), No English name (*Colaphellus sophiae* Schall.), Horse-radish leaf beetle (*Phaedon cochleariae* L.), Seed-eating ceutorrhynchus beetle (*Ceuthorrhynchus quadridens* Panz.), Cabbage seed-pod beetle (*Ceuthorrhynchus assimilis* Payk.), Rape stem weevil (*Ceuthorrhynchus napi* Gyll.), No English name (*Ceuthorrhynchus syrites* Germ.), Rutabaga barid (*Baris coerulesces* Scop.), Rape barid (*Baris chlorizans* Germ.), No English name (*Lixus ascanii* L.), Turnip fly (*Athalia rosae* L.), Diamond black moth (*Plutella maculipennis* Curt.), Cabbage worm (*Evergestis extimalis* Scop.), Webworm beetle (*Margaritia sticticalis* L.), Cabbage moth (*Baratra (Mamestra) brassicae* L.), Gamma moth (*Autographa gamma* L.), Turnip moth (*Scotia (Agrotis) segetum* Schiff.), Cabbage butterfly (*Pieris brassicae* L.), Turnip white butterfly (*Pieris rapae* L.), European cranefly (*Tipula paludosa* Ng.), Brassica pod midge (*Dasyneura brassicae* L.).

The frequency of the pest species occurrence on the rape and mustard crops 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 line, 2 species belong to the Hemiptera line, 1 species belong to the Homoptera line and 1 species belong to the Lepidoptera line.

From Figure 1 it is seen that the representatives of the Coleoptera line are the dominant species; their part in the entomocomplex structure is 48% (26 species).

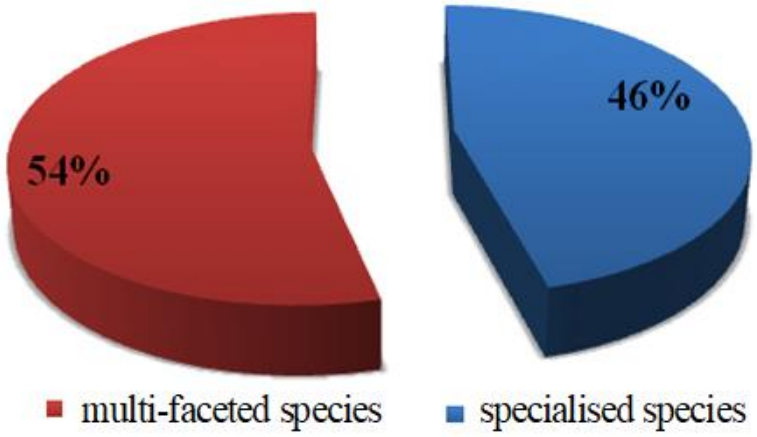


Figure1. Trophic structure of oil producing cabbage crops pests (2007–2021)

The economic importance of these pests is not the same and greatly depends on the population density, phenophase of the crop (Table 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

Taxonomic structure of oil producing cabbage crops pests (2007–2021)

Lines	Species number	Line 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

Figure 2. Colony of cabbage aphid on spring rape stalk, Educational, Research and Production Centre "Experimental Field" of Kharkiv National Agrarian University named after V.V. Dokuchaiev, 1st decade of June 2016 (photo by the author)

Figure3. Cabbage bugs on spring rape crop, Educational, Research and Production Centre "Experimental Field" of Kharkiv National Agrarian University named after V.V. Dokuchaiev, 2nd decade of June 2017 (photo by the author)

Figure 4. Mass of cruciferous fleas on spring rape leaves, Educational, Research and Production Centre "Experimental Field" of Kharkiv National Agrarian University named after V.V. Dokuchaiev, 1st decade of June 2009 (photo by the author)

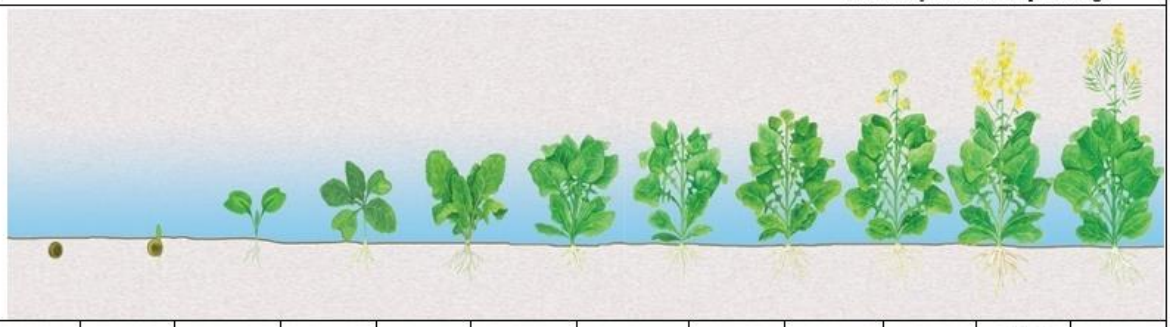
Figure 5. Rape blossom beetle on spring rape flower, Educational, Research and Production Centre "Experimental Field" of Kharkiv National Agrarian University named after V.V. Dokuchaiev, 3rd decade of June 2010 (photo by the author)

Figure 6. Rose chafer and larva of rape blossom beetle on white mustard flower, Educational, Research and Production Centre "Experimental Field" of Kharkiv National Agrarian University named after V.V. Dokuchaiev, 3rd decade of June 2017 (photo by the author)

Figure 7. Caterpillar of diamond black moth on spring rape plant, Educational, Research and Production Centre "Experimental Field" of Kharkiv National Agrarian University named after V.V. Dokuchaiev, 2nd decade of June 2016 (photo by the author)

Table 2

Harmful entomofauna of oil producing cabbage crops (2007–2021)

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

In the phase of the rosette formation 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 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, chafers and cabbage aphid. 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.

Conclusions:

1. 54 species of harmful insects were found on the oil producing cabbage crops which belong to 8 lines 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 line.

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.

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