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CHANGE OF ENTOMOCOMPLEXES STRUCTURE IN AGROCOENOSIS OF GRAIN CROPS IN BELARUS

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Abstract

Recently due to violation of phytosanitary situation, change of sowing area structure, technology of agricultural crop growing, temperature rise, the structural changes in entomocomplexes of spring and winter grain crops have been revealed.

Key words: entomofauna, spring and winter grain crops, anasoplia beetles, frit flies, cereal leaf beetle, entomophages, phytosanitary situation, varieties.

Introduction

Recently in Belarus, the situation in grain crop agrocoenosis has changed essentially for a number of reasons. Changes in the species composition of flora, fauna, diseases, and noxious and useful insects have taken place. The results of many years phytosanitary monitoring have shown that apart from the technology of grain crop growing, weather conditions render an essential influence on structural changes of noxious flora and fauna. Rise in temperature has caused mass development of anisoplia austriaca beetle, the number of which did not increase the threshold one earlier.

Improvement of the ecologically safe plant protection system against pests, diseases and weeds should consider the dynamics of dominant species of phytophages and entomophages populations and their harmfulness.

To reach this objective it is necessary to introduce phytosanitary monitoring in spring and winter grain crops cultivated in different agroecological and climatic conditions.

Based on phytosanitary monitoring results the models will be developed allowing to forecast the quantitative and qualitative entomocoenosis changes, evaluate the dominant phytophage species harmfulness, ecologically and economically substantiate the pesticides application, which in turn, enables reduction of yield losses up to economically imperceptible level and anthropogenic load on agrocoenosis.

Materials and Methods

The researches on the formation of dynamics, number and harmfulness of main species of phytophage and entomophage populations were carried out during 2001–2007 on stationary fields of spring and winter grain crops of base farms located in different agroclimatic zones of Belarus.

Moreover, the itinerary inspections of phytosanitary situation in production grass family crops in the farms of the Republic were carried out in chosen three periods of grain crop development: seedlings–tillering, stem formation–heading, grain formation.

For monitoring the entomocoenoses of cereal crops the methods accepted in entomology were used / Polyakov et al., 1955; Osmolovsky, 1964; Migalov, 1968; Tansky, 1988 /. The number and plant infestation records during vegetation were done by plant inspection, plant sample selection, records on stationary grounds (0.25 x 0.25 cm) frames putting, entomological net cutting, collection of entopmophages and phytophages by hand.

The collected biological material was analysed. The specification of phytophage species composition, their number and harmfulness was accomplished using the general methods /Fasulati, 1971; Voronina, 1975; Tansky, 1988; Volodichev, 1989; Trepashko, 1999/. The structure of arthropods was determined using Engelmann 1978 scale.

The obtained data were statistically processed using analysis of variance and regression-correlation analysis methods /Dospekhov, 1979/.

Results and Discussion

During 2001–2007 the formation of entomocomplexes in spring and winter grain crops cultivated in different agroclimatic zones of Belarus was studied. The results of monitoring showed that a nucleus of pest etomocomplexes formed in grain crops was represented by frit flies (*Oscinella frit* L., *Oscinella pusilla* Mg.), cereal leaf beetle (*Lema melanopus* L., *L. lichenis* Woet), corn miner (*Agromiza albipennis* Mg.); big cereal aphid (*Sitobion avenae* F.) and bird cherry (*Rhopalosiphum padi L.*), 2 species of cereal thrips-rye thrips (*Limothrips denticornis* Hal.) and sterile-flowered (*Haplothrips aculeatus* Fabr.).

It was determined that in grain crops predatory and parasitic insect fauna is represented rather widely. The grass stand layer main mass is created by beetles (*Coleoptera)* and parasitic hymenopterous (*Hymenoptera*), which are represented by families: *Carabidae*, *Staphylinidae*, *Ichneumonidae*, *Pteromalidae*, *Aphididae*, *Eulophidae* and etc.

In grass stand layer the most numerous beetle species were the representatives from the families hister beetles (*Histeridae*), leather winged beetles (*Cantharidae*) and antike flower beetles (*Anthicidae*).

Hippodamia tredecimpunctata L., *Adalia bipunctata* L. and *Coccinella septempunctata* L., were mass developed from *Coccinellidae* family, from predatory bugs – *Nabis ferus* L., *N. brevis* Scholtz and *N. pseudoferus* Rem.

A useful fauna of fly order (Diptera) is represented by predatory flies from the families lesser bulb flies (*Syrphidae*), robber flies (*Asilidae*), dance flies (*Empididae*) and parasitic tachinid flies (*Tachinidae*).

Among other entomophages in grass stand layer lacewings (*Chrysopa abbreviata* Gurt. and *Ch. dasyptera* Mcl.) were found.

In soil layer of gramineous coenosis considering species diversity and number dominated ground beetles and staphylinids (*Coleoptera*, *Carabidae*, *Staphylinidae*), among which the most frequent were *Bembidion lampros Herbst*, *B. properans Steph*., *B. quadrimaculatum* L., *Agonum dorsale* Pont., *Pterostischus melanarius* Ill, *P. cupreus*,

Calathus ambiguus Pk., *C. erratus Schalb*., *C. melanocephalus* L., *Ophonus rufipes* Deg., *Philonthus fuscipennis* Mnnh., *Tachyporus chrysomelinus* L.

It was determined that recently in Belarus as a result of temperature rise, the formed structure of sowing areas, the technology of agricultural crops growing; the structural changes have taken place in the formed entomocomplexes of grain crop agrocoenosis cultivated in different agroclimatic zones.

An essential difference in the dynamics of spring and winter grain crop phytophages and entomophages populations is observed in the southern agroclimatic zone where the focuses of mass development of anisoplia beetle have been formed for the first time.

Among the representatives of this genus on the territory of Belarus two species of *Anisoplia* – anisoplia segetum beetle (*Anisoplia segetum* Hrbst.) and anisoplia austriaca beetle (*Anisoplia austriacea* Hrbst.) were found in 2006–2007 in winter rye crops at flowering stage rose chafer (*Epicometis hitra* Poda) feeding was observed, this species density did not exceed 2 units per m^2.

The I-instar and II-instar of *Anisoplia austriacea* larvae hibernate. The movement of hibernating larvae to soil surface starts in the second ten-day period of April by warming up the upper soil layer up to 8^o C. *Anisoplia segetum* beetle larvae and twice hibernating *Anisoplia austriaca* larvae are the first to appear on the soil surface and in 10–20 days – the I-instar of *Anisoplia austriaca* larvae.

Beetle larvae feed on rotted plant residues in soil and when live plants are present, they eat their root system. Ear crops suffer from older instar larvae during seedlings–tillering stage. Winter grain crops of early sowing periods are damaged most of all by anisoplia beetle larvae in comparison with crops of optimum sowing time and also margins. Both along the margins and in the middle of grain crops the damages are spread in the fields by spots of different size and form.

In Gomel district in winter rye crops in the formed focuses on the acreage of 80 ha the larvae damaged 10–15% of seedlings (by number 8.2 larvae per m^2), in winter triticale crops on the acreage of 120 ha at 5.8 larvae per m^2 – 8% of plants.

Mass imago flight coincides with winter rye and triticale grain milk ripeness – more favourable for insect feeding. In 2006–2007 in Rechitsky and Gomel regions, anisoplia beetle number reached 40–50 units per m^2. In winter rye fields during flowering the most numerous were *A. segetum* species beetles and made up 76% of the total collections.

The main damage is done by the beetles simply feeding on grain, converting it into low-value residues and also a lot of grain is knocked out from ears into soil, especially in winter rye. At margins rye yield losses caused by beetles make 150–200 ha^{-1}.

Some predatory insects eat anisoplia beetle larvae: ground beetles *Carabas scarbiusculus* and *Harpalus calceatus*. It is observed that anisoplia beetles are infected by fungal and bacterial disease agents. In our collections anisoplia segetum beetle larvae kill caused by muscardine made up to 15%, bacterial diseases – up to 50%.

Considering the insect migrating ability up to 15 km distance and more, the subsequent rise in temperature and non-observance of required agrotechnical measures, the intensive anisoplia beetle spread on the territory of the Republic is possible.

In the Southern agroclimatic zone, as a result of winter wheat sowing area increase, pentatomid eurygaster has been also revealed.

Moreover, in spring grain crops an increase of wheat stem maggot and apomea noctuid moth and also click beetle harmfulness is observed. When their number is high, winter and spring wheat, oats damage can increase 50–60%.

Our researches determined the cyclic recurrence of mass development of phytophage and entomophage species: lady beetles, syrphids, lacewings, leather winged beetles and their feed specialization. Mass frit flies development was observed in 2001 and 2004, the first generation number has made from 50 to 102 individuals per 100 aerial net sweeps, and stem damage depending on crop made up 21.9–35.4%. The experimental data showed that frit flies colonized in a larger degree oats in comparison with barley and spring wheat. For the first time it was revealed that the second generation frit flies do not invade spring wheat ears and do not bring the subsequent generation but fly into barley and oats, where their further development takes place. Even at high number of flies (1810–2000 individuals per 100 aerial net sweeps) there were no spring wheat grain damaged, that is why the insecticide treatments against summer generation of frit flies are inexpedient. In barley and oat crops, at the second generation imago the number from 387 to 1334 individuals per 100 aerial net sweeps grain damage made up 10 and 15%, accordingly.

In 2002, big grain aphid and bird-cherry aphid were mass developed in spring crops. The maximum pest density (150 pests per stem) was in oats, spring wheat – 6.7, barley – 80.2 record unit per stem which increased the economic threshold of harmfulness 18, 10 and 8 times, accordingly.

In the experimental field, high cereal leaf beetle number was observed in 2005, in other years the pest density did not increase 0.6 pests per stem. Leaf damage made up, on the average, from 5.2 to 34.1%, in 2005 – up to 43.2%. In permanent formed focuses of Gomel and Minsk districts, the pest number was at the threshold level.

The analysis of our research results showed that the phytosanitary situation in winter grain crops also differed essentially in research years.

The damages done by the third generation frit flies, cicadids, cereal leaf beetles, big cereal aphid and cereal thrips were of economic importance. It was observed that the dynamics of the number and plant damage was unequal in the share of crops and by research years. The highest frit fly number and harmfulness in winter crops was observed in 2001 and 2005 which was promoted by warm weather in August-September. The number of flies in rye, triticale and wheat at optimum-early sowing time at the beginning of September reached 40–60 flies per record which is 2 times higher than the threshold one. Plant damage made up 23–48%. Frit flies did the greatest damage to winter wheat.

High cereal leaf beetle number – 0.8–0.9 individuals per stem was noticed in 2003-2004, on such crops the leaves were damaged for 48–50%.

Among winter grain crops, cereal leaf beetle invaded in a larger degree winter and triticale crops and less – winter rye.

Among sucking winter grain crop pests' big cereal aphid and rye thrips brought damage. These pests were mass developed in 2005. The highest aphid number (16–18 units per ear) was in winter wheat and triticale, in winter rye – 9–10 units per stem.

Corn thrips were more harmful in winter rye. In winter triticale their number was higher than the threshold one only in separate fields. For winter wheat crops, corn thrips did not have any economic importance under conditions of Belarus.

It was determined that during formation, the dynamics of phytophages and their entomophages populations' complex, crop varietal properties are of great importance. In years of mass cereal aphid development the dynamics of their number essentially differed in the share of spring wheat varieties. The highest pest number was observed in cv. 'Dariya', in less degree the crops cv. 'Rostan' were colonized.

The selective ability of frit flies was revealed while invading different varieties of spring and winter crops. For example, in 2005 by mass development of the third generation insects, winter wheat varieties sown during one period were not equally damaged. Frit flies damaged more than 40% of stems cv. 'Bylina', meanwhile the plants of cv. 'Legend' – 19–22%, 'Kubus F_1' – 11–12%.

At mass development of dominant pests, the insecticide applications at the start of plant invasion allowed to preserve yield at the cost of their harmfulness decrease. The proportion of spring and wheat grain crop preserved yield changed according to insect number in the share of crops. The highest preserved grain yield was in years of mass cereal aphid development, which in oats made up 0.8 t ha^{-1}, in winter wheat – 0.29 t ha^{-1}.

As a result, under conditions of Belarus it is necessary to extend the researches on studying anisoplia beetles, pentatomid eurygaster, polyphagous pests: cutworms and click beetles, develop a forecast of their number, economic thresholds of harmfulness, form a range of insecticides, improve the technology of grain crop protection.

Conclusions

1. It was determined that in the formed etomocomplexes of grain crops the dominant species were: *Oscinella frit* L., *Oscinella pusilla* Mg*., Lema melanopus* L., *L. lichenis* Woet, *Agromiza albipennis* Mg., *Sitobion avenae* F*., Rhopalosiphum padi* L., *Limothrips denticornis* Hal. and *Haplothrips aculeatus* Fabr.

2. The predatory and parasitic insects' fauna is mass represented by the families: *Carabidae*, *Staphylindae*, *Ichneumonidae*, *Pteromalidae*, *Aphididae*, *Eulophidae*, *Cantharidae*, *Coccinellidae*, *Syrphidae* and *Chrysopidae*.

3. In Belarus, as a result of temperature rise, the formed structure of sowing areas, the technology of agricultural crops growing, the structural changes have taken place in the formed entomocomplexes of grain crop agrocoenosis cultivated in different agroclimatic zones.

4. An essential difference in the dynamics of spring and winter grain crop phytophages and entomophages populations is observed in the southern agroclimatic zone where the focuses of mass development of anisoplia beetle have been formed for the first time.

5. In spring grain crops, an increase of wheat stem maggot and apomea noctuid moth number is observed, also click beetle harmfulness is noticed. When their number is high the damage of winter and spring wheat, oats damage can increase 50–60%.

6. Our researches determined the cyclic recurrence of mass development of phytophage and entomophage species: lady beetles, syrphids, lacewings, leather winged beetles and their feed specialization.

7. It was determined that the varietal crop features and cultivation technologies influence the dynamics of populations of the whole complex of phytophages and entomophages.

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