EFFECT OF FERTILIZER APPLICATION SYSTEMS ON THE DYNAMICS OF AGROCHEMICAL, AGRO PHYSICAL AND BIOLOGICAL INDICATORS OF SOIL AND WASTE SOIL MEZOFAUNA

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ABSTRACT

Pesticides alter the biological properties of the soil, leading to a complete loss of their fertility. Chestnut soils (meadow brown, light brown) are resistant to contamination by pesticides and by fertilizers in particular. We have carried out studies on the effect of the examined soil pollution with high doses of fertilizers and pesticides on the soil mesofauna representatives.

The work is based on studying influence of anthropogenic impacts on soil biological activity in comparison with its main indicators, which allowed to establish the soil fauna correlative connection with major traditional indicators of soil fertility, and significantly enhances their ecological importance in the assessment of agricultural techniques in agricultural production.

In Kazakhstan such research has a fragmented character; soil animals and their effects on soil properties have been studied poorly. The reason for the relatively poor knowledge of soil animals is not only the complexity of the conditions for the existence of organisms in the soil, but also the difficulties in the observation and study of the soil fauna due to the opacity and density of habitat. And, despite the importance of soil fauna in the soil-forming process, in Kazakhstan it is still poorly understood, especially in the agrotechnical influences in irrigation and rainfed areas of south-eastern Kazakhstan. Lack of information on the biological activity in this area, the underestimation of the role of soil invertebrates and their value in the formation and reproduction of soil fertility, lack of methods for biodiagnostics and indication of soil identified the relevance and need for systemic research in this direction.

The title and direction of research on the effect of different systems of application of fertilizers, pesticides and other agricultural methods on living component of soil environment in the long-term stationary experiments, and, based on them, the development of parameters for monitoring of anthropogenic impacts in the system of modern agriculture in irrigation and rainfed areas of south-eastern Kazakhstan were chosen on the basis of above mentions.

Keywords: soil, soil invertebrates, bioindicators, anthropogenic impact

INTRODUCTION

Pesticides are the ecological factor which appeared in the nature in connection with wide application by the person of stranger connections for fight against weeds and pests of cultural plants. Pesticides are capable to change biological properties of soils, to break partially or lead to the complete loss of their fertility. Besides, pesticides and high doses of fertilizers change also more conservative signs of soils ecosystems, such as humus state, structure, pH. In the polluted soils along with microorganisms perish such valuable indicators of humus maintenance and pH soil regulators as earthworms [1].
Chestnut soils (meadow-chestnut, light-chestnut) have resistance to pollution by pesticides and, to fertilizers, in particular. However and they are not always capable to resist to influence of pollutants.
We have conducted researches on influence of contamination of the explored soils with high doses of fertilizers and pesticides on representatives of soil mesofauna [2].
On the basis of complex researches the comparative analysis of assessment methods of the explored soils biological activity is carried out. Comparison of investigational soils is conducted on the degree of change of soils' mesofauna with the purpose of determination of their relative stability to contamination by pesticides and high doses of fertilizers [3]. The obtained data allowed revealing degree of stability of meadow-chestnut and light-chestnut soils of irrigation zone and boghara of the southeast of Kazakhstan to contamination by pesticides and high doses of fertilizers. The types of soil invertebrates animals are exposed, which must be used as bio indicators for monitoring of chestnut soils contamination by pesticides and high doses of fertilizers. Materials of the scientific–research work are used in teaching elective courses "Bio indication of soils", "Protection of soils", "Soil science" at Kazakhstan Engineering-Technological University and Kazakh National Agrarian University.
We established influence of pesticides and high doses of fertilizers and on the number of basic groups of soils mesofauna in system of the modern agriculture in irrigation zone and boghara of the southeast of Kazakhstan.
The activity of soil mesofauna is influenced by the degree of soil contamination with high doses of fertilizers and pesticides. For soils in which the content of pesticides exceeds in 2 more times there are the expressed changes. The quantity of types of soil invertebrates decreases from family (*Carabida*), the most steady kinds begin to prevail (*Curculionidae, Scarabaidae*).
Studying of pesticides influence on the soil invertebrates is especially important as agricultural crops, soil animals, soil are in dark interaction. Application of pesticides causes reduction of quantity of useful soil invertebrates, influences on processes, what be going on a boghara and irrigation.
The analysis of literature about influence of pesticides on soil mesofauna shows that the majority of researches is conducted in agrobiocenosis, as a rule, they concern impact of pesticides on separate groups of invertebrates [4].
Influence of pesticides on soil fauna depends on many factors: not only from chemical properties, forms of application and concentration of medicine, but also from properties of soil, first of all from the maintenance of humus in it, humidity, mechanical structure, pH, etc. It is established by us that pesticides low-toxic for Lumbricidae and high-toxic even in slight quantities for representatives from the *Carabida* family.
Larva from family of Elateridae, Staphylinidae is very sensible to influence of pesticides, their quantity sharply reduced on 41%, while Collembola and Formicidae

had a peak of quantity (40–60 copies/sq.m). In our opinion it is explained by such circumstances as: short life cycle (up to 8 weeks), ability to fast resettlement, and also death of their enemies (Staphylinidae, Araneae) who under routine conditions control their number (figure 1).

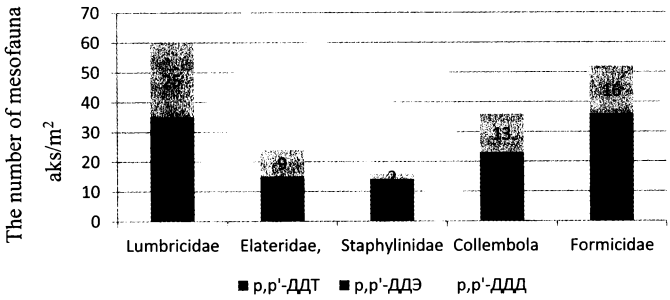

Figure 1 – Influence of pesticides on soil fauna

The results received by us demonstrate that pollution of soils by slight doses of pesticides leads to change in the specific composition of soil invertebrates.

The data obtained by us confirms that there is the considerable decrease of a specific variety (for 20%) of complex of soil invertebrate laminar families (*Scarabaidae*), elater (*Elateridae*) and increase in absolute dominance of such types as: earthworms (*Lumbricidae*), ants (*Formicidae*).

The received results give the grounds to conclude that, unlike indexes of number, the specific structure of soil organisms can be used as criterion for quality estimate of impact extend of pesticides on the soil.

The analysis of data on mesofauna on the studied experience options, showed that general views are larvae of insects from family – *Carabidae, Scarabaeidae, Elateridae, Formicidae, Lumbricidae, Coccinellidae* – as these types have plasticity (ability to dwelling in the most various biotopes).

The dominating types are larvae of insects – *Lumbricidae, Formicidae, Scarabaeida.*

It is established that the prolonged use of fertilizers, changing the size of soil parameters, makes essential impact on a condition of soil mesofauna (table 1).

Table 1 – Influence of fertilizers on mesofauna of the meadow-chestnut soil (Saimasai)

Variant	The soil invertebrates	
	all types	Abundance , aks/m^2
Control b/y	7	14
The estimated rate of NPK	5	10
Biohumus, 6 t / ha aftereffect	8	16
The manure 30 t / ha aftereffect	12	24
The manure 60 t / ha	15	30

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aftereffect		
HCP=1,958		

From table 1 it is visible that use of organic fertilizer of dung in a dose of 30-60 t/hectare improves conditions of a delivery of the cultivated crops, promotes formation of more powerful root system and accumulation of larger quantity of vegetable oddments which exert positive impact on conditions of dwelling of soil animals.

Therefore, on option dung in a dose of 30-60 t/hectare higher numbers of representatives of mesofauna was noted, which made from 24–30 copies/sq.m that above control values of 14 copies /sq.m.

In our opinion, higher number on option with a dung, is explained to its direct and indirect influence: direct influence is expressed – padding receipt of manure mesofauna from the *Scarabeidae* family, indirect – nutritious elements of a dung are the padding power supply and organic matter that promote improvement of structure of soil, its water physical properties and increase in buffer ability.

Eventually, in our opinion all this creates the favorable conditions for dwelling, and deliveries of mesofauna of soils.

Dependence of indexes of biological activity (mesofauna) from contents in soil of organic compounds is established.

The resulted sizes show that there is legibly expressed correlation between contents in soil of humus and the number of a complex of soil invertebrates that gives the chance to use data on general composition of mesofauna for description of this index.

Except the high number, notable biomass and ubiquitous occurrence, ability to fast reaction to changes in an ecosystem, availability of specific definition and a possibility of use for comparison of the quantitative characteristics of the bound with existence of the standard methods of selection is characteristic of mesofauna.

The increased number of these groups remains also under the chick-pea placed on couple. In the field with chick-pea decreases the number of wireworms (*Elateridae*) with simultaneous increase of larvae from family of ground beetles (*Carabidae*).

Researches of processing methods influence of the soil showed that when using the blade cultivator plenty of insect increases by 12%, earthworms on the contrary decreases by 17%.

At direct crops recommended by system of agriculture on the explored fields, there is a decrease in number of insects' wreckers to 9%.

The most favorable ecological conditions for dwelling of soil mesofauna develop in the conditions of the meadow-chestnut soil on option dung of 60 t/hectare at bringing under the cultures under cultures of short crop rotation

It should be noted, soil conditions influence not only the total number of representatives of mesofauna, but also their structure. On the light-chestnut soil under crops of wheat on a boghara, generally there are from ground beetles representatives of a sort – *Harpalus. Harpalus* – zoo phages, weevils (*Curculionidae*) on option of couples (zero processing) which potential food are wreckers of grain crops whereas on colza, soya, corn cultivated on an irrigation meet bugs – a turtle harmful *Eurygaster integriceps*.

Studying of agro physical properties of the explored soils confirm more favorable conditions for development and the resettlement of mesofauna on meadow-chestnut and light-chestnut soils which developed as a result of the long-lived cultivation of the soil, and also rational use of fertilizers.

Our researches showed that an anthropogenous factor (the agro technical methods used at cultivation of various cultures, use of fertilizers, pesticides) have significant effect on mesofauna of soils.

At the choice of organisms which occurrence in the soil can be the indicator of soil conditions there is a question of food communications as this factor can be decisive in distribution of an animal, but absolutely unessential for the characteristic of the soil.

The analysis of number and group structure of mesofauna in the explored soils, shows that division as a delivery has not only positive global – ecological, but also and agronomical value. From our observations it became clear that larvae from the family *Pyrrhocoridae, Chrisomelidae Geophilidae* are bound to soils more humus, moisture provided (meadow-chestnut soils) which do not meet on light-chestnut. On light-chestnut soils generally meet larvae from the family *Curculionidae, Juliformidae* which were not found on meadow-chestnut soils.

The mesofauna, along with other soil characteristics can be quite used, as the bio indicator. Bio diagnostics of the explored soils was carried out by us on the classification based on trophic connection and a habitat of soil invertebrates (table 2).

Table 2 - Bio indicators of the explored soils

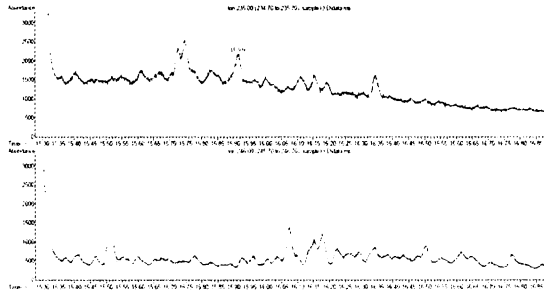
The type, soil subtype	The type	The species	The order	The stirpes
Meadow-chestnut soils	Arthropod *Arthropoda*	Insects *Insecta*	Beetles *Coleoptera*	Bugs *Pyrrhocoridae* chrysomelid beetles *Chrisomelidae*
		Chilopoda	*Geophilomorha*	Geophilid *Geophilidae*
Light-chestnut soils	Arthropod *Arthropoda*	Insects *Insecta*	Beetles *Coleoptera*	Weevil *Curculionidae*
		Diplopoda myriapod, or Diplopoda (*Diplopoda*)	Millipede *Julida*	Millipede *Juliformidae*

The specified bio indicator views of the explored soils are present irrespective of application of mineral fertilizers and respectively a level of content of pesticides. Lack of such soil invertebrate inhering to the families *Chrisomelidae, Geophilidae* which meet on meadow-chestnut soils whereas for light brown soils the reference representatives are larvae of mesofauna of soils from family – *Curculionidae, Juliformidae* is characteristic of light-chestnut soils. Representatives of these families can be also used as bio indicators when carrying out researches on the explored soils.

Physical and chemical indexes of the soil on a live component of the soil environment in the long-lived stationary experiences.

In the soil samples which are selected from Saimasai and Almalybak were found p, p '-DDE in trace quantities. In the majority of the studied soil samples from Saimasai were not found out organochlorine pesticides (OCHP), except samples of the soil No.1, 16 and 19. In samples of the soil No.1, 16 and 19 are found DDE and DDD in very trace

amounts. According to the obtained data, in the soils selected from Almalybak are found DDE in the range from 0,7 to 1,8 mkg/kg. These concentration are trace as the maximum allowable concentration of organochlorine pesticides makes 100 mkg/kg.



Picture 1 – Chromatogram GH-MS received in the analysis of a soil sample No.16.

Determination OCHP in soil by the method of GH-EZD

The analysis was carried out on a gas chromatograph 7890A (Agilent, USA), equipped with auto sampler MultiPurpose Sampler (Gerstel, Germany). The sample of 1, 0 mkl with the help of auto sampler was entered into the device for test input heated to 250°C in the mode without division of a stream. For division used the capillary column DB-35MS (Agilent, USA) with length 30 m, inner diameter 0,25 mm and thickness of tape 0,25 mkm. Gas carrier (helium of the "A" brand) was given in the mode of constant speed of a stream, a component of 1,0 ml/min (average peripheral speed of a stream 36 cm/s). Temperature of the thermostat of a column was programmed from 40°C (endurance 1 min) to 160°C (endurance 5 min) with a speed of heating 5°C/min with the subsequent heating to 280°C (endurance 5 min) with a speed of 5°C/min. Detecting was carried out on an electron-capture detector (EZD) on retention time of the corresponding pesticides (Agilent, USA).

In the majority of the studied samples of the soil which are selected in April were found trace quantities of p,p'-DDE.

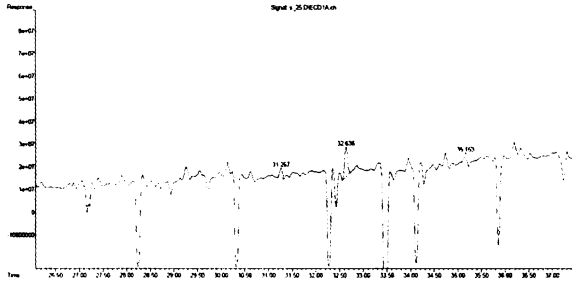
In samples of the soils selected in June from under cultures such as corn, soy and beet, were also found trace amounts of organ chlorine pesticides, in particular p,p'-DDE. In soil samples from under colza OCHP were not found. In soil samples from under corn all three organ chlorine pesticides were found, however their concentration in the soil does not exceed threshold limit value (maximum allowable concentration = 100 mkg/kg) [5].

In the soil samples which are selected in July trace quantities of p,p'-DDE were also found.

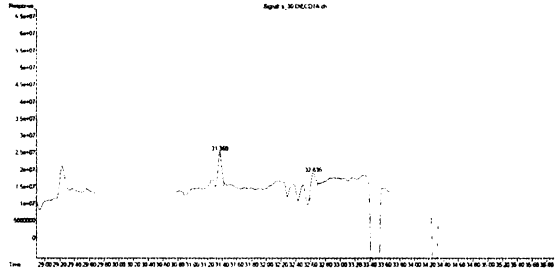
Besides soil samples were selected and analyzed samples of plants of cultures (leaves and stems). Results of a chromatographic analysis showed that in a stalk of corn collects p,p'-DDD in quantity from 1,69 to 2,99 mkg/kg and in leaves of fodder beet 1,11 - 2,7 mkg/kg. The found concentration of p,p'-DDE in other samples of plants are trace.

Results of the analysis of soils and plants are presented in Appendixes B, V, G, D.

Chromatograms of soil and vegetable samples are presented on figures 2, 3.



Picture 2 – A chromatogram of the polluted OCHP of soil sample No.13 (June)



Picture 3– A chromatogram of the polluted OCHP of soil sample No.18 (June)

Thus, results of chromatographic analysis of soil samples and plants on the maintenance of OCHP, showed that in the majority of tests these connections are absent, and the found concentrations of pesticides are trace and do not render harm.

CONCLUSIONS

The dynamics of soil fertility (agrochemical, agrophysical, biological indicators) and soil mesofauna were studied depending on the examined factors.

Species of soil invertebrate animals as the indicators of soil contamination with pesticides and high fertilizer rates were identified.

It was established that the COP (chlororganic pesticides) content in samples of the light chestnut soil in the experimental crops of the Kazakh Research Institute of Agriculture and Crop Production did not exceed MPC. The results of chromatographic analysis of soil samples and plants for the COP content showed that these compounds were absent in most samples, and the concentrations of pesticides found were trace and did not cause any harm.

It was established that pesticides were low-toxic for *Lumbricidae* and high-toxic, even in insignificant amounts, for representatives of the *Carabida* family.

It was revealed that there was a significant decrease in the species diversity (by 20%) of the complex of soil invertebrate families *Scarabaidae, Elateridae*, and

an increase in the absolute dominance of such species as *Lumbricidae, Formicidae.*

It was established that the species composition of soil organisms can be used as a criterion for the qualitative assessment of the degree of pesticide impact on soil. Analysis of the mesofauna data obtained from the experiment variants showed that the insect larvae belonging to the families *Carabidae, Scarabaeidae, Elateridae, Formicidae, Lumbricidae, Coccinellid*ae were the common species, since these species possess plasticity (ability to inhabit various biotopes). Dominant species included the insect larvae belonging to the families *Lumbricidae, Formicidae, Scarabaeida.*

It was revealed that fertilizers throughout the growing season of the studied crops had a positive effect on the accumulation of the plant dry mass in comparison with the control. The effects of pesticides and fertilizers on the biological activity, humus state, soil content of nitrogen, phosphorus, and potassium forms available to plants were studied, which makes it possible to use these indicators in the monitoring of anthropogenic impacts.

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