

The Impact of the Agricultural Technology upon the Biodiversity of the Arthropods Present in the Corn Culture in Sibiu County

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Abstract In Romania as well as worldwide the creation of a lasting agriculture should take into consideration the ecologic component and the prerogatives of the protection of the customers. This fact is necessary because there are, presently serious processes of deterioration of the fertile properties of the soil as a result of an irrational agriculture that doesn't take into account the rotation of the cultures, the fertilization, the control of weeds, illnesses and pests and the reduction of energetic consumes. The goal of our researches was the establishing of the degree of the impact of the agricultural technologies applied upon the biodiversity of the arthropods present in the corn cultures in three localities in Sibiu County: Poplaca, Ocna Sibiu and Axente Sever (Copşa Mică area). There were used two methods of collecting for the arthropods in the researched areas: the drillings in the soil and the Barber traps. In the same time for the chemical and agrochemical bulletins there were collected in March soil samples from the three agro systems with the help of the agrochemical drills. For each and every agro ecosystem there was analyzed the fauna in the soil and on the ground, making connections with the applied agricultural technology. There was established for all three corn agro ecosystems the fact that the report between the useful and pest fauna is in favor for the former category.

Key words

culture technologies, corn, fauna

The agricultural policy in Romania, starting from the European one will lead to the development of a lasting agriculture, which will take into consideration the ecologic component as well as the protection of the consumers. The creation of a lasting agriculture will take into account the new techniques of the enginery for the elimination of some risk factors which might be found in some points of the food chain. In her work *Development of Sustainable Agriculture* Pompilica Iagaru in 2011 [2] underlines the fact that a lasting agriculture is promoted successfully only if there are followed certain conditions by the agricultural producers, namely the rotation of the cultures, fertilization, the weed and illnesses control, reducing the energetic consumes and last but not least, the pests.

The goal of our researches was the establishing the degree of impact of the applied agricultural technologies upon the biodiversity of the arthropods present in the investigated corn cultures. Specialty studies regarding the impact of the agricultural technologies, with special reference at the cereal cultures in intensive system are quite few, both in our country and abroad. The studies focused on the knowledge of the structure and the fauna component of a group of insects [1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13,

14, 15, 16] or on the knowledge of the biodiversity of the species of some pests from the *Elateridae* and *Curculionidae* families. Manole, 2010, (unpublished data) emphasizes the structure of the coleopteron fauna in the potatoes and corn cultures during the entire period of vegetation from an agricultural area where is practiced the intensive agriculture (Călugăreni-Giurgiu County).

Material and Method

- The localities where the investigations were done are: Poplaca, Axente Sever and Ocna Sibiu (Sibiu County)
- The collecting of the arthropods from the soil as well as from the ground took place in 2012 during the months: April, June and September.
- The collecting in March of the soil samples from the researched agro systems with the agro pedological drill;
- Running the agrochemical analysis (ph, texture, humus, N, P, K)
- Running the chemical analysis and establishing the influence of heavy metals from the soil upon the soil fauna;

- Methods of collecting: the use of Berber trap and drillings in the soil by using the survey method.

Obtained Results

The experiments and researches took place in the localities Poplaca, Ocna Sibiu and Axente Sever (Coșca Mică area) – Sibiu County with the specific agro meteorology conditions and were applied distinctive agricultural technologies (Table 1).

Table 1

The Agricultural Technology Used in the Researched Areas in the Corn Cultures in Sibiu County

| TECHNOLOGIC ELEMENT | POPLACA | OCNA SIBIULUI | AXENTE SEVER |
|-------------------------|--|--|----------------------------------|
| Preparation of the soil | Ploughing –disking- sowing | Ploughing-disking-crushing-sowing | Ploughing –disking- sowing |
| Previous plant | wheat | wheat | corn |
| Kind/hibrid | Pioneer PR 38A24 | Pioneer P9025 | Pioneer PR 39 D81 |
| Sowing date | 25.04.2012 | 18.04.2012 | 13.04.2012 |
| Sowing density | 65,000 plants/ha | 66,000 plants/ha | 62,000 plants/ha |
| Soil texture | clay-sand (middle) | middle(clay) | clay-sand (middle) |
| Fertilization | Stabble garbage (30t/ha) | N P K 15/15/15 (300 kg/ha) | N P K 15/15/0 (200 kg/ha) |
| Chemical treatments | | | |
| A-at seed | Signal 500FS (3.5 l/t seed) | Signal 500 FS, Nuprid AL 600 FS (for soil pests-10 l/ha) | Semnal 500 FS |
| B-in vegetation | - | - | - |
| Herbicides | - | Merlin Duo (monocotyledonous dycotyledonous) | Dicopur Top 464 (dycotyledonous) |
| Fungicides | - | - | - |
| Insecticides | - | - | - |
| Other elements | Notirigated system;mechanic works; Mecanic weeding: (harrow) an by Hand (hoe) | notirigated system | notirigated system |

In the experimental corn fields in Poplaca the agrochemistry of the soil presents neither reduced values nor excessive ones of the chemical composition but the nourishment needs for the corn plants are not entirely respected. The reaction of the soil expressed by pH is moderated acid (5.76); the texture is middle (clay); the organic carbon is reduced (1.8%). The humus content is moderated (3.04%) as well as the quantity of N(0.148 ppm). The P content is low (20 ppm) and that of K presents moderated values (179 ppm). The soil has a low fertility due to the moderated acid reaction, limestone amendments being needed. It is possible that the moderate acid reaction of the soil to favor the development of *Agriotes* (bugs). Under the aspect of the necessary fertilizers there must be applied moderated dozes of stable garbage, big dozes of P and moderated dozes of K. The chemical fertilizers must have a physiologic alkaline reaction. Regarding the pollution factor in the chemical charge of the soil in Poplaca the Pb content is moderated 48.738 (mg/Kg),

and Cd is in low charge (1.39mg/Kg). The soil in Polaca is not polluted by heavy metals. In Ocna Sibiu the agrochemical characterization shows that the reaction of the soil expressed by ph is low acid-6.21; the texture is middle (clay); the content of organic carbon is reduced (1.09%); the humus content is small (1.88%); also the N content (0.147ppm) is small as well as the P content (35 ppm) and the K content is middle (215 ppm). The soil texture is good but under the aspect of its reaction expressed by pH is an inadequate, limestone amendment being needed. Under the aspect of nutritious it is poor, organic and natural fertilizers being needed. The Pb contain is framed in the low charge class (37.738 mg/Kg) and Cd is in the low charge class (1.16mg/Kg). The soil is not polluted.

In Axente Sever the reaction of the soil expressed by pH is low alkaline (7.72); the texture is clay and sand (middle); the C organic contain is reduced (0.074 ppm), that of P is also low (30 ppm). The K value presents moderate values (100ppm).

Under the aspect of the favorability of the soil this is of middle fertility, having a reaction low alkaline. The texture is middle but needs moderated doses of organic fertilizers and big doses of chemical fertilizers. The clay and sand texture favors also the species *Locusta migratoria*. This explains the growth of the population of this pest in the area. Axente Sever is a locality situated nearby a source of major pollution for several decades (the plant of black smoke in Copșa Mică). In the soil where were placed the experimental corn fields were detected through the method of spectrometry with absorption of atomic mass levels of heavy metals, Pb and Cd more over the limit of alert and intervention, being framed in the “very strong” class for both elements (558.45 mg/kg for Pb and 19.10 mg/kg for Cd). Regarding the technologic impact in Poplaca was used a classic rotation wheat-corn with mechanized work of the soil accordingly to the technology of massive type, a hybrid of great productivity and relatively resistant to illnesses and pests, sowing early and with a density of the plants per ha over average. Nevertheless the soil can be framed in the inadequate category for the agro techniques of the corn. The technology is a combination of elements with intensive character with those characteristic for the traditional, organic agriculture,

In Ocna Sibiu case with an adequate soil cambia black earth type but poor in nutritious substances due to the over exploitation, the applied technology of intensive type is almost identical with that applied in Axente Sever.

One of the main technologic elements, common for the experimental corn culture in Sibiu County was that all were situated in a not irrigated system. For the corn culture, taking into consideration its tropical and subtropical origin, the humidity represents one of the factors of great importance both for growing and, especially for fulfilling the values of optimum productivity. The chosen area for experiment, including the three localities mentioned above are situated on an area of 30-40km round the town Sibiu was affected in the last years, but especially in the year of experiment (2012) by a systematic, profound drought that influenced negatively, in the highest degree the cereal production from the entire Sibiu County. The structure of the biodiversity of the invertebrates in the soil and on the soils with corn cultures was directly and strongly influenced by this command factor. The samples collected from the experimental field comprise invertebrates from the taxonomic groups, as follows:

Poplaca: 6 classes: *Annelida*, *Arachnida*, *Chilopoda*, *Diplopoda*, *Crustacea* and *Insecta*; 17 orders: *Haplotaxida*, *Aranea*, *Acari*, *Lithobiomorpha*, *Scolopendromorpha*, *Geophilomorpha*, *Julida*, *Polydesmida*, *Isopoda*, *Collembola*, *Orthoptera*, *Homoptera*, *Heteroptera*, *Hymenoptera*, *Coleoptera*, *Diptera*, *Lepidoptera*; 46 families; 117 sorts; 93 species.

Ocna Sibiu: 6 classes: *Annelida*, *Arachnida*, *Chilopoda*, *Diplopoda*, *Crustacea* and *Insecta*; 17 orders: *Haplotaxida*, *Aranea*, *Acari*, *Scutigermorpha*, *Geophilomorpha*, *Julida*, *Polydesmida*, *Isopoda*, *Collembola*, *Thysanoptera*, *Orthoptera*, *Homoptera*, *Heteroptera*, *Hymenoptera*, *Coleoptera*, *Diptera*, *Lepidoptera*; 88 families; 87 sorts; 114 species.

Axente Sever: 4 classes: *Annelida*, *Arachnida*, *Chilopoda* and *Insecta*; 11 orders: *Haplotaxida*, *Aranea*, *Acari*, *Lithobiomorpha*, *Geophilomorpha*, *Collembola*, *Orthoptera*, *Heteroptera*, *Hymenoptera*, *Coleoptera*, *Diptera*; 65 families; 79 sorts; 68 species.

The common characteristics of the samples collected from the experimental variants after applying the two technologies can be synthesized in the following aspects: the presence of some species of invertebrates belonging to the classes *Annelida*, *Arachnida*, *Chilopoda* and *Insecta*; the highest weight of *Insecta* class (as the number of species and samples); similitude in the trophic structure (first, second and third consumers); a relative poor fauna as a result of the drought in the experiment area comparatively with other years of investigation, as well as the specific conditions of microclimate and chemistry of the soil.

The weight of the invertebrates groups and the differences among the localities chosen for experiment were, as follows: the presence in the corn cultures in Poplaca and Ocna Sibiu of the species of invertebrates belonging to the classes *Diplopoda* and *Crustacea*.

The structure on the families of arthropods, common for all three localities comprised characteristic species that generally lives on the soil or under it: *Annelida* class comprised species from the families *Lumbricidae* și *Enchytreidae*; The *Arachnida* class comprised species from the families: *Theridiidae*, *Lycosidae*, *Opilionidae*, *Thomisidae*, *Araneidae*, *Gnaphosidae*, *Salticidae*, *Amaurobiidae*, *Pisauridae*, *Agelenidae*, *Linyphiidae*; The *Chilopoda* class comprised species from the families *Scutigeleridae*, *Lithobiidae*, *Scolopendriidae* and *Geophilidae*; The *Diplopoda* class comprised species from the families: *Julidae* and *Polydesmidae* and the class *Crustacea* comprised a species belonging to *Parcellionidae* family. We want to mention the fact that the insects were best represented from all the groups of arthropods identified in the experimental variants. The determined and common fauna belong to the following orders: *Collembola* (*Sminthuridae*, *Entomobryidae*, *Hypogastruridae*); *Orthoptera* (*Gryllidae*); *Heteroptera* (*Miridae*, *Anthracoridae*); *Hymenoptera* (*Formicidae*, *Myrmecidae*); *Coleoptera* (*Carabidae*, *Histeridae*, *Staphylinidae*, *Chrysomelidae*, *Elaterridae*, *Anthicidae*, *Curculionidae*); *Diptera* (*Agromyzidae*).

The characteristics that were not in common were represented by the presence of species belonging to the order *Lithobiomorpha* (1 sort), *Scolopendromorpha* (1 sort), *Julida* (2 sorts),

Polydesmida (1 sort), Isopoda (1 sort), Thysanoptera (1 sort), Homoptera (1 sort), Lepidoptera (1 sort).

Regarding the trophic categories in which they fell the arthropods from the experimental variants we can quote: phytophagous species (pests specific for corn, polyphagous species, specific pests for the adjacent cultures); zoophagous species (predatory and parasite ones); necrophagous species; coprophagous species; detritophagous species.

Among the specific pest for corn we quote: *Blaniulus guttulatus* Bosch., *Bryobia praetiosa* Koch, *Dociostaurus maroccanus* Thunb., *Melanogryllus desertus* Pall., *Macrosteles laevis* Rib., *Adelphocoris lineolatus* Goeze, *Adelphocoris seticornis* F., *Leptoterna dolabrata* L., *Amara eurynota* Panz., *Agriotes lineatus* L., *Agriotes pilosus* L., *Athous niger* L., *Drasterius bimaculatus* Rossi, *Melanotus rufipes* L., *Tanymecus dilaticollis* Gyll., *Diabrotica virgifera virgifera* LeConte, *Phyllotreta vittula* Redtb., *Phyllotreta undulata* Kut., *Phyllotreta atra* F., *Phyllotreta nemorum* L., *Melolontha melolontha* L., *Oxythyrea funesta* Poda, *Opatrum sabulosum* L., *Agrotis segetum* Den. & Schiff.

Among the polyphagous species present in the experimental variants we quote: *Sminthurus viridis* L., *Oedaleus decorus* Germ., *Cacopsylla melanoneura* Först., *Pyrrhichia apterus* L., *Phymatocera aterrima* Klug., *Aphthona herbigrada* Crt., *Podagrica malvae* Illig., *Haltica palustris* Weise., *Cryptocephalus fulvus* Goeze, *Elater praeustus* F., *Meligethes coracinus* Strm., *Otiorrhynchus morio* F.

The most important predators species present in the researched corn cultures are: *Lithobius forficatus* L., *Ommatoiulus rutilans* Eug., *Chromatoiulus unilineatus* Koch., *Hypoaspis aculeifer* Canest., *Amblyseius degenerans* Berlese, *Theridion ovatum* Clerck., *Phalangium opilio* L., *Pardosa lugubris* Clerck., *Scolopendra cingulata* Latr., *Scutigera immaculata* Newp., *Polydesmus complanatus* L., *Geophilus flavus* De Geer, *Formica rufa* L., *Lasius fuliginosus* L., *L. flavus* L., *L. niger* L., *Cicindela campestris* L., *Poecilus cupreus* L., *Harpalus pubescens* Müll., *H. calceatus* Duft., *H. distinguendus* Duft.

The parasite species were slightly represented. A possible explanation being that the collecting method of the samples adequate for the fauna at the level of the soil or at corn plants, in the area were *Tanymecus dilaticollis* had its activity. There were present in small numerical densities species from the Chalcididae and Braconidae families. We want to mention a single species belonging to *Ichneumonidae* family; (*Stenichneumon culpator* Schr.), which presence can be considered accidental.

The necrophagous species, reduced as area and numeric density were represented by *Pleurophorus caesus* Creutz, Aphodiidae family and *Anthrenus verbasci* L., Dermesidae family.

The coprophagous species were represented specially by dipters (*Calliphora vicina* Rob&Desv., *Sarcophaga carnaria* L.), Sarcophagidae and Stratiomyidae.

The detritophagous species were well represented by the orders: *Haplotaxida*, *Isopoda*, *Collembola*, *Hymenoptera*, *Coleoptera* și *Diptera*. From these we mention: *Lumbricus terrestris* L., *Allolobophora rosea* Sav., *Fredericia bulbosa* Rosa, *Porcelio scaber* L., *Hypogastrura manubrialis* Tullb., *Sminthurus viridis* L., *Entomobrya arborea* Tullb., *Ceratophysella bengtssoni* Agren, *Folsomia fimetaria* L., *Microglossa gentilis* Märk., *Mycetoporus Mulsanti* Gnglb., *Mycetoporus clavicornis* Steph., *Trogophloeus rivularis* Strm., *Cerylon fagi* Bris., *Cerylon histeroides* F., *Atomaria prolixa* Er., *Myrmica rubra* L., species of Diptera from Sciaridae family.

Characteristic for the fauna structure of the corn biocenosis was the low effective of the captured species, expressed in the number of collected samples as well as in the values of the relative numerical abundance. Nevertheless there is a biologic diversity due to the immigration of fauna from the adjacent ecosystems. The captured fauna with the help of Barber traps was richer as number of species and samples than the fauna in the soil, excepting that in Poplaca where to the soil was applied the agricultural technology closed to the organic one but with many elements from the mechanized system of the intensive technologies.

Regarding the ecologic quantity analysis of the biodiversity components in the experimental fields organized on the territory of Sibiu County there were noticed semnificative differences among the applied technologies, the degree of impact. These are going to be analyzed statistically after the centralization of the data in the final data base. There was also noticed a greater pressure of the command factors upon the biodiversity in Axente Sever as a result of the excessive pollution in the past, especially with heavy metals, as was seen in the agrochemical analysis of the soil.

Regarding the fauna structure emphasized through the two methods of collecting used there was also noticed differences among the investigated experimental fields, which indicated a degree of impact different function the used technology or other values of the command factors (microclimate conditions, chemical characteristics of the soil, etc.)

In Poplaca (technology with elements of organic agriculture) the fauna in the soil was better represented and more diverse than the fauna collected through the Barber trap method. In the case of the fauna in the soil there were dominating the population of anelide from Haplotaxida order and the species from the Coleoptera order. In the case of mobile fauna at the surface of the soil dominated the population from the Hymenoptera order followed by Aranea and coleopteron species.

In Ocna Sibiu (agricultural technology of intensive type) the fauna in the soil was, also better represented than that at the surface of the soil, the species from Haplotaxida being dominating upon those belonging to the Hymenoptera and Coleoptera orders. Differing from Poplaca taking into consideration the technology of intensive type, the Oribatidae (acari) species were better represented. In the case of mobile fauna on the surface of the soil, the dominating populations were those from Acari order followed by the species from the Collembola, Hymenoptera and Coleoptera orders, the last two in equal proportions.

In Axente Sever besides the applied technology of semi intensive type the impact upon the local biodiversity in the corn cultures is stressed by the area pollution with heavy metals and black smoke upon the environment produced by the former plant in Copșa Mică, closed after 1990 because of these aggressions upon the environment. The soil and the entire zone covered with biocenosis of natural and semi natural type remained till nowadays affected by high doses, more over the normal of chemical noxae. The structure of the biodiversity of the invertebrates in the case of drillings in the soil presented, in comparison with the other two localities reduced values in the first phase of the investigations, both in number and values of the relative abundance (4 orders of Hymenoptera and Coleoptera in the dominating position).

Regarding the comparison between the level of the fauna and its structure on the entire period of vegetation and the investigation (March-October) in the experimental field in Poplaca were emphasized the most groups of invertebrates (17 orders), the same number being registered in the experimental field in Ocna Sibiu. The differences were registered in the case of the dominant components of the biodiversity: while in Poplaca the dominating populations were from Hymenoptera, Coleoptera and Collembola Orders comparatively with the situation in Ocna Sibiu where dominating were the populations of insects belonging to Collembola Order, followed by Acari, Coleoptera and Hymenoptera. In Axente Sever the strong reducing of the components of the biodiversity is very considerable, 11 orders with the domination of the populations from Hymenoptera and Coleoptera Orders.

An indicator of great importance for the state of the structural and functioning parameters of a biocenosis, belonging to the inhabited ecosystems, with often modification of the entering in the system (input), modification that represents in fact the variation of pressure and command factors upon the components of the biodiversity, is the rapport between the useful and pest fauna. It is noticeable that in all localities where the researches were organized this parameter had positive values.

Conclusions

1. Upon the inhabited agricultural systems the impact of the applied technology on the biodiversity of the invertebrates community was amplified by maintaining at high values, of pressure of the natural command factor, mainly the excessive drought, persistent during the last three years, taking into consideration the not irrigated system in which the corn was cultivated in the experimental plots in the three localities in Sibiu County;

2. The study of the fauna structure and the biodiversity of the species of invertebrates in the corn cultures mentioned upper, the collected samples through two specific methods, comprised organisms from the following taxonomic groups: Poplaca: 6 classes: *Annelida, Arachnida, Chilopoda, Diplopoda, Crustacea and Insecta*; 17 orders: *Haplotaxida, Aranea, Acari, Lithobiomorpha, Scolopendromorpha, Geophilomorpha, Julida, Polydesmida, Isopoda, Collembola, Orthoptera, Homoptera, Heteroptera, Hymenoptera, Coleoptera, Diptera, Lepidoptera*; 46 families; 117 sorts; 93 species; Ocna Sibiu: 6 classes: *Annelida, Arachnida, Chilopoda, Diplopoda, Crustacea and Insecta*; 17 orders: *Haplotaxida, Aranea, Acari, Scutigermorpha, Geophilomorpha, Julida, Polydesmida, Isopoda, Collembola, Thysanoptera, Orthoptera, Homoptera, Heteroptera, Hymenoptera, Coleoptera, Diptera, Lepidoptera*; 88 families; 87 sorts; 114 species; Axente Sever: 4 classes: *Annelida, Arachnida, Chilopoda and Insecta*; 11 orders: *Haplotaxida, Aranea, Acari, Lithobiomorpha, Geophilomorpha, Collembola, Orthoptera, Heteroptera, Hymenoptera, Coleoptera, Diptera*; 65 families; 79 sorts; 68 species.

3. The common characteristics of the collected samples on the experimental plots after applying the three types of agricultural technologies (organic system, intensive system and semi intensive system) can be synthesized through the following aspects: the presence of the species of invertebrates belonging to the classes *Annelida, Arachnida, Chilopoda and Insecta*; the greatest weight of the *Insecta* class (as number of species and samples); the fauna was relatively poor because of the drought existing in the area of experiment comparatively with other years;

4. From the groups of invertebrates present on the soil and in the soil of the experimental corn plots the arthropods were best represented: *Arachnida* Class with two orders *Acari* and *Aranea*; *Chilopoda* Class with orders *Lithobiomorpha, Geophilomorpha* and *Scutigermorpha*; *Diplopoda* Class was represented by the orders *Polydesmida* and *Julida*; *Insecta* Class comprised the most orders (9): *Collembola, Thysanoptera, Orthoptera, Homoptera, Heteroptera, Hymenoptera, Coleoptera, Diptera, Lepidoptera*;

5. The characteristics that were not in common consist in the presence of the species belonging to the species to *Thysanoptera* Order (1 species) and of those

from Crustacea Class, Isopoda Order (1 species) that weren't present in Poplaca and Axente Sever (Thysanoptera) and in Axente Sever (Isopoda);

6. The trophic categories in which the invertebrates framed in the experimental corn plots we can mention: phytophagous species (pests specific for corn), polyphagous, pests specific for the adjacent cultures); zoofagous species (predators and parasites); coprophagous species; detritophagous species;

7. The comparative analysis of the biologic material collected on the entire vegetation period of the corn cultures (April-October) showed a level of the biodiversity of the invertebrates much lower in the case of the cultures in Axente Sever, stressed by the high level of pollution of the soil with heavy metals (lead and cadmium);

8. On the assembly of the collected fauna in all three localities the rapport of the useful and pest fauna was positive, in the favor of the useful fauna, that indicates the maintaining of the structural and functioning parameters of the ecosystems at values above the level of resilience (Poplaca and Ocna Sibiu) as well as a start of ecologic restoration (Axente Sever).

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