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Insects and agroecosystems, a review

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Abstract: The Agroecosystem can be characterized as the natural ecosystem that is undergoing modifications by the human being, with the purpose of serving as a work unit and agricultural production. However, the exacerbated use of synthetic products and the inadequate management of natural resources can cause several imbalances to the system. In the same proportion in which agricultural production expands gradually, the cases of agricultural pests are also raised in the different agricultural crops, gaining even prominence in recent years. It is important to emphasize that in addition to the increase in pressure with herbivorous insects, some insects considered beneficial to the productive systems, such as biological control agents, soil organisms and pollinators, are also affected precisely by the management Agricultural practices in Agroecosystems. The objective of the present work is to explain in the form of bibliographic review the main concepts involved in agroecosystems, sustainable agriculture and insects associated with productive systems.

Keywords: Biodiversity, Ecosystem, Soil.

Contextualization and analysis

Agroecosystems are open systems that rely on human participation for the transformation and use of the medium for the extraction of food, fibers, raw materials and other components essential for contemporary survival. With increased production and rampant agricultural expansion in recent years, the intensive use of fertilizers, agrochemicals and inadequate soil management can result in irreversible losses to the system itself.

Several human-beneficial organisms, such as pollinators, biological control agents, ecosystem engineers and individuals of the soil fauna, reduce their biological contributions to the system as the negative effects of activities Anthropic harm them. The components of soil biology, especially those belonging to the macro fauna, constantly suffer from the agricultural practices and the cultivation systems employed.

Thus, the objective of this work is to bring an overview of basic concepts about agroecosystems and their importance to insects.

Agroecosystems

The ecosystem because it is a functional system is delimited by the relationships between living beings and their natural habitats. The structure of the system is constituted by the interactions of the organisms with the environment, other individuals in the medium and also by the dependence of abiotic factors such as luminosity, soil, temperature and humidity (FEIDEN, 2005).

In the early days of mankind, the balance between humans and ecosystems predominated. With Sedentarism, the discovery of agriculture and exacerbated population growth, it became necessary the technical and intellectual improvement of the exploitation of natural resources and agricultural production processes (MACHADO; MACHADO FILHO, 2014).

The term agroecosystem has been highlighting in recent years within the scientific community for addressing important concepts of modern agriculture. It is often associated with polemic issues of environmental preservation, use of synthetic chemicals, exploitation and conservation of natural resources.

There are different definitions for agroecosystems, however, according to Feiden (2005):

> *"The modification of a natural ecosystem by man, for the production of goods necessary for its survival, forms the Agroecosystem. With human*

interference, the mechanisms and natural controls are replaced by artificial controls, whose logic is conditioned by the type of society in which the farmer is inserted (...). For practical purposes, agroecosystem can be considered equivalent to production system, agricultural system or production unit. In this case, it is the set of farms and activities carried out by a farmer, with a system of own management (FEIDEN, 2005)".

Agroecosystem can also be defined as the set of interactions between biotic and abiotic factors, which may be mediated by human action. Agroecosystems are reported as dynamic and complex systems by contemplating the set of different variable factors. It is possible to highlight the relationship with the different classes of soil, the variability of cultural aspects, the issues focused on food quality and safety, the execution of agricultural activities in relation to the use of natural resources and the use of managements and Inputs as tools for the production (ROBOREDO et al., 2017).

According to Altieri et al. (1999), Agroecosystem can be defined in many ways, but it is important to substantiate the concept focused on human interactions with the resources for food production. Also, according to the authors, agroecosystems are agricultural systems within geographic units, being difficult to determine the area of coverage because they are open systems that receive external inputs.

The Agroecosystem operates in several scales, and can be highlighted as the management of the natural ecosystem focused on the production, distribution and consumption of food and also fibers and different raw materials. Globally, topics such as climate change, global food system, political instability and economic discrepancy are directly linked to the current model of exploration and commitment to natural resources (CABEL; OELOFSE, 2012).

There are currently several discussions about the extent to which natural resources and humanity can withstand the current model of development (DELUIZ; NOVICKI, 2017). Environmental education, considered in the past decade as being a concern only of the diverse groups of ecological movements, has been highlighted by presenting the direction towards sustainable development, being such a priority and relevant theme by various governmental and non-governmental institutions (BARRETO; VILAÇA, 2018).

The current model of development, alienated only the market economy, has negatively transformed society, without worrying about the recoverability and regeneration of the exploited system. The aspects of great impact are related to issues focused on social culture, the preservation of the environment and the concepts related to the need for human consumption and what is only represented by interests and greed (VARGAS et al., 2012).

The modifications promoted in the natural ecosystem, often as a consequence of the actions of modern man, promote changes in natural processes and consequently uncertainties about the near future. Unfortunately, nowadays agroecosystems undergo several changes in biophysical scale. Being often motivated by irregular land use, intensive farming, urbanization without planning and land abandonment, leading to the degradation of vast areas (HANAČEK; RODRÍGUEZ-LABAJOS, 2018).

The increase in productivity through the use of fertilizers and synthetic chemicals, also led to the reduction of natural biodiversity (MÉDIÈNE et al., 2011). Also, with the expansion of the agricultural areas, the system of exploratory cultivation and the removal of areas of environmental preservation, such as areas of permanent preservation (APP) or legal reserves (RL), have mainly harmed beneficial species as is the Case of enemies-natural agricultural pests, pollinating agents and the well-known "ecosystem engineers".

Pest control in agroecosystems

The productive model used in agriculture has been facing serious challenges, especially with regard to the models of management adopted and the concern focused on sustainable development. It is possible to highlight that many of the practices employed in Brazil's current production system are originated and based on technological packages that have been used still during the "green revolution" period, in the mid-70 (MARTINS et al., 2004).

At the level of agroecosystem, it is undeniable to affirm that the intensive use of technological packages, mainly of fertilizers and synthetic insecticides, has contributed to significant increases in production and productivity. However, at the same time, the disoriented use of such resources provides the loss of natural biodiversity and environmental impacts that end up causing the imbalance of beneficial populations in the system (MARTINS et al., 2004; MÉDIÈNE et al., 2011).

With the expansion of new agricultural frontiers and the predominance of monocultures, mainly delimited by agricultural commodities, the production system started to demand increasingly efficient tools for pest control. The modification of the landscape, the concentration of resources, the expansion of large areas with the presence of host plants, become environments of easy detection by pests. In addition, these conditions favor the formation of specialized and adapted populations to stay in these environments (SCHNEIDER et al., 2015).

The removal of native areas, forests and the accelerated expansion of agricultural areas, became a favorable environment for the expansion of populations of herbivorous insects, which motivated by the abundance of food and ecological imbalance, became Key pests in their respective crops of interest. With the most frequent incidence of insect pests, the continuous and intensive use of synthetic insecticides has promoted several undesirable consequences to the environment. According to Schneider et al. (2015), the intensive use of synthetic insecticides in recent years has provided the formation of numerous cases of resistance of agricultural pests to active principles and also caused negative effects on beneficial agents of the environment, such as pollinators and natural enemies. This fact leads to awareness and review of management choices to be adopted as future tools for pest management in agroecosystems.

Seeking methods that may be alternative to the conventional model, we highlight the practices focused on the organic production system. Using techniques consistent with the sustainability of agroecosystem and matching principles, concepts and methodologies defended by agro ecology (MARTINS et al., 2004), it is possible to minimize the negative effects of the exacerbated use of Synthetic insecticides.

As tools for pest control in alternative production systems, preventive and curative methods can be used. It is possible to highlight as strategies the use of biological control, use of phytoprotective plant, cultural, mechanical and behavioral control and also the use of botanical insecticides.

Agriculture in alternative production systems

Alongside the expansion of conventional systems, cultivation in alternative production systems has been highlighted in the world scenario. This practice aims to guarantee the production and final productivity at a high level, damaging the natural relationships of the agroecosystem as little as possible, thus maintaining the harmony and natural equilibrium of the environment.

Alternative production systems are preferred to the independence of the use of external inputs, the rational use of technologies that respect ecological principles and which, consequently, promote the conservation and maintenance of biodiversity (SANTOS et al., 2013). According to Campanhola and Valarini (2001), alternative production systems can be classified into: 1) biodynamic farming, 2) natural farming, 3) organic farming, 4) organic farming and 5) permaculture.

All systems are based on the recycling of natural resources, composting and formation of hummus in the soil, soil and acidity correction through the use of dolomitic or calcytic limestone, use of dead plant cover on the soil, use of Bio fertilizers, rotation and intercropping of crops, restriction to the use of synthetic products such as growth reducers, chemical fertilizers or pesticides and the use of biological control of pests and diseases (CAMPANHOLA; VALARINI, 2001).

Insects-pest in organic soybean crops

Although the conventional cultivation has a larger scale, organic cultivation is presented as an alternative income for small farmers. In the 2008/2009 crop, the organic soybean crop presented, in the state of Paraná, 1,649.92 hectares of planted area and estimated production of 4,942 tons, totaling the universe of 214 producers (EMBRAPA, 2011).

However, just like any other culture of the conventional system, the management in organic crops should be conducted in a coherent, strategic and cautious way. According to Corrêa-Ferreira et al. (2003), within the organic production practices, the greatest management challenges are related to weed control and insect pest control.

The organic soybean crop is constantly attacked by dozens of insect pests, and the development phase of the plant, the affected plant part and the severity of damage is variable for each insect species. Soybean production in Brazil is subjected to pest attack from germination to harvesting. In general, the same pests of traditional cultivation also affect organic production (LOZANO et al., 2017).

They stand out as important pests to the initial and vegetative development of the crop, the soil pests and the caterpillars complex. During the reproductive period, the grain-sucking stink bug are the main responsible for direct and indirect damage to the crop (CORRÊA-FERREIRA et al., 2003; LOZANO et al., 2017).

Within the caterpillar's complex, the most common defoliators for the organic soybean crop are: the soybean caterpillar, Anticarsia gemmatalis (Hübner, 1818), (Lepidoptera: Erebidae), the false soybean Looper Chrysodeixis includens (Walker, 1858), (Lepidoptera: Noctuidae) and the caterpillar-enroslope Omiodes indicata (Fabricius, 1775), (Lepidoptera: Pyralidae). It is also noteworthy, as species of most recent occurrence, caterpillars of the Spodoptera complex, basically represented by Spodoptera cosmioides (Walker, 1858) and Spodoptera eridania (Cramer, 1782), (Lepidoptera: Noctuidae). (HOFFMANN-CAMPO et al., 2000; SOSA-GÓMEZ et al., 2014; LOZANO et al., 2017).

Among the soil pests, emphasis on the caterpillar-elasmo, Elasmopalpus lignosellus (Zeller, 1848) (Lepidoptera, Pyralidae), the white grub complex (Coleoptera: Melolonthidae e Scarabaeidae), in the same order the larva-wire (Elateridae) and the larva-pin (Chysomelidae). The brown stink bug of the root, Scaptocoris castanea (Perty, 1830) (Hemiptera: Cydnidae) and the root cochineal, Dysmicoccus texensis (Tinsley, 1900) (Hemiptera: Pseudococcidae) may also be harmful to soybean crop (HOFFMANN-CAMPO et al., 2000; OLIVEIRA et al., 2012).

Sucking stink bug are considered as pests of importance in organic soybean culture, due to the damage they affect during the reproductive phase. When feeding the pods and grains, they cause wilt and malformation of the seeds, damaging factors such as yield, uniformity of maturation, vigor, germination capacity and weight of grains (CORRÊA-FERREIRA; PANIZZI, 1999).

The most important phytophagous stink bug for agricultural crops, as well as for the culture of organic soybean, are belonging to the family of pentatomids. Highlighting the species of Nezara viridula (Linnaeus, 1758), Piezodorus guildinii (Westwood, 1837) and Euschistus heros (CORRÊA-FERREIRA; PANIZZI, 1999; HOFFMANN-CAMPO et al., 2000; LOZANO et al., 2017).

According to Lozano et al. (2017), E. Heros popularly known as brown stink bug of soybean, is the predominant species and also the most common in the cultivation of organic soybean. This is a key pest, as adults and nymphs feed on the pods and grains of organic soybeans, causing loss of quality and productivity.

As a promising alternative, the use of beneficial insects for pest control has shown efficient results in preliminary assays. For the control of E. Heros in organic soybean, the parasitoid Telenomus podisi Ashmead (Hymenoptera: Platygastridae) In addition to presenting a natural occurrence in agroecosystems, it can also be inserted as a biological control agent (LOZANO et al., 2017).

Edaphic fauna in agroecosystems

Brazil can be regarded as one of the countries with the greatest biological diversity on the planet. In general, it can be classified in up to six different biomes: Cerrado, Amazon, Atlantic Forest, Caatinga, Pampa-South and Pantanal. The great diversity can still be justified due to the vast diversity of ecosystems and agroecosystems throughout the national territory.

Among the biological diversity that stands out in the country, the existing in the soil becomes one of the most important, due to the great importance it presents to Agroecosystems. Although not so "visible", the edaphic fauna plays important environmental contributions that end up being little recognized (SILVA et al., 2012)

Despite studies with edaphic fauna in Brazil are still beginners, it is possible to emphasize that soil management, tillage systems, vegetation cover and chemical managements exert influence on the variations of populations and diversity of individuals (BARETTA et al., 2006). According to Drescher et al. (2011), the indiscriminate use of agricultural inputs, inadequate soil management, plus the lack of awareness of the population contribute to the increase of environmental pollution and the natural alteration of the edaphic fauna.

Thus, soil organisms can be considered as a sensitive portion of the soil to modifications of management practices, cultivation systems, fertilization, liming and application of synthetic chemicals (DRESCHER et al., 2011). According to Baretta et al. (2006), soil cultivation and tillage systems may interfere with the density and diversity of the organisms of the edaphic fauna.

Soil quality is directly related to physical, chemical and biological factors. Soil modifications due to its use may alter processes related to organic matter decomposition, particle aggregation and nutrient cycling velocity, and may negatively affect the presence of macro fauna (ROSA et al., 2015).

Baretta et al. (2006), using multivariate analyses, evaluated the effect of different tillage systems and soil cultivation on the groups of individuals of the edaphic fauna. Using traps of the type "Tretzel Trampas" under conditions of soil cultivation in conventional system, minimum cultivation and no-tillage, in system of rotation and succession of crops.

The authors showed that the groups Acarina, Hymenoptera, Isopoda and Collembola were the orders that most contributed to discriminate the different tillage and soil cultivation systems. In general, it is possible to emphasize that the soil fauna can, in a practical way, be used as bioindicators of soil management alterations (BARETTA et al., 2006).

The forestry system also has significant participation in the Brazilian economy, being mainly focused on the cultivation of eucalyptus trees. The forestry sector has been highlighting the advances in research and works that prioritize beyond the increase in productivity, the reduction of the use of phytosanitary products, such as insecticides and herbicides (GARLET et al., 2017).

In studies conducted by Garlet et al. (2017), in order to test the effect of different alternatives of chemical control of weeds on the arthropod fauna in commercial planting of Eucalyptus grandis (W. Will). Using pitfall soil traps, the authors collected a total of about 26,136 specimens, distributed in four different classes and 13 orders. From the total collected, the results showed that 71.5% of the individuals belonged to the order Hymenoptera.

The authors highlighted that in treatments without weed control, or only with the control of eudicotiledons (broad leaves) the results showed a smaller number of specimens collected when compared to treatments with higher exposure Chemistry. This fact can be justified by virtue of some populations, such as ants, who can develop in environments with some degree of anthropic modification (GARLET et al., 2017).

However, in most of the treatments in which there was the permanence of weeds, favored the establishment of the most diversified soil fauna, collaborating for the formation of environment in ecological equilibrium. According to the Shannon Diversity index, the highest value was obtained for the treatment situation without weed control (1.92). The lowest index was obtained (0.92) precisely where the total chemical control of weeds was performed (GARLET et al., 2017).

Evaluating the attributes of abundance of organisms, richness, diversity index (H ') and Shannon equitability in conventional tillage conditions, minimum cultivation, no-tillage in tobacco (Nicotiana tabacum L.) Culture, change of Cultivation for viticulture and the native forest environment, using "PROVID" traps. The authors reported that the minimum cultivation system presented the lowest H ' value.

The no-tillage showed the highest number of individuals, but without significant differences in diversity. It is important to highlight that the absence or presence of soil revolving, in addition to the rotation and soil cover, were the main factors that contributed to differentiate the edaphic populations (DRESCHER et al., 2011).

Evaluating the distribution of different groups of soil macrofauna and their relationship with the soil use system, as well as the physical and chemical attributes, Rosa et al. (2015) describe that the modifications in the macrofauna composition of the soil were Observed as a result of the soil use system, highlighting the systems that had the greatest anthropic intervention. Still according to the authors, conditions of native forest, pasture and eucalyptus reforestation stood out as more stable in the characteristics of biodiversity, different than when compared to agricultural areas of no-tillage or even Situations of constant exploitation as crop-livestock integration.

In a study about different soil uses in coffee plantations in relation to the function and diversity of the edaphic fauna, Silva et al. (2012) described that in view of this agroecosystem, the groups of Formicidae were dominant. According to the authors, the collection period may influence the abundance of richness and diversity of the collected groups. However, in general, the groups collected from the edaphic fauna were similar for all management systems. This fact evidences that in perennial crops, there is a greater stability of the soil fauna.

In ecotoxicological assays using seeds with treatments based on insecticides and chemical fungicides, the survival and reproductive potential of F. candida (Collembola) were evaluated. According to Alves et al. (2014), all the products used in the (Gaucho®, Cruizer®, Standak Top®, Vitavax® e Captan®) caused F. candida mortality. The active principles of Fipronil and Imidacloprid are the most lethal.

In a similar study, the toxic effect of the active ingredient Cypermethrin (Pyrethroid) on the behavior and reproduction of the species F. Candida (Collembola) was evaluated. According to the observed, in the short term the effect of Cypermethrin was repellent to Collembola and in the long term, the active ingredient showed negative effects on the reproduction of individuals (ZORTÉA et al., 2015).

In the knowledge of the widespread use of herbicides based on glyphosate, the ecotoxicity of four formulated products was evaluated (Roundup Original®, Trop®, Zapp Qi® e Crucial®) on earthworms (Eisenia Andrei), F. Candida and isopods (Porcellio dilatatus). It was observed that, in behavioral tests, the species E. Andrei and P. Dilatatus showed no behavior to avoid contact (repellent action) with the products in oat straw on the soil (NIEMEYER et al., 2018). Still, according to the authors the F. Candida species presented behavioral change (repellent effect) when in contact with the Zapp Qi® product, even at the recommended dosage. Reproductive aspects were not influenced, but the percentage of food activity was influenced in the treatment with the Crucial® product, which presents a red stripe in the toxicological classification of the bull (NIEMEYER et al., 2018).

Knowing the importance of the edaphic fauna for the maintenance of fundamental activities for the ecosystem and also for the agroecosystem, soil conservation and the option for managements that prioritize the preservation of soil biology are essential. The adoption of conservationist practices, prioritizing nutrient cycling, accumulation of organic matter, through crop rotation, minimal revolving and use of vegetal cover, in addition to reducing the use of synthetic chemical inputs are Feasible alternatives for the success of environmental preservation.

Final considerations

It is important to highlight that the different agroecosystems suffer greater or lesser negative interference according to the methods and farming practices to which they are constantly subjected. Consequently, the organisms that are inhabitants of the different systems, especially insects, are also subject to human interference. Awareness, choice for alternative farming practices and the use of harmful inputs to the environment are the most convenient tools in the purpose of contributing to the sustainable development of agriculture.

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