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Weed Population Dynamics

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1. Introduction

Clearly, the growing infestation of weeds in agricultural systems causes damage to crops, with sharp declines in productivity, either by direct competition for factors of production, whether by allelopathic compounds released into the soil (MARTINS and PITELLI, 1994). There are many factors related to population dynamics of these plants. However this chapter will be referred to those who, according to research, seem to be the most important.

2. Factors influencing the population dynamics of weed

In various cultures was observed the influence of farming system, being of fundamental importance to understand these dynamics through studies on the floristic composition and phytosociological structure of the same. The cultivation of maize intercropped with tropical forages in the system of direct planting can reduce the incidence of weeds due to the high biomass production and allelopathy provided by surface deposition of straw on the soil. The presence of *B. brizantha* intercropping reduced weed density. Therefore, the use of intercropping maize with *B. brizantha* provides control rate of 95% of the weeds in the soil (BORGHI et al., 2008).

A survey of weeds in conventional farming sunflower family Poaceae was the most representative among species (SILVA et al., 2010). In the experiment carried out by MARQUES et al. (2010) the plants originate in poultry farming sprouts in cowpea had the highest rates of importance values. However, they are dependent on the season and the continuity of the system.

Mechanized harvesting of raw cane enables the maintenance of the layer of straw on the surface, so by reducing the movement of soil and alter the dynamics of herbicides. These changes promote changes in microclimatic conditions, which in turn affect the composition of specific weeds. In this culture, the population dynamics of weeds in no-tillage system reduces up to 531% the incidence of weeds compared to the conventional system after treatment with herbicides. This provides 27% reduction in the productivity of cane sugar in conventional tillage soil (DUARTE JR et al., 2009).

The results obtained by VAZ-DE-MELO et al. (2007) showed that the practices adopted in growing organic green corn under no-tillage system, provide the appropriate management of weeds while with adoption of soil cover with oat straw. Among the weed species, *B. pilosa* was the one that had the highest relative importance, that due to higher efficiency of this species to produce biomass in the absence of competition. In addition, this species shows high capacity for regrowth after mowing adopted in the organic system. The maize cultivars also interfere with the relative importance of *C. rotundus,* indicating the importance of knowledge of the floristic composition and the cultivar of corn to be adopted for the proper management of weeds.

Another important factor in weed control is to define the ability of weed species to compete for water, light and nutrients that are the factors responsible for reduced productivity of the main crop.

According GAZZIERO et al. (2004), features such as growth rate, efficiency of space occupation of the soil, shading, release of toxic chemicals to weeds, crop residues produced different and the specific methods of control used in each culture are also considered important features of competition between the crop and weeds.

2.1 Humic substances in the dynamics and allelopathy and weed control

The herbicides have specific mechanisms of interaction with organic compounds in humic matter in soil. This interaction interferes with the dynamics of molecules of herbicides in soil as well as implementing the recommendations.

The humic substances present in agricultural systems are caused by the biological degradation of plant and animal remains in the soil. The maintenance of straw on the soil surface and the permanence of the root system of crops harvested in the soil increases, the medium and long term, its organic matter content. This enables the maintenance of temperature and soil moisture at adequate levels, favoring the perfect physiological functioning of plants, ensuring the survival of a wide variety of organisms such as fungi and bacteria, which are primary decomposers of crop residues and serve as food for the small animals (MATZENBACHER, 1999).

In addition, the products then formed associate themselves into complex structures more stable, dark colored, high molecular weight, separated on the basis of solubility characteristics. Classified into: humin, humic acids, fulvic and hymatomelâmicos.

The humic substances increase the CTC CTA and soil, protecting and providing the cations and anions for the plants. This property of ion exchange of soil humic substances, when properly managed, enhances the efficiency of pesticides and fertilizers, and reduce the contaminant action (FOLONI e SOUZA, 2010, 2010).

The cultures used as soil cover in general have the ability to recycle nutrients, promote decompression of the soil, increase organic matter content and suppress weeds (THEISEN et al., 2000). The suppression occurs through the production of secondary metabolites, called allelochemicals, which accumulate in various organs of plants and are released with important ecological function. The main forms of release into the environment occur through the processes of volatilization, exudation from roots, leaching and decomposition of waste (DURIGAN and ALMEIDA, 1993).

The allelopathic action, both during vegetative growth and during the decomposition process, interspecific inhibition exerts on other species. The inhibition is linked primarily to reduced availability of light and to allelopathic effects, which have potent phytotoxic and can act as inhibitors of photosystem II (CZARNOTA et al. 2003; KADIOGLU et al., 2005).

The biochemical production of inhibitors, the remains of crops or the soil microorganisms can inhibit the germination and emergence of some species (MATEUS, 2004), as well as reduce the initial growth of plants.

Sorghum and millet are C4 plants, which have fast growth and good ability to cover soil. Furthermore, sorghum has allelopathic compound that is exuded by their roots, sorgoleone, which is able to differentially suppress the growth of various weeds and crops (NIMBAL et al., 1996).

Another factor that may alter the production of allelopathic compounds and modify the intensity of the effects found in the field, are the characteristics of the environment where these allelochemicals are produced. According to MARTINS et al. (1999) in the system of production of sugarcane, if allelopathic compounds are present in the straw, without fire, will be released larger amounts of these substances in the soil and may promote weed control or cause reductions shoots in culture due to autointoxication, similar to that observed in the cultivation of *Brachiaria brizantha* (RODRIGUES and REIS, 1994).

Thus, determining the nature of the effects of straw on the seed germination process and may lead to the adoption of different techniques of behavior control of invasive plants. In addition to the species and numbers of viable weed seeds that are dependent on culture, the presence of humic substances in the soil and in the application solution interferes with the population dynamics of weeds.

2.2 Weed control through trash on the soil

In Brazil, the adoption of production systems where crops are planted on some kind of plant waste / trash has increased in several regions. The layer of straw on the soil is essential to the success of no-tillage system. It creates an extremely favorable environment for the improvement of physical, chemical and biological soil, contributing to weed control, stabilization and recovery of production or maintenance of soil quality. The system of crop rotation and succession must be suitable for the maintenance of a minimum cover the soil with straw.

The weed control by vegetation can occur by physical effect, preventing the incidence of light, which can be maximized by reducing the spacing between rows, favoring rapid soil cover (BARROS et al 2009), and by allelopathic effects (KREMER, 1998; THEISEN and VIDAL, 1999; FÁVERO et al., 2001 and MESCHEDE et al., 2007).

According to RODRIGUES and ALMEIDA (2005), species such as *Galinsoga parviflora* (buttercup) and *Sonchus oleraceus* (milkweed) did not germinate in soil covered, while *Raphanus raphanistrum* (wild radish) sprouts normally. The greater the amount of straw, the greater the physical barrier that will influence the germination of weed seeds and the higher the amount of allelochemicals produced.

The amount of straw depends on the source material, soil and climatic conditions of the region and the management system. The decomposition of the mulch depends directly on the relationship between the levels of carbon and nitrogen in each material. C / N ratio indicates a high content of high cellulose and lignin. In places where climatic conditions favor the rapid decomposition of the mulch should be preferred to species with high C / N ratio, for example, grains.

According to ALVARENGA et al. (2002), can be considered that 6 t ha $^{-1}$ of residue on the soil surface constitutes an adequate amount to no-tillage system, with which it can proper rate of soil cover. However, for this same author, the quantity and quality of straw on the soil surface depends largely on the type of plant cover and management practices is given. Therefore, this amount can vary greatly depending on the ease or difficulty of biomass production or the rate of decomposition. In this case, one must consider the permanence of straw on the soil surface. It is known that the C / N ratio becomes larger as the plant grows, and the C / N ratio around 40 seems satisfactory when the objective is to collect straw.

A plant of adequate coverage is one that maintains or improves soil conditions. Grasses have fasciculate roots, making them useful in reconstructing the structure of the soil, improving water infiltration and controlling erosion. Since legumes are the most efficient in the process of biological nitrogen fixation, rapidly decomposing waste by the lower C / N ratio (PECHE-FILHO et al., 1999). In choosing these plants, is a decisive factor to know their adaptation to the region and its ability to grow in an environment less favorable, since the crops are laid down in auspicious times. Therefore the straw to form the Brazilian Cerrado conditions, can be sown corn, sorghum, millet, pigeon pea, sunflower and crotalaria after cultivation of main crop (second crop).

The cultivation of oats and other species to cover the soil, either alone or in consortium, within a system of crop rotation, promotes significant increases in the yield of subsequent crops, and make them more lucrative by reducing the use of mineral fertilizers (MATZENBACHER, 1999). DERPSCH et al. (1985), reported that oat winter covering produced larger amounts of dry matter (8670 kg ha $^{-1}$) and high levels of total N (147 kg ha $^{-1}$), while reducing the amplitude of variation of temperature and soil humidity. To VIDAL et al. (1998), the mulch originated from oat straw to reduce weed infestations.

Results of experiments conducted in five tillage in Nebraska, USA, indicated that five seven t ha $^{-1}$ of wheat straw residue on the soil reduced the biomass of weeds in 21 and 73%, respectively, compared with soil discovered (WICKS et al., 1994). CRUTCHFIELD et al. (1985) reported that five t ha $^{-1}$ of wheat residue reduced weed density by 65%, contrasted with soils without residue.

Thus, we can say that the presence of plant residue / straw affects the establishment of weeds in different ways. Among the forms of interference cites are: formation of physical barrier to be broken by the plant in emergency temperature control on the soil surface, increased microbial biomass that can reduce the seed bank in the soil, apart from possible allelopathic effects that inhibit germination (FOLONI e SOUZA, 2010).After the biochemical transformation of these residues occur in the presence of soil humic substances, which will interfere with the dynamics of molecules of herbicides in the soil, or even the recommended doses of herbicides.

Herbicides when applied to the soil come, either directly or by incorporation of vegetable crop residues. In this sequence, there is a branch of the most complex and fascinating study of environmental soil chemistry, where little is known.

3. Organic matter and sorption of herbicides in the soil

Organic Matter (OM) present a strong ability to absorb herbicides (STEVENSON, 1972) and this reduces the mobility and biological activity of chemical compounds applied to soil

(SCHEUNERT et al., 1992). The pronounced reactivity of the OM is mainly related to its high specific surface area and presence of various functional groups such as carboxyl, hydroxyl and amine, and aliphatic and aromatic structures (STEVENSON, 1972; STEARMAN et al. 1989; KUCKUK et al. 1997).

CHEFETZ et al. (2004) observed greater adsorption of ametryn in sediment with 1.25 dag kg $^{-1}$ of organic carbon in relation to the other with 1.63 dag kg $^{-1.}$ The authors attributed this behavior to the fact that most of the sediment showed higher adsorption of aromatic compounds in the organic fraction, followed by a smaller number of polysaccharides, which favors its adsorption capacity.

Among the compartments of soil organic matter, humic substances are reported as the main responsible for the sorption of herbicides (PUSINO et al. 1992; CELIS et al., 1997). Most humic substances, especially in tropical regions, is in the form of clay-organic complexes (52 to 98%), according to STEVENSON (1994), whose total binding energy depends on the different forms of interaction promoted by functional groups of components organics. In this condition, neutralize their functional groups with loads of clay minerals, which reduces its sorption capacity of herbicides (PROCOPIO et al., 2001).

3.1 Quality of OM and HS on the sorption of herbicides

The quality of organic matter because of their functional groups determine the sorption of atrazine in soils, since different humic substances show different sorption intensities (PICCOLO et al., 1992). Among the constituents of organic matter, humic acid is responsible for about 70% of the sorption capacity of atrazine (BARRIUSO et al., 1992). Another important physical and chemical sorption of pesticides in soil is pH. In this sense, TRAGETTA et al. (1996) observed maximum sorption of atrazine in humic and fulvic acid near pH 3, while for pH conditions normally found in soils (5-7) sorption is lower.

PROCOPIO et al. (2001) observed that the sorption of atrazine by humic acids isolated was approximately nine times greater than that found sorption to kaolinite, goethite and ferridrita also examined separately. This indicates the high affinity between the herbicide and humic acids (MARTIN-NETO et al., 1994).

According MARTIN-NETO et al. (1999), the high intensity of hydrophobic sites to which the fraction of atrazine coupled (non-ionic behavior) can bind would be the main mechanism involved in sorption of atrazine with humic substances.

FERRI et al. (2005), in his study of sorption of herbicides on different substrates and found that the sorption ability of acetochlor was higher in the soil under no-tillage compared to conventional tillage.This behavior was explained only partially by higher content of C in the treatment of the sample of direct seeding.

When isolated, humin and humic acids showed acetochlor ability to absorb higher than when contained in the soil. Humin had higher ability to absorb acetochlor than the humic acids (FERRI et al., 2005).

Spectroscopic studies performed by PICCOLO et al. (1996) demonstrated that the main mechanism linking glyphosate and humic substances can be hydrogen bonds. The sorption of this herbicide may vary depending on the macromolecular structure and size of humic substances. The less aromatic C, the greater the sorption of the molecule.

3.2 Humic substances on the recommendation of herbicides

The humic acids in general allow a better exchange of chemicals, so that some authors suggest a decrease in those with the maintenance of efficacy was observed that the FOLONI and SOUZA (2010) working with cane sugar, concluding in his work that the use of humic acid in doses of 3.0 and 6.0 L ha^{-1} did not cause phytotoxicity apparent effect on the culture of sugar cane plant. The addition of the use of humic acid with Dual Gold in different combinations, even with dose reduction of 25% allowed an excellent control of the main weeds present, equaling or surpassing traditional treatments until 120 DAT.

In assessing the remobilization of bound residues of 14C-anilazina fulvic acids in two soils of Germany, LAVORENTI et al. (1998) observed a small percentage of this waste in the humic and humin fractions and that the microorganisms were stimulated by applying the treatments corn stover (1.5 g 100 g^{-1} dry soil) and glucose + peptone (0.2 g + 0.2 g 100 g^{-1} dry soil).

4. Allelochemicals release and control weed

4.1 Concept and production of allelopathy

Allelopathy is said to have any effect that plants have on the production of other chemical compounds released into the environment (RICE, 1984). Plants are able to produce chemicals with properties that affect beneficial or harmful in other plant species phenomenon called allelopathy, which is of Greek origin meaning *allelon* (from one to another) and *pathos* (suffering) (MOLISCH, 1937). Currently, this conceptual definition has become broader, expanding into the animal kingdom, since the interaction can occur between them and the plants and between animals and plants (GARDEN OF FLOWERS, 2001).

The chemicals responsible for allelopathy are called allelochemicals, whose function is primarily protective (SORIANO, 2001). The natural compounds with phytotoxic properties may have a high potential to control weeds (SOUZA-FILHO, 2006). According to MORALES et al. (2007), these compounds tend to have low toxicity to non-target organisms of control, as a potential source in the discovery of new molecules of herbicides less harmful to the ecosystem.

Unlike the common occurrence of compounds with allelopathic properties in higher plants, the amount and composition of these may vary depending on the species, age of the organ of the plant, temperature, light intensity, nutrient availability, microbial activity of the rhizosphere and composition of the soil in which they are the roots (PUTNAM, 1985; EINHELLIG and LEATHER, 1988).

Many are organic compounds produced by higher plants or microorganisms that have been identified as allelochemicals, which are: terpenes, steroids, organic acids, soluble in water, aliphatic aldehydes, ketones, long chain fatty acids, polyacetylenes, naphthoquinones, anthraquinones and complex quinones, originate from the mevalonate metabolic pathway of acetate (REZENDE and PINTO, 2003). Already the simple phenols, benzoic acids and derivatives, cinnamic acids and derivatives, coumarins, amino acids, polypeptides and sulfides and glycosides, alkaloids, cianidrina, flavonoids, and purine nucleoside derivatives, quinones and hydrolysable and condensed tannins are derived from the acid metabolic pathway shikimic (REZENDE and PINTO, 2003).

These compounds can be released from allelopathic plants through leaching and volatilization, root exudation and decomposition of plant residues (WEIR et al., 2004). A large number of allelopathic compounds such as oxalic acid, the amygdalin, coumarin and transcinâmico acid, are released into the rhizosphere and can act directly or indirectly in plant-plant interactions and the action of microorganisms.

The allelopathic effects may occur in the forms of auto toxicity and hetero toxicity (MILLER, 1996). The autotoxicidade occurs when the plant produces toxic substances that inhibit seed germination and growth of plants of the same species. Research has shown that alfalfa plants contain water-soluble phytotoxic compounds that are released into the soil environment by means of fresh leaves, stems and crown tissues as well as dry material, decaying roots and seeds (HALL and HENDERLONG, 1989). The phytotoxic hetero toxicity occurs when substances are released by leaching and root exudation and decomposition of waste in any type of plant on seed germination and growth of other plants (NUÑEZ et al., 2006). This second form is more potential to be explored by science, as a subsidy for the control of weeds in organic farming systems, or even as a tool to reduce costs with herbicides in conventional systems management.

4.2 Mode of action of allelochemicals

The action of allelochemicals and modification involves inhibition of growth or development of plants. According to SEIGLER (1996), the allelochemicals can be selective in their actions and plants can be selective in their response, which is why it is difficult to clarify the mode of action of these compounds. Several mechanisms of action of allelochemicals can affect the processes of respiration, photosynthesis, enzyme activity, water relations, stomatal opening, level of hormones, mineral availability, division and cell elongation, structure and permeability of membranes and cell wall (REZENDe et al. 2003). The same authors reported that many of these processes occur as a result of oxidative stress. One of the many effects of allelochemicals in plants is to control the production and accumulation of reactive oxygen species (ROS), which accumulates in cells in response to the allelochemical, thereby being responsible for damaging the cells causing their death (TESTA, 1995). Among them, blocking chain that carries electrons, where electrons are free and easily react with O_2 to form superoxide. Another known mechanism in the formation of ROS is the activity of allelochemicals on the NADPH oxidase, an enzyme that transfers electrons from the NDPH and donates to an acceptor (O_2) forming superoxide (FOREMAN et al., 2003).

Some allelochemicals rapidly depolarize cell membranes, increasing permeability and inducing lipid peroxidation, causing a generalized cell disorder that leads to cell death (YU et al., 2003).

4.3 Weed control by allelopathic effect

Seeds of *Coronilla L varies.* showed reduced germination rate when exposed to aqueous extracts of *Eucalyptus camaldulensis* and *Juglans regia* (ISFAHAN and SHARIAT, 2007). Soils planted with species *E.grandis, E.* and *E. urophylla grandis x urophylla* contains water-soluble phenolic compounds that inhibit the germination and early growth of black beans *(Phaseolus vulgar)* (ESPINOSA-GARCIA et al., 2008). According BURGOS et al. (2004), the allelochemicals produced by *Secale cereale L.* reduces root growth of *Cucumis sativus L.* causing changes in cellular structures of the roots. Thus, a large part of allelochemicals acts on oxidative stress by producing reactive oxygen species, which act directly or as flags to the processes of cell degradation, thus preventing the germination and early development, as well as physiological processes of plants.

Another effective technique for controlling weeds, mainly due to physical and allelopathic effects is the use of green manure. FONTANÉTTI et al. (2004) observed that species velvetbean *(Stizolobium aterrimum)* and pork-bean *(Canavalia ensiformis)* significantly reduced the number of nutsedge when incorporated into the soil before planting romaine lettuce and cabbage. Already CAVA et al. (2008) found that plants such as *C. juncea, C. spectabilis, M. aterrima* and *M. pruriens* have high competitive capacity by reducing the production of dry mass and number of weeds. SEVERINO and CHRISTOFFOLETI (2001) found that the use of green manures *Arachis pintoi, C. juncea* and *Cajanus cajan* have significantly reduced the seed bank of species *Brachiaria decumbens, Panicum maximum* and *Bidens pilosa.*

Thus, it is clear that the population dynamics of weed species is a function not only of the main crop, soil and planting season, but also because of the tillage system, the quantity and quality of dry matter present in the soil surface. This is due to the fact that each species used in land cover has production of metabolites that interfere with specific control of weeds. The association provides interaction with herbicides and microorganisms in the soil fauna, as well as decreasing the dose of herbicides due to the increased amount of straw on the soil surface.

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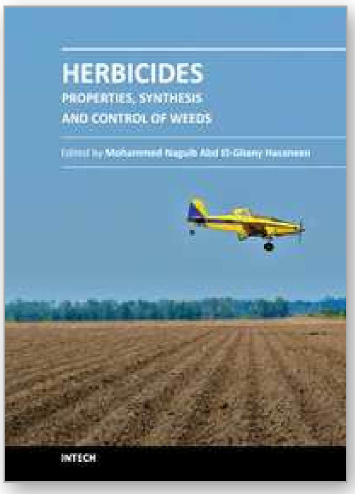

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