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Weed Competition in the Soybean Crop Management in Brazil

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1. Introduction

The soybean culture (*Glycine max* (L.) Merrill), driven by the market and especially the selection and development of cultivars widely adapted to its cultivation, has expanded from the southern region to other regions of Brazil, being grown even in the north. In recent years, its importance as an agricultural commodity has a highlighted position among other crops in Brazil. With approximately 58.2 million tons produced on 20.6 million hectares in 2007/08 (FAOSTAT, 2008), the country became the second largest producer and the first in world exports of grains and soy products. The incentive to production is related to the growing global demand for oil and protein for animal feeding and human food, besides the recent feasibility of grain in the production of biodiesel.

Factors like technical expertise and the use of high technological level also contribute to the increase in production and in productivity. The introduction of GM soy, for example, tolerant to glyphosate, has provided several changes related to the cropping system, especially in relation to the weed management in the culture. More recently, EMBRAPA is enabling the introduction of soybeans resistant to the chemical group imidazolinone, as an alternative in the weed management. Tied to these technologies, we highlight some concerns regarding weed control in soybeans, primarily for being bound to just one or two groups of herbicides, exerting a high selection pressure on weed species (Christoffoleti et al, 1994). Furthermore, in the last 30 years, no chemical method allowed the eradication or the complete control of weeds, although they contributed to the increase in the number and to the selection of herbicide-tolerant species (Altieri, 1991).

Despite advances in their controlling, weeds in soy are still a cause of losses in quality and productivity, and the same happens to other crops. This fact contributes to an increased demand for herbicides by the Brazilian market, the most representative of all, with about 40% of pesticides commercialized and among these, 50% dedicated to the soybean production system (Sindag, 2006).

According to estimates made by Oerke & Dehne, (2004), even with the adoption of control measures, Brazil loses the equivalent of U.S$ 2 billion by the weed competition in soybeans and corn crops. These losses are caused, among others, by the initial coexistence with the

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weeds (Meschede et al., 2004) and, mainly, related to variability in the determination of the critical periods of prevention of the interference in soybean. The critical periods, currently defined, are grounded in losses in crop productivity resulting from competition by the weeds, highlighting the most appropriate growth stage for the performing of their control. However, Vidal et al., (2005) questioned this definition by considering that only the biotic components of the culture are observed in the determination of critical periods, without knowing the competitive ability of the weed species. Furthermore, the authors propose that the costs of control and the amount received by the commercialization of grains should be used as criteria for defining the interference periods of the weed. Thus, there is a need to identify the competitive ability of the species, being reported as the main limiting parameter.

1.1 Overview: Weed competition in the soybean crop in Brazil

1.1.1 Weeds and their occurrence in soybeans

Weeds appearance along with agriculture development, about twelve thousand years ago. At that time, with the abundance of species, there was a major balance among the many different plants, each one respecting its genetic inheritance and its habitat to development.

With the growth of the population and, consequently, a greater human interference in the proportion and distribution of species, a process of selection of the plants most suited to development in various habitats occurred gradually. Their proliferation and high adaptive capacity have enabled them to be recognized by the human as undesirable in crops, be it due to the reduction in the crop yield, to the losses in the quality of the harvested crop or even to allelopathic effects on successive crops.

Currently, many weeds are widely distributed in the territory, and some species that were typical of the colder regions, such as *Conyza bonariensis*, have been spread in sites of hot and humid tropical climate. Among the species often occurring in soybean crop we can highlight:

Euphorbia heterophylla, which is well-known for its rapid spread and difficulty of control. Its presence is common in places kept under no tillage system (Adegas, 1998) and besides reducing the crop yield, it undermines the system of cleaning and processing the seeds. The losses due to *Euphorbia heterophylla* can reach up to 80% (Kissmann & Groth, 1992), for it presents a high efficiency in water use and higher rates of net photosynthesis than soybean (Procópio et al., 2004). The occurrence of the many biotypes of this species also complicates its management (Vidal & Winkler, 2004), mainly because the chemical control which is effective to a certain place may not be effective to another.

The species *C. bonariensis*, mentioned above, has been one of the major problems faced by products of the various regions of southern and southeastern Brazil. Present in much of the American Continent, *C. bonariensis* and *C. canadensis* are among the species resistant to the herbicide glyphosate (Lamego & Vidal, 2008), complicating its management, especially in the conservation cropping system (Fig 01). These species tend to germinate under optimum soil moisture, especially in no tillage system, not tolerating waterlogged sites. Especially *C. bonariensis* presents greater selectivity to variations in soil moisture (Yamashita & Guimarães, 2010), allowing its germination period to be extended according to local rainfall. Its germination is often concentrated in the coldest period of the year, from May to July. However, the emergence of *C. bonariensis* has been observed during September, October and even in December, when temperatures for the southern hemisphere are extremely high. This allows the plant to develop throughout the year and spread more quickly. Another advantage of the species is its way of spreading by the wind, allowing only one plant to spread its seeds kilometers away. This fact allied to its high seed production, 110 to 200.000 seeds for *C. bonariensis* and *C. canadensis*, respectively (Wu & Walker, 2004), its presence can reduce the soybean productivity up to 80%. The control of this species is linked, in the practice, to herbicides mixtures, with use of ingredients such as flumioxazin and chlorimuron-ethyl. However, research does not stop and new chemicals are being launched to assist North American and Brazilian producers in managing this species.

Fig. 1. Corn-soybean crop rotation area infested by *Conyza bonariensis* resistant to the herbicide Glyphosate, 2010, Castro / PR, Brazil.

Sourgrass is the common name for the species *Digitaria insularis*, which is one of the most present weeds in the soybean crop, from south to north of the country. Its problem with resistance to glyphosate since 2008 in Brazil has hindered its managing in crops, increasing the affected area. Being a perennial species with broad rhizomatous development, its chemical control becomes difficult after 45 days of growth, when the formation of rhizomes begins (Machado et al. 2006). Due to its rapid growth and photosynthetic efficiency, this species can suppress the development of the crop, limiting the production to less than 20%. Its management boils down to using graminicide in the early stages of the soybean development. However, because of its ineffectiveness when the plant is already perennial, other alternatives such as the crop rotation system are needed, allowing a better control and resistance management for the species (Pereira & Velini, 2003).

Another plant of great adaptability and one of the most difficult to control in the soybean cropping system is *Bidens pilosa*. The species has numerous biotypes scattered in the most disparate regions of the country, favoring the formation of large seed banks (Souza et al., 2009). Its main features are: the extensive formation of achenes, easy dissemination by humans, for it has an efficient system for adherence to surfaces of clothes, bags, and even to crops such as cotton, besides exhibiting dormancy, which facilitates its viability in soil. *B. pilosa* is also resistant to herbicides which inhibit the acetolactate synthase (ALS - B/2 group), complicating its management in conventional soybeans or even in RR soy (Roundup ready soy), for, in several regions, a single application of glyphosate has not provided satisfactory control of this species. For it shows the highest germination index in the surface layers of the soil, the occurrence of major emergencies of this kind is common in direct sowing, as well as its difficulty to control by glyphosate. The income losses in soybeans caused by the presence of *B. pilosa* are numerous and this is favored by its high efficiency of water use (Aspiazú et al., 2010) in dry regions or regions of prolonged drought stress.

Commelina benghalensis and *Ipomoea grandifolia* are other species commonly occurring in soybeans and offering management difficulties and economic losses. *C. benghalensis*, for example, presents itself as a perennial weed species in tropical regions of Brazil, with seed production in both shoot and root of the plant. Its control requires integrated management of different rotation systems, soil management and chemical treatment. In RR soybeans, its control with a single application of glyphosate is not possible, as well as for the *Ipomoea grandifolia*, which requires sequential sprays or the use herbicides with a different action mechanism. *I. grandifolia,* usually present in corn crops, also infests soybean, and besides the income losses, it impedes the mechanical harvest, making the work in the field difficult. The management of these species has helped to control them. Among the most used, no tillage system in conjunction with the use of crop rotations and cover crops help reduce the occurrence of several species, especially grasses, providing greater sustainability of farming system.

Numerous other not highlighted species are worrying Brazilian soy producers. S*permacoce latifolia, Tridax procumbens* and *Alternathera tenella*, among others (Tab. 1), are species with high adaptability to different ecological niches throughout the national territory and they are on the list of species likely to be capable of developing resistance to herbicides used in cultivation, being it a GMO or not.

Scientific name	**Common name**	**Scientific name**	**Common name**
Acanthospermum hispidum	Starbur	*Eragrostis pilosa*	Lovegrass
Alternanthera tenella	Alligatorweed	*Euphorbia heterophylla*	Wild Poinsettia
Amaranthus retroflexus	Pigweed	*Galinsoga parviflora*	Smallflower
Bidens pilosa	Hairy beggarticks	*Ipomoea purpurea*	Morningglory
Brachiaria plantaginea	Alexandergrass	*Panicum maximum*	Urochloa maxima
Cenchrus echinatus	Sandbur	*Pennisetum setosum*	Bufflegrass
Commelina benghalensis	Dayflower	*Portulaca oleracea*	Purslane
Cynodon dactylon	Bermudagrass	*Setaria geniculata*	Foxtail
Conyza bonariensis	Hairy Fleabane	*Sida rhombifolia*	Sida
Conyza canadensis	Horseweed	*Sida spinosa*	Sida
Digitaria horizontalis	Jamaican crabgrass	*Sorghum halepense*	Johnsongrass
Digitaria sanguinalis	Sourgrass	*Spermacoce latifolia*	Buttonweed
Eleusine indica	Goosegrass		

Table 1. Main weed species on soybean Brazilian crop.

The species *Alternanthera tenella, Tridax procumbens* and *Digitaria ciliaris* have been now identified as weeds of high occurrence in the Southeast and Midwest, although few details are yet available about its ability to compete. Among the various species occurring in Brazil, *Alternanthera tenella* L. (Fig. 2) has emerged as a weed in many agricultural crops (Freitas et al., 2006, Salgado et al., 2007, Petter et al., 2008). Although there are few records, this species causes considerable damage to crops (Nepumoceno et al., 2007), mainly in mechanical harvesting, when its branches and fruits hamper operation and reduce the yield per area. Its occurrence and destruction are mainly related to the cultivation of soybeans in southern, southeastern and central-west Brazil, presenting a high potential to spread and difficulties in its control.

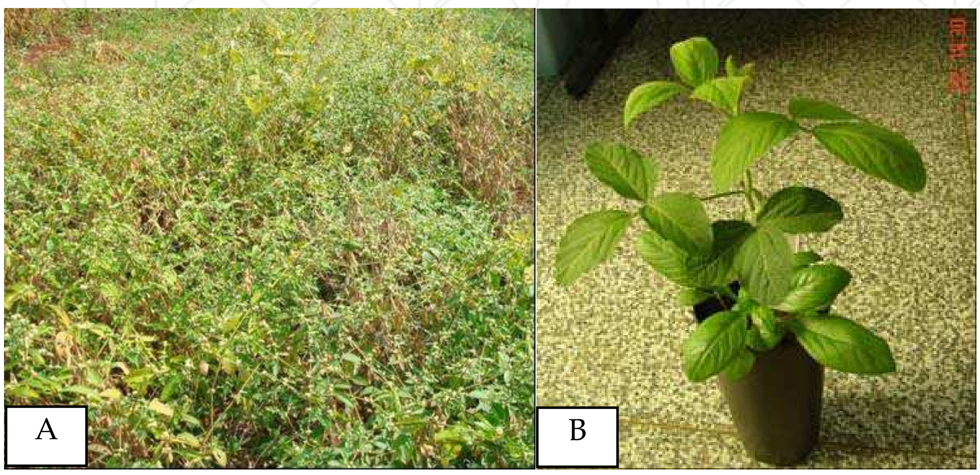

Fig. 2. A) Soybean crop and *Alternanthera tenella* in field; B) Soybean + *Alternanthera tenella* in growth chamber.

1.1.2 Weed management in soybean crops (GM and conventional) in systems of conventional and no tillage

The cultivation of transgenic soybeans in the world and of course also in Brazil increased significantly in the last 5 years. Nowadays, about 73-75% of all soybeans grown in Brazil are GMO (Round-up Ready Soybean) and receives the standard treatment with glyphosate, year after year. The effortlessness of cultivation and profitability are the main arguments for the adoption of this technology. The regions that still remain with non-GM soy are located in the states of Bahia and Parana, mainly. In these locations, the weed management still follows the pattern of pre-emergence application followed by post-emergence herbicides selective to the crop.

Soil management, in turn, is very much associated with the technological system adopted, using annual plowing and disking. Although this system (soil tilling and conventional soybean) represents the minority in Brazilian territory, it still prevails in some places, mainly in the Brazilian cerrado (Savanna). Chemical management in this system is based on the applications of metribuzin, cletodin, trifluralin, etc in pre-emergence, followed by applications of post-emergence herbicides: bentazon, fomesafen, imazethapyr, setoxydin, tepraloxydin, chlorimuron-ethyl, fluazifop-p-butil, clorasulan-methyl, etc. After applying the pre-emergence, it is necessary to monitor the area. In many areas, where the weed infestation is small, it is not necessary to use post-emergence or just the use of more specific post-emergence applied in tracks. The use of post-emergence demands some requirements to be effective, including the developmental stage of the weed and the weather conditions during application (humidity and air temperature, wind speed) among others (Buzatti, 1999).

With the emergence of numerous soil losses by erosion and sub-surface leaching it was necessary to adopt a system which would be less aggressive to the physical characteristics of the soil, with preservation of the stubble on the arable layer and maintenance of the soil organic matter. The conversion of areas under conventional planting to no tillage areas and their maintenance for long periods have enabled the recovery in the carbon content of the soil, reaching in some cases, a level above the soil's original level under natural vegetation (Dick et al., 1998). This system also allowed major advances in the practice of sowing, completely altering the lines of Brazilian research in the last 15 years. The microbiology of the soil began to be important in cropping systems and the understanding of integrated production management gained strength.

However, the viability of no tillage system depends on the efficient control of weeds. Thus, one should relate some important aspects of the biology and management of infesting weeds in areas cultivated under this system. A major benefit was the reduction in its germination over time (Perreira et al., 2000) and greater use of the crop control. Moreover, the presence of species not commonly observed in the conventional preparation demand better preparation and expertise of producers. Such modifications are related to the absence of soil disturbance, favoring perennial cycle weeds, as well as changes in patterns of temperature and light incidence, influencing the seed's mechanisms of dormancy.

Several strategies for weed control in no tillage system also require knowledge of population dynamics of the soil's seed bank and must combine integrated methods of control to reduce herbicide use. Generally, the seed bank in no tillage is higher than the one recorded for the conventional system, although the percentage of viable seeds that become competitive with the crop is smaller (Buzatti, 1999). The monitoring of the soil seed bank is crucial in order to evaluate changes in weed community, especially for species with persistent seeds. Among the factors that contribute to the reduction of viability of seed banks in the conservation system we can mention: density and natural aging, changes in soil temperature and soil moisture (Voll et al., 2005), depth of deposition of the seed bank in the soil (Yenish et al., 1992), among others.

Mainly the grasses had their occurrence reduced its occurrence over the years after the adoption of no tillage system, as illustrated (Fig. 02). The system allows greater exposure of the seeds on the soil surface layer, also assists as a physical barrier to germination of positively photoblastic species, as well as enables the reduction of the expression of dormancy mechanisms of species (Vivian et al., 2008), predisposing to faster depletion of the soil seed bank (Carmona & Villas Bôas, 2001).

The remaining straw after desiccation in the no tillage system can also act, through changes in the soil C/N ratio and through the allelopathic action, which prevent or reduce the germination and development of weeds, and even provoke a negative impact on the crop growth. Nevertheless, the activity of allelochemicals in soil is transient and highly complex, as they are also subject to adsorption by soil colloids, degradation, inactivation and transformation by microorganisms (Paes & Rezende, 2001). Among the species with allelopathic action, we can highlight the effects of *Avena strigosa* on grasses (Ruedell, 1995) and *Lolium multiflorum* on *Sida sp.*, *Digitaria horizontalis* and *Brachiaria plantaginea* (Roman, 2002).

Some examples of species with the highest expression, especially in the initial establishment of the sowing reported in southern Brazil are *Bidens pilosa* (Carmona & Villas Bôas, 2001) and *Euphorbia heterophylla*. The absence of soil disturbance favors the concentration of seeds of these species in the surface layer, causing an increased flow of germination in short term,

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which requires a further care during the establishment of the system. However, in the long term, its adoption is advantageous for it accelerates the decrease in the seed bank, enabling the uniformity of the seedling emergence and the effectiveness of control measures, especially the chemical.

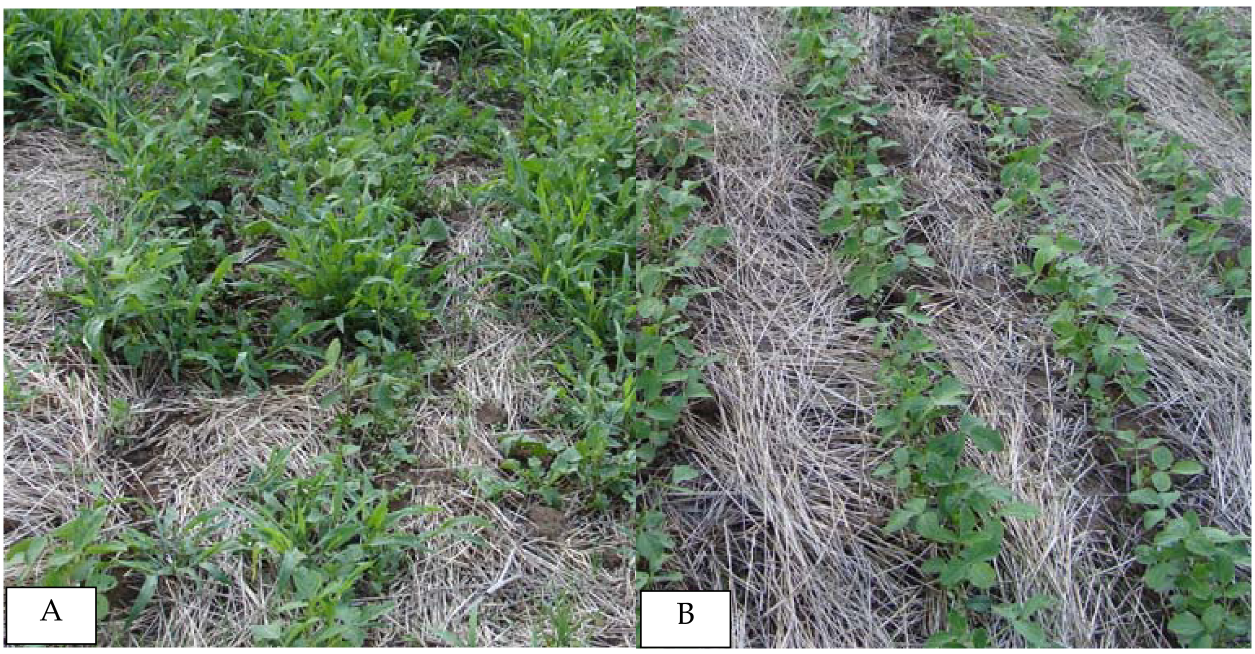

Fig. 2. A) No tillage system on soybean with application of glyphosate in an area with high seed bank *Brachiaria plantaginea,* in the beginning of soil system adoption - second year of cultivation. B) No tillage system of soybean with application of glyphosate in an area with crop rotation, during the sixth year of cultivation. Ponta Grossa/PR, Brazil.

In other Brazilian regions, such as cerrado and Alto Paranaíba, one can verify a growth of the population of some weeds in the no tillage system, among which we can highlight: *Tridax procumbens, Chamaesyce hirta, Conyza bonariensis, Spermacoce latifolia, Alternanthera tenella, Leonorus sibiricus, Digitaria insularis* and *Cenchrus echinatus* (Paes & Rezende, 2001). Many species also gain ground due to failures of the chemical control, which allow their vegetative tissues to regrowth, even after burn down. Weeds such as *Senecio brasiliensis, Brachiaria plantaginea, Digitaria horizontalis, Richardia brasiliensis* and *Euphorbia heterophylla*, as well as those belonging to the genus *Sida* and *Cyperus* multiply rapidly in the no tillage system rather because of control failures in the crop rotation system than because of the influence of the cropping system (Ruedell, 1995).

The GM soy was one of the great advances in agriculture and contributed to the development of the no tillage system. The system that provides a single application of glyphosate in the early stages of the crop gained market for its ease of adoption, undeniable efficiency in weed control and guarantee of profitability. However, the continuing and disorganized use of the technology, linked to low rotation of cultures resulted in the emergence of herbicide-resistant species, as mentioned earlier. Currently, Brazilian producers are using sequential applications of glyphosate in order to control species which are difficult to manage in crops, such as *Bidens pilosa*, *Ipomoea grandifolia* and *Commelina benghalensis.* Along with glyphosate herbicides, they also associate herbicides of other chemical control groups. Another technique used by producers in southern and

southeastern Brazil is the autumn management, in areas where these species are present. Residual herbicides such as imazethapyr and imazapic are also used to reduce the emergence of weeds during the fallow period and/or associated with the herbicide 2,4-D on burn down, about 15-20 days before the sowing, for the management of dicotyledonous difficult to control by glyphosate. Apart from the variation of biotypes selectivity, the level of herbicide application also contributes to the tolerance of the species. Late applications bring problems of control for the tolerant biotypes, for they hinder the translocation of the herbicide and allow a greater accumulation of reserves in stems, leaves and roots of plants.
Both in no tillage and conventional sowing, the current management in soybean aims to integrate cultivation techniques that minimize the effects to the environment and that offer adequate security control. The integrated management provides for connection of all the involved organisms, whether the weeds, pests or diseases should focus on decision-making with case study. There are no more ready-made and generalized solutions without risk of errors.

1.1.3 Weeds resistance and their management in crop

Any suitable chemical management of weeds in any cropping should, besides aiming to achieve the control, include the precautionary principle of a possible emergence of resistance. This means that the attempt to eradicate a species of the area is often extremely dangerous from the point of view of selection of resistant individuals. The occurrence of herbicide-resistant biotypes may include only the active ingredient in question, or be extended to the entire chemical group of control (cross resistance) or to other groups (multiple resistance), such as what occurs to *E. heterophylla*, resistant to ALS inhibitors herbicides, to some herbicides which inhibit protoporphyrinogen oxidase, as well as to glyphosate.
There is yet no evidence to indicate that the herbicides have a mutagenic effect on plants, capable of inducing or creating resistance. The natural genetic variability existent in any population of plants is responsible for the initial source of resistance in a susceptible population of weeds. Thus, all populations of weeds, even those that were not subject to the application of herbicides, are likely to contain individual plants that are resistant to herbicides.
However, the dearth of new mechanisms of action predisposes to repetitive use of herbicides from the same chemical groups of control. In soybean, one of the first herbicides used in the 1970's was the metribuzin, which has the action of inhibition of the electron flow in photosystem II (PS II) of sensitive plants. This herbicide was developed in the 1950's and 1960's and its application to soybean is only made in pre-emergence of weeds (Vidal & Merotto Jr., 2001).
Already in the 1980's, the first selective post-emergence herbicides for soybeans were developed for controlling dicotyledonous. These herbicides act by inhibiting the enzyme protoporphyrinogen oxidase (PROTOX) and are distributed in various commercial products belonging to the chemical groups of diphenylethers, phthalimides and riazolinonae (Vidal & Merotto Jr., 2001). The weed control by these groups occurs particularly in the moment the weeds have between two to six leaves. .
Even in the mid 1980's, the herbicides inhibiting the enzyme acetolactate synthase (ALS) appeared, selective to the crop and with a broader spectrum of action on weeds. Highly efficient products with low dose, these herbicides are still used on a large scale, although they present numerous cases of resistance in Brazil and other countries. In the country,

reports of resistance to herbicides inhibiting ALS were first notified in *Bidens pilosa* in 1993. Since then, the number of reports increased each year. Brazil currently has several reports of species with herbicide resistance, and from these, mainly relate to ALS inhibitors (Table 2).

Species	Common Name	Year	Herbicide Mode of Action
Bidens pilosa	Hairy Beggarticks	1993	ALS inhibitors
Bidens subalternans	Beggarstick subalternans	1996	ALS inhibitors
Bidens subalternans (Multiple resistance)	Beggarstick subalternans	2006	ALS inhibitors Photosystem II inhibitors
Brachiaria plantaginea	Alexandergrass	1997	ACCase inhibitors
Conyza bonariensis	Hairy Fleabane	2005	Glycines
Conyza canadensis	Horseweed	2005	Glycines
Cyperus difformis	Smallflower Umbrella	2000	ALS inhibitors
Digitaria ciliaris	Southern Crabgrass	2002	ACCase inhibitors
Digitaria insularis	Sourgrass	2008	Glycines
Echinochloa crusgalli	Barnyardgrass	1999	Synthetic auxins
Echinochloa crusgalli (Multiple resistance)	Barnyardgrass	2009	ALS inhibitors Synthetic auxins
E. cruspavones	Gulf Cockspur	1999	Synthetic auxins
Eleusine indica	Goosegrass	2003	ACCase inhibitors
Euphorbia heterophylla	Wild Poinsettia	1992	ALS inhibitors
E. heterophylla (Multiple resistance)	Wild Poinsettia	2004	ALS inhibitors PPO inhibitors
E. heterophylla (Multiple resistance)	Wild Poinsettia	2006	ALS inhibitors Glycines
E. heterophylla	Wild Poinsettia	2007	ALS inhibitors
Fimbristylis miliacea	Globe Fringerush	2001	ALS inhibitors
Lolium multiflorum	Italian Ryegrass	2003	Glycines
Oryza sativa	Red Rice	2006	ALS inhibitors
Parthenium hysterophorus	Raddish	2001	ALS inhibitors
Sagittaria montevidensis	California Arrowhead	1999	ALS inhibitors

Table 2. Herbicide resistant weeds of Brazil, according to the Weed Science Society of America 2010.

For the *Bidens subalternans* biotypes resistant to ALS inhibitors, studies by (Gelmini et al., 2002) found that plants from the resistant population showed a high level of cross-resistance to the chemical group of sulfonylurea and imidazolinones, although they were easily controlled by alternative herbicides to soybeans such as fomesafen, bentazon, ammonium glufosinate and glyphosate. Cross-resistance to ALS inhibiting herbicides is the result of a single mutation or combination of two separate mutations in the gene encoding the ALS, where each mutation results in resistance to a group of herbicides belonging to the same chemical group (Wright et al. 1998).

Among the species with multiple resistance in Brazilian territory are *E. heterophylla, B. pilosa* and *Echinochloa crusgalli.* Mainly *E. heterophylla* and *B. pilosa* are common species on soybeans and even in the system of cultivation with GM soy, the control of *E. heterophylla* is not possible due to its resistance to glyphosate. Specifically for *E. heterophylla*, a cross between susceptible and resistant biotypes of this weed results in fully resistant plants, being the genetic inheritance encoded by a dominant nuclear gene with complete dominance (Vargas et al., 2001). This fact, among other abilities of the weed, makes it one of the most problematic in the management of resistant weeds in Brazil.

In Brazil, the emergence of resistance cases involving the herbicide glyphosate is directly related to its intensive use in areas of no-tillage system and other areas of non-selective control of weeds. In the country, besides those already mentioned (*C. bonariensis, D. insularis* and *E. heterophylla*), *L. multiflorum* also presents resistance (Vargas et al., 2005) and there are unpublished reports of *B. pilosa* biotypes. All these species are present in GM soy, bringing the need to change the entire control management of weeds in crop. With this, the technology used without caution up to then, loses its usefulness or control potential in areas where these plants are present.

In this sense, it is considered that the management of weed populations resistant to herbicides is a direct consequence of problems related to the prevention of the occurrence of these cases. Therefore, in order to the production system used be sustainable over time, with respect to the control of weed species, it is essential to prevent the outbreak of new cases within the system itself. This fact is proven, since many of the management steps recommended in the areas of resistance are also applicable to the condition of prevention. According to (Retzinger & Mallory-Smith, 1997), the prevention and especially the resistance management should consider: (i) identification and prior knowledge of species and the justifiable economic harm before the establishment of chemical control, (ii) search for alternative methods of weed management (mechanical, cultural, etc.) (iii) use of crop rotation and herbicides with different mechanisms of control, (iv) consider the number of recommended applications of an herbicide or herbicides with the same mechanism of action within the same crop year, (v) using sequential mixtures with herbicides of different mechanisms of action, (vi) evaluation after application of the treatment, looking for areas with signals of weeds.

In Brazil, as in other countries, even after the emergence of resistance, chemical management remains the main tool in the management of the plants. For the species *C. bonariensis, D. insularis* and *E. heterophylla,* resistant to glyphosate, the addition of a second or third herbicide to the spray is still regarded as the best alternative. The mixture of herbicides in tank is the first strategy used by the chemical industry. However, many researchers continue their research, seeking to manage sustainably the agricultural environments and propose new management alternatives.

Globally, the body that monitors the evolution and emergence of new accessions of weeds resistant to herbicides, as well as the impact of these biotypes around the world is the Herbicide Resistance Action Committee (HRAC). Its action, in addition to registration and monitoring of resistance worldwide, is the constant updating of new cases. The Committee also has as its mission the promotion of research, while supporting the development of public policies that help farmers and ensure the least impact on natural systems.

2. Mechanisms of weed competition

Many metabolic processes in plants can be influenced by low water availability in the soil, promoting the partial or total closing of the stomata and limiting water loss and, consequently, the CO_2 fixation. When they close, they conserve water and reduce the risk of dehydration. As soon as the availability of water in the soil decreases, the transpiration rate also decreases, resulting in the closing of the stomata. Thus, stomatal functioning is a physiological impairment, when opened, allowing the assimilation of carbon dioxide. In the agriculture, the competition with weeds reduces growth, the biomass and the grain yield of crops, and the advantage of intercropping among cultures basically depends on the extent to which the species are not competing with each other (Wilson, 1988).

Plants can compete with each other (intraspecific) and with other species of plants (interspecific) for environmental resources (light, water, nutrients, CO_2, etc.). The length of competition time, determines losses in growth, development and hence, in crop production. A considerable reduction in the growth of species, both in intra-and interspecific combinations, is the result of spatial competition between two groups of plants that occupy the same location at a certain time period. Raventós & Silva (1995) affirmed that this reduction, caused by two neighbor plants, could be due to competition for water during the dry season and for light during the wet season, being that the complex nature of competition between plants has been largely ignored, being investigated only in the form of experimental studies and in controlled conditions. However, interspecific competition for environments conducive to plant establishment, over evolutionary time, may be generating adjustments in strategies of species regeneration.

In recent years, research related to the competitive ability of cultivars with weeds have been gaining importance, especially because the adoption of competitive genotypes constitutes a cultural practice that can reduce costs and environmental impacts (Balbinot Jr., 2003). The increase of the competitive capacity of plants is attributed to the early emergence, high seedling vigor, rapid leaf expansion, formation of dense canopy, high height of plant, long development cycle and fast growing of root system (Rees & Bergelson, 1997; Haugland &Tawfuq, 2001; Sanderson & Elwinger, 2002). Plants bearing high speed emergence and early growth have priority in the use of environmental resources and, therefore, generally have an advantage in using these (Gustafson *et al.*, 2004).

According Park *et al.*, (2001), there are two factors that influence the outcome of the competition: i) exhibiting phenotypic plasticity that can be used by a plant in a competitive environment; ii) potential competitive ability (including seed size, seedling size, emergence timing and size of plant).

All these features influence or reflect, in one way or another, the ability of an individual plant to capture resources. The degree of interference in interspecific competition depends on factors related to the weed community (species composition, density and distribution) and on the crop itself (genus, species and cultivar, row spacing and planting density). It also depends on the duration of cohabitation, the time period in which this occurs, being modified by the conditions of soil and climate and by the cultural practices (Kuva *et al*, 2003).

Competition for resources should not be confused with allelopathy, in accordance with Ferreira (2000). Allelopathy would be any direct or indirect, harmful or beneficial effect that a plant (including microorganisms) has on the production of other chemical compounds released into the environment. What distinguishes allelopathy from competition among plants is that the competition reduces or removes from the environment a growth factor required for both plants (light, water, nutrients, etc.), while allelopathy occurs by adding a factor to the environment. In practice, it is not easy to distinguish whether the adverse effect of a plant on the other is due to competition or to allelopathy (Souza *et al.*, 2003).

Studies based on physiology commonly identify how the capture of a resource by an individual affects the amount of the resource captured by another, without determining the consequences on the performance of the plant. The level of population or community gives an idea of the phenomenological responses, but fails to identify the intermediate source. The ability to raise funds in the soil and the competitive ability of plants are not necessarily correlated (Casper & Jackson, 1997). Lemaire & Millard (1999) identified five steps for analyzing the effect of plants competition through a mechanistic approach: i) model of the acquisition of source and use by the canopy in the absence of competition; ii) analysis of the canopy response to the reduction of sources, when induced by the presence of neighboring plants; iii) study of the spatial distribution of different physical sources when resulting from the presence of neighboring plants and how plants perceive these changes and develop an integrated response; iv) analysis of signaling plant to plant by means of other means but the quantitative reduction of physical sources; v) sources effects integration with non-source effects in a more understandable model in terms of the stand of the plant.

Weed competition for environmental resources (water, light and nutrients) is frequently described as the direct cause of reduction in crop production, although the limitation of these resources has different effects between species. For soybeans, for example, it appears that competition for light is the main competitive factor for weeds (King & Purcell, 1997). However, other factors such as water and nutrients are involved in defining the competitive ability, which can vary depending on the species, their plasticity and the environmental conditions that occur during their growth.

2.1 Water competition

Ground water is included among the most important resources for which plants compete. The supply of this resource depends on precipitation, evapotranspiration and water movement in the soil profile. In the case of weeds, water and nutrients extraction reduce the availability of these resources for the target culture, which causes stress and ultimately reduces the growth of both and also the yield of the crop (Patterson, 1995).

Competition for water and, consequently, the effects of its stress are undoubtedly factors that also contribute to lowering the productivity of crops (Meckel et al., 1984), as the occurrence of droughts become more and more frequent. In this sense, soy generally shows less tolerance than the weed, as found by Scott & Guedes (1979). Jones Junior & Walker (1993) observed that the water absorption in *Xanthium strumarium* exceeded twice the capacity of soy and *Cassia obtusifolia*. However, soy reduced the water uptake by *C. obtusifolia,* demonstrating that the competitive interactions between species are distinct. According to (Costa et al., 1999), soy tends to maximize the efficiency of radiation use when subjected to water deficit. However, this does not occur in the reproductive phase, mainly because of the higher energy requirement in the formation of the oil and protein content of the grains. Thus, the competition for water is critical to the culture during its reproductive phase, when the demand and translocation of assimilates to the fruits are high.

The effect of water stress on soybean yield, for example, is constantly related to their occurrence period during the crop cycle. It is known that the low water availability in the growing season has an effect on the species productive definition (Costa et al., 1999), being that the highest accumulation of dry matter mass in plants occurs between the beginning of the flowering and the filling of the grains. However, the relationship between water demand and the ability to tolerate drought can be changed. In this condition, it is assumed that the effect of drought should be proportional to the potential of the competitor species on the uptake and efficiency in the water use.

Although scarce, some research has shown that certain weeds may be more competitive under water deficit in relation to the culture, while others may have an equal or lower ability to compete than the cultivated plants. *Desmodium tortuosum,* for example, shows a greater competitive effect with soybean under low water availability in relation to the absence of stress (Griffin et al., 1989). The same does not happen to *Ambrosia artemisiifolia*, because (Coble et al., 1981) found that in years of droughts, the critical period for control of this species was lower than in years with normal rainfall, representing an increased aggressiveness of *A. artemisiifolia* in normal water supply conditions.

However, few results define precisely the dispute of resources among species, making it difficult to isolate the factors during the competition, especially regarding the interpretation of the effects of water stress, which can interfere in the photosynthesis and growth rates (Flexas et al., 2004), in cell signaling, and according to Bray (2002) on the plants' gene expression.

2.2 Light competition

Solar radiation is a significant component of the competition for some weeds. Above the soil surface, light is perceived by specific photoreceptors, including phytochrome, cryptomeria and phototropin, which induce photomorphogenic responses that influence the investment pattern of the resource that is being captured and the ability of plants to capture additional features (Ballaré & Casal, 2000). The effects of signals perceived by these photoreceptors differ between cultures and weeds (Ballaré, 1999). Furthermore, as noted by Rajcan & Swaton (2001), the mechanisms of competition between plants seem to occur much earlier than what was known until recently. The authors found that environmental signals, such as differential detection of light by plants in the red region (660-670 nm) and far red (730-740 nm) allow the change of the competitive ability between plants. This provides conditions of radiation availability variables in the different extracts of a community, and thus, the ratio red/far red is modified. The understanding of how plants detect, respond and adapt to environmental stimuli is very important for a better farming of the genotypes currently available, however, these studies should be conducted in locations that simulate the situations of crops, i.e., in an environment with natural radiation and plants growing in planting densities. Thus, physiological determinations along with some biochemical analysis can promote the clarification of the mechanisms and period of weed competition in crops.

The determination of the nitrate reductase activity (NR) (EC1.6.6.1.), for example, a key enzyme in the nitrogen metabolism in plants, can collaborate with the studies of competition. It is known that its activity is stimulated by light intensity and duration, and it may respond to different water contents in the soil (Sung, 1993). More recently, the carbohydrate content and other environmental factors have also been identified as agents in the activation of this enzyme (Xu & Zhou, 2004). Thus, we can verify that there is a close relationship between the physiology of plants and their ability to compete with weeds.

Plants generally reach their maximum photosynthetic capacity in conditions of light saturation and decrease their growth rate when exposed to shade. Most of the weeds, however, may change its photosynthetic capacity in response to variations in light intensity (Radosevich et al., 1997). Bazzaz & Carlson (1982) found that annual weeds such as *Ambrosia trifida* L., *Datura stramoniun* L. and *Polygonum pensylvanicum* L. have high photosynthetic flexibility, allowing these to grow and reproduce even at low light levels. These adaptation mechanisms allow greater tolerance to low soil fertility, drought stress or shade. The species *Isatis tinctoria* is an example of weed with high plasticity in response to shading, allowing changes in leaf area and its distribution between shoot and root. These modifications enhance the capture of light and allow its survival in the environment (Monaco et al., 2005).

According to the research conducted by Patterson (1982), the species *Cyperus rotundus* also has high capability to modulate according to the light conditions. Its plasticity was evidenced by an increase of 38% in the leaf area when transferred to an environment with 75% of light reduction, allowing greater competition ability.

2.3 Competition for nutrients

Adequate mineral nutrition is essential for the growth and development of plants. When the essential elements are missing or when there is competition between plants for a particular element, the fixation of other elements can also be affected. The competition of competing plants by sources of nitrogen and other minerals in the soil depends on its specific ability to capture these sources (root architecture and absorption properties of root tissue) (Lemaire & Millard, 1999). The high extraction capacity of soil nutrients by plants is an important factor in the delimitation of competitive parameters. In this sense, it was found that increasing plant density (increased competition) caused a decline in the absolute concentration of nitrogen (N), phosphorus (P) and potassium (K) in leaves, stems and vegetables in soybean (Marvel et al., 1992). Ronchi et al. (2003) noted, for example, that *Bidens pilosa* accumulates 5.53, 11.19 and 5.32 times more nitrogen, phosphorus and potassium, respectively, compared to the coffee crop, with maximum accumulation of dry matter mass at the pre-flowering stage. For soybeans, Pitelli et al. (1983) also found increased intake of phosphorus and potassium on dry matter of *Cyperus rotundus* in relation to the crop, which demonstrates the high potential of these species in the uptake of soil nutrients. Soil resources are fetched by the root surface through three processes: i) root interception; ii) flow of water mass and nutrients and iii) diffusion.

Less than 10% of the capitation is due to the root interception (Marschner, 1995). The supplementation of N, P and K, often depends on the mass flow and on the diffusion, processes which are difficult to separate experimentally in the field (Casper & Jackson, 1997). Aerts (1999) affirmed that competition in nutrient-poor environments do not necessarily represent a competitive ability for nutrients and a high growth rate, but may result from features that reduce nutrient losses, i.e. low nutrient concentrations in the tissues and low tissue flow. Thus, the low growth rate of some species in nutrient-poor environments should be considered as a consequence of the higher rate of nutrients retention than the competition for absorbing them.

Soil water can significantly affect the movement and availability of nutrients. Thus, there may be interactions between multiple cations, leading to replacement with a subsequent increase or decrease in its availability (Patterson, 1995). In general, the availability of water and nutrients are positively correlated. On the other hand, Aerts (1999) correlated nutrient availability with light intensity, saying that under high nutrient availability, competition for light occurs primarily. When light is a unidirectional resource, habitats with high nutrient levels are dominated by fast-growing perennials with tall stature and a greater vertical arrangement of the leaf area. Moreover, these species have high flow rate of leaves and roots and a high morphological plasticity during the differentiation of leaves.

3. Methods of weeds control

The degree of interference of weeds on crops depends on the infesting plant community (species, density and population), on the crop (cultivating, spacing and density), environment (soil, climate and management), on the period of coexistence and basically on the control method used.

For soybeans, several studies with weeds show the negative effects of competition on crop productivity, from small reductions to more than 40% drops in income, as reported for the species *Desmodim tortuosum* in soy (Melhorança, 1994).

One of the main alternatives to reduce losses to the crop is to know the critical period of weed interference. The critical periods, currently defined, are grounded in losses of crop productivity resulting from competition by the weeds, highlighting the developmental stage most appropriate for the conduct of its control. However, this definition is currently being discussed, for it considers that only the biotic components of the crop are observed in the determination of critical periods, without knowing the ability of competition and interaction of plant species.

Alternatively, new control programs must be proposed to ensure technological advancement, which shall focus mainly on studies designed to determine the biology and the mechanisms of competition between species (Chao et al., 2005). Some researches have proven the efficiency in the adoption of integrated weed management systems, based on inter-cropping. These systems are supported primarily by descriptive and mechanistic models of analysis, making it possible to optimize inter-cropping.

Considering the control methods fundamentally known, the principle of its application must consider all factors involved in the management system and be based on the use of one or more methods where the cost of implementation is lower than the economic results obtained by it. It must be sustainable, allowing its use to prevail for long periods. Being applicable to the reality of the farmer and to the socioeconomic status, besides being environmentally friendly is also important.

Didactically, control methods are divided into six, and their integration as a form of integrated management of weeds is the safest and least error-prone in the medium and long term. Among the control methods known, we can mention: preventive, cultural, mechanical, physical, chemical and biological.

3.1 Preventive

The preventive control aims, as its name already says, to prevent the introduction of weeds which are difficult to control and prevent their spread and or reproduction, keeping the other species in controllable conditions that will not cause economic damage to the crop. The main action of preventive control is the acquisition of certified commercial seed with high purity without the presence of other species. Once this measure is observed, one should be careful in the handling of agricultural machinery and implements so that they do not disseminate or introduce weeds species to the area under cultivation.

For soybeans, production and marketing of seeds shall conform to standards established by the Brazilian law in 2009. Among other prohibited species, the main is *Vigna unguiculata,* which can not be present in fields of seed production. This measure, as well as other levels of tolerance for other weed species is fundamental to the success of production and helps as a preventive management measure.

The practice of cleaning in areas with terraces and level curves, fences lines, road edges and irrigation and drainage canals also help as a preventive measure against the installation of weeds. Another simple but not very used practice is the area management area at the time between crops or second-crop. The control of plants, regardless of which method is used, is also part of the preventive management of species, for it seeks to reduce the spread and/or reproduction of weeds such as *E. heterophylla, Bidens pilosa, Tridax procumbens,* etc. which increase significantly the seed bank. The management between crops can be conducted by the integrated use of cover crops associated with sequential applications of non-selective desiccants.

3.2 Cultural

The cultural control is among the most important means of weed management and can be easily used by all producers of soy and other cultures. Some management tools make up the cultural control, such as crop rotation, use of cultivars adapted to climate and regional conditions, the adequacy of the spacing of the crop depending on the technology available and on the weed species, use of plants as green fertilizers, etc.

For soybeans, especially in the south, one of the major problems is the presence of *Cardiospermum halicacabum.* This species has an annual cycle and, besides reducing productivity, it later hampers the harvest. For it is so difficult to control, an alternative to its reduction in soybean area is the use of annual rotation with corn, allowing also the rotational chemical control. In the rotation system, especially linked to direct sowing, the diversity of organisms in the soil layer is also larger, allowing many microorganisms to conduce to degradation of dormant seeds through its deterioration and loss of viability.

The spacing and sowing density are further tools in cultural management and allow less weed interference in soybeans, basically to plants with low tolerance to shade. Usually, the density experiments for weed control are conducted in graminae: maize, rice and also wheat. However, even in soybean, studies conducted in Brazil show that reducing the spacing between rows of crops (e.g. 60 cm to 30 cm) interferes with the period of weed control (Melo et al., 2001).

Another means of cultural control is the use of green coverage in areas with high infestation of plants. Often, the species used in Brazil are legumes such as *Canavalia ensiformes*, *Cajanus cajan*, *Mucuna aterrinum*, *Mucuna deeringiana* and *Crotalaria juncea*. These species have a great potential for nutrient cycling in soil and fixation of atmospheric nitrogen. For regions with high incidence of nematodes (*Meloidogyne incognita, M. Javanica*, *Pratylenchus brachyurus* and *Rotylenculus reniformis*, the green cover with *Crotalaria juncea* or sorghum and millet are also recommended. In cooler regions, south and southwestern Brazil, other species are grown for formation of green pot plants, among them *Lupinus albus, Lollium multiflorum, Vicia villosa, Avena strigosa* and others.

In general, any cultural practices which have the objective to accelerate the growth of the culture and that reduce the growth and development of weeds can be considered as a practice of culture management.

3.3 Mechanical

Currently, the mechanical control is used on a small scale, especially for soybeans, a commodity which is mostly represented by medium and large producers. Among the mechanical methods used, it appears that the hand-weeding is the most widespread, although they also use the mechanical weeding or the mowing through mowing tractors, as well as cultivators. The latter are common in other cultures that have a wider sowing spacing.

For mechanical control, the selection of equipment appropriate to the conditions of the farming system and to the crop implementation system is very important. Under organic farming, for example, the use of mechanical control in soybeans is necessary and adapting the models of machines used, over 70% of the weeds present can be eliminated.

Often, as in manual weeding, mechanical weeding demand more than one management. Special care related to the time of year is also fundamental. The beginning or first weeding should occur between 15 and 20 days after the crop emergence, not exceeding this period, especially when the area is infested with graminae, which grow extremely fast. For the second weeding, the limit is established between the 25th and 30th days, although these periods are variable depending on the cultivars, weeds and soil and climatic conditions. In case of use of mechanical weeding with rotary drag device, the initial period shall not extend to plants with more than two pairs of leaves, for besides being harmful to the crop, the efficiency of the control will be lower.
The main limitation of this type of management is the time needed to complete the task and the short period of time for its conduction, since the weeds show a rapid natural growth. Thus, all equipment used must be calibrated and adjusted to the cropping system used. Soil moisture at the time of completion of the weeding is also important, especially for the rotary drag.

3.4 Physical

Although widespread in other countries, the physical control in Brazil is rarely used. This method is based on techniques that seek to control weeds by physical actions of water, heat, radiation, among others. As an example, we can mention the control of *Cynodon dactylon* and *Cyperus rotundus* through flooding, often used in rice cultivation.
In Brazil, a prime example of physical control in soybeans is the direct sowing, which allows the formation of an extensive layer of straw on the ground. The straw acts as a physical barrier against the germination of many weeds that need light to germinate or even hinders the emergence of weeds with very small seeds. Besides this effect, the no tillage and the accumulation of straw present other means of weed control. Even the allelopathic effects of cover plants through the release of substances from straw decomposition are a form of control, although its principle is classified within the chemical control.
Other examples known are the mulching and solarization techniques, although they are not applied in the cultivation of soybeans, they show an excellent control on vegetable and fruits crops. Their high cost and the need of control before the start of the cultivation makes its use in major crops impossible.

3.5 Chemicals

Chemical control is currently the most widely used control for soybean crops, due to its ease of control and to the large areas planted in Brazil. Such management includes pre and post-emergence herbicides, desiccants with a wide spectrum of action and non-selective with low residual power.
Choosing the chemical management for weed has been changed by the adoption of GMO soybean cultivars. Therefore, the management can vary depending on several factors, among them, the main thing is the cost of the management system. In this case, one should also take into account the cost of the GMO seeds and of the weed control.
Soybean cultivars tolerant to glyphosate (GMOs) often provide more flexibility to control a broad spectrum of weeds in soybean (Reddy, 2001). Thus, despite the higher cost of transgenic cultivars seeds, the low cost and the ease in controlling weeds has been favorable to this market.
Another important factor in this system is the time of application of glyphosate, more than the dose of the product used. Therefore, despite the need to amend the application rates

depending on the size of the weeds, the stage of implementation becomes essential when common weeds like *Chenopodium album*, *Sesbania exaltata*, *Ipomea spp*., *Abutilon theophrasti*, *Spermacoce latifolia* or even *Commelina benghalensis* are present.

3.5.1 GM soy

Currently, the lack of residual effect in the programs of GM soy in post-emergence has required multiple applications or the use of herbicides with stronger effect in new emergencies. Thus, since the glyphosate does not provide residual effect, weeds can emerge and grow during the growing season of the crop.

In this control program, it is important that the sequential application of glyphosate is mainly done between the growth stages 13 and 14. Applications made between the 3^{rd} and 5^{th} weeks after planting offer an effective control of many weeds. The second (sequential) application of glyphosate spaced 10-14 days after the first application is necessary to control weeds with later emergency or difficult to control.

In a culture system with high infestation of *Commelina benghalensis,* it is advisable to make a spray of glyphosate approximately 30 days before sowing. After the sowing, an application of glyphosate at 2.0 L ha^{-1} is performed 15 days after the emergence and in sequence, 2.0 L ha^{-1} 15 days after the first application.

For the cases of a single application of glyphosate, the application of a pre-emergence in order to delay the future application of glyphosate is recommended. The pre-emergence herbicides reduce the early weed interference and allow a greater flexibility in the use post-emergence. This can be important, mainly in the rainy season in which the application is not possible, allowing greater ease of management. Although the use of pre-emergence herbicides is recommended, it increases the cost of the program, being viable only in case of need for additional control (Reddy, 2001).

In a general way, producers, mainly from southern Brazil, perform the desiccation in the prior crop to serve as mulch. After approximately 15 days, the sowing on the straw is started. The application of glyphosate in post-emergence is performed when the soybeans have three trifoliate leaves, according to the level of infestation of weeds. In this case, the principal for the single application of glyphosate in soybean GMO is to perform the spraying when most weeds have already emerged, without allowing, however, the reduction of the crop yield.

3.5.2 Conventional soybeans

In conventional soybeans not resistant to glyphosate, the chemical control of weeds should mainly consider the selectivity of the crop to the herbicide, followed by observation of the application technology, as well as other important details such as the mixture of compounds, the environmental conditions, and the use of adjuvants, among others.

Usually, the system of plowing and harrowing for soil preparation is used in the sowing of conventional soybeans. In the case of direct sowing, the chemical control program is very similar, considering that, in this system, glyphosate is used as a desiccant in the pre-sowing rather than the use of mechanic control. For no tillage in non-GM soy, the different management of weeds in the fallow period is also important, and we can use products such as paraquat, glyphosate, 2-4 D, chlorimuron or carfentrazone.

After sowing, followed by the application of a pre-emergence, monitoring the area is necessary. In many areas where the weed infestation is small, the use of a post-emergence is not necessary, or o farmers use to spray only specific post-emergence. In area with high infestation, selective post-emergence applications are performed, both to monocotyledons and dicotyledons.

Although still under-explored in studies, the allelopathic effect of vegetable covering species on the weed control is also considered as chemical control, because its action occurs by releasing substances from the decomposition process of straw on the soil cover. The effects can occur both from crops to weeds as from weeds to crops. Among the species with proven effect, we can mention *Brachiaria decumbens, Pennisetum typhoides, Cajanus cajan, Brassica napus*, among others. Innumerable studies are aimed at evaluating the effect of allelopathic substances in the reduction of seed banks and weed control. Especially in systems of crop rotation and where green manure is used, many species assist in weed management, along with other control methods.

3.6 Biological

The biological control of weeds is still very limited, because a major problem is the selectivity of the species in relation to the culture of interest, as well as the system of multiplication of control organisms. These may be fungi, bacteria, viruses or even birds, insects, fish, etc.

In the country, some attempts were made to control extracts and chemical compounds obtained from biomass produced by *Pestalotiopsis guepinii.* Its effect was more significant in the germination of some weeds than on the seedling development. From the species tested, *Mimosa pudica* showed greater sensitivity to the inhibitory effects of the extracts (Santos et al. 2008).

Another example of use, but not in soy, is the application of a isolate of *Fusarium graminearum* as a biological control agent of *Egeria densa* and *E. najas*, submerged aquatic plants that cause problems in hydroelectric dams (Borges Neto et al., 2005), as well as the use of fish (*Piaractus mesopotamicus*) in the control of these species (Miyazaki & Pitelli, 2003).

3.7 Integrated control (Integrated Management of Weeds)

The principle of integrated weed management (IWM) is the management of all factors that affect the crop yield related to the weed population, in order to allow the crop to express its potential productivity. The IWM is to provide the maximization of resources with maximum efficiency. Moreover, the integrated management searches to equalize the environmental, economic and social issued in order to make the production system sustainable in long term. In this regard, some initiatives in combination of control methods are being used. But we are still far from the IWM. In Brazil, as in other parts of the world, the integrated management is not practiced, but we practice an integration of methods which provide a satisfactory control of weeds at lowest cost.

Some examples in soybean illustrate the shortage of IWM, among them: over-sowing systems of *Brachiaria brizantha*, *B. ruziziensis* and *B. decumbens,* helping in the management of weeds of emergency sequential to the culture (Pacheco et al., 2009), as a tool to reduce the seed bank of other weeds in the crop.

The combination of chemical control with the use of sorghum straw coverage in soybean is also a further alternative in the control of various weeds, such as *Leonotis nepetifolia, Alternanthera tenella, Amaranthus hibridus, A. retroflexus, A. spinosus, Ipomoea grandifolia,* *Commelina benghalensis* and *Nicandra physaloides,* besides helping reducing the use of post-emergence herbicide (Correia et al., 2005).

Variations in spacing of the culture, along with applications of post-emergence herbicides for controlling *Brachiaria plantaginea* (Pires et al., 2001) is another study for integrating control methods, although with no bases of IWM.

From a technical standpoint, the IWM must consider the biology and the ecological relationships of species. Seeking to understand the dynamics of nutrient cycling between compositions of weeds and crop. Relating the pressure of pathogens and pests to the presence or absence of weeds at the site and understand their symbiosis. All these aspects show how important and multidisciplinary the adoption of integrated management systems is, as well as our need to improve our research.

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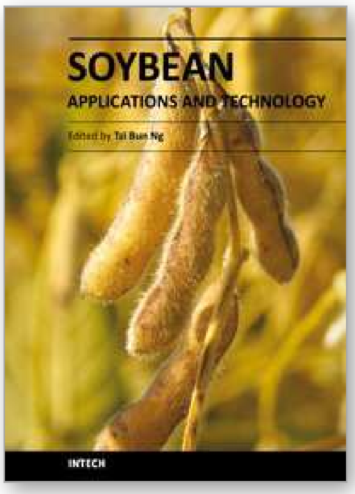

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