PLANTA DANINHA

SOCIEDADE BRASILEIRA DA CIÊNCIA DAS PLANTAS DANINHAS

<http://www.sbcpd.org>

ISSN 0100-8358 (print)
1806-9681 (online)

Article

Phytosociology of Weeds in Off-Season Maize Crops in the Middle Paranapanema

Fitossociologia de Plantas Daninhas em Lavouras de Milho Safrinha no Médio Paranapanema

GAZOLA, T.[1]*
DIAS, M.F.[1]
DUARTE, A.P.[2]
CARBONARI, C.A.[1]
VELINI, E.D.[1]

ABSTRACT -This work is the first one after the consolidation of the introduction of the RR technology in maize and soybean crops, following weed surveys previously carried out in the region of the Middle Paranapanema, São Paulo state. The objective was to carry out a phytosociological survey of weeds in off-season maize crops no-tillage, in the same properties where the studies had been previously carried out, in the described region, taking into account the management of the weed community adopted by farmers, and the percentage of plant coveron the soil. The surveys were carried out in 19 farms conducted under no-tillage systems, with off-season maize cultivated in soybean succession, both RR crops, in nine municipalities of the São Paulo region of the Middle Paranapanema, in 2016. The main weeds were *Bidens pilosa*, *Cenchrus Echinatus*, *Commelina benghalensis*, *Digitaria horizontalis*, *Gnaphalium spicatum*, *Leonotis nepetifolia*, *Raphanus sativus* and *Sonchus oleraceus*. The predominant management of weeds was the chemical method, and in the vast majority of properties, control was based on the use of glyphosate and atrazine. The other used herbicides are nicosulfuron, chlorimuron-ethyl, clethodim, haloxyfop, tembotrione and 2,4-D, almost always associated with the EPSPs inhibitor. The soil cover with straw, found at the time of the evaluation, had no correlation with the presence or absence of the weeds.

Keywords: herbicides, weeds, no-tillage, *Zea mays*.

RESUMO - Este trabalho é o primeiro depois da consolidação da introdução da tecnologia RR nas culturas de milho e soja, em continuidade aos levantamentos de plantas daninhas realizados anteriormente na região do Médio Paranapanema, São Paulo. O objetivo foi realizar um levantamento fitossociológico de plantas daninhas em lavouras de milho safrinha sob plantio direto, nas mesmas propriedades em que os trabalhos foram realizados anteriormente, na região descrita, levando em consideração o manejo da comunidade infestante adotado pelos agricultores e a porcentagem de cobertura vegetal no solo. Os levantamentos foram realizados em 19 lavouras conduzidas em sistema plantio direto, com milho safrinha cultivado em sucessão à soja, ambas culturas RR, em nove municípios da região paulista do Médio Paranapanema, no ano de 2016. As principais plantas daninhas encontradas foram ***Bidens pilosa***, ***Cenchrus echinatus***, ***Commelina benghalensis***, ***Digitaria horizontalis***, ***Gnaphalium spicatum***, ***Leonotis nepetifolia***, ***Raphanus sativus***, *and* ***Sonchus oleraceus***. *O manejo predominante de plantas daninhas é o método químico, e na grande maioria das propriedades o controle baseia-se no uso de glyphosate e atrazine. Os demais herbicidas utilizados foram nicosulfuron, clorimuron-ethyl, clethodim, haloxyfop, tembotrione e 2,4-D, quase sempre associados ao inibidor da EPSPs. A cobertura do solo com palha presente no momento da avaliação não teve correlação com a presença ou ausência das plantas daninhas encontradas.*

Palavras-chave: herbicidas, plantas daninhas, plantio direto, *Zea mays*.

*** Corresponding author:**
<tiago-gazola@hotmail.com>

Received: March 28, 2017
Approved: June 8, 2017

Planta Daninha 2018; v36:e018177498

[1] Universidade Estadual Paulista, Botucatu-SP, Brasil; [2]Dr. Instituto Agronômico (IAC), Campinas-SP, Brasil.

Doi: 10.1590/S0100-83582018360100115

INTRODUCTION

The plant community of a given area is the result of interactions among climate, soil type, cultural practices, seed bank, and animal action, among others. Thus, individuals from the same species, which make up a population, can respond differently under these interactions. According to Schneider (2007), disturbances in the natural environment potentiate the dispersion and establishment of weeds, especially after the reduction of natural diversity.

Taking into account this concept, for a proper weed control, the first step in the management should involve the identification of the species in the area. From this, strategies to be adopted can be defined, since the infestation conditions are extremely varied over the different locations, and in some cases, even in the same field of a property, and, therefore, must be considered in the appropriate choice of management for each location. According to Pitelli (2000), phytosociological indices are important to analyze the impact that management systems and agricultural practices have on the dynamics of growth and occupation of weed communities.

Off-season maize cultivated under rainfed conditions in autumn-winter, in succession to summer crops, stands out as an important agricultural system with about 10 million hectares and 66% of the total maize production in Brazil (Conab, 2016). In the State of São Paulo, this modality of maize cultivation is concentrated in some regions, with emphasis on the Middle Paranapanema, with about 51% of the total area cultivated in the State (IEA, 2015), due to the succession system with soybean cultivations and the availability of medium to high fertility soils (Tsunechiro et al., 2006).

In the last 10 years in Brazil, the main studies related to weed surveys have involved studies in pastures (Galvão et al., 2011; Froufe and Seoane, 2011; Inoue et al., 2012) and in forest areas (Moretti et al., 2013). For maize crops in the country during the same period, the main surveys were only in Roraima (Albuquerque et al., 2013), in Maranhão (Mesquita et al., 2016) and in the region of the Middle Paranapanema (Hirata et al., 2017).

Off-season maize has evolved over the last few years, and weed management followed this process, mainly due to the introduction of transgenic cultivars that are resistant to the herbicide glyphosate and to reports about the resistance of some species to herbicides in Brazil, such as *Conyza* spp., *Digitaria insularis*, *Amaranthus* spp., *Bidens pilosa*, *Euphorbia heterophylla*, among others (Heap, 2016).

Allied to this, during autumn-winter, there is a tendency where the infestation of these plants is different in comparison to the one that occurs in summer, due to the peculiarities of the climate and the cultivation of soybean before its implantation. In the São Paulo region of the Middle Paranapanema, there is a reduction in temperatures along the maize cycle, and short periods of water deficiency alternating with good availability of water in the soil (CIIAGRO, 2016).

The last survey in the State of São Paulo, specifically in the region of Paranapanema, was carried out between 2006 and 2008 on maize crops, when the adoption of the transgenic RR technology in soybean crops was starting (Hirata et al., 2017). Subsequently, in 2009, RR maize was introduced, which came to predominate in the region, starting from 2010. Therefore, no phytosociological survey of weeds was performed after the usage predominance of glyphosate on both crops.

The objective of this work was to identify and quantify the current infestation of weeds in off-season maize crops at the stage of grain filling until harvesting, taking into account the management of the weed community adopted by farmers and the percentage of plant cover found on the soil.

MATERIAL AND METHODS

The surveys were carried out in off-season maize crops, under no-tillage system, cultivated in succession to soybean crops, in nine municipalities of the São Paulo region on the Middle Paranapanema: Campos Novos, Cândido Mota, Cruzália, Florínea, Ibirarema, Maracaí, Palmital, Pedrinhas Paulista and Platina.

Nineteen crops were evaluated in July 2016, when the crop was at the stages of grain filling until recently harvested (Figure 1). They had been previously georeferenced by Duarte and Deuber (1999) and Duarte et al. (2007), in their phytosociological surveys carried out in the region. However, some farms, which were the target of these studies, migrated over the years to the cultivation of other crops, such as sugarcane, and were therefore not included in these surveys, so that changes in the weed community could be monitored in the same culture system.

Stage of crops at the time of the surveys. Properties: 8, 9, 10 and 11 - milky grain; 3, 18 and 19 - chalky grain; 1, 4, 6, 12, 15, 16 and 17 - physiological maturation; 2, 5, 7, 13 and 14 - recently-harvested.

Figure 1 - Location of maize crops in the Middle Paranapanema region - São Paulo state, where phytosociological surveys were carried out in the agricultural year of 2016.

For the weed survey, the square inventory method was used. In each property, from four random entry points, the plot was zigzagged, so that the survey was carried out in a representative area of the total. At each entry point, a metal frame with a usable area of 1 m² was randomly cast four times, and the infestation and the existing weed species were then analyzed and recorded. The phytosociological parameters were calculated according to Mueller-Dombois and Ellenberg (1974), in which:

$$Frequency\,(Fre) = \frac{Number\ of\ plots\ containing\ the\ species}{Total\ plot\ number}$$

$$Density\,(Den) = \frac{Total\ number\ of\ individuals\ per\ species}{Total\ sampled\ area}$$

$$Abundance\,(Abu) = \frac{Total\ number\ of\ individuals\ per\ species}{Total\ number\ of\ plots\ containing\ the\ species}$$

$$Relative\ \ frequency\,(RFR) = \frac{Frequency\ of\ \ the\ species}{Total\ \ frequency\ of\ \ the\ species} \times 100$$

$$Relative\ density\,(DER) = \frac{Density\ of\ \ the\ species}{Total\ density\ of\ \ the\ species} \times 100$$

$$Relative\ abundance\,(RAB) = \frac{Abundance\ of\ \ the\ species}{Total\ abundance\ of\ \ the\ species} \times 100$$

$$Importance\ value\ index\ (IVI) = RFR + DER + RAB$$

In order to analyze the similarity of the weed populations in the areas of off-season maize, the Similarity Index (SI) was used (Sorensen, 1972). For the calculation, the following formula was adopted:

$$Similatity\ index\,(SI) = \frac{2a}{b+c} \times 100$$

where variable *a* is the number of species that are common to both properties and that were compared at a time, out of the total of 19 properties; *b* and *c* represent the total of species in the two compared areas. The SI was expressed as percentage, being maximum (100%) when all species were common to all properties and minimum (0%) when there were no common species.

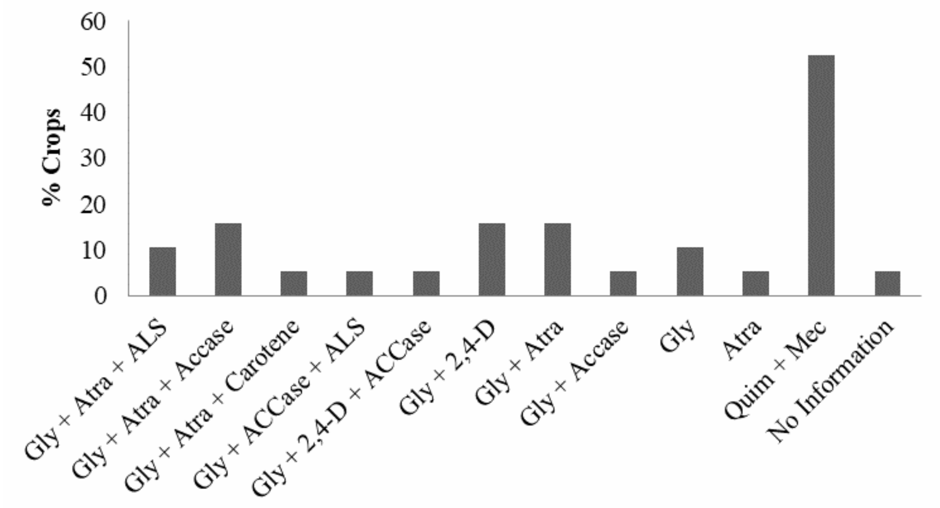
Information on crop management was also collected, such as weed management methods, used herbicides and percentage of straw soil cover found at the time of the evaluations. Soil cover was evaluated through a visual scale method, which varied from 0 to 100%, where 0 indicated the absence of straw and 100% the total straw coverage in the analyzed area. For this, in each crop, from four random entry points, the field was zigzagged, so that the survey was carried out in a representative area of the total. At each entry point, a metal frame with a usable area of 0.25 m^2 was randomly cast four times at each evaluation point, where grades corresponding to the soil cover index within the square were given.

With this information, the phytosociological parameters of the weed community were determined, according to the control methods adopted by farmers in the region, as well as the correlation between the percentage of soil cover and the presence of weeds, using the statistic software Sigma Plot 12.5.

RESULTS AND DISCUSSION

In the region of the Middle Paranapanema, in the 1990's, the management adopted to control weeds in off-season maize was based on the use of atrazine, whether or not mixed with 2,4-D and/or nicosulfuron, being associated or not to soil plowing (Duarte et al., 2007). Then, there was the consolidation of the no-tillage system and, recently, the introduction of maize that was genetically modified for herbicide tolerance. The Roundup Ready technology began to be adopted in soybean in 2006/2007 and, three years later, also in maize crops. Rapidly, rural producers adopted this technology: in 2016, in the areas where the surveys were carried out, 95% of the properties used the RR technology.

Currently, in the Middle Paranapanema region, it is common for farmers to use herbicide mixtures (Figure 2) to control weeds with a difficult management, such as *Digitaria insularis*, *Conyza* spp., *Commelina benghalensis*, *Ipomoea* spp., *Euphorbia heterophylla*, *Bidens pilosa*, *Eleusine indica*, among others. In addition, there is a strong tendency (58% of the evaluated farms) in the region to associate the chemical control with the mechanical control with hoes, mainly aiming the management of glyphosate-resistant *D. insularis* and, more recently, the one resistant to



Atra (Atrazine), gly (Glyphosate), ALS (Nicosulfuron or Chlorimuron-ethyl), Accase (Clethodim or Haloxyfop), carotene (Tembotrione), quim + mec (chemical control + mechanical control with hoes).

Figure 2 - Management of weeds adopted in off-season maize crops in 2016, in the region of the Middle Paranapanema.

ACCase-inhibiting herbicides [fenoxaprop and haloxyfop] (Heap, 2016). The reason is the difficulty of controlling this weed, because it is perennial and has a high proliferation capacity, multiplying by rhizomes, which gives it high regrowth capacity, and also by seeds, which are highly viable and with several dispersion flows throughout the year. Since most of the properties in the region are small, it is common to use family labor, which makes it possible to harvest and weed with hoes, since the soil is no longer prepared by plowing and harrowing, due to the consolidation of the no-tillage system.

In the 1990's, no-tillage systems were still in transition in the region, and the technologies to cultivate off-season maize crops were still under development. In 1995, commonly found weeds, according to Duarte and Deuber (1999), were: *Digitaria insularis*, *Sorghum halepense*, *Urochloa decumbens*, *Cenchrus echinatus*, *Digitaria horizontalis*, *Urochloa plantaginea*, *Eleusine indica*, *Commelina benghalensis*, *Euphorbia heterophylla*, *Amaranthus* spp., *Acanthospermum hispidum*, *Senna obtusifolia*, *Sida* spp., *Raphanus sativus*, *Bidens pilosa*, *Phyllantus tenellus* and *Coronopus didymus*.

Two years later, in new surveys conducted in the region in 1997, 1998 and 1999, the most important species were: *Euphorbia heterophylla*, *Glycine max*, *Commelina benghalensis*, *Bidens pilosa*, *Raphanus sativus*, *Cenchrus echinatus*, *Acanthospermum hispidum*, *Urochloa plantaginea*, *Sida spp.*, *Coronopus didymus*, *Eleusine indica*, *Digitaria horizontalis* and *Amaranthus retroflexus* (Duarte et al., 2007). In 2006, 2007 and 2008, when the Roundup Ready technology was introduced, the species with the highest importance value in the region were: *C. echinatus*, *B. pilosa*, *E. heterophylla*, *R. sativus*, *C. benghalensis*, *D. horizontalis*, *Sorghum halepense*, *Leonorus sibiricus*, *Sida spp.*, *Chamaesyce spp.*, *Emilia sonchifolia*, *Glycine max*, *Echinochloa crusgalli* and *Amaranthus* spp. (Hirata et al., 2017). According to these authors, in 2007/2008 it was possible to observe the presence of *Gnaphalium spicatum*, previously not found in the region in surveys carried out by Duarte and Deuber (1999) and Duarte et al. (2007).

In this survey, *G. spicatum* was once again observed, probably due to the repeated use of glyphosate on these areas, which may be selecting biotypes that are tolerant to the featured herbicide and, therefore, deserve attention. Besides that, the use of the same management system (post-emergence herbicides, mainly glyphosate, and no-tillage system with soybean and maize crops in succession) selected others new weeds in the region, such as *Conyza* spp., *Richardia brasiliensis*, *Sonchus oleraceus*, *Emilia fosbergii*, *Soliva sesselis*, *Leonotis nepetifolia e Chamaesysce hyssopifolia* (Table 1), which adapted to the no-tillage conditions of the soil and the permanent cover of organic matter on the surface, which are the main characteristics of the direct sowing system (Yamashita, 2010). According to this author, fleabane seeds, for example, germinate when placed at depths lower than 0.5 cm; this condition is compatible with the no-tillage

Table 1 - Weeds found in off-season maize crops in the Middle Paranapanema in 2016 and classified by family, genus, species, code and common name, according to Lorenzi (2000)

Family	Specie	Code	Common Name
Amaranthaceae	*Amaranthus* spp.	AMADE	Pigweed
Asteraceae	*Gnaphalium spicatum*	GNASP	Cudweed
	Sonchus oleraceus	SONOL	Sowthistle
	Emilia fosbergii	EMISO	Florida tasselflower
	Bidens pilosa	BIDPI	Blackjack
	Conyza spp.	-	Fleabane
	Soliva sessilis	SOVPT	Lawnweed
Brassicaceae	*Lepidium virginicum*	LEPVI	Pepperweed
	Raphanus sativus	RAPSV	Radish
Convolvulaceae	*Ipomoea* spp.	-	Morning glory
Commelinaceae	*Commelina benghalensis*	COMBE	Benghal dayflower
Euphorbiaceae	*Euphorbia heterophylla*	EPHHL	Wild pointsettia
	Chamaesyce hyssopifolia	EPHHS	Hyssopleaf sandmat
Fabaceae	*Glycine max*	-	Soybean
	Senna obtusifolia	CASOB	Sicklepod
Lamiaceae	*Leonotis nepetifolia*	LEONE	Christmas candlestick
	Leonurus sibiricus	LECSI	Honeyweed
Malvaceae	*Sida spinosa*	SIDSP	Prickly fanpetal
Poaceae	*Digitaria horizontalis*	DIGHO	Crabgrass
	Digitaria insularis	DIGIN	Sourgrass
	Urochloa spp.	-	Signalgrass
	Echinochloa crus-galli	ECHCG	Cockspur
	Cenchrus echinatus	CCHEC	Southern sandbur
	Sorghum arundinaceum	SORAR	Sorghum
Solanaceae	*Solanum americanum*	SOLAM	American black nightshade
Rubiaceae	*Richardia brasiliensis*	RCHBR	Brazil Pusley

system, because it allows seeds from previously produced weeds to remain on the soil surface, helping their germination.

In addition, it is possible to observe that species such as *Digitaria horizontalis*, *D. insularis*, *Raphanus sativus*, *Bidens pilosa*, *Euphorbia heterophylla*, *Sida* spp., *Commelina benghalensis*, occur in the region since the 1990's, when the first weed surveys were performed (Duarte and Deuber, 1999). In 2008, *D. horizontalis* was the second most important species in the Middle Paranapanema (Hirata et al., 2017), probably because the mixture of nicosulfuron and atrazine applied in post-emergence did not provide a satisfactory control of this plant. Glyphosate was also not effective in controlling of these grasses, since they remain important in the region. In addition, since *D. insularis* control was not satisfactory, the continuous use of ACCase-inhibiting herbicides in combination with glyphosate may have selected resistant biotypes.

Another species that is still very important in the region is *Raphanus sativus*, since the 1990's, during the first weed surveys in the Middle Paranapanema. At that time, its presence was attributed to the replacement of wheat crops by off-season maize, instead of the soybean-wheat binomial that had been cultivated in the region for many years (Duarte and Deuber, 1999). *R. sativus* presents emergence flows during the development of off-season maize crops, with new infestations occurring after post-emergence chemical control. Studies by Souza and Velini (1997) showed that this species has a high reproductive potential (5,000 m^{-2} seeds in non-weeded plots) and verified the inefficiency of short-term control programs in terms of seed bank reduction; this is in agreement with this study, since after two decades, this species still remains widely disseminated in the plantations of the Middle Paranapanema.

In addition to *R. sativus*, the species *E. heterophylla* has also been found in the region since the 1990's, showing that this plant has not been well managed over the years with the used herbicides and management practices. Moreover, there are biotypes of this weed species that have multiple resistance to ALS- and PROTOX-inhibiting herbicides (Heap, 2016), which raises concern about adequate managements. In addition, with the repeated use of glyphosate in these areas, it is already possible to observe in the region populations where the commercial dose of herbicides based on this molecule is not enough to suppress the development of the species. It is a worrying weed, since, in addition to the fact that there are few herbicide molecules effective for its handling and to cases of multiple resistances, it presents an extraordinary capacity of multiplication and rapid growth, and this forms dense stands, since seeds are formed in large amounts (Brighenti and Oliveira, 2011).

Another species that was not found before and that is currently very important in the region is *Conyza* spp. The direct sowing system, combined with the lack of crop rotation and the intensification of chemical control, especially in continuous applications of herbicides with the same mechanism of action, mainly glyphosate, contributed to increase the infestation of this species, which adapted very well to the climate of the region. These factors, associated, favored the rapid emergence of resistance cases for this weed, which until the agricultural year of 2008 (Hirata et al., 2017) was not found in the region.

As for the percentage of weed-infested crops according to the management adopted in the properties, it is possible to observe that the species *G. spicatum* and *S. oleraceus* were the ones that were present in the largest number of areas (Table 2). However, these weeds do not have reports of resistance to herbicides in Brazil, and are usually easily controlled with the used herbicides. This can be probably explained by the fact that these plants germinate and develop during the crop cycle, thus escaping from the action of these herbicides, applied at early stages of maize development, because they do not have a prolonged residual effect.

As the direct seeding system predominates in the region, there was an attempt to understand the correlation between these plants and the soil cover in these farms. However, there is no correlation between the percentage of soil cover (average of 42%) and the presence of weeds found in the evaluations (Figure 3).

This can probably be explained by the low percentage of dead plant cover on the soil in most areas, since evaluations occurred about four months after maize sowing; therefore, part of this cover, in areas that had not been harvested yet, were degraded throughout the crop cycle. In addition, the weeds found were not common to all evaluated properties, as is the case of *Urochloa* spp., which was observed only in a recently harvested area (75% plant cover). This explanation is accepted, since mulch prevents the emergence of minor weed seeds, since they have a small amount of reserve, which may be insufficient for newly emerged seedlings to break the mulch in search for light (Velini and Negrisoli, 2000). According to these authors, the effects of mulch influence the quality and quantity of light that reaches weed seeds, and this affects their behavior through the induction of dormancy or germination.

It is also worth mentioning that the evaluated areas belong to a climatic transition region with a rainy winter, but without a marked drop in temperature, unlike the south of the country, and this also influences the formation of straw and the development of the weed community. In addition, as mentioned, 2016 was a rather atypical year, with drought followed by frost, which may have contributed to the lower amount of straw.

Also, the intense use of herbicides in these areas, together with the mechanical control with hoes to manage some of these weeds, resulted in difficulties for a more accurate interpretation of data, that is, it was not possible to infer that the presence of straw was responsible for suppressing the development of weeds, since the management adopted by farmers and the climatic conditions of 2016 may also have been responsible for the suppression of these plants, therefore highlighting the observed non-correlation.

Currently, with the intensive use of glyphosate in soybean and maize crops, the most important weeds found in the region were: *G. spicatum*, *L. nepetifolia*, *R. sativus*, *C. benghalensis*, *S. oleraceus*, *C. echinatus*, *D. horizontalis* and *B. pilosa* (Table 3). In addition, *C. benghalensis*, *B. pilosa*, *C. echinatus*, *R. sativus*, *D. horizontalis* have always been and still are present in the

Table 2 - Percentage of off-season maize crops infested with weeds in the region of the Middle Paranapanema, in 2016, according to the adopted control methods [1]

Specie	Gly+Atra+ ALS[2]	Gly+Atra+ ACCase[2]	Gly+Atra+ HPPD[2]	Gly+ACCa se+ALS[2]	Gly+ 2,4-D+ACCase[2]	Gly+ 2,4-D[2]	Gly+Atra[2]	Gly+ACCa se[2]	Gly[2]	Atra[2]	Quim+Mec*
	Percentage of infested crops										
Amaranthus spp.	0	0	0	0	0	0	0	0	0	5	0
Gnaphalium spicatum	11	11	5	5	5	16	16	5	11	5	32
Sonchus oleraceus	11	5	0	5	5	5	11	0	11	0	21
Emilia fosbergii	0	0	0	0	0	5	0	0	5	0	0
Bidens pilosa	5	5	5	0	0	5	5	0	5	0	11
Conyza spp.	0	5	0	0	5	5	0	0	0	0	5
Soliva sessilis	0	0	0	0	0	0	0	5	0	0	5
Lepedium virginicum	0	0	0	0	0	0	5	0	5	0	5
Raphanus sativus	0	11	0	0	0	0	5	0	5	5	16
Ipomoea spp.	5	0	0	0	0	0	0	0	5	5	0
Commelina benghalensis	0	5	0	0	0	11	11	0	0	5	16
Euphorbia heterophylla	5	0	0	0	0	5	5	0	5	5	11
Chamaesyce hyssopifolia	0	5	0	0	0	0	5	0	0	5	11
Glycine max	5	11	0	0	0	5	0	5	5	0	16
Senna obtusifolia	5	0	0	0	5	0	0	0	0	0	0
Leonotis nepetifolia	11	0	0	0	0	0	5	0	5	0	5
Leonorus sibiricus	0	0	0	0	0	5	0	0	5	5	0
Sida spinosa	0	5	0	0	0	0	0	0	5	0	5
Digitaria horizontalis	5	0	0	0	5	5	0	0	0	0	5
Digitaria insularis	0	5	5	0	0	0	5	0	0	5	11
Urochloa spp.	0	0	0	5	0	0	0	0	0	0	0
Echinochloa crus-galli	0	0	0	0	0	5	0	0	0	0	5
Cenchrus echinatus	0	11	5	0	5	5	5	0	5	0	21
Sorghum arundinaceum	0	0	0	0	0	5	0	0	5	0	5
Solanum americanum	0	5	0	0	0	0	0	0	0	5	0
Richardia brasiliensis	0	5	0	0	0	0	0	0	0	5	0

[1]Applied in the post-emergence of maize, with the exception of the non-selective herbicides, which were applied in the pre-planting of the crop.[2] Gly = glyphosate; Atra = atrazine; ACCase = haloxyfop or clethodim; ALS = chlorimuron-ethyl or nicosulfuron; HPPD (carotenoid synthesis inhibitors) = tembotrione, Quim + Mec = chemical control + mechanical control (hoe). * Specifically for the management of *Digitaria insularis* and, in some cases, *Conyza* spp.

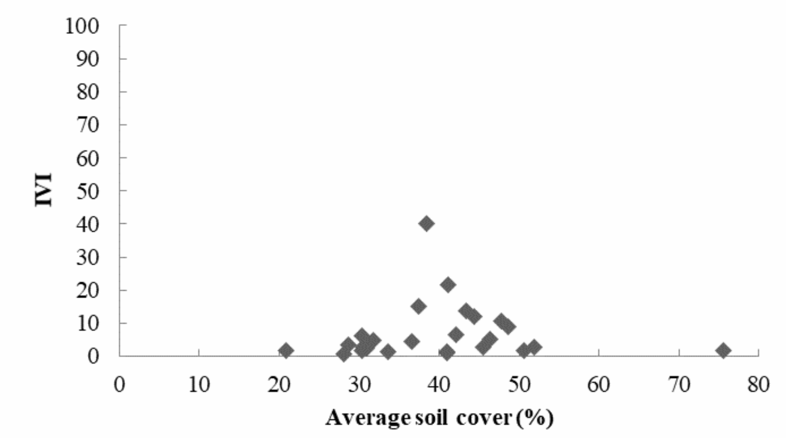


Figure 3 - Correlation of the importance value index (IVI) of weeds in off-season maize crops in the region of the Middle Paranapanema, according to the percentage of straw soil cover.

region (Duarte and Deuber, 2007; Hirata et al., 2017), highlighting that the management adopted by farmers has not been effective for these plants; moreover, their own ability to survive and multiply has contributed to this. However, other plants with a difficult control, such as *D. insularis*, *Conyza* spp., *E. indica*, *E. heterophylla*, *Amaranthus* spp., and *Ipomoea* spp., did not present a high importance value index (IVI) in the last year. Special attention should be paid to the genus *Amaranthus* spp., since there are reports about the resistance of *A. retroflexus* and *A. viridis* biotypes that have multiple resistances to ALS and photosystem II inhibiting herbicides; *A. retroflexus* is also resistant to PROTOX inhibitors (Heap, 2016) and, therefore, it depends on

Table 3 - Phytosociological parameters of weeds found in off-season maize crops in the region of the Middle Paranapanema, July 2016

Specie	Phytosociological Parameters							
	T.I	Fre	Den	Abu	RFR	RD	RA	IVI
Gnaphalium spicatum	4969	0.13	11.29	82.82	28.71	70.90	25.31	124.90
Leonotis nepetifolia	826	0.02	1.87	75.09	5.26	11.80	22.95	40
Raphanus sativus	361	0.02	0.82	40.11	4.30	5.15	12.26	21.72
Commelina benghalensis	231	0.02	0.52	21	5.26	3.30	6.41	14.98
Sonchus oleraceus	95	0.05	0.21	4.13	11	1.36	1.26	13.62
Cenchrus echinatus	127	0.03	0.28	7.93	7.65	1.81	2.42	11.89
Digitaria horizontalis	120	0.01	0.27	20	2.87	1.71	6.11	10.70
Bidens pilosa	85	0.02	0.19	7.72	5.26	1.21	2.36	8.83
Echinochloa crus-galli	19	0.00	0.04	19	0.47	0.27	5.80	6.55
Chamaesyce hyssopifolia	49	0.00	0.11	12.25	1.91	0.70	3.74	6.35
Glycine max	18	0.02	0.04	2	4.30	0.26	0.61	5.17
Digitaria insularis	20	0.01	0.04	2.50	3.82	0.29	0.76	4.87
Euphorbia heterophylla	13	0.01	0.03	1.62	3.82	0.19	0.49	4.51
Sorghum arundinaceum	12	0.01	0.02	2.40	2.39	0.17	0.73	3.29
Conyza spp.	9	0.00	0.02	2.25	1.91	0.13	0.68	2.73
Leonurus sibiricus	11	0.00	0.02	3.66	1.43	0.16	1.12	2.71
Emilia fosbergii	13	0.00	0.01	2	1.91	0.11	0.61	2.63
Lepidium virginicum	9	0.00	0.02	4.50	0.95	0.13	1.37	2.46
Ipomoea spp.	4	0.00	0.00	1.33	1.43	0.06	0.40	1.90
Urochloa spp.	4	0.00	0.00	1.33	1.43	0.06	0.40	1.90
Amaranthus spp.	4	0.00	0.00	4	0.47	0.06	1.22	1.75
Senna obtusifolia	5	0.00	0.01	2.50	0.95	0.07	0.76	1.79
Richardia brasiliensis	3	0.00	0.00	3	0.47	0.04	0.91	1.43
Sida spinosa	2	0.00	0.00	1	0.95	0.03	0.30	1.29
Solanum americanum	2	0.00	0.00	2	0.47	0.03	0.61	1.11
Soliva sessilis	1	0.00	0.00	1	0.47	0.01	0.30	0.79

TI = total of individuals; Fre = frequency; Den = density; Abu = abundance; RFR = relative frequency; RD = relative density; RA = relative abundance; IVI = importance value index.

glyphosate for its effective management. This could be a serious problem if this genus were to be selected as resistant to this last herbicide.

Some species, such as *G. spicatum*, *R. sativus* and *L. nepetifolia*, had a high abundance index (Abu) and IVI, and therefore require special attention, since they will have a great chance of continuing to multiply and, through natural selection, there will be a predominance of herbicide-resistant biotypes. According to Melo et al. (2015), resistant weeds are always present; when these products are applied, they eliminate sensitive plants, and the resistant ones survive and multiply. Resistant biotypes have become one of the major challenges in agricultural systems, due to the various cases of resistance and the high dependence on herbicides (Jasieniuk et al., 2008).

As for the comparison analysis of the presence of weeds among the properties, it is observed that the similarity index (SI) ranged from 0% to 66.7%, with average values around 35.5%. Although the locations present very similar climate and soils, since the region is relatively uniform and the crop production system does not differ much, there was variability in the floristic composition among the crops (Table 4).

In most evaluated properties, farmers adopted the use of atrazine-associated glyphosate in the post-emergence of maize crops (Figure 2); it was the first broad-spectrum herbicide used to eliminate the weeds found in the area. The second product specifically targeted the control of persistent soybean, since in almost all areas, both the implanted crops (soybean and off-season

Table 4- Similarity index of weed composition in off-season maize crops, among the crops where the surveys were carried out

Area	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	44.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	37.5	30.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	25.0	15.4	40.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	18.2	25.0	26.7	26.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	28.6	36.4	44.4	44.4	61.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	66.7	44.4	25.0	12.5	18.2	42.9	-	-	-	-	-	-	-	-	-	-	-	-	-
8	50.0	44.4	25.0	37.5	54.5	57.1	33.3	-	-	-	-	-	-	-	-	-	-	-	-
9	50.0	44.4	50.0	25.0	18.2	42.9	66.7	33.3	-	-	-	-	-	-	-	-	-	-	-
10	0.0	0.0	14.3	14.3	44.4	50.0	20.0	60.0	20.0	-	-	-	-	-	-	-	-	-	-
11	50.0	44.4	50.0	25.0	54.5	57.1	33.3	66.7	50.0	40.0	-	-	-	-	-	-	-	-	-
12	28.6	50.0	18.2	18.2	33.3	22.2	28.6	28.6	28.6	0.0	28.6	-	-	-	-	-	-	-	-
13	20.0	28.6	28.6	28.6	44.4	66.7	40.0	40.0	40.0	50.0	40.0	40.0	-	-	-	-	-	-	-
14	18.2	25.0	40.0	53.3	40.0	46.2	36.4	18.2	18.2	0.0	18.2	33.3	22.2	-	-	-	-	-	-
15	20.0	28.6	14.3	42.9	44.4	50.0	20.0	40.0	20.0	25.0	40.0	40.0	50.0	22.2	-	-	-	-	-
16	26.7	33.3	42.1	31.6	28.6	47.1	53.3	40.0	40.0	30.8	26.7	20.0	30.8	42.9	15.4	-	-	-	-
17	46.2	40.0	58.8	23.5	50.0	66.7	46.2	46.2	46.2	36.4	61.5	25.0	54.5	33.3	18.2	50.0	-	-	-
18	22.2	33.3	15.4	15.4	50.0	36.4	22.2	44.4	22.2	28.6	44.4	50.0	28.6	25.0	57.1	16.7	20.0	-	-
19	30.8	40.0	35.3	70.6	33.3	53.3	30.8	46.2	46.2	18.2	46.2	25.0	36.4	33.3	54.5	50.0	42.9	20.0	-

maize) are genetically modified to resist to glyphosate. This implies the need to improve the management of these persisting plants, since in 37% of the surveyed areas, the presence of *Glycine max* was observed; out of these, 16% had received atrazine. Soybean has always been present in the region, since the beginning of the surveys carried out by Duarte and Deuber (1999), Duarte et al. (2007) and Hirata et al. (2017), indicating that the use of atrazine was not fully effective. However, in situations where there are resistant or difficult-to-control weeds, such as *Conyza* spp., *D. insularis*, *B. pilosa* and *C. benghalensis*, farmers used a combination of 2,4-D, ALS inhibitors, carotenoid synthesis inhibitors or ACCase inhibitors. This indicates that differences in weed management may have been the main determinant for the variability in the floristic composition found in the areas.

Considering the aforementioned, it was possible to observe that the management adopted by farmers over the years has not had an effect on some weed species, since they have been in the region since the 1990's. In addition, it was possible to observe that some species, previously not present, were found in the region. Moreover, new studies should be conducted in the region to monitor the weed community, as well as the management adopted by farmers.

ACKNOWLEDGMENTS

To the supporting technicians of the agricultural research of the APTA Middle Paranapanema, Edimilson Alves Mello and Evaldo Pereira da Silva, for their help in the field activities.

REFERÊNCIAS

Albuquerque J.A.A. et al. Fitossociologia e características morfológicas de plantas daninhas após cultivo de milho em plantio convencional no cerrado de Roraima. **Rev Agroambiente On-line**. 2013;3:313-21.

Brighenti A.M., Oliveira M.F. Biologia de plantas daninhas. In: Oliveira Jr R.S., Constantin J., Inoue M.H. Biologia e manejo de plantas daninhas. Curitiba: Ominipax, 2011. p.1-36.

Centro Integrado de Informações Agrometeorológicas - CIIAGRO. **Resenha Agrometeorológica**. [Acessado em: 05 dez. 2016]. Disponível em: <http://www.ciiagro.sp.gov.br>.

Companhia Nacional de Abastecimento – Conab. **Acompanhamento de safra Brasileira: grãos, segundo levantamento, outubro/2016**. Brasília, DF: 2016. p.105-15.

Duarte A.P., Deuber R. Levantamento de plantas infestantes em lavouras de milho "safrinha" no estado de São Paulo. **Planta Daninha**. 1999;17:297-307.

Duarte A.P., Silva A.C., Deuber R. Plantas infestantes em lavouras de milho safrinha, sob diferentes manejos, no médio Paranapanema. **Planta Daninha**. 2007;25:285-91.

Froufe L.C.M., Seoane C.E.S. Levantamento fitossociológico comparativo entre sistema agroflorestal multiestrato e capoeiras como ferramentas para a execução da reserva legal. **Pesq Flor Bras.** 2011;31:203-25.

Galvão A.K.L. et al. Levantamento fitossociológico em pastagens de várzea no estado do amazonas. **Planta Daninha**. 2011;29:69-75.

Heap I. **The international survey of herbicide resistant weeds**. [Accessed on: 05 Dec. 2016]. Available on: <http://www.weedscience.org>.

Hirata A.C.S., Duarte A.P., Duarte R.C.R.M. Levantamento de plantas infestantes em lavouras de milho safrinha do médio Paranapanema em 2006, 2007 e 2008. **Planta Daninha**. 2017 [no prelo].

Inoue M.H. et al. Levantamento fitossociológico em pastagens no município de Denise, MT. **Sci Plena**. 2012;8:1-8.

Instituto de Economia Agrícola - IEA. **2015 - Produtos & Serviços – Conjuntura – Previsão de Safra – Banco de Dados Biblioteca Virtual**. [Acessado em: 10 mar. 2017]. Disponível em: <http://www.bibliotecavirtual.sp.gov.br/saopaulo-geografia.php>.

Jasieniuk M. et al. Glyphosate-resistant Italian ryegrass (*Lolium multiflorum*) in California: distribution, response to glyphosate, and molecular evidence for an altered target enzyme. **Weed Sci.** 2008;56(496-502).

Lorenzi H. **Plantas daninhas do Brasil:** terrestres, aquáticas, parasitas e tóxicas. 3ª.ed. Nova Odessa: Instituto Plantarum, 2000. 608p.

Melo M.S.C. et al. Herança genética da resistência de capim-amargoso ao glyphosate.**Rev Bras Herb.** 2015;14:296-305.

Mesquita M.L.R., Andrade L.A., Pereira W.E. Germinação, composição florística e fitossociologia no banco de sementes de plantas invasoras em áreas de arroz consorciado com milho. **Rev Bras Ci Agr.** 2016;11:14-20.

Moretti M.S. et al. Levantamento fitossociológico de mata de galeria e cerradão no município de poconé, Mato Grosso, Brasil. **Rev Eletr Geoaraguaia.** 2013:193-208.

Mueller-Dombois D., Ellenberg H. **Aims and methods of vegetation ecology**. New York: John Wiley & Sons, 1974. 547p.

Pitelli R.A. Estudos fitossociológicos em comunidades infestantes de agroecossistemas. **J Conserb.** 2000;1(2):17.

Schneider A.A. A flora naturalizada no Estado do Rio Grande do Sul, Brasil: herbáceas subespontâneas. **Biociências**. 2007;15:257-68.

Sorensen T.A. Method of stablishing groups equal amplitude in plant society based on similarity of species content. In: Odum E.P. **Ecologia**. 3ª ed. México: Interamericana, 1972. p.341-405.

Souza J.R.P., Velini E.D. Efeitos da cultura da cevada e de períodos de controle sobre o crescimento e produção de sementes de *Raphanus sativus* L. **Planta Daninha**. 1997;15:97-103.

Tsunechiro A. et al. Análise técnica e econômica dos sistemas de produção de milho safrinha, com alta e média tecnologia, região do Médio Paranapanema, Estado de São Paulo. **Inf Econ.** 2006;36:62-70.

Velini E.D., Negrisoli E. Controle de plantas daninhas em cana crua. In: Anais do 22º Congresso Brasileiro da Ciência das Plantas Daninhas.Foz do Iguaçú: Sociedade Brasileira da Ciência das Plantas Daninhas. 2000. p.148-64.

Yamashita O.M. **Biologia germinativa das plantas daninhas *Conyza canadenses* L. (Cronquist) e *Conyza bonariensis* L. (Cronquist)** [tese]. Cuiabá: Universidade Federal de Mato Grosso, 2010.