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Phytosociological survey of weeds in glyphosate resistant and susceptible soybean cultivation areas

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ABSTRACT: The objective of the present study was to perform a phytosociological study of weeds present in areas of glyphosate resistant and susceptible soybeans, in the stage of maximum infestation, in the 2013/14 and 2014/15 crops. The phytosociological survey of the weed community was carried out in Palotina - PR, in glyphosate resistant and susceptible soybeans soybean cultivation areas, in two summer crops, as plants were at physiological stage of maturity (R7). The species are identified and quantified by the square of the inventory (1.0 x 1.0 m), with a sample of 20 m^{-2} per area, totaling 200 points in each evaluation condition. Calculations were made for density, relative density, frequency, relative frequency, abundance, relative abundance, importance value index and similarity index. In the areas of glyphosate-susceptible soybean cultivation as main species found according to the importance value index (IVI) were: *Bidens pilosa*, *Conyza* spp. and *Euphorbia heterophylla*. As for the glyphosate-resistant soybean cultivation system, the main components are: *Conyza* spp., *Commelina benghalensis* and *Digitaria insularis*. The similarity between the areas of glyphosate resistant and susceptible soybean was less than 80%. It is concluded that there are differences in the weed community, between the areas of glyphosate resistant and susceptible soybeans.

Key words: competition; *Glycine max* L.; phytosociological parameters; relative importance index; similarity index

Levantamento fitossociológico de plantas daninhas em áreas de cultivo de soja resisnte e suscetível ao glyphosate

RESUMO: O objetivo do presente trabalho foi realizar um estudo fitossociológico, de plantas daninhas presentes em áreas de cultivo de soja resistente e suscetível ao glyphosate, em fase de máxima infestação, nas safras de 2013/14 e 2014/15. O levantamento fitossociológico da comunidade de plantas daninhas foi realizado no município de Palotina – PR, em dez áreas de cultivo de soja suscetível e resistente ao glyphosate, em duas safras de verão, as plantas de soja encontravam-se em estádio de maturação fisiológica dos grãos (R7). As espécies foram identificadas e quantificadas pelo método do quadrado inventário (1,0 x 1,0 m), com amostragem de 20 m^{-2} por área, totalizando 200 pontos em cada condição de avaliação. Foram realizados cálculos para densidade, densidade relativa, frequência, frequência relativa, abundância, abundância relativa, o índice de valor de importância e índice de similaridade. Nas áreas de cultivo de soja suscetível ao glyphosate as principais espécies encontradas de acordo com o índice de valor de importância (IVI) foram: *Bidens pilosa*, *Conyza* spp. e *Euphorbia heterophylla*. Enquanto que para o sistema de cultivo de soja resistente ao glyphosate, as principais foram: *Conyza* spp., *Commelina benghalensis* e *Digitaria insularis*. A similaridade entre as áreas de soja suscetível e resistente ao glyphosate foi menor que 80%. Conclui-se que há diferenças na comunidade infestante, entre as áreas de cultivo com soja suscetível e resistente ao glyphosate.

Palavras-chave: competição; *Glycine max* L.; parâmetros fitossociológicos; índice de importância relativa; índice de similaridade

Introduction

The management of weed control is one of the main practices adopted in the soybean production system. The interference of invasive plants in fields of production of this crop can result in losses of productivity, leaf area, quality and grain mass (Silva et al., 2009). The success of weed control is related to the proper identification of the species present in the entire area, from which it is possible to define the most efficient strategies to control these plants.

In order to adopt an adequate management of invasive plants, besides the identification of weeds present, which allows only qualitative analyzes, there is also need of quantitative assessments, which are obtained through the phytosociological method proposed by Braun-Blanquet (1979) and also through the calculations elaborated by Müeller-Dombois & Ellenberg (1974). This set of methodologies provides specific data about the species present and enables the elaboration of inferences about the relationships of invasive flora in the area in question.

Soy cultivation has evolved over the last few years. An important factor contributing to this evolution in relation to weed management was the official release of the commercialization of tolerant transgenic soybeans (Roundup Ready - RR) to glyphosate in 2004. With the adoption of RR technology, several herbicides and even combinations of these, previously used in the control of invasive plants, were replaced by only one herbicide, glyphosate. In addition, reports of weed resistance to this herbicide have been occurring frequently in Brazil due to the selection pressure caused by the intense and continuous use of only one mechanism of action (Lopez-Ovejero & Christoffoleti, 2004).

According to Adegas et al. (2010), phytosociological studies are carried out in a given stage of the crop, usually close to harvest. This is because this period corresponds to the maximum infestation of weeds. These authors report the importance of taking into account the critical period of interference prevention (CPIP) of weeds with agricultural crops, which is when interference causes crop damage. Still in this context, Krenchinski et al. (2015) emphasize that the appropriate time for performing the evaluations used in these studies should primarily serve the authors' objective.

This type of study should collect data in more than one harvest, as it may indicate variations in the importance of one species from one crop to another (Oliveira & Freitas, 2008). Albrecht et al. (2018) emphasize that judicious phytosociological monitoring and study are essential in integrated weed management (IWM).

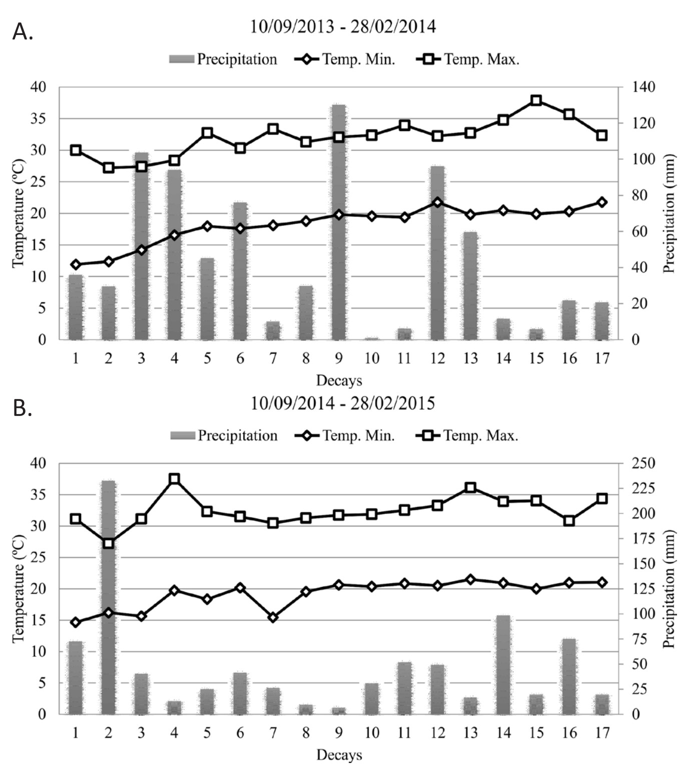
In this context, the objective of the present phytosociological survey was to identify and quantify the main weeds present in areas of glyphosate resistant and susceptible soybeans at the stage of maximum infestation in the harvests of 2013/14 and 2014/15 in the city of Palotina-PR.

Material and Methods

Weed surveys were carried out in two "summer crops" (first crop) of 2013/14 and 2014/15, in the city of Palotina-PR, whose average altitude is 300 meters, and in soils classified as clayey eutroferric Red Latosol, with a very clayey texture and eutroferric latosol Red Nitosol with a very clayey texture (Embrapa, 2017). Figure 1 shows the average meteorological conditions of both crops. The surveys consisted in evaluating areas with a history of glyphosate resistant and susceptible soybeans cultivation, in which 10 areas were selected for each type of soybean crop. Samples were taken in the two crops cited, when the soybean was in the R7 phenological stage, that is, at the moment of the physiological maturity of the grains.

As a criterion of choice for the areas, a production history was carried out, where areas with the same cultivation time were homogenized, both with glyphosate resistant and susceptible soybeans; all areas presented a history of at least three years of soybean production of glyphosate resistant and susceptible soybeans.

In the areas of glyphosate-susceptible soybean, the management adopted for the control of weeds was a desiccation prior to soybean sowing (an application of glyphosate), and with applications of acetolactate synthase (ALS) inhibitors after the emergence of the crop. In the case of glyphosate-resistant soybean, desiccations were carried out before soybean sowing (an application of glyphosate), but the applications after the emergence were



Source: Simepar (2016).

Figure 1. Precipitation, maximum and minimum temperature in the soybean crops of 2013/14 (A) and 2014/15 (B) in which weed surveys were performed. Pallotine, PR, Brazil.

made exclusively by using the herbicide glyphosate, mainly associated with graminicides (ACCase inhibitors). The areas have as a common feature the succession of soybean crops in the first crop, and maize in the second crop, with a short fallow period between the two crops. At the end of the survey, the data of the areas were grouped according to the soy technology used.

For the weed survey we used the square inventory technique, in which a square of 1.0 X 1.0 m was used, totaling 1 m^2. Twenty pitches were made within each analyzed area, totaling 200 points in each evaluation condition. The sampling plan was performed randomly, following the zigzag path within the area. After identification and counting, calculations of density, relative density, frequency, relative frequency, abundance, relative abundance and importance value index were made according to Müeller-Dombois & Ellenberg (1974).

The Sorensen Similarity Index (SI), SI = (2a / b + c) x 100, was used to evaluate the similarity (estimated similarity degree in species composition) among botanical populations, where a = number of species common to both areas; and b and c = total number of species in the two areas compared. SI varies from 0 to 100, being maximum when all species are common to both areas, and minimum when there are no species in common.

Results and Discussion

In the survey conducted in the 2013/2014 harvest in the areas under glyphosate-susceptible soybean, 18 weed species were identified, grouped in 11 families, with the highest number of species present among the Poaceae, with 5, and the Asteraceae, with 4 species (Figure 2A). During the survey conducted in the 2014/2015 harvest, 16 species were found, divided among 10 families, where the main ones were Poaceae (5) and Asteraceae (3). However, although the families Euphorbiaceae, Commelinaceae and Rubiaceae were represented by only one species each, in both harvests, *Euphorbia heterophylla, Commelina benghalensis* L. and *Richardia brasiliensis* G., respectively, attracted attention due to the high number of individuals present in these areas (Table 1).

In the areas under glyphosate-resistant soybean cultivation (Figure 2B) during the 2013/2014 harvest, 13 species were identified, distributed among 7 families, where the families Poaceae and Asteraceae predominated, with 6 and 2 species, respectively. In the 2014/2015 harvest, 11 species of 6 families were present, and again the families with the highest number of species were Poaceae (6) and Asteraceae (2).

According to Adegas et al. (2010), the Asteraceae and Poaceae families represent great expressiveness among the weeds occurring in agricultural production areas in Brazil, as they are present in areas of grain crops, such as soybean and sunflower, and also appear predominantly in other systems in sugarcane fields (Oliveira & Freitas, 2008), in cassava cultivation (Cardoso et al., 2013), in maize crops (Teodoro

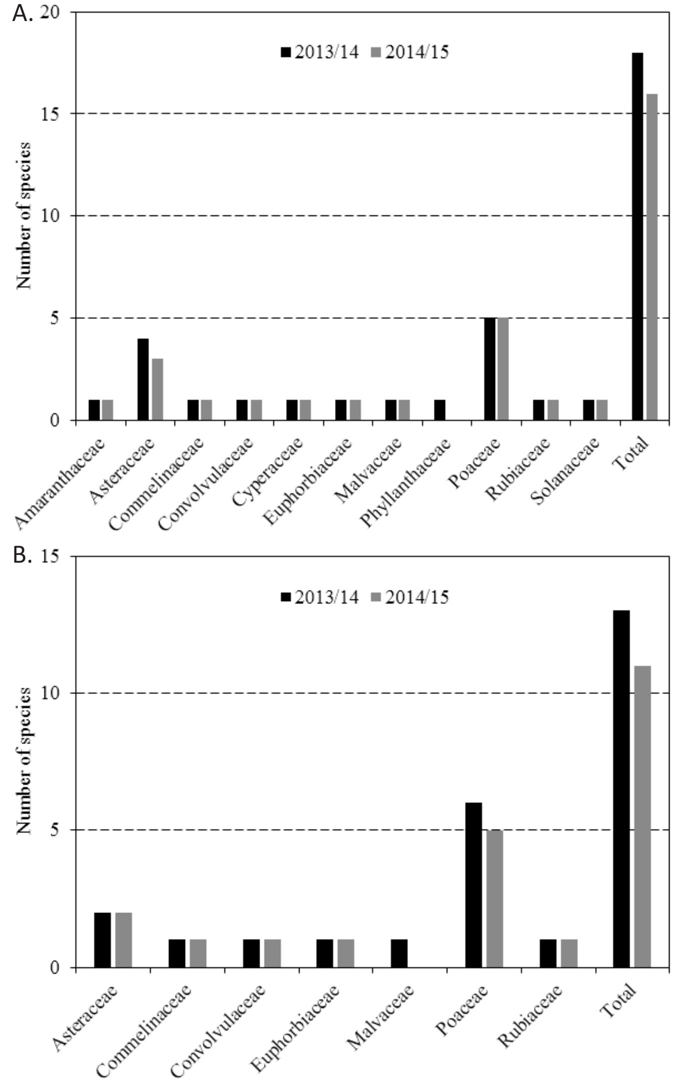


Figure 2. Families and number of species found in areas of glyphosate-susceptible soybean (A) and areas with glyphosate-resistant soybean (B).

et al., 2006), during off-season (Krenchinski et al., 2016) and after the cultivation of cover species (Albrecht et al., 2018).

In glyphosate-susceptible soybean cultivars (Table 1), in the survey conducted in the 2013/2014 crop, the species with the highest importance value index (IVI) were *Bidens* spp. (44.28), *Conyza* spp. (32.03) and *Euphorbia heterophylla* (30.01). These species were also identified as the main ones, in order of importance, in the 2014/2015 harvest, where they presented values of 44.21, 41.87 and 30.22, respectively.

Although the IVI values found for these species are similar between the two harvests, there was increase in the number of individuals (Ni) and the number of squares (Nq) in which these species were present, from the 2013/2014 crop to 2014/2015 crop, which, consequently, caused higher values for the phytosociological parameters, Frequency (Fre) and Density (Den). However, the parameter Abundance (Abu) decreased for *Conyza* spp., from 2.33 in 2013/2014 to 2.07 in 2014/2015. This occurred due to the Ni of this species having increased in smaller proportion to the increase in Nq of this species, thus

Table 1. Number of presence in squares (Nq), number of individuals (Ni), frequency (Fre), density (Den), abundance (Abu), relative frequency (Fr), relative density (Der), relative abundance (Abr) of importance value index (IVI) of the weed species present in glyphosate-susceptible soybean crops in the 2013/14 and 2014/15 crops, in the city of Palotina, PR, Brazil.

Species	Phytosociological parameters								
	Nq	Ni	Fre	Den	Abu	Frr	Der	Abr	IVI
	2013/2014 crop								
Bidens spp.	74	150	0.37	0.75	2.03	18.23	20.05	6.00	44.28
Conyza spp.	45	105	0.23	0.53	2.33	11.08	14.04	6.91	32.03
Euphorbia heterophylla L.	34	98	0.17	0.49	2.88	8.37	13.10	8.54	30.01
Gnaphalium coarctatum Willd.	42	54	0.21	0.27	1.29	10.34	7.22	3.81	21.37
Cenchrus echinatus L.	28	56	0.14	0.28	2.00	6.90	7.49	5.92	20.31
Commelina benghalensis L.	33	46	0.17	0.23	1.39	8.13	6.15	4.13	18.41
Sorghum halepense L.	31	46	0.16	0.23	1.48	7.64	6.15	4.40	18.18
Urochloa plantaginea (Link) Hitchc	07	28	0.04	0.14	4.00	1.72	3.74	11.85	17.32
Digitaria sanguinalis L.	28	39	0.14	0.20	1.39	6.90	5.21	4.13	16.24
Sida spp.	10	27	0.05	0.14	2.70	2.46	3.61	8.00	14.07
Ipomoea triloba L.	10	22	0.05	0.11	2.20	2.46	2.94	6.52	11.92
Phyllanthus tenellus Roxb.	25	19	0.13	0.10	0.76	6.16	2.54	2.25	10.95
Amaranthus spp.	12	15	0.06	0.08	1.25	2.96	2.01	3.70	8.66
Cyperus spp.	07	12	0.04	0.06	1.71	1.72	1.60	5.08	8.41
Solanum americanum Mill.	08	12	0.04	0.06	1.50	1.97	1.60	4.44	8.02
Richardia brasiliensis G.	03	06	0.02	0.03	2.00	0.74	0.80	5.92	7.47
Siegesbeckia arientalis L.	06	09	0.03	0.05	1.50	1.48	1.20	4.44	7.12
Eleusine indica L.	03	04	0.02	0.02	1.33	0.74	0.53	3.95	5.22
Total	-	748	2.03	3.74	33.76	100.00	100.00	100.00	300.00
	2014/2015 crop								
Bidens spp.	94	249	0.47	1.25	2.65	13.30	20.51	10.41	44.21
Conyza spp.	108	224	0.54	1.12	2.07	15.28	18.45	8.15	41.87
Euphorbia heterophylla L.	60	147	0.30	0.74	2.45	8.49	12.11	9.62	30.22
Commelina benghalensis L.	104	129	0.52	0.65	1.24	14.71	10.63	4.87	30.21
Sorghum halepense L.	73	108	0.37	0.54	1.48	10.33	8.90	5.81	25.03
Gnaphalium coarctatum Willd.	54	82	0.27	0.41	1.52	7.64	6.75	5.97	20.36
Digitaria sanguinalis L.	44	57	0.22	0.29	1.30	6.22	4.70	5.09	16.01
Richardia brasiliensis G.	41	45	0.21	0.23	1.10	5.80	3.71	4.31	13.82
Cenchrus echinatus L.	38	44	0.19	0.22	1.16	5.37	3.62	4.55	13.55
Amaranthus spp.	22	31	0.11	0.16	1.41	3.11	2.55	5.54	11.20
Urochloa plantaginea (Link) Hitchc	19	26	0.10	0.13	1.37	2.69	2.14	5.38	10.20
Ipomoea triloba L.	17	24	0.09	0.12	1.41	2.40	1.98	5.55	9.93
Sida spp.	08	14	0.04	0.07	1.75	1.13	1.15	6.87	9.16
Solanum americanum Mill.	04	08	0.02	0.04	2.00	0.57	0.66	7.86	9.08
Eleusine indica L.	09	14	0.05	0.07	1.56	1.27	1.15	6.11	8.54
Cyperus spp.	12	12	0.06	0.06	1.00	1.70	0.99	3.93	6.61
Total	-	1214	3.54	6.07	25.46	100.00	100.00	100.00	300.00

reducing the amount of plants present by m^{-2} in relation to the previous harvest, a fact that happened in an inverse way for the other two species (*Bidens* spp. and *Euphorbia heterophylla*).

Duarte et al. (2007) observed the increase of weed infestation over the years in no-tillage, conventional and minimum soybean systems. According to these authors, this fact may be linked to the continuous succession of soybean/maize crop, added to the absence of crop rotation. In addition, the management adopted by the owners of the glyphosate-susceptible soybean cultivation areas for the weed control in the present study was composed of the desiccation of the predecessor crop and applications of acetolactate synthase (ALS) inhibitors herbicides after the emergence of soybean. According to Lopez-Ovejero & Christoffoleti (2004), these herbicides were the most used in this crop because they provided excellent control of dicotyledons, especially *E. heterophylla*. Nevertheless, the intense and continuous use of herbicides of the same chemical group or with the same mechanism of action enabled the selection of resistant biotypes.

Ponchio et al. (1996) reported the occurrence of *B. pilosa* biotypes with resistance to ALS inhibitor herbicides in Brazil. Later, Vidal & Fleck (1997) reported resistance in *E. heterophylla* biotypes and Monqueiro et al. (2000) identified resistance in *B. subalternans* biotypes in soybean growing areas. Therefore, biotypes of these weeds resistant to the herbicides used in the management of these areas may have contributed to the increase of infestation of these species in the areas of the present study.

The species *Commelina benghalensis* and *Richardia brasiliensis* presented lower IVI values when compared to the three main species found in the glyphosate-susceptible soybean cultivation areas. However, they were highlighted in the second glyphosate-susceptible soybean crop due to the significant increase in IVI in compared to the previous harvest, from 18.41 and 7.47 in 2013/2014 to 30.21 and 13.82 in 2014/2015, respectively for each species.

In the evaluated properties with glyphosate-resistant soybean cultivation (Table 2), in the crop year 2013/2014, the weeds with the highest IVI were *Conyza* spp. (41.57), *Commelina benghalensis* (40.44) and *Digitaria insularis* (32.45). For the 2014/2015 harvest, the three main species were the same, with the following IVI values: 58.12, 49.81 and 43.12, respectively for each species.

Buva was the species that presented the highest IVI in both harvests. The genus *Conyza* is represented by approximately 50 species, divided between annual and bi-annual herbaceous, of which the species *C. bonariensis*, *C. canadenses* and *C. sumatrensis* are among the most important, as they present the greatest problems for management in agricultural systems (Silva et al., 2014).

As mentioned previously, the use of herbicides with the same mechanism of action makes possible the selection of resistant biotypes, and this possibly contributed to that species of the genus *Conyza* predominate in these areas. It is important to point out that there is a record of resistance to the glyphosate herbicide of these three species, of which for *Conyza sumatrensis*, biotypes with multiple resistance to the glyphosate and chlorimuron-ethyl herbicides were identified in the Paraná state (Santos et al., 2013) and glyphosate-resistant buva biotypes (*Conyza* spp.) were identified in the western and southwestern regions of this state (Trezzi et al., 2011) and, more recently, the multiple resistance to three different action mechanisms of buva in the western region of Paraná.

According to Mitsuo & Carneiro (2013), with the introduction of tolerant glyphosate crops, as in the case of soybeans, the incidence of species of this genus in fields of production increased, thus corroborating with the findings of the present survey.

The second most important species in the areas of glyphosate-resistant soybean production was *Commelina benghalensis*, which presented IVI of 40.44 in the 2013/2014 crop and 49.81 in the 2014/2015 crop. According to Krolikowski et al. (2017), the species *C. benghalensis* tolerates the herbicides flumioxazin, glyphosate and nicosulfuron. These authors also point out that the phenological stage in which this species is at the moment of application influences its control. This is in line with Dias et al. (2013), who identified that the stage of development of the trapoeraba, significantly interferes with the degree of tolerance presented to the glyphosate herbicide. Other researchers have evidenced the selection of tolerant biotypes of this species to this herbicide (Webster & Grey, 2008; Maciel et al., 2011).

Table 2. Number of presence in squares (Nq), number of individuals (Ni), frequency (Fre), density (Den), abundance (Abu), relative frequency (Fr), relative density (Der), relative abundance (Abr) of importance value index (IVI) of the weed species present in glyphosate-resistant soybean crops in the 2013/14 and 2014/15 crops, in the city of Palotina.

Species	Phytosociological parameters								
	Nq	Ni	Fre	Den	Abu	Frr	Der	Abr	IVI
					2013/2014 crop				
Conyza spp.	55	90	0.28	0.45	1.64	16.32	16.95	8.30	41.57
Commelina benghalensis L.	45	90	0.23	0.45	2.00	13.35	16.95	10.14	40.44
Digitaria insularis L.	25	64	0.13	0.32	2.56	7.42	12.05	12.98	32.45
Sida spp.	33	51	0.17	0.26	1.55	9.79	9.60	7.84	27.23
Bidens spp.	36	50	0.18	0.25	1.39	10.68	9.42	7.04	27.14
Richardia brasiliensis G.	36	42	0.18	0.21	1.17	10.68	7.91	5.92	24.51
Digitaria horizontalis Willd.	15	31	0.08	0.16	2.07	4.45	5.84	10.48	20.77
Digitaria sanguinalis L.	24	34	0.12	0.17	1.42	7.12	6.40	7.18	20.71
Cenchrus echinatus L.	24	28	0.12	0.14	1.17	7.12	5.27	5.92	18.31
Euphorbia heterophylla L.	15	18	0.08	0.09	1.20	4.45	3.39	6.09	13.93
Urochloa plantaginea (Link) Hitchc	15	15	0.08	0.08	1.00	4.45	2.82	5.07	12.35
Ipomoea triloba L.	07	09	0.04	0.05	1.29	2.08	1.69	6.52	10.29
Sorghum halepense L.	07	09	0.04	0.05	1.29	2.08	1.69	6.52	10.29
Total	-	531	1.69	2.66	19.72	100.00	100.00	100.00	300.00
					2014/2015 crop				
Conyza spp.	159	201	0.80	1.01	1.26	24.31	24.72	9.08	58.12
Commelina benghalensis L.	138	164	0.69	0.82	1.19	21.10	20.17	8.54	49.81
Digitaria insularis L.	103	142	0.52	0.71	1.38	15.75	17.47	9.91	43.12
Richardia brasiliensis G.	87	94	0.44	0.47	1.08	13.30	11.56	7.76	32.63
Sorghum halepense L.	72	87	0.36	0.44	1.21	11.01	10.70	8.68	30.39
Bidens spp.	21	33	0.11	0.17	1.57	3.21	4.06	11.29	18.56
Digitaria horizontalis Willd.	22	29	0.11	0.15	1.32	3.36	3.57	9.47	16.40
Euphorbia heterophylla L.	9	14	0.05	0.07	1.56	1.38	1.72	11.18	14.27
Urochloa plantaginea (Link) Hitchc	17	21	0.09	0.11	1.24	2.60	2.58	8.88	14.06
Cenchrus echinatus L.	17	19	0.09	0.10	1.12	2.60	2.34	8.03	12.97
Ipomoea triloba L.	9	9	0.05	0.05	1.00	1.38	1.11	7.18	9.67
Total	-	813	3.27	4.07	13.92	100.00	100.00	100.00	300.00

Table 3. Similarity index (%) of the phytosociological surveys carried out in Palotina - PR in areas of glyphosate resistant and susceptible soybean cultivation, in the 2013/14 and 2014/15 crops.

Areas	Glyphosate-resistant 1	Glyphosate-resistant 2	Glyphosate-susceptible 1	Glyphosate-susceptible 2
Glyphosate-resistant 1	----	----	----	----
Glyphosate-resistant 2	92.00	----	----	----
Glyphosate-susceptible 1	71.00	62.00	----	----
Glyphosate-susceptible 2	76.00	67.00	94.00	----

* Glyphosate-resistant 1 and 2: Areas cultivated with glyphosate-resistant soybeans in the 2013/14 and 2014/15 crops, respectively. Glyphosate-resistant 1 and 2: Areas cultivated with glyphosate-susceptible soybeans in the 2013/14 and 2014/15 crops, respectively.

In this way, the *C. benghalensis* species becomes problematic, mainly in the areas of the present survey, where the management of invasive plants in the glyphosate-resistant soybean crop is based on successive applications of glyphosate.

Digitaria insularis is present among the three main species found in the areas of glyphosate-resistant soybean cultivation. This species presented high IVI values in the evaluated crops, namely 32.45 in 2013/2014 and 43.12 in the 2014/2015 crop. According to Gazola et al. (2016), bittergrass is a species with high infestation potential, and it is highly competitive because it has characteristics of rapid and aggressive development, reproduces via seeds and rhizomes, and can form considerable clumps from these. This species also has reports of resistance to the glyphosate herbicide in Brazil (Carvalho et al., 2011; Reinert et al., 2013), and also specifically in Paraná (Licorini et al., 2015), with reports of great difficulty of control (Zobiole et al., 2016).

The coefficient of similarity can range from 0 to 100%, where 0 corresponds to no common species between areas and 100 when all species are common. Table 3 shows greater similarity between the species when compared to the same areas, but in different crops, the areas with glyphosate-resistant soybean cultivation in the 2013/2014 crop, when compared to the same areas in the 2014/2015 crop, presented similarity of 92%, while in areas where glyphosate-susceptible soybeans were cultivated, when comparing the crops, they presented a similarity of 94%. This indicates that the species found were practically the same from one crop to another, which was expected, since the control system of weed adopted by the producers in these areas was the same for the two harvests analyzed.

However, areas of glyphosate-resistant soybean cultivation, when compared to those of glyphosate-susceptible soybeans, presented lower values (<76%), regardless of the harvests in which they were compared, that is, there is a difference between the species found in glyphosate resistant and susceptible soybeans soybean areas. This difference occurs mainly due to the weed control maneuvers in areas of glyphosate-susceptible soybean cultivation, where the control is done through the use of ALS inhibitor herbicides, whereas for the cultivation of the glyphosate-resistant soybean, it is based almost exclusively on the use of glyphosate and, with that, species that present resistance or tolerance to these herbicides tend to predominate in these areas.

Conclusions

In glyphosate-susceptible soybean areas, the predominant species in the two harvested crops are *Bidens* spp., *Conyza* spp. and *E. heterophylla*, whereas for both crops in the areas of glyphosate-resistant soybean, the main species are *Conyza* spp., *C. benghalensis* and *D. insularis*.

There was greater similarity between the weed species present in the areas with the same cropping system, when comparing both glyphosate resistant and susceptible soybean crops. This same index decreased when the glyphosate-susceptible soybean crops were compared with the glyphosate-resistant soybean crops.

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