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Influence of glyphosate herbicide in the weed community in the agricultural region of Rio Verde, Goiás[1]

Influência do herbicida glyphosate na comunidade de plantas daninhas na região agrícola de Rio Verde, Goiás

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Abstract - The increasing use of glyphosate in Brazil has increased the selection pressure on species of weeds tolerant and resistant to this herbicide. This study aimed to evaluate the influence of glyphosate use pattern in the population dynamics of weeds in soybeans in thirty-five sampling areas of different properties. These areas were classified as to the number of applications and equivalent amount of glyphosate acid. We used the square-inventory method in thirty-five sampling areas in the 2012/2013 harvest. The structural parameters relative frequency, abundance and value indicator of individuals number and dry weight of shoot were calculated. The graphical representation of the differences of the floristic composition was performed by the non-metric multidimensional scaling technique, with distances of Sorensen. The multi response permutation procedures test was used to test hypotheses of differences in floristic composition. The occurrence of typical species of each treatment was evaluated by the indicator value using the Monte Carlo test ($p<0{,}05$). The floristic composition of the number of plants differ between areas using average standards of glyphosate (six applications or 6001 to 8000 g ha^{-1} of acid equivalent) compared to very low standard areas (four or five applications or 2000 to 4000 g ha^{-1} of a.i.). The *Gnaphalium coarctatum*, *Eugenia* sp., *Rumex acetosella* and *Spermacoce latifolia, Digitaria horizontalis, Urochloa decumbens, Panicum maximum*, *Gossypum hirsutum* and *Indigofera hirsuta* species showed significant indicator value of environments with different levels of use of glyphosate. Different glyphosate usage patterns exerted influence on the floristic composition of weeds in soybean areas evaluated.
Keywords: floristic; endurance; tolerance; soybeans; crop rotation

Resumo - A crescente utilização do glyphosate no Brasil aumentou a pressão de seleção sobre as espécies de plantas daninhas tolerantes e resistentes a este herbicida. Este estudo objetivou avaliar a influência do padrão de utilização do glyphosate na dinâmica populacional das plantas daninhas na cultura da soja em trinta e cinco áreas amostrais de diferentes propriedades. Estas áreas foram classificadas quanto ao número de aplicações e quantidade de equivalente ácidos de glyphosate. Foi utilizado o método do quadrado-inventário nas trinta e cinco áreas amostrais na safra 2012/2013. Calcularam-se os parâmetros estruturais relativos de frequência, abundância e valor indicador do número indivíduos e biomassa seca da parte aérea. A representação gráfica das

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diferenças da composição florística, foi realizada pela técnica de non-metric multidimensional scaling, com distâncias de Sorensen. O teste multi response permutation procedures foi utilizado para testar hipóteses de diferenças nas composições florísticas. A ocorrência de espécies típicas de cada tratamento foi avaliada pelo valor indicador, utilizando-se o teste de Monte Carlo ($p<0,05$). A composição florística do número de plantas, diferiu entre áreas que utilizam padrões médios de glyphosate (seis aplicações ou 6001 a 8000 g ha^{-1} de equivalente ácido) em comparação com áreas de padrão muito baixo (quatro ou cinco aplicações ou 2000 a 4000 g ha^{-1}). As espécies *Gnaphalium coarctatum*, *Eugenias* sp., *Rumex acetosella* e *Spermacoce latifolia*, *Digitaria horizontalis*, *Urochloa decumbens*, *Panicum maximum*, *Gossypum hirsutum* e *Indigofera hirsuta* apresentaram valor indicador significativo de ambientes com diferentes níveis de utilização de glyphosate. Diferentes padrões de utilização de glyphosate exerceram influência na composição florística das plantas daninhas nas áreas de soja avaliadas.
Palavras-chaves: florística; resistência; tolerância; soja; sucessão de culturas

Introduction

Glyphosate herbicide is the largest in the global market share (Steinmann et al., 2012). With the release of planting soybean cultivars Roundup Ready® (RR®), the use intensity of this herbicide, which was already large in Brazil, due to desiccation management applications, has become even greater with the possibility of post-emergence applications, ie on genetically modified soybean plants (Petter et al., 2007). After being released in the country, approximately 35% of all soybeans grown in the Central-West region consisted of cultivars RR® (Biotech Brasil, 2007). In the season 2014/2015 the total area for genetically modified soybeans in the Central-West was 77.2%, and in Brazil only 6.8% of the total soybean acreage was intended to varieties not genetically modified (Passos, 2015).

The mechanism of action of this herbicide is characterized by inhibition of phenol-pyruvyl-shikimate-phosphate synthase enzyme (EPSPs) (Agostinetto et al., 2009). In general, two or three applications of glyphosate have been used in the culture of genetically modified soybeans, the first was on desiccation management performed prior to seeding the culture in standalone application or in association with other herbicides. In post-emergence, farmers have done one, or even two applications of glyphosate, depending on the infestation density and canopy closing speed.

With the emergence of soybean varieties resistant to glyphosate, the application period for weed control has become much broader (Barros, 2012). Today there is a possibility of earlier applications due to greater selectivity acquired by culture, or more delayed, because this product is also effective on some plants in advanced stages of development. However, regardless of soy is resistant to glyphosate, the control must be carried out within the critical period of interference, to avoid potential productivity losses.

The widespread adoption of crops resistant to glyphosate in a significant portion of the total cultivated area brought a strong selection pressure for weeds that are not controlled by this herbicide (Webster and Sosnoskie, 2010).

Regarding the tolerant weeds selected by the successive application of glyphosate, Maciel et al. (2009) state that the morning glory (*Ipomoea* spp.), spiderwort (*Commelina* spp.), ipecac-white (*Richardia brasiliensis*), pill-bearing spurge (*Euphorbia hirta*), tridax daisy (*Tridax procumbens*), tall windmill grass (*Chloris dandyana*) and Oval Leaf False Buttonweed (*Spermacoce latifolia*) species present position to expand their populations by selection for the cultivation of soybeans resistant to glyphosate. In Argentina changes were recorded in the community of weeds, characterized by eight species that have been selected, mainly belonging to the

Convolvulaceae and Commelinaceae families (Papa et al., 2002). According to Culpepper (2006), the increased infestation by *Ipomoea* sp. and *Commelina* sp. has occurred in the areas cultivated with soybeans resistant to glyphosate in the US. In addition, Procópio *et al.* (2007) found that invasive species, such as Oval Leaf False Buttonweed (*Spermacoce latifolia*), straggler daisy (*Synedrellopsis grisebachii*), spiderwort (*Commelina benghalensis*) and tridax daisy (*Tridax procumbens*) have been selected because of successive applications of glyphosate in the agricultural areas from the Cerrado.

By the year 2015 thirty-two weed species resistant to glyphosate were reported in the world. In Brazil, six are confirmed resistant biotypes: *Chloris elata, Conyza canadensis, Conyza bonariensis, Conyza sumatrensis, Digitaria insularis* and *Lolium multiflorum* (Heap, 2015). Considering these confirmations, this study aimed to analyze the occurrence of weeds, diagnosing the ones tolerant and resistant to glyphosate. In addition, the objective was to also assess the direct influence of this herbicide use level in the floristic composition and dynamics of weeds in agricultural areas of the Rio Verde region - GO.

Material and Methods

The work was carried out on properties of southwestern agricultural region of Goias. The field surveys have covered the municipalities of Rio Verde, Santa Helena de Goiás, Santo Antonio da Barra and Montividiu in the harvest of 2012/2013 with data collection between the months of June 2012 to July 2013.

Regarding the Koppen and Geyser classification, the studied municipalities present climate AW: with average temperatures between 23,0 and 24,3^{o} C and average annual rainfall from 1,510 to 1,663 mm, with the highest concentration in summer. Winter presents itself dry with mild temperatures and no rain between the months of May to September. The soils of the region are the types Rhodic Distroferric and Oxisoil (Santos et al., 2011).

The field surveys took place in thirty-five agricultural areas of 20 hectares that predominate soy cultivation and the harvest of maize, sorghum, millet and fallow in the off-season (Table 1).

Table 1. Location of the properties in which the weed survey was performed in the agricultural region of Rio Verde (GO), 2012/2013.

Cities	Coordinates (UTM) 22 K	Cities	Coordinates (UTM) 22 K
Montividiu	482613,93/8100304,26	Rio Verde	506231,98/8044023,95
Montividiu	505769,78/8079871,48	Rio Verde	526129,0/8018108,76
Montividiu	506350,89/8079876,84	Rio Verde	525957,64/8018272,84
Montividiu	482278,90/8083495,89	Rio Verde	518887,66/8019237,99
Montividiu	480231,77/8099772,54	Rio Verde	525933,31/8018614,52
Montividiu	503766,73/8078668,74	Rio Verde	526285,71/8018965,53
Montividiu	481486,73/8099463,40	Rio Verde	525763,47/8018402,43
Montividiu	480977,40/8099669,14	Rio Verde	507115,76/8044911,38
Montividiu	500502,47/8079165,26	Rio Verde	506929,16/8044116,21
Montividiu	500701,46/8079859,67	Santa Helena	560434,78/8044516,10
Rio Verde	540809,09/8008785,91	Santa Helena	532499,20/8030623,97
Rio Verde	524462,03/8019154,20	Santa Helena	560464,02/8042437,67
Rio Verde	528012,52/8021719,00	Santo Antônio da Barra	540987,37/8057939,34
Rio Verde	503225,37/8077848,74	Santo Antônio da Barra	541670,84/8058093,42
Rio Verde	524439,59/8016860,74	Santo Antônio da Barra	541911,35/8057517,36
Rio Verde	525340,12/8020605,52	Santo Antônio da Barra	540645,54/8073577,33
Rio Verde	502135,51/8079836,23	Santo Antônio da Barra	540331,35/8073928,66
Rio Verde	503231,39/8080329,71		

Survey was conducted on cultivation history for three years, including the chemical control and the type of management of all sampling areas. The data were correlated with the occurrence of species in different cropping systems analyzed.

The field survey was conducted in three evaluation periods: before drying for soybean implantation; prior to application of post-emergence herbicides in the soybean crop at 20 days after sowing; and prior to application of herbicide in post-emergence at 20 days after the implementation of off-season crop, or in fallow area. The weeds were inventoried by Square-Inventory Method (Braun-Blanquet, 1979). Hollow squares made up of PVC with dimensions of 0.5x0.5 m were randomly thrown, which acted as sample units.

For each area twenty sampling units of 0.25 m^2 were settled, in three seasons, totaling 2100 square-hollow inventoried and a sample area of 525 m^2 in the entire region. In each agricultural area three hundred squares were inventoried in the three evaluations, ie, 15 m^2 for area, or 5 m^2 for period of evaluation.

The weeds present in the squares were cut close to the ground and taken to the laboratory for identification and accounting of the number of individuals per species. Later they were placed in paper bags to determine the dry matter of the aerial part, by drying in forced ventilation air oven at 65 °C for 72 h and weighed on a precision scale.

From the information collected in the phytosociological survey, a multivariate array to the floristic composition was built, determined both by the number of individuals and the dry mass of the aerial part of the weed species, added later to the three seasons of the floristic survey.

For carrying out the statistical analysis we used the PC-ORD Software 6.0. The areas were classified according to the number of glyphosate applications made in the last three years in four groups: Group 1 (three applications of glyphosate - very low use standard); Group 2 (four or five applications of glyphosate - low use standard); Group 3 (six applications of glyphosate - average use standard); and Group 4 (nine applications of glyphosate - high standard use). The areas were also classified in relation to the amount of glyphosate acid equivalent applied in the last three years: Group 1 (2000 to 4000 g ha^{-1} – very low use standard); Group 2 (4001 to 6000 g ha^{-1} - low use standard); Group 3 (6001 to 8000 g ha^{-1} - average use standard); and Group 4 (8001 at 10000 g ha^{-1} - high use standard).

The graphical representation of the differences between samples on the floristic composition was performed by the technique of "non-metric multidimensional scaling" (NMS), with distances of Sorensen (Sokal, 1979). We have chosen the number of dimensions to be represented as stress criteria, according to the Monte Carlo test and the stability of printing solutions. The species of low frequency (less than 5% of observations) were excluded from this analysis because of their low significance. The test "multi response permutation procedures" (MRPP) (Mielke Jr. and Berry, 2007) was used to test hypotheses of differences in floristic composition between the different treatments.

We used analysis of the indicator species (Dufrene and Legendre, 1997) to evaluate the occurrence of weed species by rating groups. This analysis calculates an indicator value, derived from the product between the frequency and relative abundance, which is tested for statistical significance by Monte Carlo test ($p < 0.05$). In the results only the indicator value of the data compressing tables were presented.

Results and Discussion

The total number of subjects and dry mass of aerial part of different species data were the basis for the assessments carried out in all areas evaluated, regardless of the condition of use of glyphosate (Table 2).

The species *Acanthospermum hispidum*, *Ageratum conyzoides*, *Bauhinia* sp., *Brosimum gaudichaudii*, *Sida urens*, *Connarus suberosus*, *Couepia grandiflora*, *Cresta sphaerocephala*, *Crotalaria incana*, *Cyperus odoratus*, *Digitaria ciliares*, *Heliotropium indicum*, *Hyptis lophanta*, *Lithraea melleoides*, *Neea theifera*, *Qualea parviflora*, *Rumex obtusifolius*, *Sida spinosa*, *Smilax brasiliensis*, *Smilax ovolifolia*, *Sorghum halepense*, *Spermacoce verticilata*, and *Vernonia ferruginea* were excluded because they were classified as rare occurrence (less than 5% of observations).

Table 2. Number of individuals (NI), shoot dry mass (DM) of the weed species sampled in the agricultural region of Rio Verde (GO), 2012/2013.

Species	NI	DM (g)	Species	NI	DM (g)
Cenchrus echinatus	680	1.589,75	*Rumex obtusifolius*	2	22,46
Conyza bonariensis	44	398,78	*Smilax campestris*	3	21,65
Alternanthera tenella	244	367,41	*Digitaria ciliares*	5	19,51
Sida glaziovii	134	366,72	*Solanum americanum*	5	19,42
Praxelis pauciflora	60	198,82	*Acanthospermum hispidum*	2	18,65
Commelina benghalensis	261	193,92	*Heliotropium indicum*	1	16,51
Malvastrum coromandelianum	39	152,24	*Cnidoscolus urens*	1	15,13
Conyza canadensis	48	151,66	*Eugenia* sp.	3	15,03
Chamaesyce hirta	276	146,70	*Leonotis nepetaefolia*	12	15,00
Eleusine indica	112	143,46	*Cissampelos sp1*	9	14,73
Panicum maximum	13	138,99	*Sida cordifolia*	5	12,45
Sida rhombifolia	48	136,92	*Synedrellopsis grisebachii*	3	12,41
Bidens subalternans	176	111,68	*Bidens pilosa*	6	11,04
Tridax procumbens	56	103,21	*Pennisetum americanum*	16	10,44
Digitaria horizontalis	44	94,55	*Rumex acetosella*	6	9,38
Setaria parviflora	22	91,71	*Myrcia guianensis*	2	7,90
Smilax polyantha	9	86,61	*Couepia grandiflora*	1	7,63
Glycine max	284	85,89	*Heteropterys sp.*	3	7,29
Cyperus difformis	85	79,21	*Sida urens*	3	7,19
Pennisetum setosum	45	74,39	*Spermacoce latifolia*	7	7,19
Senna obtusifolia	33	73,24	*Simaba* sp.	1	6,72
Cissampelos sp2	10	60,95	*Crotalaria incana*	1	6,68
Rhinchelytrum repens	15	49,93	*Indigofera hirsuta*	6	5,61
Emilia fosbergii	6	47,97	*Spermacoce verticilata*	3	4,79
Gnaphalium coarctatum	22	43,29	*Smilax ovolifolia*	1	4,69
Ipomoea grandifolia	65	42,00	*Brosimum gaudichaudii*	1	4,03
Crotalaria spectabilis	15	40,78	*Neea theifera*	2	3,83
Smilax brasiliensis	5	39,41	*Sida spinosa*	1	1,75
Sorghum halepense	1	38,00	*Ageratum conyzoides*	1	1,40
Richardia brasiliense	14	37,15	*Pavonia rosa-campestris*	3	1,24
Euphorbia heterophyla	100	35,82	*Cresta sphaerocephala*	1	1,20
Urochloa decumbens	11	35,19	*Hyptis lophanta*	1	1,16
Mimosa hirsutissima	5	35,11	*Cyperus odoratus*	1	1,05
Amaranthus viridis	13	33,79	*Phyllanthus tenellus*	2	0,93
Ipomoea cordifolia	46	33,49	*Lithraea melleoides*	1	0,90
Andira vermifuga	4	30,74	*Connarus suberosus*	1	0,85
Cissampelos ovolifolia	8	28,41	*Qualea parviflora*	1	0,45
Vernonia ferruginea	2	28,20	*Bauhinia* sp.	1	0,31
Digitaria insularis	21	26,81	*Gossypum hirsutum*	3	0,19
Zea mays	16	24,07	Total	3.219	5.815,74

Ordination of the samples were represented as the similarity among its floristic composition, described by the number of plants, depending on the number of glyphosate applications made in the last three years (Figure 1A).

The selected two dimensional solution represented 67% of the original variability of species composition data, which is representation distributed in 36 and 31% on the shafts 1 and 2, respectively. The pattern of use of very low glyphosate (centroid 1), that is, when on average three applications are performed every three years, it showed floristic composition different from Class 3 (six applications of glyphosate - average use standard), not differing from the other classes (Figure 1A). According to Wilson et al. (2007), increments of one or two applications of glyphosate can reduce the diversity of weed species in agricultural areas.

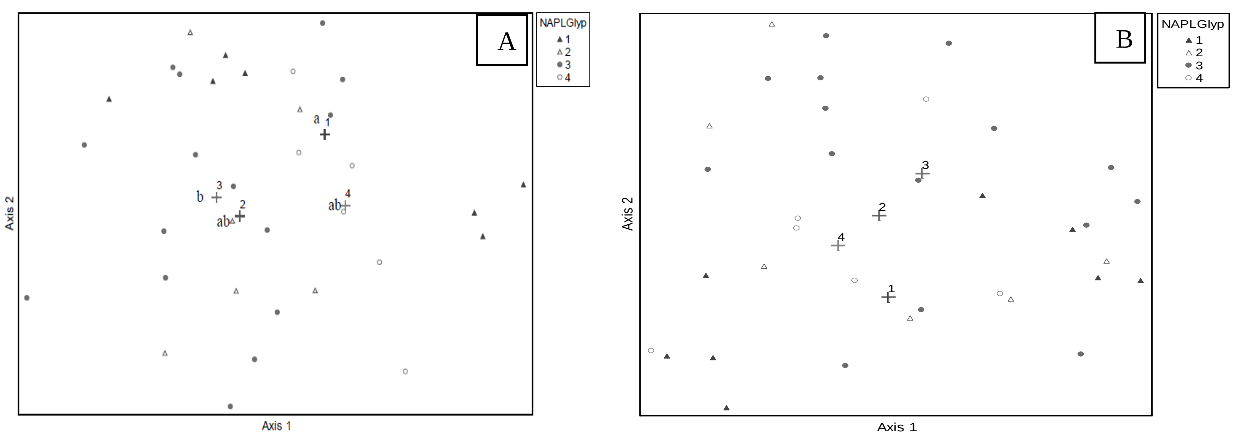

Figure 1. Representation of the variability of floristic composition (A – Number of plants; B – Shoot dry mass) sampled in agricultural areas with different levels of glyphosate use based on the number of applications in the last three years. Conditions with centroid followed by same letter no differs by the MRPP test ($p<0.05$). Subtitle: Group 1 (Three applications of glyphosate – Standard of very low use), Group 2 (Four or five applications of glyphosate – Standard of low), Group 3 (Six applications of glyphosate – Standard of medium use), and Group 4 (Nine applications of glyphosate – Standard of high use). Rio Verde (GO), 2012/2013.

In the dry matter of aerial parts the two-dimensional solution represented 51% of the original variability of floristic composition data based on the number of applications (Figure 1B). This representation is distributed in 27 and 24% on the shafts 1 and 2, respectively. Although there is a trend of differentiation of floristic composition when the pattern of use of glyphosate is too low (centroid 1), when on average three applications every three years are performed, compared to other use classes, these differences were not significant for the test "multi response permutation procedures" (MRPP). According to Webster and Sosnoskie (2010), species such as *Senna obtusifolia*, *Senna occidentalis*, *Xanthium strumarium* and *Desmodium tortuosum* presented widespread occurrence in US cotton crops in 1995, however, ten years after the introduction of cotton cultivars resistant to glyphosate, these species have become less important in the weed community for being susceptible to this herbicide, being replaced by *Richardia scabra*, *Commelina communis*, *Commelina benghalensis*, and *Amaranthus palmeri*.

The ratio of the amount of acid equivalent of glyphosate used in the last three years and the floristic composition, described by the number of recorded plants were also evaluated (Figure 2A). The selected two-dimensional solution represented 63% of the original variability of floristic composition data, which is distributed in 39 and 24% on the shafts 1 and 2, respectively. As verified in the evaluation of ordination between number of applications and number of plants sampled, the very low use standard of glyphosate (centroid 1), ie when, on average, three applications are performed every three years, presented floristic composition different from the class 3 (six applications of glyphosate - average use standard), but not differing from the other classes. This demonstrates that the use of the number of plants counting is a more sensitive criteria to the variability of floristic composition in comparison to the dry mass of aerial part. In studies conducted by Wilson et al. (2007), changes in the weed community can promote changes in the choice of crops, cultural practices, or even the control methods of weeds.

Despite the strong tendency for differentiating the floristic composition when it imposes a low use standard of glyphosate (centroid 1) regarding the amount of equivalent acid, by the MRPP test, there were no significant differences between the application of this herbicide class (Figure 2B). The selected two-dimensional solution represented 51% of the original variability of floristic composition data, which is distributed in 27 and 24% on the shafts 1 and 2, respectively. It is noteworthy that the database used in this analysis consisted on the dry mass of the aerial part of the matrix. According to Owen (2008), the biggest alterations in the weed flora changing in agricultural areas of the United States from the introduction of cultivars resistant to glyphosate, were an increase in infestations on *Conyza canadensis*, *Amaranthus palmeri*, and *Ambrosia trifida* species.

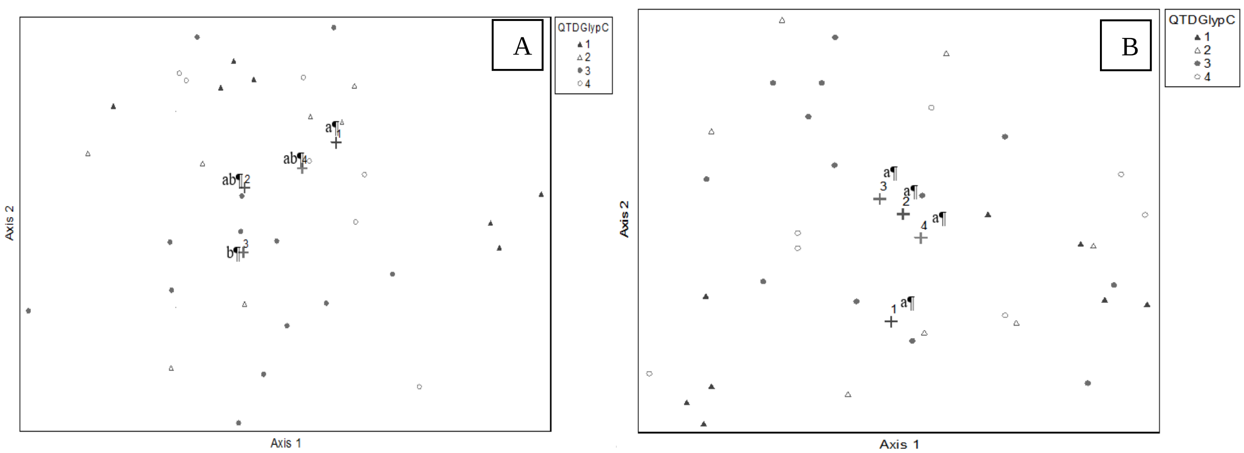

Figure 2. Representation of the variability of floristic composition (A – Number of plants; B – Shoot dry mass) sampled in agricultural areas with different levels of glyphosate use based on the quantity of acid equivalent applied in the last three years. Conditions with centroid followed by same letter no differs by the MRPP test ($p<0.05$). Subtitle: Group 1 (2000 to 4000 g ha^{-1} – Standard of very low use), Group 2 (4001 to 6000 g ha^{-1} – Standard of low), Group 3 (6001 to 8000 g ha^{-1} – Standard of medium use), and Group 4 (8001 to 10000 g ha^{-1} – Standard of high use). Rio Verde (GO), 2012/2013.

As for the indicator analysis of species (Table 3) in which indicator values (VI) in a group (treatment) are calculated, the *Cenchrus echinatus* species was excluded for being present in all samples (100% frequency in all treatments), which makes the indicator value expressed only by the relative abundance.

The species *Urochloa decumbens* and *Panicum maximum* were typical species of Group 4 (nine applications of glyphosate in three years - high use standard of glyphosate). As for the specie *Gnaphalium coarctatum*, it was identified as typical of Group 2 (4 or 5 applications of glyphosate - low use pattern). Although all species were classified as belonging to some type of dominant group (DG), low frequency relative values, that is, the occurrence of plants of a given species in just a few sample units of an application condition were primarily responsible for no significance at Monte Carlo test.

Table 3. Indicator value (IV) of weeds present in the agricultural areas subdivided in four groups in relation to the number of glyphosate application in the last three years. Group 1 (Three applications of glyphosate – Standard of very low use), Group 2 (Four or five applications of glyphosate – Standard of low), Group 3 (Six applications of glyphosate – Standard of medium use), and Group 4 (Nine applications of glyphosate – Standard of high use). Calculations based on the number of individuals. Rio Verde (GO), 2012/2013.

Species	IV					Monte Carlo Test		Species	IV					Monte Carlo Test	
	DG	1	2	3	4	SD	P*		DG	1	2	3	4	SD	P*
Acanthospermum hispidum	4	0	0	0	17	4.43	0.348	*Ipomoea grandifolia*	3	4	10	30	18	7.71	0.362
Ageratum conyzoides	3	0	0	7	0	4.42	1.000	*Ipomoea cordifofolia*	3	3	15	19	16	7.22	0.827
Alternanthera tenella	4	24	5	3	38	8.04	0.109	*Ipomoea grandifolia*	3	4	10	30	18	7.71	0.362
Amaranthus viridis	4	9	0	1	28	8.23	0.087	*Leonotis nepetifolia*	4	1	7	2	18	8.93	0.399
Andira vermifuga	2	0	10	1	5	8.02	0.526	*Lithraea molleoide*	4	0	0	0	17	4.43	0.347
Bauhinia sp.	4	0	0	0	17	4.41	0.349	*M. coromandelianum*	4	11	9	8	24	7.92	0.413
Bidens pilosa	4	0	0	4	6	6.82	0.9	*Mimosa hirsutissima*	4	5	0	1	9	7.75	0.713
Bidens subalternans	3	23	3	31	17	8.58	0.561	*Myrcia guianesis*	2	0	12	2	0	6.05	0.58
Urochloa decumbens	4	4	0	0	35	8.07	0.026	*Neea theifera*	3	0	0	7	0	4.39	1.000
Brosimum gaudichaudii	3	0	0	7	0	4.39	1.000	*Panicum maximum*	4	1	5	0	51	9.77	0.019
Chamaesyce hirta	4	7	29	20	39	6.05	0.232	*Pavonia rosa-campestris*	4	0	0	1	14	6.35	0.255
Cissampelus ovolifofolia	4	0	0	3	13	7.41	0.346	*Pennisetum americanum*	2	0	8	7	4	9.21	0.968
Cissampelos sp1	4	1	16	0	16	8.28	0.428	*Pennisetum setosum*	2	1	15	9	4	0.17	0.668
Cissampelos sp2	3	4	0	18	0	8.39	0.307	*Phyllanthus tenellus*	4	0	8	0	8	5.94	0.797
Cnidoscolus urens	1	13	0	0	0	4.42	0.568	*Praxelis pauciflora*	4	9	7	9	14	9.49	0.977
Commelina benghalensis	4	20	22	14	31	4.24	0.369	*Qualea parviflora*	4	0	0	0	17	4.43	0.347
Connarus suberosus	4	0	0	0	17	4.43	0.347	*Rhynchelytrum repens*	3	0	0	23	3	8.57	0.243
Conyza bonariensis	2	0	37	1	7	9.83	0.08	*Richardia brasiliensis*	2	1	12	1	7	8.44	0.615
Conyza canadensis	2	1	23	8	18	8.46	0.481	*Rumex acetosella*	3	3	5	10	0	8.14	0.761
Couepia grandifolia	3	0	0	7	0	4.4	1.000	*Rumex obtusifolius*	4	0	0	0	17	4.43	0.348
Cresta sphaerocephala	3	0	0	7	0	4.4	1.000	*Senna obtusifolia*	2	13	28	1	12	9.38	0.292
Crotalaria incana	4	0	0	0	17	4.43	0.348	*Setaria parviflora*	2	1	22	4	13	8.63	0.347
Crotalaria spectabilis	3	0	0	6	3	6.61	1.000	*Sida cordifolia*	2	0	6	4	0	6.67	0.895
Cyperuss difformis	1	34	0	16	14	8.73	0.173	*Sida glaziovii*	1	30	3	11	26	7.76	0.452
Cyperus odoratus	3	0	0	7	0	4.42	1.000	*Sida rhombifolia*	4	12	3	8	17	8.86	0.753
Digitaria ciliares	3	0	0	7	0	4.42	1.000	*Sida spinosa*	2	0	17	0	0	4.38	0.347
Digitaria horizontalis	3	5	6	16	0	8.88	0.538	*Sida urens*	4	0	0	6	9	7.7	0.522
Digitaria insularis	4	11	0	3	16	8.64	0.505	*Simaba* sp.	4	0	0	2	12	5.92	0.577
Eleusine indica	4	30	3	11	37	9.06	0.398	*Smilax brasiliensis*	4	0	0	0	17	4.41	0.349
Emilia fosbergii	2	0	24	2	0	7.54	0.118	*Smilax campestris*	4	0	0	3	13	7.45	0.382
Eugenias sp.	2	0	28	1	0	7.78	0.079	*Smilax ovolifolia*	3	0	0	7	0	4.4	1.000
Euphorbia heterophyla	1	26	19	4	9	9.72	0.673	*Smilax polyantha*	3	0	4	10	0	7.35	0.608
Glycine max	3	12	28	31	19	3.33	0.365	*Solanum americanum*	1	11	0	1	0	6.57	0.675
Gnaphalium coarctatum	2	1	40	3	0	8.96	0.029	*Sorghum halepense*	2	0	17	0	0	4.41	0.346
Gossypum hirsutum	4	0	0	0	33	6.08	0.051	*Spermacoce latifolia*	2	4	14	3	0	8.03	0.496
Heliotropium indicum	4	0	0	0	17	4.43	0.348	*Spermacoce verticilata*	3	0	0	7	0	4.41	1.000
Heteropteris sp.	3	0	0	13	0	6.05	0.433	*S. grisebachii*	4	0	0	1	14	6.15	0.247
Hyptis lophanta	3	0	0	7	0	4.39	1.000	*Tridax procumbens*	2	6	20	10	9	9.07	0.706
Indigofera hirsuta	4	0	0	0	33	6.07	0.055	*Vernonia ferruginea*	4	0	0	0	17	4.43	0.348
Ipomoea cordifofolia	3	3	15	19	16	7.22	0.827	*Zea mays*	2	0	21	0	6	7.42	1.000

DG: Dominance group of the species, SD: Standard deviation, and P* Probability.

Glyphosate herbicide is known for being highly effective in controlling grasses such as *Urochloa decumbens* and *Panicum maximum*, making it difficult to explain the results. One hypothesis is the previous history of the areas with high use of glyphosate as standard with pastures, which would cause a significant increase in the seeds of these species in the soil bank, reflecting on the infestation of these areas with such species.

Species indicator value evaluations have also been formed based on the number of glyphosate applications over the last three years for the dry mass of the aerial part of weeds (Table 4).

Table 4. Indicator value (IV) of weeds present in the agricultural areas subdivided in four groups in relation to the number of glyphosate application in the last three years. Group 1 (Three applications of glyphosate – Standard of very low use), Group 2 (Four or five applications of glyphosate – Standard of low), Group 3 (Six applications of glyphosate – Standard of medium use), and Group 4 (Nine applications of glyphosate – Standard of high use). Calculations based on the shoot dry mass. Rio Verde (GO), 2012/2013.

Species	IV					Monte Carlo Test		Species	IV					Monte Carlo Test	
	DG	1	2	3	4	SD	P*		DG	1	2	3	4	SD	P*
Acanthospermum hispidum	4	0	0	0	17	4.39	0.334	*Ipomoea cordifofolia*	2	0	35	4	11	1.67	0.392
Ageratum conyzoides	3	0	0	7	0	4.39	1.000	*Ipomoea grandifolia*	4	9	1	14	36	9.55	0.276
Alternanthera tenella	1	28	4	7	26	8.14	0.381	*Leonotis nepetifolia*	4	0	1	2	26	0.12	0.26
Amaranthus viridis	1	17	0	1	10	9.78	0.476	*Lithraea molleoide*	4	0	0	0	17	4.38	0.335
Andira vermifuga	2	0	15	1	1	8.08	0.385	*M. coromandelianum*	4	6	13	10	22	8.74	0.65
Bauhinia sp.	4	0	0	0	17	4.44	0.345	*Mimosa hirsutissima*	1	8	0	0	6	7.43	0.902
Bidens pilosa	4	0	0	4	6	6.61	0.901	*Myrcia guianesis*	3	0	2	6	0	6.55	1.000
Bidens subalternans	3	16	2	30	25	9.51	0.668	*Neea theifera*	3	0	0	7	0	4.38	1.000
Urochloa decumbens	4	4	0	0	35	8.02	0.026	*Panicum maximum*	4	0	1	0	63	9.46	0.001
Brosimum gaudichaudii	3	0	0	7	0	4.38	1.000	*Pavonia rosa-campestris*	4	0	0	4	6	6.74	0.909
Chamaesyce hirta	4	5	24	22	46	7.23	0.14	*Pennisetum americanum*	2	0	14	7	1	9.09	0.557
Cissampelus ovolifofolia	4	0	0	5	10	7.68	0.395	*Pennisetum setosum*	2	1	26	6	1	0	0.245
Cissampelos sp1	2	0	21	0	12	8.47	0.232	*Phyllanthus tenellus*	2	0	10	0	7	6	0.724
Cissampelos sp2	3	5	0	17	0	9.03	0.425	*Praxelis pauciflora*	4	11	5	11	11	0.24	0.993
Cnidoscolus urens	1	13	0	0	0	4.39	0.58	*Qualea parviflora*	4	0	0	0	17	4.38	0.335
Commelina benghalensis	2	10	38	10	30	7.2	0.304	*Rhynchelytrum repens*	3	0	0	21	4	9.06	0.294
Connarus suberosus	4	0	0	0	17	4.38	0.335	*Richardia brasiliensis*	2	1	13	1	7	8.3	0.511
Conyza bonariensis	2	0	42	0	5	1.33	0.089	*Rumex acetosella*	3	3	2	13	0	8.71	0.55
Conyza canadensis	2	1	34	5	7	9.98	0.2	*Rumex obtusifolius*	4	0	0	0	17	4.39	0.334
Couepia grandifolia	3	0	0	7	0	4.42	1.000	*Senna obtusifolia*	1	15	10	4	15	9.92	0.905
Cresta sphaerocephala	3	0	0	7	0	4.42	1.000	*Setaria parviflora*	4	0	12	3	22	0.42	0.528
Crotalaria incana	4	0	0	0	17	4.39	0.334	*Sida cordifolia*	3	0	1	6	0	6.49	1.000
Crotalaria spectabilis	3	0	0	7	0	6.4	1.000	*Sida glaziovii*	1	28	6	11	22	8.88	0.61
Cyperuss difformis	1	27	0	21	12	0.29	0.508	*Sida rhombifolia*	4	9	4	6	22	9.01	0.483
Cyperus odoratus	3	0	0	7	0	4.43	1.000	*Sida spinosa*	2	0	17	0	0	4.42	0.357
Digitaria ciliares	3	0	0	7	0	4.39	1.000	*Sida urens*	3	0	0	7	7	7.88	0.899
Digitaria horizontalis	3	2	6	20	0	1	0.519	*Simaba* sp.	3	0	0	5	4	6.71	1.000
Digitaria insularis	4	10	0	5	12	9.61	0.709	*Smilax brasiliensis*	4	0	0	0	17	4.44	0.345
Eleusine indica	4	24	6	15	34	7.92	0.386	*Smilax campestris*	4	0	0	4	12	7.53	0.379
Emilia fosbergii	2	0	27	1	0	7.41	0.081	*Smilax ovolifolia*	3	0	0	7	0	4.39	1.000
Eugenias sp.	2	0	22	2	0	7.38	0.154	*Smilax polyantha*	3	0	1	12	0	7.2	0.518
Euphorbia heterophyla	4	23	11	2	26	1.41	0.777	*Solanum americanum*	1	10	0	1	0	6.42	0.668
Glycine max	3	6	24	33	27	4.9	0.392	*Sorghum halepense*	2	0	17	0	0	4.4	0.335
Gnaphalium coarctatum	2	0	42	3	0	9.62	0.025	*Spermacoce latifolia*	2	2	9	7	0	8.65	0.852
Gossypum hirsutum	4	0	0	0	33	6.53	0.046	*Spermacoce verticilata*	3	0	0	7	0	4.39	1.000
Heliotropium indicum	4	0	0	0	17	4.39	0.334	*Synedrellopsis grisebachii*	4	0	0	0	16	6.82	0.255
Heteropteris sp.	3	0	0	13	0	6.68	0.507	*Tridax procumbens*	2	3	16	11	15	9.65	0.889
Hyptis lophanta	3	0	0	7	0	4.42	1.000	*Vernonia ferruginea*	4	0	0	0	17	4.39	0.334
Indigofera hirsuta	4	0	0	0	33	6.78	0.049	*Zea mays*	4	0	3	0	15	7.95	0.495

DG: Dominance group of the species, SD: Standard deviation, and P* Probability.

The species *Gnaphalium coarctatum* was identified again as typical of Group 2 (4 or 5 applications of glyphosate - low use pattern). Using the dry mass as a basis for quantification of plants, two new species, besides the ones already reported *Urochloa decumbens* and

Panicum maximum, were selected as typical of areas with high application rates of glyphosate (nine applications in the last three years - high standard use), being *Gossypum hirsutum* and *Indigofera hirsuta*. It is noteworthy that the presence of the species *Gossypum hirsutum* (cotton) must be related to any contamination of seeds, or some planting in previous years, as there was no cotton planting stories in the last three years, and possibly be from any cultivar resistant to glyphosate. The relatively high frequency of volunteer soybean plants may also be highlighted (*Glycine max*) in the areas of all groups evaluated: 83, 93, 100 and 75%, respectively for groups 1, 2, 3 and 4. These points to the need for the adjustment of processes of mechanized harvesting in the region and in the management of off-season cultivation, as well as concern about the presence of these plants during the period of fallowing.

The relationship between the amount of glyphosate applied in the last three years and the floristic composition of the weed species, based on the calculations for the number of individuals counting, is shown in Table 5. The specie *Digitaria horizontalis* presented value indicator for areas that received 6001 to 8000 g ha^{-1} (average use standard of glyphosate), represented in this work by Group 3. Compared to Group 2, using 4001 to 6000 g ha^{-1}, that is a low use standard of glyphosate, both species were considered typical of these environments, which are *Eugenias* sp. and *Rumex acetosella*. For areas that have been classified in Group 1 and Group 4, very low and high use standard, respectively, there were no plants with value indicator for the Monte Carlo test, although several species were found predominantly in these environments. Petter et al. (2007), in Nova Xavantina - MT, evaluating the control of *Chamesyce hirta*, *Alternanthera tenella*, *Euphorbia heterophylla*, *Spermacoce latifolia* and *Tridax procumbens* in five varieties of genetically modified soybeans concludes that a herbicide in the management desiccation associated with an application in post-emergence was sufficient to yield efficient weed control. However, in this study, it was observed that species are persisting in the areas analyzed, even in those that consistently apply high levels of glyphosate.

The data collected under the historical amount of glyphosate applied and dry matter of aerial part are shown in Table 6. For Group 2 (4001 to 6000 g ha^{-1} – low use standard of glyphosate), the species *Eugenias* sp., *Rumex acetosella* and *Spermacoce latifolia* presented significant value to be typical of that environment. *Gnaphalium coarctatum* acted as typical of Group 3 (6001 to 8000 g ha^{-1} – average use standard) and the specie *Urochloa decumbens* was representative for Group 4 (8001 to 10000 g ha^{-1} – high use standard). According to Correia and Duringan (2010), the weed control is directly influenced by the rates of glyphosate. Some species may require higher doses of glyphosate, or sequential applications, addition of another herbicide for more effective control (Ateh and Harvey, 1999). Even with the high number of glyphosate applications, it is clear that persistence of weeds in agricultural areas is very large, among the possible causes we have: the large number of seeds present in the soil bank; the growth during the fallow period and reproduction of species tolerant or resistant to this herbicide.

After analyzing the results, it is clear that, although they continue to have the same tendency, the results are different when evaluating the number of glyphosate applications in relation to the amount-applied sum. That is, an application of 2000 g ha^{-1} does not appear to produce the same effects on the weed flora than two applications of 1000 g ha^{-1}. Therefore, it is important to analyze the two variables in this type of study. The use of wild plants count changed in a significant way the analysis compared the use of these species dry mass aerial part, and the use of this variable discriminated largest number of species typical of areas with different use levels of glyphosate.

Table 5. Indicator value (IV) of weeds present in the agricultural areas subdivided in four groups in relation to the number of glyphosate application in the last three years. Group 1 (2000 to 4000 g ha^{-1} – Standard of very low use), Group 2 (4001 to 6000 g ha^{-1} – Standard of low), Group 3 (6001 to 8000 g ha^{-1} – Standard of medium use), and Group 4 (8001 to 10000 g ha^{-1} – Standard of high use). Calculations based on the number of individuals. Rio Verde (GO), 2012/2013.

Species	IV					Monte Carlo Test		Species	IV					Monte Carlo Test	
	DG	1	2	3	4	SD	P*		DG	1	2	3	4	SD	P*
Acanthospermum hispidum	4	0	0	0	14	2.98	0.406	*Ipomoea cordifofolia*	4	3	3	22	33	6.77	0.129
Ageratum conyzoides	3	0	0	8	0	2.97	1.000	*Ipomoea grandifolia*	3	4	13	32	14	7.36	0.257
Alternanthera tenella	1	27	8	6	19	7.78	0.42	*Leonotis nepetifolia*	3	1	7	12	2	8.1	0.718
Amaranthus viridis	4	9	2	0	12	7.87	0.675	*Lithraea molleoide*	4	0	0	0	14	2.96	0.397
Andira vermifuga	2	0	8	1	4	7.33	0.74	*M. coromamdelianum*	4	10	15	6	17	7.52	0.85
Bauhinia sp.	4	0	0	0	14	2.96	0.402	*Mimosa hirsutissima*	4	5	0	1	7	7.52	0.836
Bidens pilosa	3	0	0	6	4	6.19	1.000	*Myrcia guianesis*	2	0	9	3	0	6.43	0.56
Bidens subalternans	3	22	3	31	20	8.35	0.506	*Nesa theifera*	3	0	0	8	0	2.96	1.000
Urochloa decumbens	4	4	0	0	29	7.82	0.065	*Panicum maximum*	4	1	1	3	31	9.21	0.122
Brosimum gaudichaudii	3	0	0	8	0	2.96	1.000	*Pavonia rosa-campestris*	4	0	0	2	11	6.18	0.396
Chamaesyce hirta	3	9	21	43	20	5.79	0.1	*Pennisetum americanum*	2	0	24	4	0	8.81	0.164
Cissampelus ovolifofolia	4	0	0	4	11	7.54	0.473	*Pennisetum setosum*	3	1	4	13	7	9.54	0.759
Cissampelos sp1	2	1	14	1	4	7.55	0.395	*Phyllanthus tenellus*	4	0	0	3	9	6.3	0.54
Cissampelos sp2	4	3	2	4	5	7.9	0.932	*Praxelis pauciflora*	3	10	5	25	3	8.99	0.459
Cnidoscolus urens	1	13	0	0	0	2.96	0.623	*Qualea parviflora*	4	0	0	0	14	2.96	0.397
Commelina benghalensis	4	21	22	19	24	4.09	0.947	*Rhynchelytrum repens*	2	0	9	6	1	8.23	0.704
Connarus suberosus	4	0	0	0	14	2.96	0.397	*Richardia brasiliensis*	2	1	13	1	6	7.64	0.565
Conyza bonariensis	3	0	1	30	9	9.37	0.18	*Rumex acetosella*	2	2	32	1	0	7.32	0.039
Conyza canadensis	3	1	14	20	9	7.75	0.566	*Rumex obtusifolius*	4	0	0	0	14	2.98	0.406
Couepia grandifolia	2	0	14	0	0	2.95	0.403	*Senna obtusifolia*	2	14	16	4	6	9.06	0.872
Cresta sphaerocephala	2	0	14	0	0	2.95	0.403	*Setaria parviflora*	4	1	9	9	11	7.92	0.922
Crotalaria incana	4	0	0	0	14	2.98	0.406	*Sida cordifolia*	3	0	5	5	0	6.26	1.000
Crotalaria spectabilis	3	0	0	7	2	5.85	1.000	*Sida glaziovii*	1	30	8	13	12	7.47	0.412
Cyperuss difformis	1	27	18	2	8	8.24	0.394	*Sida rhombifolia*	4	12	7	7	12	8.41	0.967
Cyperus odoratus	3	0	0	8	0	2.95	1.000	*Sida spinosa*	2	0	14	0	0	2.94	0.4
Digitaria ciliares	3	0	0	8	0	2.97	1.000	*Sida urens*	3	0	0	8	7	7.68	0.632
Digitaria horizontalis	3	5	0	37	0	8.2	0.04	*Simaba* sp.	3	0	0	15	0	6.2	0.244
Digitaria insularis	1	13	1	5	4	8	0.687	*Smilax brasiliensis*	4	0	0	0	14	2.96	0.402
Eleusine indica	1	33	7	19	16	8.8	0.566	*Smilax campestris*	4	0	0	4	11	7.58	0.464
Emilia fosbergii	2	0	9	5	0	7.28	0.502	*Smilax ovolifolia*	3	0	0	8	0	2.96	1.000
Eugenias sp.	2	0	43	0	0	7.52	0.009	*Smilax polyantha*	4	0	2	0	25	7.24	0.079
Euphorbia heterophyla	2	27	45	3	2	9.32	0.081	*Solanum americanum*	1	10	3	0	0	6.39	0.756
Glycine max	2	12	30	26	22	3.21	0.424	*Sorghum halepense*	2	0	14	0	0	2.95	0.405
Gnaphalium coarctatum	3	1	1	33	0	8.32	0.057	*Spermacoce latifolia*	2	3	27	1	0	7.33	0.077
Gossypium hirsutum	4	0	0	2	11	6.18	0.395	*Spermacoce verticilata*	3	0	0	8	0	2.96	1.000
Heliotropium indicum	4	0	0	0	14	2.98	0.406	*Synedrellopsis grisebachii*	4	0	5	0	10	6.25	0.661
Heteropteris sp.	2	0	7	4	0	6.36	0.919	*Tridax procumbens*	2	5	40	4	3	8.69	0.077
Hyptis lophanta	2	0	14	0	0	2.94	0.4	*Vernonia ferruginea*	4	0	0	0	14	2.98	0.406
Indigofera hirsuta	4	0	0	0	29	6.35	0.073	*Zea mays*	2	0	18	0	5	7.56	0.261

DG: Dominance group of the species, SD: Standard deviation, and P* Probability.

Plants considered tolerant to glyphosate, such as *Commelina benghalensis, Tridax procumbens, Richardia brasiliensis, Ipomoea cordifolia and Ipomoea grandifolia,* did not show significant indicator value to Group 4 (high use standard of this herbicide). It demonstrates that the chemical management of plantation areas in the region is accelerating the selection of species tolerant to this herbicide, mainly due to successive applications with a low standard of use, making it difficult to control these species. This same behavior occurred in relation to species with glyphosate resistant biotypes already been distributed in the region, such as *Conyza bonariensis*, *Conyza canadensis* and *Digitaria insularis*, which also did not show indicator value to the areas framed within Group 4.

Tabela 6. Indicator value (IV) of weeds present in the agricultural areas subdivided in four groups in relation to the number of glyphosate application in the last three years. Group 1 (2000 to 4000 g ha^{-1} – Standard of very low use), Group 2 (4001 to 6000 g ha^{-1} – Standard of low), Group 3 (6001 to 8000 g ha^{-1} – Standard of medium use), and Group 4 (8001 to 10000 g ha^{-1} – Standard of high use). Calculations based on the shoot dry mass. Rio Verde (GO), 2012/2013.

Species	IV					Monte Carlo Test		Species	IV					Monte Carlo Test	
	DG	1	2	3	4	SD	P*		DG	1	2	3	4	SD	P*
Acanthospermum hispidum	4	0	0	0	14	2.96	0.389	*Ipomoea cordifofolia*	4	38	29	62	71	1.17	0.346
Ageratum conyzoides	3	0	0	8	0	2.95	1.000	*Ipomoea grandifolia*	3	38	57	77	57	9.08	0.717
Alternanthera tenella	1	75	43	46	57	7.5	0.37	*Leonotis nepetifolia*	2	13	29	23	14	9.69	0.891
Amaranthus viridis	4	25	14	8	29	9.41	0.587	*Lithraea molleoide*	4	0	0	0	14	2.96	0.401
Andira vermifuga	4	0	14	8	14	7.35	0.463	*M. coromandelianum*	4	50	43	38	57	8.5	0.917
Bauhinia sp.	4	0	0	0	14	2.96	0.406	*Mimosa hirsutissima*	4	13	0	8	14	7.31	0.877
Bidens pilosa	4	0	0	8	14	6.3	1.000	*Myrcia guianesis*	2	0	14	8	0	5.9	1.000
Bidens subalternans	4	75	43	77	86	9.24	0.554	*Nesa theifera*	3	0	0	8	0	2.95	1.000
Urochloa decumbens	4	13	0	0	43	7.85	0.049	*Panicum maximum*	4	13	14	23	43	9.56	0.07
Brosimum gaudichaudii	3	0	0	8	0	2.95	1.000	*Pavonia rosa-campestris*	4	0	0	8	14	6.36	1.000
Chamaesyce hirta	4	88	86	92	100	6.87	0.065	*Pennisetum americanum*	2	0	29	23	0	8.98	0.131
Cissampelus ovolifofolia	3	0	0	15	14	7.67	0.619	*Pennisetum setosum*	4	13	29	23	29	9.63	0.67
Cissampelos sp1	2	13	29	8	14	7.91	0.187	*Phyllanthus tenellus*	4	0	0	8	14	6.39	0.817
Cissampelos sp2	3	13	14	15	14	8.65	0.952	*Praxelis pauciflora*	3	25	29	69	29	9.91	0.98
Cnidoscolus urens	1	13	0	0	0	2.95	0.633	*Qualea parviflora*	4	0	0	0	14	2.96	0.401
Commelina benghalensis	4	75	86	85	100	7.05	0.501	*Rhynchelytrum repens*	3	0	14	23	14	8.37	0.748
Connarus suberosus	4	0	0	0	14	2.96	0.401	*Richardia brasiliensis*	2	13	29	8	14	7.93	0.584
Conyza bonariensis	3	0	14	46	29	1.07	0.171	*Rumex acetosella*	2	13	43	8	0	8.38	0.044
Conyza canadensis	3	13	43	54	43	9.56	0.337	*Rumex obtusifolius*	4	0	0	0	14	2.96	0.389
Couepia grandifolia	2	0	14	0	0	2.95	0.4	*Senna obtusifolia*	4	38	43	38	43	9.31	0.882
Cresta sphaerocephala	2	0	14	0	0	2.95	0.4	*Setaria parviflora*	3	13	29	38	29	0.18	0.605
Crotalaria incana	4	0	0	0	14	2.96	0.389	*Sida cordifolia*	2	0	14	8	0	5.73	1.000
Crotalaria spectabilis	4	0	0	8	14	5.68	1.000	*Sida glaziovii*	3	63	57	77	57	8.74	0.587
Cyperuss difformis	1	75	43	31	57	9.61	0.571	*Sida rhombifolia*	4	38	43	31	43	8.42	0.815
Cyperus odoratus	3	0	0	8	0	2.96	1.000	*Sida spinosa*	2	0	14	0	0	2.97	0.396
Digitaria ciliares	3	0	0	8	0	2.95	1.000	*Sida urens*	3	0	0	15	14	7.49	0.83
Digitaria horizontalis	3	25	0	46	0	0.55	0.056	*Simaba* sp.	3	0	0	15	0	5.94	0.25
Digitaria insularis	1	38	14	15	14	9.44	0.907	*Smilax brasiliensis*	4	0	0	0	14	2.96	0.406
Eleusine indica	1	88	71	77	57	7.74	0.91	*Smilax campestris*	3	0	0	15	14	7.37	0.506
Emilia fosbergii	3	0	14	15	0	7.32	0.845	*Smilax ovolifolia*	3	0	0	8	0	2.97	1.000
Eugenias sp.	2	0	43	0	0	7.35	0.009	*Smilax polyantha*	4	0	14	0	29	7.6	0.083
Euphorbia heterophyla	2	63	100	38	43	0.98	0.647	*Solanum americanum*	2	13	14	0	0	6.45	0.769
Glycine max	2	75	100	92	86	4.72	0.146	*Sorghum halepense*	2	0	14	0	0	2.94	0.39
Gnaphalium coarctatum	3	13	14	38	0	9.2	0.041	*Spermacoce latifolia*	2	13	43	8	0	8.13	0.044
Gossypum hirsutum	4	0	0	8	14	5.94	1.000	*Spermacoce verticilata*	3	0	0	8	0	2.95	1.000
Heliotropium indicum	4	0	0	0	14	2.96	0.389	*Synedrellopsis grisebachii*	4	0	14	0	14	6.14	0.578
Heteropteris sp.	2	0	14	8	0	6.26	1.000	*Tridax procumbens*	2	50	57	38	29	8.92	0.098
Hyptis lophanta	2	0	14	0	0	2.96	0.396	*Vernonia ferruginea*	4	0	0	0	14	2.96	0.389
Indigofera hirsuta	4	0	0	0	29	6.07	0.07	*Zea mays*	2	0	29	0	14	7.19	0.705

DG: Dominance group of the species, SD: Standard deviation, and P* Probability.

Conclusions

The different ways of using glyphosate regarding the number of applications and amount of acid equivalents applied in the areas of the survey determine distinct floristic composition. Species of weeds tolerant and resistant to glyphosate were recorded on the inventoried areas and are selected in areas with a low use standard of the herbicide due to repeated applications over the years of cultivation.

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