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Article

PHYTOSOCIOLOGICAL SURVEY OF WEEDS IN ERECT PROSTRATE COWPEA CULTIVARS

Levantamento Fitossociológico de Plantas Daninhas em Cultivares de Feijão-Caupi de Porte Ereto e Prostrado

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ABSTRACT - The goal of this study is to characterize the weed phytosociology in some major erect and prostrate cowpea cultivars in Brazil, in the Northern growing conditions of Minas Gerais state. The test was conducted in Janaúba, Minas Gerais state. The treatments consisted in five erect cultivars (BRS Guariba, BRS Tumucumaque, BRS Novaera, BRS Itaim and BRS Cauamé) and four prostrate ones (BRS Marataoã, BRS Pajeú, BRS Pujante and BRS Xiquexique). The plots were composed of four five meter rows, spaced 0.5 m apart, for erect cultivars and 1.0 m for the prostrated ones. Weed sampling was performed 50 days after sowing by standard Square Method. The species were identified and quantified, and then dried at 65 °C for 72 hours and weighed. The frequency, absolute and relative density and abundance, the importance value index (IVI) and the similarity index were evaluated. In the erect cultivars, the Amaranthaceae, Euphorbiaceae, Asteraceae and Convolvulaceae families stood out with higher IVI's. In prostrate cultivars, the Amaranthaceae, Asteraceae and Malvaceae families stood out. *Portulaca oleracea* and *Amaranthus* spp. were the species with the highest IVI. The similarity index between erect and prostrate cultivars was 72%; nine of the 16 families occurred in both cultivars. BRS Tumucumaque, erect, and BRS Pujante, prostrate had lower weed infestation.

Keywords: *Vigna unguiculata*, phytosociological, plant habit, weeds.

*RESUMO - Objetivou-se com este trabalho caracterizar a fitossociologia de plantas daninhas em alguns das principais cultivares de feijão-caupi do Brasil, de porte ereto e prostrado, nas condições de cultivo do Norte de Minas Gerais. O ensaio foi conduzido em Janaúba, MG. Os tratamentos consistiram de cinco cultivares de porte ereto (BRS Guariba, BRS Tumucumaque, BRS Novaera, BRS Itaim e BRS Cauamé) e quatro de porte prostrado (BRS Marataoã, BRS Pajeú, BRS Pujante e BRS Xiquexique). As parcelas foram compostas por quatro fileiras de cinco metros, espaçadas de 0,5 m entre si, para os cultivares de porte ereto, e de 1,0 m, para os cultivares de porte prostrado. A amostragem das plantas daninhas foi realizada aos 50 dias após a semeadura, pelo método-padrão do quadrado inventário. As espécies foram identificadas e quantificadas e, em seguida, secas em estufa a 65 ºC por 72 horas e pesadas. Avaliaram-se as frequências, densidades e abundâncias, absolutas e relativas, o índice de valor de importância (IVI) e o índice de similaridade. Nos cultivares de porte ereto, destacaram-se as famílias Amaranthaceae, Euphorbiaceae, Asteraceae e Convolvulaceae com maiores IVI. Nos cultivares de porte prostrado, destacaram-se as famílias Amaranthaceae, Asteraceae e Malvaceae. **Portulaca oleracea** e **Amaranthus** spp. foram as espécies*

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com maior IVI. O índice de similaridade entre os cultivares de porte ereto e prostrado foi de 72%, sendo que nove das 16 famílias ocorreram em cultivares dos dois portes. Os cultivares BRS Tumucumaque, de porte ereto, e BRS Pujante, de porte prostrado, apresentaram menor infestação de plantas daninhas.

Palavras-chave: *Vigna unguiculata*, fitossociologia, hábito de crescimento, plantas infestantes.

INTRODUCTION

The cultivation of cowpea (*Vigna unguiculata*) presents great socio-economic importance, mostly in countries and region under development and with tropical climate. It is an important component of the diet, especially for needy populations in various regions of Brazil and the world; it also contributes to the creation of work opportunities and income in the agricultural area (Rocha et al., 2009).

In Brazil, cowpea cultivation is still performed mainly by family farmers, which frequently have low technology. Many producers prefer prostrate cultivars which, generally, present longer cycles and provide more than one harvest. However, over the last few years, this culture has been expanding to new cultivation regions and it has changed the traditional profile of the cowpea producer in the country, with the adoption of high technology in the culture and of plating over great areas. Thus, there is also an increase in the demand for erect cultivars, which are more suitable for the mechanized harvest; there is also a growth in the creation of technologies that allow to reach greater productivity (Freire Filho et al., 2011). According to Embrapa Arroz e Feijão (2015), cowpea production in Brazil during 2014 was 482.7 thousand tons; the country is the third world biggest producer.

The most traditional Brazilian regions in the cultivation of cowpea are the North and Northeast, where familiar agriculture is predominant and, more recently, the West-Center, where high technology is used in the cultures. With semi-arid climate, characterized by the predominance of high temperatures, low relative air humidity and irregular rain distribution, the Northern region of Minas Gerais state is also traditional in this cultivation, due to the great adaptation capacity to these conditions (Freire Filho et al., 2011). However, the average regional productivity is still under the culture productive potential, which is related to the low technologic level used (Tavares et al., 2013).

Among the factors influencing the productive performance of cultures, the interference of weeds is one of the most important (Ferreira et al., 2006); they are responsible for up to 90% productivity reduction (Freitas et al., 2009). However, despite the importance of cowpea for the Northern region of Minas Gerais and the interference of weeds in the culture productivity, little is known about the issue within the region.

In order to create strategies to manage weeds in cultivated environments, it is important and necessary to identify weed species, since each one of them presents the potential to establish itself in the area, and its aggressiveness may interfere among the cultures in different ways (Cruz et al., 2009). Thus, through phyto-sociological indices, it is possible to analyze the impact that management systems and cultural practices have over the growth dynamic and occupation of infesting communities in agro-systems (Pitelli, 2000).

In addition to the characteristics of the weed community, its interference rate over cultures also depends on the characteristics of the cultivated plants, such as stand, arrangement and size of the plants, environment conditions, such as climate, soil and management, as well as the period and duration of the coexistence of weeds and cultures (Pitelli, 1985; Silva and Silva, 2007). Therefore, the growth habit of plants, which directly influences the determination of plant distance and arrangement, also determines the interference degree of weeds in the culture, since the use of different distances surely causes different competitive interactions between cultivated plants and weed species. Moreover, infesting communities may also vary according to the type of growth and the size of plants in the culture, since erect plants may produce less shadowed environments than prostrate plants and, thus, they may change the interaction between infesting community and cultivated plants.

The size of cowpea plants may influence the floristic composition of weeds in the production area. Thus, the phyto-sociological survey of weeds in different-sized cultivars is of utmost importance to create strategies of integrated weed management in cowpea. Therefore, the goal of this work was, through the phyto-sociological survey of weeds performed in some of the main erect and prostrate cowpea cultivations in Brazil, to identify the main occurring weeds species, within the cultivation conditions of Northern Minas Gerais.

MATERIAL AND METHODS

The experiment was conducted in Janaúba, Minas Gerais state, in the geographic coordinates 15°47'50"S and 43°18'31"W and at 516 m height, on a soil classified as Eutophic Red Latosol. The climate of the region is AW type (rainy tropical, savannah with dry winters), according to Köppen.

Treatments were composed of some of the main current cowpea cultivars in Brazil; five were erect ones (BRS Guariba, BRS Tumucumaque, BRS Novaera, BRS Itaim and BRS Cauamé) and four were prostrate ones (BRS Marataoã, BRS Pajeú, BRS Pujante and BRS Xiquexique). The used experimental design was the completely randomized one with four replications. Plots were composed by four 5 meter lines, spaced 0.5 apart for erect cultivars and spaced 1.0 meter apart for the prostrate ones.

The area was prepared in a conventional way, with one plowing and two harrowings. After soil preparation, a sower-fertilizer machine was used in order to sap and distribute the fertilizer and to sow the lines. Sowing was performed in February 2014, with the help of manual sowers, placing about 15 seeds per meter. Fertilization consisted in 300 kg ha^{1} of 8 30-10 formulation in the sowing, plus 40 kg ha^{-1} of N in coverage during stage V4, using urea as a nitrogenous source. Moreover, a leaf application was performed with 40 g ha^{-1} of molybdenum, using sodium molybdate as a source. The culture was irrigated through conventional sprinkling during all cycle.

Weed collection was performed on day 50 after sowing, when cowpea plants were blooming, by the square inventory standard method. To do so, a 0.5 m x 0.5 m square was used, which was randomly launched once in the usable area of each plot. All weeds that were contained in the square were collected with full structure, with root system and aerial part. The weeds collected in each square were stored in paper bag for later identification. After that, the collected species were identified for comparison, according to the description by Lorenzi (2008), and quantified according to family, genus and species. Subsequently, samples from each species were placed in paper bags and forwarded to a forced air circulation oven; they were kept at 65 °C for 72 hours. After that, they were weighed on a precision scale, in order to determine the dry mass.

The number of individuals per species was determined in each cultivar and so was the total number per harvest. Starting from the identification and counting of the species, the calculation of the following phyto-sociological variables was performed: absolute frequency (F), relative frequency (Rf), absolute density (D), relative density (Rd), absolute abundance (A), relative abundance (Ra) and importance value index (IVI), for each one of the experimental plots (Brandão et al., 1998; Brighenti et al., 2003). Relative indices were used to calculate the importance value (IVI) and similarity (SI) indices.

When performing the calculations, the following formulas were used:

F = n. of squares containing the species / total n. of obtained squares

Rf = F of the species * 100 / total frequency of the species

D = total n. of individuals per species / total area occupied by the squares

Rd = D of the species * 100 / total density of the species

A = n. of individuals per species / total n. of squares containing the species

Rd = D of the species * 100 / total density of the species

IVI = Rf + Rd + Ra

SI = [(2 * a) / (b + c)] * 100

where a is the number of common species to both types and b and c, the total number of species on both compared types.

RESULTS AND DISCUSSION

Two hundred and five weed species were counted in the erect cultivars, and 258 in the prostrate ones. This infesting community was represented by 16 species, distributed in eight families (Table 1 and 2); 6.25% were monocots and 93.75% were dicots. Marques et al. (2011) and Freitas et al. (2009) also observed greater dicot infesting flora in the cowpea culture: 71.22% and 63%, respectively. It is possible to notice that the higher importance of dicot weeds is related to the fact that they belong to the same class as cowpea; this hinders control, especially the chemical one.

In erect cultivars, 9 families were identified, together with 12 genera and 14 weed species (Table 1). The most numerous families in terms of species were Amaranthaceae (3), Asteraceae (2) and Convolvulaceae (2). In the prostrate type cultivars 7 families were identified, together with 10 genera and 11 species, and the families Amaranthaceae (3), Asteraceae (2) and Malvaceae (2) were the most numerous (Table 2). Despite being represented by only species, the Portulacaceae family also showed great importance for erect and prostrate cultivars, given the density of individuals found in the phyto-sociological survey.

Table 1 - Weeds identified in erect cowpea cultivars, during the summer-autumn harvest, in Northern Minas Gerais. Janaúba, Minas Gerais state, 2015

Family	Species	
	Scientific Name	Common Name
Amaranthaceae	*Alternanthera tenella*	Joseph's coat
	Amaranthus deflexus	Large-fruit amaranth
	Amaranthus viridis	Slender amaranth
Asteraceae	*Bidens pilosa*	Common blackjack
	Emilia fosbergii	Florida tasselflower
Convolvulaceae	*Ipomoea Grandifolia*	Morning glory
	Merremia aegyptia	Hairy woodrose
Euphorbiaceae	*Chamaesyce prostrata*	Prostrate spurge
Fabaceae	*Abrus precatorius*	Jequirity
	Aeschynomene denticulata	Jointvetch
Malvaceae	*Sida cordifolia*	Flannel weed
Molluginaceae	*Mollugo verticillata*	Green carpetweed
Poaceae	*Sorghum halepense*	Johnson grass
Portulacaceae	*Portulaca oleraceae*	Purslane

Table 2 - Weeds identified in prostrate cowpea cultivars, during the summer-autumn harvest, in Northern Minas Gerais. Janaúba, Minas Gerais state, 2015

Family	Species	
	Scientific name	Common name
Amaranthaceae	*Alternanthera tenella*	Joseph's coat
	Amaranthus deflexus	Slender amaranth
	Amaranthus viridis	Slender amaranth
Asteraceae	*Bidens pilosa*	Common blackjack
	Emilia fosbergii	Florida tasselflower
Fabaceae	*Senna obtusifolia*	Chinese senna
Malvaceae	*Malvastrum coromadelianum*	False mallow
	Sida cordifolia	Flannel weed
Molluginaceae	*Mollugo verticillata*	Green carpetweed
Poaceae	*Sorghum halepense*	Johnson grass
Portulacaceae	*Portulaca oleraceae*	Purslane

The Amaranthaceae, Asteraceae, Convolvulaceae, Malvaceae and Portulacaceae families showed great importance in cowpea cultivars, regardless of the type; they present the highest species number. Marques et al. (2010), while evaluating the floristic composition of weeds in the cowpea culture in the mulch system, verified that the Cyperaceae, Fabaceae, Poaceae, Malvaceae, Asteraceae and Rubiaceae families were the ones presenting the highest number of species and greatest importance. This result contrasting from the main weed species is related to differences in climate, soil type, previous cultures and weed seed bank of each region, demonstrating in a concrete way that the phyto-sociological survey in the area is fundamental to perform an effective weed control; this may reduce costs and losses in productivity.

Among erect cultivars, seven weed species were found in the BRS Guariba cultivar, with total dry mass (DM) of 21.62 g; six were found in BRS Novaera, with total DM of 13.91 g; eight in the BRS Itaim one, with total DM of 24.77 g; seven in the BRS Cauamé one, with total DM of 10.87 g; and five in the BRS Tumucumaque cultivar, with total DM of 6.47 g (Table 3).

BRS Tumucumaque was the erect cultivar with the lowest weed infestation, lowest total DM weed values, lowest species and specimen number. This lower occurrence of weeds is certainly related to the quick establishment of the cultivar in the area, reducing the incidence of light for the weeds, which represents a higher competitive benefit compared to the other cultivars.

The *Portulaca oleracea* species was the one presenting the highest importance value index (IVI), for the BRS Guariba (122.67), BRS Novaera (130.32) and BRS Itaim (142.38) cultivars. In the BRS Cauamé cultivar, the *Amaranthus viridis* species presented the highest IVI (88.64), and in the Tumucumaque one, *Amaranthus deflexus* was the one presenting the highest IVI (123.03) (Figure 2). Marques et al. (2010), during a floristic survey in the cowpea culture in the mulch system, verified that *Cyperus diffusus* and *Digitaria horizontalis* were the species with the highest IVI values during the years 2007 and 2008, respectively.

Performing the phyto-sociological survey and the IVI calculation is important to establish proper management strategies for each condition. Thus, weed species with higher IVI values must be managed first, that is, the population of these plants must be reduced so that they do not interfere in the culture productivity.

Species belonging to the *Amaranthus* genus are characterized as difficult management plants, since they have a long germination period of the seed bank, high production of feasible seeds and long feasibility of its seeds in the soil, as well as quick growth and development (Horak and Loughin, 2000). In addition to these factors, it is possible to state that plants belonging to the genus have a C4 carbon fixation pathway and a photosynthetic mechanism that give them different profitable characteristics in establishing in the area, in relation to C3 plants. On the other hand, *Portulaca oleracea*, commonly known as purslane, is an annual cycle herbaceous plant, prostrate and currently dispersed in all Brazilian territory; it is a very prolific plant: a single plant produces 10,000 seeds, which may remain dormant for 19 years (Lorenzi, 2008). It also has a photosynthetic system, is C4 with a relatively short cycle; according to Kissman and Groth (2000), as well as competing with the cultivated plant, it also serves as a host for viruses and nematodes. Thus, both species from the Amaranthus genus and the Portulaca oleraceae,

Table 3 - Dry mass (DM), in grams, and number of individuals per species (NIS) of weeds identified in erect cowpea cultivars, in the summer-autumn harvest, in Northern Minas Gerais. Janaúba, 2015

Cultivars															
BRS Guariba			BRS Novaera			BRS Itaim			BRS Cauamé			BRS Tumucumaque			
Weed	DM	NIS	Weed	DM	NIS	Weed	DM	NIS	Weed	DM	NIS	Weed	DM	NIS	
Abrus precatorius	0.28	1	*Amaranthus viridis*	0.88	4	*Aeschynomene denticulata*	1.87	1	*Aeschynomene denticulata*	1.08	1	*Amaranthus viridis*	0.82	4	
Amaranthus viridis	1.54	7	*Alternanthera tenella*	0.75	3	*Amaranthus viridis*	1.27	4	*Amaranthus viridis*	1.96	13	*Portulaca oleraceae*	1.37	1	
Alternanthera tenella	1.71	6	*Portulaca oleraceae*	4.60	19	*Alternanthera tenella*	0.32	1	*Portulaca oleraceae*	2.15	9	*Amaranthus deflexus*	2.36	8	
Portulaca oleraceae	9.54	35	*Sorghum halepense*	1.60	2	*Portulaca oleraceae*	11.30	40	*Bidens pilosa*	1.76	1	*Merremia aegyptia*	1.32	1	
Amaranthus deflexus	1.19	1	*Amaranthus deflexus*	0.40	2	*Amaranthus deflexus*	0.26	3	*Amaranthus deflexus*	0.32	3	*Mollugo verticillata*	0.60	1	
Ipomoea grandifolia	1.77	3	*Ipomoea grandifolia*	5.68	2	*Emilia fosbergii*	1.27	1	*Chamaesyce prostrata*	1.04	1				
Sida cordifolia	5.59	10				*Ipomoea grandifolia*	2.05	2	*Sida cordifolia*	2.56	8				
						Sida cordifolia	6.43	7							
Cultivar Total	21.62	63		13.91	32		24.77	59		10.87	36		6.47	15	

identifies as the ones obtaining the highest IVI values for erect cultivars, certainly benefited from greater solar radiation occurring between the rows of the culture, which results from the culture type.

For prostrate cultivars, five weed species were identified in the BRS Marataoã cultivar, with total DM of 42.42 g; eight in the BRS Pajeú, with total DM of 62.13 g; two in BRS Pujante, with total DM of 42.49 g; and nine in BRS Xiquexique, with total DM of 96.5 g. BRS Pujante was the cultivar presenting the lowest weed species number and lowest total weed plant number (26), whereas BRS Marataoã was the one presenting the lowest total weed DM (Table 4).

The highest IVI values were obtained by the *Amaranthus deflexus* species (121.18) in the BRS Marataoã cultivar; *Sorghum halepense* (86.05) in the BRS Pajeú cultivar; and *Portulaca oleracea*, in the BRS Pujante (247.31) and BRS Xiquexique (69.56) cultivars (Figure 3). Marques et al. (2011), in a cultivation with the BRS Guariba semi-erect cowpea cultivar, in the municipality of Zé Doca, Maranhão state, verified that the species with the highest importance index were *Cyperus* sp., *C. iria* and *C. flavus*.

When comparing the incidence of weeds in erect and prostrate cultivars, a lower density is expected in prostrate cultivars, due to the higher speed in "closing" the area. However, in this work a higher DM and number of plants in prostrate cultivar were observed, compared to the erect ones (Figure 1 and 2). This result is related to the higher distance between rows adopted for prostrate cultivars, since a longer period is necessary to cover the soil; this represents more time for weeds to grow between the lines. According to Salgado et al. (2007), cultures that less shadow the soil suffer from higher weed interference, resulting in growth damages and productivity losses, which in the cowpea culture may reach 67%. Moreover, results from this work also demonstrated the importance of adopting a proper distance for each cultivar and its effects in the occurrence of weeds in the cultivation of cowpea.

According to Lorenzi's classification (2008), among the 16 species identified in this work, with the exception of Sorghum halepense, which reproduces by seeds and rhizome, all species reproduce exclusively by seeds. Thirteen species (81.24%) present annual cycle, and twelve of them (75%) have herbaceous growth habits. Knowing some of the biological aspects of weeds, such as propagation medium, life cycle and growth habit, is extremely important to determine the necessary management and the choice of the period to control them. Since most of the identified species propagates exclusively by mating, it is extremely important to control them before they produce seeds.

The calculated similarity index (SI) was 72, which indicates that 72% of the identified species were common to both cowpea types. They were: *Alternanthera tenella*, *Amaranthus deflexus*, *Amaranthus viridis*, *Bidens pilosa*, *Emilia fosbergii*, *Portulaca oleraceae*, *Sida cordifolia*, *Mollugo verticillata* and *Sorghum halepense*. Considering Felfili and Venturoli's classification (2000), where the SI is high when higher than 50%, it is possible to deduce that there was high similarity of the species found in prostrate and erect cultivars in this work, which is certainly related to the similarity of cultivation conditions to which all cultivars were submitted, as well as the physical-chemical characteristics of soil, climate, planting period and weed seed bank.

Table 4 - Dry mass (DM), in grams, and number of individuals per species (NIS) of weeds identified in prostrate cowpea cultivars, in the summer-autumn harvest, in Northern Minas Gerais. Janaúba, 2015

Cultivars											
BRS Marataoã			BRS Pajeú			BRS Xiquexique			BRS Pujante		
Weed	DM	NIS	Weed	DM	NIS	Weed	DM	NIS	Weed	DM	NIS
Portulaca oleraceae	13.38	13	*Amaranthus viridis*	0.32	5	*Amaranthus viridis*	11.10	14	*Amaranthus viridis*	0.54	2
Sorghum halepense	0.23	4	*Alternanthera tenella*	1.67	12	*Alternanthera tenella*	1.39	13	*Portulaca oleraceae*	41.95	24
Amaranthus deflexus	24.85	18	*Portulaca oleraceae*	28.75	28	*Portulaca oleraceae*	23.18	27			
Sida cordifolia	1.83	1	*Bidens pilosa*	0.61	4	*Sorghum halepense*	47.71	17			
Senna obtusifolia	2.13	2	*Sorghum halepense*	4.95	40	*Amaranthus deflexus*	7.70	9			
			Amaranthus deflexus	24.14	13	*Emilia fosbergii*	0.33	1			
			Mollugo verticillata	0.27	1	*Malvastrum coromadelianum*	1.45	4			
			Sida cordifolia	1.42	3	*Senna obtusifolia*	2.88	2			
						Sida cordifolia	0.76	1			
Cultivar Total	42.42	38		62.13	106		96.5	88		42.49	26

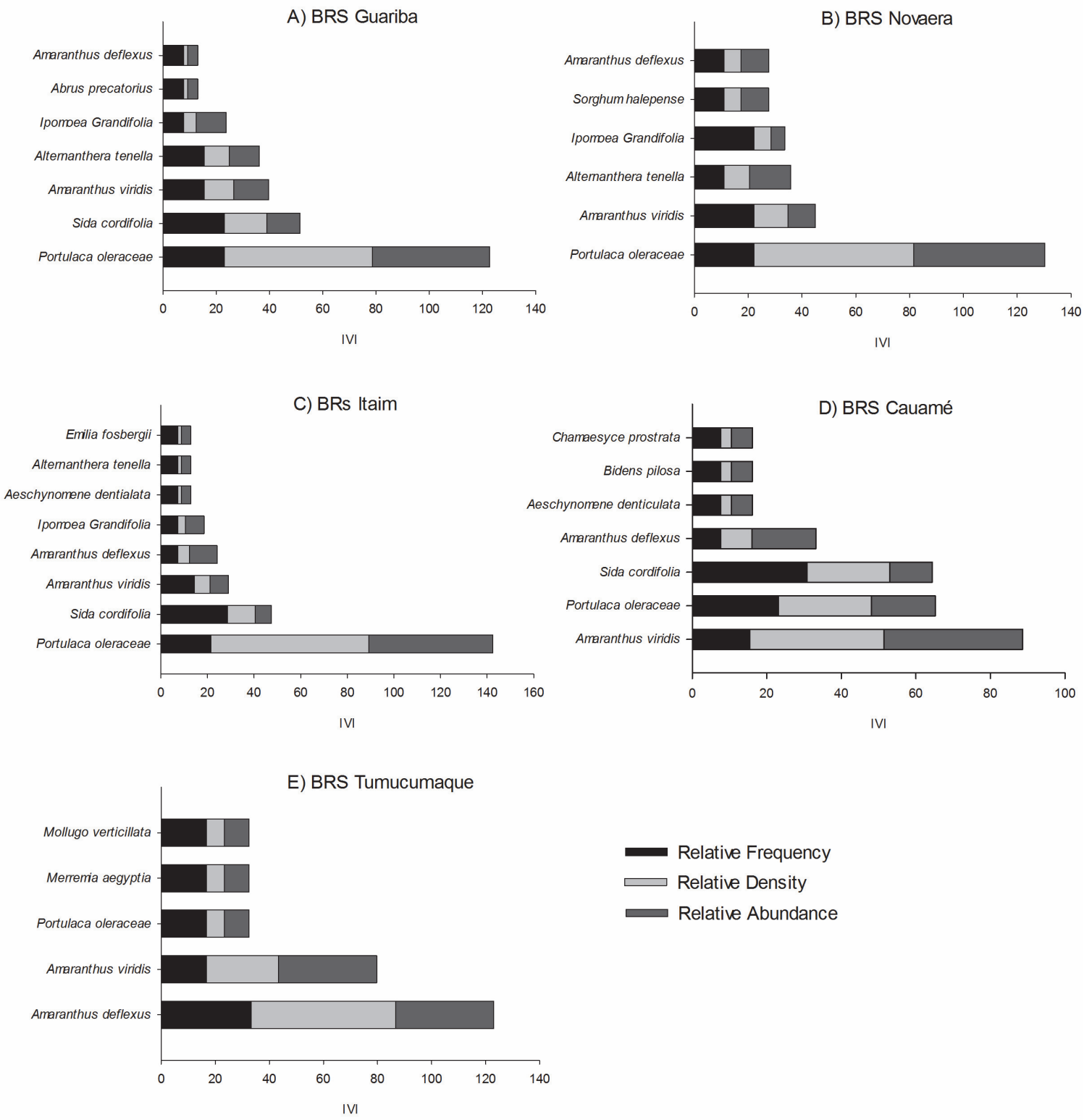

Figure 1 - Importance value index (IVI) of the weeds found in erect cowpea cultivars, during the summer-autumn harvest, in Northern Minas Gerais. Janaúba, 2015.

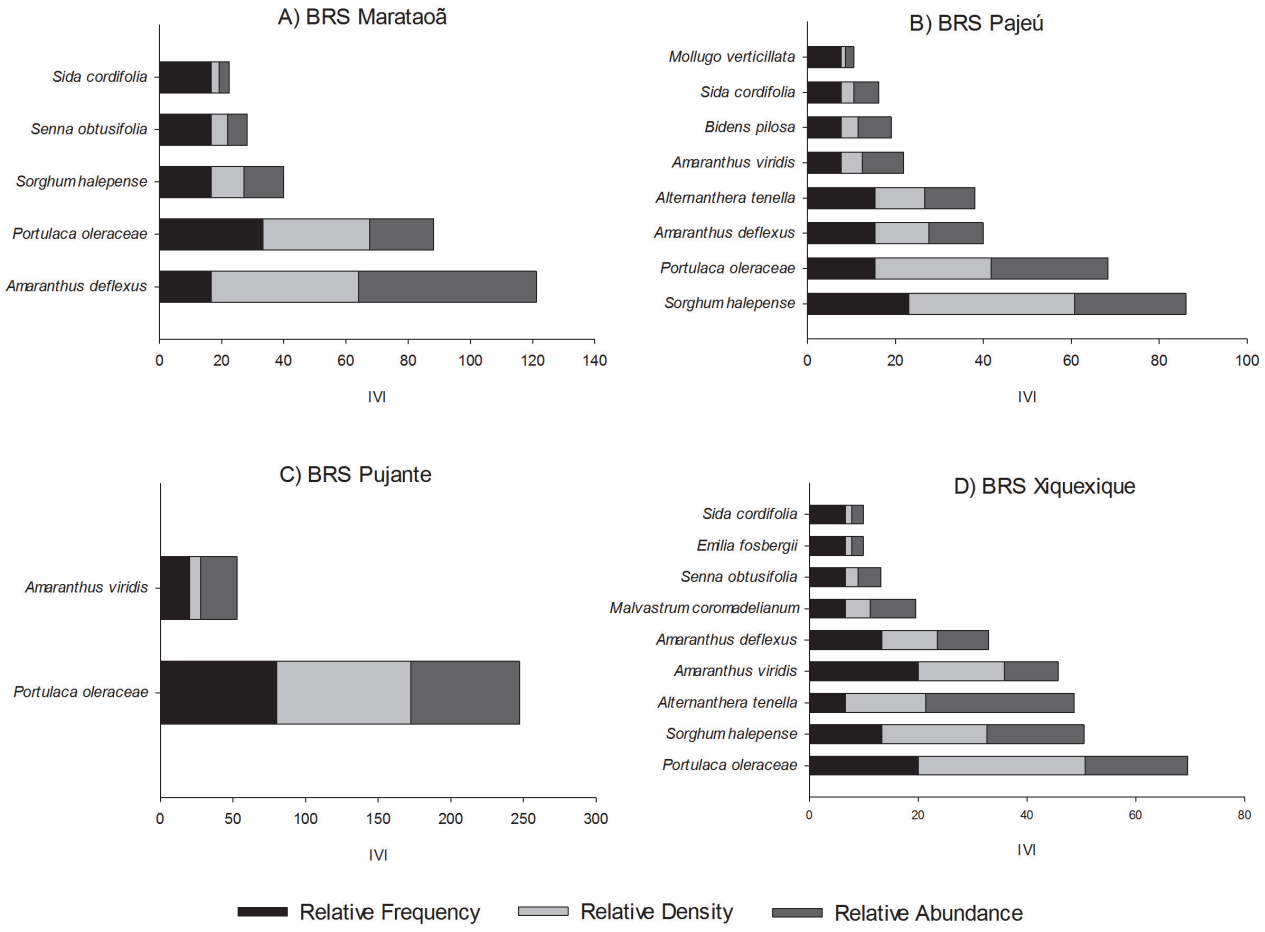

Figure 2 - Importance value index (IVI) of the weeds found in prostrate cowpea cultivars, during the summer-autumn harvest, in Northern Minas Gerais. Janaúba, 2015.

Results allowed concluding that there is high floristic similarity among weed species in erect and prostrate cowpea cultivars in Northern Minas Gerais. The *Portulaca oleracea* and *Amaranthus* spp. species are the ones presenting the highest importance value index, in the conditions under which this study was conducted. BRS Tumucumaque, erect, and BRS Pujante, prostrate, are the cultivars presenting lower weed infestation than the others.

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