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Phytosociological Survey of Weeds on Degraded and Well-Managed Pastures: Agronomical and Ecological Implications

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Abstract

The objective of this research was to carry out a survey of weeds in pastures in the Middle Valley of Paraíba do Sul, Rio de Janeiro State, Brazil, in order to subsidize weed management and pasture recovery. Weed identification and plant count were carried out in pastures with four levels of degradation, classified as low (N_1), moderate (N_2), strong (N_3) and very strong (N_4), with five replications. Thirty-nine weed species were identified and distributed into16 botanical families. Poaceae, Asteraceae and Fabaceae were the most relevant families. The number and density of weeds increased as the level of degradation decreased. The relative importance of weed species varied with the level of degraded pasture. The main weeds found in N_1 were *Melinis minutiflora*, *Desmodium incanum*, *Croton lundianus*, *Andropogon bicornis*, and *Imperata brasiliensis*; in N_2: *Paspalum notatum*, *Melinis minutiflora*, *Imperata brasiliensis*, *Sida rhombifolia*, and *Desmodium incanum*; in N_3: *Paspalum notatum*, *Melinis minutiflora*, *Sida rhombifolia*, *Eupatorium maximilianii*, and *Imperata brasiliensis*; in N_4: *Paspalum notatum*, *Melinis minutiflora*, *Cynodon dactilon*, *Eupatorium maximilianii*, and *Imperata brasiliensis*. The similarity index was high, showing the homogeneity of weeds among areas. The predominant species, considering all areas, were in increasing order of importance: *Cynodon dactilon*, *Melinis minutiflora* and *Paspalum notatum*. Decision-making about applying control measures could be marked out when the plant density reached out or exceed the average of 3.58 plants m^{-2}.

Keywords: livestock, recovery of degraded pastures, unwanted plants

1. Introduction

Pasture degradation is a problem that affects the world's livestock. This phenomenon causes great economic and environmental damage in Brazil. In the State of Rio de Janeiro, 50% of pastures show some degradation degree (Government of the State of Rio de Janeiro, 2018). The causes of degradation vary in each specific situation and usually more than one cause is involved in the process. For exemple: forages not adapted to edaphoclimatic conditions, inappropriate soil management practices, overgrazing, and inefficient weed control. All of these factors lead to significant losses in pasture productivity, reaching extreme degraded levels. Pasture degradation is classified into four levels, according to Dias Filho (2017). Level 1 is considered low, being the one in which the pasture is still productive, although with some areas of bare soil and the presence of weeds. At level 2 (moderate), there is an increase in the weed infestation and also bare soil when compared to level 1. Level 3 (strong) is the one in which there is an excessive increase in weed species and bare soil in relation to level 2. At level 4 (very strong), there is a predominance of bare soil and signs of erosion. In this situation, recovery or renewal becomes recommended to reverse the entire process (Nunes, 2001). Consequently, the time, effort, and costs of recovery are greater. Establishment of weed populations occur as result of inadequate pasture management. Gaps left by the forage are occupied by the weeds due to their opportunistic behavior and competitiveness (Caldeira et al., 2013). The problems caused by weeds are more significant in pastures with a higher degree of degradation and assume greater importance when considering large areas of infested pastures. Weed species surveys help producer make more accurate decisions regarding weed control practices in pastures. One of difficulties of

producers is the need of having parameters that guide the decision-making of when to carry out the appropriate weed control practices. The objective of this work was to carry out the registration of weeds in pastures in the Middle Valley of Paraíba do Sul, Rio de Janeiro State, Brazil, in order to subsidize weed management and pasture recovery.

2. Method

Weed surveys were carried out in pastures with 4 (four) different levels of degradation, during the month of February 2019. The original vegetation consisted of coffee crop fields, replaced by pastures of *Urochloa brizantha* with an approximate 40 years old. The areas were located in the municipality of Valença, in the middle Valey of Paraíba do Sul, State of Rio de Janeiro, Brazil (Figure 1and Table 1). Each level of degradation (N_1: low, N_2: moderate, N_3: strong and N_4: very strong), was evaluated visually, according to Spain and Gualdrón (1991), and composed by five replications, with 20 experimental units. The sampled areas are located in the middle third of the slope, considering the representative regional landscape. The soil is classified as Haplic Cambisol (Santos et al., 2018), whose analysis of chemical and physical attributes are shown in Table 2. The climate of the region was identified as Cwa (Köppen, 1948); typical climate of the Southeast Region of Brazil, characterized by dry winter and rainy summer (Alvares et al., 2013). The areas used in the study were, initially, selected visually by Google Earth Pro, to draw the map with the geographic coordinates of the central point of the plot. Field expeditions were carried out *in loco* to locate the georeferenced points with the aid of the eTREX 10 GARMI GPS. Finally, the confirmation of the soil classification and degradation levels were concluded.The method of square inventory or census of plant populations was adopted to the weed registration (Braun-Blanquet, 1950). The process is based on the use of a square of 1.0 × 1.0 m = 1 m², placed randomly inside the areas. Each level of degradation consisted of five replications, with 10 samples of $1m^2$, totaling 50 m^2 per level of degradation. Weeds were identified by species and counted. Subsequently, frequency, relative frequency, density, relative density, abundance, relative abundance, relative importance index and similarity index were calculated as follows: Frequency (F) = Number of squares containing the species/Total number of squares obtained (total area), Relative frequency (RF) = (Species frequency/Total frequency of all species) × 100, Density (D) = Total number of plants per species/Total number of squares obtained (total area), Relative density (RD) = (Species density/Total density of all species) × 100, Abundance (A) = Total number of plants per species/Total number of squares containing the species, Relative abundance (RA) = (Species abundance/Total abundance of all species) × 100. Relative importance index (RII) = Relative frequency + Relative density + Relative abundance. The similarity index (SI) was calculated based on the method proposed by Sorensen (1972). SI = (2a/b + c) × 100, a = number of species common to two habitats and b and c = total number of species existing in each location. The SI is expressed as a percentage, being 100% when all species are common to both areas and 0% when there is no species in common.

Figure 1. N_1: Low; N_2: Moderate; N_3: Strong and N_4: Very strong degradation

Source: Google Earth Pro.

Table 1. Geographical coordinates of experimental units at different levels of degradation of pastures in the municipality of Valença, Rio de Janeiro State, Brazil

Treatments	Replication	Site	Longitude	Latitude
N_1	R1	*CESAM	42°42′35.85″W	22°31′15.10″S
	R2	CESAM	42°42′32.53″W	22°31′9.51″S
	R3	PRIVATE	42°42′58.34″W	22°30′41.86″S
	R4	PRIVATE	42°42′53.53″W	22°30′32.70″S
	R5	PRIVATE	42°42′53.29″W	22°33′18.88″S
N_2	R1	CESAM	42°42′29.36″W	22°31′41.93″S
	R2	CESAM	42°42′21.78″W	22°31′34.81″S
	R3	CESAM	42°42′17.97″W	22°31′48.90″S
	R4	CESAM	42°42′26.63″W	22°31′7.22″S
	R5	PRIVATE	42°43′0.90″W	22°31′59.08″S
N_3	R1	CESAM	42°42′36.51″W	22°31′27.22″S
	R2	CESAM	42°42′39.46″W	22°31′25.53″S
	R3	CESAM	42°42′30.77″W	22°31′56.24″S
	R4	CESAM	42°42′31.24″W	22°30′45.41″S
	R5	PRIVATE	42°42′2.55″W	22°30′54.77″S
N_4	R1	PRIVATE	42°42′52.01″W	22°31′18.21″S
	R2	PRIVATE	42°43′19.81″W	22°31′27.21″S
	R3	PRIVATE	42°42′22.57″W	22°30′50.47″S
	R4	PRIVATE	42°42′46.60″W	22°33′14.89″S
	R5	PRIVATE	42°42′54.54″W	22°32′45.32″S

Note. N_1: Low; N_2: Moderate; N_3: Strong; N_4: Very strong degradation. *CESAM: Experimental Field of Santa Mônica, in Valença, Rio de Janeiro.

Table 2. Soil attributes as active acidity, V (base saturation), Al^{3+}, Ma (macroporosity) and BD (bulk density) according to degradation levels and sampled layers

Degradation Levels[1]	Soil Layers (cm)	pH H_2O	V (%)	Al^{3+} ($cmol_c\ dm^{-3}$)	Ma ($m^3\ m^{-3}$)	BD ($kg\ dm^{-3}$)
N_1	0-10	5.27 (0.32)	28.27 (0.1)	0.45 (0.35)	0.04 (0.01)	1.31 (0.07)
	10-20	4.91 (0.11)	13.51 (0.05)	0.99 (0.27)	0.04 (0.01)	1.40 (0.07)
N_2	0-10	5.87 (0.14)	62.85 (0.08)	0.04 (0.07)	0.06 (0.02)	1.39 (0.11)
	10-20	5.56 (0.25)	54.92 (0.09)	0.18 (0.06)	0.07 (0.03)	1.44 (0.1)
N_3	0-10	4.87 (0.16)	19.53 (0.07)	1.01 (0.30)	0.05 (0.02)	1.43 (0.07)
	10-20	4.73 (0.09)	10.2 (0.03)	1.41 (0.25)	0.06 (0.02)	1.48 (0.05)
N_4	0-10	4.79 (0.39)	12.5 (0.10)	1.31 (0.64)	0.10 (0.02)	1.32 (0.1)
	10-20	4.80 (0.22)	8.12 (0.06)	1.33 (0.43)	0.09 (0.02)	1.37 (0.08)

Note. [1]: N_1: Low; N_2: Moderate; N_3: Strong and N_4: Very strong degradation. Values in parentheses indicate the standard deviation of the measure.

Source: Valle (2018).

3. Results and Dicussion

It was identified 39 species, distributed into 16 botanical families (Table 3). Considering all areas, Poaceae, Asteraceae and Fabaceae were the families with the most identified species. Twenty-three species were found in N_1 area, totaling 179 plants (Table 4). Taking into account the RII, the predominant species in area N_1 were *Melinis minutiflora*, *Desmodium incanum*, *Croton lundianus*, *Andropogon bicornis* and *Imperata brasiliensis*. Twenty-seven species were identified in N_2 area, totaling 3,394 plants (Table 5). The predominant species, in function of the RII, were *Paspalum notatum*, *Melinis minutiflora*, *Imperata brasiliensis*, *Sida rhombifolia*, and *Desmodium incanum*. Twenty-one species were found in N_3 area, totaling 7,664 plants (Table 6). The predominant species, in function of the RII, were *Paspalum notatum*, *Melinis minutiflora*, *Sida rhombifolia*, *Eupatorium maximilianii* and *Imperata brasiliensis*. Twenty-five species were identified in N_4 area, totaling 7,747 plants (Table 7). The predominant species according to the RII were *Paspalum notatum*, *Melinis minutiflora*, *Cynodon dactilon*, *Eupatorium maximilianii*, and *Imperata brasiliensis*. The most relevant species

varied with the levels of degradation, taking as reference the values obtained for the relative importance indices. This fact is also related to the increase in acidity and exchangeable aluminum content, as observed from the less degraded level to more degraded ones (Table 2). Consequently, certain weeds are more adapted to conditions of higher acidity and aluminum content in the soil. *Melinis minutiflora*, for example, is adapted to acidic and degraded soils (Botrel et al., 1994). *Paspalum notatum* and *Imperata brasilienis* are also adapted to acidic and poor soils (Kissmann & Groth, 1997). It appears that physical attribute is closely related to the soil structure when analyzing soil density (Valle, 2018). In this way, density monitoring over time is the key part in investigating the use and management of soil physical quality (Ferreira, 2012). Higher soil density values are observed in the levels of degradation N_2 and N_3, both in surface and in depth, confirming the evidence of compaction (Table 2). The areas assessed at N_3, for example, are located on private rural properties. In this situation, landowners intensify grazing during the dry season in order to have less biomass to be burnt in case of fire threats from neighboring areas. Consequently, the compaction and degradation process of these soils intensify year after year. Another important factor that corroborates to the density of soils at different levels of degradation is macroporosity. Considering that an aeration porosity lower than 0.10 $m^3 m^{-3}$ or 10% is harmful to agricultural production by compromising the soil gas exchange, it is noted that all macroporosity values are lower than this reference value (Table 2). Since macropores are scarce, the diffusion of CO_2 and O_2 in the water predominates over the diffusion in the air (Ferreira, 2012) and also compromising the infiltration of water into the soil (Oliveira et al., 2015). Threfore, under extreme conditions of compaction of the soils, some weeds have adapted to this unfavorable situation. An example is S*ida rhombifolia*, which has an aggressive root system (pivoting roots), growing in depth even in the profile of compacted soils. This fact is confirmed at levels N_2 and N_3, in which *S. rhombifolia* presented relative importance indices of 17.63% and 28.12%, respectively (Tables 5 and 6). Another importante indicator in studying pasture degradation is weed density (Santos et al., 2015). Regarding the evaluation of all areas, weed density increased progressively from the least degraded area to the most degraded ones. This phenomenon is correlated with soil conditions and grazing pressure. As the chemical and physical properties of the soil get worse and/or there is overgrazing, there is a disadvantage to the growth and development of the forage. Consequently, weeds will occupy soil gaps left by the forages. This fact further aggravates the reduction in forage yield due to damage caused by competition and allelopathic effects exerted by weed populations. Density of 3.58 plants m^{-2} was achieved in area N_1 (Table 4). These values increased in the N_2 area with 67.88 plants/m^2 (Table 5). And, it was obtained higher densities in the two most degraded areas (N_3 and N_4), with values of 153.28 plants/m^2 and 154.94 plants/m^2, respectively (Tables 6 and 7). According to the low degradation (Table 4), from the moment the plant density reaches or exceeds the average value of 3.58 plants/m^2 would justify the use of control measures in function of the main weed species found in the area. There is a predominance of species from the Poaceae family when the four areas are analyzed together (Table 8). Greater highlights are observed for *Paspalum notatum* with 90.32% of relative importance index, followed by *Melinis minutiflora* with 58.04% and *Cynodon dactylon* (46.75%). These results were similar to those obtained in tifton pastures in Rio Largo, Alagoas State (Cunha et al., 2016). The authors found that the most representative family was also Poaceae. Guglieri-Caporal et al. (2010) also observed that *Paspalum notatum* was a predominant species in phytosociological surveys in Brazilian savanna areas, with the highest relative importance index and relative coverage. The similarity indices (SI) makes it possible to calculate the percentage of weed species that are common among the studied areas, being considered high when it exceeds 50% (Felfili & Venturoli, 2000). The highest values obtained were between N_1/N_2 and also for N_2/N_3, with SI of 76% and 75%, respectively (Table 9). The other areas N_1/N_3, N_1/N_4, N_2/N_4 and N_3/N_4 also presented values above 50%, demonstrating homogeneity between the evaluated areas, with values ranging from 65% to 70%. High similarity indices can be explained by the proximity among areas, under the same environmental conditions. And, the differences are attributed, in part, to anthropic actions and different practices of pasture management, influencing the germination and establishment of weed species (Souza et al., 2020).

Table 3. Weed species distributed by family occurring in four levels of pasture degradation in the south of the State of Rio de Janeiro

Family	Species
Poaceae	*Imperata brasiliensis*
	Melinis minutiflora
	Andropogom bicornis
	Aristida longiseta
	Sporobolus indicus
	Cynodon dactylon
	Paspalum notatum
Cyperaceae	*Rhynchospora nervosa*
	Cyperus esculentus
Fabaceae	*Neonotonia wightii*
	Desmodium incanum
	Mimosa pudica
	Stylosanthes viscosa
	Calopogonium mucunoides
	Senna obtusifolia
Asteraceae	*Mikania cordifolia*
	Pterocaulon virgatum
	Eupatorium maximilianii
	Vernonia polyanthes
	Acanthospermum australe
	Emilia fosbergii
	Baccharis dracunculifolia
Euphorbiaceae	*Croton lundianus*
	Chamaesyce hirta
Bignoniaceae	*Tabebuia ochracea*
Tiliaceae	*Triumfetta bartramia*
Cannabaceae	*Celtis pubescens*
Verbenaceae	*Lantana camara*
Lamiaceae	*Hyptis suaveolens*
Malvaceae	*Sida glaziovii*
	Sida rhombifolia
Rubiaceae	*Richardia brasiliensis*
	Spermacoce latifolia
	Borreria verticillata
Solanaceae	*Solanum palinacanthum*
	Solanum lycocarpum
Melastomataceae	*Tibouchina candolleana*
Scrophulariaceae	*Veronica* sp.
Phyllanthaceae	*Phyllanthus tenellus*

Table 4. Number of squares in wich the species was found (SN), number of plants (NP), frequency (F), relative frequency (RF) (%), density (D) (plants/m²), relative density (RD) (%), abundance (A), relative abundance (RA) (%) and relative importance index (RII) (%) of weeds occurring in pasture areas relative to the N_1 level

Species	N_1								
	SN	**NP**	**F**	**RF**	**D**	**RD**	**A**	**RA**	**RII**
Andropogon bicornis	8	11	0.160	9.756	0.220	6.145	1.375	3.556	19.458
Croton lundianus	9	11	0.180	10.976	0.220	6.145	1.222	3.161	20.282
Hyptis suaveolens	6	6	0.120	7.317	0.120	3.352	1.000	2.586	13.255
Desmodium incanum	15	27	0.300	18.293	0.540	15.084	1.800	4.656	38.032
Mikania cordifolia	2	3	0.040	2.439	0.060	1.676	1.500	3.880	7.995
Melinis minutiflora	10	76	0.200	12.195	1.520	42.458	7.600	19.657	74.310
Neonotonia wightii	1	1	0.020	1.220	0.020	0.559	1.000	2.586	4.365
Lantana camara	2	2	0.040	2.439	0.040	1.117	1.000	2.586	6.143
Emilia fosbergii	2	3	0.040	2.439	0.060	1.676	1.500	3.880	7.995
Vernonia polyanthes	2	2	0.040	2.439	0.040	1.117	1.000	2.586	6.143
Sida glaziovii	3	3	0.060	3.659	0.060	1.676	1.000	2.586	7.921
Solanum palinacanthum	3	4	0.060	3.659	0.080	2.235	1.333	3.449	9.342
Triumffeta bartramia	1	4	0.020	1.220	0.080	2.235	4.000	10.346	13.800
Eupatorium maximilianii	1	2	0.020	1.220	0.040	1.117	2.000	5.173	7.510
Imperata brasiliensis	3	10	0.060	3.659	0.200	5.587	3.333	8.621	17.866
Rhynchospora nervosa	2	2	0.040	2.439	0.040	1.117	1.000	2.586	6.143
Tabebuia ochracea	1	1	0.020	1.220	0.020	0.559	1.000	2.586	4.365
Borreria verticillata	1	1	0.020	1.220	0.020	0.559	1.000	2.586	4.365
Stylosanthes viscosa	4	4	0.080	4.878	0.080	2.235	1.000	2.586	9.699
Mimosa pudica	2	2	0.040	2.439	0.040	1.117	1.000	2.586	6.143
Celtis pubescens	1	1	0.020	1.220	0.020	0.559	1.000	2.586	4.365
Sida rhombifolia	2	2	0.040	2.439	0.040	1.117	1.000	2.586	6.143
Pterocaulon virgatum	1	1	0.020	1.220	0.020	0.559	1.000	2.586	4.365
Paspalum notatum	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Phyllanthus tenellus	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Veronica sp.	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Spermacoce latifolia	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Calopogonium mucunoides	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Chamaesyce hirta	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Cyperus esculentus	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Acanthospermum australe	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Solanum lycocarpum	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Aristida Longiseta	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Sporobolus indicus	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Senna obtusifolia	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Richardia brasiliensis	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Baccharis dracunculifolia	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Tibouchina candolleana	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Cynodon dactilon	0	0	0.000	0.000	0.000	0.000	0	0.000	0.000
Total	-	179	1.640	100.00	3.580	100.0	38.664	100.00	300.00

Table 5. Number of squares in wich the species was found (SN), number of plants (NP), frequency (F), relative frequency (RF) (%), density (D) (plants/m²), relative density (RD) (%), abundance (A), relative abundance (RA) (%) and relative importance index (RII) (%) of weeds occurring in pasture areas relative to the N_2 level

Species	N_2								
	SN	**NP**	**F**	**RF**	**D**	**RD**	**A**	**RA**	**RII**
Andropogon bicornis	1	1	0.020	0.588	0.020	0.029	1.000	0.429	1.047
Croton lundianus	12	21	0.240	7.059	0.420	0.619	1.750	0.751	8.429
Hyptis suaveolens	17	47	0.340	10.000	0.940	1.385	2.765	1.187	12.572
Desmodium incanum	21	98	0.420	12.353	1.960	2.887	4.667	2.004	17.244
Mikania cordifolia	3	5	0.060	1.765	0.100	0.147	1.667	0.716	2.628
Melinis minutiflora	19	478	0.380	11.176	9.560	14.084	25.158	10.802	36.062
Neonotonia wightii	5	27	0.100	2.941	0.540	0.796	5.400	2.319	6.055
Lantana camara	3	3	0.060	1.765	0.060	0.088	1.000	0.429	2.282
Emilia fosbergii	3	6	0.060	1.765	0.120	0.177	2.000	0.859	2.800
Vernonia polyanthes	1	1	0.020	0.588	0.020	0.029	1.000	0.429	1.047
Sida glaziovii	1	1	0.020	0.588	0.020	0.029	1.000	0.429	1.047
Solanum palinacanthum	5	7	0.100	2.941	0.140	0.206	1.400	0.601	3.749
Triumffeta bartramia	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eupatorium maximilianii	2	3	0.040	1.176	0.060	0.088	1.500	0.644	1.909
Imperata brasiliensis	17	170	0.340	10.000	3.400	5.009	10.000	4.294	19.303
Rhynchospora nervosa	5	7	0.100	2.941	0.140	0.206	1.400	0.601	3.749
Tabebuia ochracea	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Borreria verticillata	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Stylosanthes viscosa	4	16	0.080	2.353	0.320	0.471	4.000	1.717	4.542
Mimosa pudica	4	10	0.080	2.353	0.200	0.295	2.500	1.073	3.721
Celtis pubescens	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sida rhombifolia	19	124	0.380	11.176	2.480	3.654	6.526	2.802	17.632
Pterocaulon virgatum	3	5	0.060	1.765	0.100	0.147	1.667	0.716	2.628
Paspalum notatum	16	2352	0.320	9.412	47.040	69.299	147.00	63.118	141.828
Phyllanthus tenellus	1	2	0.020	0.588	0.040	0.059	2.000	0.859	1.506
Veronica sp.	1	1	0.020	0.588	0.020	0.029	1.000	0.429	1.047
Spermacoce latifolia	1	1	0.020	0.588	0.020	0.029	1.000	0.429	1.047
Calopogonium mucunoides	2	3	0.040	1.176	0.060	0.088	1.500	0.644	1.909
Chamaesyce hirta	2	2	0.040	1.176	0.040	0.059	1.000	0.429	1.665
Cyperus esculentus	1	1	0.020	0.588	0.020	0.029	1.000	0.429	1.047
Acanthospermum australe	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Solanum lycocarpum	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aristida longiseta	1	2	0.020	0.588	0.040	0.059	2.000	0.859	1.506
Sporobolus indicus	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Senna obtusifolia	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Richardia brasiliensis	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Baccharis dracunculifolia	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tibouchina candolleana	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cynodon dactilon	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total		3.394	3.400	100.00	67.88	100.00	232.89	100.00	300.00

Table 6. Number of squares in wich the species was found (SN), number of plants (NP), frequency (F), relative frequency (RF) (%), density (D) (plants/m²), relative density (RD) (%), abundance (A), relative abundance (RA) (%) and relative importance index (RII) (%) of weeds occurring in pasture areas relative to the N_3 level

Species	N_3								
	SN	**NP**	**F**	**RF**	**D**	**RD**	**A**	**RA**	**RII**
Andropogon bicornis	9	17	0.180	4.813	0.340	0.222	1.889	0.481	5.516
Croton lundianus	15	27	0.300	8.021	0.540	0.352	1.800	0.459	8.832
Hyptis suaveolens	11	34	0.220	5.882	0.680	0.444	3.091	0.788	7.114
Desmodium incanum	11	115	0.220	5.882	2.300	1.501	10.455	2.664	10.047
Mikania cordifolia	5	6	0.100	2.674	0.120	0.078	1.200	0.306	3.058
Melinis minutiflora	28	2234	0.560	14.973	44.680	29.149	79.786	20.329	64.451
Neonotonia wightii	8	24	0.160	4.278	0.480	0.313	3.000	0.764	5.356
Lantana camara	1	1	0.020	0.535	0.020	0.013	1.000	0.255	0.803
Emilia fosbergii	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Vernonia polyanthes	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sida glaziovii	1	2	0.020	0.535	0.040	0.026	2.000	0.510	1.070
Solanum palinacanthum	4	6	0.080	2.139	0.120	0.078	1.500	0.382	2.600
Triumffeta bartramia	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eupatorium maximilianii	18	58	0.360	9.626	1.160	0.757	3.222	0.821	11.203
Imperata brasiliensis	11	144	0.220	5.882	2.880	1.879	13.091	3.335	11.097
Rhynchospora nervosa	5	103	0.100	2.674	2.060	1.344	20.600	5.249	9.266
Tabebuia ochracea	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Borreria verticillata	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Stylosanthes viscosa	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mimosa pudica	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Celtis pubescens	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sida rhombifolia	17	679	0.340	9.091	13.580	8.860	39.941	10.177	28.127
Pterocaulon virgatum	6	9	0.120	3.209	0.180	0.117	1.500	0.382	3.708
Paspalum notatum	21	4156	0.420	11.230	83.120	54.228	197.905	50.424	115.882
Phyllanthus tenellus	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Veronica sp.	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Spermacoce latifolia	2	2	0.040	1.070	0.040	0.026	1.000	0.255	1.350
Calopogonium mucunoides	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Chamaesyce hirta	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cyperus esculentus	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Acanthospermum australe	6	35	0.120	3.209	0.700	0.457	5.833	1.486	5.152
Solanum lycocarpum	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aristida longiseta	6	10	0.120	3.209	0.200	0.130	1.667	0.425	3.764
Sporobolus indicus	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Senna obtusifolia	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Richardia brasiliensis	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Baccharis dracunculifolia	1	1	0.020	0.535	0.020	0.013	1.000	0.255	0.803
Tibouchina candolleana	1	1	0.020	0.535	0.020	0.013	1.000	0.255	0.803
Cynodon dactilon	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	-	7.664	3.740	100.00	153.280	100.00	392.479	100.00	300.00

Table 7. Number of squares in wich the species was found (SN), number of plants (NP), frequency (F), relative frequency (RF) (%), density (D) (plants/m²), relative density (RD) (%), abundance (A), relative abundance (RA) (%) and relative importance index (RII) (%) of weeds occurring in pasture areas relative to the N_4 level

Species	N_4								
	SN	**NP**	**F**	**RF**	**D**	**RD**	**A**	**RA**	**RII**
Andropogon bicornis	2	2	0.040	1.449	0.040	0.026	1.000	0.142	1.617
Croton lundianus	3	9	0.060	2.174	0.180	0.116	3.000	0.425	2.715
Hyptis suaveolens	4	8	0.080	2.899	0.160	0.103	2.000	0.284	3.285
Desmodium incanum	2	2	0.040	1.449	0.040	0.026	1.000	0.142	1.617
Mikania cordifolia	7	11	0.140	5.072	0.220	0.142	1.571	0.223	5.437
Melinis minutiflora	18	3308	0.360	13.043	66.160	42.700	183.778	26.054	81.798
Neonotonia wightii	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lantana camara	2	6	0.040	1.449	0.120	0.077	3.000	0.425	1.952
Emilia fosbergii	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Vernonia polyanthes	2	2	0.040	1.449	0.040	0.026	1.000	0.142	1.617
Sida glaziovii	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Solanum palinacanthum	4	5	0.080	2.899	0.100	0.065	1.250	0.177	3.140
Triumffeta bartramia	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eupatorium maximilianii	16	82	0.320	11.594	1.640	1.058	5.125	0.727	13.379
Imperata brasiliensis	13	97	0.260	9.420	1.940	1.252	7.462	1.058	11.730
Rhynchospora nervosa	7	27	0.140	5.072	0.540	0.349	3.857	0.547	5.968
Tabebuia ochracea	2	2	0.040	1.449	0.040	0.026	1.000	0.142	1.617
Borreria verticillata	3	3	0.060	2.174	0.060	0.039	1.000	0.142	2.354
Stylosanthes viscosa	3	4	0.060	2.174	0.080	0.052	1.333	0.189	2.415
Mimosa pudica	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Celtis pubescens	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sida rhombifolia	9	26	0.180	6.522	0.520	0.336	2.889	0.410	7.267
Pterocaulon virgatum	2	3	0.040	1.449	0.060	0.039	1.500	0.213	1.701
Paspalum notatum	16	3304	0.320	11.594	66.080	42.649	206.500	29.276	83.518
Phyllanthus tenellus	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Veronica sp.	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Spermacoce latifolia	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Calopogonium mucunoides	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Chamaesyce hirta	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cyperus esculentus	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Acanthospermum australe	13	36	0.260	9.420	0.720	0.465	2.769	0.393	10.278
Solanum licocarpum	1	1	0.020	0.725	0.020	0.013	1.000	0.142	0.879
Aristida longiseta	1	1	0.020	0.725	0.020	0.013	1.000	0.142	0.879
Sporobolus indicus	2	12	0.040	1.449	0.240	0.155	6.000	0.851	2.455
Senna obtusifolia	1	1	0.020	0.725	0.020	0.013	1.000	0.142	0.879
Richardia brasiliensis	2	2	0.040	1.449	0.040	0.026	1.000	0.142	1.617
Baccharis dracunculifolia	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tibouchina candolleana	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cynodon dactilon	3	793	0.060	2.174	15.860	10.236	264.333	37.475	49.885
Total	-	7.747	2.760	100.000	154.94	100.00	705.367	100.00	300.00

Table 8. Number of squares in wich the species was found (SN), number of plants (NP), frequency (F), relative frequency (RF) (%), density (D) (plants/m²), relative density (RD) (%), abundance (A), relative abundance (RA) (%) and relative importance index (RII) (%) of weeds occurring in four degraded pasture areas in the middle Vale of Paraíba do Sul River, State of Rio de Janeiro, Brazil

Species	N_1, N_2, N_3 and N_4								
	SN	**NP**	**F**	**RF**	**D**	**RD**	**A**	**RA**	**RII**
Andropogon bicornis	20	31	0.100	3.466	0.155	0.163	1.550	0.247	3.876
Croton lundianus	39	68	0.195	6.759	0.340	0.358	1.744	0.277	7.395
Hyptis suaveolens	38	95	0.190	6.586	0.475	0.500	2.500	0.398	7.484
Desmodium incanum	49	242	0.245	8.492	1.210	1.275	4.939	0.786	10.553
Mikania cordifolia	17	25	0.085	2.946	0.125	0.132	1.471	0.234	3.312
Melinis minutiflora	75	6096	0.375	12.998	30.480	32.111	81.280	12.931	58.040
Neonotonia wightii	14	52	0.070	2.426	0.260	0.274	3.714	0.591	3.291
Lantana camara	8	12	0.040	1.386	0.060	0.063	1.500	0.239	1.688
Emilia fosbergii	5	9	0.025	0.867	0.045	0.047	1.800	0.286	1.200
Vernonia polyanthes	5	5	0.025	0.867	0.025	0.026	1.000	0.159	1.052
Sida glaziovii	5	6	0.025	0.867	0.030	0.032	1.200	0.191	1.089
Solanum palinacanthum	16	22	0.080	2.773	0.110	0.116	1.375	0.219	3.108
Triumffeta bartramia	1	4	0.005	0.173	0.020	0.021	4.000	0.636	0.831
Eupatorium maximilianii	37	145	0.185	6.412	0.725	0.764	3.919	0.623	7.800
Imperata brasiliensis	44	421	0.220	7.626	2.105	2.218	9.568	1.522	11.366
Rhynchospora nervosa	19	139	0.095	3.293	0.695	0.732	7.316	1.164	5.189
Tabebuia ochracea	3	3	0.015	0.520	0.015	0.016	1.000	0.159	0.695
Borreria verticillata	4	4	0.020	0.693	0.020	0.021	1.000	0.159	0.873
Stylosanthes viscosa	11	24	0.055	1.906	0.120	0.126	2.182	0.347	2.380
Mimosa pudica	6	12	0.030	1.040	0.060	0.063	2.000	0.318	1.421
Celtis pubescens	1	1	0.005	0.173	0.005	0.005	1.000	0.159	0.338
Sida rhombifolia	47	831	0.235	8.146	4.155	4.377	17.681	2.813	15.336
Pterocaulon virgatum	12	18	0.060	2.080	0.090	0.095	1.500	0.239	2.413
Paspalum notatum	53	9812	0.265	9.185	49.060	51.686	185.132	29.453	90.324
Phyllanthus tenellus	1	2	0.005	0.173	0.010	0.011	2.000	0.318	0.502
Veronica sp.	1	1	0.005	0.173	0.005	0.005	1.000	0.159	0.338
Spermacoce latifolia	3	3	0.015	0.520	0.015	0.016	1.000	0.159	0.695
Calopogonium mucunoides	2	3	0.010	0.347	0.015	0.016	1.500	0.239	0.601
Chamaesyce hirta	2	2	0.010	0.347	0.010	0.011	1.000	0.159	0.516
Cyperus esculentus	1	1	0.005	0.173	0.005	0.005	1.000	0.159	0.338
Acanthospermum australe	19	71	0.095	3.293	0.355	0.374	3.737	0.594	4.261
Solanum licocarpum	1	1	0.005	0.173	0.005	0.005	1.000	0.159	0.338
Aristida longiseta	8	13	0.040	1.386	0.065	0.068	1.625	0.259	1.713
Sporobolus indicus	2	12	0.010	0.347	0.060	0.063	6.000	0.955	1.364
Senna obtusifolia	1	1	0.005	0.173	0.005	0.005	1.000	0.159	0.338
Richardia brasiliensis	2	2	0.010	0.347	0.010	0.011	1.000	0.159	0.516
Baccharis dracunculifolia	1	1	0.005	0.173	0.005	0.005	1.000	0.159	0.338
Tibouchina candolleana	1	1	0.005	0.173	0.005	0.005	1.000	0.159	0.338
Cynodon dactilon	3	793	0.015	0.520	3.965	4.177	264.333	42.053	46.750
Total	-	18.98	2.88	100.00	94.920	100.00	628.565	100.0	300.00

Table 9. Similarity indices (%) of weed occurring in four levels of pasture degradation in southern Rio de Janeiro State, Brazil

Areas[1]	N_2	N_3	N_4
N_1	76	68	70
N_2	-	75	65
N_3	-	-	69

Note. [1]: N_1: Low; N_2: Moderate; N_3: Strong and N_4: Very strong degradation.

4. Conclusions

Thirty-nine weed species were identified and distributed into16 botanical families. Poaceae, Asteraceae and Fabaceae were the most relevant families. The predominant species, considering all areas, are in increasing order of importance: *Cynodon dactilon, Melinis minutiflora* and *Paspalum notatum*. The similarity in weed occurrence was high, demonstrating the homogeneity of species among areas with different levels of degradation. Decision-making about applying control measures could be marked out when the plant density reached out or exceed the average of 3.58 plants m^{-2}.

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