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PHYTOSOCIOLOGICAL SURVEY OF WEEDS IN THE GRAPEVINE

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Abstract
Viticulture is expanding in the state of Espírito Santo, Brazil. Weed management is essential for the crop, so knowing the floristic composition of weeds in the vineyards makes this practice sustainable. This study aimed to evaluate the floristic composition of weed populations in grape crops in two seasons, considering different altitudes. The experiment was performed in four properties located in Santa Teresa, ES, Brazil, two of which were at altitudes above 500 m of and two below 500 m, in the winter (2018) and summer (2019) seasons. Weeds were identified with the square inventory method. The phytosociological analysis was based on absolute and relative parameters of frequency, density, dominance, importance value index, and relevance index, besides the diversity, evenness, and similarity indices. Fifty species, 41 genera, and 19 families were identified. The most representative families regarding the number of species were Asteraceae, Poaceae, and Malvaceae. In properties with higher altitudes, the species with the highest IVI was *Pilea microphylla* (L.) Liebm., in both seasons. In properties with lower altitudes, the highest IVI values were found for *Malvastrum coromandelianum* L. in the winter and *Commelina benghalensis* and *Portulaca oleracea* L. in the summer. The areas below 500 m of altitude showed the highest diversity and evenness indices. The proximity between the areas in both regions contributed to the increased similarity index. Altitude and time of the year contribute to the composition of the infesting community.

Keywords: Cultural practices. Infesting community. Phytosociology. Viticulture. *Vitis vinifera* L.

1. Introduction

Viticulture (*Vitis vinifera* L.) has high economic importance in the Brazilian territory, and grapes are cultivated in virtually all regions. Data from 2016 show a cultivated area of 77,786 hectares, with an annual production of 984,244 tons (Melo 2017).

In the state of Espírito Santo, Brazil, farmers have invested in grape production and, from 2014 to 2016, the cultivated area increased from 138 to 177 hectares, corresponding to a 22% growth, while the national territory had a reduction in cultivated area (Melo 2017). In this state, the largest producer is the city of Santa Teresa, where grapes are produced for winemaking and fresh consumption (Esteves 2018). Among the varieties cultivated in the state, it is worth mentioning the 'Niágara Rosada', which represents 80% of table grape production (Esteves 2018).

The grape production in the state of Espírito Santo meets only 2% of the demand, so producers still have a vast field to explore with vitiviniculture. However, the reality of vitiviniculture in this state shows that producers need to improve cultivation techniques for developing the use of the area, reducing costs, and increasing profitability, making them more competitive and encouraging investments in the activity in the countryside. Among the techniques to be improved, weed management is essential to crop success.

The low production levels of many vineyards may be associated with the competition with weeds (Cardoso et al. 2013). Proper weed management requires knowing and identifying the floristic composition (Oliveira and Freitas 2008). Such identification is performed through the phytosociological survey (Rodrigues et al. 2016).

Weed is usually managed chemically or mechanically. However, knowledge of the weed population at the site is limited when using these methods. Therefore, for a better application of control methods, knowledge of the floristic composition and structure of weed populations in vineyards becomes important for extensionists and producers seeking more efficient management methods, as well as maximizing vineyard yield and profitability, and reducing environmental damage.

Weeds are present in the most diverse areas, given their adaptation along the evolutionary process. Hence, they have developed characteristics that adapted them to colonize several environments. Among the main characteristics, the high ability to multiply, ease of dispersion, and large genetic variability stand out. These characteristics make these plant species unwanted due to the high competition ability for production factors in agricultural areas and for reducing production (Rodrigues et al. 2010).

Due to the peculiar characteristics presented, weed management becomes difficult and expensive, so using integrated management methods in which the crop of economic interest can coexist with these species without yield losses is recommended. This form of management can be used in the grapevine, but for it to be adequate, the first step is identifying the species in the area and those of higher importance (Oliveira and Freitas 2008).

Weed species may vary according to the edaphoclimatic characteristics, seed bank, and agronomic practices, such as soil management, plant arrangement, fertilization, and herbicide application (Adegas et al. 2010; Soares et al. 2012). Weed interference with the crop may cause losses of yield and product quality and increased production costs (Adegas et al. 2010). The phytosociological survey is important for obtaining knowledge about populations, constituting an important tool for the technical basis of management recommendations and cultural practices (Rodrigues et al. 2016).

Given the lack of information about the infesting community in grape vineyards and the need for producers to improve cultivation techniques, especially weed management, this study aimed to survey the floristic composition of weed populations in vineyards of the grape cv. 'Niágara Rosada' in the trellis system, in two seasons (winter and summer), considering different altitudes.

2. Material and Methods

The experiment was performed in Santa Teresa, a city located in the central mountainous region of the state of Espírito Santo, Brazil. The city has altitudes ranging from 140 to 1065 m relative to the sea level. The climate of Santa Teresa, according to the Köppen classification, is Cfb, characterized as temperate humid with warm summer (Alvares et al. 2013).

In Santa Teresa, the rainfall levels of high and low regions reach annual averages of 1,331 and 1,103 mm, respectively, as of records of 28 years in the high region (downtown area of the city) and 29 years in the low region (São João de Petrópolis), according to Castro et al. (1981). The city has two distinct agro-climatic zones: one comprising the downtown area and surroundings, with altitudes above 500 m; and another in the lower portion, with altitudes from 140 to 500 m, according to the climatic data described in Table 1.

The areas were chosen to evaluate the floristic composition of weeds at different altitudes. Vineyards were selected for the study according to the following criteria: vineyards with plants of the 'Niágara Rosada' cultivar, considered table grape; conducted in a trellis system; ten years of age; spacing of 3.0 m x 2.0 m; localized irrigation according to crop requirements; weed management with three to four herbicide applications and one to two mowing operations/year. The production pruning of the vineyards was performed in August/2018.

Table 1. Climatic data of two agro-climatic zones (high and low regions) of the city of Santa Teresa. ES, Brazil.

Characteristics	Region	
	High	Low
Occupation of the territorial area of the city (%)	60	40
Climate	Cold humid	Hot dry
Altitude (m)	500/1,065	140/500
Average Annual Temperature	19.9ºC	23.1ºC
Average Maximum Temperature	29.3ºC	32.8ºC
Average Minimum Temperature	10.6ºC	13.4ºC
Annual Potential Evapotranspiration	1,094 mm	1,320 mm

Source: Incaper (2011).

Considering they belonged to agro-ecological regions with distinct agro-climatic conditions (INCAPER 2011), areas representing the regions above and below 500 m were selected. After meeting the pre-established criteria, four properties located at different altitudes in Santa Teresa, ES, Brazil, were chosen: two above 500 m and two below 500 m.

Property 01: Aparecidinha – altitude of 806 m; 20º 0'17,4024"S; 40º 34'20,0172"W; dystrophic yellow latosol (Oxisol); average temperature of 19.18°C; annual rainfall of 1,240 mm.

Property 02: Vargem Alta – altitude of 709 m; 19º 55'57.8"S; 40º 38'14.2"W; dystrophic red yellow latosol (Oxisol); average temperature of 19.18ºC; annual rainfall of 1,240 mm.

Property 03: Rio Cinco de Novembro – altitude of 272 m; 19º 52'37"S; 40º 36'3"W; dystrophic yellow latosol (Oxisol); average temperature of 24.80ºC; annual rainfall of 1,016 mm.

Property 04: Barra do Tabocas – altitude of 163 m; 19º 51'02.7"S; 40º 39'43.4"W; dystrophic red yellow latosol (Oxisol); average temperature of 24.80ºC; annual rainfall of 1,016 mm.

The phytosociological survey was performed in two seasons: winter (August/2018) and summer (February/2019). Weeds were quantified and identified with the square inventory method proposed by Erasmo et al. (2004). To collect the samples, 10 plots of 100 m^2 were established in each property. A hollow square (1.0 m x 1.0 m) was thrown in each plot at a minimum distance of 1 m from the edges. The square was thrown in zigzag 60 days after mowing, and plants taller than 5 cm were collected close to the soil. After the collection, the plants were placed in plastic bags and taken to the laboratory, where they were identified (Lorenzi 2000) and, when necessary, botany specialists were consulted.

After identification, the plants were quantified and weighed, then placed in paper bags, and dried in a forced-air circulation oven at 65°C for 72 hours. After drying, they were weighed on precision scales and counted, which allowed calculating the following absolute and relative variables: frequency, density, dominance, and importance value index (Mueller-Dombois and Ellemberg 1974; Moura Filho et al. 2015). Diversity, evenness, and similarity indices were also evaluated with the Shannon-Weaver diversity index (H') and Pielou evenness index (J') (Magurran 2004); and the Jaccard similarity index (Sj) for assessing the similarity between species in the studied areas (Jongman et al. 1995):

- Absolute frequency (F) = the number of samples containing the species ÷ the total number of samples. It evaluates the distribution of species in the plots;
- Absolute density (D) = the total number of individuals per species ÷ the total number of samples. It allows knowing the number of plants of each species per area unit;
- Absolute dominance (Do) = total accumulated dry biomass of the species ÷ total area sampled. It allows knowing the volume of the dry biomass of the species per area;
- Relative Frequency - RFr (%) = 100 x frequency of the species ÷ total frequency of all species;
- Relative Density - RDe (%) = 100 x density of the species ÷ total density of all species;
- Relative dominance - RDo (%): (DMs/DMt) x 100, where DM is the dry biomass accumulated by a given species and DMt is the dry biomass accumulated by the entire infesting community;
- Importance value index: IVI (%) = RDe + RFr + RDo;
- Shannon-Weaver Index (H') =

$$H' = \sum_{i=1}^{s} p_i \ln p_i$$

where:

H’ = Shannon-Weaver index;

S = the number of species found;

Pi = proportion of species (the number of individuals of species; i - the total number of individuals found). The biological diversity and balance of the agroecosystem are known through the Shannon-Weaver Index.

- Evenness index and/or Pielou evenness (J): H’/H max:

J = Pielou evenness;

H’ = Shannon-Weaver index;

H max = ln(S);

It determines the balance and/or uniformity among the species in the environment. The J value ranges from 0 to 1. The maximum value indicates there would be the same number of individuals, meaning there would be no dominance of one weed species over the others.

- Jaccard Similarity Index (Sj): Sj = a/(a+b+c), where:

a = the number of species found in both sites (a and b);

b = the total number of species in site b, but not in a;

c = the number of species in site a, but not in b.

The PAST 3.26 software (Hammer et al. 2001) was used to determine the Jaccard index (Sj), with results obtained with unweighted averages (Unweighted Pair Group Method with Arithmetic mean - UPGMA). This index allowed verifying the species in common in the studied areas, indicating which environments are more similar.

3. Results

Many studies have been performed to analyze the floristic composition of cultivation areas of commercial crops but none of the phytosociological surveys in Brazil refer to areas cultivated with ‘Niágara Rosada’ grape vineyards in the trellis system.

The evaluation of the floristic composition of four areas occupied by grape vineyards in Santa Teresa, ES, Brazil, considering winter and summer seasons, identified 50 species, 41 genera, and 19 families of weeds (Table 2).

Overall, in the vineyards of Santa Teresa, the most representative families regarding the number of species were Asteraceae (10), Poaceae (09), and Malvaceae (6), according to Table 2. The family with the highest IVI was Urticaceae, and its predominant species was *Pilea microphylla* (L.) Liebm., as shown in Figure 1A.

When evaluating the floristic composition considering both seasons, 15 families were identified in the winter, distributed in 34 genera and 37 species. The most representative families were Asteraceae (9), Malvaceae (6), and Poaceae (4) (Figures 1B and 1D). In the summer, 16 families were identified, distributed in 34 genera and 41 species, and the most representative were Poaceae, Asteraceae, and Malvaceae, with nine, six, and five species, respectively (Figures 1C and 1E). However, when evaluating the floristic composition considering different altitudes (above and below 500 m) in both seasons, the most representative families regarding the number of species in the region above 500 m were Asteraceae (6), Malvaceae (5), and Poaceae (4) (Figures 1B and 1C), whereas below 500 m, the most representative families were Asteraceae, Poaceae, and Malvaceae with eight, seven, and four species, respectively (Figures 1D and 1E).

Table 2. List of weeds distributed by family, species, common name, and region found with the survey performed in four vineyards of 'Niágara Rosada' grape in the city of Santa Teresa, ES, Brazil, located at altitudes from 140 to 1,065 m in the winter (August/2018) and summer (February/2019).

Family	Species	Region above 500 m (a) and below 500 m (b)
Amaranthaceae	*Amaranthus hybridus*	b
	Amaranthus viridis	ab
	Alternanthera tenella	b
Apiaceae	*Anethum foeniculum*	a
Euphorbiaceae	*Euphorbia heterophylla*	ab
	Euphorbia hirta L.	b
Asteraceae	*Bidens pilosa*	ab
	Galinsoga parviflora	ab
	Erigeron bonariensis	b
	Vernonia polysphaera	a
	Achyrocline satureioides	b
	Taraxacum officinale	a
	Sonchus oleraceus	ab
	Blainvillea acmella (L.) Philipson	ab
	Tridax procumbens	b
	Delilia biflora (L.) Kuntze	b
Basellaceae	*Basella alba*	ab
Commelinaceae	*Commelina benghalensis*	ab
Convolvulaceae	*Ipomoea acuminata* (Vahl) Roemer & Schultes	b
Cucurbitaceae	*Momordica charantia*	b
Cyperaceae	*Cyperus rotundus*	b
Fabaceae	*Chamaecrista rotundifolia* (Pers.) Greene	b
	Calopogonium mucunoides Desv.	b
	Desmodium tortuosum	b
Hypericaceae	*Hypericum perforatum* L.	a
Malvaceae	*Sida rhombifolia* L.	ab
	Malvastrum coromandelianum L.	ab
	Triunfetta rhomboidea	ab
	Sida glaziovii	a
	Sida cordifolia	b
	Peltaea sessiliflora	a
Oxalidaceae	*Oxalis corniculata* L.	a
Phyllanthaceae	*Phyllanthus niruri* L.	ab
Poaceae	*Chloris barbata* Sw.	ab
	Digitaria insularis (L.) Fedde	ab
	Cenchrus echinatus L.	b
	Panicum maximum Jacq.	b
	Brachiaria decumbens	b
	Chloris radiata Sw.	b
	Brachiaria plantaginea	b
	Melinis minutiflora P. Beauv.	a
	Brachiaria mutica	a
Portulacaceae	*Portulaca oleracea* L.	ab
	Talinum triangulare (Jacq.) Willd.	b
Rubiaceae	*Spermacoce verticillata*	ab
	Spermacoce latifolia	a
Solanaceae	*Solanum americanum*	ab
	Solanum paniculatum L.	b
Urticaceae	*Pilea microphylla* (L.) Liebm.	a
	Parietaria debilis G. Forst.	ab

*Species found in the regions above 500 m (a) and below 500 m (b).

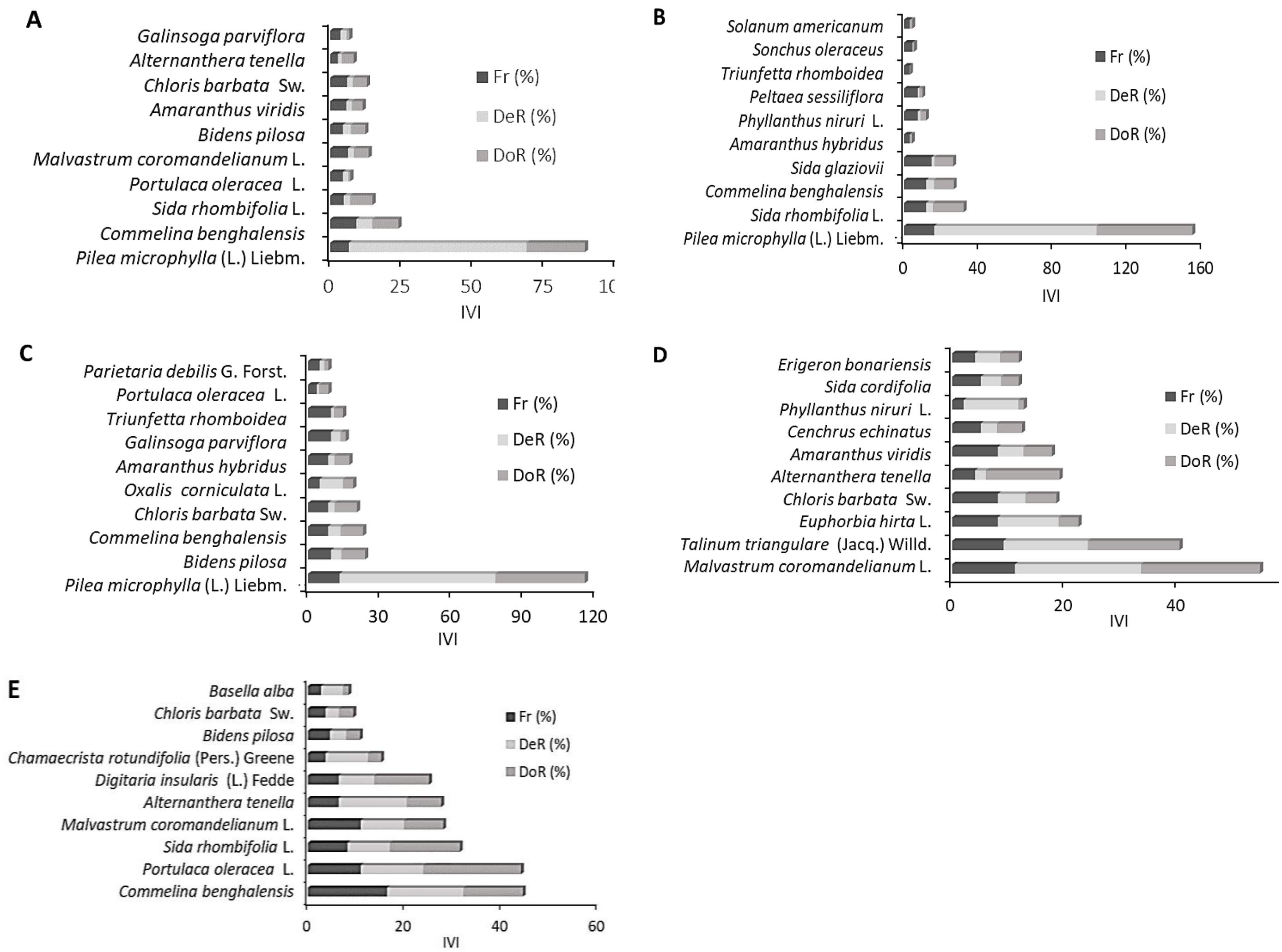

Figure 1. Relative frequency (RFr%), relative density (RDe%), relative dominance (RDo%), and importance value index (IVI) of the main weed species in 'Niágara Rosada' grape vineyards. A - City of Santa Teresa; B - At altitudes above 500 m in the winter; C - Above 500 m in the summer D - Below 500 m in the summer; E - Below 500 m in the summer.

Floristic composition of 'Niágara Rosada' grape vineyards cultivated at altitudes above 500 m in two seasons

The evaluation of the floristic composition in the winter, according to Figure 1B, shows that the species with the highest IVI were *Pilea microphylla* (L.) Liebm. (154.61), *Sida rhombifolia* L. (31.94), *Commelina benghalensis* (26.64), *Sida glaziovii* (26.33), and *Amaranthus hybridus* (4.13). In the summer (Figure 1C), those with the highest IVI were *Pilea microphylla* (L.) Liebm. (115.36), *Bidens pilosa* (23.74), *Commelina benghalensis* (22.88), *Chloris barbata* Sw. (20.35), and *Oxalis corniculata* L. (18.81). Among the five species with the highest IVI, two were observed in the evaluated seasons: *Pilea microphylla* (L.) Liebm. and *Commelina benghalensis*, especially the former.

Floristic composition of 'Niágara Rosada' grape vineyards cultivated at altitudes below 500 m in two seasons

Under lower altitude conditions, for the winter evaluation (Figure 1D), the species with the highest IVI in decreasing order were *Malvastrum coromandelianum* L. (54.54), *Talinum triangulare* (Jacq.) Willd. (40.29), *Euphorbia hirta* L. (22.38), *Chloris barbata* Sw. (18.44), and *Alternanthera tenella* (19.03). In the summer (Figure 1E), those with the highest IVI were *Commelina benghalensis* (44.39), *Portulaca oleracea* L. (43.99), *Sida rhombifolia* L. (31.39), *Malvastrum coromandelianum* L. (27.95), and *Alternanthera tenella* (27.52).

Evaluation of Shannon-Weaver diversity (H') and Pielou evenness (J) indices

The Shannon-Weaver index informs the biological diversity of the agroecosystem. This index was chosen because it gives intermediate weight to the less rare species, meaning that this index has a higher sensitivity under these conditions, providing higher weight to species richness. The Pielou evenness index derives from the Shannon index (H') and allows measuring the balance and/or uniformity among the species in the vineyards.

The properties located at higher altitudes - Aparecidinha (806 m) and Vargem Alta (709 m) - indicated diversity values corresponding to 0.62 in the winter and 1.43 in the summer. These values were lower than those observed in the properties of lower altitudes - Rio Cinco de Novembro (272 m) and Barra do Tabocas (163 m) -, which had diversity values of 2.65 in the winter and 2.60 in the summer (Table 3). Regarding the uniformity among species, the properties with higher altitudes had values ranging from 0.21 in the winter and 0.46 in the summer, which are lower than those observed in the properties of lower altitudes that presented values from 0.78 in the winter to 0.83 in the summer (Table 3).

Table 3. Shannon-Weaver diversity index (H') and Pielou evenness index (J) for 'Niágara Rosada' grape vineyards located in regions of altitudes above and below 500 m in the winter and summer seasons.

Properties/ Vineyards	Altitudes	Season	Shannon Weaver diversity index (H´)	Pielou evenness index (J)
Aparecidinha and Vargem Alta	Above 500 m	Winter	0.62	0.21
		Summer	1.43	0.46
Rio Cinco de Novembro and Barra do Tabocas	Below 500 m	Winter	2.65	0.78
		Summer	2.60	0.83

Evaluation of the Jaccard Similarity index (J) among weed species

The highest similarity indices among weed species occurred in properties with similar altitudes. The highest numerical value (0.41) was found in properties with altitudes above 500 m, while the second highest value (0.36) was found in those with altitudes below 500 m when comparing the two evaluation periods (Table 4).

Table 4. Similarity coefficient of the phytosociological survey performed in 'Niágara Rosada' grape vineyards planted in regions with different altitudes (above and below 500 m) in two seasons (winter /summer), in the city of Santa Teresa, ES, Brazil.

Properties	Altitude/ 500m	Seasons evaluated	Jaccard similarity index (Sj)
Aparecidinha and Vargem Alta	above	winter x summer	0.41
Barra do Tabocas and Rio Cinco de Novembro	below	winter x summer	0.36
Aparecidinha and Vargem Alta	above	winter and summer	0.36
Barra do Tabocas and Rio Cinco de Novembro	below	winter and summer	
Aparecidinha and Vargem Alta	above	winter	0.33
Barra do Tabocas and Rio Cinco de Novembro	below	winter	
Aparecidinha and Vargem Alta	above	summer	0.29
Barra do Tabocas and Rio Cinco de Novembro	below	summer	
Aparecidinha and Vargem Alta	above	summer	0.24
Barra do Tabocas and Rio Cinco de Novembro	below	winter	
Aparecidinha and Vargem Alta	above	winter	0.20
Barra do Tabocas and Rio Cinco de Novembro	below	summer	

4. Discussion

The survey showed a great diversity of weeds in the vineyards of Santa Teresa, but only one group of five (5) species corresponds to more than 50% of the IVI, highlighting, in decreasing order, the following species: *Pilea microphylla* (L.) Liebm. (88.87), *Commelina benghalensis* (23.79), *Sida rhombifolia* L. (14.73), *Portulaca oleracea* L. (14.43), and *Malvastrum coromandelianum* L. (13.38) (Figure 1A).

According to the survey, the *Pilea microphylla* (L.) Liebm. species prevailed in the region with higher altitudes, regardless of the season, and it was not found at lower altitudes. The *Commelina benghalensis* species was observed at altitudes above and below 500 m, regardless of the season. In turn, the *Sida rhombifolia* L. species occurred in the summer at low altitudes, and only in the winter at higher altitudes. *Portulaca oleracea* L. was observed in both seasons in the region below 500 m and only in the winter in the region above 500 m. *Malvastrum coromandelianum* L. was observed in the region below 500 m in both seasons, but only in the winter in the region of higher altitudes.

It is important to know, overall, the floristic composition of the 'Niágara Rosada' grape vineyards in the city of Santa Teresa, in the winter and summer seasons, in both agro-climatic zones. However, for the grape growers who manage weeds in some stages of the production process, such as in the winter at grapevine pruning and in the summer before harvesting and considering that the city has two zones with very distinct agro-climatic conditions, according to Table 1, a detailed study is required on the floristic composition of each agro-climatic zone in each season.

The *Pilea microphylla* (L.) Liebm. species is a perennial, herbaceous plant, prostrate with the tip of the branches pointing up, very branched, with juicy and glabrous leaves, 10- to 20-cm long, and native to tropical America, and can be cultivated for ornamental purposes. However, it becomes undesirable when growing spontaneously in home vegetable gardens and orchards. This species is often found in the coastal plain, where it is common in domestic environments but without forming dense infestations (Lorenzi 2000). It is also not much demanding regarding soil conditions but requires a fair level of humidity and diffuse light conditions.

These climatic conditions are found in the regions of higher altitudes (above 500 m), where the high humidity level promoted by rainfall rates about 30% higher than those at low altitude regions (Castro et al. 1981) can favor the development and dissemination of this invasive species, making it highly competitive compared to the infesting community.

The *Malvastrum coromandelianum* L. species belongs to the Malvaceae family, is of tropical origin, herbaceous, and branched, and can reach 30 to 60 cm in height (Lorenzi 2000). In Brazil, this species occurs more frequently in the southeast and south regions, being propagated by seeds, and its main root is a very deep taproot, forming dense infestations that completely dominate crops (Bringhenti 2010). Cover plants compete with invasive plants that compete for the resources in the environment. At first, the highest competition is for water (if limited), then for nutrients, and finally, depending on the development stage, for solar radiation (Oliveira and Bringhenti 2018).

There may be an intense competition in the case of vineyards in the formation stage, but the possibility of impacts on vineyards already formed cannot be discarded because the root formation of this species will promote competition for water and nutrients if the quantity available in the soil is not sufficient to meet the demands.

The *Commelina benghalensis* species, which obtained the highest IVI in the summer season, is a perennial and semi-prostrate plant that can reach 70 cm in height and is native to southeast Asia (Lorenzi, 2000). This infesting species develops in annual and perennial crops and occurs in all regions of Brazil, with a preference for soils of good fertility and adequate moisture content, and more shaded sites (Bringhenti 2010). These characteristics are found within the studied vineyards, especially in lower regions where the higher temperatures combined with fertility, humidity, and shading create a perfect environment for developing this species. Chemical control is difficult because this species tolerate high doses of the glyphosate herbicide (Gazziero et al. 2015).

The *Portulaca oleracea* L. species had an IVI of 43.99, which is worth noting among the main infesting plants. It is an annual herbaceous species that develops across Brazil, commonly found in vine-producing areas (Santos et al. 2014). This plant can be recognized by its creeping growth habit and fleshy leaf texture, and it propagates through seeds and stem fragmentations. This species can host nematodes of the Meloidogyne genus and viruses that cause diseases, the *Ralstonia solanacearum* bacterium that causes bacterial wilt known as Moko, and aphids of the *Aphis gossypii* species. Although it does not host harmful pathogens to the grape crop, grape growers should be alert because it may somehow compete for nutrients due to its rapid development cycle if there are no sufficient nutrients available for the crop.

The phytosociological survey showed that the region of altitudes above 500 m presented less invasive species (29) than the region of lower altitudes (39). It is also worth mentioning that the similarity between plants found under both altitude conditions evaluated was 36% (Table 4).

In a phytosociological survey on bananas, it was observed that the presence and density of species, the number of individuals, and distribution per family change according to the sampling period (Lima et al. 2015). In this context, besides the time of the year, altitude tends to influence the floristic composition of the infesting community due to the microclimate promoted by this factor. It is important to emphasize that the study was performed in areas of altitudes ranging from 163 m to 806 m, a difference of more than 600 m between the lowest and highest altitudes, which allows inferring that such difference contributes to producing environments with differentiated microclimate, which in turn may lead to the reduction of certain species or even their absence according to the environment in which they are inserted. Corroborating this, Soares et al. (2012) report that differences in the development of some weeds relate to the edaphoclimatic conditions of the region, which directly affect the local population.

The fact that vineyards located at higher altitudes have lower diversity and evenness indices can be attributed to a high degree of dominance of some species, especially *Pilea microphylla* (L.) Liebm. in the winter (51.39%) and summer (37.27%) (Figures 1B, 1C). Likewise, the lowest degree of dominance was found in areas of low altitudes, which reveals higher evenness in these areas and more uniform distribution of abundances among species.

In study of influence of altitude on the floristic composition and diversity of plants in Serra do Caparaó, southeastern Brazil, areas of the higher altitudinal belt with a lower diversity of species than the other altitudinal belts, which suggests a strong influence of the more restrictive environmental conditions of higher altitudes on the composition of species and the spatial patterns of diversity (Cordeiro 2017).

Regarding the time of the year, in regions of higher altitudes in the summer, the diversity values were higher than those in the winter, but the opposite occurred in areas of low altitudes, so a seasonal pattern could not be established. In recent years, regions of low altitudes have shown small differences in temperature between the winter and summer seasons, which may explain the maintenance of weed diversity when evaluated in both seasons.

Although the areas located at low altitudes have higher diversity indices than those at higher altitudes, they cannot be characterized as belonging to environments with high species diversity because only values above 3.11 for the Shannon-Weaver index can indicate high diversity (Saporetti et al. 2003).

Values higher than or equal to 0.5 indicate high species similarity in the areas (Fabricante et al. 2007). The values found in the present study are considered low but indicate an increasing trend for the similarity index when comparing properties with similar altitudes. In study that evaluated the effect of altitudes and soils on the abrupt variations of vegetation in an altitudinal gradient of Atlantic Forest, it was found that the more distant and the higher the sampling points of the study area, the lower the similarity among the existing species (Caglioni et al. 2018).

Another result showing that this factor may influence the formation of the floristic composition of the infesting community is that only 36% of the species were similar when comparing the regions below and above 500 m in the winter and summer, demonstrating that similar altitudes and nearby areas present a higher similarity among species.

Overall, 19 families, 41 genera, and 50 weed species were identified in the vineyards, and the *Pilea microphylla* (L.) Liebm. species from the Urticaceae family showed the highest IVI. This species is only found in areas of higher altitudes, possibly favored by the higher humidity and shading of vineyards.

The vineyards located in the region of altitudes below 500 m had the highest diversity and evenness indices, indicating a potential influence of temperature. The distance between the vineyards within the same agro-climatic zone at higher or lower altitudes tends to contribute to a higher similarity among the species of the infesting community.

Edaphoclimatic conditions, type of relief, altitude, the distance between the areas, and time of the year are responsible for composing the infesting community, but there is a lack of information on how such factors may influence this composition. Therefore, phytosociological studies in vineyards need to be expanded and deepened to consolidate these findings and provide accurate information for grape growers to make the most appropriate decisions in weed management.

5. Conclusions

The altitude and time of the year contribute to the composition of the infesting community. The most representative families regarding the number of species were Asteraceae, Poaceae, and Malvaceae. In properties with higher altitudes, the species with the highest IVI was *Pilea microphylla* (L.) Liebm., in both seasons. While in properties with lower altitudes, the highest values of IVI were found for *Malvastrum coromandelianum* L. in the winter and *Commelina benghalensis* and *Portulaca oleracea* L. in the summer.

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