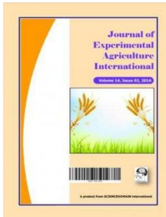

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Agronomic Aptitude and Quality of Vinifera Grapes in a Non-traditional of Culture Region in the Agreste of Pernambuco States

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Authors' contributions

This work was carried out in collaboration among all authors. Author FGS elaborated the study and participated in all the steps of conducting and writing of the manuscript. Authors JVA and RSR were decisive in conducting the experiment, writing and correction phase. Authors RSM, MMS, PCSL and JBA were a work mentors, working in the process of planning and supervisors of the experiment. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This study evaluate the agronomic and quality characteristics of grape (*Vitis vinifera* L.) varieties in a non-traditional region of the Agreste of Pernambuco States.
Study Design: The experiment was conducted in a randomized block design with five replications and eight plants per plot.
Place and Duration of Study: Was carried out in the municipality of Brejão, PE, at the Experimental Station of the Agronomic Institute of the Pernambuco. The vines were implanted on

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September, 2013, whose pruning was performed on August and harvesting began on December, 2016 to January, 2017.
Methodology: Ten treatments represented by the varieties of European vines: Cabernet Sauvignon, Malbec, Merlot Noir, Petit Verdot, Pinot Noir and Syrah for producing of red wines and Chardonnay, Muscat Petit Grain, Sauvignon Blanc and Viogner for producing of white wines, grafted on the Paulsen 1103 rootstock were evaluated. The vineyard was conducted in espalier vine-tying system in double short pruning type, with spacing 3 m x 1 m. The characterization of the phenological stages was made using as reference the phenological scale. The thermal requirement of the crop per period was estimated. Agronomic characteristics were also evaluated, such as: fertility of gems, budding (%), production, productivity, number of bunches per plant, length and width of bunch, bunch weight, soluble solids, titratable acidity, hydrogen ionic potential, SS / TA ratio, volume of 100 berries, yield of must, mass of the husks and seeds. The data were submitted to two selection indices: Classic Index and Distance Genotype-Ideotype Index.
Results: Sprouting varied from 13.68% (Petit Verdot) to 81.6% (Sauvignon Blanc) and the fertility of gems from 0.1 $bunch.bud^{-1}$ (Chardonnay) to 0.67 $bunch.bud^{-1}$ (Sauvignon Blanc). The pruning cycle and Day Degrees (DD) cumulated ranged from 133 days and 1,684 DD (Muscat Petit Grain) to 167 days and 2,070 DD (Merlot Noir). The number of bunches ranged from five (Merlot Noir) to 29 $bunches.plant^{-1}$ (Sauvignon Blanc). Muscat Petit Grain stood out for bunch weight, not differing from Syrah and Malbec. The varieties showed no difference in length and width of bunches. In the volume of 100 berries, Muscat Petit Grain (213.6 ml) and Malbec (216.0 ml) stood out. For the yield of must, Sauvignon Blanc (70.87%) stood out, not differing from Malbec (64.31%), Viognier (69.79%), Muscat Petit Grain (70.22%). Muscat Petit Grain, Sauvignon Blanc and Viognier (white wine), Cabernet Sauvignon, Malbec, Merlot Noir and Syrah obtained acceptable values for soluble solids (SS), titratable acidity (TA), SS/TA ratio and pH. From the selection index analyzes, the Muscat Petit Grain, Cabernet Sauvignon and Syrah varieties were indicated for the selection by the highest Mulamba and Mock index and by the Genotype-Ideotype distance index.
Conclusion: The cycle of grapevine varieties evaluated in the Garanhuns, PE, Microregion is longer than that observed in the sub Medio of the São Francisco Valley, similar to those in the South Region of Brazil. In the evaluated cycle the varieties produced grapes with characteristics suitable for the production of quality fine wines, showing to be promising for this non-traditional microregion in the production of fine grapes. From the selection index analyzes, the Muscat Petit Grain, Syrah and Cabernet Sauvignon varieties were indicated for selection by the highest Mulamba and Mock index and Genotype-Ideotype distance index.

Keywords: Vitis vinifera L.; white wine; red wine; selection indexes.

1. INTRODUCTION

The *Vitis vinifera* L. is the most cultivated grape species in the world and is widely used in wine production. The main varieties used for the production of white wine are Chardonnay, Muscat Petit Grain, Sauvignon Blanc and Viognier, while the Cabernet Sauvignon, Malbec, Melot Noir, Petit Verdot, Pinot Noir and Syrah varieties stand out in the production of red wines. Together, these varieties occupy a prominent place in the world scenario in the elaboration of fine wines [1].

The vine is an exotic species, but increasingly representative in Brazilian fruit growing, since it is no longer exclusively cultivated in temperate zones and has become a promising alternative to fruit growing also in tropical regions [2].

The semi-arid region presents peculiar climatic conditions that differ from the other regions producing grapes. These climatic conditions favor the rapid evolution of elaborated wines, especially of the grapes harvested between October and January, in the sub Medio of the São Francisco Valley. This is due to the high temperatures exceeding 33-35°C, limiting temperatures to ensure the stability of phenolic compounds and aroma precursors [3].

However, one alternative to solve these problems is the identification of micro regions with different climatic conditions and potential aptitude for the elaboration of quality wines in the Northeast region.

The Garanhuns Microregion where the town of Brejão, PE, is located is not traditional in the production of grapes, but it has similar climatic and altitude characteristics to those of the main regions producing European grapes. Preliminary studies indicate that the Garanhuns, PE, Microregion has a high potential for the production of grapes [4].

Therefore, it is important to study the behavior of these varieties under these edaphoclimatic conditions, characterizing the phenological behavior, the thermal demand and the quality parameters of the grape. This scientific knowledge contributes to improve cultural practices with the varieties, as well as, they allow to identify which varieties are more adapted to each region [5,6].

The analysis of production components, such as number of fruits and yield, is of great importance in the perennial plant breeding [7]. In addition, in grapes for winemaking, in addition to these characteristics, the quality of the fruit is also essential, being decisive in the production of a quality wine. When multiple characters are considered simultaneously, the selection indexes are presented as a great alternative to the selection gain prediction.

In view of the above, the objective was to evaluate agronomic and grape quality characteristics in *Vitis vinifera* L. varieties in a non-traditional region to identify varieties with potential for the production of fine wines, contributing to the development and strengthening of viticulture in the Brazilian Northeast region.

2. MATERIALS AND METHODS

The experiment was carried out in the municipality of Brejão, PE, at the Experimental Station of the Agronomic Institute of the Pernambuco (IPA). The municipality is located in the Microregion of Garanhuns, PE, which comprises nineteen municipalities. Garanhuns is located at 234 Km from Recife, 08º58'S and 36º51'W with 823 m of altitude, being Brejão at approximately 24,7 Km from Garanhuns 08º53'S and 36º30 'W, with an altitude of 788 m and temperatures average of 22.8ºC. Throughout the year, the temperature generally ranges from 15°C to 31°C and is rarely below 13°C or above 33°C. The average annual rainfall is 1,273 mm, occurring in the period from March to August and, occasionally, in the months of December and January. The climate is classified as "As".

The work consisted of ten treatments represented by the varieties of European vines (*Vitis vinifera* L.): Cabernet Sauvignon, Malbec, Merlot Noir, Petit Verdot, Pinot Noir and Syrah for producting of red wines and Chardonnay, Muscat Petit Grain, Sauvignon Blanc and Viogner for producting of white wines, grafted on the Paulsen 1103 rootstock.

The experiment was conducted under a randomized block design with five replicates, each experimental plot consisting of eight plants. The vines were implanted on September 10, 2013, whose pruning was performed on August 11 and harvesting began on December 22, 2016 to January 25, 2017. The vineyard was conducted in espalier vine-tying system in double short pruning type, with spacing 3 m x 1 m and irrigated by micro sprinkler, being the cultural treatments used according to the recommendations for cultivation. In this work the second productive cycle of the plants was evaluated.

The characterization of each phenological stage of the different varieties was carried out through three weekly visits to the experimental area during five months. From these visits were established the dates of beginning of occurrence of the main stages of growth of the vine, using as reference the phenological scale proposed by Eichorn and Lorenz [8] and adapted by Coombe [9]: 4 - Green tip (first foliar tissues visible); 12 - Five to six separate leaves, visible inflorescence; 19 - Beginning of flowering (first open flowers); 23 - Full bloom (50% of open flowers); 27 - Fruiting (growing berries); 31 - Berries size "pea"; 35 - Beginning of ripening (berries beginning to color and softening); 38 - Harvest (berries in full maturity).

The thermal requirement of the crop per period was calculated by the sum of the Degrees-Day (DD). To characterize the crop thermal requirement, the sum of DD from pruning to harvesting was used, as well as for each of the phenological subperiods, using the equation proposed by Villa Nova et al. [10] for mean temperature higher than the base temperature:

$$DD = (\mathrm{Tm} - \mathrm{Tb}) + \frac{(TM - Tm)}{2}$$

Where DD corresponds to the sum of Degrees-Day in each subperiod; Tb is the base temperature of the vine, equal to 10°C [11]; TM is the daily maximum temperature (ºC) and Tm is the daily minimum temperature (ºC).

In plants previously identified (two plants per plot), the number of production units and the number of remaining gems for pruning were recorded. The emergence and fertility of the gems were determined from the following formulas:

Fertility of gems ($bunch.bud^{-1}$) = (number of bunches / number of gems budded);

Budding (%) = (number of gems budded / total number of gems.) X 100.

The following characteristics were evaluated: production (PROD), in $kg.plant^{-1}$; productivity (PRODUT), in $t.ha^{-1}$; number of $bunches.plant^{-1}$ (NB); length (LE) and width of bunch (WB), in centimeters; bunch weight (BW), in grams; soluble solids (SS), expressed in °Brix, determined by direct reading in a manual refractometer; titratable acidity (TA), determined using 0.1 N NaOH, with 1% phenolphthalein as the indicator, the result being expressed as a percentage of tartaric acid; hydrogen ionic potential (pH), from direct reading in previously calibrated pH meter; SS / TA ratio; volume of 100 berries (BV), in ml and yield of must (YM), in %.

The selection indexes analyzed were: Classic Index of Mulamba and Mock [12] and Distance Index Genotype-Ideotype [13]. The variables in which variability were found were submitted to the two selection indices, using the most relevant characteristics for wine grapes: NB, MC, TA, pH and YM.

Estimates of selection gain prediction, using selection indices, were obtained based on the means of the experiment, with a selection percentage of 30%, and the two best varieties were selected in each index.

The averages of the genotypes selected for each trait were compared by the Tukey test, at 5% probability. The obtained data were analyzed with the computational resources of the Genes software [14].

3. RESULTS AND DISCUSSION

There was higher percentage of vegetative shoots than fertility of gems for the ten varieties (Table 1). The averages obtained for sprout and fertility of gems of the grapevines showed that the varieties presented differentiated responses, with the lowest fertility values being 0.10, 0.12 and 0.18 $bunch.buds^{-1}$ found for Chardonnay, Petit Verdot and Pinot Noir respectively, which was reflected in the very low production for these varieties, making it impossible to do the rest of the analyzes for them.

Table 1. Analysis of sprout and fertility of gems of grape varieties in the Garanhuns Microregion, PE, 2017

Treatments	Sprouting (%)	Fertility of gems ($bunch.bud^{-1}$)
Muscat Petit Grain	43.36cde	0.46abc
Merlot Noir	26.64ef	0.36bcde
Chardonnay	67.68ab	0.10e
Syrah	66.20abc	0.52ab
Cabernet Sauvignon	41.10de	0.59ab
Petit Verdot	13.68f	0.12de
Pinot Noir	57.68bcd	0.18cde
Malbec	35.62def	0.44abc
Viognier	76.98ab	0.40abcd
Sauvignon Blanc	81.60a	0.67a
Coefficient of variation (%)	21.12	34.21

Averages followed by the same letter in the column do not differ by the Tukey test at 5% probability

The Petit Verdot variety presents low vigor in the sub Medio of the São Francisco Valley, reflecting at low sprouting index, associated with low fertility of gems [15]. In the first cycle of the same experiment (2015/2016), there was also a lower fertility of gems for Pinot Noir and Chardonnay, reflecting at the low yield that made it impossible continuity of the analyzes for these varieties [4].

Several factors may influence the fertility of the gems and the sprouting percentage in vineyards, such as: hormonal balance, genetic characteristics, adaptability, branch vigor, ambient conditions, water availability, mineral nutrition and cultural practices. However, since these are initial studies in a non-traditional region in grapevine cultivation, more studies are needed on the causes of this issue. Such studies are in development and it is hoped to provide such results in the literature very soon.

In the evaluation of cycle from the pruning to harvest, the varieties presented cycle duration ranging from 133 days (Muscat Petit Grain) to 167 days (Merlot Noir) (Table 2). According to the classification of Leão et al. [16], early varieties have a cycle duration of 100 days or less, while medium varieties have a cycle length of 101 to 120 days and late varieties have a cycle length of more than 121 days. So all the cultivars under study were classified as late.

Table 2. Analysis of the phenological phases and day degrees of grape varieties in the Garanhuns Microregion, PE, 2017

Treatments	Phenological phases								
	4	**12**	**19**	**23**	**27**	**31**	**35**	**38**	**Total**
Muscat Petit G.	18a	7b	23bc	2b	7a	10ab	35c	31d	133b
Merlot Noir	20a	5b	21c	4a	3b	8b	41a	65a	167a
Syrah	15c	10a	23bc	2b	3b	11a	35c	60ab	159a
Cabernet S.	15bc	5b	26a	4a	3b	8b	41a	58b	160a
Malbec	18ab	7b	18d	3ab	7a	8b	34c	65a	160a
Viognier	13c	5b	23b	2b	7a	11a	38b	39c	138b
Sauvignon B.	15c	5b	26a	2b	2b	11a	38b	39c	138b
CV (%)	8.05	2.05	5.12	18.93	13.01	11.45	2.92	5.43	2.96
Treatments	**Degrees-day in the phenological phases**								
	4	**12**	**19**	**23**	**27**	**31**	**35**	**38**	**Total**
Muscat Petit G.	178b	86a	237a	41a	43b	147a	443ab	509b	1.684b
Merlot Noir	198a	52b	241a	39a	36b	145a	458ab	901a	2.070a
Syrah	137c	69ab	238a	36a	50ab	153a	456ab	859a	1.998a
Cabernet S.	161b	54b	252a	37a	50ab	125a	504a	831a	2.014a
Malbec	172b	60b	236a	37a	54ab	125a	433b	901a	2.018a
Viognier	129c	57b	251a	34a	71a	140a	473ab	536b	1.691b
Sauvignon B.	137c	65ab	250a	33a	45b	140a	456ab	574b	1.700b
CV (%)	6.06	19.59	10.90	27.89	23.07	13.46	7.15	6.38	2.81

Averages followed by the same letter in the column do not differ by the Tukey test at 5% probability

Table 3. Characteristics analysis of production (PROD), productivity (PRODUCT), number of bunches.plant-1 (NB), bunch weight (BW), length of bunch (LE), width of bunch (WB), volume of 100 berries (BV) and yield of must (YM) of grapes in the Microregion of Garanhuns, PE, 2017

Treatments	PROD ($Kg.planta^{-1}$)	PRODUCT ($t.ha^{-1}$)	NB	BW (g)
Muscat P.	1.762bc	5.7bc	11bcd	160.2a
Merlot Noir	0.506d	1.8d	5d	101.2b
Syrah	2.504ab	8.6ab	18b	139.1ab
Cabernet S.	1.378cd	4.3cd	12bcd	114.8b
Malbec	1.418cd	5.0c	10cd	141.6ab
Viognier	1.555bc	5.5bc	14bc	111.1b
Sauvignon	3.198a	10.9a	29a	110.3b
CV (%)	12.01	25.96	20.64	15.85
Treatments	**LE (cm)**	**WB (cm)**	**BV (ml)**	**YM (%)**
Muscat P.	15.37a	7.15a	213.6a	70.22ab
Merlot Noir	12.02a	7.75a	141.0b	60.09c
Syrah	12.09a	6.81a	146.3b	63.32bc
Cabernet S.	12.32a	7.64a	118.8b	61.01c
Malbec	13.44a	9.09a	216.0a	64.31abc
Viognier	12.92a	6.60a	141.0b	69.79ab
Sauvignon	11.08a	7.25a	133.9b	70.87a
CV (%)	18.42	22.31	9.57	5.53

Averages followed by the same letter in the column do not differ by the Tukey test at 5% probability

Values close to those obtained in this work were observed in regions traditionally producing grapes, indicating areas of cultivation with characteristics similar to those of the Garanhuns, PE, Microregion.

In the Campanha-RS region, the Cabernet Sauvignon, Merlot and Sauvignon Blanc varieties demanded 174, 161 and 147 days respectively to complete the cycle [17]; 160 days for Cabernet Sauvignon in Guarapuava, PR [18]; in the southeast of Belgrade in Serbia, the Muscat Petit Grain variety was classified as medium-late cycle [19]; in Parma, Italy, Malbec, Syrah and Cabernet Sauvignon respectively required 161, 157 and 155 days [20].

Likewise, values close to the obtained at this work were found in the first productive cycle of this same experiment (2015/2016), in which 130, 155, 148, 158, 147, 132 and 144 days were demanded from the pruning to harvest for Muscat Petit Grain, Merlot Noir, Syrah, Cabernet Sauvignon, Malbec, Viognier and Sauvignon Blanc, respectively [4].

This variation to the conclusion of the cycle might be attributed to the intrinsic characteristics of each variety, due to its origin and to the climatic conditions that the plants are submitted during the all productive cycle [21,22].

Regarding the thermal demand in day degrees, it ranged among 1.684 DD (Muscat Petit Grain) and 2.070 DD (Merlot Noir) (Table 2). These values are directly related to maturation of the bunches and date of harvest.

In São Joaquim, SC, a thermal demand of 1.694, 1,430 and 1,402 DD was required for the varieties Sauvignon Blan, Cabernet Sauvignon and Merlot, respectively [6]. Values close to those verified in this work also were reported by Radünz et al. [17], in the region of Campana, RS, with a thermal need of 2,084 and 1,759 DD for the Cabernet Sauvignon and Sauvignon Blanc varieties, respectively. This values were close to those found in the first cycle of this same experiment (2015/2016), where there was a thermal need of 1.485, 1.804, 1.721, 1.794, 1.731, 1.451 and 1.666 DD for Muscat Petit Grain, Merlot Noir, Syrah, Cabernet Sauvignon, Malbec, Viognier and Sauvignon Blanc respectively [4].

It was observed that the first six phenological phases, as well as the thermal demand in these phases, provided less variation among the varieties, being the final phenological phases (35 and 38) responsible for presenting a longer duration and greater accumulation of DD, thus contributing with a higher number of days for the total phenological cycle and subsequent classification of varieties as early, medium and late (Table 2). In these maturation phases changes in grape metabolism, sugar concentrations, organic acids, amino acids, aromatic compounds and phenolic composition occur, which are very important components in the elaboration and quality of the wine [23].

These values reflect what Radünz et al. [17] affirms about the phenological behavior, which is influenced by the variety, but also by the evaluated harvest, being verified greater thermal need in the development and fruit maturation phases and the less need in the flowering phase.

The modern viticulture requires knowledge of the duration of the phenological phases, helping to decide the most appropriate time to carry out the cultural treatments and scheduling the probable dates of harvest, making possible the rationalization of phytosanitary treatments and the optimization of the workforce [24].

Production and productivity ranged from 3.198 $kg.plant^{-1}$ and 10.9 $t.ha^{-1}$ to 0.506 $kg.plant^{-1}$ and 1.8 $t.ha^{-1}$ for Sauvignon Blanc and Merlot Noir, respectively (Table 3). Cabernet Sauvignon, Sauvignon Blanc and Syrah presented approximate values to that of the sub Medio of the São Francisco Valley [25] and Merlot Noir and Cabenet Sauvignon to Rio Grande do Sul [26]. In this way the values obtained in this work are considered as interesting production in grapes for processing conducted in espalier, since it is the second productive cycle.

For the number of $bunches.plant^{-1}$, the Sauvignon Blanc variety stood out to the others (Table 3). This result was superior to that found in two productive cycles in São Joaquim city, SC, for this variety 18.4 and 17.4 $bunches.plant^{-1}$ in the first and second cycle, respectively. In contrast, in the sub Medio of the São Francisco Valley, Cabernet Sauvignon (19 and 24 $bunches.plant^{-1}$), Syrah (17 and 39 $bunches.plant^{-1}$) and Sauvignon Blanc (21 and 34 $bunches.plant^{-1}$) varieties obtained higher averages in the first and second cycle, respectively [25]. For the average number of bunches per plant the values were considered interesting even some being smaller than those found in other works in Brazil, considering that this is a non-traditional region in the cultivation of grapes.

For the average bunch weight Muscat Petit Grain stood out, not differing from Syrah and Malbec (Table 3). The values obtained in this work were not very distant from those found in Uruguaiana, RS, and Quaraí, RS, for the Cabernet Sauvignon (210.0 g and 99.8 g) and Merlot (213.5 g and 105.1 g) varieties, respectively [26]. In the sub

Medio of the San Francisco Valley the varieties Cabernet Sauvignon and Syrah presented 77.59 g and 102.42 g, 85.82 g and 156.53 g, and 94.84 g and 118.42 g, in two productive cycles, respectively [25]. These values were higher than those found in the first cycle (2015/2016) of this same experiment for the varieties Muscat Petit Grain (124.45 g), Merlot Noir (93.19 g), Syrah (43.77 g) Cabernet Sauvignon (108.44 g), Malbec (106.86 g), Viognier (62.17 g) and Sauvignon Blanc (66.92 g) [4].

The varieties did not present significant difference in length and width of bunches (Table 3). This results ware superior to those found in the first cycle (2015/2016) of this same experiment for the varieties Muscat Petit Grain (11.2 cm and 5.66 cm), Merlot Noir (11.6 cm and 6.22 cm), Syrah (8.0 cm and 4.36 cm), Cabernet Sauvignon (12.8 cm and 6.02 cm), Malbec (11.0 cm and 6.68 cm), Viognier (8.1 cm and 4.92 cm) and Sauvignon Blanc (8.1 cm and 5.34 cm) for length and width of bunches, respectively [4].

For volume of 100 berries, Malbec stood out together with Muscat Petit Grain (Table 3). In the yield of must, the varieties Sauvignon Blanc and Muscat Petit Grain stood out from the others to reach the average yield in volume, considered as 70% of must and 30% of the solid part [27]. Approximate values were found in the same experiment in the first cycle, ranging from 122.2 ml to 197.2 ml and 62% to 77% for Cabernet Sauvignon, Malbec and Muscat Petit Grain varieties, respectively [4].

For soluble solids there was no statistical difference among the varieties, as well for SS/TA ratio (Table 4). All varieties obtained a greater accumulation of soluble solids, varying from 21.0 ºBrix to 22.9ºBrix, which is considered satisfactory for vinification, without the need for "chaptalization" for better conservation and quality of wine [28]. Table wines and fine wines should be between 10ºGL and 14ºGL, through fermentation of yeasts [29].

The titratable acidity ranged from 0.54% to 0.77 % of tartaric acid (Table 4). These values are considered interesting for the most of varieties, for Conde et al. [30] report that the total acidity considered ideal for grapes is in the range of 0.65% to 0.85%.

Table 4. Physical-chemical and chemical analysis of grape varieties in the Garanhuns Microregion, PE, 2017

Treatments	SS	TA	SS/TA	pH
Muscat Petit Grain	21.9a	0.60ab	36.68a	3.73bc
Merlot Noir	21.0a	0.59ab	39.42a	3.50d
Syrah	22.9a	0.54b	42.28a	3.86abc
Cabernet Sauvignon	22.3a	0.77a	29.31a	3.68cd
Malbec	22.2a	0.71ab	34.39a	3.75bc
Viognier	22.7a	0.64ab	35.48a	3.97a
Sauvignon Blanc	22.6a	0.57ab	40.29a	3.90ab
CV (%)	5.64	17.54	21.42	2.51

Averages followed by the same letter in the column do not differ by the Tukey test at 5% probability. SS - Soluble Solids; TA - Titratable Acidity; SS / TA - Soluble Solids/Titratable Acidity ratio; pH - hydrogen ionic potential

Table 5. Estimates of genetic gains predicted by the selection index proposed by Mulamba and Mock [12] and by the Genotype-Ideotype distance index [13], in the selection of grape varieties in the Garanhuns, PE, Microregion, 2017

Selection index	Selection gains (%)						Selected varieties
	Product	NB	BW	YM	TA	pH	
Mulamba and Mock	-15.5	-17.43	8.52	-0.01	5.79	-1.55	Muscat Petit Grain Cabernet Sauvignon
Genotype-Ideotype Distance	18.18	3.58	15.81	-0.87	-6.68	0.66	Muscat Petit Grain Syrah
Averages of varieties	1.34	-6.92	12.17	-0.44	-0.45	-0.45	

Product - Productivity (t.ha-1); NB - Number of Bunches.plant-1; BW - bunch weight (g); YM - yield of must (%); TA - titratable acidity (% of tartaric acid); pH - hydrogen ionic potential

The relationship of the soluble solids content with the titratable acidity represents the balance between the sweet and sour taste of the grape [31], being the most representative measure of grape flavor, which is considered to be sweet over 20 [32].

As for pH (Table 4), all varieties presented relatively high averages, for, in wine grapes, the recommended pH for the must is at most 3.30 [33]. High values were also observed for the same varieties in the first cycle of the same experiment [4]. Very high levels of pH might destabilize the wine both biologically and physic-chemically, making it more prone to microbial oxidation and proliferation, and consequently compromising its useful life [33]. These values of pH, acidity and soluble solids may be adjusted by modifying the time elapsed for harvesting.

From the value of the several characters considered simultaneously, it was possible to predict the selection gains through the selection indexes. With the results of the genetic gain estimates obtained by the use of the two combined indexes, it was verified that the Genotype-Ideotype distance index [13] provided positive gains for NG, NB, MC and pH, while the Mulamba and Mock [12] presented positive index only for MC and TA (Table 5). Thus, the Genotype-Ideotype distance index [13] allowed to predict higher and balanced gains among the characteristics when compared to the Mulamba and Mock index [12].

The Genotype-Ideotype distance index [13] has also been indicated in other studies, such as the one that provided the best result for the selection of superior genotypes, as well as those verified in varieties of popcorn corn (*Zea mays* L. everta) [34], and together with the index of Mulamba and Mock [12] for sour passion fruit (*Passiflora edulis* Sims) [7] and alfalfa (*Medicago sativa*) [35].

The Muscat Petit Grain variety was indicated to be selection together by the Mulamba and Mock index [12] and the Genotype-Ideotype distance index [13]. The Syrah variety was selected only by the Genotype-Ideotype distance index [13], and the Cabernet Sauvignon variety only by the Mulamba and Mock index [12]. Thus, a group of three varieties to be indicated were obtained, approximately 43 % of the group of evaluated varieties.

4. CONCLUSION

The cycle of grapevine varieties evaluated in the Garanhuns, PE, Microregion is longer than that observed in the sub Medio of the São Francisco Valley, similar to those in the South Region of Brazil.

In the evaluated cycle the varieties produced grapes with characteristics suitable for the production of quality fine wines, showing to be promising for this non-traditional microregion in the production of fine grapes.

From the selection index analyzes, the Muscat Petit Grain, Syrah and Cabernet Sauvignon varieties were indicated for selection by the highest Mulamba and Mock index and Genotype-Ideotype distance index.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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