Scientia Agraria Paranaensis

Scientia Agraria Paranaensis – Sci. Agrar. Parana.
ISSN: 1983-1471 – Online
DOI: https://doi.org/10.18188/sap.v21i4.31663

AGRONOMIC POTENTIAL OF BLUEBERRY CULTIVARS IN AN ORGANIC CROPPING SYSTEM IN THE BRAZILIAN SUBTROPICS

José Luís Trevizan Chiomento[1*], Tobias Furtado Bittencourt[1], Brenda Tortelli[1], Thomas dos Santos Trentin[2], Diógenes Cecchin Silveira[3], Alexandre Augusto Nienow[1]

SAP 31663 Received: 12/04/2021 Accepted: 02/08/2022
Sci. Agrar. Parana., Marechal Cândido Rondon, v. 21, n. 4, oct./dec., p. 390-397, 2022

ABSTRACT - The lack of information on the agronomic potential of blueberry cultivars in response to edaphoclimatic and biogeographical characteristics limits the establishment of commercial orchards in the producing regions of southern Brazil. Thus, the research objective was to investigate whether the agronomic potential differs among blueberry cultivars in an organic cultivation system in the Brazilian subtropics. The experiment was conducted in the municipality of Lagoa Vermelha, Brazil, from August 2021 to January 2022, in a commercial orchard. The treatments were three blueberry cultivars belonging to the rabbiteye group (‘Bluegem’, ‘Clímax’ and ‘Florida’), arranged in a completely randomized design, with eight replications. Fruit production and quality were evaluated. ‘Florida’ produced the highest number of fruits and had the highest blueberry production and yield. ‘Bluegem’ and ‘Clímax’ stood out in terms of fruiting rate. ‘Bluegem’ and ‘Florida’ had fruits with greater longitudinal diameter. ‘Clímax’ stood out for its larger cross-sectional fruit diameter and for producing blueberries with higher sugar content, lower citric acid content and better palatability. In conclusion, the three blueberry cultivars in organic cultivation system in the Brazilian subtropics differ in terms of their productive potential and fruit quality. ‘Florida’ has the best yield potential and ‘Clímax’ produces blueberries with the best chemical quality.
Keywords: *Vaccinium* sp., agroecology, small fruits, production, quality.

POTENCIAL AGRONÔMICO DE CULTIVARES DE MIRTILEIRO EM SISTEMA DE CULTIVO ORGÂNICO NO SUBTRÓPICO BRASILEIRO

RESUMO - A falta de informações sobre o potencial agronômico de cultivares de mirtileiro em resposta às características edafoclimáticas e biogeográficas limita o estabelecimento de pomares comerciais nas regiões produtoras do sul do Brasil. Assim, o objetivo da pesquisa foi investigar se o potencial agronômico difere entre cultivares de mirtileiro em sistema de cultivo orgânico no subtrópico brasileiro. O experimento foi conduzido no município de Lagoa Vermelha, Brasil, de agosto de 2021 a janeiro de 2022, em um pomar comercial. Os tratamentos foram três cultivares de mirtileiro pertencentes ao grupo rabbiteye (‘Bluegem’, ‘Clímax’ e ‘Florida’), dispostos no delineamento inteiramente casualizado, com oito repetições. Foram avaliadas a produção e a qualidade de frutos. ‘Florida’ produziu o maior número de frutos e teve as maiores produção e produtividade de mirtilos. ‘Bluegem’ e ‘Clímax’ destacaram-se quanto à taxa de frutificação. ‘Bluegem’ e ‘Florida’ apresentaram frutos com maior diâmetro longitudinal. ‘Clímax’ destacou-se pelo maior diâmetro transversal de frutos e por produzir mirtilos com maior teor de açúcar, menor teor de ácido cítrico e melhor palatabilidade. Em conclusão, as três cultivares de mirtileiro em sistema de cultivo orgânico no subtrópico brasileiro diferem quanto ao seu potencial produtivo e qualidade de frutos. ‘Florida’ tem o melhor potencial produtivo e ‘Clímax’ produz mirtilos com a melhor qualidade química.
Palavras-chave: *Vaccinium* sp., agroecologia, pequenos frutos, produção, qualidade.

INTRODUCTION

As it represents an important source of income for small and medium-sized farmers and due to the benefits arising from fruit consumption, the blueberry (*Vaccinium* sp.) is increasingly participating in the list of crops that aim to diversify the production of properties in the main temperate regions of the world (MEDINA et al., 2022). The blueberry was introduced in Brazil in the 1980s, in the state of Rio Grande do Sul (RS), with commercial expansion starting in the year 2000. Compared to other producing countries in the Southern Hemisphere, Brazil has important comparative advantages export of fresh blueberries, such as the possibility of early production in the off-season in the Northern Hemisphere, proximity to European markets and the availability of water and land suitable for cultivation (CANTUARIAS-AVILÉS, 2014).

Because it is a crop recently introduced in Brazil, with incipient studies on genetic improvement at national level, the technologies available and used by producers are adapted from other countries and adapted to local conditions (CANTUARIAS-AVILÉS et al., 2014). This fact, coupled with the scarcity of information on the potential of genotypes in response to edaphoclimatic and biogeographical conditions of the growing environment,

[1] University of Passo Fundo, Passo Fundo, RS, Brazil. E-mail: jose-trevizan@hotmail.com. *Corresponding author.
[2] University of São Paulo, Piracicaba, SP, Brazil.
[3] Federal University of Rio Grande do Sul, Porto Alegre, RS, Brazil.

limit the choice of blueberry cultivars by growers in the Brazilian subtropics. Therefore, one of the challenges for scientists, producers and industry is to know the blueberry potential for production and quality in order to establish management practices and apply technologies based on the behavior of orchards in southern Brazil. This will allow to intensify the crop's performance and will also contribute to increase the implantation of commercial blueberry orchards.

We also emphasize that the interest in the blueberry consumption is mainly related to their nutraceutical properties. Blueberries are rich in anthocyanins, substances with high antioxidant power and preventive action against various pathologies (CASSIDY et al., 2016; CEREZO et al., 2020). Furthermore, the fruits contain a high concentration of phenolic compounds, which have the ability to scavenge free radicals (RODRIGUES et al., 2011). In addition, in order to improve the purchase of fruits by consumers, we must intensify studies on sugar and acidity levels in fruits and seek a balance between these levels to improve the palatability of blueberries.

Therefore, the objective of this work was to investigate whether the agronomic potential differs among blueberry cultivars in an organic cropping system in the Brazilian subtropics. Here, we provide an overview of the productive performance and fruit chemical quality of three blueberry cultivars. Our findings will allow us to provide producers with a portfolio of cultivars aimed at establishing commercial blueberry orchards, in an organic system, with staggered materials.

MATERIAL AND METHODS

We used sod daughter plants, obtained by the cutting's technique, from the Mirtilos Bortolotto nursery (28º 26' 32.31" S, 50º 52' 54.77" W) located in the municipality of Vacaria, RS, Brazil.

The study was developed at SG Mirtilos company, in the municipality of Lagoa Vermelha (28º 12' 39" S; 51º 31' 34" W), RS, Brazil, with an altitude of 801 m. The experiment was conducted from August (fall) 2021 to January (summer) 2022 in a commercial orchard (Figure 1). The company emerged in 2012 with the mission to produce and commercialize organic blueberries with high quality, in a way that respects and values human and natural resources.

FIGURE 1 - Commercial blueberry orchard, belonging to the company SG Mirtilos, conducted in the organic system.

The treatments were three blueberry cultivars belonging to the rabbiteye group ('Bluegem', 'Climax' and 'Florida'), arranged in a completely randomized design, with eight single-plant replications. 'Bluegem' originates from Florida, United States of America (USA), and has moderate hibernal chilling requirement (from 250 to 400 h below 7.2ºC). 'Climax' originates from Georgia, USA, and has moderate hibernal chilling requirement (from 250 to 400 h below 7.2ºC). 'Florida' originates from Florida, USA, and has low hibernal chilling requirement (≤250 h below 7.2ºC).

The orchard was implanted in 2015, with a trellis preparation and a spacing of 1 m between plants and 3.5 m between rows. The area has not received chemical fertilization since the orhcad implantation because an organic seal covers it. Fertilization in the area occurs exclusively with mulch, which is mowed during the year. The chemical characterization of the soil, carried out according to the methodology described in Brazil (2014), is presented in Table 1.

TABLE 1 - Chemical properties of cultivated soil.

Clay	pH	SMP	P	K	OM	Al	Ca	Mg	H+Al	CEC	Saturation (%)		
%	H_2O[1]	index	mg.dm^{-3}		%	cmol$_c$.dm^{-3}					Bases	Al	K
46	5.2	5.3	4.4	184	4.1	0.1	5.4	6.6	9.7	7.1	71	0.1	2.8

Sulfur	Boron	Manganese	Zinc	Copper
mg.dm^{-3}				
8.0	0.6	29.6	13.1	14.0

[1]pH H_2O: hydrogen potential in water; SMP index: Shoemaker-Mac'Lean-Pratt index; P: phosphorus; K: potassium; OM: organic matter; Al: aluminum; Ca: calcium; Mg: magnesium; H+Al: potential acidity; CEC: cation exchange capacity.

The irrigation used in the experiment was localized, by means of drip tapes, in the manual system. Also, to avoid frost damage to flowers and fruits, we used the anti-frost system. It consisted of wrapping the flowers and branches of blueberry with ice (Figure 2) and protecting these structures from cell rupture, which can occur from -2.0ºC to lower temperatures. Thus, a layer of ice was formed on the plants by sprinkling water during a constant period, without interruption, when temperatures were low. The sprinkler was turned on when the temperature on the night before the frost began to decrease, reaching 2.0 to 3.0ºC. We only turned off the sprinkling when the plants had fully thawed the following morning.

FIGURE 2 - Anti-frost system installed in the blueberry orchard to protect flowers and branches from low temperatures.

The number of flowers and fruits per branch was obtained by selecting six branches per plant. Subsequently, these organs were counted per branch. The fruiting rate (FR, %) per plant was obtained by the Equation 1:

$$FR\ (\%) = \left(\frac{\text{number of fruits per branch}}{\text{number of flowers per branch}}\right) \times 100 \qquad \text{(Equation 1)}$$

From fruit set, in November (spring) 2021, the average fresh fruit mass (AFFM, g), the total number of fruits per plant (TNF, number per plant) and the total fruit production per plant (PP, kg per plant) were evaluated, harvested when they were fully ripe (Figure 3). The fruits were weighed on an electronic digital scale. AFFM was determined from the mass of 40 fruits per treatment. To estimate the TNF, the number of fruits per branch was multiplied by the number of productive branches per plant. PP was determined by multiplying AFFM and TNF. Productivity (TP, t ha^{-1}) was estimated by multiplying PP by the number of plants inserted in one hectare, according to the crop spacing (2,857 plants ha^{-1}).

FIGURE 3 - Mature blueberries suitable for harvesting for further evaluation.

The quality analysis was carried out in December (summer) 2021. The chemical characteristics related to the total soluble solids content (TSS, %) and total titratable acidity (TTA, expressed as % citric acid) were evaluated, from 40 fruits of each treatment for each repetition. The TSS content was determined in an analog refractometer, while the TTA was performed according to the standards of the Adolfo Lutz Institute (ZENEBON et al., 2008). To evaluate the fruit flavor, the ratio between TSS/TTA (FLA) was determined. In addition, the transverse diameter (TD, mm) and longitudinal diameter (LD, mm) of each fruit were measured using a digital caliper.

The data obtained were submitted to analysis of variance (Anova) and, when there was significance, the means of the treatments were compared by the Tukey test, at 5% probability of error, with the aid of the Sisvar® program.

Also, to illustrate the relationship among the three blueberry cultivars regarding the production and quality attributes of fruits evaluated, through dendrogram, we used the cluster analysis by the method of Unweighted Pair Group Method with Arithmetic Mean (UPGMA) of Tocher optimization (RAO, 1952), calculated by the Mahalanobis distance. Subsequently, the dendrogram that obtained the highest cluster consistency for the cultivars was constructed, using the cophenetic correlation coefficient (CCC) (SOKAL; ROHLF, 1962), skewness, and stress as criteria for validation. In addition, we investigated the relative contribution of attributes to divergence among cultivars, using the method of Singh (1981), and performed Person's correlation analysis. Multivariate analyses were performed with Genes® software (CRUZ, 2016).

RESULTS AND DISCUSSION

With the exception of AFFM, the Anova indicated that there was a significant effect of cultivars in relation to the other production attributes analyzed. ‘Florida’ showed the best productive potential, with the highest amount of fruit produced, the highest production and the highest blueberry yield (Table 2). However, ‘Bluegem’ and ‘Climax’ stood out in terms of FR.

TABLE 2 - Yield potential of three blueberry cultivars in an organic cropping system in Brazil.

Cultivars	FR[1] (%)	TNF (number per plant)	PP (kg per plant)	TP (t ha^{-1})
‘Florida’	62.1±6.1 b*	7,868±340.2 a	7.1±0.7 a	20.4±3.4 a
‘Bluegem’	79.0±8.4 a	6,352±338.3 b	5.6±0.4 b	16.0±2.9 b
‘Clímax’	72.9±8.1 a	5,183±327.1 c	4.7±0.3 c	13.4±1.8 c
Mean	71.3	6,468	5.8	16.6
CV (%)[2]	12.8	13.3	14.5	14.5

*Data was presented as mean ± standard deviation. Means followed by the same letter in the column do not differ between each other by Tukey’s test (p≤0.05). [1]FR: fruiting rate; TNF: total number of fruits; PP: total fruit production per plant; TP: productivity. [2]CV: coefficient of variation.

The Anova indicated that there was a significant effect of cultivars in relation to all the quality attributes analyzed. ‘Bluegem’ and ‘Florida’ produced more elongated fruits, with higher LD (Table 3). ‘Climax’ produced fruits with higher TD and with better chemical quality of the harvested berries as it originated sweeter, less acidic and more palatable blueberries.

TABLE 3 - Fruit quality of three blueberry cultivars in an organic cultivation system in the Brazilian subtropics.

Cultivars	LD[1] (mm)	TD (mm)	TSS (%)	TTA (%)	FLA
‘Florida’	10.4±1.1 a*	08.7±0.6 c	11.9±1.4 c	0.7±0.02 a	16.9±2.3 b
‘Bluegem’	10.6±1.5 a	09.6±0.7 b	12.9±1.6 b	0.7±0.02 a	16.7±3.5 b
‘Clímax’	09.8±0.8 b	13.5±1.7 a	14.7±1.9 a	0.5±0.01 b	23.3±4.3 a
Média	10.3	10.6	13.2	0.7	18.9
CV (%)[2]	2.3	1.7	3.3	6.8	6.8

*Data was presented as mean ± standard deviation. Means followed by the same letter in the column do not differ between each other by Tukey’s test (p≤0.05). [1]LD: longitudinal diameter of fruits; TD: transverse diameter of fruits; TSS: total soluble solids; TTA: titratable total acidity; FLA: flavor. [2]CV: coefficient of variation.

Through multivariate analysis, we observed that there was heterogeneity among the cultivars studied. The dissimilarity among the blueberry cultivars, in relation to the attributes of production and fruit quality, was illustrated by the dendrogram generated by the UPGMA method (Figure 4), whose fit to the Mahalanobis distance matrix, calculated by CCC, was 95%, indicating adequacy of the model. Thus, there was the formation of two groups, showing the dissimilarity among the cultivars regarding the investigated attributes.

One of the groups was formed only by ‘Climax’. This cultivar presented particular characteristics regarding fruit chemical quality. The other group was composed by ‘Bluegem’ and ‘Florida’. This group of cultivars presented similar performance in relation to the productive potential.

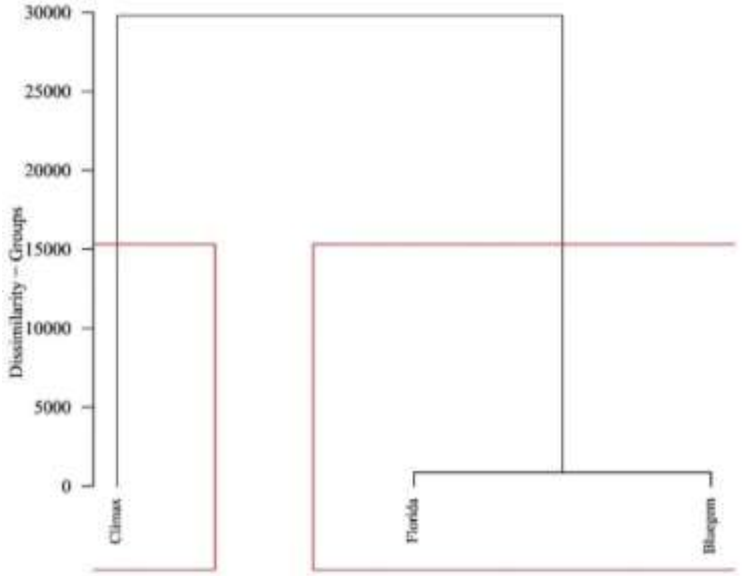

FIGURE 4 - Dendrogram of dissimilarity among blueberry cultivars obtained by the UPGMA method based on the Mahalanobis distance matrix. Cophenetic correlation index: 0.95. Distortion and stress (%): 2.78 and 16.67, respectively.

Based on the Tocher optimization method, we verified the formation of two groups (Table 4), with the junction of the cultivars in the same way as observed by the UPGMA method. Group I was superior to group II in the attributes TNF, PP, TP, TTA and LD.

TABLE 4 - Clustering by Tocher's method and averages in the ten characters studied.

Group	Cultivars
I	'Florida' and 'Bluegem'
II	'Clímax'

	Attributes[1]									
Group	FR	AFFM	TNF	PP	TP	TSS	TTA	FLA	LD	TD
I	70.53	0.90	7109.53	6.40	18.28	12.43	0.74	16.86	10.50	9.15
II	72.85	0.91	5182.85	4.70	13.44	14.68	0.63	23.29	9.83	13.55

[1]FR: fruiting rate; AFFM: average fresh fruit mass; TNF: total number of fruits; PP: total fruit production per plant; TP: productivity; TSS: total soluble solids; TTA: titratable total acidity; FLA: flavor; LD: longitudinal diameter of fruits; TD: transverse diameter of fruits.

The trait that contributed most to the divergence among cultivars was PP, which explained 66.17% of the variability among the cultivars studied (Table 5). Added to this, the attributes with the highest relative contribution to dissimilarity were TD, TSS and TNF, with 19.80%, 4.72% and 4.34%, respectively. These attributes accounted for 95.02% of the total dissimilarity among cultivars (Table 5) and are therefore considered important to genetic diversity studies in blueberry. The attributes LD, FR, AFFM, TP and FLA showed the lowest relative contributions and thus are not relevant to the assessment of the overall divergence among cultivars.

From the correlation matrix between yield and fruit quality attributes, we observed that 25 associations were significant (Figure 5), of which 10 were positive (PP-TNF, TP-TNF, LD-TNF, TP-PP, LD-PP, LD-TP, FLA-TSS, TS-TSS, LD-TTA and TD-FLA) and another 15 were negatively associated (TSS-TNF, FLA-TNF, TD-TNF, TSS-PP, FLA-PP, TD-PP, TSS-TP, FLA-TP, TD-TP, TTA-TSS, LD-TSS, FLA-TTA, TD-TTA, LD-FLA and TD-LD).

TABLE 5 - Relative contribution of the attributes to dissimilarity among blueberry cultivars.

Attributes[1]	Contribution (%)
PP	66.17
TD	19.80
TSS	4.72
TNF	4.33
TTA	3.42
LD	1.50
FR	0.03
AFFM	0.00
TP	0.00
FLA	0.00

[1]PP: total fruit production per plant; TD: transverse diameter of fruits; TSS: total soluble solids; TNF: total number of fruits; TTA: titratable total acidity; LD: longitudinal diameter of fruits; FR: fruiting rate; AFFM: average fresh fruit mass; TP: productivity; FLA: flavor.

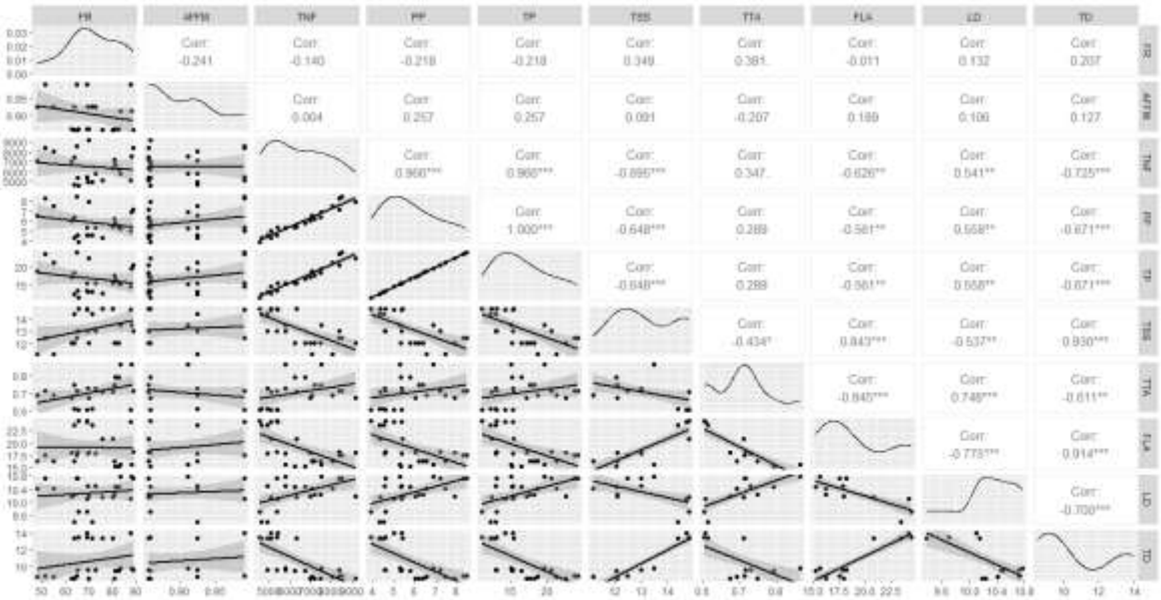

FIGURE 5 - Correlation matrix among the attributes evaluated in the study. FR: fruiting rate; AFFM: average fresh fruit mass; TNF: total number of fruits; PP: total fruit production per plant; TP: productivity; TSS: total soluble solids; TTA: titratable total acidity; FLA: flavor; LD: longitudinal diameter of fruits; TD: transverse diameter of fruits.

Understanding the blueberry ecophysiology in agroecosystems, with emphasis on the main producing regions, is a promising strategy to enhance the crop performance because, in addition to the genetic factor, productivity depends on the cultivar adaptability to climatic conditions (FISCHER et al., 2014). Thus, in order to increase the supply time of fruits in the market, with a good added value and with fresh fruits throughout the harvest, the staggering with the three cultivars that we studied here proves to be an effective bio-tool for producers.

Climatic factors act differently in the blueberry tree development phases and this interferes in determining the crop productive potential. During the resting phase, cold is the most important factor. As a temperate fruit tree, the blueberry undergoes a period of dormancy (temporary suspension of visible plant growth activities) as a protection against cold. The effect of cold is linked to the entry and exit from dormancy and is related to the differentiation of flowering buds. The blueberry tree needs hibernal chilling accumulation ranging from 250 to 850 h of temperature below 7.2ºC (SANTOS; RASEIRA, 2002). Chill hour accumulation data from municipalities near Lagoa Vermelha, RS, Brazil, indicate that, on average, the chill hours required by the three cultivars are met annually (MATZENAUER et al., 2005).

In the southern region of RS (slope of the 'Serra do Sudeste'), it is recommended to plant cultivars of the rabbiteye group because these cultivars need to accumulate approximately 360 h of cold. However, if at the flowering stage the temperature remains low for several hours, necrosis of the pistil and ovary of the flowers may occur (HERTER; WREGE, 2006). In addition to the climatic characterization, the choice of cultivars according to the phenological phases is fundamental, as it provides the staggering of production, increases the period of fruit supply to the market and makes it possible to adapt available technologies to that cultivar and region (SILVA et al., 2006).

The productive potential of 'Clímax', 'Bluegem' and 'Florida' is already known in the region of Pelotas, RS, with 'Bluegem' standing out in productivity terms (ANTUNES et al., 2010). However, here we show that 'Florida' presented the best productive potential, with productivity of 20.4 t ha^{-1} (Table 2). For 'Bluegem' and 'Clímax' the estimated production is 2 and 3 kg per plant, respectively (PEREIRA et al., 2013), different from what we obtained, of 5.6 and 4.7 kg per plant for 'Bluegem' and 'Clímax', respectively (Table 2). This may occur due to the intrinsic factors of adaptation of cultivars to the growing environment, such as the need for low local climatic temperatures (NIENOW; FLOSS, 2002). Our findings confirmed the high blueberry productive capacity in organic production systems, which is the fastest growing sector compared to conventional agriculture and covers 5% of Brazil (GONZALEZ et al., 2022). In addition, the organic cultivation system represents a social development because it mainly involves the participation of small and medium farmers, within the base of family farming (FERRAZ et al., 2013).

We observed that the fruits with the highest TD and lowest LD showed the best palatability, which suggests that fruit morphology may have some relationship with the accumulation and deposition of certain compounds in the fruit. The chemical fruit quality was within the range considered ideal for blueberries, such as sugar content greater than 10%, acidity between 0.3 and 1.3% and palatability ratio of 10 and 33 (GÜNDÜZ et al., 2015). In addition, we showed that the largest fruits were produced by the least productive cultivars, which can be explained by the relationship between source and drain, in which the greater availability of photoassimilates to the fruits can increase their size and reduce the total production (DORAIS et al., 2001).

Our results highlight the importance of choosing blueberry cultivars in an organic production system, which should be a strategic activity aimed at enhancing yield and fruit quality. The three cultivars studied have characteristics that allow improving the production system from their scaling. Thus, this study contributes to blueberry producers choosing cultivars aiming at their adaptability to the producing regions. This can positively impact the production of blueberries, improve the income of producers and meet the consumer market demand for quality fruits.

CONCLUSIONS

The three blueberry cultivars in organic cultivation system in the Brazilian subtropics differ in their productive potential and fruit quality.

'Florida' has the best fruit yield potential and 'Clímax' produces the sweetest and least acidic fruits, which gives the berries the best chemical quality.

Through multivariate analysis, we identified that the total production of fruits per plant and the cross-sectional diameter of fruits are the attributes that most contribute to genetic divergence.

'Florida' and 'Bluegem' have similar horticultural performance, regardless of the method used (UPGMA or Tocher optimization). We suggest the adoption of both methods in genetic divergence studies.

REFERENCES

ANTUNES, L.E.C.; GONÇALVES, E.D.; RISTOW, N.C.; CARPENEDO, S.; TREVISAN, R. **Comportamento de variedades de mirtileiro sob cultivo agroecológico.** Pelotas: Embrapa Clima Temperado, 2010. 8p.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. **Manual de métodos analíticos oficiais para fertilizantes minerais, orgânicos, organominerais e corretivos.** Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Defesa Agropecuária. Coordenação-Geral de Apoio Laboratorial; Murilo Carlos Muniz Veras (Org.) – Brasília: MAPA/SDA/CGAL, 2014. 220p.

CANTUARIAS-AVILÉS, T.; SILVA, S.R.; MEDINA, R.B.; MORAES, A.F.G.; ALBERTI, M.F. Cultivo do mirtilo: atualizações e desempenho inicial de variedades de baixa exigência em frio no estado de São Paulo. **Revista Brasileira de Fruticultura**, v.36, n.1, p.139-147, 2014.

CASSIDY, A.; BERTOIA, M.; CHIUVE, S.; FLINT, A.; FORMAN, J.; RIMM, E.B. Habitual intake of anthocyanins and flavanones and risk of cardiovascular disease in men. **The American Journal of Clinical Nutrition**, v.104, n.3, p.587-594, 2016.

CEREZO, A.B.; CATUNESCU, G.M.; GONZÁLEZ, M.M.P.; HORNEDO-ORTEGA, R.; POP, C.R.; RUSU, C.C.; CHIRILA, F.; ROTAR, A.M.; GARCIA-PARRILLA, M C.; TRONCOSO, A.M. Anthocyanins in blueberries grown in hot climate exert strong antioxidant activity and may be effective against urinary tract bacteria. **Antioxidants**, v.9, n.6, p.478, 2020.

CRUZ, C.D. Genes software - extended and integrated with the R, Matlab and Selegen. **Acta Scientiarum.** Agronomy, v.38, n.4, p.547-552, 2016.

DORAIS, M.; GOSSELIN, A.; PAPADOPOULOS, A.P. Greenhouse tomato fruit quality. **Horticultural Reviews**, v.26, n.1, p.239-306, 2001.

FERRAZ, A.P.C.R.; MALHEIROS, J.M.; CINTRA, R.M.G. A produção, o consumo e a composição química dos alimentos orgânicos. **Revista Simbio-Logias**, v.6, n.9, p.31-42, 2013.

FISCHER, D.L.O.; FACHINELLO, J.C.; PIANA, C.F.B.; BIANCHI, V.J.; MACHADO, N.P. Seleção de genótipos de mirtileiro obtidos a partir de polinização aberta. **Revista Brasileira de Fruticultura**, v.36, n.1, p.221-231, 2014.

GOZALEZ, D.L.P; OLIVEIRA, E.D.; SOUZA, G.B.; BONAVIDES, P.S.D.; SANTOS, N.O.M.; COIMBRA, C.N.; QUINONES, E.M.; ARES, N.C.; DINIZ, R.; MACCAGNAN, P. Benefícios do consumo de alimentos orgânicos - Revisão bibliográfica. **Revista Científica das Faculdades de Medicina, Enfermagem, Odontologia, Veterinária e Educação Física**, v.4, n.7, p.1-8, 2022.

GÜNDÜZ, K.; SERÇE, S.; HANCOCK, J. F. Variation among highbush and rabbiteye cultivars of blueberry for fruit quality and phytochemical characteristics. **Journal of Food Composition and Analysis**, v.38, n.1, p.69-79, 2015.

HERTER, F.G.; WREGE, M.S. Fatores climáticos. In: ANTUNES, L.E.C.; RASEIRA, M.C.B. (Eds.). **Cultivo do mirtilo (*Vaccinium* spp.)**. Pelotas: Embrapa Clima Temperado, 2006. 98p.

MATZENAUER, R.; BUENO, A.C.Â.; CARGNELUTTI FILHO, A.; DIDONÉ, I.A.; MALUF, J.R.T.; HOFMAN, G.; TRINDADE, J.; STOLZ, A.; SAWASATO, J.T.; VIANA, D. Horas de frio no Estado do Rio Grande do Sul. **Pesquisa Agropecuária Gaúcha**, v.11, n.2, p.71-76, 2005.

MEDINA, R.B.; TEZOTTO-ULIANA, J.V.; SANTORO, M.B.; SILVA, S.R. Postharvest quality of ‘Emerald’ blueberry cultivated in a subtropical region. **Pesquisa Agropecuária Brasileira**, v.57, n.1, e-02683, 2022.

NIENOW, A.A., FLOSS, L.G. Floração de pessegueiros e nectarineiras no Planalto Médio do Rio Grande do Sul, influenciada pelas condições meteorológicas. **Ciência Rural**, v.32, n.1, p.931- 936, 2002.

PEREIRA, I.S.; PICOLOTTO, L.; CORRÊA, A.P.A.; RASEIRA, M.C.B.; ANTUNES, L.E.C. **Informações técnicas de cultivares de mirtilo**. Pelotas: Embrapa Clima Temperado, 2013. 2p.

RAO, C.R. **Advanced statistical methods in biometric research**. New York: John Wiley & Sons, 1952. 390p.

RODRIGUES, E.; POERNER, N.; ROCKENBACH, L.I. GONZAGA, L.V.; MENDES, C.R.; FETT, R. Phenolic compounds and antioxidant activity of blueberry cultivars grown in Brazil. **Food Science and Technology**, v.31, n.4, p.911-917, 2011.

SANTOS, A.M.; RASEIRA, M.C.B. **A cultura do mirtilo**. Pelotas: Embrapa Clima Temperado, 2002. 23p.

SILVA, R.P.; DANTAS, G.G.; NAVES, R.V.; CUNHA, M.G. Comportamento fenológico de videira, cultivar Patrícia em diferentes épocas de poda de frutificação em Goiás. **Bragantia**, v.65, n.3, p.399-406, 2006.

SINGH, D. The relative importance of characters affecting genetic divergence. **Indian Society of Genetics and Plant Breeding**, v.41, n.1, p.237-245, 1981.

SOKAL, R.R.; ROHLF, F.J. The comparison of dendrograms by objective methods. **Taxon**, v.11, p.33-40, 1962.

ZENEBON, O.; PASCUET, N.S.; TIGLEA, P. **Métodos físico-químicos para análise de alimentos**. São Paulo: Instituto Adolfo Lutz, 2008. 1020p.