Ciência Agrícola, Rio Largo, v. 19, n. 3, p. 211-218, 2021

AGRONOMIC PERFORMANCE OF STRAWBERRY GENOTYPES CULTIVATED IN 'PLANALTO NORTE CATARINENSE'

Douglas André Wurz[1*], Antônio Felippe Fagherazzi[2], Leo Rufato[2]

[1]Instituto Federal de Santa Catarina, Campus Canoinhas, Avenida Expedicionários 2150, Canoinhas/SC, Brasil.
[2]Universidade do Estado de Santa Catarina, CAV/UDESC, Avenida Luiz de Camões, Lages/SC, Brasil.
***Corresponding author:** Email: douglas.wurz@ifsc.edu.br

ABSTRACT: The objective of this work is to evaluate advanced strawberry cultivars and selections in relation to productive performance and fruit quality in the edaphoclimatic conditions of `Planalto Norte Catarinense`, seeking to identify more adapted cultivars that can reach their maximum productive and qualitative potential in this region. The experiment was conducted at the Federal Institute of Santa Catarina (IFSC), located in the municipality of Canoinhas, state of Santa Catarina. The experiment was carried out in the 2018/2019 harvest. The experimental design was in randomized blocks, with four replicates and plots of fifteen plants. Treatments consisted of 7 strawberry genotypes: two North American cultivars (Albion and San Andreas); two Italian cultivars (Pircinque and Jonica) and three advanced Italian selections developed at CREA-FRF (Italy) (FRF LAM 269.18, FRF PA 109.2 and FRF 104.1). Pircinque, Jonica, FRF LAM 269.18, and FRF 104.1 genotypes presented the highest yield. Due to the productive potential of these genotypes, they can be considered more adapted to cultivation in the `Planalto Norte Catarinense` region compared to the other genotypes. Pircinque genotype has the best fruit qualitative potential, with higher soluble solids, pH, RATIO and pulp firmness values, and lower total acidity value, compared to the other genotypes. Due to the productive and qualitative characteristics of fruits, the cultivation of the Pircinque genotype is recommended in the `Planalto Norte Santa Catarina` region.

KEY WORDS: *Fragaria vs. ananassa* Duch, Pircinque, yield, fruit quality

DESEMPENHO AGRONÔMICO DE GENÓTIPOS DE MORANGUEIRO CULTIVADOS NO PLANALTO NORTE CATARINENSE

RESUMO: Tem-se como objetivo deste trabalho avaliar cultivares e seleções avançadas de morango, em relação ao desempenho produtivo e à qualidade dos frutos nas condições edafoclimáticas do Planalto Norte Catarinense, buscando identificar cultivares mais adaptadas, que possam expressar seu máximo potencial produtivo e qualitativo nessa região. O experimento foi conduzido no Instituto Federal de Santa Catarina (IFSC), localizado no município de Canoinhas, em Santa Catarina. O experimento foi realizado na safra 2018/2019. O delineamento experimental foi em blocos casualizados, com quatro repetições e parcelas de quinze plantas. Os tratamentos consistiram em 7 genótipos de morango, sendo: duas cultivares norte-americanas (Albion e San Andreas); duas cultivares italianas (Pircinque e Jonica) e três seleções avançadas italianas, desenvolvidas no CREA-FRF (Itália) (FRF LAM 269.18, FRF PA 109.2 e FRF 104.1). Os genótipos Pircinque, Jonica, FRF LAM 269.18 e FRF 104.1 apresentaram as maiores produtividades. Devido ao potencial produtivo destes genótipos, podem ser considerados mais adaptados ao cultivo na região do Planalto Norte Catarinense em comparação aos demais genótipos. O genótipo Pircinque apresentou o melhor potencial qualitativo de frutos, com valores superiores de sólidos solúveis, pH, RATIO e firmeza de polpa, e menor valor de acidez total, em comparação aos demais genótipos. Devido as características produtivas e qualitativas de frutos, recomenda-se a cultivar Pircinque na região do Planalto Norte Catarinense.

PALAVRAS CHAVE: *Fragaria vs. ananassa* Duch, Pircinque, produtividade, qualidade de frutos.

INTRODUCTION

Strawberry (*Fragaria x ananassa* Duch) is the world's most important socioeconomic species in the small fruit group, with 395,844 hectares harvested in 2017, followed by raspberries (118,219 ha) and blueberries (109,541 ha) (Fao, 2019). In Brazil, production is carried out in several states, especially Minas Gerais, Paraná, Rio Grande do

Sul, São Paulo, Espírito Santo and Santa Catarina (Fagherazzi et al., 2017a).

One of the determining factors of success in strawberry production is the choice of the cultivar most adapted to the place of cultivation, considering that interactions between genotypes and the environment may occur (Costa et al., 2016). The adaptability of a strawberry cultivar is defined by the following factors: temperature, photoperiod and the interaction between them, and in this way, they control the beginning and end of the productive phase from flowering to fruiting, varying in each cultivar (Honjo et al. al., 2016). The selection of cultivars also interferes in all aspects of the production chain, such as planting time, fertilizer use, planting spacing, harvest point and aspects related to the post-harvest period (Fagherazzi et al., 2017b).

The evaluation of cultivars to be planted in a given region is an important tool for producers to make their decisions regarding the replacement of old materials with better adapted cultivars (Guimarães et al., 2015), as well as for the indication of new genotypes by breeding programs (Cocco et al., 2020).

Strawberry has been cultivated in the `Planalto Norte Catarinense` region, as a way of diversifying production in small rural properties, aiming to increase income (Wurz et al., 2020). However, it was observed in a study carried out by Wurz et al. (2019a) that many strawberry growers were unaware of which cultivars they have been growing on their properties, and among cultivars, there was predominance of 'San Andreas' and 'Aromas'. These strawberry cultivars originate from breeding programs developed at the Universities of California and Florida, USA (Zanin et al., 2020), with imports being made by companies that buy seedlings from Chilean and Argentinean nurseries (Antunes and Peres, 2013).

The availability of few cultivars offered to Brazilian producers results in a series of problems, from adverse weather conditions that can damage the entire crop synchronized in a single phenological stage and even in periods of greater production, causing the producer to market the entire production at lower prices (Fagherazzi et al., 2017b). In this context, the State University of Santa Catarina (UDESC), in partnership with the *Consiglio per la Ricerca in Agricoltura and L 'Analisi dell' Economia Agraria - Unità di Ricerca per la Frutticoltura* (CREA-FRF-Italy), established an agreement for the introduction and evaluation of Italian genotypes in the Brazilian territory, with the main objective of increasing the number of cultivars available to producers, contributing to the entire production chain (Zanin et al., 2019).

It is noteworthy that when introducing new cultivars, it is necessary to carry out adaptability studies and to determine if these cultivars will express the desired productive potential in different cultivation places (Costa et al., 2015), and thus knowing the different agronomic performances of genotypes available to producers is essential for defining cultivar recommendation strategies (Costa et al., 2019).

The objective of this work is to evaluate advanced strawberry cultivars and selections in relation to productive performance and fruit quality in the edaphoclimatic conditions of `Planalto Norte Catarinense`, seeking to identify the most adapted cultivars, which can express their maximum productive and qualitative potential in this region.

MATERIAL AND METHODS

The experiment was conducted at the Federal Institute of Santa Catarina (IFSC), located in the municipality of Canoinhas, state of Santa Catarina. The experimental area is located under coordinates 26º10'38" in south latitude and 50º23'24" in west longitude, at altitude of 765 m a.s.l. The region is characterized by having average annual temperature between 17 and 18°C and precipitation from 1,500 to 1,700 mm on average, flat to wavy relief and medium fertility soils (Wrege et al., 2012). The climate of the region is humid with mild summers, Cfb type, average temperatures in the coldest month are below 18°C and above -3°C, with cool summers, average temperature in the hottest month below 22°C, with no drought season defined according to the Köppen classification (Wrege et al., 2012). Frosts occur during the winter season, in the summer with oscillation around 22ºC; however, temperatures above 30ºC are common. As for the rainfall characteristics, some seasonal differences are observed. The months from December to March are characterized by more frequent and more intense rains, and the months from May to September are characterized by lower rainfall intensity and frequency (Gonçalves, 2017).

The predominant soils on the undulating and heavily undulating reliefs of the `Planalto Norte Catarinense` are aluminic and humic cambisols, aluminic and haplic cambisols and humic and litholic neosols. Humic red latosols also occupy significant areas in this region, usually occurring in areas of gently undulating relief at watersheds (Tomporoski and Marchesan, 2016; Almeida et al., 2018).

The experiment was carried out in the 2018/2019 harvest. The experimental design was in randomized blocks, with four replicates and plots of fifteen plants. Treatments consisted of 7 strawberry genotypes, as follows: two North American cultivars (Albion and San Andreas); two Italian cultivars (Pircinque and Jonica) and three advanced Italian selections developed at CREA-FRF (Italy) (FRF LAM 269.18, FRF PA 109.2 and FRF 104.1).

The experiment was installed on May 2, 2018. The cultivation system was a high tunnel, using beds prepared with an implement coupled to a tractor, and covered with black polyethylene film. The planting spacing used was 30 cm, between rows and plants, with three rows of plants per bed. The irrigation system used was drip irrigation, with three drip hoses per bed, provided with drippers spaced 15 cm. Liming and fertilization of the experimental area were carried out three weeks before planting, based on recommendations of the Fertilization and Liming Manual for the states of Rio Grande do Sul and Santa Catarina (SBCS, 2004). Weed control was carried out by means of manual removal, carried out every fifteen days.

Harvests began in August 2018 and lasted until February 2019, with intervals of five days. Fruits were harvested in the coolest hours of the day, when at least 75% of the epidermis was red. After each harvest, fruits were taken to the Laboratory of Physicochemical Analysis of the Federal Institute of Santa Catarina, where they were counted. In this procedure, fruits were classified according to the following criteria: a) commercial – fruits with 10g or more and free of rot or deformity; (b) small: fruit less than 10 g; c) deformed - quantified by the percentage of deformed fruits in relation to total production (% deformed fruits).

At the end of the harvest period, the following productive variables were evaluated: a) number of fruits per plant, total and commercial fruits (fruits plant^{-1}); b) total production (g plant^{-1}); c) total yield (t ha^{-1}) - estimated by multiplying the yield per plant by the planting density; d) fresh mass of commercial fruits (g fruit^{-1}) - calculated by dividing the commercial yield (g plant^{-1}) by the number of commercial fruits (fruits plant^{-1}) and; e) fruit diameter and length (cm fruit^{-1}), measured with the aid of a digital caliper.

Fruit quality was evaluated by six batteries of physicochemical analyses, carried out on October 15, 2018 and November 15, 2019. Analyses were performed at the Laboratory of Physicochemical Analysis of IFSC – Campus of Canoinhas. Laboratory analyzes were: a) pulp firmness - obtained with the aid of a benchtop digital penetrometer, equipped with pressure head with 3.5 mm in diameter, evaluating fifteen fruits per plot, taking two readings on the opposite sides in the equatorial zone of fruits. Values were obtained by the average of all readings performed for each replicate. Results are given in Newtons (N); b) titratable acidity - performed by titrating 5 ml of the juice extracted from all fruits in each plot, using 0.1 N sodium hydroxide (NaOH) solution and phenolphthalein as acid-base indicator at sample color change point. Results were expressed in grams per 100 grams of citric acid (g 100 g^{-1} of citric acid); c) soluble solids content - performed by placing a small sample of juice in the prism of a digital refractometer. Results were expressed in degrees Brix (°Brix); d) soluble solids/titratable acidity ratio (RATIO) - calculated by dividing the results obtained for soluble solids content by the titratable acidity of each sample.

Analyses of variance were performed following recommendations of FERREIRA (2018), with the Scott-Knott test being applied at 5% probability in the comparison of means of strawberry genotypes, using the SISVAR computer application (FERREIRA, 2011).

RESULTS AND DISCUSSION

The values observed in relation to productive variables of different strawberry genotypes are described in Table 1. The coefficients of variation, for the most part, presented values between 10% and 15%, indicating good experimental precision, according to criterion proposed by Ferreira (2018). For variable number of fruits, it was observed that Pircinque, Jonica, FRF LAM 269.18, FRF 104.1 genotypes presented values higher than 33 units.

plant^{-1}, not differing statistically from each other. The lowest values for variable number of fruits were observed for FRF PA 109.2, Albion and San Andres genotypes, which did not differ statistically from each other and presented mean values of 23.9 units. plant^{-1}. Regarding variable fresh fruit mass, it was observed that FRF PA 109.2, Pircinque and Jonica genotypes resulted in fruits with greater weight (g fruit^{-1}), with values of 17.4, 16.4 and 16.4 g fruit^{-1}, respectively, while the other genotypes presented values ranging from 14.2 to 15.8 g fruit^{-1}. Variable number of fruits has a relationship of genotype-environment interaction, where factors temperature and photoperiod determine variables associated with yield (Oliveira and Bonow, 2012), which may indicate greater adaptation of genotypes in a given place of cultivation, as observed with Pircinque, Jonica, FRF LAM 269.18, FRF 104.1 genotypes.

Table 1. Yield variables of different strawberry genotypes cultivated in the 'Planalto Norte Catarinense' region. Canoinhas, Santa Catarina, 2018/2019 harvest.

Genotype	Total Production Variables			
	Number of fruits	Production	Yield	Fresh mass
	un plant^{-1}	g plant^{-1}	t ha^{-1}	g fruit^{-1}
Pircinque	35.5 a	526 a	33.7 a	16.4 a
Jonica	39.7 a	567 a	34.0 a	16.4 a
FRF LAM 269.18	39.4 a	605 a	36.3 a	15.4 b
FRF PA 109.2	26.4 b	457 b	27.4 b	17.4 a
FRF 104.1	33.7 a	515 a	30.9 a	15.3 b
Albion	25.7 b	352 b	21.1 b	15.8 b
San Andreas	19.7 b	422 b	25.3 b	14.2 b
Average	31.4	492	29.8	16.0
CV (%)	12.1	12.1	12.2	5.1

*Means followed by the same letter in the column do not differ from each other by the Scott Knott test at 5% error probability.

According to Otto et al. (2009), the average fresh mass of 12.2 grams per fruit verified in their work is considered to be of excellent commercial quality, and this average weight is exceeded by all genotypes evaluated in the present work; however, according to Carvalho et al. al. (2013), larger fruits are more valued, attracting the attention of consumers.

Variables production (g plant^{-1}) and yield (t ha^{-1}) present behavior similar to variable number of fruits (un plant^{-1}). The highest production values were observed for FRF LAM 269.18, Jonica, Pircinque and FRF 104.1 genotypes, with production of 605, 567, 526 and 515 g fruit^{-1}, respectively, and yield of 36.3, 34.0, 33.7 and 30.9 t ha^{-1}, respectively. According to Fagherazzi et al. (2017a), the average Brazilian strawberry yield is 36 t ha^{-1}. FRF PA 109.2, San Andreas and Albion genotypes showed the lowest productive values, with average production of 457, 422 and 352 g plant^{-1}, respectively, and average yield of 27.4, 25.3 and 21.1 t ha^{-1}. According to Shaw and Larson (2008), the Albion cultivar presents as characteristic lower intensity for the emission of new flowers, corroborating data observed in the present study, being the cultivar that presented the lowest production and yield values. According to Zanin et al. (2019), the low yield of some cultivars and selections may be related to the non-adaptation of these genotypes to the study site.

The analysis of variance of the classification of strawberry fruits are shown in Table 2. Coefficients of variation, for the most part, presented values below 5%, indicating excellent experimental precision, according to criterion proposed by Ferreira (2018). Fruits from FRF PA 109.2, Albion and Pircinque genotypes presented the highest fruit diameter and length values, while Jonica, FRF LAM 269.18, FRF 104.1 and San Andreas genotypes presented the lowest fruit diameter and length values. Fruit size stability is a desired characteristic when selecting a new genotype for commercial cultivation, as larger fruits result in shorter harvesting time, resulting in lower labor costs and ensuring greater profitability for the producer (Fagherazzi et al., 2014).

Table 2. Classification of fruits of different strawberry genotypes cultivated in the 'Planalto Norte Catarinense' region. Canoinhas, Santa Catarina, 2018/2019 harvest.

Genotype	Fruit classification				
	Fruit Diameter	Fruit Length	Commercial	Deformed	Small
	mm	mm	%	%	%
Pircinque	30.6 a	46.3 a	82.5 a	1.2 a	2.0 a
Jonica	29.1 b	37.9 b	84.9 a	1.1 a	1.6 a
FRF LAM 269.18	28.8 b	41.2 b	81.9 a	1.3 a	1.8 a
FRF PA 109.2	31.7 a	45.4 a	82.0 a	1.8 a	1.9 a
FRF 104.1	29.5 b	39.7 b	83.4 a	2.0 a	2.2 a
Albion	31.4 a	44.2 a	83.4 a	2.3 a	1.6 a
San Andreas	29.2 b	41.2 b	83.8 a	2.3 a	2.1 a
Average	30.0	42.3	83.1	1.7	1.9
CV (%)	4.1	4.2	1.6	13.7	28.8

*Means followed by the same letter, in the column, do not differ from each other by the Scott Knott test at 5% error probability.

The classification of fruits, in the categories % commercial fruits, % deformed fruits and % small fruits do not present statistically significant differences among the seven genotypes evaluated, observing average values of 83.1% of commercial fruits, 1.7% of deformed fruits and 1.9% of small fruits. Data observed in the present study are superior to those observed by Zanin et al. (2020), and similar to those observed by Zanin et al. (2019). These results are very important when choosing a cultivar, because according to Wurz et al. (2019b), the cultivar may even be productive; however, if fruits do not have the potential for fresh fruit marketing, it may result in low added value.

The results of the analysis of variance of the qualitative variables of strawberry fruits are shown in Table 3. Coefficients of variation, for the most part, presented values below 10%, indicating excellent experimental precision, according to criterion proposed by Ferreira (2018). Regarding variable soluble solids, it was observed that the Pircinque genotype had the highest value, with 8.1 °Brix, statistically differing from the other genotypes evaluated. San Andreas, FRF PA 109.2 and FRF 104.1 genotypes presented the lowest soluble solids content, 6.9, 6.4 and 6.3 °Brix, respectively. According to Cocco et al. (2015) and Pinelli et al. (2011), the soluble solids content is a genetically determined character and is influenced by climatic conditions. In strawberries, variation in soluble solids contents is expected from 4.0 to 11.0 ºBrix (Chitarra and Chitarra, 2005); therefore, all genotypes evaluated in the present study presented values considered adequate.

Table 3. Qualitative variables of different strawberry genotypes cultivated in the 'Planalto Norte Catarinense' region. Canoinhas, Santa Catarina, 2018/2019 harvest.

Genotype	Qualitative variables				
	SS	TA	pH	RATIO	FIR
	°Brix	% citric acid	-	SS/AT	kgf
Pircinque	8.1 a	0.57 c	3.49 a	14.0 a	3.9 a
Jonica	7.5 b	0.62 b	3.21 b	10.2 b	3.0 b
FRF LAM 269.18	7.4 b	0.67 a	3.25 b	11.0 b	3.4 b
FRF PA 109.2	6.4 c	0.67 a	3.28 b	9.5 b	3.4 b
FRF 104.1	6.3 c	0.66 a	3.41 a	9.5 b	3.1 b
Albion	7.4 b	0.68 a	3.28 b	10.8 b	3.0 b
San Andreas	6.9 c	0.67 a	3.23 b	10.4 b	3.2 b
Average	7.1	0.65	3.30	11.00	3.3
CV (%)	8.2	4.8	2.7	10.8	9.5

*Means followed by the same letter, in the column, do not differ from each other by the Scott Knott test at 5% error probability.

The high SS levels observed in the Pircinque genotype are confirmed by the study carried out by Fagherazzi et al. (2017c) and Zanin et al. (2020), under the conditions of the `Planalto Norte Catarinense`. The high soluble solids content is a striking genetic characteristic of the Pircinque genotype, and fruits are classified as super sweet (Faedi et al., 2014; Baruzzi et al., 2017).

For variable total acidity (% citric acid), FRF LAM 268.18, FRF PA 109.2, FRF 104.1, Albion and San Andreas strawberry genotypes presented the highest values, 0.67, 0.67, 0.66, 0.68 and 0.67% citric acid, respectively. The Jonica genotype presented acidity value corresponding to 0.62% citric acid, while the Pircinque genotype presented the lowest total acidity value, among the seven strawberry genotypes evaluated, with value of 0.57% citric acid. Titratable acidity is an important chemical attribute for genotypes intended for fresh consumption, since consumers prefer fruits with maximum acidity of 0.8%, and the pulp acidity cannot be too high as it can compromise the acceptance of fruits by consumers (Resende et al., 2008; Chitarra and Chitarra, 2005). It is noteworthy that all genotypes evaluated in the present study presented values below 0.8%.

It was observed for Pircinque and FRF 104.1 genotypes, higher pH values in relation to the other genotypes, with 3.49 and 3.41, respectively. Jonica, FRF LAM 269.18, FRF PA 109.2, Albin and San Andreas genotypes did not differ statistically from each other for variable pH, with values of 3.21, 3.25, 3.28, 3.28 and 3.23, respectively. In general, the pH values observed in the present study are lower than those observed by Costa et al. (2019).

Variable RATIO, characterized by the relationship between soluble solids and total acidity, showed difference among strawberry genotypes under study. The highest RATIO value was observed for Pircinque genotype, with value of 14.0, while the other genotypes presented values without statistically significant differences, ranging from 9.5 to 11.0. The Pircinque genotype stands out for its high RATIO value, which has already been reported by Fagherazzi et al. (2017c).

According to Cantillano and Silva (2010), the SS/TA ratio can vary between 6 and 20, with consumers preferring the range from 15 to 18. According to Brackmann et al. 2011), higher RATIO values favor a better balance between sweetness and acidity, providing a more pleasant flavor to fruits, making them more attractive. Of strawberry genotypes evaluated in this work, only the Pircinque cultivar had RATIO value close to this range.

In relation to variable pulp firmness (FIR), the highest value was observed for the Pircinque cultivar, presenting value of 3.9 kgf, statistically differing from the other genotypes, which presented values from 3.0 to 3.4 kgf, which differed statistically from each other. Pulp firmness can be considered one of the most important qualitative parameters for strawberries, as it is related to the post-harvest fruit conservation capacity, greater post-harvest durability and rotting resistance (Brackmann et al., 2011; Oliveira and Bonow, 2012). In this sense, higher pulp firmness values indicate greater capacity for fruit conservation, which was observed for the Pircinque cultivar. The possibility of storing the product for a long time and marketing it in more distant locations is a great advantage for producers, especially in the case of highly perishable fruits such as strawberries (Brackmann et al., 2011).

Pircinque, Jonica, FRF LAM 269.18, and FRF 104.1 genotypes showed the highest yields. Due to the productive potential of these genotypes, they can be considered more adapted to cultivation in the `Planalto Norte Catarinense` region, compared to the other genotypes.

The Pircinque genotype showed the best qualitative fruit potential, with higher soluble solids, pH, RATIO and pulp firmness values, and lower total acidity value, compared to the other genotypes. Due to the productive and qualitative characteristics of fruits, the Pircinque strawberry cultivar had, in the 2018/2019 harvest, the best performance in the `Planalto Norte Catarinense` region.

REFERENCES

Almeida, J.A; Ribeiro, C.F; Oliveira, M.V.R. de; Sequinatto, L. Mineralogia da argila e propriedades químicas de solos do Planalto Norte Catarinense. Revista de Ciências Agroveterinárias: Universidade do Estado de Santa Catarina, Lages, SC, p. 267-277, **2018**.
Antunes, L.E.C.; Peres, N.A. Strawberry Production in Brazil and South America. *International Journal of Fruit Science*, **2013**, 13, 156-161.

Baruzzi, G.; Ballini, L.; Birolli, M.; Capriolo, G.; Carullo, A.; Anna, F.D.; Funaro, M.; Lucchi, P.; Magnani, S.; Maltoni, S.; Sbrighti, P.; Turci, P.; Faedi, W. Updates on Italian strawberry breeding programs coordinated by CREA-FRF. *Acta Horticulturae*, **2017**, 1156, 179-184, 2017.

Brackmann, A.; Pavanello, E.P.; Both, V.; Janisch, D.I.; Schmitt, O.J.; Giménez, G. Avaliação de genótipos de morangueiro quanto à qualidade e potencial de armazenamento. *Revista Ceres*, **2011**, 58, 542-547.

Cantillano, R.F.F.; Silva, M.M. Manuseio pós-colheita de morangos. Pelotas: Embrapa Clima Temperado, **2010**. 37p. (Embrapa Clima Temperado. Documentos, 318).

Carvalho, S.F.; Ferreira, L.V.; Picolotto, L.; Antunes, L.E.C.; Cantillano, R.F.; Amaral, P.A.; Weber, D.; Malgarim, M.B. Comportamento e qualidade de cultivares de morango (Fragaria x ananassa Duch.) na região de Pelotas-RS. *Revista Iberoamericana de Tecnología Postcosecha*, **2013**, 14, 176-180.

Chitarra, M.I.F.; Chitarra, A.B. Pós-colheita de frutas e hortaliças: fisiologia e manuseio. 2ed. Lavras: UFLA, **2005**. 785p.

Cocco, C.; Magnani, S.; Maltoni, M.L.; Quacquarelli, I.; Cacchi, M.; Antunes, L.E.C.; D'antuonni, L.F.; Faedi, W.; Baruzzi, G. Effects of site and genotype on strawberry fruits quality traits and bioactive compounds. *Journal of Berry Research*, **2015**, 5, 145-155.

Cocco, C.; Schildt, G.W.; Giacomel, F.; Fagherazzi, A.F.; Zanin, D.S.; Kretzschmar, A.A. Desempenho produtivo de genótipos de morangueiro de dia neutro na Serra Gaúcha. *Revista Eletrônica Científica*, **2020**, 6, 155-163.

Costa, A.F.; Leal, N.R.; Ventura, J.A.; Gonçalves, L.S.A.; Amaral Júnior, A.T.D.; Costa H. Adaptability and stability of strawberry cultivars using a mixed model. *Acta Scientiarum. Agronomy*, **2015**, 37, 435-440.

Costa, A.F.; Teodoro, P.E.; Bhering, L.L.; Leal, N.R.; Tardin, F.D.; Daher, R.F. Biplot analysis of strawberry genotypes recommended for the State of Espírito Santo. *Genetics and Molecular Research*, **2016**, 15, 01-09.

Costa, S. I.; Ferreira, L.V.; Benati, J.A.; Cantillano, R.F.; Antunes, L.E.C. Parâmetros qualitativos de morangueiros de dias neutros produzidos em cultivo sem solo. *Revista Engenharia na Agricultura* – REVENG, **2019**, 27, 481-489.

Faedi, W.; Baruzzi, G.; Lucchi, P.; Magnani, S.; Carullo, A.; Maltoni, M.L.; Migani, M.; Sbrighi, P. The new 'Pircinque' strawberry cultivar released under Italy's PIR Project. *Acta Horticulturae*, **2014**, 1049, 961-966.

Fagherazzi, A. F. Adaptabilidade de novas cultivares e seleções de morangueiro para o Planalto Sul Catarinense. 2017. Tese em Produção Vegetal (Doutorado) - Curso de Doutorado, Universidade do Estado de Santa Catarina, Lages, **2017b**. 147 p.

Fagherazzi, A. F.; Cocco, C.; Antunes, L.E.C.; Sauza, J.A. La fragolicoltura brasiliana guarda avanti. *Frutticultura*, **2014**, 6, 20-24.

FagherazzI, A.F.; BortolinI, A.J.; Zanin, D.S.; Bisol, L.; Santos, A.M.; GrimaldI, F.; Kretzschmar, A.A.; Baruzzi, G.; Faedi, W.; Lucchi, P.; Rufato, L. New strawberry cultivars and breeding acitivities in Brazil. *Acta Horticulturae*, **2017c**, 1156, 167- 170.

Fagherazzi, A.F.; Grimaldi, F.; Kretzschmar, A.A.; Molina, A.R.; Gonçalves, M.J.; Antunes, L.E.C.; Baruzzi, G.; Rufato, L. Strawberry production progress in Brazil. *Acta Horticulturae,* **2017a**, 1156, 937-940.

Faostat. Food and Agriculture Organisation Statistics Database **2019**. Produção mundial de pequenas frutas. Disponível em http://www.fao.org/faostat/en/#compare. Acesso em: 08 jan. 2021.

Ferreira P.V. Estatística experimental aplicada às ciências agrárias. Viçosa: Ed. UFV, **2018**. 588 p.

Ferreira, D. F. Sisvar: um sistema computacional de análise estatística. ***Ciência e Agrotecnologia*** [online]. **2011**, 35, 1039-1042.

Gonçalves, F. N. Índices de precipitação para o estado de Santa Catarina. Dissertação (Mestrado), Criciúma, **2017**.

Guimarães, A. G.; Andrade Junior, V.C.; Elsayed, A.Y.A.; Fernandes, J.S.C.; Ferreira, M.A.M. Potencial produtivo de cultivares de morangueiro. *Revista Brasileira de Fruticultura*, **2015**, 37, 112-120.

Honjo, M.; Nunome, T.; Kataoka, S.; Yano, T.; Hamano, M.; Yamazaki, H.; Yamamoto, T.; Morishita, M.; YUI, S. Simple sequence repeat markers linked to the everbearing flowering gene in long-day and dayneutral cultivars of the octoploid cultivated strawberry *Fragaria* × *ananassa. Euphytica*, **2016**, 209, 291-303.

Oliveira, A.B.C.; Bonow, S. Novos desafios para o melhoramento genético da cultura do morangueiro no Brasil. *Informe Agropecuário*, **2012**, 33, 21-26.

Otto, R.F.; Moramaki, R.K.; Reghin, M.Y.; Caíres, E.F. Cultivares de morango de dia neutro: produção em função de doses de nitrogênio durante o verão. *Horticultura Brasileira*, **2009**, 27, 217-221.

Pinelli, L.D.; Moretti, C.L.; Santos, M.S.; Campos, A.B.; Brasileiro, A.V.; Cordova, A.C.; Chiarello, M.D. Antioxidants and other chemical and physical characteristics of two strawberry cultivars at different ripeness stages. *Journal of Food composition and Analysis,* **2011**, 24, 11-16.

Resende, J.T.V.; Camargo, L.K.P.; Argandoña, E.J.S.; Marchese, A.; Camargo, C.K. Sensory analysis and chemical characterization of strawberry fruits. *Horticultura Brasileira*, **2008**, 26, 371-374.

Shaw, D.V.; Larson, K.D. Strawberry plant named 'Albion'. **2008**. Disponível em: https://patentimages.storage.googleapis.com/61/ce/e7/aca66ac422372b/USPP16228.pdf. Acesso em: 15 dez. 2020.

Sociedade Brasileira de Ciência do Solo Manual de adubação e calagem para os estados de Rio Grande do Sul e Santa Catarina. 10ª ed. Porto Alegre, Núcleo Regional Sul: Comissão de Química e Fertilidade do Solo – RS/SC, **2004**, 400 p.

Tomporoski, A.A.; Marchesan, J. Planalto Norte Catarinense: algumas considerações sobre aspectos históricos, características físico-naturais e extrativismo. DRd – *Desenvolvimento Regional em debate*, **2016**, 6, 2, 51-63.

Wrege, M.S.; Steinmetz, S.; Reisser Júnior, C.; Almeida, I.R. Atlas climático da Região Sul do Brasil: estados do Paraná, Santa Catarina e Rio Grande do Sul. 2ª ed. Brasília, Embrapa, **2012**, 334p.

Wurz, D.A.; Dubiela, C.; Nunes, H.F. Caracterização de propriedades de rurais e sistemas produtivos com morango em Canoinhas – SC. *Revista Científica Rural*, **2020**, 22, 82-99.

Wurz, D.A.; Dubiela, C.; Nunes, H.F. Perfil socioeconômico de produtores de morango no município de Canoinhas – Santa Catarina. *Revista Científica Rural*, **2019a**, 21, 13-27.

Wurz, D.A.; Piechontcoski, C.B.; Fagherazzi, A.F.; Rufato, L.; Ribeiro, J.A. Desempenho agronômico de novos genótipos de morangueiro com potencial de cultivo no Planalto Norte Catarinense. In 10º Seminário Brasileiro sobre Pequenas Frutas. Anais...Vacaria, **2019b**, p. 1-5.

Zanin, C.S.; Fagherazzi, A.F.; Santos, A.M.; Martins, R.; Kretzschmar, A.A.; Rufato, L. Agronomic performance of cultivars and advanced selections of strawberry in the South Plateau of Santa Catarina State. *Revista Ceres*, **2019**, 66, 159-167.

Zanin, D.S.; Lima, J.M.; Santos, M.F.S.; Tillwitz, K.; Fagherazzi, A.F.; Richter, A.F.; Kretzschmar, A.A.; Rufato, L. Productive and qualitative characteristics of strawberry genotypes in the Plateau of the State of Santa Catarina, Brazil. *Revista de Ciências Agroveterinárias*, **2020**, 19, 178-187.