

Original Research Article

PERFORMANCE OF STRAWBERRY VARIETIES UNDER GREENHOUSE IN FOLLOWING THREE CULTIVATION CROPPING SYSTEMSPRACTICES IN GREENHOUSE

ABSTRACT

Strawberry is a crop of high added value, which ~~has necessitated the expansion of its cultivation area to new regions, was extended to new producing zones~~ such as the State of Mato Grosso ~~in Brazil~~. Therefore the need to test the adaptability of varieties to soil and climatic conditions arises. ~~us, it is necessary to test the adaptability of varieties to the edaphoclimatic conditions of the region and the technologies of cultivation.~~ The study objective ~~of this study~~ was to evaluate ~~the development, production and quality of strawberry agro-morphological traits, fruit yield and quality of strawberry to be cultivated under greenhouse conditions following three different cropping practices. fruits of three cultivated varieties in three protected environment systems.~~ The Experiment design was a split-plot in four replications with three cropping practices as main plots and three strawberry varieties as subplots. ~~was carried out at the Federal University of Mato Grosso, in the University Campus of Rondonópolis, in a greenhouse. A randomized blocks design was employed, with subdivided plots, using three cultivation systems in the main plot (Plastic Vase, Slab and Ceramic Block) and the subplots with three strawberry cultivars (San Andreas, Albion and Oso Grande), with four replications, totaling 36 subplots. Water application was made following a drip irrigation system. The drip irrigation system was used, with self-compensating drippers. The number of leaves and flowers, leaf area, number of commercial fruits, diameter of commercial fruits, total fresh fruit mass, soluble solids content and total~~

titratable acidity were analyzed. It came out that cropping practices ~~The Vase, Slab and Ceramic Block cultivation systems~~ did not influence strawberry fruit yield and quality ~~the production and quality of strawberry fruits~~. However, The lower growth performance of strawberry was recorded on Ceramic Block compared to that of system ~~provided the lowest vegetative performance of the strawberry in relation to the Vase and Slab systems~~ cropping practices considering number of leaves and leaves area. Regardless of the system ~~cropping practice~~, ~~the~~ San Andreas and Albion varieties were ~~are~~ more productive with better quality fruit and adapted to local environment conditions ~~with respect to~~ than Oso Grande variety. ~~The San Andreas and Albion varieties are better adapted to local environmental conditions and produce more and better quality commercial fruits compared to Oso Grande.~~

Keywords: Fragaria ananassa; ceramic block; Slab; strawberry production; agromorphological trait, fruit yield, fruit quality, hydroponic condition, commercial substrate, drip irrigation.

1. INTRODUCTION

Strawberry (*Fragaria ananassa*) is a species of great economic importance and of high added value in the horticultural sector at both ~~the~~ national and international levels [1]. It is involved in the diversification of agricultural systems, since it is widely cultivated in almost all regions of the world, including Brazil, with greater adaptability in mild climate regions.

The flavor (aroma and taste) and the intense red coloration of the fruits are determinants of consumer acceptance. The fruits have aromatic compounds that act on the nerves of smell and taste, thereby increasing appetite. The fruit has health benefits, facilitates digestion and improves liver function by its high natural sugars content. Thus, it is essential to identify

Formatted: Font: Not Italic

Formatted: Font: Not Italic

varieties of strawberry ~~that best adapt to the region~~most adapted to local environmental conditions and produce better quality fruits.

South America produces 318,686 tons of strawberry ~~on-over~~ just-over 11,000 hectares.

Brazil, Argentina and Chile are the largest producers. In Brazil, the cultivated area is approximately 4,000 hectares, with an estimated annual production of 105,000 tons. The State of Minas Gerais is the largest national producer with approximately 40,000 tons per year, followed by São Paulo (29,000 tons per year). Rio Grande do Sul, Santa Catarina, Paraná, Espírito Santo and Rio de Janeiro, account for the remaining ~~der-of~~ Brazilian strawberry producing ~~ing zonestion~~ [2].

The average ~~yield of strawberry in productivity-of~~ Brazil is 30 Mg ha⁻¹ ~~which reaches , reaching-~~ up to 60 Mg ha⁻¹ in ~~areas of best farming practices, more technical areas.~~ São Paulo is ~~The high yielding~~ state with ~~higher average productivity is São Paulo-~~ with 34 Mg / ha⁻¹, followed by Rio Grande do Sul with 32 Mg ha⁻¹ and Minas Gerais with ~~an average productivity of~~ 25 Mg ha⁻¹ [2]

~~The area of S~~trawberry producing ~~ing zonestion~~ in Brazil ~~increase together with the use of best performing cultivars under tropical conditions grows every year, and with this arises the need to develop innovative technologies of production and choice of cultivars adapted to regions of typical tropical climate,~~ with dry winter, well defined rainy season and temperatures above 25°C ~~like the one prevailing in. Among these regions is the~~ southern region of Mato Grosso. ~~As such, the strawberry crop could become an income alternative for farmers at different scales.~~

~~In view of~~

~~The above, the~~ objective ~~of the study~~ was to evaluate the ~~development, production and quality of performance of three~~ strawberry ~~fruits of three-~~ varieties cultivated ~~under~~

~~greenhouse following three different cropping practices, in three protected environment systems.~~

2. MATERIALS AND METHODS

The experiment was conducted at the Federal University of Mato Grosso, University Campus of Rondonópolis, in a greenhouse located at latitude 16°27'50.8 "S and longitude 54°34'49.9" W at 230 meters altitude. ~~According to the climatic classification of Köppen, the climate of the region is classified as the~~ Aw type with dry winter. The greenhouse ~~used~~ has a metallic structure ~~with , covered with a covering~~ polyethylene _film and ~~was equipped~~ with an adiabatic cooling system. ~~The design was in randomized blocks, Experimental design was a in~~ split plot ~~in four replications with three cropping practices as main plots (Plastic Vessel, Slab and Ceramic Block) and three strawberry varieties as subplots (San Andreas, Albion and Oso Grande). , and the plots utilized three cropping systems (Plastic Vessel, Slab and Ceramic Block) and the subplots were composed of three strawberry cultivars (San Andreas, Albion and Oso Grande), with four replicates, totaling 36 subplots. As a useful area, the four central plants of each variety in each subplot were considered~~ Net cropped area per plot was composed of 4 central strawberry plants per variety (Fig. 1).

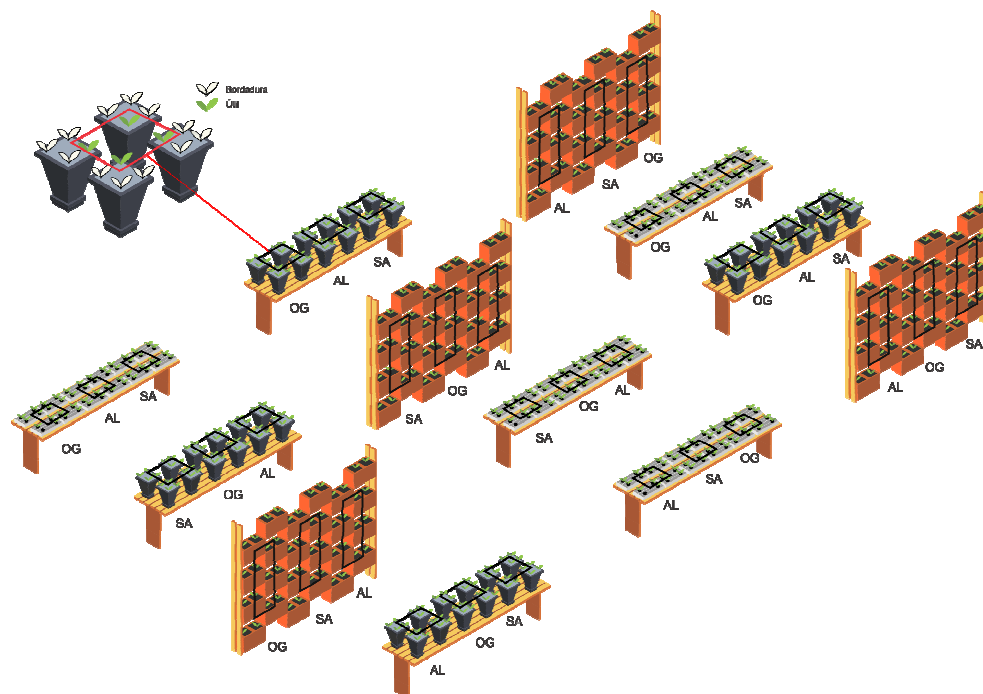


Fig. 1. View of the experimental design used.

For the plastic Vase system, wooden benches with dimensions of 2.40 m in length, 0.70 m in width and 0.85 m in height were installed. Twelve pots of 8 dm³ per plot were used, and 4 plants per pot were transplanted with a total of 48 plants.

In the Slab system, plastic bags measuring 0.40 m long, 0.35 m wide with a volume of 8 dm³, were placed on benches with the same design of the Vase system. At the top of each Slab, holes were drilled to transplant 4 plants, making 48 plants per plot.

On the other hand, for the constitution of the Ceramic Block system, hydraulic ceramic blocks were used in the civil construction area with dimensions of 0.19 m in height; 0.29 m long and 0.14 m wide. For the composition of the plots 24 blocks were used, alternately overlapped forming a wall of 1.52 m in height and 1.74 m in length, the ends being supported by screws fixed in wooden supports to provide support. The bottoms of the blocks were closed with

107 mortar and for each block, two containers were formed with a volume of 2 dm³, totaling 4
108 dm³ per block. One plant was transplanted for each volume totaling 48 plants per block.
109 In all systems, holes were drilled for the drainage of water from the semi-hydroponic
110 irrigation system.

111 For substrate formation, soil and commercial substrate were mixed. The soil used ~~is~~ classified
112 as Oxisol [3], was collected in a Cerrado area near the Campus of Rondonópolis of the
113 Federal University of Mato Grosso, in the 0.0 to 0.20 m deep layer. It was later sieved in a
114 mesh of 4-2 mm for chemical and granulometric analyses and for correction, so as to increase
115 the saturation of bases to 80% (Table 1).

116 **Table 1. Chemical and granulometric analyses of Oxisol.** Unclear Table
117

pH		P	K	Ca + Mg	Ca	Mg	Al	H	O.M.	Sand	Silt	Clay
H ₂ O	CaCl ₂	mg dm ⁻³		cmol _c dm ⁻³				g dm ⁻³		g kg ⁻¹		
4.8	4.0	1.4	23	0.6	0.4	0.2	0.8	5.4	10.7	423	133	444

118 O. M. - Organic Matter

119
120 The commercial substrate TECHNOMAX®, recommended for the production of strawberries
121 in semi-hydroponics, was used. It has in its composition organic materials, such as expanded
122 vermiculite, peel of Pinus and Eucalyptus, coconut fiber and recovered paper fiber. ~~The S~~soil
123 and ~~the~~ substrate were homogenized in a ratio of 1:1 and mixed in a concrete mixer. After
124 mixing, samples were collected for chemical analysis and subsequent fertilization
125 recommendation (Table 2).

126

127

128

Table 2. Chemical and granulometric analyses of the substrate mixed with soil.

Table

pH	P	K	Ca + Mg	Ca	Mg	Al	H	O.M.	Sand	Silt	Clay
H ₂ O	CaCl ₂	mg dm ⁻³		cmol _c dm ⁻³			g dm ⁻³		g kg ⁻¹		
6.1	5.2	35.4	189.6	5.39	3.9	1.49	0.0	6.53	52.6	456	134 410

O. M. - Organic Matter

The varieties used (San Andreas, Albion and Oso Grande) were recommended by ~~the researcher~~ Francisco Antônio Passos, a strawberry agonomist from of the Brazilian Agronomic Institute of Campinas (IAC), a specialist in strawberry cultivation in Brazil. The varieties have the following characteristics: San Andreas and Albion are of neutral days, developed by the University of California in 2008 and 2004, respectively. They have high content of soluble solids and total acidity, with large fruits, of good shape and good flavor [4].

The Oso Grande variety was also developed by the University of California in 1977. A rather short but vigorous vegetation variety, being short, with vigorous and high adaptation ability and, as well as high production capacity [5].

The seedlings were purchased from the nursery of Baptistella Brothers, Campinas - SP. For acclimatization of the strawberry seedlings before transplanting to the cropping systems, 200 seedlings of each variety were separated. Afterwards, 600 plastic bags were prepared with 0.2 kg of substrate, with one seed per bag hand-irrigated. On April 12, 2016 the seedlings were transplanted to the three cropping systems.

A light reflecting polypropylene screen with 50% shading was opened on the cropping systems. The opening and closing of the screen occurred between 9:00 a.m. to 4:00 p.m., where the highest temperature of the day is recorded.

Formatted: Left

Formatted: Underline

The irrigation system consisted of a 1 m³ carton, a single-phase centrifugal motor pump Model: ECSB-50M, Polyvinyl chloride tubes (PVC) measuring 32 mm in diameter for the main line and 16 mm polyethylene hoses as secondary lines for each experimental plot. Each line was elevated from the ground to the top of the benches, extending along it, where they were drilled for the installation of the Naan self-compensating drippers with average flow of 4 L h⁻¹. After the installation of the drippers, Naan brand cross connectors of 4 outlets of 5 x 4 mm and 4 micro-tubes of 5 mm were placed, which were fixed individually to the side of each plant with the aid of dripping piles (Fig. 2).



Fig. 2. View of central line of irrigation system and secondary lines

Irrigation was performed daily and the system was kept connected until the beginning of the drainage in the experimental plots. The nutrient solution used was formulated according to recommendation for strawberry [6].

The number of fruits and flowers, leaf area, number of commercial fruits, diameter of commercial fruits, commercial fruit mass, total soluble solids content (°Brix) and Total Titratable Acidity were evaluated.

At 30, 60 and 90 days after transplanting (DAT) the number of leaves and the number of flowers were evaluated. All the composite leaves and all the flowers present in the plants were counted. ~~The~~ Leaf area was determined by means of a destructive method (at 90 DAT), in which ~~the~~ leaves were removed from ~~the~~ plants. After being cut, ~~the~~ leaves ~~of and the~~ petioles were separated and later scanned ~~in using the equipment~~ LI 3100 (LI-COR®) ~~equipment~~.

~~S~~The selection of commercial fruits was performed ~~on the basis of~~ ~~based on the~~ fruit diameter ~~of the fruit~~ using a digital caliper, ~~and those~~ Fruits ~~that had with~~ a diameter greater than 15 mm and without deformations were considered commercial fruits [7]. For the number of commercial fruits, all fruits ~~of the~~ regarding each subplot were counted and ~~for mass the same~~ ~~fruits were~~ weighed ~~using in~~ a semi-analytical balance ~~having the values expressed in grams~~.

Fruit quality ~~expressed in Brix i.e. was evaluated by the~~ total soluble solids content (TSS), ~~with fruit pulp samples was measured by means of a~~ and with the aid of a refractometer, obtaining the values in °Brix (IAL, 2005). To evaluate the Total Titratable Acidity (TTA) ~~were weighed~~ 5-10 g of homogenized pulp ~~were used in presence of~~ ~~with~~ 100 ml of distilled water, ~~adding~~ 3 drops of phenolphthalein solution and ~~titrated with~~ 0.1 M ~~of~~ sodium hydroxide solution, ~~shaking by means of a magnetic stirrer until the solution has a pink color~~ [8].

The data were submitted for ANOVA and Tukey test when F was significant ($P = .05$). All statistical analyses were performed using the SISVAR software [9].

3. RESULTS AND DISCUSSION

Cultivation systems and varieties did not present significant interaction, thereby providing isolated responses. No significant difference was observed for soluble solids content and fruit

diameter. The cultivation systems did not influence the evaluated characteristics, except for the number of leaves and leaf area. Regarding the varieties, San Andreas and Albion stood out in relation to Oso Grande in all evaluations, except for the number of leaves.

The Vase and Slab culture systems differed statistically from the Ceramic Block in the 30, 60 and 90 DAT evaluations for the number of leaves (Fig. 3). At 30 DAT, the San Andreas and Oso Grande varieties presented the highest number of leaves, followed by Albion, although this did not differ statistically from the Oso Grande variety (Fig. 4). Regardless of the system, there is a greater response of the San Andreas culture in relation to the others regarding leaf production. This may be due to the greater robustness and adaptability of the variety in relation to the edaphoclimatic characteristics compared to the others.

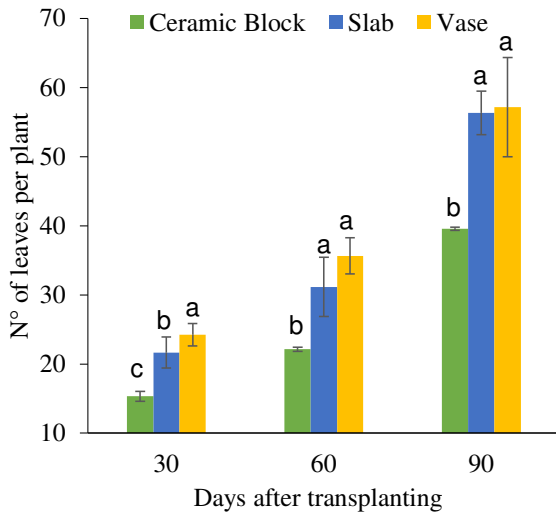


Fig. 3. Number of leaves per plant in the crop systems at 30, 60 and 90 DAT

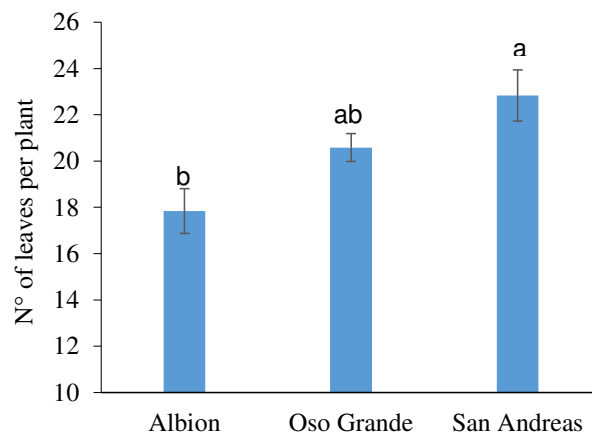


Fig. 4. Number of leaves per plant in strawberry varieties at 30 DAT

Regarding flower production, there was a significant difference for the varieties only at 30 DAT. San Andreas and Albion did not differ statistically from each other, whereas Oso Grande did not differ from Albion and had the lowest number of flowers (Fig. 5).

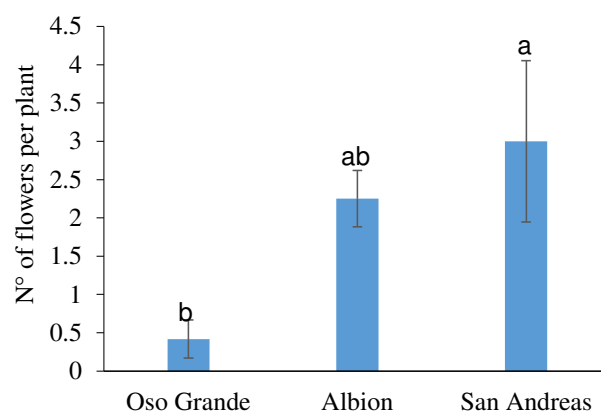


Fig. 5. Number of flowers per plant in strawberry varieties at 30 DAT

Analyzing the number of leaves and flowers, we observed a greater vegetative development of strawberry ~~independent regardless of the system cropping practices~~ and strawberry cultivars. This ~~imbalance~~ may be an ~~adaptive~~ adaptive response of cultivars to weather conditions ~~during cultivation~~, such as ~~elevated high~~ temperature (Table 3). The average temperature ~~during the months of from~~ May to August remained above 27°C. High temperatures provide greater vegetative development to the detriment of fruiting [10], although this characteristic ~~can be harnessed is required in when the seedling production of seedlings is desired.~~

Table 3. Temperature and relative humidity recorded ~~during over strawberry growing the cultivation period.~~

Month	Mean Temperature (°C)	Relative Humidity (%)
May	29.56	94.63
June	27.67	95.04
July	27.37	76.27
August	27.12	93.74

~~Leaf area of strawberry regarding In relation to the leaf area, the Vase and Slab cultivation systems cropping practices was significantly high compared to that of presented the highest values, differing statistically from the Ceramic Block (Fig. 6).~~

Formatted: Left

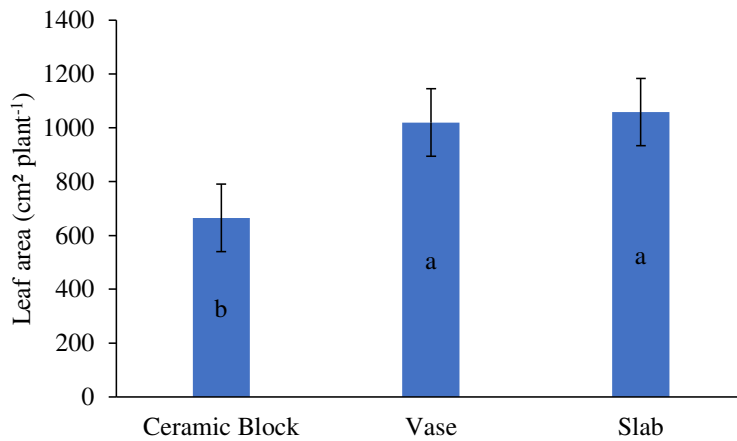


Fig. 6. Average Leaf area in cm² per strawberry plant evaluated in crop systems following cropping practices used.

The leaf area was positively correlated positively with the number of leaves produced.

Unfair writing skills below.

Thus, the greater the leaf production, the greater the leaf area. As previously observed, the Vessels and Slab systems provided the largest number of leaves and consequently a larger leaf area, which also reflected in the Ceramic Block system with number of leaves.

The lower performance of the Ceramic Block system may be related to the lower incidence of radiation on the strawberry, since the blocks are overlapping, causing shading in the plants of the lower blocks. Regarding commercial fruit production (NFC), the difference was isolated for cultivars San Andreas and Albion with higher fruit yield followed by Oso Grande with the lowest production. The dynamics are similar to the previous variables, since the varieties developed better in the vegetative period are more likely to produce higher quantity and better quality of fruits.

Formatted: Font color: Red

Formatted: Font color: Red

Formatted: Highlight

The low fruit yield of the Oso Grande variety was probably due to poor adaptation to the climatic conditions of the region. Thus, strawberry varieties of short days probably do not adapt to the climatic conditions of the southern region of Mato Grosso (Fig. 7).

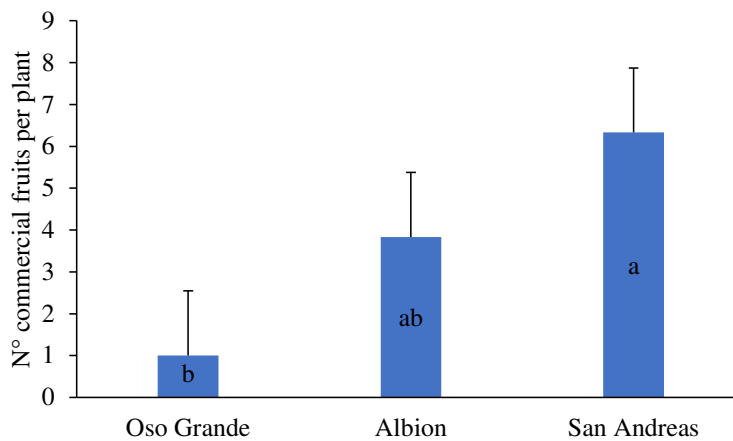


Fig. 7. Number of commercial fruits of the cultivars in semi-hydroponic cultivation

[Unfair writing skills below.](#)

The low fruit yield was due to the low emission of flowers, possibly due to the high temperatures registered (average of 27.93°C) during the cultivation, providing greater vegetative development (stolon productions). The temperature significantly influenced the development and production of the strawberry [11] [1]. In general, flowering is favored by mild temperatures, while high temperatures favor vegetative development [11]. Researchers observed a reduction of flowers and fruits and an accelerated increase in the emission of stolon's and high yields of deformed and small fruits due to the increase of the temperature in the region during the day [12].

Yields of strawberry fruits are certainly linked to the amount of cold hours that the seedlings receive in the greenhouses [13]. In study of the productive behavior of neutral day cultivars in

Formatted: Justified

Formatted: Highlight

temperate climate in Pelotas-RS, shown that San Andreas variety produced an average of 11.16 fruits per plant [14].

The absence of pollinating insects, such as native bees, may also have influenced the low production of commercial fruits, since the greenhouse used is not equipped with a system that allows pollination by bees. Pollination, either by different species of bees, provides higher production and quality of strawberry fruits [15]

In relation to the production of total fresh fruit mass, the San Andreas and Albion varieties were again highlighted, differing from Oso Grande (Fig. 8), which reflects the low flower production mentioned previously.

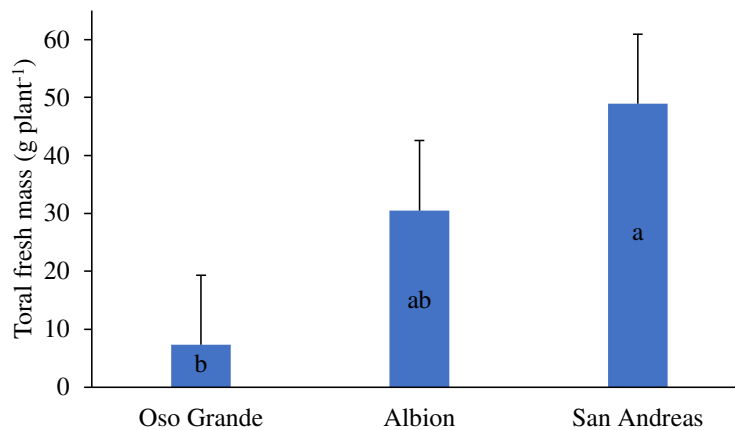


Fig. 8. Total fresh mass of commercial fruits of the Oso Grande, Albion and San Andreas varieties in semi-hydroponic crop systems

[Unfair writing skills below.](#)

Research has shown the superior performance of the San Andreas variety in relation to the others in conventional and organic systems, with production of 20.96 g for the dry fruit mass [16]. These results demonstrate the adaptability of the variety in relation to the characteristics intrinsic to the site. The Albion variety also has good adaptability and productivity. When

Formatted: Justified, Space After: 0 pt, Line spacing: Double

Formatted: Highlight

evaluated in combinations of substrates, it produced on average 342 g plant⁻¹ in Passo Fundo - RS [17].

The varieties presented significance for Total Titratable Acidity, in which San Andreas and Albion presented higher acidity than Oso Grande (Fig. 9). The acidity is indicative of fruit quality, since the fruits have a lower sour taste at the time of harvesting, they will be more accepted by the consumers. The higher citric acid content of the cultivars San Andreas and Albion is not depreciative, since they are responsible for the aroma of the fruits and, after harvesting, the soluble solids contents and acidity decrease, because these compounds are used with substrate for respiration [18] [19] [20].

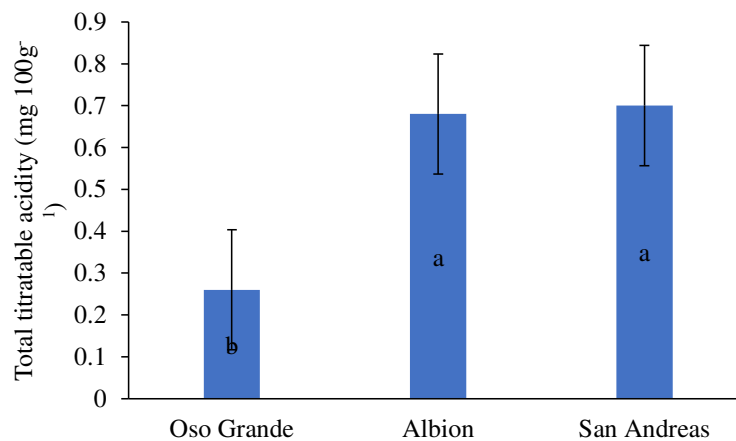


Fig. 9. Total Titratable Acidity of commercial fruits of strawberry varieties in semi-hydroponic crop systems

[Unfair writing skills below.](#)

In relation to acidity, the San Andreas and Albion varieties fit within the acceptable range (0.73 - 1.58%) [21] showing that despite the low production, the fruits produced good quality. For the Oso Grande cultivar, the total titratable acidity did not meet the standards for the cultivar, possibly due to the low adaptability of the variety to the region. Researchers in the

Formatted: Justified, Space After: 0 pt, Line spacing: Double

Formatted: Highlight

region of Minas Gerais, by evaluating sensorial and chemical characteristics of strawberry fruits, observed values of acidity of 0.65% for the variety [22].

4. CONCLUSIONS

It came out that cropping practices did not influence strawberry fruit yield and quality. However, lower growth performance of strawberry was recorded on Ceramic Block compared to that of Vase and Slab cropping practices. Regardless of the cropping practice, San Andreas and Albion varieties were more productive with better quality fruit and adapted to local environment conditions than Oso Grande variety.

The Vase, Slab and Ceramic Block cultivation systems did not influence the production and quality of strawberry fruits. The Ceramic Block system provided the lowest vegetative performance of the strawberry in relation to the Vase and Slab systems considering number of leaves and leaves area. Regardless of the system, the San Andreas and Albion varieties are more productive with respect to Oso Grande.

The San Andreas and Albion varieties are better adapted to local environmental conditions and produce more and better quality commercial fruits compared to Oso Grande.

COMPETING INTERESTS

Authors declared that no competing interests exist.

REFERENCES

Poor quality presentation of references

Formatted: Not Highlight

Formatted: Font color: Red

Formatted: Font color: Red

- 324 1. Stewart PJ, Folta KM. A Review of Photoperiodic Flowering Research in Strawberry
325 (*Fragaria* spp.). Crit Rev Plant Sci. 2010; 29(1): 1-13.
326 [Doi:10.1080/07352680903436259](https://doi.org/10.1080/07352680903436259)
- 327 2. Junior CR, Antunes LEC, Aldrichi M, Vignolo G. Panorama of strawberry cultivation
328 in Brazil. Camp Neg. 2014; 1: 1-3. Portuguese
- 329 3. Brazilian Agricultural Research Corporation - EMBRAPA. Brazilian system of soil
330 classification. 3rd ed. Embrapa: Brasília; 2013.
- 331 4. Fagherazzi AF. Evaluation of strawberry cultivars in the southern plateau of Santa
332 Catarina. Master dissertation. State University of Santa Catarina. Santa Catarina; 2013.
333 Portuguese
- 334 5. Silva SCA, Junior JLAM, Pereira APA, Souto PC, Oliveira VP. Production of
335 strawberry in semi-hydroponic systems for the municipality of Garanhuns - PE. In:
336 Anais of XIII Journey of teaching, research and extension. Pernambuco; 2013.
337 Portuguese
- 338 6. EMBRAPA. Production of strawberries in the semi-hydroponic system. Accessed 01
339 December 2016. Available: <https://sistemasdeproducao.cnptia.embrapa.br>. 2006.
340 Portuguese
- 341 7. Alvarenga JO. Classification, packaging and labeling of strawberry. In: Carvalho SP.
342 (ed.). Strawberry bulletin: conventional farming, food security and organic farming. 1st
343 ed. Belo Horizonte: FAEMG; 2006. Portuguese
- 344 8. IAL - Instituto Adolfo Lutz. Physicochemical methods for food analysis. 4th ed.
345 Brasília: IAL; 2005. Portuguese
- 346 9. Ferreira DF. SISVAR: A computer statistical analysis system. Cienc Agrotec. 2011; 6:
347 1039-1042. Portuguese

- 348 10. Resende SR. Vegetable Crops - The culture of strawberry. Emater. Accessed 31
349 October 2016. Available:
350 <http://www.emater.mg.gov.br/portal.cgi.pgnlivrariavirtualarquivos>. Portuguese
- 351 11. Chabot BF. Environmental influences on photosynthesis and growth in *Fragaria Vesca*.
352 | New Phytol. 1978; 80: 87-98.
- 353 12. Calvete EO, Mariani F, Wesp CL, Nienow AA, Castilhos T, Cecchetti D. Phenology,
354 production and anthocyanin content of strawberry cultivars in protected environment.
355 | Rev Bras Frutic. 2008; 30: 396-401. Portuguese
- 356 13. Stapleton SC; Chandler CK; Legard DE; Price JF; Sumler Junior JC. Transplant source
357 affects fruiting performance and pests of 'Sweet Charlie' strawberry in Florida. Hort
358 | Tech. 2001; 11: 61-65.
- 359 14. Höhn D, Gonçalves MA, Cocco C, Rutz L, De Paula G, Antunes LEC. Productive
360 behavior of neutral day cultivars with late planting. In: Anais of Congress of Scientific
361 Initiation. Pelotas; 2013. Portuguese
- 362 15. Abrol DP, Gorka AK, Ansari MJ, Al-Ghamdi A, Al-Kahtani S. Impact of insect
363 | pollinators on yield and fruit quality of strawberry. Saudi J Biol Sci. 2017; 1: 1-7.
- 364 16. Santos LDS. Quality of strawberries produced under conventional and organic systems
365 in the Valley of Ipojuca-PE. Monograph. Federal University of Paraiba. Paraiba; 2013.
366 Portuguese
- 367 17. Costa RC. Ecophysiology, yield and strawberry quality of neutral days cv. Albion on
368 different substrates. Doctoral thesis. University of Passo Fundo. Passo Fundo; 2012.
369 Portuguese
- 370 18. Cantillano RFF, Castañeda LMF, Schunemann APP. Physical-chemical and sensorial
371 quality of strawberry cultivars during refrigerated storage. 1st ed. EMBRAPA. Pelotas;
372 2008. Portuguese

- 373 19. Françaoso ILT, Couto MAL, Canniatti-Brazaca SG, Arthur V. Physic-chemical changes
374 in strawberries (*Fragaria ananassa* Duch.) Irradiated and stored. *Cienc Tecnol Alim.*
375 | 2008; 28:(3): 614-619. Portuguese
- 376 20. Camargo LKP, Resende JTV, Galvão AG, Baier JE, Faria MV, Camargo CK. Chemical
377 characterization of strawberry fruits cultivated in pots under organic and conventional
378 | management systems. *Semina.* 2009; 30:(1): 993-998. Portuguese
- 379 21. Kallio H, Hakala M, Pelkkikangas AM, Lapcetteläinen A. Sugars and acids of
380 | strawberry varieties. *Eur Food Res Technol.* 2000; 212:(1): 81-85.
- 381 22. Resende JTV, Camargo LKP, Argandoña EJS, Marchese A, Camargo CK. Sensory
382 | analysis and chemical characterization of strawberry fruits. *Hort Bras.* 2008; 26:(1):
383 371-374.