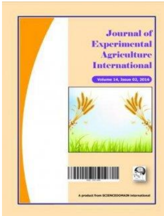

Journal of Experimental Agriculture International

27(2): 1-8, 2018; Article no.JEAI.44381
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Formation of Yellow Passion Fruit Seedlings under Different Substrates and Water Blades

Gisele Lopes dos Santos[1*], Juliana Formiga Almeida[1], Adriana da Silva Santos[1], Valéria Fernandes de Oliveira Sousa[1], Cesenildo de Figueiredo Suassuna[1], Albanisa Pereira de Lima Santos[1] and Evandro Franklin de Mesquita[2]

[1]*Academic Unit of Tropical Horticulture, Federal University of Campina Grande, Pombal, PB, Brazil.*
[2]*Teacher of the Graduate Program in Tropical Horticulture, Federal University of Campina Grande, Pombal, PB, Brazil.*

Authors' contributions

This work was done through collaboration between all authors. From field research to manuscript writing, where at the end, everyone read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2018/44381
Editor(s):
(1) Dr. Anita Biesiada, Professor, Department of Horticulture, Wroclaw University of Environmental and Life Sciences, Poland.
Reviewers:
(1) R. K. Mathukia, College of Agriculture, Junagadh Agricultural University, India.
(2) Arun Kumar Mahawar, SKN College of Agriculture, SKN Agriculture University, India.
(3) Anibal Condor Golec, Perú.
Complete Peer review History: http://www.sciencedomain.org/review-history/26702

Original Research Article

Received 03 July 2018
Accepted 28 September 2018
Published 19 October 2018

ABSTRACT

Aim: To evaluate the influence of different substrates and water slides on the development of yellow passion fruit seedlings.
Study Design: This experiment was carried out from October to December 2017, at the Universidade Federal de Campina Grande, in the Agro-Food Science and Technology Center, located in the city of Pombal, Paraíba.
Methodology: The treatments were constituted by four different substrates, these being Solo (control); Soil + bovine manure (S + BM); Soil + sheep manure (S + SM) and Soil + avian bed (S + AB), being associated to four water slides 40, 60, 80 and 100% of Real Evapotranspiration (ETr), determined from lysimetry of drainage from a 10% leaching fraction. The experimental design was a randomized block design, in a 4 × 4 factorial arrangement, with five replications.

*Corresponding author: E-mail: gisele1612@gmail.com;

Results: 60 days after transplanting, leaf area, number of leaves, diameter, height, dry mass of shoot and root, Dickson quality index and relative water content were evaluated. To which a significant effect was observed by the F test ($P \leq 0.01$), of the different types of Substrates (S) and irrigation blades (B), as well as the interaction of these factors (SxB) for all variables studied, demonstrating that both factors simultaneously interfere in the production of passion fruit seedlings.
Conclusion: The S + AB substrate combined with the 100% ETr blade promoted the best yield under the seedling development.

Keywords: Passiflora edulis; fruticulture; proportions; organic matter; water regime.

1. INTRODUCTION

Yellow passion fruit (*Passiflora edulis* Sims f. *flavicarpa* Degener) belonging to the family Passifloraceae, is a fruit with wide adaptation in Brazil, and has been considered an important culture, since it has several purposes of use to the market and, in addition, it employs a large number of people from cultivation to commercialisation [1].

According to Sá et al. [2], there was a growth in the production of this crop, intensifying agribusiness of the crop and collaborating for the economic development of the country. As an effect of the expression of the passion fruit culture, there is a greater interest of the producers in the increase of the orchards. However, for the formation of good orchards, obtaining quality seedlings is necessary, since it facilitates the production process and ensures greater uniformity, since the use of seedlings of low phytosanitary, genetic and nutritional quality compromises productivity and longevity of the culture.

According to Santos et al. [3], there are many factors that influence the final quality of passion fruit. Among them, the choice of substrate and the amount of water applied by the irrigations can be highlighted.

The substrates must therefore provide suitable conditions for the proper development of the plant as: sustenance, retention and sufficient quantities of water, oxygen and nutrients, for these reasons, it is advisable to use organic substrates due to the effects it produces on chemical, physical attributes and biological properties of the soil, thus reducing the need for chemical fertiliser application and lower costs [4,5].

The availability of water in the substrate, in turn, has a marked influence since the emergence and vigour of yellow passion fruit, with water regimes of 45 and 60% of field capacity considered the most advantageous [6].

The semi-arid region has little water available for irrigated cultivation; in addition, the use of these organic inputs in the rural properties of the semi-arid Paraíba could be an alternative in the production of seedlings, therefore it was proposed to evaluate the development of yellow passion fruit seedlings submitted to different sources of organic compound added to the substrate under different irrigation slides.

2. MATERIALS AND METHODS

This experiment was conducted under at the Universidade Federal de Campina Grande, in the Agro-Food Science and Technology Center, located in the city of Pombal, Paraiba, Brazil at the geographical coordinates 6°48'16 " of latitude S and 37°49'15 "of longitude W and altitude of 148 m [7]. As for the climate, according to Koppen, it is classified as hot and dry semiarid, with average annual evaporation of 2,000 mm and an average precipitation of approximately 750 mm year^{-1} [8].

The treatments were composed of four different substrates, being: soil only (Soil); soil + bovine manure (S + BM); soil + sheep manure (S +SM) and soil + avian bed (S + AB), each in the proportion of 1: 1, and four water slides (40, 60, 80 and 100% of the Real Evapotranspiration determined from drainage lysimetry from a 10% leaching fraction [9]. The design was a randomised complete block design, in a 4 × 4 factorial arrangement, with five replications.

Were used seeds of cultivar yellow sour of the Feltrin® Golden line, being sowing carried out on October 2, 2017 in polyethylene bags with a capacity of 1 L, duly filled with each substrate, with the chemical characteristics of the substrates set out in Table 1:

Table 1. Chemical characteristics of the components of each substrate, used in the formation of yellow passion fruit seedlings

	pH	P	S - $SO4^{-2}$	K^+	Na^+	H^+Al^{+3}	Al^{+3}	Ca^{+2}	Mg^{+2}	SB	T	OM
	Water (1:2,5)	...........mgdm^{-3}..........			.....................................cmolcdm^{-3}...............................							gkg^{-3}
Soil	8.1	632.59	-	116.59	0.22	0.00	0.00	5.69	5.57	11.78	11.78	4.44
Soil+BM	8.4	665.53	-	4433.58	1.59	0.00	0.00	5.58	3.51	22.05	22.05	59.90
Soil+SM	8.0	708.96	-	2988.95	1.47	0.00	0.00	6.10	5.37	20.60	20.60	115.36
Soil+AB	8.0	680.51	-	1281.17	1.58	0.00	0.00	4.27	0.31	9.44	9.44	7.65

** SB: sum of bases; T: total cation exchange capacity; OM: organic matter*
Analysis by the Soil Analysis Laboratory, Universidade Federal da Paraíba.

At 60 days after sowing (DAS), plant growth parameters were evaluated, of which: leaf area (cm²), determined according to the methodology used by Schmildt et al. [10] considering field conditions and leaf format at the molting stage, by the formula AF = β0 + β1CL, where β0 = -0.0956, β1 = 0.8434, C = Measured length and L = Measured width (R^2 = 0.99); number of leaves, from basal leaves to last leaf open; diameter of the stem through measurements in digital caliper (mm); height (cm) obtained with the aid of a measuring tape; dry mass of the aerial part, as well as of the root (g), obtained by weighing the oven dried material with air circulation at 65ºC until reaching a constant mass; Dickson quality index (DQI): considering total dry mass (TDM), plant height (PH), mass of the air part (MAP), stem diameter (SD) and root dry mass (RM), using the formula below [11]:

$$DQI = \frac{TMD}{\frac{PH\,(cm)}{SD(mm)} + \frac{MAP\,(g)}{RM\,(g)}}$$

It was also determined the relative water content of the leaves, using the methodology adapted from Barrs and , Weatherley [12], where the newest 4th leaf of each plant was removed with the appropriate treatments, weighed it in a precision analytical balance, to obtain mass of the fresh material, later, were placed in plastic bags with 100 ml of distilled water, remaining in these for 24 h. After this time, the sheets were dried on a paper towel and weighed again to obtain mass of the saturated material. After this, the leaves were placed in an oven at 65°C in order to obtain a constant mass and then the mass of the dried material. This parameter is calculated using the formula:

$$RWC = \frac{[(MFM - MDM)]}{(MSM - MDM)} \times 100$$

Where, RWC: relative water content in the leaf (%)

MFM: mass of the fresh material (g)
MDM: mass of the dried material at 65°C (g)
MSM: mass of the saturated material (g)

Data was submitted to the F test through analysis of variance and when significant the means of the variables were compared by regression, and the statistical analyses were performed in SISVAR software version 5.6 [13].

3. RESULTS

According to the results, the F (P ≤0.01) test of the different types of substrates (S) and irrigation slides (B) was observed, as well as the interaction of these factors (SxB) for all variables studied, demonstrating that both factors interfere simultaneously in the production of passion fruit seedlings.

The highest leaf area (Fig. 1A) was obtained by the use of substrate based on soil and bed of the aviary (S + AB) reaching 12362.30 cm^2, followed by sheep manure (S + SM) 1682.60 cm^2, when associated to the studied blade of 100% water replenishment. For the other substrates, it was observed that the plants responded in an increasing linear manner, proportional to the increase of the irrigation blade, however, obtaining smaller gains, being of 1449.00 cm^2 and 1263.94 cm^2, with the use of solo and with an addition of bovine manure (S + BM), respectively.

In the number of leaves (Fig. 1B), when the soil substrate and the S + BM were used, the values 9.18 and 7.66 were respectively obtained in the 100% studied slide. The linear adjustment was also observed for this variable when S + AB was used in the composition, which is responsible for the highest number of leaves per plant, with a mean increase of 0.09 per unit increase of the irrigation water, the value of 13.36 with the largest blade. In relation to the S + SM, a quadratic mathematical effect was observed, with an increase of this variable up to the 80% blade, where it reached a value of 8.50 and from this, it decreased.

For the stem diameter variable (Fig. 1C), there was linear increase due to the increase of water availability for the plants cultivated without organic fertiliser (soil) and with addition of aviary bed in the substrate, reaching in the 100% values of 2.86 mm and 4.71 mm. For plants with S + SM and S + BM there was quadratic polynomial effect, reaching the maximum points of, respectively, 2.31 mm and 2.15 mm, in the slides estimated of 82 and 74%, and from these decreases.

The plants cultivated in soil, S + SM and S + BM presented increasing linear behavior at the height (Fig. 1D), due to the increase in the amount of available water in the substrate to increase of 0.14; 0.05 and 0.03 cm, respectively, per unit increase of the irrigation blade, reaching values of 14.49 cm; 9.91 cm and 9.72 cm in the 100% slide. When S + AV was used, the plants showed a quadratic polynomial effect, increasing to the highest value in height (45.44 cm), also in the studied lamina of 100%.

As for the MAP (Fig. 2A), it was observed that the substrate composed of S + AB, provided greater increments in comparison to the others, mainly using the 100% lamina with a maximum value of 4.63 g, not different from RM (Fig. 2B), which obtained a maximum point corresponding to approximately 5.37 g, the same occurred with the use of the soil only substrate, but with lower gains (0.94 and 1.60 g) obeying the same order of the variables, with blade equally. For both variables, the substrate with bovine manure insertion did not fit any mathematical model, obtaining, therefore, 0.32 g and 0.39, for the shoot and root, respectively. With regard to S + SM, there was a quadratic mathematical effect with decreases observed from the slides estimated from 86.5% for MAP and 77% for RM.

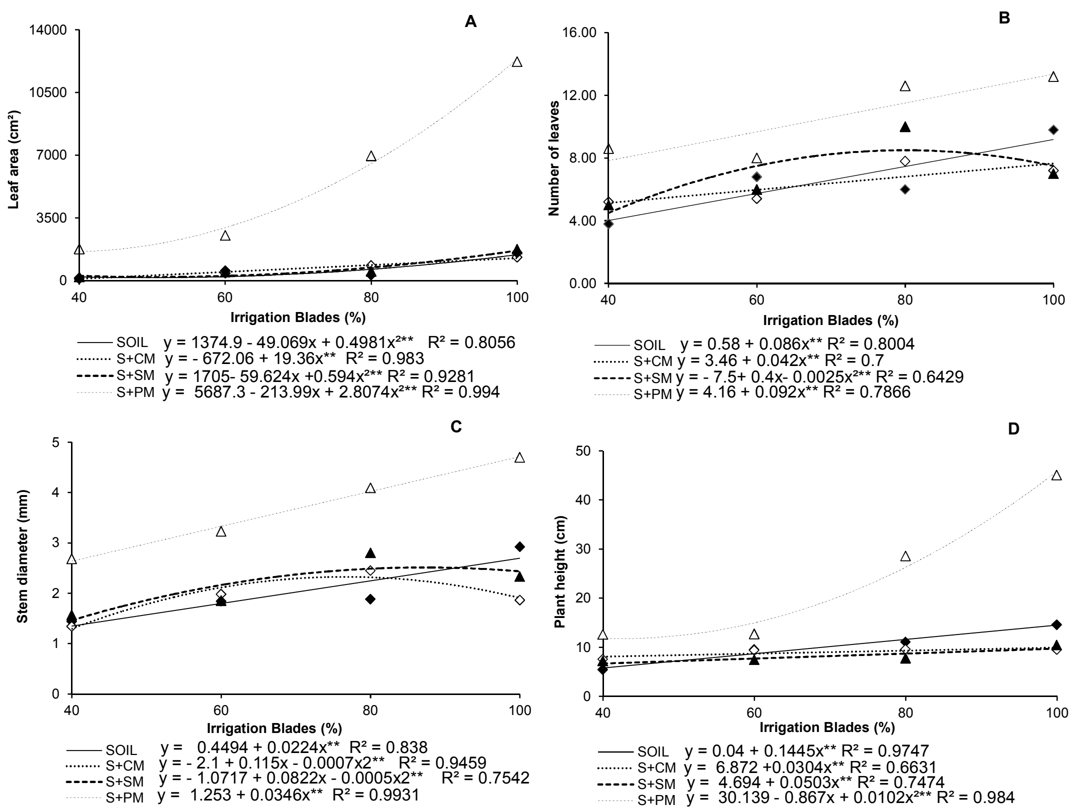

Fig. 1. Leaf area (A), number of leaves (B), diameter (C) and height (D) of yellow passion fruit seedlings submitted to different substrates: SOIL (♦), S + BM (◊), S + SM (▲), S + AB (Δ) and irrigation blades

Relative water content (Fig. 2C) showed a gradual increase, proportional to the increase in water availability caused by the slides, where the substrate S + AB caused the highest increase corresponding to 0.97%, followed by the substrate S + SM (0.42%), S + BM (0.35%) and soil only (0.25%) with the 100% slide.

In relation to quality index (Fig. 2D), not different from that already presented, the substrate composed of soil + bed of aviary stands out in relation to the other substrates, even with the lowest water condition imposed, however, for S + SM and S + BM associated with slides greater than and less than 69% and 88%, respectively, caused decreases for this variable.

4. DISCUSSION

For most of the evaluated variables, the addition of organic matter as the lowest available water availability was beneficial and contributes with greater increments when compared to use of only soil. Such response represents that the physical conditions present in each substrate influence intensively the development of the seedlings, especially when considering the supply of water to the plant. The influence on the seedling production process by the substrate formulation, as well as the amount of water provided in the growth and accumulation of seedlings, was also verified by Oliveira et al. [14] in baru tree seedlings and Days et al. [15] in pepper plants.

The use of organic inputs in substratum formulations increases the growth of several fruits such as mangabeira [16], soursop [17], umbuzeiro [18] and pineapple [19]. This beneficial effect is possibly due to the high organic matter content, nutrients such as calcium, magnesium, higher aeration and moisture retention that these inputs provide [20]. Thus producing organic solutes such as sugars, free amino acids, proline and betaine glycine positively affecting plant nutrition [21].

Among these inputs, cattle manure, goat and poultry manure are those that are easily accessible to seedlings producer [22,19]. The bovine and ovine manure had the highest organic matter content compared to soil only (Table 1), consequently presented higher cations exchange capacity (CEC), thus increasing the growth of the seedlings treated with such inputs in the substrate in relation to the treatment absent.

However, the substrate composed of aviary bed, despite the lower content of organic matter and CEC in relation to the other organic inputs, presents superiority in all the growth characteristics of the seedlings. Peixoto et al. [23] state that even sheep and cattle manure presenting high concentrations of organic matter and nutrients at the rate of decomposition and consequent mineralisation of these, becomes greater generally at 90 days, which explains the fact that the substrates with these types of organic materials, did not stand out in relation to poultry manure, since the necessary duration for the seedling phase during this experiment was 60 days.

Days et al. [15] when studying the production of peppermint seedlings in the substrates Red Latosol Eutrophic; Eutrophic Red Latosol (70%) + bovine manure (30%) and Eutrophic Red Latosol (90%) + chicken litter (10%) found that Latosol (90%) + chicken bed (10%) positively affect seed germination and development of chili pepper plants. According to [24] the growth of passion fruit seedlings is maximised with the addition of 10% of avian bed, which is equivalent to mineral fertilisation, being a low cost producer alternative.

The application of water around 100% of the Etr was satisfactory for the production of passion fruit seedlings, this fact can be explained by increase in water demand to increase the growth of plants [25,26]. The biomass allocation in the root system and in leaves of passion fruit is good more accentuated in function of increase availability water [27]. According to Araújo et al. [28] the water availability present in the substrate also has a marked influence on emergence and vigor of yellow passion fruit seedlings, with high water regimes being the most advantageous.

The physical characteristics of the poultry manure interfered positively in the maintenance of humidity, since the seedlings presented with substrate still wet between a turn and another of irrigation, even in the smallest slides. The poultry manure promotes the good development in yellow passion fruit cv. IAC 277, Cerrado Sun and Yellow, Round because of high percentage of "inert" material of shavings and rice hulls, which provides greater moisture retention [29,30].

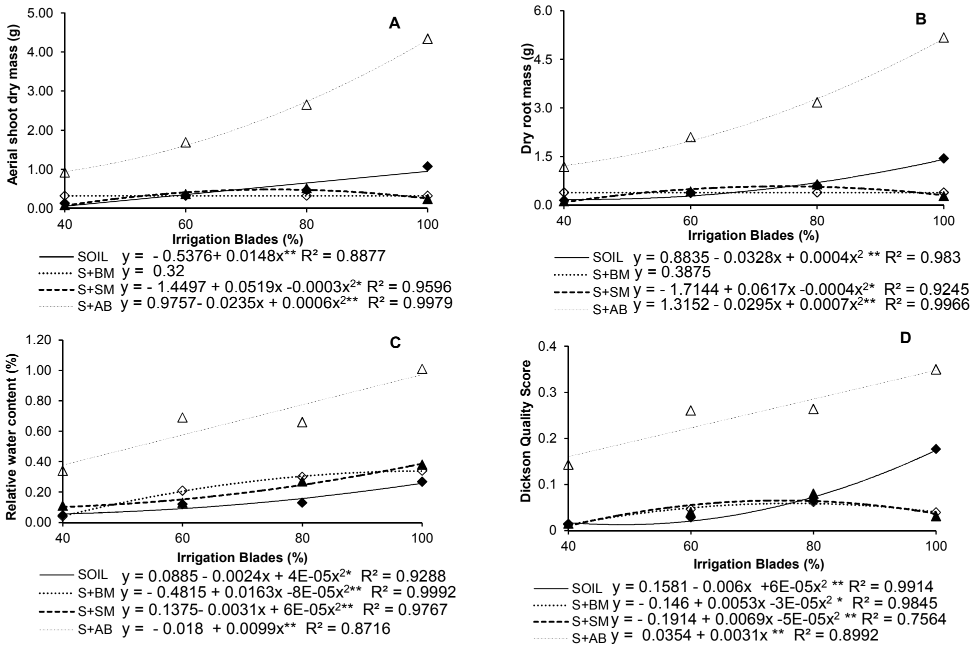

Fig. 2. Mass of the air part (A), root dry mass (B), relative leaf water (C) and Dickson quality index (D) on yellow passion fruit seedlings submitted to different substrates: SOIL (♦), S + BM (◊), S + SM (▲), S + AB (Δ) and irrigation blades.

5. CONCLUSIONS

Yellow passion fruit plants were significantly influenced by the use of different substrates, as well as the water conditions imposed.

The best development of the seedlings was obtained by using the formulated substrate of soil and bed of aviary, especially when associated with 100% of ETr.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Birth MCBS, Range CQS. Phytochemical study of passion fruit (*Passiflora edulis* Sims form *flavicarpa* O. Deg. - Passifloraceae) and chromatographic profile of passion fruit juices. Science and Technology Perspectives. 2015;7(1):16-27.
2. Sá FV, Bertino AMP, Ferreira NM, Bertino AMP, Soares LS, EF Mosque. Formation of yellow passion fruit seedlings with different doses of goat manure and substrate volumes. Magistra. 2014;26(4): 482-492.
3. Santos VAS, Ramos JD, Laredo RR, Silva FOR, Chagas EA, Pasqual M. Production and quality of yellow passion fruit fruits from the cultivation with seedlings at different ages. Journal of Agroveterinary Sciences. 2017;16(1):33-40. DOI: 10.5965 / 223811711612017033
4. Araújo AC, Araújo AC, Dantas MKL, Pereira WE, Aloufa MAI. Use of organic substrates in the production of papaya seedlings. Brazilian Journal of Agroecology. 2013;8(1):210-216.
5. Melo-Junior JCF, Costa DS, Gervásio ES, Lima AMN, Sediyama GC. Effect of substrate water depletion levels and doses of controlled release fertilizer on the production of yellow passion fruit seedlings. Irriga. 2015;20(2):204-219.
6. Araujo MMV, Fernandes DA, Camili EC. Emergence and vigor of yellow passion fruit seeds due to different water availability. Unities. 2016;20(2):82-87.
7. Beltrão BA, Souza Júnior LC, Morais F, Mendes VA, Miranda JLF. Diagnosis of the municipality of Pombal. Project designation of sources of groundwater supply. Recife: Ministry of Mines and Energy / CPRM / PRODEM; 2005.
8. Alvares CA, Stape JL, Sentelhas PC, Gonçalves JLM, Sparovek G. Köppen's

climate classification map for Brazil. Meteorologische Zeitschrift. 2013;22(1): 711-728.

9. Bernardo S, Soares AA, Mantovani EC. Irrigation manual. 8th ed., Viçosa: UFV; 2006.
10. Schmildt ER, Oliari LS, Schmildt O, Alexandre RS, Pires FR. Determination of the leaf area of Passiflora mucronata from linear leaf blade dimensions. Revista Agro @mbiente On-line. 2016;10(4):351-357. DOI: 10.18227/1982-8470ragro.v10i4.372 0
11. Dickson A, Leaf AL, Hosner JF. Quality appraisal of white spruce and white pine seedling stock in nurseries. Forest Chronicle. 1960;36(1):10-13.
12. Barrs HD, Weatherley PE. A re-examination of the relative turgidity technique for estimating water deficits in leaves. Aust. J. Biol. Sci. 1962;15(1):413-428.
13. Ferreira DF. Sisvar: A guide for its boot-strap procedures in multiple comparisons. Science and Agrotechnology. 2014;38(2): 109-112.
14. Oliveira HFE, Souza CL, Félix DV, Fernandes LS, Xavier OS, Alves LM. Initial development of barley seedlings (*Dipteryx alata* vog) as a function of substrates and irrigation slides. Irriga. 2017;22(2):288-300.
Available:http://dx.doi.org/10.15809/irriga.2017v22n2p288-300
15. Days MA, Lopes JC, Corrêa NB, DCFS Days. Seed germination and development of chilli pepper plants as a function of substrate and water depth. Brazilian Journal of Seeds. 2008;30(3):115-121.
Available:http://dx.doi.org/10.1590/S0101-31222008000300015
16. Silva EA, Oliveira AC, Mendonça V, Soares FM. Substrates on the production of mangabeira seedlings in tubes. Tropical Agriculture Research. 2011;41(2):273-278.
Available:http://dx.doi.org/10.5216/pat.v41i2.9042
17. Costa E, Sassaqui AR, Silva AK, Rego NH, Fina BG. Soursop seedlings: Biomasses and biometric relations in different farming environments and substrates – Part II. Engenharia Agrícola. 2016;36(2):229-241.
Available:http://dx.doi.org/10.1590/1809-4430-Eng.Agric.v36n2p229-241/2016
18. Cross FRS, Andrade LA, Feitosa RC. Production of umbuzeiro (*Spondias tuberosa* Arruda Câmara) seedlings in different substrates and container sizes. Forest Science. 2016;26(1):69-80.
Available:http://dx.doi.org/10.5902/1980509821092
19. Sá FVS, Brito MEB, Ferreira IB, Antônio Neto P, Silva LA, Costa FB. Balance of salts and initial growth of pineapple (*Annona squamosa* L.) seedlings under substrates irrigated with saline water. Irriga. 2015;20(3):544-556.
20. Rauber LP, Andrade AP, Friederichs A, Mafra AL, Barreta D, Rosa MG, Mafra MSH, Correa JC. Soil physical indicators of management systems in traditional agri-cultural areas under manure application. Scientia Agricola. 2018;75(4):354-359.
Available:http://dx.doi.org/10.1590/1678-992x-2016-0453
21. Nunes JAS, Nunes JC, Silva JÁ, Oliveira AP, Cavalcante LF, Oresca D, Silva OPR. Influence of spacing and application of biofertilizer on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench). African Journal of Biotechnology. 2018; 17(1):17-23.
Available:https://doi.org/10.5897/AJB2017.16277
22. Mesquita EF, Chaves LHG, Freitas BV, Silva GA, Sousa MVR, Andrade R. Production of papaya seedlings as a function of substrates containing bovine manure and container volumes. Brazilian Journal of Agricultural Sciences. 2012; 7(1):58-65.
23. Peixoto Filho JU, Freire MBGS, Freire FJ, Miranda MFA, LGM Person, Kamimura KM. Lettuce yield with doses of manure of chicken, cattle and sheep in successive crops. Brazilian Journal of Agricultural and Environmental Engineering. 2013;17(4): 419-424.
Available:http://dx.doi.org/10.1590/S1415-43662013000400010
24. Brugnara EC. Bed of aviary on substrates for seedlings of yellow passion fruit. Brazilian Journal of Agroecology. 2015; 9(3):21-30.
25. Oliveira JM, Coelho Filho MA, Rabbit EF. Growth of the great naine banana submitted to different irrigation slides in a coastal tray. Brazilian Journal of Agri-cultural and Environmental Engineering. 2013;17(10):1038-1046.
26. Soares LAA, Brito MEB, Fernandes PD, Lima GS, Soares Filho WS, Oliveira ES. Growth of copa - rootstock combinations of citrus under water stress in a greenhouse.

Brazilian Journal of Agricultural and Environmental Engineering. 2015;19(3): 211-217.
Available:http://dx.doi.org/10.1590/1807-1929/agriambi.v19n3p211-217
27. Suassuna JF, Melo AS, Sousa MSS, Costa FS, Fernandes PD, Pereira VM, Brito MEB. Development and photo-chemical efficiency of passion fruit hybrids under water slides. Bioscience Journal. 2010;26(4):566-571.
28. Araújo MMV, Fernandes DA, Camili EC. Emergence and vigor of yellow passion fruit seeds due to different water availability. Unities. 2016;20(2):82-87.
29. Favare HG, Serafim LG, Serafim ME, Correa AF, Bareli MA, Luz PB, Araújo KL. Development of passion fruit cultivars in different substrates and container sizes. Brazilian Journal of Agriculture. 2013; 88(1):62-69.
30. Brugnara EC, Nesi CN, Verona LAF. Bed of aviary and composed of swine manure on substrates for seedlings of yellow passion fruit. Scientific. 2014;42(3):242-251.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/26702