

Agronomic Analysis of Seeding of Peppers Submitted to Different Organic Substrates and Trays

ABSTRACT

The demand for organic products has been increasing due to the great acceptance of the consumers. However there are obstacles that make it difficult for the population to access this food, among them are the inadequate system of cultivation, mainly in relation to the type of substrate and tray, but the most appropriate management will lead to the obtaining of better quality organic products. Thus, the objective of this work was to perform an agronomic analysis of pepper seedlings submitted to different organic substrates and trays. The experiment was conducted in a completely randomized design, in a 5 x 2 factorial scheme, where the five substrates evaluated were S₁: Bioplant® commercial substrate (control treatment), S₂: earthworm humus, S₃: soil, S₄: 50% soil + 50% earthworm humus and S₅: 75% soil + 25% earthworm humus; and the two types of trays were B₁: tray with 98 cells and B₂: tray with 200 cells. The results show that for the pepper emergence have not presented significant difference among the different substrates used in the experiments. The average mean value was 81.29%. The vegetative growth characteristics of pepper seedling studied provide good physical structure of fixation, good porosity, and excellent sources of nutrients. When trays were compared B₁ with B₂, the following variables diameter of the lap; plant height; root length; dry mass of aerial part; fresh root mass, with tray of 98 cells, the results showed the best results. In addition to trays 200 cells showed lesser pepper seedling production. The substrates based on humus presented good physical and nutritional characteristics, besides being cheaper.

Keywords: *Capsicum annuum*, Yolo Wonder, sustainability, cell volume, substrate fertilization.

1. INTRODUCTION

Global demand for food from the organic production system has increased by about 50 percent a year, even with a higher final cost compared to the conventional system [1]. Thus, it is clear that the organic production system is an interesting economical alternative, in view of the aggregation of value, without mentioning the issue of ecological sustainability and social benefits [2,3].

The first step in obtaining quality organic products is the production of quality organic seedlings, in which their performance is strongly influenced by the cultivation substrate and the type of tray used.

In the design of the substrate various organic and inorganic materials being need to determine the most appropriate for each species, in order to meet their demand for nutrient supply and physical properties such as water retention, aeration, ease of root penetration and do not favor the appearance of diseases, and the requirements to be an abundant material in the region of low economic value [4].

Another issue to mention about the quality of the seedling is the effect of the volume of the substrate in the tray, since it is the most widely used vegetable seedling production system, which affects growth, photosynthesis, nutrient and water absorption, respiration and flowering of plants, in which the adequate space available for root development, coupled with the nutritional quality of the substrate, can allow the molt to express all its quality, which can culminate in an interesting economic return and, in addition to not impairing moul quality [5].

Despite the importance of the best combination between the substrate and the tray type, there are few works that address these two aspects to cultivate pepper Yolo Wonder, so this knowledge can result in higher quality seedlings and more efficient resource management.

In view of the above, the objective of the present work was to analyze the responses of pepper (*Capsicum annuum*) seedlings submitted to different organic substrates and trays.

2. MATERIAL AND METHODS

2.1 Site Location

The present work was conducted in shaded area at the Agricultural Sciences Center of the Federal University of Alagoas (CECA/UFAL), located in the municipality of Rio Largo-AL (09°28'02"S; 35°49'43"W; 127 m), in the month of August 2016.

2.2 Experimental Design and Treatments

The treatments consisted of the combination of five substrates with two types of trays. The five substrates evaluated were S₁: Bioplant® commercial substrate (control treatment), S₂: earthworm humus, S₃: soil, S₄: 50% soil + 50% earthworm humus and S₅: 75% soil + 25% earthworm humus (chemical compositions indicated in Table 1); and the two types of trays were B₁: tray with 98 cells and B₂: tray with 200 cells, because they are more used in the management of this crop.

Table 1. Chemical composition of the five substrates. Rio Largo-AL, 2016.

Parameters	Substrates*				
	S ₁	S ₂	S ₃	S ₄	S ₅
pH (CaCl)	5.00	7.40	5.10	6.30	5.70
H+Al (cmol.dm ⁻³)	3.70	1.70	4.00	2.90	3.40
Al (cmol.dm ⁻³)	0.01	0.01	0.04	0.02	0.03
M.O. (g.dm ⁻³)	21.80	30.10	16.70	23.40	20.10
Ca (mmol.dm ⁻³)	22.00	56.00	26.00	41.00	33.50
Mg (mmol.dm ⁻³)	12.00	46.00	18.00	32.00	25.00
K (mmol.dm ⁻³)	16.30	6.50	2.10	4.30	3.20
P (mmol.dm ⁻³)	5.90	8.00	0.30	4.20	2.20
SB (mmol.dm ⁻³)	50.00	108.50	48.00	78.30	63.10
CTC (mmol.dm ⁻³)	87.00	125.50	88.00	106.80	97.40
V (%)	58.00	86.50	54.40	70.40	62.40
Mn (mg.dm ⁻³)	4.70	140.20	11.40	75.80	43.60
Fe (mg.dm ⁻³)	113.10	76.10	236.00	156.10	196.00
Cu (mg.dm ⁻³)	21.20	1.00	0.40	0.70	0.50
Zn (mg.dm ⁻³)	28.20	71.00	1.80	36.40	19.10

* S₁: Bioplant® commercial substrate (control treatment); S₂: earthworm humus; S₃: Solo; S₄: 50% soil + 50% earthworm humus and S₅: 75% soil + 25% earthworm humus.

The research was implemented in a completely randomized design, in the 5 x 2 factorial scheme (five substrates and two types of trays), with four replications. The sowing was done in trays, being the plot considered as a tray, in which sample consisted of 60 central seedlings of the tray, regardless of the type of tray used. Before sowing the cells of the trays were filled with the substrates corresponding to the treatments, then a space of 1 cm depth was made to deposit the pepper seed of the Yolo Wonder variety.

2.3 Evaluated Parameters

Irrigations were carried out frequently from once a day to 20 days after sowing (DAS), from that frequency it happened to be about twice a day until the 33 DAS, this period deemed suitable for transplanting the seedling, so proceeded to the evaluation of the characteristics following: emergency (E) in %; emergency velocity index (IVE), dimensionless; number of leaves (NF), in unit; diameter of the lap (DC), in mm; plant height (AP), in cm; root length (CR), in cm; fresh mass of aerial part

(MFPA), in g; dry mass of aerial part (MSPA), in g; fresh root mass (MFSR) in g; and dry mass of roots (MSSR) in g.

The variable E was calculated by the formula $E = \frac{N}{A} \times 100$, on what N is the total number of emerged seeds and A is the total number of seed sown. The IVE was measured by the formula $IVE = \frac{E_1}{N_1} + \frac{E_2}{N_2} + \dots + \frac{E_n}{N_n}$, on what E1, E2,..., En is the number of seedlings emerged in the first, second to last count, and N1, N2,..., Nn is the number of days of sowing the first, second to last count.

The NF was counted per unit true leaves (non-cotyledonal leaves), whereas the DC was measured with the aid of a digital pachymeter, at the height of the lap of seedling. For AP, a millimeter ruler was used, where it was measured from the surface of the substrate until the insertion of the last sheet, in followed the CR was measured length of the largest root. For MFPA and MFR, the seedlings were cut and then weighed the two variables in analytical balance. Then the two parts of the seedlings were placed in paper bags and subjected to a forced ventilation oven at 65 ° C for 72 hours and then weighed to evaluate MSPA and MSR.

2.4 Statistical Analysis

Analyzes of variance were performed, and in case the F test was significant, the Tukey test was applied at 5% probability using the Assisat 7.7 computational software [6].

3. RESULTS AND DISCUSSION

According to the F test at 1% probability, for the substrates there was a significant difference at 1% probability for the number of leaves (NF), diameter of the neck (DC), height of the plant (AP), mass fresh of the aerial part (MFPA) and dry mass of the aerial part (MSPA). For root length (CR) and dry mass of roots (MFR) there was a significant difference at 5% of probability and the others did not present difference by the same significance. For trays, there was a significant difference at 1% probability for NF, DC, AP, CR, MFPA, MSPA and MFR. For emergency (E) and MSR there was a significant difference at 5% probability and for E and MSR there was no significant difference for the same significance. For S x B interaction there was a significant difference at 1% probability only for NF, MFPA and MSR. For the emergency velocity index (IVE) there was a significant difference at 5% probability, indicating that there was the influence of the trays in the substrates. For the other variables, there was no significant difference at 5% probability for the F test.

Table 02. Analysis of variance of the characteristics of pepper seedlings submitted to different substrates and tray types.

Sources of variation	QM									
	E	IVE	NF	DC	AP	CR	MFP A	MSP A	MFR	MSR
Substrate s (S)	2.292 5 ns	34.359 9 ns	0.145 9 **	0.255 1 **	7.5238 **	3.7537 *	0.130 9 **	0.003 0 **	0.008 1 *	0.000 1 ns
Trays (B)	9.038 0 ns	61.318 4 *	0.330 0 **	0.533 3 **	14.560 3 **	19.764 0 **	0.368 2 **	0.002 5 **	0.050 1 **	0.000 1 ns
Interactio n S x B	2.193 6 ns	38.885 7 *	0.044 2 **	0.030 4 ns	0.5661 ns	0.8299 ns	0.017 2 **	0.000 1 ns	0.005 2 ns	0.000 1 **
Residue	2.999 6	13.114 8	0.009 9	0.024 2	0.6833	1.3370	0.002 8	0.000 1	0.002 0	0.000 1
CV (%)	19.56	28.66	4.54	8.86	11.01	14.90	12.17	25.74	38.53	25.39

** Significant at 1% probability by F test; * Significant at 5% probability by F test; ns not significant at 5% probability by F test.

The production of vegetable seedlings is influenced by several factors, from the seed to the inputs to the production as containers that will keep the seedlings, the nature of the substrate, as well as other factors of the environment. The influence of these various factors changes according to the species of seedling that is produced, depending on the type of seed, seedling requirements, among other factors [7,8].

According to Table 3 the Tukey's test at 5% probability can make some considerations.

Table 03. Average of the substrates and trays of the characteristics of chili seedlings.

Substrates	E	DC	AP	CR	MSPA	MFR
Bioplant	82.59 a	1.70 a	7.10 ab	8.25 ab	0.0407 b	0.1237 ab
Humus	72.78 a	1.93 a	8.32 a	7.55 ab	0.0713 a	0.1467 a
Soil	87.70 a	1.43 b	5.75 b	6.53 b	0.0143 c	0.0590 b
50% soil + 50% humus	81.43 a	1.90 a	8.48 a	8.58 a	0.0643 a	0.1510 a
75% soil + 25% humus	81.98 a	1.84 a	7.90 a	7.88 ab	0.0510 ab	0.1133 ab
Average general	81.29	-	-	-	-	-
$\Delta_{5\%}$	29.81	0.27	1.43	1.99	0.0215	0.0791
Trays	E	DC	AP	CR	MSPA	MFR
98 cells	88.57 a	1.89 a	8.21 a	8.57 a	0.0575 a	0.1596 a
200 cells	74.00 a	1.63 b	6.81 b	6.95 b	0.0392 b	0.0779 b
Average general	81.29	-	-	-	-	-
$\Delta_{5\%}$	13.13	0.12	0.63	0.88	0.0094	0.0348

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

For the E the substrates did not present significant difference among the substrates, with a mean of 81.29%. In order for seed germination to occur, it is necessary that the seed present a viable embryo, has the minimum of reserve and humidity so that the cellular processes can occur, in this way the substrate does not influence the emergence, since among the main functions of the substrate is the fixation of the seedling, maintenance of available water and the supply of nutrient, being then emergency more influenced by a characteristic physiological condition when the seed address the need of water [9].

The DC had the humus (1.93 mm) presenting the highest mean, not statistically differing from substrates 50% soil + 50% humus and 75% soil + 25% humus with respective averages of 1.90 and 1.84 mm. For AP the substrate 50% soil + 50% humus (8.48 cm) humus presented higher average, not statistically different from humus, Bioplant, and 75% soil + 25% humus, with respective mean of 8.32; 7.10 and 7.90 cm. The CR had the substrate 50% soil + 50% humus (8.58 cm) with higher average, but not statistically different from Bioplant, 75% soil + 25% and humus, with respective averages of 8.25; 7.88 and 7.55 cm.

The MSPA was higher for humus (0.0713 g), not statistically differing for the substrate 50% soil + 50% humus and 75% soil + 25% humus, with respective averages of 0.0643 and 0.0510g. For the dry mass of roots, the substrate 50% soil + 50% humus (0.1510 g) presented higher mass, not statistically different from humus, Bioplant, and 75% soil + 25% humus.

For vegetative growth characteristics such as DC, AP, CR, MSPA and MFR the substrates humus, 50% soil + 50% humus and 75% soil + 25% humus showed the best results, because they provide a good physical structure of fixation presenting good proportion of porosity, besides being excellent sources of nutrients [10].

In the comparison between the trays, for the variables DC, AP, CR, MSPA and MFR the tray of 98 cells presented the best results, with respective averages of 1.89 mm, 8.21 cm, 8.57 cm, 0.0575 g and 0.1596 g. Trays with larger cells provide greater storage capacity of water, nutrients, besides providing more space for the roots of the seedlings to develop, besides these advantages, the larger cells provide the seedlings with greater safety, because it is possible to keep the seedlings in the trays for longer if necessary [11].

The IVE showed variation regarding the use of the substrates in the different trays, in the trays of 98 cells there was no significant difference, in the tray with 200 cells the 50% soil + 50% humus presented higher index, not statistically different from Bioplant and 50% soil + 50% humus and 75% soil + 25% humus, all of them differing only from humus (Table 4). The speed of emergence is dependent on the vigor of the seed and the characteristics of the substrate surrounding the seed, in this way the physical structure of the substrate can form a barrier making the emergence difficult, as the substrate humus, because its composition is rich in cementing minerals, which after moistening are added and with the decrease of moisture forms a thin crust, then the best alternative to being mixed with the soil to increase the porosity of the substrate [12].

Table 04. Averages of the substrate unfolding within the types of trays to characteristic of pepper seedlings.

Substrates	IVE		NF		MFPA		MSR	
	98 cells	200 cells	98 cells	200 cells	98 cells	200 cells	98 cells	200 cells
Bioplant	11.55 a	17.49 a	5.00 ab	4.00 b	0.5087 c	0.2453 bc	0.0153 ab	0.0110 ab
Humus	11.90 a	5.88 b	6.00 a	5.67 a	0.6780 ab	0.5360 a	0.0123 ab	0.0180 a
Soil	13.18 a	17.66 a	4.00 b	4.00 b	0.2727 d	0.1787 c	0.0093 b	0.0113 ab
50% Soil + 50% Humus	9.16 a	15.49 a	6.00 a	4.33 b	0.7213 a	0.3540 b	0.0173 ab	0.0143 ab
75% Soil + 25% Humus	10.25 a	14.82 a	5.67 a	4.00 b	0.5567 bc	0.3153 b	0.0200 a	0.0080 b
$\Delta_{5\%}$	8.85	8.85	1.09	1.09	0.13	0.13	0.0085	0.0085

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

For NF in trays with 98 cells, the humus and 50% soil + 50% humus presented larger amounts, not statistically differing from 75% soil + 25% humus. For the trays of 200 cells the humus presented higher NF, differing statistically from the other substrates, humus presents great amount of nutrients, both macro and micronutrients, thus, in trays with 98 cells because they are larger and contain more mineral nutrients, all substrates were similar, in 200 cell trays where the volume of nutrients is lower the humus for being richer provided that the seedlings leading to a greater number of sheets [13].

For MFPA in the trays with 98 cells the 50% soil + 50% humus presented higher mass, not statistically differing from humus. In the tray with 200 cells the humus presented bigger mass, differing from the other substrates.

For the MSR in the trays of 98 cells the substrate 75% soil + 25% humus presented higher mass, not statistically different from the substrates Bioplant, humus, 50% soil + 50% humus and 75% soil + 25% humus. In the tray of 200 cells, the substrate humus presented greater mass, not statistically differing from Bioplant, soil and 50% soil + 50% humus.

The substrates humus, 50% soil + 50% humus and 75% soil + 25% humus stood out for most of the evaluated variables, and any of these may be used for the production of pepper seedlings, being that the substrate 50% soil + 50% humus presents in technical terms the favorite, because it presents the good physical characteristics of the soil and the optimal nutritional proportion of the humus, being even cheaper in terms of cost-benefit [12].

4. CONCLUSION

The substrates humus, 50% soil + 50% humus and 75% soil + 25% humus stood out for most of the variables evaluated in the production of pepper seedlings.

The trays of 98 cells presented the best conditions for production of sweet pepper seedlings.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

REFERENCES

1. Santos RHS, Silva F, Casali VWD, Conde AR. Residual effect of organic fertilization on lettuce growth and yield. *Braz. Agri. Res.* 2001;36(11):1395-1398. English.
2. Martins VA, Camargo Filho WP, Bueno CRF. Prices of fruits and vegetables of organic agriculture in the retail market of the city of São Paulo. *Econ. Inf.* 2006;36(9):42-52. English.
3. Solino AJS, Ferreira RO, Ferreira RLF, Araujo Neto SE, Negreiro JRS. Organic cultivation of arugula in no-tillage under different types of coverages and doses of compost. *Caat. Mag.* 2010;23(2):18-24. English.
4. Severino LS, Lima RLS, Beltão NEM, Sampaio LR. Growth and macronutrient content in castor seedlings grown on five organic substrates. *Mag. of Biol. and Ear. Sci.* 2008;8(1):1-6. English.
5. Maggioni MS, Rosa CBCJ, Rosa Junior EJ, Silva EF, Rosa YBCJ, Scalón SPQ, Vasconcelos AA. Development of basil (*Ocimum basilicum* L.) seedlings in relation to the container and the type and density of substrates. *Braz. Jour. of Med. Plant.* 2014;16(1):10-17. English.
6. Silva FAS, Azevedo CAV. The Assistat Software Version 7.7 and its use in the analysis of experimental data. *Afri. Jour. of Agri. Res.* 2016;11(39):3733-3740.
7. Coelho JLS, Silva RM, Baima WDS, Gonçalves HRO, Santos Neto FC, Aguiar AVM. Different substrates in the production of sweet pepper seedlings. *Sci. Agric. of the Semi-Arid.* 2013;9(2):01-04. English.
8. Reghin MY, Otto RF, Jacoby CFS, Olinik JR. Influence of tray type on seedling production and yield and quality of onion bulbs of different cultivars under straw cultivation. *Agrot. Sci.* 2006;30(1):58-66. English.
9. Albuquerque KS, Guimarães RM, Gomes LAA, Vieira AR, Jácome MF. Osmotic and gibberellin conditioning in the physiological quality of chili seeds harvested at different maturation stages. *Braz. Jour. of Seed.* 2009;31(4):100-109. English.
10. Delarmelina WM, Caldeira MVW, Faria JCT, Gonçalves EO, Rocha RL. Different substrates for the production of seedlings of *Sesbania virgata*. *For. and Env.* 2014;21(2):224-233. English.
11. Donegá MA, Ferezini G, Mello SC, Minami K, Silva SR. Containers and substrates in the production of seedlings and in the hydroponic cultivation of thyme (*Thymus vulgaris* L.). *Braz. Jour. of Med. Plant.* 2014;16(2):271-274. English.
12. Pelizza TR, Silveira FN, Muniz J, Echer AHB, Morselli TBGA. Production of yellow melon seedlings under protected cultivation on different substrates. *Ceres Mag.* 2013;60(2):257-261. English.
13. Chagas PSM, Costa CAC, Teixeira LB. Chemical composition of California red worm humus (*Eisenia foetida*). *Agra. Sci. Mag.* 2003;39(1):87-94. English.