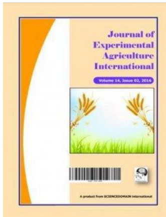

Journal of Experimental Agriculture International

21(6): 1-7, 2018; Article no.JEAI.40464
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Effect of Alternative Substrates and Trays for Production of Biquinho Pepper

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Authors' contributions

This work was carried out in collaboration between all authors. Authors ABSJ and JS participated in the idea and management of the experiment, besides writing the article. Authors MTS and JST were responsible for data collection and analysis. Authors APVC and KDSC conducted the experiment from the implantation to the data collection. Author JLXLC participated in the management and data collection of the experiment, as well as in the bibliographic review. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2018/40464
Editor(s):
(1) Moreira Martine Ramon Felipe, Associate Professor, Departamento de Enxeñaría Química, Universidade de Santiago de Compostela, Spain.
Reviewers:
(1) Halil Demir, Akdeniz University, Turkey.
(2) MK Yadav, SVP University of Agriculture and Technology, India.
Complete Peer review History: http://www.sciencedomain.org/review-history/23887

Short Research Article

Received 17th January 2018
Accepted 26th March 2018
Published 29th March 2018

ABSTRACT

This plant was cultivated long ago. However, the proper management of Biquinho pepper in relation to the production of the seedlings is unknown, being this a fundamentally important stage of the productive system. In which the quality of the seedling will directly influence the final performance of the plants, nutritional quality of the fruits, and in the time for seedling production. Thus, the present research had the objective of evaluating the effect of alternative substrates and trays for the production of Biquinho pepper seedlings. Five substrates and two types of trays were evaluated. Substrates were S_1: Bioplant® commercial substrate (control); S_2: earthworm humus; S_3: soil; S_4:

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50% soil + 50% earthworm humus and S_5: 75% soil + 25% earthworm humus, and tray types B_1: with 98 cells, and B_2: with 200 cells, in a completely randomized design, in the 5 x 2 factorial scheme, with four replications. For MSPA and MSSR it can be observed that substrates S_1, S_2, S_4 and S_5 had the best results, this was due to the accumulation of photoassimilates. Note that for both characteristics B_1 provided the highest values, generating the greatest development of seedlings, S_2, S_4 and S_5 substrates, combined with the B_1 type of tray in the production of Biquinho pepper seedlings (*Capsicum chinense*) are recommended.

Keywords: Capsicum chinense; seedling quality; initial development; cell volume; organic compounds.

1. INTRODUCTION

Peppers of the genus *Capsicum*, belong to the Solanaceae family and have their origin in the South American region. These plants have found in Brazil satisfactory conditions for their development, also being cultivated in numerous countries. The consumer market for peppers has been growing because of its versatility of products and by-products, which can be consumed in natura or processed. Its fruits can be used in the food industry, being part of countless condiments; extraction and use of their active principles in the manipulation of medicines; and floristics, when used for ornamental purposes [1,2].

Among the domesticated species, the species *Capsicum chinense* Jacq. stands out for being considered the most Brazilian among other species, since its greatest center of genetic diversity is in the Amazon. This species presents six different morphotypes, which are chilli pepper, goat's chili, cumari of Pará, murupi, habanero and biquinho [3].

Although cultivated long ago, little is known about the proper handling of the biquinho pepper, being the production of the seedlings a very important stage of the productive system. In this sense, in order to obtain high yields in fruit harvest, it is necessary that the seedlings for the transplanting be of high quality, present high vigor and that there be absence of phytopathogenic agents. Thus, these characteristics are considered decisive, because it will influence the final performance of the plants, the nutritional quality of the fruits, and will also influence on the time for seedling production [3,4].

The quality of the seedling is highly dependent on the volume of the container where it will be planted and the quality of the substrate used, which should provide adequate conditions for seed germination and seedling development, due to its characteristics like structure, aeration, water retention capacity, degree of pathogen infestation, among others, which can favor or damage germination of seeds [5].

In this sense, the substrate to be used should guarantee adequate texture for the root system and stability of the plant, retention of water as well as the availability of nutrients and aeration required for growth and development. Manufacturing of the substrates can be done by use of natural compounds with different proportions, taking into account the availability in the region and the low cost [6]. Substrates may also contain residues from agro-industrial processes and agriculture, becoming a viable alternative for sustainable development, helping to reduce production costs and reducing dependence on commercial inputs, avoiding the accumulation of waste and reducing environmental pollution [7].

Another aspect that influences the quality of the seedling is the volume of substrate to be exploited by the root system of the seedling. Thus, reducing the volume of the substrate may affect growth, photosynthesis, and chlorophyll content in leaves, the absorption of nutrients and water, respiration and flowering, thus preventing the seedling from expressing its quality, with a reflection on productivity. Therefore, knowledge of the proper substrate volume is very important, because it can reduce the cost of production of seedlings [8].

The present research aimed at the evaluation of the effect of substrates and alternative trays for the production of pepper seedlings.

2. MATERIALS AND METHODS

2.1 Site Location

The experiment was conducted in a greenhouse at the Agricultural Sciences Center of the Federal University of Alagoas (CECA/UFAL), located in the municipality of Rio Largo-AL (09º28' 02" S; 35º49’43”W; 127 m), in March 2016.

2.2 Experimental Design and Treatments

Five combined substrates and two types of trays were evaluated, the substrates were S_1: Bioplant® commercial substrate (control); S_2: Earthworm humus; S_3: Soil; S_4: 50% Soil + 50% Earthworm humus and S_5: 75% Soil + 25% Earthworm humus, whose chemical compositions are presented in Table 1, and tray types B_1: with 98 cells and B_2: with 200 cells.

The design was completely randomized, in the 5 x 2 factorial scheme (five substrates and two types of trays), with four replications. Sowing was done in the respective trays. The area of the 40 central seedlings on the tray was considered the useful area, regardless of the type of tray used. Before sowing, the cells of the trays were filled with the substrates corresponding to the treatments. Seeds were planted at 1 cm deep.

2.3 Evaluated Parameters

Irrigations were performed daily until the 33rd day after sowing (DAP). This period was considered suitable for transplanting the seedlings. From there on, the following characteristics were evaluated: emergence (E) in%; number of leaves (NF) in units; base diameter (DC), in mm; plant height (AP), in cm; root length (CR), in cm; shoot mass (MSPA), in g; and root dry mass (MSSR), in g.

The variable "E" was calculated by the formula $E = \frac{N}{A} x\ 100$ $E = \frac{N}{A} x\ 100$ where, "N" is the total number of emerged seeds; "A" is the total number of seeds sown. For the "NF" and the "DC", a digital caliper was used. Measurements were taken at the height of the molt. To define the "AP", a milimetric ruler was used, when it was measured from the base of the plant until the insertion of the last leaf. Then, the "CR" was determined through the length of the root of greatest length. For the variables "MSPA" and "MSSR", the seedlings were sectioned at the base, when the root was separated from the substrate in running water, placed in paper bags separately and then taken to a forced circulation oven at 65ºC for 72 hours. After this period, they were weighed with an analytical balance.

2.4 Statistical Analysis

Analyzes of variance were performed. In case the F test was significant, the Tukey test was applied at 5% probability using the Assistat 7.7 computational software [9].

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

Parameters	Substrates*				
	T_1	T_2	T_3	T_4	T_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

**T_1*: Bioplant®; T_2: Earthworm humus; T_3: Soil; T_4: 50% Soil + 50% Earthworm humus; 50% Soil + 50% Earthworm humus*

3. RESULTS AND DISCUSSION

Significance was observed at the 5% probability level by the F test for the substrate interactions x trays for the variables "DC", "AP" and "MSSR". On the other hand, there was no significance at 5% probability level for the F test for the substrates, trays and substrates x trays interactions in relation to "E" (Table 2).

The "E" emergence was not influenced by the substrates nor by the volumes of substrates contained in the trays. It does not interfere with the performance and development of the plant at the early stage of development. However, the alternative substrates have properties that favor the greater retention of water and higher level of fertility, which provide higher moisture contents in relation to more porous substrates. These conditions favor the emergence and development of seedlings. These characteristics are of great relevance for the use of the substrate. These statements may be confirmed by observing the results obtained by [10] who evaluated the substrate composed of soil and cattle manure in the ratio of 7:3, with several irrigation slides on the Biquinho pepper, and obtained a maximum emergence of 50.18% below the mean substrate emergence of the present study, which was 74.06% (Table 3).

Table 2. Summary of analysis of variance and coefficients of variation in the evaluation of alternative substrates and trays for production of Biquinho pepper seedlings, Rio Largo - AL, 2016

Source of variation	QM						
	E[1]	NF	DC	AP	CR	MSPA	MSSR
Substrates (S)	0.7180ns	0.1837**	0.0810**	1.1147**	3.2058*	0.0006**	0.0001*
Trays (B)	1.1615ns	0.4205**	0.0615**	3.8083**	2.4067**	0.0041**	0.0001*
Interaction S x B	0.3326ns	0.0482ns	0.0172**	0.3369**	2.0023ns	0.0003ns	0.0001ns
Residue	0.7528	0.0389	0.0034	0.0300	1.0030	0.0001	0.0001
CV (%)	10.13	8.03	4.65	4.70	11.04	37.12	33.24

*ns and *, not significant and significant, respectively, to 5% probability by the F test.*
[1/] emergence (E), base diameter (DC), plant height (AP), root length (CR), shoot dry mass (MSPA) and root dry mass (MSSR)

Table 3. Mean values of emergence (E), number of leaves (NF), root length (CR), dry mass of the aerial part (MSPA) and dry mass of the root system (MSSR) in the evaluation of alternative substrates and trays for production of Biquinho pepper seedlings, Rio Largo - AL, 2016

Substrate[2]	E (%)	NF (uni.)	CR (cm)	MSPA (g. seedling^{-1})	MSSR (g. seedling^{-1})
S_1	79.71 a[1]	6.20 ab	8.80 ab	0.0308 ab	0.0128 ab
S_2	73.02 a	7.00 a	8.20 b	0.0420 a	0.0148 a
S_3	64.38 a	4.80 b	8.72 ab	0.0134 b	0.0070 b
S_4	79.62 a	6.80 a	10.14 a	0.0396 a	0.0136 ab
S_5	73.81 a	5.67 ab	9.58 ab	0.0312 ab	0.0127 ab
Overall average	74.06	-	-	-	-
DMS	26.74	1.69	1.86	0.0219	0.0073
Tray[3]	E (%)	NF (uni.)	CR (cm)	MSPA (g. seedling^{-1})	MSSR (g. seedling^{-1})
B_1	77.66 a	6.77 a	10.05 a	0.0447 a	0.0143 a
B_2	70.72 a	5.50 b	8.16 b	0.0198 b	0.0104 b
Overall average	74.06	-	-	-	-
DMS	11.68	0.73	0.81	0.0095	0.0032

[1]/ Averages followed by the same letter in the column do not differ from each other by the Tukey test at 5% probability. [2]/ S_1: Bioplant®; S_2: Earthworm humus; S_3: Soil; S_4: 50% Soil + 50% Earthworm humus; S_5: 75% Soil + 25% Earthworm humus; [3]/ B_1: 98 cells; B_2: 200 cells

As for the number of leaves (NF) emitted by the plants, it was observed that the substrates S_1, S_3 and S_5 presented the lowest values, which may reflect on the quality of the seedlings, because seedlings with fewer leaves tend to synthesize fewer photo assimilates. According to [11] the NL difference between the substrates S_1, S_3 and S_5 and the others can be explained by the amount of N in the substrates, which is one of the essential elements directly related to growth and foliar mass [12]. In addition, according to the chemical composition of the substrates (Table 1), it is noteworthy that these treatments had the lowest OM (where N is also contained), and also higher levels of acidity in the substrates (pH), the latter being responsible for not making many elements available) [13]. In relation to the trays, B_1 (98 cells) obtained the highest NF with 6.77 units. This response tied to the greatest volume of soil contained in this treatment.

Root length (CR) is one of the parameters responsible for the glue of the seedling in the field, being an indirect indicative of aeration of the substrate. Plants with higher CR present low resistance to root penetration, thus reflecting on more vigorous seedlings [5]. Thus, substrates S_1, S_3, S_4 and S_5 presented the best results. It is worth noting that the treatments S_3, S_4 and S_5, with the alternative substrates, had the same performance as the commercial, evidencing the good quality of these substrates. Regarding the types of trays, B_1 treatment (98 cells) had the highest value differing from B_2 (200 cells). This result is due to the higher volume of cells. Several authors report that as the seedlings grow, cells with low volume of substrates would provide less nutrients and water. Consequently, these exhaust quickly, limiting the quality of seedlings, being preferable to opt for trays with higher volumes of cells [8,14,15].

For the shoot dry mass (MSPA) and the root dry mass (MSSR) it can be observed that the substrates S_1, S_2, S_4 and S_5 had the best results. Thereby, most of the alternative substrates provided conditions of satisfactory vegetative development of the plants in relation to the commercial substrate, thus evidencing an alternative in the production of seedlings with quality, evidencing the possibility of substitution of the commercial substrate. Considering the types of trays, it is noted that for both characteristics, B_1 (98 cells) provided the highest values, generating the greatest development of the seedlings in detriment of the greater space available for the roots and for the amount of substrate [8].

As can be seen in Table 4, base diameter (DC) and plant height (AP) characters showed significant interaction between substrates and trays.

Substrates S_2 and S_4 presented the highest values of DC for B_1 (98 cells). When compared to B_2 (200 cells), treatment S_2 always obtained the largest diameters. However, no significant difference was observed for the S_5 treatment. When analyzing the three substrates (S_2, S_4, and S_5), the best agronomic performances are observed in relation to the other compositions. [16] attribute the greater availability of nitrogen, which has a great contribution to the developmental characteristics of crops.

The chemical composition of these substrates (Table 1) follows the descending order of MO,

Table 4. Mean values of base diameter (DC) and plant height (AP) in the evaluation of alternative substrates and trays for production of Biquinho pepper seedlings, Rio Largo - AL, 2016

Substrates[2]	DC (mm)		AP (cm)	
	Tray[3]		Tray	
	B_1	B_2	B_1	B_2
S_1	1,0700 b[1]	1,0275 bc	3,2667 a	3,9500 b
S_2	1,3333 a	1,4800 a	3,5667 a	4,9333 a
S_3	1,0900 b	1,1233 c	2,5000 b	3,3500 c
S_4	1,3500 a	1,3000 b	3,7000 a	4,1000 b
S_5	1,1767 b	1,3467 ab	3,3000 a	4,0000 b
DMS	0,1317		0,3902	

[1]/ Averages followed by the same letter in the column do not differ from each other by the Tukey test at 5% probability. [2]/ S_1: Bioplant®; S_2: Earthworm humus; S_3: Soil; S_4: 50% Soil + 50% Earthworm humus; S_5: 75% Soil + 25% Earthworm humus; [3]/ B_1: 98 cells; B_2: 200 cells

thus: S_2> S_4> S_1> S_5. However, pH 5.0 of S_1 may have made several nutrients unavailable, reflecting on several parameters, such as Mg, Mn, SB, CTC and V that had the highest values for S_2, S_4 and S_5 respectively, being Mg and Mn important constituents in the complex process of assimilation of CO_2 by plants, indicating that lower DC are related to the low ability that this substrate has in providing nutrients, compared with other substrates [11,17].

When analyzing substrates S_2, S_4 and S_5, it was verified that they have the same performance as the commercial S_1 for tray type B_1 (98 cells) for plant height (AP). With respect to B_2 (200 cells), substrate S_2 obtained the highest value, differing from all others, expressing a superior behavior in relation to the others, as well as the substrate commercial, making it clear that it is possible to use alternative sources of substrates without loss of seedling quality. Some authors attribute the result of S_2 to the higher essential ion contents available in the substrate and to the pH because it is close to neutrality, favoring greater availability of nutrients for seedlings, because despite the smaller volume of the substrate B_2, the nutritional quality of S_2 ensured the adequate supply of the elements to the seedlings, being statistically superior to other substrates [7,11, 18,19].

4. CONCLUSION

In the conditions under which the experiment was conducted, it was concluded that the substrates and the types of trays used influenced the production of Biquinho pepper seedlings. Substrates S_2, S_4 and S_5 are recommended, since there is no loss of quality and vigor of the molt when compared to the control treatment, allied to tray type B_1.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/23887