Original Research Article

Effect of Organic Biofertilizer on Initial Lettuce Development

ABSTRACT

Aims: The objective of this work was to evaluate the effects of the application of organic fertilizer in different concentrations under the initial development of lettuce plants.
Study design: The experimental design was completely randomized with four replications of 5 plants for each treatment.
Place and Duration of Study: The present work was carried out in the premises of the Escola Família Agrícola de Ladeirinhas 'A' - EFAL, located in the Municipality of Japoatã in the State of Sergipe, Brazil. Between September 2022 - December 2022.
Methodology: Daily applications of biofertilizer were performed in lettuce plants of Cv. Repolhuda, with a volume of 200 ml per plant, in the morning and afternoon, except for days with precipitation. To evaluate the effect of biofertilizer, different concentrations 0% (control) were used. 5%, 10% and 20%. The following variables, fresh mass, number of leaves, plant height and root system length were analyzed.
Results: The results obtained with the application of organic biofertilizer, showed that the plants that were biofertilized showed better initial development of lettuce Repolhuda, when compared with plants that did not receive the application of biofertilizer for most of the variables analyzed in this study, and the concentration of 20% presented the best result.
Conclusion: The results obtained with the application of organic biofertilizer, showed that the plants that were biofertilized showed better initial development of lettuce

Keywords: Agriculture; sustainability; vegetables; plant nutrition.
;

1. INTRODUCTION

The conventional system of agriculture has several economic advantages, however, can cause environmental damage, thus preventing the development of sustainable agriculture. The sustainability theme has been highlighted in the agricultural environment by adopting alternative practices to the conventional system, reducing damage to the environment [1].
In recent years the demand for healthier foods by consumers has changed the production process of products of animal and plant origin. Causing exponential growth and appreciation of products produced sustainably [2]. This fact has modified the production system mainly of small and medium-sized street producers, who began to interact more as an environment [3].
Thus, the production and use of organic biofertilizers in agriculture has been gaining more and more followers, being an alternative to chemical fertilizers that present rapid responses of the plant, however, provide a greater degradation of the soil and the environment [4].
The biofertilizer is defined as an organic fertilizer that contains microorganisms and macro and micronutrients, which improve the defense of plants, providing a greater tolerance to the attack of pests and diseases [5]. According to Finatto et al. [6] the organic fertilizer is

constituted by sources of animal and/or vegetable origin, which after the decomposition process, results in an organic compound.
The use of biofertilizers has been showing growth, where they partially or totally replace the use of fertilizers of mineral origin in agriculture [7].
The use of organic waste from animal husbandry and by-products of agricultural production is a long-term and promising alternative in crop fertilization [8]. The manipueira that is a residue of cassava root processing has been used as a biofertilizer, for promoting the recycling of nutrients in the soil [9]. Another positive point regarding the use of biofertilizers is that this agricultural input can be produced by the farmer himself on his property, bringing economy and reduction of application of chemical fertilizers.
In recent years several studies have been conducted on the use of biofertilizers in the production of different crops, strawberry [10], passion fruit [11], lettuce [12] and others.
Lactuca sativa (lettuce) is a vegetable belonging to the botanical family of Asteraceae, being the leafy vegetable with greater importance worldwide [13]. In Brazil, being among the main vegetables in terms of production, marketing [14], due to these factors has significant economic importance.
In addition, lettuce is well accepted by consumers, because it is balanceable and quick and easy to prepare [15]. Its leaves are the most used part, followed by stalks (in the preparation of juice), usually consumed fresh in different salads and in recent years as microgreens (cotyledon phase) [16].
In Brazil, vegetables are produced within family farming, with lettuce growing is no different, being one of the preferred vegetables of small farmers, due to the little space needed for cultivation, use of few inputs and due to its short cycle [17]. Thus, the cultivation of this vegetable has contributed to the generation of employment, inserted mainly in family farming, being a primary source of income for families [18]..
Given the above, the objective of this study was to evaluate the effects of the application of organic biofertilizer at different concentrations under the initial development of lettuce plants.

2. MATERIAL AND METHODS

2.1 Description of the experiment site

The present work was carried out in the premises of the Escola Família Agrícola de Ladeirinhas 'A' - EFAL, located in the Municipality of Japoatã in the State of Sergipe, Brazil (Fig. 1A and 1B).

2.2 Preparation of the experiment area and production of lettuce seedlings

The first activity carried out for the development of the work, was the cleaning of the area to be used during the experiment, and it performs on September 14, 2022.
On September 17, seeds of the cultivar of Lettuce Repolhuda (Topssed) for seedling production were sown in polypropylene trays of 200 cells with dimensions of 54x28x5 cm (Fig. 2), where they remained until transplanting, which was carried out 34 days after sowing.

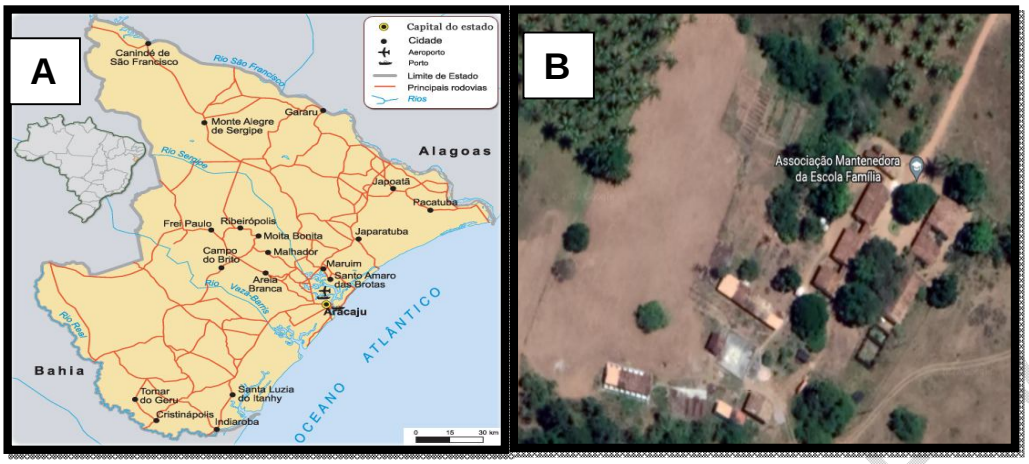

Fig. 1. Map of the State of Sergipe (1A), location of EFAL (1B).

Fig. 2. Seedling production

The seedlings were transplanted to 2-liter pet bottles, which were filled with soil collected at EFAL, remaining until the evaluations (Fig. 3).

2.3 Production of the biofertilizer

2.3.1The following ingredients were used to produce the biofertilizer:

- 10kg of bovine manure.
- 3kg poultry manure (chicken).
- 1kg of chewed sugar.
- 2kg of ash.
- 40 L of water.

2.3.2 How to prepare the biofertilizer.

First was placed the 10 kg of cattle manure, then added poultry manure, sugar, ash and added 40 liters of water, all in a barrel of 200 liters. Afterwards, the ingredients were homogenized, after this stage, remaining at rest for 6 days.

After this period the biofertilizer presented dark color and strong smell, being ready to be used.

Fig. 3. Conducting the Experiment

2.4 Application of the biofertilizer

Daily applications of biofertilizer were performed in lettuce plants of Cv. Repolhuda, with a volume of 200 ml per plant, in the morning and afternoon, except for days with precipitation. To evaluate the effect of the biofertilizer, different concentrations were used with the following:

T1- Control (Without biofertilizer)
T2- 5% biofertilizer concentration
T3- 10% biofertilizer concentration
T4- 20% biofertilizer concentration

2.5 Variables that were analyzed

a) Fresh mass: a household balance was used to determine fresh mass
b) Number of leaves: count of existing leaves per plant.
c) Plant height: a graduated ruler was used to determine the plant height.
d) Length of the Root System: a graduated ruler was used to determine the height of the plant.

2.6 Statistical analysis

The experimental design was completely randomized with four replications of 5 plants for each treatment. The data obtained were submitted to the tests of normality, homoscedasticity, analysis of variance, Tukey test at 5% probability with the aid of the statistical program GENES. The graphics were generated using the software Sigma Plot version 14.

3. RESULTS AND DISCUSSION

The results obtained by the F test of the analysis of variance show that there were significant differences for most of the variables evaluated, except for variable length of the root system (Table 1). Demonstrating that the application of biofertilizer at different concentrations significantly influence the initial development of lettuce plants Cv. Cabbage (Table 1).
It was observed that the increase in biofertilizer concentration provided an increase in fresh mass, being significant by the Tukey test at the 5% probability level (Fig.4). Where the application of the biofertilizer with concentration of 20% showed a mean fresh mass value of 6.05 g/plant, while the control treatment plants was 2.65 g/plant, a decrease of about 56,2%

when compared to plants that received the biofertilizer at a concentration of 20% (Table 1 and Fig. 4).

Table 1. Fresh mass averages (MF), number of leaves (NL), plant height (AH) and root length (RL) of lettuce plants Cv. Repolhuda, after application of organic biofertilizer at different concentrations.

Tratamentos	MF (g)	NL	AH (cm)	RL (cm)
Control	2.65	5.20	5.80	5.10
5%	4.10	6.30	8.40	5.88
10%	5.60	5.70	9.05	5.58
20%	6.05	6.45	9.00	5.50
Test F	18.52 **	6.32 **	12.39**	1.511 ns
DMS	1.50	0.96	1.83	5.65
CV%	15.6	7.74	10.83	9.42

***, significant at the level of 1% respectively by the F. ns test = not significant at the level of 5 % probability.*

The results corroborate with Crivelare et al. [14], which identified a significant difference with the use of algae-based biofertilizer for variable fresh mass, where concentrations of 25% and 50% provided an increase in fresh mass. The results corroborate with the study conducted by Adiloğlu et al. [19] and Cardarelli et al. [20], which demonstrate that the application of organic fertilizers provides an increase in the fresh mass of lettuce leaves. Similar results were obtained with the use of liquid biofertilizer in biquinho pepper plants, providing a wow in the fruit mass [21].

Different results were found by [22] when applying a biofertilizer based on efficient microorganisms (EM) in lettuce culture, did not observe significant difference when applying the biofertilizer.

The results reported in the literature show that depending on the raw material used in the production of biofertilizer can influence the plant's response to its application.

As well as, in the fresh mass variable, the concentration of 20% provided better average number of leaves, however, not differing significantly from the results obtained with the concentration of 5%, being the average respectively 6.45 leaves/plant and 6.30 leaves/plants (Table 1 and Fig. 5).

Similar result was observed by, with application of biofertilizer with concentration of 50%, obtaining an average number of leaves per plant of 4.17, providing an increase in the number of leaves in relation to the control treatment [14], the ones obtained in this study when the plants received the biofertilizer at concentrations of 5% and 20%. As well as Freitas et al. [23] who found 5.6 leaves/plant, when they applied Organomineral Nucleus® fertilizer in lettuce seedling production.

The results of the variable plant height showed the beneficial effect of the use of biofertilizer in the initial development of lettuce plants Cv. Repolhuda, where all concentrations were significantly higher than the control treatment (without biofertilizer), but similar to each other (Fig. 6).

According to Oliveira et al. [3] the number of leaves and plant height may be associated with the effect that the biofertilizer exerted on the physical-chemical and biological properties of the soil, thus increasing the ability of the soil to store nutrients indispensable for plant development.

The variable root system length did not show significant difference between the treatments tested (Figure 7). However, the application of biofertilizer provided a greater development of the root system when compared to the control treatment (Table 1 and Figure 7).

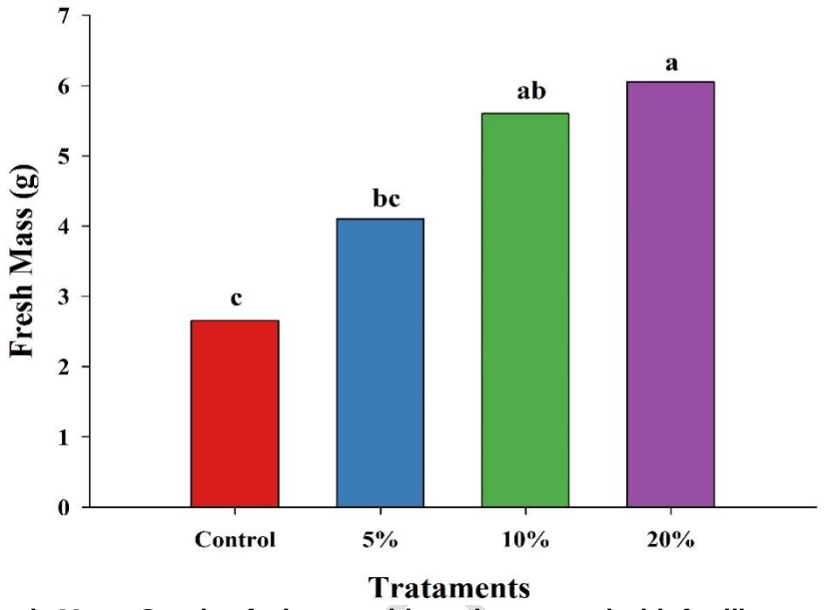

Fig. 4. Fresh Mass Graph of plants subjected to organic biofertilizer application at different concentrations. Treatments followed by the same letter do not differ statistically by Tukey's test at the 5% probability level.

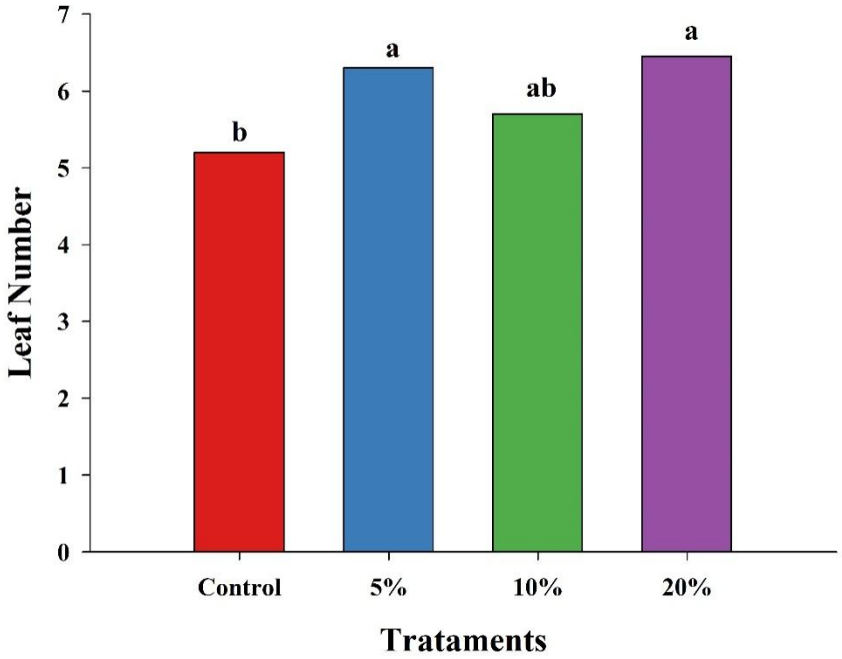

Fig. 5. Leaf Number Graph of plants subjected to organic biofertilizer application at different concentrations. Treatments followed by the same letter do not differ statistically by Tukey's test at the 5% probability level.

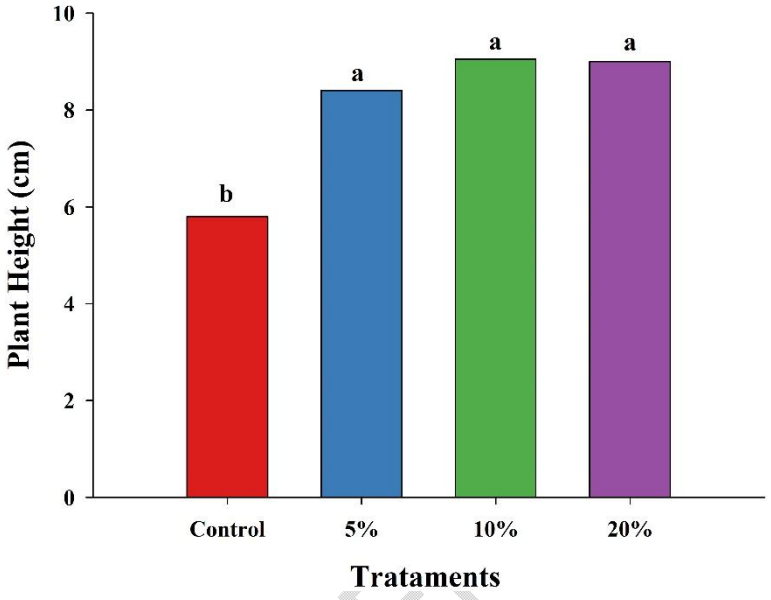

Fig. 6. Plant Height Graph, of plants subjected to organic biofertilizer application at different concentrations. Treatments followed by the same letter do not differ statistically by Tukey's test at the 5% probability level.

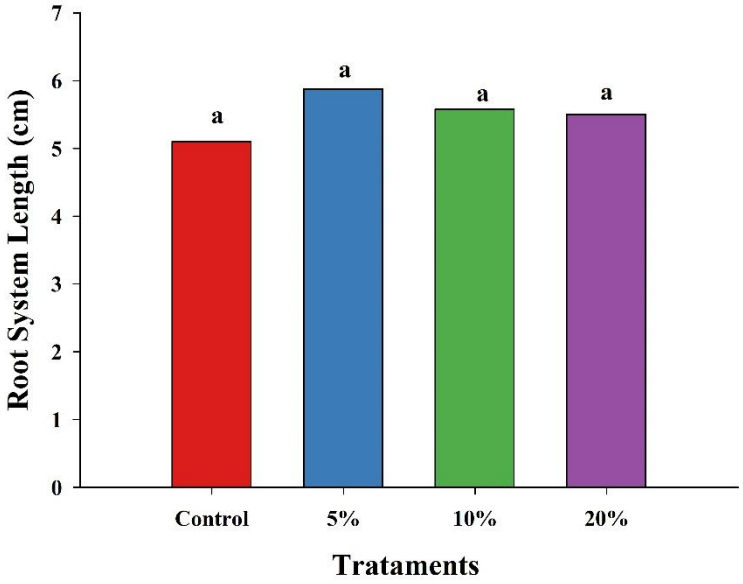

Fig. 7. Root System Length Graph of plants subjected to organic biofertilizer application at different concentrations. Treatments followed by the same letter do not differ statistically by Tukey's test at the 5% probability level.

The results corroborate with the study conducted by Costa et al. [24] with fourth lettuce cultivars, obtained 5.5 cm for root length as one of their best results, when applying biofertilizer based on cattle manure. As well as the study conducted by Mohammed et al. [25], who observed an increase in dry mass, fresh mass and roots of plants that received manure from birds.

This was not observed by Sabka [22], where the plants that received the application of biofertilizer showed lower results in relation to plants that did not receive the application of biofertilizer during its cycle.

Demonstrating that the application of biofertilizer as a source of nutrients in the production of vegetables, at the initial stage of development is usually brings positive effects to its development, however, each crop or cultivar responds differently.

4. CONCLUSION

The results obtained with the application of organic biofertilizer showed that the plants that were treated with biofertilizer showed better initial development of lettuce cv. Repolhuda, being significantly higher when compared to plants that did not receive the application of biofertilizer for most of the variables analyzed in this study, and the concentration of 20% presented the best result.

It was also observed that with increased concentration of biofertilizer, there is an increase in the mean values of fresh mass, number of leaves, plant height and root system length, increasing the concentration of biofertilizer did not negatively affect the development of plants.

However, new studies should be performed to verify the maximum concentration that the plants will tolerate without causing stresses that may limit their development and productivity.

REFERENCES

1. Barbosa, Cleisson Hugo et al. Nutritional efficiency of different biofertilizers produced from family farming residues in the development of sweet pepper. 2019. Portuguese.

2. Cruz, FTD and SChneider, S. Food quality, production scales and valuation of traditional products. Brazilian Journal of Agroecology. 2010; 5(2), 22-38. Portuguese.

3. Oliveira, A., Costa, A., Mota, t., Ferreira, WS. Homemade biodigester applied to the production of biofertilizer from bovine biomass. Scientia Amazonia. 2019; 8(1), e14-e19. Portuguese.

4. Johannsen, SS and Armitage, P. Agricultural practice and the effects of agricultural land-use on water quality. In Freshwater forum. 2010 (Vol. 28).

5. Stuchi, JF. Biofertilizer: a quality liquid fertilizer that you can make.2015. Portuguese.

6. Finatto J, Altmayer T, Martini MC, Rodrigues M, Basso V, Hoehne LA. Importance of using organic fertilizer in agriculture. Academic highlights magazine. 2013; 5(4). Portuguese.

7. Silva, ACMD. Biofertilizers: opinion study, research trends and Brazilian legislation. 2021. Portuguese.

8. Paolini V, Petracchini F, Segreto M, Tomassetti L, Naja N, Cecinato A. Environmental impact of biogas: A short review of current knowledge. Journal of Environmental Science and Health. 2018; Part A, 53(10), 899-906.

9. Ramos, JG, de Lima, VLA, de Oliveira, MP, do Nascimento, MTCC, de Araujo, NC, de Araujo Pereira, MC. Cultivation of hybrid corn with macronutrients, human urine and cassava applied via foundation and fertigation. IRRIGATE. 2020; 25(2), 420-431.

10. Mazaro, SM, Mangnabosco, MC, Citadin, I, Paulus, D, de Gouvea, A. Yield and quality of strawberry plants under different concentrations of Bordeaux mixture, calcium sulphur, and supermagro biofertilizer. Seminar: Agricultural Sciences. 2013; 1(34), 3285-3294. Portuguese. DOI 10.5433/1679-0359.2013v34n6Supl1p3285

11. Lima AS, Alves JM, Mesquita FO, Mesquita EF, Sousa CS, Silva FL, Soares LS. Organic Fertilization and Hydric Reposition in the Initial Production of Passiflora edullis. flavicarca

Deg. Journal of Experimental Agriculture International. 2019; 30(3), 1-14. DOI: 10.9734/JEAI/2019/46338

12. Chiconato DA, De Simoni F, Galbiatti JA, Franco CF, Caramelo AD. Lettuce response to biofertilizer application under two levels of irrigation. Bioscience Journal.2013; 392-399. Portuguese.

13. Sala, FC and Costa, CPD. Retrospective and trend of Brazilian alphaciculture. Brazilian horticulture. 2012; 30, 187-194. Portuguese.

14. Crivelari, AD, Correa, JS, da Silva, C. P. Development of lettuce and arugula seedlings treated with seaweed extract biofertilizer. Científic@-Multidisciplinary Journal. 2021; 8(1), 1-10. Portuguese. Doi.org/10.37951/2358-260X.2021v8i1.5652

15. Teng, J, Liao, P, Wang, M. The role of emerging micro-scale vegetables in human diet and health benefits—An updated review based on microgreens. Food & function. 2021; 12(5), 1914-1932. Doi.org/10.1039/D0FO03299A

16. Turner ER, Luo Y, Buchanan RL. Microgreen nutrition, food safety, and shelf life: A review. Journal of food science.2020; 85(4), 870-882. doi.org/10.1111/1750-3841.15049

17. Bonett LP, Oliveira KM, KabayashI GH, Gino BG, Magalhaes HM, da Cruz RMS. CV lettuce productivity. Isabela® under application of liquid fertilizers. in

Colloquium Agrariae.2019;15, nº.4, pp. 74-81. Portuguese

DOI: 10.5747/CA.2019.V15.N4.A313

18. Resende, GM, Alvarenga, MAR, Yuri, JE, Souza, RJD. Yield and macronutrient contents in iceberg lettuce as a function of nitrogen and molybdenum doses. Brazilian horticulture. 2012; 30, 373-378. Doi.org/10.1590/S0102-05362012000300003

19. Adiloğlu S, Eryılmaz Açıkgöz F, Solmaz Y, Çaktü E, Adiloğlu A. Effect of vermicompost on the growth and yield of lettuce plant (Lactuca sativa L. var. crispa). International Journal of Plant & Soil Science. 2018; 21(1), 1-5. DOI: 10.9734/IJPSS/2018/37574

20. Cardarelli, M, El Chami, A, Iovieno, P, Rouphael, Y, Bonini, P, Colla, G. Organic Fertilizer Sources Distinctively Modulate Productivity, Quality, Mineral Composition, and Soil Enzyme Activity of Greenhouse Lettuce Grown in Degraded Soil . Agronomy. 2023; 13(1), 194. Doi.org/10.3390/agronomy13010194

21. Pereira, JM, Stolf, R, da Silva, JDCB, Vicentini-Polette, CM, da Silva, PPM, Biazotto, AM, Sala, FC. Agronomic, physicochemical, and sensory characteristics of fruit of Biquinho pepper

cultivated with liquid biofertilizer. Scientia Horticulturae. 2021; 288, 110348. DOI.org/10.1016/j.scienta.2021.110348

22. Sabka, VDS. Application of biofertilizer in the production of lettuce (Lactuca sativa L.).2021. Portuguese

23. Freitas, A, Silva, A, Santi, A, Magalhães, M, Silva, G. Production of lettuce seedlings in substrate under doses of organomineral fertilizer. Biosphere Encyclopedia. 2019; 16(29). Portuguese.

24. Costa AC, Rodrigues MDL, Vasconcelos LC, Garcia RV, Carvalho AHDO, Lima WL. Bovine manure biofertilizer in productiono de mudas de alface. Cadernos de Agroecologia. 2018; 13(1). Portuguese

25. Omohammed, OO, Saleh, MA, Mandour, MA. Effect of different sources of organic fertilizers on vegetative growth, yield and storability of lettuce plants. Egyptian Journal of Agricultural Research. 2019; 97(4), 685-703. DOI: 10.21608/EJAR.2019.111102