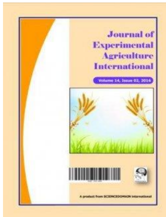

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The Effects of a Biofertilizer Containing Growth-Promoting Bacteria on the Eggplant (*Solanum melongena* L.)

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The use of organic fertilisers in vegetable cultivation is important in the pursuit of increased production to improve the physical, chemical and biological characteristics of the soil, to promote plant growth, and to achieve economically viable productivity for farmers of small- and medium-sized farms. This study aimed to evaluate the development and productivity of eggplant after its fertilisation with a biofertiliser that was composed of sugar and alcohol waste and a bacteria growth promoter for plants. The Ciça genotype of eggplant plants werewas distributed in 20 pots with a

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capacity of 10 L for each pot. The experiment was conducted using a completely randomised design with four treatments and five repetitions. The following treatments were analysed: control (without any fertiliser), chemical fertiliser (NPK), manure and biofertiliser. The analysed parameters included height, stem diameter, weight and number of fruit. The treatments that received some type of fertiliser (chemical or organic) showed higher plant height, and the 'bio-fertiliser' treatment showed better results than the remaining treatments for all parameters. The results for growth in height, stem diameter and number of fruit demonstrated that eggplant adequately responded to fertilisation with biofertiliser in the experimental conditions and about the assessed conventional fertilisers.

Keywords: Biofertiliser; NPK; PGPR; Pseudomonas fluorescens; Solanum melongena.

1. INTRODUCTION

Studies related to interactions between plant and microorganisms have been intensifying in the last years, aiming to understand the diverse factors involved in the selection of strains of efficient bacteria in the promotion of crop growth [1].

An alternative for the biofertilisers is the combination of fertiliser with *Pseudomonas* rhizobacteria, which promotes growth in plants [2,3]. These microorganisms are active in nutrient transformations in soil, which influence their solubility and availability to plants.

The most beneficial species regarding biofertilisation is *Pseudomonas. fluorescens* [4]. These bacteria can fix atmospheric nitrogen, degrade aromatic compounds, and promote the regulation of the synthesis of plant growth and other antagonistic metabolites, as well as siderophores, lytic enzymes (glucanases and chitinases) and antibiotics [5]. These species have been extensively investigated due to their positive interaction with the growth, development and resistance of crops, such as tomatoes, lettuce and citrus [6,7].

The eggplant (*Solanum melongena* L.), a plant of Asian origin, has been introduced and employed for consumption since the Middle Ages. It belongs to the *Solanaceae* family. A height that exceeds 1.0 m and well-developed side branches, hermaphrodite flowers and fruit of an elongated and dark form [8] are the characteristics of it. Eggplant is grown in Brazil in an area of approximately 1,500 ha; its increased consumption is attributed to its properties, which are beneficial to human health, and its ability to provide an alternative to vegetable producers [9].

The objective of this study was to evaluate the growth, bioamass content and eggplant production, using biofertiliser composed of sucroenegetic residues with growth promoter bacteria in plants.

2. MATERIALS AND METHODS

The experiment was conducted in a greenhouse on the IFPE – Vitoria de Santo Antão, Pernambuco Forest in the Greater Region, with 8°5'53"S 35°17'28"W coordinates and an altitude of 167 m. The climate is a type as climate, which is characterised as warm tropical and humid with autumn and winter rains according to the Köppen classification. The micro-region of Vitória de Santo Antão has high temperatures and a long dry season; the average annual rainfall is between 1,008 and 1,395 mm [10].

Eggplant seeds of the Ciça genotype were purchased from domestic businesses; they satisfied all quality specifications (ISLA – Rio Grande do Sul – Brazil). The test microorganism that was employed in this study—*Pseudomonas fluorescens*—was purchased from the Microorganisms Reference Collection of the National Health Institute (FIOCRUZ – Rio de Janeiro – Brazil). The culture was maintained on nutrient agar (NA) at 28°C. Aliquots of bacterial cultures were diluted in saline (0.85 g/100 mL) until a concentration of approximately 10^8 UFC/mL, which corresponds to the range of 0.5 McFarland, was attained. The soil employed in the experiment was obtained in the IFPE- Vitória area and is classified as Chromic Acrisols [11]. The soil chemical properties, which were determined according to EMBRAPA - Brazilian Agricultural Research Corporation [12] are listed in (Table 1). Soil correction was performed with hydrated plaster at a dose of 685 $Kg.ha^{-1}$ [13].

The chemical fertiliser (NPK) consisted of urea, superphosphate and potassium chloride. The cattle manure was obtained in the cattle sector of IFPE –Vitória. The biofertiliser was composed of a mixture of derivatives of sugarcane products (filter cake and vinasse) and the bacterium *Pseudomonas fluorescens* inoculum in the concentration of 10^8 UFC/mL. The filter cake was collected in the Santa Tereza sugarcane industry, which is located in the Goiana District

Table 1. Soil chemical properties employed in the experiment

pH	Ca^{2+}	Mg^{2+}	K^+	Na^+	SB	Al^{3+}	CTCe	(H+Al)	T	v	m	P
(H_2O)	---------------------------------Cmolc/dm3---------------------------------									%		$mg.dm^{-3}$
5,48	1,67	3,73	0,20	0,19	5,79	1,37	7,16	4,83	11,99	48,29	19,13	10,37

and the vinasse was collected in the JB sugarcane industry, which is located in the Vitoria de Santo Antão District of Pernambuco state, Brazil.

Initially, eggplant seeds of the Ciça genotype were manually sown in a Styrofoam tray that contained 200 cells. The substrate consisted of a mixture of soil and cattle manure in a 2:1 proportion. Micro- irrigation was performed throughout the crop cycle. Thinning was conducted fifteen days after sowing to obtain one plant per cell. Transplanting was performed when the average height of the seedlings was ten centimetres, which occurred after 45 days. The treatments were distributed in 20 pots with a capacity of 10 L for each pot. Due to the absence of pests and diseases, pesticides were not utilised.

The experiment was conducted using a completely randomised design with four treatments and five repetitions. The following treatments were analysed: control, chemical fertiliser, manure and biofertiliser.

The control treatment contained soil without any fertiliser. The chemical fertiliser treatment (NPK), which consisted of urea (0.5 g per pot in planting + 0.75 g per pot in cover) superphosphate (2.8 g per potted planting) and potassium chloride (0.5 g per pot in planting + 0.33 g per pot in cover), was placed according to the soil analysis and the recommendations for culture in the state of Pernambuco [14]. The manure treatment contained only cattle manure. The biofertiliser treatment was composed of a mixture of derivatives of sugarcane products (filter cake and vinasse) and the bacterium *Pseudomonas fluorescens* inoculum in the concentration of 10^8 UFC/mL. The addition of manure and bio-fertiliser was performed according to the organic fertiliser recommendation for culture in the state of Pernambuco [14].

Each batch of biofertiliser was obtained by mixing 5.5 kg of the filter cake that was air- dried, 300 ml of the bacterial inoculum, 400 ml of distilled water and 2.5 L of vinasse to obtain a homogeneous material with a moisture level that was similar to the moisture level of the field capacity.

The analysed parameters included the height, stem diameter, weight and number of the fruit. Plant height (cm) was determined by measuring the plant cervix to the upper edge using a ruler that was graduated in centimetres (cm). The stem diameter was estimated to be 150 mm by performing measurements close to the ground with the aid of a digital calliper model. Measurements were obtained for all plants for each repetition of four treatments. To determine the weight and number of fruit, one sample was extracted per week for four weeks.

Variables were submitted to Analysis of Variance (ANOVA), where the F- test was significant for diameter, plant height, root and aboveground biomass, fruits number and wet fruit weight. The regression analysis and the Tukey test were performed to compare each treatment.

3. RESULTS AND DISCUSSION

Dry root mass and dry shoot mass treatment with biofertiliser stood out among the others, showing the best results (Table 2). Bernardes et al. [15] found higher values of root growth in lettuce plants inoculated with isolates of *Pseudomonas fluorescens*.

Hartmann et al. [16] found a positive correlation between onion shoot dry mass and inoculation of bacteria growth promoter isolates. The isolate from *Pseudomonas fluorescens* was the most influencial among these results. Lopez et al. [17] found out that isolates of *Pseudomonas fluorescens* promoted increment in the development and biomass of lettuce plants.

Several studies reported that endophytic microorganisms can promote plant growth in different plants. Plant growth-promoting rhizobacteria (PGPR) like Pseudomonas are of particular interest because of the intrinsic ability of certain strains to colonise the rhizosphere at a high density, to compete successfully with other microbes, and to produce secondary metabolites involved in plant growth stimulation and induced systemic resistance to biotic stress posed by pests and pathogens [18].

Table 2. Root and aboveground biomass, fruits number and fresh fruit mass from eggplants after 80 days of transplanting

Treatments	DRM	DMAP	Number of fruits	weight fruit
	g plant^{-1}			g plant^{-1}
Control	3,50 c	6,00 d	0,00 b	0,00 c
Chemical fertiliser	19,00 b	27,60 c	1,40 a	149,67 b
Cattle manure	16,00 b	40,40 b	0,40 ab	9,00 c
Biofertiliser	49,33 a	73,67 a	2,60 a	266,33 a
CV (%)	8,86	5,56	15,21	17,08

*DRM: Dry root mass, DMAP: Dry mass aerial part, CV: coefficient of variation. * The averages followed by the same letter in the column do not statistically differ based on the Mann-Whitney test (p < 0,01)*

Regarding the number of fruit (Table 2), no significant difference between the biofertiliser treatment and chemical fertiliser treatment was observed, which differed from the cattle manure treatment and the control, which yielded the lowest average. This result is probably attributed to the potential slow release of the nutrients in the biofertiliser. The deficiency or excess of some nutrients can directly affect the fruit yield and quality. Nitrogen and potassium, for example, are nutrients that significantly affect the quality of fruit; they are applied in optimal ratios and amounts to the culture and may enhance the physical and chemical characteristics of fruit [19].

The results of this study corroborate the results obtained by Castro et al. [20], who determined that eggplant adequately responds to fertilisation and organic management, including similar productivity to other cropping systems.

A larger number of fruit in treatment with biofertilisers are also observed by Oliveira et al. [21], who claim that vegetables adequately react to the use of solid organic fertilisers and that biofertiliser is noteworthy because its composition nutrients are readily available compared with other organic fertilisers.

Treatment with biofertilisers also showed higher fruit weight (Table 2). Thus, the best performance in the number and weight of fruit for treatment with biofertilisers is because this material contains vinasse. Stillage is a byproduct of sugarcane, which contains a significant amount of potassium. According to Andriolo et al. [22], potassium important is in production and fruit formation as participates in carbohydrate metabolism, which directly influences the productivity and maintenance of the turgor leaf, which is essential in the internal transport of sugars and the electrochemical balance of the plant.

Concerning the plant height (Fig. 1), the results show that the bio-fertiliser yielded higher values than the remaining treatments. This occurrence was possibly attributed to the presence of the bacteria of the genus *Pseudomonas* sp., which was added to the organic material employed in this treatment.

The bacteria that belong to the genus *Pseudomonas* sp. can produce different substances that accelerate plant growth, especially in the early stages, and induce growth and root formation [23]. The major stimulator substances include hormones, such as auxins, cytokinins and gibberellins, as well as other types of substances, such as amino acids and specific growth promoters [24].

Another factor that may have enhanced the positive action of bio-fertiliser in the plant height is the inclusion of vinasse in its constitution, which is abundant in potassium. Ezziyyani et al. [23] suggested that the potassium present in a greater or lesser amount was sufficient for establishing the differences in plant height.

Within 40 days after transplanting, different treatments were provided to plants, such as growth behaviour, although treatment with biofertiliser has achieved greater plant height values from 20 days after transplanting.

Between 40 and 50 days, a significant increase in the growth rate was observed for the treatments, except control. After 60 days, the tendency of stabilisation of this growth, which coincided with the beginning of the production phase of the plants, was observed.

The decrease in vegetative growth, 60 days after the transplanting may be related to the beginning of the plant production period. Queiroz et al. [25] also found that lower relative growth rates in plant height and stem diameter coincide with the reproductive phases of the plant.

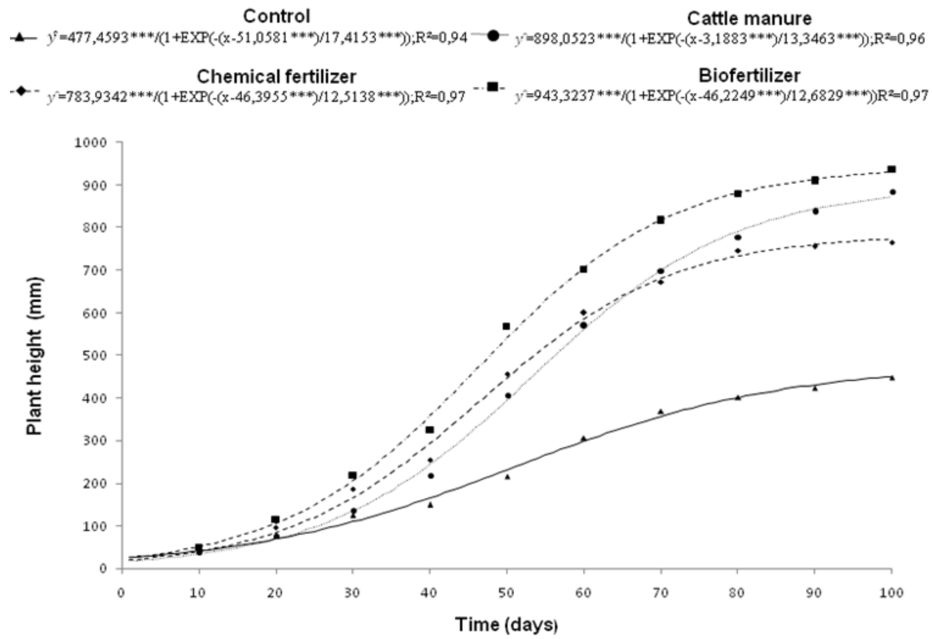

Fig. 1. Plant height of eggplants submitted to different treatments of fertilisation as a function of time

After 70 days, the treatment with bovine manure exceeded the average height of a chemical fertiliser. This finding is probably attributed to the notion that the mineral topdressing occurred after 20, 40 and 60 days after transplanting. After this period, the availability of nutrients in the chemical fertiliser, which is more soluble, may have decreased. Thus, the manure may have enabled a gradual release of nutrients, which enabled this material to continue to supply nutrients to plants for a longer period, especially nitrogen, which directly affects plant growth.

These results corroborate the results obtained by Cardoso et al. [26], who also observed a positive correlation between the application of manure and the growth of eggplant. According to Silva et al. [27], the release of nutrients in cattle manure is gradual compared with other organic materials, such as chicken litter.

For the stem diameter (Fig. 2), the treatment with biofertiliser continued to present in higher averages than the other treatments. This finding is attributed to the presence of growth-promoting bacteria in the material, which contributes to an increase in the growth rate of plants, germination, root growth, and the growth of stalks or stems.

Oliva-Llaven et al. [28] observed that leachate added with *P. fluorescens* and *G. fasciculatum* affected stem diameter and the soluble solids and pH of the tomato fruits.

Almaghrabi et al. [29] noted that rhizosphere bacteria, such as *Pseudomonas fluorescens*, can stimulate plant growth and reduce the incidence of nematodes by antagonism. Fankem et al. [30] found a higher average plant height in the presence of *P. fluorescens.* The same was observed in the study of Vyas and Gulati [31], which had significant differences in the height of corn plants in the presence of *Pseudomonas*.

As noted for plant height, stem diameter also yielded values of a stabilising trend for the plant flowering period (60 days after transplanting).

Increased force production was frequent due to a reduction in vegetative growth. Recent studies, for example, have indicated that spraying apple trees with gibberellin biosynthesis inhibitor can reduce vegetative growth and improve fruit quality [32]. Its application before the harvest regulator prohexadione-calcium growth (ProCa) reduces vegetative growth and the competition between branches and fruits by available photoassimilates can generate a greater quantity and quality of fruit [33].

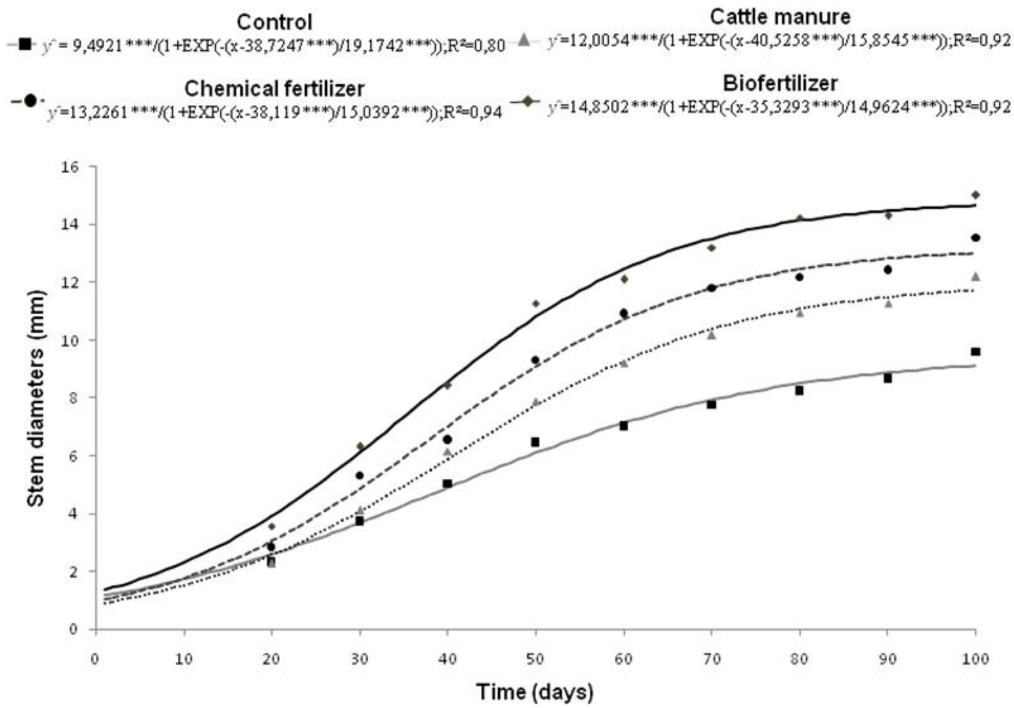

Fig. 2. Stem diameters of eggplants submitted to different treatments of fertilisation as a function of time

4. CONCLUSION

The results revealed that eggplant plants of the Ciça genotype show a better response to organic fertiliser with bio-fertiliser than the response of conventional fertilisers. The biofertiliser prepared with *Pseudomonas fluorescens* is a promising alternative to conventional fertilisation in the eggplant culture.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ferreira EPB, Knupp AM, Didonet CCGM. Growth of rice cultivars (*Oriza sativa* L.) influenced by inoculation with plant growth promoting bacteria. Biosci. J. 2014;30:655-665.
2. Humphris SN,Bengough AG,Griffiths BS,Kilham K,Rodger S,Stubbs V, et al. Root cap influences root colonisation by Pseudomonas fluorescens SBW25 on maize. Fems Microbiology Ecology. 2005; 54:123-130.
Avaliable:https://www.ncbi.nlm.nih.gov/pubmed/16329978
3. Coelho LF, Freitas SS, Melo AMT, Ambrosano GMB. Interaction of fluorescent bacteria of the genus Pseudomonas and Bacillus spp. with the rhizosphere of different plants. Brazilian Journal of Soil Science. 2007;31:1413-1420. Portuguese.
4. Gravel V, Antoun H, Tweddell RJ. Growth stimulation and fruit yield improvement of greenhouse tomato plants by inoculation with Pseudomonas putida or Trichoderma atroviride: Possible role of indole acetic acid (IAA). Soil Biology and Biochemistry. 2007;39:1968-1977.
Avaliable:https://doi.org/10.1016/j.soilbio.2007.02.015
5. Richardson AE, Barea JM, McNeill AM, Prigent-Combaret C. Acquisition of phosphorus and nitrogen in the rhizosphere and plant growth promotion by microorganisms. Plantand Soil. 2009; 321:305-339.
DOI: 10.1007/s11104-009-9895-2
6. Bhattacharjee RB, Singh A, Mukhopadhyay SN. Use of nitrogen-fixing bacteria as biofertilizer for non-legumes:

Prospects and challenges. Applied Microbiology and Biotechnology. 2008; 80:199-209.
DOI: 10.1007/s00253-008-1567-2
7. Santoyo G, Valencia-Cantero E, Orozco-Mosqueda MC, Peña-Cabriales JJ, Farias-Rodriguez R. Role of theiderophores in the antagonistic activity of *Pseudomonas fluorescens* ZUM80 towards hongos phytopathogens. Latin American Terra. 2010;28:53-60. Spanish. (On-line version ISSN 2395-8030 printed version ISSN 0187-5779)
8. Filgueira FAR. New manual of olericultura: Modern agro-technology in the production and commercialization of vegetables. 3rd ed. Viçosa: UFV; 2008.
9. Oliveira FA, Campos MS, Oliveira FRA, Oliveira MKT, Medeiros JF, Melo TK. Development and concentration of nitrogen, phosphorus and potassium in leaf tissue of eggplant as a function of salinity. Brazilian Journal of Agricultural Sciences. 2011;6:37-45. Portuguese.
DOI: 10.5039 / agraria.v6i1a807
10. Cunha Filho FF, Netto AM, Birth CWA, Biondi CM, Neto JAS. Heavy metals in samples of irrigation water from the largest producer of hardwood vegetables in Pernambuco. Scientia Plena. 2014;10:1-7. Portuguese.
11. USDA (United States Department of Agriculture). Soil taxonomy: A basic systems of soil classification for making and interpreting soil surveys, second edition. USDA-NRCS Agriculture Handbook Number 436; 1999.
Available:ftp://ftp-fc.sc.egov.usda.gov/NSSC/SoilTaxonomy/tax.pdf
12. EMBRAPA - Brazilian Agricultural Research Corporation. Manual of methods of soil analysis. 2nd ed. Rio de Janeiro: Embrapa Solos; 2011
13. Alvarez VVH, Guimarães PTG, Ribeiro AC. Recommendations for the use of correctives and fertilizers in Minas Gerais - 5th approach. Viçosa: UFV; 1999.
14. IPA– Instituto Agronômico de Pernambuco. Recomendações de adubação para o Estado de Pernambuco. 2nd ed. Recife: IPA; 2008.
15. Bernardes FS, Patricio FRA, Santos AS, Freitas SS. Induction of systemic resistance by rhizobacteria in hydroponic crops. Summa Phytopathologica. 2010;36: 115-121. Portuguese.
Available:http://dx.doi.org/10.1590/S0100-54052010000200002
16. Hartmann A, Schmid M, Tuinen D, Berg G. Plant-driven selection of microbes. Plant Soil. 2009;321(1-2):235–257.
17. Lopez BR, Bashan Y, Trejo A, de-Bashan LE. Amendment of degraded desert soil with wastewater debris containing immobilized *Chlorella sorokiniana* and *Azospirillum brasilense* significantly modifies soil bacterial community structure, diversity, and richness. Biol Fertil Soils. 2013;49:1053–1063.
DOI: 10.1007/s00374-013-0799-1
18. Prasad AA, Babu S. Compatibility of *Azospirillum brasilense* and *Pseudomonas fluorescens* in growth promotion of groundnut (*Arachis hypogeal* L.). An. Acad. Bras. Ciênc. 2017;8(2):1027-1040.
DOI: 10.1590/0001-3765201720160617
19. SWP Keys, Aroucha EMM, Son FST Bridges, JF Medeiros, Souza MS, Nunes GHS. Conservation of cantaloupe melon cropped under different nitrogen and potassium levels. Brazilian Horticulture. 2014;32:468-474. Portuguese.
Available:http://dx.doi.org/10.1590/S0102-053620140000400016
20. Castro CM, Almeida DL, Ribeiro RLD, Carvalho JF. Direct planting, green manuring and supplementation with poultry manure in the organic production of eggplant. Agricultural Research. 2005;40: 495-502. English.
Available:http://dx.doi.org/10.1590/S0100-204X2005000500011
21. Oliveira AP, Silva OPR, Flag NVS, Silva DF, Silva JÁ, Pinheiro SMG. Maxixe yield in sandy soil as a function of bovine manure and biofertilizer doses. Brazilian Journal of Agricultural and Environmental Engineering. 2014;18:1130-1135. Portuguese.
DOI:http://dx.doi.org/10.1590/1807-1929/agriambi.v18n11p1130-1135
22. Andriolo JL, Jänisch DI, Schmitt OJ, Picio MD, Cardoso FL, Erpen L. Doses of potassium and calcium in plant growth, yield and quality of strawberry fruits under no-till cultivation. Rural Science. 2010; 40: 267-272. Portuguese.
Available:http://dx.doi.org/10.1590/S0103-84782010000200003
23. Ezziyyani M,Requena ME, Sánchez CP, Castillo MEC. (2005) Efectodelsustrato y la temperatura em elcontrol biológico de Phytophthora capsici em pimiento

(*Capsicum annuum* L.). Anales de Biología. 2010;27:119-126. Espanish.
24. Alfonso ET, Padrón JR, Peraza TT. Effect of a bioproduct based on *Pseudomonas aeruginosa* Sem the tomato crop (*Solanum licopersicum* Mill). Revista Colombiana de Biotecnologia. 2010;12:32-38. Espanish.
25. Queiroz ISR, Leitão ARF, Ferreira LL, Silva Dias N, Cosme, CR, Mota AF. Eggplant tolerance to salinity cultured on coconut fiber substrate. Scientific Agropecuária in the Semiarid. 2013;9(2): 15-20. Portuguese.
26. Cardoso MO, Pereira WE, Oliveira AP, Souza AP. Eggplant growth as affected by bovine manure and magnesium thermophosphate rates. Scientia Agricola. 2008;65:77-86.
Available:http://dx.doi.org/10.1590/S0103-90162008000100011
27. Silva VB, Silva AP, Dias BO, Araujo JL, Santos D, Franco RP. Decomposition and release of isolated, or mixed, N, P and K of bovine manure and chicken litter. Brazilian Journal of Soil Science. 2014;38:1537-1546. Portuguese.
Available:http://dx.doi.org/10.1590/S0100-06832014000500019
28. Oliva-Llaven M, Rodríguez-Hernández L, Mendoza-Nazar P, Ruiz-Sesma B, Alvarez-Solís J, Dendooven L, et al. Optimization of worm-bed leachate for culturing of tomato (*Lycopersicon esculentum* Mill) inoculated with *Glomus fasciculatum* and *Pseudomonas fluorescens*. Electronic Journal of Biotechnology. 2010;13(2):1-8.
DOI:10.2225/vol13-issue2-fulltext-2
29. Almaghrabi OA, Massoud SI, Abdelmoneim TS. Influence of inoculation with plant growth promoting rhizobacteria (PGPR) on tomato plant growth and nematode reproduction under greenhouse conditions. Saudi Journal of Biological Sciences. 2013;20:57–61.
DOI: 10.1016/j.sjbs.2012.10.004
30. Fankem H,Ngo Nkot L, Deubel A, Quinn J, Merbach W, Etoa FX, et al. Solubilization of inorganic phosphates and plant growth promotion by strains of *Pseudomonas fluorescens* isolated acidic soils of Camerron. African Journal of Microbiology Researchl. 2008;2:171-178.
(ISSN: 1996-0808)
31. Vyas P, Gulati A. Organic acid production in vitro and plant growth promotion in maize under controlled environment by phosphote-solubilizing fluorescent Pseudomonas. BMC Microbiology. 2012;9: 174-189.
DOI:10.1186/1471-2180-9-174
32. Silveira JPG, Amarante CVT, Steffens CA, Correa TR, Paes FR. Productive potential and fruit quality of apple trees treated with gibberellin and inhibitor of the biosynthesis of gibberellins. Revista Brasileira de Fruticultura. 2014;36:771-779. Portuguese.
Available:http://dx.doi.org/10.1590/0100-2945-352/13
33. Zhang C, Whiting M. Pre-harvest foliar application of prohexadione-Ca and gibberellins modify canopy source-sink relations and improve quality and shelf-life of 'Bing' sweet cherry. Plant Growth Regulation. 2011;65:145-156.

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