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Biochar as substrate conditioner in the development of melon seedlings

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Abstract

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The production of healthy seedlings is of relevant importance for the success of plant production. The reduction of production costs when using alternatives sources of fertilization is also an important fact. The objective of this work was to evaluate the influence of increasing doses of poultry litter biochar in the development of melon seedlings. The work was conducted in a protected environment with a completely randomized statistical design in a 6 x 2 factorial scheme, consisting of 6 doses of biochar (0, 4, 8, 12, 16 and 20 t ha^{-1}) and two varieties of melon (Yellow and Hales Best Jumbo) with 4 repetitions totalizing 48 experimental units. At 15, 23 and 31 days after sowing (DAS), the plant height, stem diameter, number of leaves and leaf area were evaluated and afterwards the absolute growth rates of the variables were determined. The melon seedlings height, stem diameter, number of leaves, leaf area and their absolute growth rates were favored by the inclusion of poultry litter biochar in the subtract, proportionating an increase of these studied growth variables up until a dose of 8 t ha^{-1} of biochar. With the exception of the plant height and stem diameter, under the studied conditions and with the poultry litter biochar as a constituent of the substrate, the Hales Best Jumbo melon variety had the best performance.

Keywords: poultry litter; fertility; varieties of melon

Introduction

The melon (*Cucumis melo*) is specie cultivated in different regions of the world due to its great edaphoclimatic adaptability and increasing value among the consumers. According to the Brazilian Institute of Geography and Statistics, the production in Brazil in 2017 was 873 000 tons of fruits being the Northeast production a 94% of the total production of Brazil (IBGE, 2017).

It is a very rentable crop with a fast-economical return having a great socioeconomical impact due to the high hand labor demand practically during all the crop development and production, contributing thus in a significative way to the changes in the social standards of the small productors (Nunes et al., 2018; Rabelo, 2017).

Most of the melon produced in Brazil are of the Yellow variety, which has as important characteristic, the resistance to transport conditions and a long post-harvest lifespan (Zebalos et al., 2017). However, there exist other melon varieties such us the Cantaloupe, from which its hybrids are being used in different productive areas, standing out the Goldex, Iracema, Grand Prix, Sancho and Hales Best Jumbo. For the genetical improvement of plants it is important to have information about the variability among genotypes and cultivars because these differences can be very important for the agricultural crop (Passos et al., 2010).

One of the most important phases of the agricultural productive system is the seedling production, fundamental for a successful establishment of the sowing, production and fruit quality. A nutritional optimization reduces the production costs with the use of alternatives nutrient sources providing adequate nutrient availability for the plants, cation exchange capacity and a good moisture content and aeration in the subtract.

A technological alternative to reduce production costs with fertilization, improve soil characteristics, including carbon kidnapping, optimum soil fertilization, biofuel energy production and solid wastes management (Bezerra et al., 2016; Lima, 2016) is the use of biochar. The biochar is a solid biomass rich in carbon, obtained through a oxidation=reduction process, denominated pyrolysis, where part of the biomass is reduced to carbon and part is oxidized and hydrolyzed, originating phenols, carbohydrates, alcohols, aldehydes, acetones and carboxylic acids (Moreira, 2015).

Due to its organic origin, the incorporation of biochar to the soil is able to meliorate its physic-chemical and biological characteristics, increasing the soil water retention, pH, availability of nutrients to the plant through the soil biota, cation exchange capacity, reduction of soil density and melioration of plant and mycorrhizae fungus association (Lehmann et al., 2011 Novotny et al., 2015; Warnock et al., 2007).

Dharmakeerthi et al. (2012), using rubber wood biochar as a subtract for *Hevea brasiliensis* seedlings growth, they observed positives effect on the dry biomass not affecting the canopy growth, showing that the application of 2% of biochar to the soil was not enough to improve the nutritional status and plant growth. Hong et al. (2020) evaluating the effects of the application of 2, 10, 30, 50 and 70% of biochar tree peelings on the growth of lettuce, cabbage and pepper seedlings observed that the 30% treatment was the best for the lettuce and pepper seedlings biomass, however the increase in the biomass for this treatment was not significative different from the higher doses. In a similar way, the cabbage seedlings, the biomass started to increase with the biochar application of the 10% and the increase was also not significant. Barros et al. (2017) evaluating the effect of activated native wood sawdust, on the passion fruit seedlings behavior observed that all studied growth variables were affected significatively when the commercial Mec plant® biochar was added to the subtract.

The use of poultry litter biochar has a great potential for the agriculture, because these biochar when applied to the soil produces significant improvements in the soil fertility, increasing the pH, CTC, carbon content and micro and micronutrients, such as phosphorus, nitrogen, calcium, potassium and other elements, probably presented in more soluble and available forms than in the original matter no pyrolyzed (Chan et al., 2008; Chan et al., 2009; Fernandes et al., 2018). Furthermore, considering the prohibition of using this material in animal feeding, the recycle of the poultry litter brings a benefit to the agriculture and ecosystem in general (Chaves et al., 2019; Cunha et al., 2013).

Thus, the objective of the present work was to evaluate the influence of increasing doses of poultry litter biochar in the development of melon seedlings.

Materials and Methods

The experiment was carried out in a greenhouse at the Agricultural Engineering Department, Federal University of Campina Grande, Paraiba State, Brazil (07º 13′ 11″ S; 35º 53′ 31″ W) using a soil collected at the 0-20 cm depth layer from the Agreste Region of Paraíba. Soil samples characterized chemical and physically, according to Teixeira et al. (2017) presented the following attributes: pH (H_2O) = 5.75; EC_{se} = 0.16 dS m^{-1}; Ca = 1.56 $cmol_c$ kg^{-1}; Mg = 1.18 $cmol_c$ kg^{-1}; Na = 0.06 $cmol_c$ kg^{-1}; K = 0.26 $cmol_c$ kg^{-1}; H = 1.27 $cmol_c$ kg^{-1}; organic matter=14.8 g kg^{-1}; P = 4.9 mg kg^{-1}; clay = 158.5; silt = 120.7 and sand = 720.8 g kg^{-1}.

The biochar used in this study was produced from poultry litter (PL), a solid waste resulting from chicken rearing, under slow pyrolysis, at a temperature of 400ºC, having the following composition: pH (H_2O) = 9.45; N = 3.45%; P = 7.78%; K = 4.90%; Ca = 6.83%; Mg = 1.34%; Na = 0.73%; S = 0.74%; Fe = 0.46%; Cu = 0.04%; Zn = 0.08%; Mn = 0.09%; B =0.01%; organic carbon = 39.77%; organic matter = 68.56%; C/N = 11.53% and CEC = 388.90 $mmol_c$ /kg.

The experimental design used was completely randomized, with a 6 x 2 factorial scheme, consisting of six doses of biochar (D1 = 0, D2 = 4, D3 = 8, D4 = 12, D5 = 16, D6 = 20 t ha^{-1}) and two melon varieties (V1 = Yellow and V2 = Hales Best Jumbo) with 4 replicates, totalizing 48 experimental units.

The experimental units consisted of plastic bags (15x 28 cm) with holes on their bottom for water drainage, filled with dried soil, biochar and vermiculite and sieved on a 2 mm mesh sieve. These substrates consisted of a mixture of soil and vermiculite in a 1:10 ratio, and the increasing doses of biochar. Afterwards they were left in incubation for a period of 90 days keeping the substrate moisture close to the field capacity. The addition of vermiculite in the experimental units aimed to make the soil less dense and compacted, as well as airier.

After the incubation period, simple soil samples were collected from the experimental units, air-dried, ground, sieved with a 2 mm mesh and analyzed according to the methodology proposed by Teixeira et al. (2017) (Table 1).

Table 1. Hydrogen ionic Potential (pH) and electrical conductivity (EC) of soil + vermiculite + biochar mixtures after the incubation period

t ha^{-1}	pH H_2O	EC, dS m^{-1}
0	5.99	0.530
4	6.79	0.823
8	7.05	0.955
12	7.46	1.001
16	7.49	1.413
20	7.56	1.380

Sowing was carried out by placing equidistantly, in each experimental unit, four melon seeds at 2 cm soil depth, and on the fourteenth day after sowing, thinning was conducted keeping the most vigorous plant in each experimental unit. Irrigation was carried out daily in order to keep the soil close to the field capacity aiming the best germination of the seeds, the emergence of seedlings and plant development.

The biometrical measures were executed at 15, 23 and 31 days after sowing (DAS).The plant height (cm) was measured with a measuring tape, the stem diameter (mm) with a digital caliper, placing it on the plant's neck; the number of leaves counted from the basal leaf to the last open leaf and the leaf area determined according to the methodology proposed by Nascimento et al. (2002).

With these data, the absolute growth rate of the plant height – AGRPH, of the stem diameter – AGRSD, of the number of leaves – AGRNL, and of the leaf area – AGRLA, as a function of time, were determined according to Equations 1, 2 , 3 and 4 (Benincasa, 2003):

$$\mathrm{AGRPH} = \frac{\mathrm{PH}_2 - \mathrm{PH}_1}{\mathrm{T}_2 - \mathrm{T}_1} \quad (1)$$

$$\mathrm{AGRSD} = \frac{\mathrm{SD}_2 - \mathrm{SD}_1}{\mathrm{T}_2 - \mathrm{T}_1} \quad (2)$$

$$\mathrm{AGRNL} = \frac{\mathrm{NL} - \mathrm{NL}_1}{\mathrm{T}_2 - \mathrm{T}_1} \quad (3)$$

$$\mathrm{AGRLA} = \frac{\mathrm{LA}_2 - \mathrm{LA}_1}{\mathrm{T}_2 - \mathrm{T}_1}, \quad (4)$$

where: PH = plant height plant in the time period of T_1 a T_2; SD = stem diameter in the time period of T_1 a T_2; NL = number of leaves in the time period of T_1 a T_2; LA = leaf area in the time period of T_1 a T_2 and T = time of each studied period.

The results obtained were submitted to the homogeneity test (Cochran and Bartlett), and to the normality test (Shapiro-Wilk). With the exception of the number of leaves, leaf area, plant height at 15DAS, the AGRNL 23-31DAS and the AGRLA 15-23DAS, the other parameters were submitted to the analysis of variance by the F test at 1 and 5% probability. When there was significant effect for these, polynomial regression analysis was used for doses of biochar and comparison between means for varieties by the T-student test ($p < 0.05$). To reach normality, the data of AGRPH 23-31 and AGRNL 15-23 were transformed into $\frac{x^{1,388}-1}{1,388}$ and $\sqrt{x}$, respectively.

The data of number of leaves, leaf area, plant height at 15DAS, AGRNL 23-31DAS and AGRLA 15-23DAS which did not follow the assumptions required for the ANOVA tests were analyzed by the Kruskal-Wallis non-parametric method (Ferreira, 2011).

Results and Discussion

The treatments of biochar doses, melon varieties and their interaction, submitted to the F test analyses of variance (ANOVA) influenced significantly the plant height at 23 and 31 days (Table 2). The PH data at 15 days did not satisfy the normality tests for the ANOVA, being thus analyzed statistically by the non-parametric test of Kruskal and Wallis (Ferreira, 2011) (Figure 1A). The AGRPH during the periods from 15 to 23 and from 23 to 30 DAS were influenced significatively by the biochar doses, however the varieties treatment and the interaction among doses and varieties did not influenced the AGRPH during the 15 to 23 DAS period (Table 2).

The plant height of the Yellow melon variety (V1), in all the evaluated data (15, 23 and 31 DAS) was higher than the Hales Best Jumbo Variety (V2), indicating the best response of the V1 over the V2 variety to the biochar doses applied (Figures 1A, 1B e 1C).

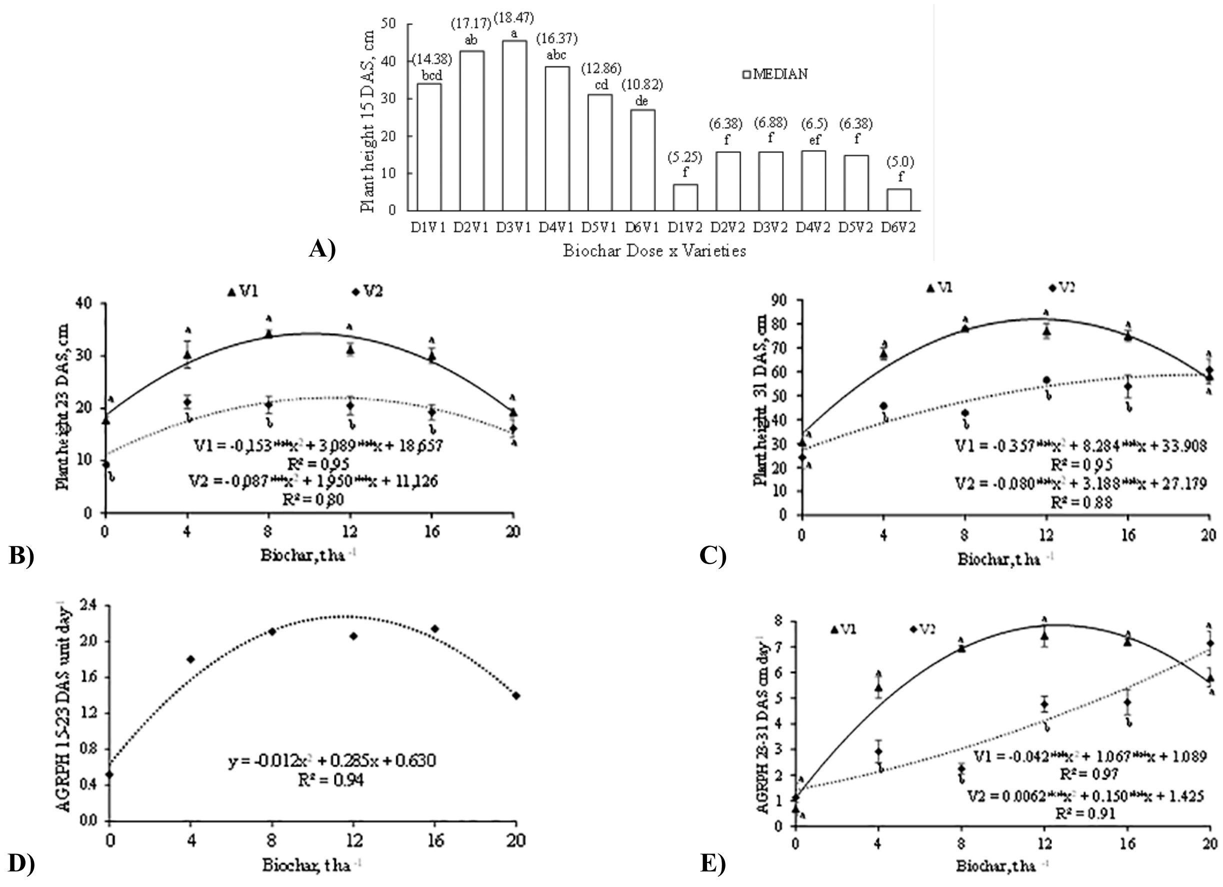
The biochar doses influenced significantly the plant height at 15 DAS, from which the 4, 8 and 12 ha^{-1} were better for the V1 variety, varying between 16.37 to 18.47 cm (not transformed data). Plant height of the V2 variety did not respond significantly to the biochar doses applied varying between 5.00 to 6.88 cm (not transformed data) (Figure A). An interesting observation is the fact that even if there are not differences between the zero biochar doses (D1) and the higher doses for each variety, there was a decrease of plant height with the higher doses, suggesting perhaps a negative effect on seedlings development.

Evaluating the biochar x melon variety interaction for plant height at 23 DAS (Figure 1B) it was observed that the results were adjusted to a polynomial regression model with the maximum plant height of 34.22cm for the Yellow variety (V1) with the dose of 10.1 t ha^{-1} and 22.01cm for the Hales Best Jumbo (V2) with 11.16 t ha^{-1}. Same behavior was observed at 31 DAS for the V1 variety reaching the maximum plant height of 81.94 cm with the dose of 11.59 t ha^{-1} and 58.74 cm for the V2 variety with 19.80 t ha^{-1} (Figure 1C). Such behaviors are in agree with the results observed by Petter et al. (2012) who observed that biochar concentrations above 30% retarded the seedlings development, due to the nutrient defi-

Table 2. Variance analyses for plant height (PH) at 23 and 31 DAS and for the absolute growth rate of e plant height – AGRPH of 15 to 23 DAS and of 23 to 31 DAS of the melon varieties under the different biochar doses

Source of Variation	DF	Mean Square			
		Plant height (PH)		AGRPH	
		23	31	15 – 23	23 – 31
Dose (D)	5	247.96**	1665.0**	3.18**	34.8**
Linear Reg.	1	29.80^{ns}	4138.43**	3.27**	138.97**
Quadrátic Reg.	1	1104.91**	3662.54**	11.64**	24.79**
Melon variety (V)	1	1033.42**	3513.03**	0.14^{ns}	36.46**
D x V Interaction	5	24.61*	355.27**	0.23^{ns}	9.98**
Error	33	8.1	36.19	0.17	1.67
VC	%	12.68	10.78	24.6	2.39

*, ** significant to the 0.05 e 0.01 probability, respectively, ns non-significant; VC: variation coefficient, DF Degree of Freedom



Means followed by the same letter do not differ statistically among them

Fig. 1. Plant height at 15 (A), 23 (B) and 31 DAS (C), and absolute growth rate of plant height at 15-23DAS (D) and 23-31DAS interval (E) for the interaction between the biochar doses and the melon varieties (V1 = Yellow e V2 = Hales Best Jumbo)

ciency produced by the increase of the soil pH. In the present work besides increasing the pH, the application of biochar increased de electrical conductivity (EC) of the soil, (Table 1) which could justify the seedlings development retardation observed by the melon, due to the fact of this fruit be sensible to alkalinity and or salinity. Evaluating the seedlings growth of the melon variety "ROPEY KING", at 30 DAS, for different organic subtracts, Ferreira et al. (2011) observed the highest plant height of 99.98 cm, for the sheep manure + soil (3:1 v/v) treatment. In a similar way, Malta et al. (2017) working with "Crioulo" melon in different subtracts found a height medium of 1.11 m using a substrate constituted by 70% of soil, 15% of sheep manure and 15% of sand, emphasizing the importance of the organic matter in plant growth.

The absolute growth rate of plant height (15-23 DAS period (Figure 1D) was significatively affected by the biochar

Table 3. Analysis of variance for the stem diameter at 15, 23 and 31 DAS and absolute growth rate of r () of 23 to 31 DAS, number of leaves (AGRNL) of 15 to 23 DAS, and leaf area (AGRLA) of 23 to 31 DAS for the melon varieties and biochar doses studied

Source of Variation	DF	Mean Square					
		STEM DIAMETER			AGRSD	AGRNL	AGRLA
		15	23	31	23 – 31	15-23	23-31
Dose (D)	5	1.63**	1.36**	2.6**	0.02^{ns}	0.0251^{ns}	851.44**
Linear Regression	1	0.22^{ns}	0.46^{ns}	2.34*	0.005^{ns}	0.0584^{ns}	0.0050**
Quadratic Regression	1	7.77**	4.44**	6.58**	0.002^{ns}	0.0126^{ns}	0.0002**
Melon Variety (V)	1	1.12*	0.21^{ns}	2.13*	0.05**	0.0406^{ns}	395.38**
D x V Interaction	5	0.59*	0.41^{ns}	0,29^{ns}	0.001^{ns}	0.0107^{ns}	187.01**
Error	33	0.19	0.23	0.45	0.002	0.0106	52.05
VC	%	12.62	10.92	13.17	51.85	33.57	25.34

* , ** significant at 0.05 and 0.01 probability, respectively, ns no significant; VC= Variation Coefficient
DF= Degree of freedom

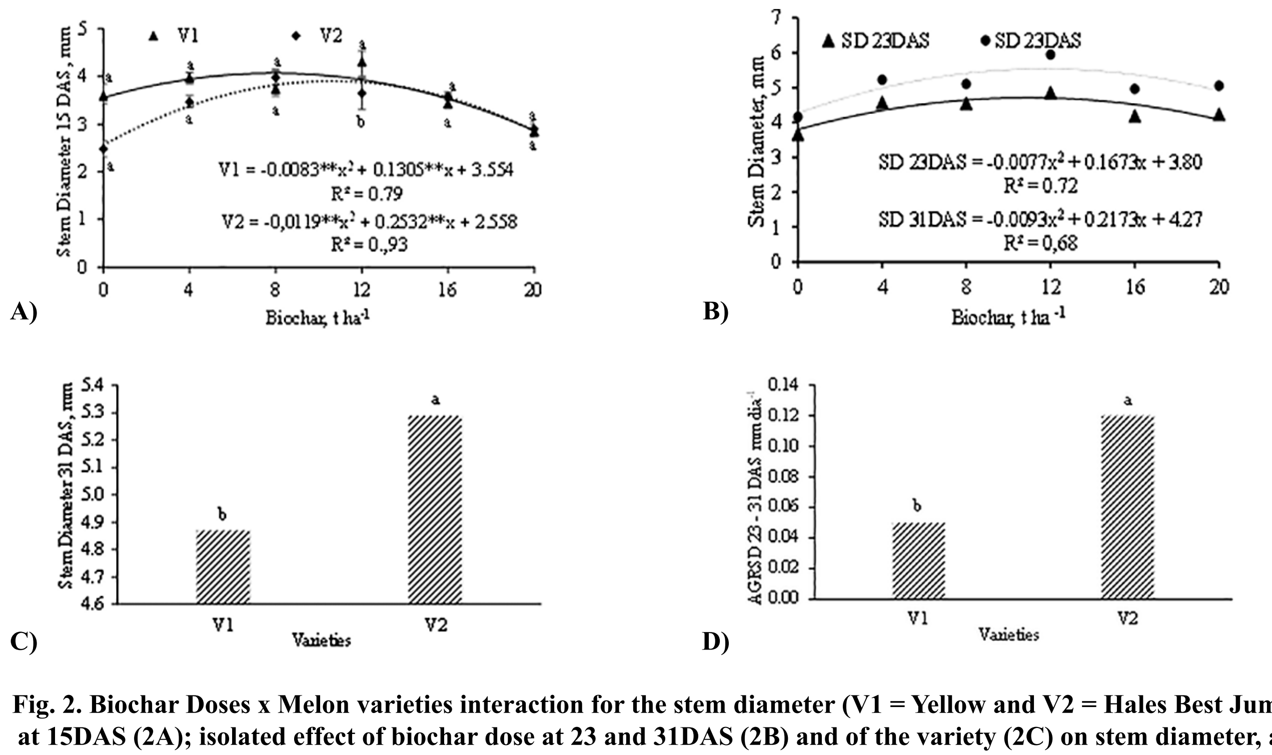


Fig. 2. Biochar Doses x Melon varieties interaction for the stem diameter (V1 = Yellow and V2 = Hales Best Jumbo) at 15DAS (2A); isolated effect of biochar dose at 23 and 31DAS (2B) and of the variety (2C) on stem diameter, and absolute growth rate of stem diameter 23-31DAS as a function of the isolated effect of varieties (2D). Means followed by the same letter do not differ statistically among them

dose, with the highest rate of 2.1407 cm day^{-1} for the biochar dose of 16 t ha^{-1}. During the period of 23 to 31 DAS the Yellow variety (V1) in general, presented bigger AGRPH than the Hales Best Jumbo (V2), with the data adjusted to a quadratic model and a maximum valor of 7.84 cm day^{-1} for the dose of 12.64 t ha^{-1}. The V2 variety had a crescent response with a AGRPH of 6.5 cm day^{-1} with the highest biochar dose (Figure 1E).

The biochar dose affected significantly the stem diameter of the melon at 15, 23, and 31 DAS. The melon varieties influenced the stem diameter at 15 and 31 days and the interaction of treatments affected only the stem diameter at 15 DAS, as observed in the Figure 2A. The absolute growth rate of the stem diameter (AGRSD) at the 23 to 31DAS period was affected only by the melon variety (Table 3).

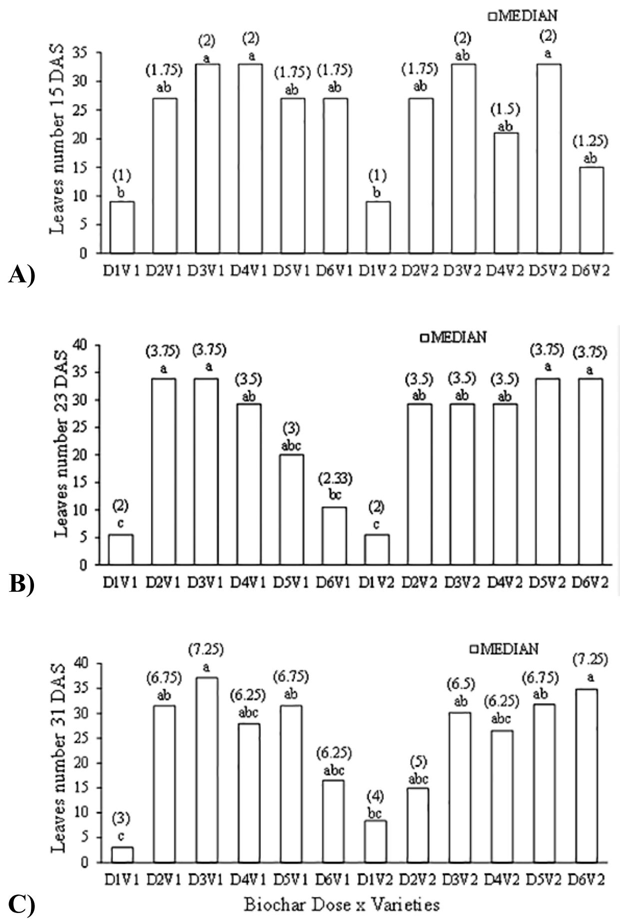
The biochar dose x melon variety interaction influenced significatively the stem diameter at the 15 days (Table 3) and this behavior followed a quadratic model for both melon seedlings (Figure 2A). The Yellow variety (V1) presented higher stem diameters as a function of the biochar doses up to 12 t ha^{-1} when compared to the Hales Best Jumbo (V2), with a maximum value of 4.07 mm in the estimated dose of 7.86 t ha^{-1}, reducing from there. Similarly, the V2 variety reached a maximum value of 3.90 mm at the 10.64 t ha^{-1} dose (Figure 2A); both varieties decreased the stem diameter with the biochar doses over 12 t ha^{-1}.

The initial increase of stem diameter of the melon varieties with the biochar dose was influenced by the enrichment of the subtract with the liberation of chemical elements coming from the biochar and probably by the melioration of the physical characteristic of the substrate such as the aeration, water infiltration and availability for the seedlings, as indicated for Ekebafe et al. (2013). As previously indicated, biochar dose over 12 t ha^{-1} had a negative effect on the seedlings due probably to the excessive increase of soil pH and electrical conductivity of the subtract (Table 1). Cavalcante et al. (2012) working with application of biochar to passion fruit seedlings corroborate these results, reporting positive effects for plant height, stem diameter, aerial phytomass and chlorophyl content, with the higher biochar dose added to the subtract.

The biochar dose influenced significatively the stem diameter at the 23 and 31DAS and were adjusted to a quadratic model with maximum values of 4.70 and 5.53 mm for the doses of 10.86 e 11.68 t ha^{-1}of biochar, respectively (Figure 2B). When comparing the variables, the better result was obtained for the V2 variety with 5.29 mm, 7.9% higher than the one obtained for the V1 variety (4.90 mm) (Figure 2C). The absolute rate of the stem diameter (AGRSD) of the Hales Best Jumbo variety, during the period of 23 to 31DAS (0.12 mm dia^{-1}) was statistically 41.7% higher than the one observed for the Yellow variety (0.05 mm dia^{-1}) (Figure 2D).

The stem diameter is an important variable to evaluate the growth and survival of the seedlings because plants with higher stem diameters have the capacity to create and develop roots with higher survival rates (Almeida et al., 2020).

The number of leaves of melon seedlings, V1 and V2, at 15, 23 and 31 DAS, were analyzed using Kruskal and Wallis non-parametric statistics (Ferreira, 2011) (Figure 3). For the V1 variety, the number of leaves increased with the biochar dose, decreasing with the higher dose, for all data. For the V2 variety, the behavior was similar only for the 15 DAS data (Figure 3A). For the 23 and 31 DAS, in general, the number of leaves increased with the higher biochar doses (Figures 3B and 3C).

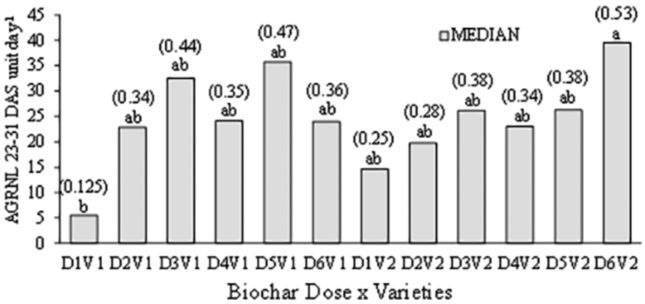


Means followed by the same letter do not differ statistically among them

Fig. 3. Interaction of the biochar dose (D) and the seedlings melon varieties (V) for the number of leaves at 15 (3A), 23 (3B) and 31 DAS (3C) (values in parenthesis are those not transformed)

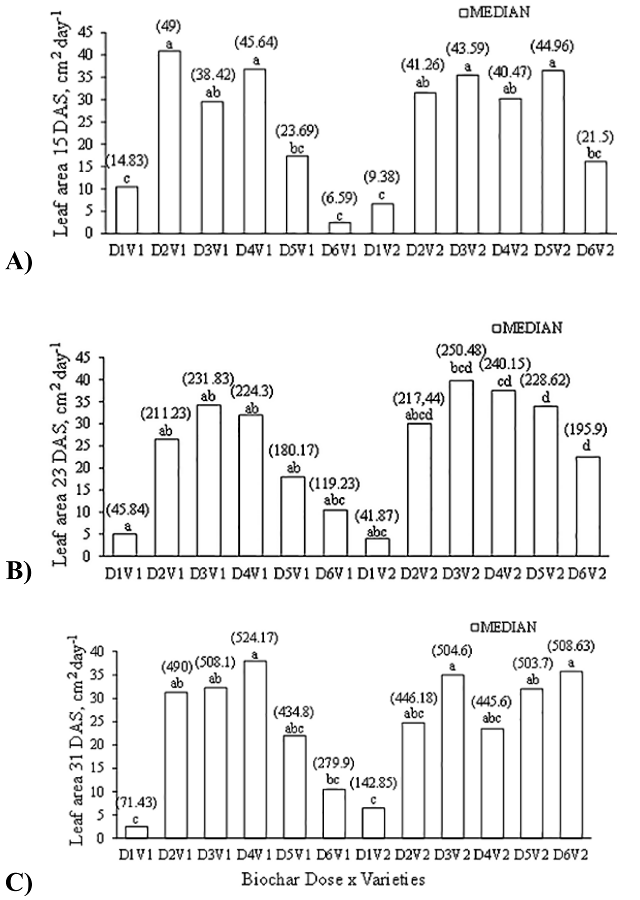
In general, the number of leaves of the melon seedlings at 31DAS, independently of the treatments (Figure 3C), were higher than those observed by Ferreira et al. (2011), that is, above 3.5 to 4.5. These authors, using different oganic substrates when planting melon, observed these numbers of leaves, without any significant difference between these substrates.

According to Figure 4, in general there was not difference among the absolute rate of the number of leaves means during the 23 to 31DAS period, although, with the exception of DIV2 and D6V2, apparently, the AGRNL of V2 were lower than in V1.



Means followed by the same letter do not differ statistically among them

Fig. 4. Interaction of the biochar dose (D) and the seedlings melon varieties (V) for the absolute growth rate of the number of leaves the 23 to 31DAS (V1 = Yellow variety and V2 = Hales Best Jumbo variety)



Means followed by the same letter do not differ statistically among them by the Kruskal-Wallis parametric at 0.05 significance level in parenthesis in parenthesis are non-transformed, observed values

Fig. 5. Interaction of the biochar dose (D) and the seedlings melon varieties (V) on the leaf area at 15, 23 and 31 DAS

Analyzing statistically the leaf areas of the V1 and V2 varieties at 15, 23 and 31 DAS by the non-parametric method of Kruskal-Wallis (Ferreira, 2011) at 0.05 probability (Figure 5), it was observed that with the exception of the V2 at 31DAS, in general, the leaf area initially increased with increasing biochar dose to a certain extent decreasing with higher ones (Figure 5C).

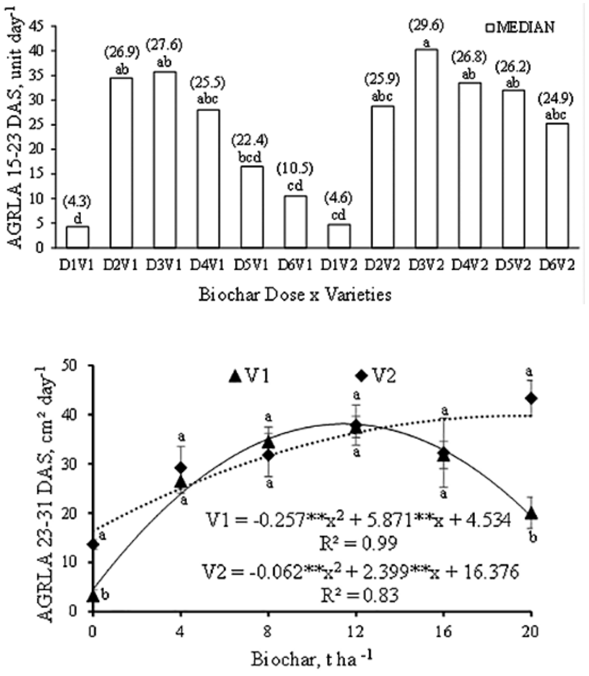
Comparing statistically the absolute rate growth of the leaf area (AGRLA) for the melon leaf of the V1 and V2 varieties at the 15 and 23 DAS by the non-parametric Method of Kruskal and Wallis (Ferreira, 2011) (Figure 6A), it was observed that the V1 variety was more sensible to the biochar dose increase than the V2 variety, decreasing with the higher dose of biochar. During the period of 23 to 31 DAS the AGRLA was influenced significatively by the variety x biochar dose interaction (Table 3) with the data adjusted to a quadratic model (Figure 6B) and the highest values of AGRLA of 38.10 and 39.73 cm^2 dia-^{1} obtained with the dose of 11.43 and 19.47 t ha^{-1} for the Yellow (V1) and Hales Best Jumbo (V2), respectively.

In the present work, biochar dose over 8 t ha^{-1} reduced the growth varieties studied, probable due to the harming effect of the increase of the pH and the electrical conductivity (EC) of the substrate. From the 12 t ha^{-1} biochar dose, in general, the pH and EC of the substrate increased (Table 1).

The increase of these parameters, increases the high salt concentration of the substrate which is normally a stress causing, reducing the osmotic potential, causing the action of ions on the protoplasm.

Harter et al. (2014) decreasing the available water for the plant and interfering negatively in the growth and productivity of the crop (Almeida et al., 2020).

According with the observed behavior of the V2 variety to the highest dose of biochar application, it can be inferred



A)

B)

Means followed by the same letter do not differ statistically among them by the Kruskal-Wallis parametric at 0.05 significance level. Values in parenthesis are non-transformed (A). Means followed by the same letter do not differ statistically within the same dose (B)

Fig. 6. Interaction of biochar doses (D) and the seedlings melon variety (V) for the absolute growth rate of the leaf area at the 15-23 and 23-31 DAS periods

that this variety is more tolerant to the salinity than the V1, corroborating Araujo et al. (2016).

Ayers & Westcot (1991) indicate that electrical conductivities of the substrate higher than 1 dS m^{-1} (threshold value) harm the growth of most plants sensible to salinity. Silva et al. (2009) corroborate this, reporting furthermore that when using poultry litter biochar as substrate for planting *Eruca vesicaria* ssp.*sativa* seedlings, it was observed an electrical conductivity of 3.05 dS.m^{-1} and elevated contents of potassium and phosphorus in the substrate, considered responsible for the low plant phytomass yields obtained. In a similar way, evaluating the effect of different doses of dry coconut bark biochar in the development and production of the sunflower phytomass and on the chemical characteristics of the soil solution, Lima et al. (2017) observed an increase of the electrical conductivity with the biochar dose, which according to them can be a limiting factor for plant growth.

The poultry litter biochar utilized in the present work, also presents a high content of phosphorus which could influence the growth variables of the melon seedlings studied.

Conclusions

The melon seedlings height, stem diameter, number of leaves, leaf area and their absolute growth rates were favored by the inclusion of poultry litter biochar in the substrate, proportionating an increase of these studied growth variables up until a dose of 8 t ha^{-1} of biochar.

With the exception of the plant height and stem diameter, under the studied conditions and with the poultry litter biochar as a constituent of the substrate, the Hales Best Jumbo melon variety had the best performance.

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