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Foliar Spray of Humic Substances on Seedling Production of Watermelon cv. Crimson Sweet

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Abstract: The objective of this research was to study the effect of humic substances on seedling production of watermelon cv. Crimson Sweet. A completed randomized blocks design with five treatments (humic substances doses) was adopted, with five repetitions of 10 seedlings each, with a total of 250 seedlings. The following humic substances doses were studied 0 (unsprayed), 7.5, 15, 22.5 and 30 mL m^{-2} (0, 0.40, 0.80, 1.19 and 1.59 mL $seedling^{-1}$), were sprayed at 10, 15 and 20 days after sowing. At the end of the experiment (25 days after sowing) the following variables were recorded: plant height; stem diameter; (3) dry weight of shoots and roots; root length; root volume; and leaf chlorophyll. Our studies demonstrate that: (1) foliar spray of humic substances enhances aerial part and root system of watermelon seedlings; (2) 22.5 mL m^{-2} dose of humic substances for foliar spray could be recommended for production of watermelon seedlings.

Key words: *Citrullus lanatus*, seedling quality, humic substances

INTRODUCTION

Watermelon (*Citrullus lanatus*) is an annual vegetable crop species commercially grown in almost all Brazilian states, especially in North-Eastern Brazil, where more than 60% of Brazilian watermelon is produced (AGRIANUAL, 2009).

Traditionally, watermelon crop has been propagated by sowing the seeds directly on field aiming to reduce production costs (Bering *et al*., 2003). However, due to the emergence of new technologies such as hybrid seed production of high cost, the production of seedlings has being increasingly used in commercial crops because it promotes a better control of plant nutrition, plant protection and it makes possible the selection of more vigorous seedlings (Costa *et al*., 2008).

Studies have been developed aiming the building of a protocol for standardization of watermelon seedlings productions by the use of biostumulants (Costa *et al*., 2008), organic products as substrate (Bjelic *et al*., 2007; Tosta *et al*., 2010) and fusaric acid (Wu *et al*., 2008), although the effects of humic substances on this process for watermelon has been poorly quantified, detaching the research of Chang and Li (2008).

The effects of Humic Substances (HSs) on plants or plant parts have been proved in the scientific literature. Its effects on plant growth depend of the source and concentration as well as on the molecular fraction weight of humus (Nardi *et al*., 2002). In addition, Asik *et al*. (2009) and Ferrara and Brunetti (2010) summarized the effects of humic substances on plant growth and mineral nutrition, pointing out the positive effects in the uptake of macro and micronutrients, seed germination, seedling growth, root initiation, root growth and shoot development.

Studies about the use of humic substances on vegetable species are scarcely reported in the literature, however, some investigations have been conducted in okra (Paksoy *et al*., 2010), cucumber (Li and Evans, 2000; Ozdamar Unlu *et al*., 2011), pepper (Karakurt *et al*., 2009) and watermelon (Salman *et al*., 2005), with promising results. However, the effect de humic substances on watermelon seedlings production has been poorly quantified.

In this sense, the objective of this research was to study the effect of humic substances on seedling production of watermelon cv. Crimson Sweet.

MATERIALS AND METHODS

Plant material and growth conditions: Seeds of watermelon (*Citrullus lanatus*) cv. Crimson Sweet were used in this study (95% of germination).

The experiment was carried out from April 2011 to May 2011 in a net-house under 50% of luminosity of the "Campus Profa. Cinobelina Elvas", Federal University of Piaui, Piaui State, Brazil. Pots with 50 cm^3 capacity were

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filled with a substrate composed by soil (red Oxisol) sieved, sand and bovine manure at a 1:1:2 ratio.

The soil and bovine manure used presented the following composition, before the execution of the experiment: (i) pH in water: 5.30 (soil) and 9.09 (bovine manure), (ii) Ca^{2+} + Mg^{2+}: 0.56 and 5.90 $cmol_c$ dm^{-3}, (iii) Ca^{2+}: 0.32 and 4.4 $cmol_c$ dm^{-3}, (iv) K^+: 0.01 and 2.78 $cmol_c$ dm^{-3}, (v) Na^+: 0.01 and 19.58 $cmol_c$ dm^{-3}, (vi) H^+ + Al^{3+}: 1.10 and 2.97 $cmol_c$ dm^{-3}, (vii) Organic matter: 2.33 and 156.00 g kg^{-1}. Accordingly, K^+ and Na^+ were determined with Mehlich-1 extractant; H^+ + Al^{3+} were determined in calcium acetate under 0.5 M and pH 7 and Ca^{2+} and Mg^{2+} were obtained in KCl 1 M.

During the execution of the experiment, the climatic data of air temperature and air humidity (thermo-Hygrometer Instrutemp®, Brazil) and luminosity (digital light meter, Instrutherm®, Brazil) were collected inside the net-house and it was registered, according to the dispersion diagram of weekly average data, a high variation range on air temperature (25-37°C, Fig. 1a), air humidity (40-68%, Fig. 1b) and luminosity (1601-6001 lux, Fig. 1c) during the execution of the experiment.

Treatments and experimental design: A completed randomized blocks design with five treatments (humic substance doses) was adopted, with five repetitions of 10 seedlings each, with a total of 250 seedlings. The following humic substances doses studied were 0 (unsprayed), 7.5, 15.0, 22.5 and 30.0 mL m^2, defined according to the 15.0 mL m^2 dose recommended by the producer and they are equivalent to 0 (unsprayed), 0.40, 0.80, 1.19 and 1.59 mL $seedling^{-1}$. The humic substances used in the experiment were extracted from leonardite and the source adopted was Humitec® which composition complete composition is humic extract (16.5%), organic carbon (11.2%), humic acids (13.2%) and fulvic acids (3.3%).

Watermelon seedlings were sprayed at 10, 15 and 20 days after sowing and daily manually irrigated according to plant requirements in an attempt to keep the substrates as close as possible to field condition.

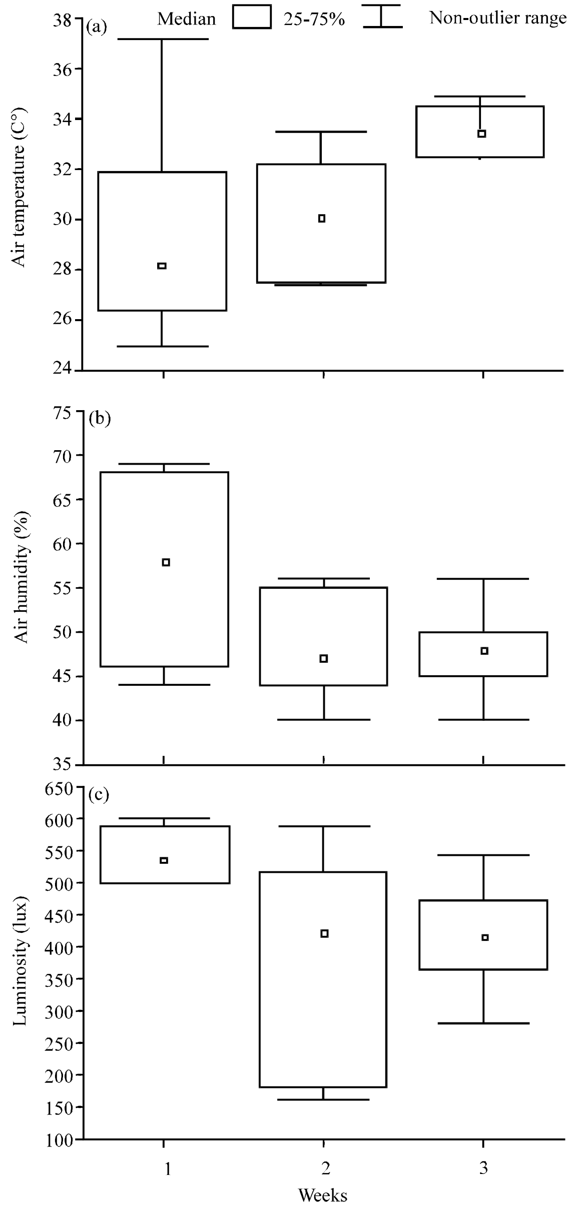

Fig. 1(a-c): Dispersion diagram of weekly average, (a) Air temperature, (b) Air humidity and (c) Luminosity inside the net-house during the execution of the experiment

Variables recorded and statistical analyses: At the end of the experiment (25 days after sowing) the following variables were recorded: (i) Plant height (cm): Measured from the base of the plant to the insertion of the youngest leave, (ii) Stem diameter [obtained with a digital paquimeter (0.01-300 mm, Digimess®)], (iii) Dry weight of shoots and roots: Plants were brought to the laboratory and dried at 70°C for 48 h and the weight of each plant part was determined in a Sartorious® brand precision balance (0.01 g precision) and expressed as g $plant^{-1}$, (iv) root length (cm): Determined using a millimeter ruler; (v) root volume (cm^3): measured according to methodology of Basso (1999) and (vi) leaf chlorophyll (Index): it was measured using a chlorophyll meter (Falker®, Brazil) in three leaves of each seedling following the methodology of El-Hendawy *et al.* (2005).

Statistical analyses included analysis of variance (ANOVA), followed by regression analysis of humic substance doses using Sigmaplot software and terms were considered significant at $p<0.01$.

RESULTS AND DISCUSSION

As can be seen in Fig. 2a and 2b, increasing humic substances doses promoted a significant average enhancement with the higher averages of height plant and stem diameter obtained for plants which received until 15 mL m^2 followed by a consecutive decay with humic substances doses increase, similar result registered by Cavalcante *et al*. (2011) who studied foliar spray of humic substances on seedling production of papaya. These results show a positive effect of these substances for watermelon seedlings that is in agreement with Boris *et al*. (2010) who concluded that humic substances provided a bio-stimulating effect on growth of cucumber, favoring a better performance. In addition, physiological mechanisms through which humic substances exert their effects may depend on hormones and, in particular, on the presence of auxin or auxin like components in their structure and, consequently its effect on plant growth and development (Eyheraguibel *et al*., 2008).

Plant height of Fig. 2a are lower than average results of Bjelic *et al*. (2007) and Costa *et al*. (2008) but compatible to Tosta *et al*. (2010).

Highest average values of shoot dry mass was obtained with addition of 22.5 mL m^{-2} dose which increased nearly 30% in relation to unsprayed plants, followed by a consecutive decay with humic substances dose increase (Fig. 2c). The positive effect of humic substances doses sprayed on dry weight of shoot followed the results of height plant and stem diameter since this variables are totally dependents between themselves.

Accordingly, Chen *et al*. (2004) argue that direct effects of humic substances depend on biochemical actions on cell wall, membrane or cytoplasm, mainly hormonal, acting in manner similar to plant growth substances (Kaya *et al*., 2005) and agricultural humic substances are reputed to drought tolerance, enhance nutrient uptake and overall plant performance resulting in increasing leaf area and biomass production, so in agreement with the findings of the present work. Similar results were obtained by Celik *et al*. (2010) who found that foliar spray of humic substances promoted positive effect on plant dry mass and Chang and Li (2008) that studied the effect of humic acids on sprouting of watermelon seeds and concluded that humic substances enhanced the growth of watermelon seedlings.

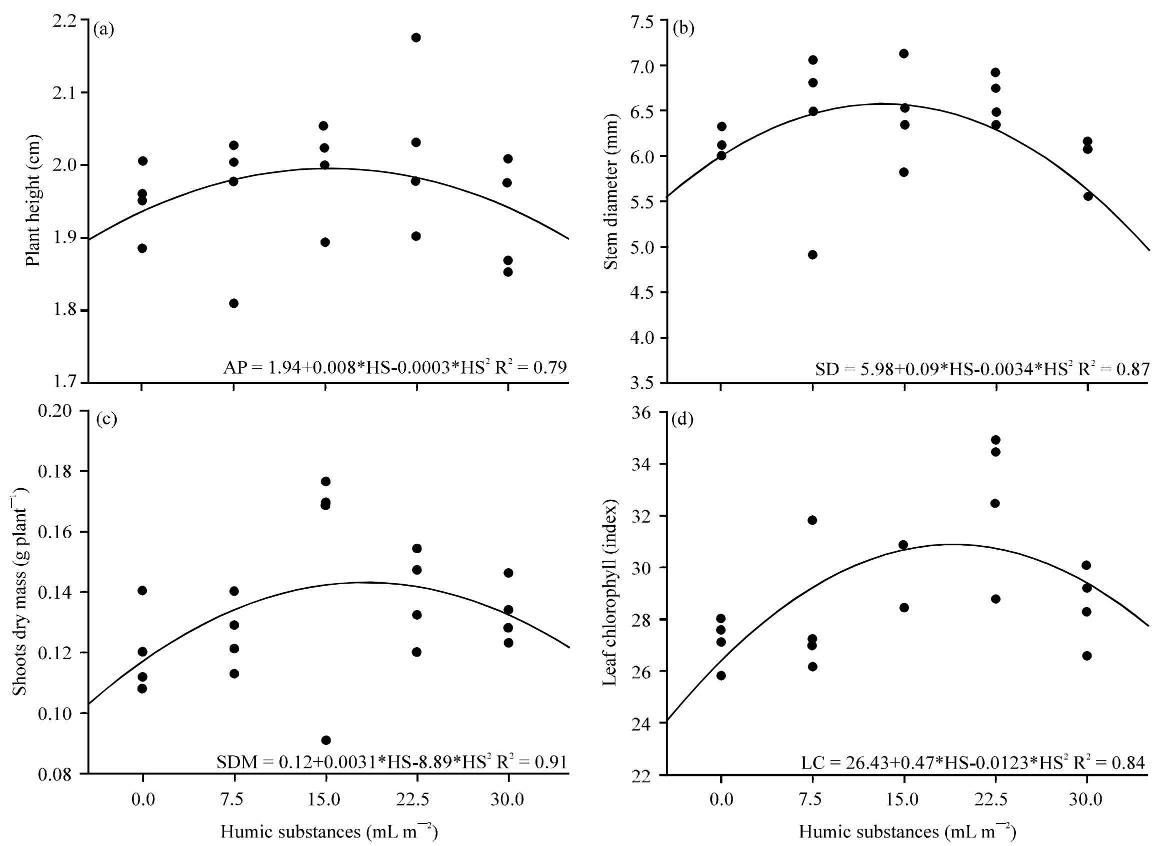

Fig. 2(a-d): (a) Plant height, (b) Stem diameter, (c) Dry weight of shoots and (d) Leaf chlorophyll of watermelon seedlings as a function of humic substances sprayed levels

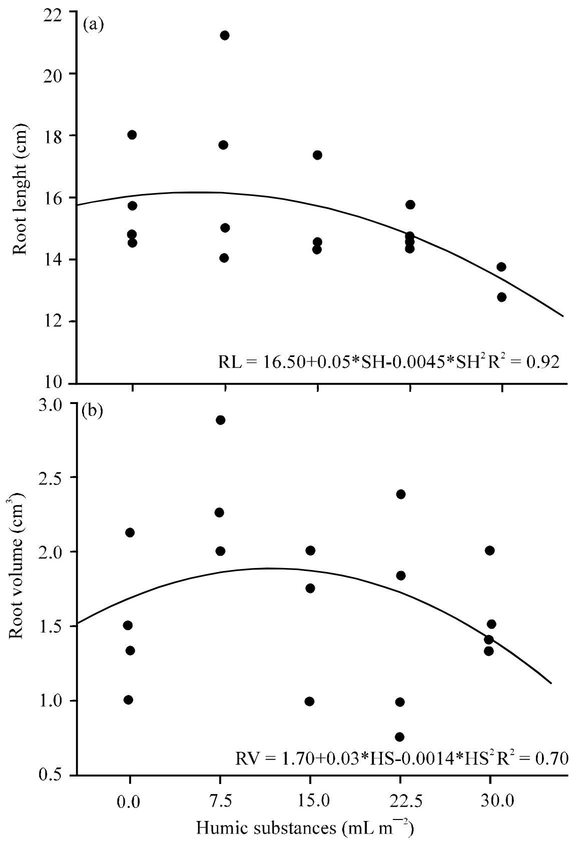

Fig. 3(a-b): (a) Root length and (b) Root volume of watermelon seedlings as a function of humic substances sprayed levels

Whether compared the shoot dry mass of Fig. 2c, it's observed that the 22.5 mL m^{-2} dose promoted average value above those reported by Costa *et al.* (2008) but below 0.5 g per plant obtained by Mota *et al.* (2011) in study about production of watermelon seedlings under irrigation with waste water.

Leaf chlorophyll of watermelon seedlings (Fig. 2d) was enhanced with humic substances doses increase until 22.5 mL m^2 dose, followed by a consecutive decay with humic substances dose increase. The results obtained in the current experiment agree with those of Cavalcante *et al.* (2011), Ferrara and Brunetti (2008) and Ferrara and Brunetti (2010) and they seem to suggest that even one application of humic substances was able to increase chlorophyll content in grape leaves and/or they delayed chlorophyll degradation. In addition, Tahir *et al.* (2011) argue that higher leaf chlorophyll associated to humic substances could be related to increased cell membrane permeability by these substances, thus promoting greater efficiency in the absorption of nutrients, especially nitrogen a nutrient with direct relation with leaf chlorophyll concentration.

Root length variables were affected by humic substances sprayed doses with quadratic data distribution, i.e., root length (Fig. 3a) and root volume (Fig. 3b) were increased until 7.5 mL m^{-2} dose and consecutively decayed, while for root dry weight didn't adjust any model. These results are congruent to findings of Trevisan *et al.* (2010) who studied the biological effect of humic substances on lateral root initiation and showed that these substances induced lateral root formation and there is a positive effect of humic substances on specific targets of auxin action.

In relation to root system, Galinha *et al.* (2009) detach that root growth and development is regulated by a complex interaction of hormone signalling pathways, especially auxin which has a central role as it is fundamental in initiating and organizing this process and the interaction between plant hormones and humic molecules act directly on growth and development of plants, what possibly happened in the present experiment.

CONCLUSION

Thus, according to the results of the experiment, the foliar spray with humic substances enhances aerial part and root system of watermelon seedlings. In addition, a 22.5 mL m^{-2} dose of humic substances for foliar spray could be recommended for production of watermelon seedlings.

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