MODELING OF WATER RETENTION IN SUBSTRATES USED IN PRODUCTION OF TOMATO "SWEET GRAPE"

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ABSTRACT

The objective of this work was the modeling of the water retention curves in three different substrates used in production of tomato variety "Sweet grape". The experiments were carried out within the existing greenhouse on the campus of UEG-UnUCET. Is saturated with water three types of substrates (sand, 40% with a commercial substrate, natural coconut fiber and commercial substrate by 80% pine bark and 20% coconut fiber) for 48 hours contained in two plastic pots for each substrate, was instrumented with three pressure sensors in each plastic pots for 59 days, where pressure measurements was performed using a digital tensiometer. Was constructed wetlands curves and pressure for each substrate in our study, each reading pressure current humidity existing on the substrates. As a result it was observed that the substrate with coconut fibers has the best ability to retain water in the assay compared to sand substrates and commercial. The model allowed us to determine the choice of substrate with improved ability to retain water for tomato production and reduce leaching loss of macro and micro nutrients in a hydroponic culture, and also allows the automation system.

Keywords: Modeling, tensiometers, Digital tensiometer, water content.

1. INTRODUCTION

Modeling is important in determining soil moisture, allows the correct irrigation crop plants, as well as to identify soil management techniques, more appropriate, enables the automation system. Water is a key factor in crop production. Their lack or an excess affects decisively in plant development and its rational management is very important in agricultural production, RABELLO et al. (2005).

The humidity sensors allow monitoring of soil water, avoiding excess irrigation and assisting in the rational use of water, control soil salinization, and erosion bioremediation, BRASEQ (2011).

The tensiometer is a device used to measure the pressure at which water is retained by the soil particles and can help control the irrigation.

The pressure of the water retained in the soil is correlated with the moisture existing in the profile forming a curve of water retention in the soil which can be determined in the laboratory.

The occurrence of water deficit undermines the productivity and quality of vegetables produced. Thus, the vegetable, except in areas or during seasons with regular distribution of rainfall is usually performed under irrigation.

Adequate irrigation minimize environmental impacts, as a rule, allow to reduce the expenditure on water and energy, nutrient losses by leaching and the incidence of diseases, with consequent reduction in the use of agrochemicals.

The objective was to model the water retention curves in three different substrates distributed in plastic pots for growing tomato variety "Sweet grape", using pressure sensors to record the data.

2. MATERIALS AND METHODS

The experiments were carried out within the existing greenhouse on the campus of Universidade Estadual de Goiás-UEG UnUCET in the months from May to July 2011. We have worked with three types of substrates is the more common vegetable crop (A: sand, with 40% a commercial substrate, Fc: coconut natural fiber and, S: commercial substrate composed of 80% pine bark and 20% coconut fiber) which were divided into two plastic pots (greater diameter, 24 cm, and base diameter 14 cm and a height of 22.5 cm) for each substrate.

Is saturated with water for 48 hours and instrumented with three pressure sensors (tensiometers puncture Fig. 1) in each plastic pots for 59 days, where pressure measurements was performed using digital tensiometer (Tensimeter – Fig. 2). On each day of readings took samples of each type of substrate for its determination of moisture content by placing in an oven at 60 ° C temperature until constant weight the samples contained in the crucibles by triplicate.

Then with the results of tension readings and the results of moisture, was performed to model the moisture curves (%) and tension (kPa) each substrate in a study used in the production of tomatoes of the variety “Sweet grape" inside the greenhouse, using the hydroponic system and drip with water and wastewater natural water. Obtaining the graphical humidity and pressure for each type of substrate.

This type of methodology is a procedure generally quite simple and extremely important because it helps in monitoring the dynamics of soil water, since it evaluates the potential of existing water.

The modeling was performed using the software Microsoft Excel 2010 Microsoft Office, and Matrix Laboratory software version MatLab version 7.10-R2010a, and software Statistic version 8, yielding equations of the models with each Software to compare the results.

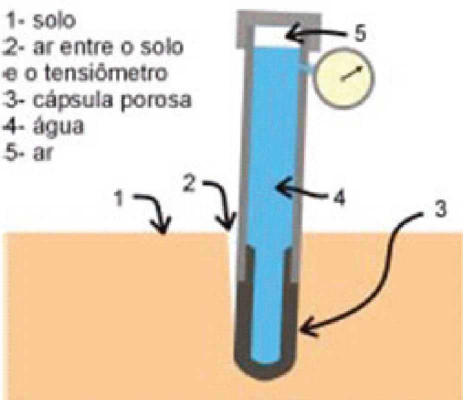


Figure 1: Tensiometer sensor. Source: CALBO (2006).

Figure 2: Digital tensiometer

3. RESULTS AND DISCUSSIONS

In this work, from coconut fiber (Fc) showed the best ability in water retention as observed in Figure 3, and validated the work of Lima et al. (2011) using natural coconut fiber as substrate for the production of tomato in hydroponic systems, and Rubio et al (2011) who also worked with coconut fiber in Sweet pepper production in substrate in response to salinity, nutrient solution management and training system. The commercial substrate (S) also showed better water retention about sand (A) the substrate.

Obtained is a linear model for the curves of moisture (%) and tension (kPa) for three substrates under study (Figure 3), where it is observed that the substrate consists of coconut fibers (Fc), has the best ability retention of water in the experiments, followed by a commercial substrate (S), indicating that could be used for the cultivation of vegetables reducing water loss, reduce leaching of nutrients loss, controlling the time of irrigation and reasonable amount of water used for the proper development of the plant, to obtain good yield and quality in the products of culture. It can be observed in the curve of Figure 3, the water evaporated very easily in the substrate composed of 60% sand and 40% of pine bark.

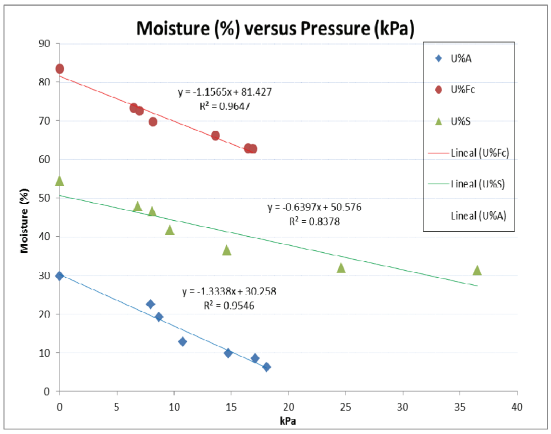
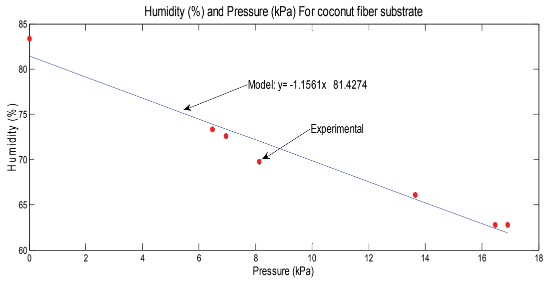
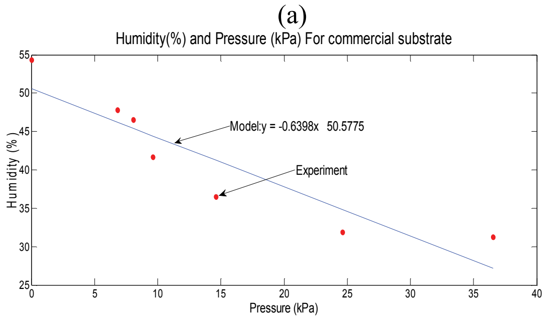


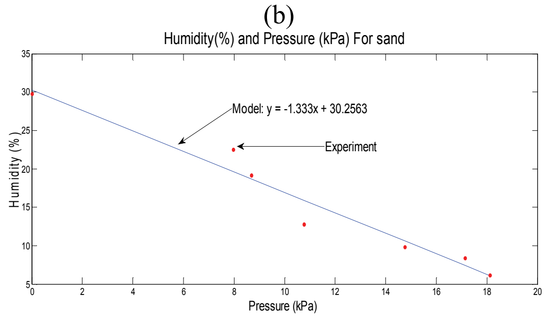
Figure 3. Modeling for Microsoft Excel 2010 of water retention curves for different substrates (A: sand: Fc: coconut fiber, S: commercial substrate) used in the cultivation of tomatoes "Sweet grape" in a greenhouse.



(a)



(b)



(c)

Figure 4: Modeling by MatLab version R2010a of water retention curves in different substrates ((a) Fc: coconut fiber, (b) S: commercial substrate and (c): Sand) used in the cultivation of vegetables in a greenhouse.

Comparing models obtained using the software Microsoftware Excel 2010 and MatLab version R2010a, the equations of the model for each type of substrate being studied are the same as shown in Figures 3 and 4 (a, b, c).

When the mathematical modeling was performed using Statistic software version 8 with the data of humidity (%) and stress (kPa) of the middle support (substrate) gave the following results:

For the medium support coconut fiber (Figure 5) was obtained in the modeling with an equation different in coefficient values (y = 78 741 - 0.9527x) compared with those obtained by MatLab software version 7.10 - R2010a (y = 81.4274 - 1.1561x) and software Microsoft Office Excel 2010 (y =81.427 - 1.1565x), where the coefficient values are almost equal to those obtained by MatLab software and Microsoft Office Excel. The best curve fit was found with the correlation coefficient when modeling was using the software Statistic version 8 (R^2 0.9793) regarding the Microsoft Office Excel (R^2 0.9647).

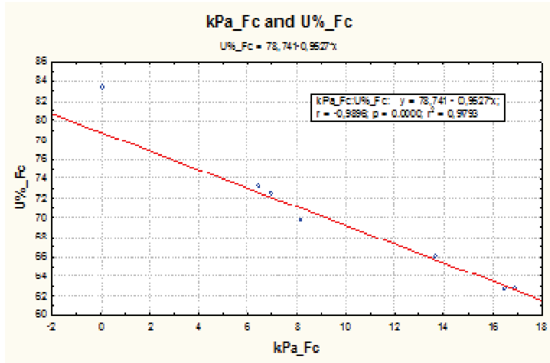


Figure 5. Modeling by Software Statistic version 8, of water retention for coconut fiber substrate (Fc), used in the cultivation of vegetables in a greenhouse.

For the commercial substrate support medium (Figure 6) was obtained with an equation modeling also different in coefficient values (y = 47.0270 - 0.4958x) compared with those obtained by MatLab (y = 50.5775 - 0.6398x) and software Microsoft Office Excel (y =50.576 - 0.6397x), where also the coefficient values are almost equal to those obtained by MatLab software and Microsoft office Excel. And the best curve fit was found with the correlation coefficient when using the modeling software was Microsoft Office Excel (R^2 0.8374) regarding the software Statistic version 8 (R^2 0.7802).

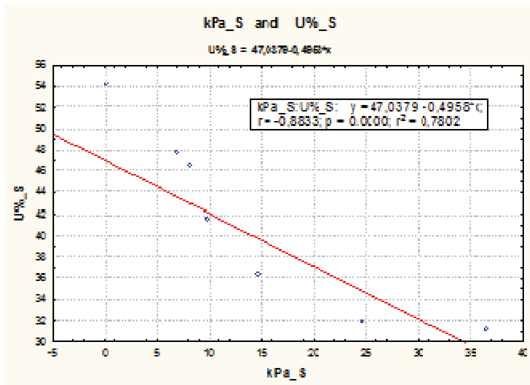


Figure 6. Modeling by Software Statistic version 8, of water retention for commercial substrate (S), used in the cultivation of vegetables in a greenhouse.

To support medium sand (Figure 7) was obtained in the modeling equation, with values nearly equal in coefficient (y = 30.1823 - 1.3292x) compared with those obtained by MatLab software version 7.10 - R2010a (y = 30.2563 - 1333) and software Microsoft Office Excel (y = 30258 - 1.3338). The best curve fit was found with the correlation coefficient when using the modeling software was Microsoft Office Excel (R^2 0.9546) regarding the software Statistic version 8 (R^2 0.9084).

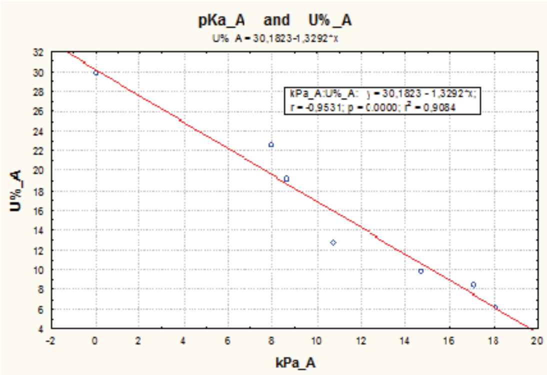


Figure 7. Modeling by Software Statistic version 8, of water retention for sand (A), used in the cultivation of vegetables in a greenhouse.

In this research the substrate coconut fiber (Fc) used as support showed the best ability in retaining water as shown in Figure 8, and validated by Lima et al. (2011) using natural coconut fiber as a substrate for the production of tomatoes hydroponically, and RUBIO et al (2011) who also worked with coconut fiber in sweet pepper production in substrate in response to salinity, nutrient solution management and training system. The commercial substrate (S) also showed better water retention respect to the substrate mixed sand (A) used as a support.

As can be observed in the curve of Figure 8, the water evaporates very easily and quickly on the substrate composed of 60% sand and 40% pine bark or commercial substrate. The model that best fit to the curves for the behavior of the substrates used as the base for retention of water, the polynomial model, yielding the following correlation coefficients for coconut fiber with R^2 0.8716, a commercial substrate for (pine bark) with R^2 0.996 and sand mixed value for R^2 was 0.8833.

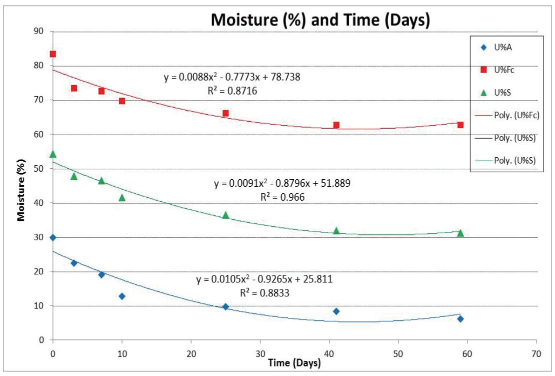


Figure 8. Curves moisture (%) versus time (days) for different substrates (A sand + 40% commercial substrate; Fc: coconut fiber and S: commercial substrate) contained in plastic pots used as supporting medium in the culture vegetables in a greenhouse.

4. CONCLUSIONS

It can be concluded that modeling has determined that the substrate with coconut fiber had the best ability of water retention time compared to the other two substrates in a study for the production of greenhouse tomato variety "Sweet grape" by hydroponic. Controlling the system set point pressure for each crop of vegetables, we can obtain a good yield and good quality end product.

The modeling shows that the software allowed Microsoft Office Excel 2010 version best fit the curves of water retention in the substrates used for production of vegetables in a greenhouse. Water evaporates quickly in sand mixed compared with coconut fiber and commercial substrate as support used to the production of vegetables.

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