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Research Article

Valuation of a Substrate Organic Retaining Humidity According to its Physical Properties

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Abstract

Substrates of organic materials (agricultural waste) that provide physical benefits to soils in texture, granulometry, apparent density, real density, porosity, infiltration and moisture retention in agricultural soils. The importance of applying these substrates to soils has a great impact on moisture retention, which can help in the comprehensive use of water, improving time and water consumption, in irrigation applied to high-demand crops, such as corn. sorghum among others. There is a wide variety of methods to evaluate retention, such as Green and Ampt, Kostiacov, among others.

In this evaluation, the stove method and the TDR-300 method were used, using three treatments T1-Control, T2- soils+10 g of substrate, T3- soils+20 g of substrate, T4- soils+30 g of substrate with three repetitions, applying the statistical error, of which in the two methods the 45% humidity in both methods were very similar in results, their physical characteristics also behaved in a similar way with a minimum variation of 2%, the increase of water was gradual, the greater the amount of substrate, the greater the retention, this substrate can be a viable alternative for the farmer to retain moisture in agricultural soils and help minimize the cost of water used to produce food in the world.

Keywords: Organic substrate, Infiltration, Moisture retention

Introduction

The substrate is above all the porous medium in which the plants are anchored, which must satisfy their physical, chemical and biological needs [1]. A good substrate is understood to be a medium that is permanently characterized by a high retention capacity of available water and its porosity [2]. In Mexico, grain production requires water consumption, which has increased in recent years [3], specifically in corn and sorghum in the northern area of Sinaloa. That is why the importance of this research is to reduce the amount of water in gravity irrigation, applying new methods of moisture retention, there are many materials such as agrolite, coconut fiber gels, among others, which are high cost and difficult to process, the retainer used is easy to process and low cost, since due to the large amounts of cellulose that exist in the area (agricultural waste) mentioned [4].

There are methods to evaluate information, such as kostiakov, palaces, Green and ampt among others. These methods are applied with physical variables with a high degree of complexity [5]. In infiltration soil physics studies, Lugo [6] mentions the high reliability of the use of the TDR-300 method in measuring humidity. This work aimed to evaluate and quantify the amount of water retained in a clay loam soil for two methods (TDR-300 and stove), applying different doses of organic substrate, knowing its physical properties, resulting in up to 30% moisture retention in a soil, this means that it would be of great support in gravity irrigation, prolonging the irrigation time which would reduce water consumption for grain production in Sinaloa.

Materials and Methods

This evaluation was carried out in the municipality of Burrioncito, Guasave, Sinaloa Mexico in two stages; The first stage was the preparation of materials, which consisted of determining the weight of the samples used with Hanna laboratory scales, subsequently the particle size of approximately 6 mm was determined and they

were mixed with a clay loam soil at the Higher Technological Institute of Guasave (ITSG) and Irrigation Research and Postgraduate Department of the Autonomous University of Chapingo in respective laboratories, in the second stage the retention of available water was evaluated by the De Bolt method and a comparison was made with other materials that exist in the market (agrolite and tezontle), collect the materials, wash them with deionized water, dry them at room temperature, crushing and sieving them until obtaining a particle size of approximately 6 mm, weighing them and adding them to 1 liter transparent plastic cups, then saturating them with water and weigh the three treatments in homogeneous conditions,by the [7] method , carrying out moisture retention studies (curves) in order to obtain data for its application of gravity irrigation in clay loam soils, on this occasion soil samples were and taken to the laboratory, where studies of physical properties were carried out such as: texture, real density, apparent density and total porosity, the variables that were measured directly in the laboratory for each treatment with its three repetitions were: apparent density ρb (paraffin method), hydraulic conductivity Ks (constant load permeameter), total porosity Ø, initial humidity (gravimetric method) , real density ρa (pycnometer method), effective saturation (So), texture (Day's method), humidity at field capacity (CC), humidity at the permanent wilting point (PMP) and the retention curve of humidity this with the purpose of expanding the data information in retention. of humidity, subsequently a 3x3 experimental design was carried out, taking as reference a pure control soil treatment 1 (T1), treatment 2 (T2) soil+20% organic substrate and treatment 3 (T3) soil+40% organic substrate. Se aplicó material procesado (MO) mediante pirolisis y no procesado (material orgánico sin ninguna modificación), e hidrogel (H) sintetizado a partir de pectinas del extracto del fruto de tejocote, mediante hidrólisis ácida.

Properties Evaluated

Moisture Stress Curves

To determine moisture tension curves, soil samples were taken on an agricultural property in Burrioncito ejido, Guasave, Sinaloa. Organic substrates were added to these samples. The same ones that were evaluated in the soil physics laboratory of the Autonomous University of Chapingo applying the Prado methodology [8].

Soil Physical Properties'

werevaluations of the physical properties of the soil were calculated in the three treatments, the variables were: texture, real density (ρb), apparent density (ρa), hydraulic conductivity (Ks), organic matter (OM), capacity of field (CC), permanent wilting point (PMP), [9]. Once these physical parameters were determined, the texture was carried out using the Boyocus method, resulting in 26% sand, 39% clay and 35% silt, giving the texture Grenn and Ampt [10] clay loam.

Validation with TDR-300

Once the samples were homogenized in about three soil spaces of 1m 2 control, treatment 1 and treatment 2, material % was calculated. used per kilogram of soil and each of the samples was added and homogenized. Subsequently, the water saturation process was carried out, applying gravity irrigation in a normal way, it was left to rest for 24 hours and the humidity was calculated with the previously calibrated TDR-300 equipment, in three repetitions of each treatment according to the methodology of [6].

Stove Method Validation

Once the samples were homogenized, one kilogram of control soil (T1), one kilogram of soil+20 g of organic substrate (T2), one kilogram of soil+40g of organic substrate (T3), the three samples were homogenized and They were added in plastic containers with a volume of 2liters in which a steel rod support equipment was used, this in order to place another container that would determine the infiltrated water for measurement. Once all the materials were installed, a liter of water to each treatment with their respective repetitions of letting it rest for 24 hours and samples were taken to take them to the oven and calculate the humidity in each sample (ISO. 1993).

Statistical Data Analysis

For the statistical analysis, it was carried out to obtain the average values validated with a 3x3 experimental design, three treatments (soil T1, soil+20 g organic substrate T2 and soil+40 g organic substrate T3, with three repetitions, the parameters minimum variance and maximum and coefficient of variation (C. V) and ANOVA. Used Sigma Plot (version 14).

Results and Discussion

Moisture Stress Curve

In Figure 1 you can see the moisture retention behavior of the three validated treatments. Treatment T1 is the one that had the lowest retention compared to T2 and T3, below 30%. This suggests that the accumulation is gradually the more material used there is a greater retention, the field capacity point (CC) and the permanent wilting point is totally different, the greater the number of organic substrates each variable increases the validation of organic substrates that improve soil properties can be of great support to the productive sectors in saving water in irrigation management mainly by gravity [11].

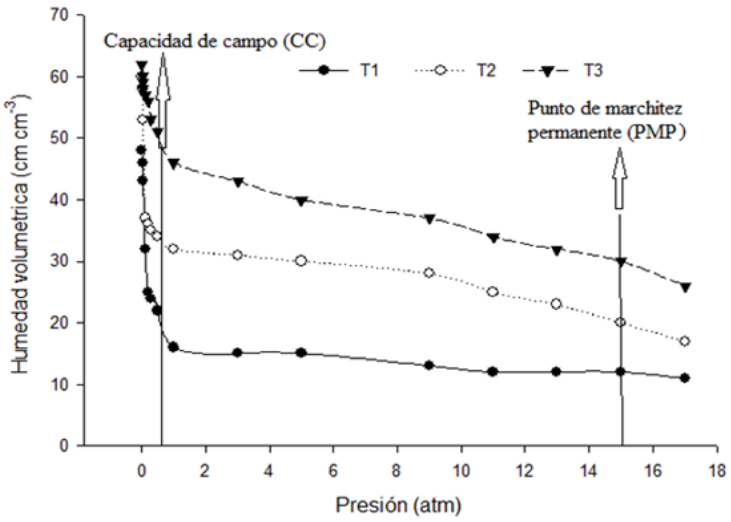

Figure 1: Soil moisture tension curves applying organic substrates with different doses.

Physical Properties

To determine the physical properties of the soil with organic substrates, they were validated according to the method of Green and [10], as indicated by [12]; These values are shown in Table 1, where it can be seen that the values are modified according to the control that contains pure soil, according to the application of organic substrates, the value of the apparent density and total porosity of each treatment changes, gradually improving moisture retention up to 30%. According to the hydraulic conductivity, a homogeneous difference is marked in the three treatments. As [13] mentions, adding organic substrates modifies physical properties such as apparent density, porosity and moisture retention, among others, generating a difference between the values.

Table 1: Physical properties of the soil with different doses of moisture-retaining organic substrate.

Parameters	Symbol	Treatment 1	Treatment 2	Treatment 3
Density apparent (g c^{m-3})	ρb_	1.31	1.07	1.11
density (g cm^{-3})	ρa	2.53	2.5	2.58
porosity (cm)	η	0.52	0.61	0.59
Conductivity hydraulic (mm h^{-1})	KS	4.8	7.9	5.6
Field capacity (cm^3 cm^{-3})	θDC	0.41	44	0.37
Permanent wilting point (cm^3 cm^{-3})	θPMP	0.13	0.15	0.14
Organic matter (%)	M.O.	12	15	17

Validation of TDR-300 Methods and Stove Methods

In Figure 2 you can see the differences of the treatments validated in the field and laboratory according to the results are very similar, in treatment T1, you can see that the data have a very similar behavior, this indicates that the two methods applied are very effective in retaining moisture by applying it firmly, it can be said that organic substrates, organic waste materials can be a solution in retaining moisture for agricultural use, improving its use and saving irrigation flows. As [14] mentions, TDR sensory equipment is highly efficient; these tools firmly monitor each value validated in soil moisture retention systems. To determine the humidity in soils and materials according to the stove method, the method described by [15] was applied.

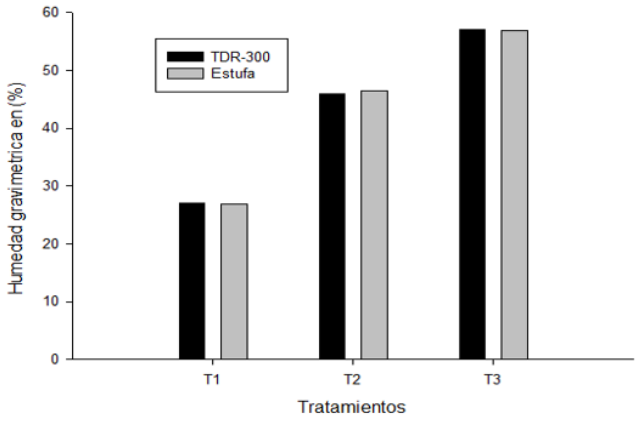

Figure 2: Evaluation of volumetric humidity in a clay loam soil applying different doses of organic substrate and different methods.

Statistical Error

The variation between the samples according to the two methods was very low, which indicates that it is exact with the coefficients of variation determined in the statistical study. As an example of a coefficient of variation of 0.17 to 47% in moisture retention for the control, for treatment 2 it was 0.16 to 0.34% and for treatment 3 it was 13 to 30%. from which it is deduced that the coefficients of variation (CV) found in the validated treatments are high and their credibility and firmness are precise to be applied in agricultural soils. Likewise, it can be mentioned that the substrates retain moisture and may be viable for agricultural use Lugo (2022). According to the analysis of variance (ANOVA) to observe the statistical difference in the results, they reflected the normality and equality of variances of the studied groups corresponding to each modality. This allowed the analysis of variance to be carried out. The results of the ANOVA indicate that there are no significant differences in the average scores of the two methods studied [16-18].

Conclusions

With the firmness that there is a gradual moisture retention according to the application of organic substrates, it can be concluded from the results obtained by the TDR-300 method and the oven method, they increased moisture retention up to 30% in gradually according to the variability shown in statistical studies. Where it is efficient according to the control, this indicates that it can be used according to the needs of the crops in their gravity irrigation, improving moisture retention and their physical properties such as apparent density and porosity.

Conflict of Interest

None.

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