PEDOTRANSFER FUNCTIONS TO ESTIMATE FIELD CAPACITY AND PERMANENT WILT POINT IN A PLANOSOL UNDER INTEGRATION CROP-LIVESTOCK-FOREST SYSTEM IN THE AGRESTE OF PARAÍBA

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ABSTRACT
Pedotransfer functions are methods proposed with the objective of obtaining indirect information, with greater speed and ease to estimate various soil attributes. Thus, the objective of this work was to generate and obtain pedotransfer functions (PTFs) to predict the moisture retained at specific potentials in a Planosol under integration crop-livestock-forest system in the Agreste of Paraíba, three years after implementing the system. The research was conducted in an area located at the Experimental Station of the Paraíba Company of Research, Rural Extension and Land Regularization - EMPAER, in the district of Alagoinha, PB. The experimental design utilized was that of randomized blocks with 5 integration systems and 4 repetitions. The treatments were structured as 1) Gliricídia + *Brachiaria decumbens* (GS+BD); 2) Mimosa *caesalpiniaefolia*+ *Brachiaria decumbens* (MC+BD); *Tabebuia alba* + *Brachiaria decumbens* (TA+BD); 4) Zea mays + *Brachiaria decumbens* (ZM+BD); 5) *Brachiaria decumbens* (BD). Soil samples with undisturbed structure were collected in three layers (0.00-0.10; 0.10-0.20 and 0.20-0.30 m). Soil water retention was determined in the following matrix potentials: Ψm = -33 e -1,500 kPa. According to the results, it was possible to observe an increase in the available water content in all treatments, as a function of depth, and the soil granulometry was shown to be related to the increase of clay particles in the subsurface.
Key words: soil water; pedofuctions; agrosilvopastoril systems

INTRODUCTION

The soil water retention curve can be obtained directly, through the tension table and Richards chamber, the psychrometer, the centrifuge, or indirectly through mathematical models.These models, also called Pedotransfer Functions (PTFs), are intended to make the obtaining of difficult determination data easier (OLIVEIRA et al., 2002; MICHELON et al., 2010; COSTA et al., 2013), based on atributes which are constantly measured with great ease and low cost (SANTRA; DAS, 2008; SILVA et al., 2008), transforming the available information into necessary data (BOUMA, 1989).

Knowing the behavior of water in the soil is important for decisions in aspects involving the environment at all scales, since the use of pedotransfer models for soils in regions, management and conditions different from the conditions that originated the calibration data must be avoided., since it increases the risk of making a wrong prediction (SILVA; ARMINDO, 2016).

It can be said that, in order to estimate water retention in the soil, using Pedotransfer Functions (PTFs), deep and textural resources, are good predictors when present in mathematical models. Andrade et al. (2020), developed models for estimating field capacity and permanent wilting point, in Argissolos Amarelos in the coastal tableland region of the state of Pernambuco, the models generated were composed of the content of clay, sand, mesoporosity and soil density.

In Agreste Paraibano, Pequeno et al. (2020), developed PTFs where the variables that most contributed to the generation of functions were coarse sand content, microporosity and soil density. The authors concluded that the generated PTFs generated good accuracy and can be used to estimate the water content retained in Dystrophic Yellow Latosol and Eutrophic Red Argisol, for the region's edaphoclimatic conditions.

In this sense, this work aimed to generate and obtain pedotransfer functions (PTFs) to predict the retained moisture to special potentials in a Planosol under integration crop-livestock-forest system in the Agreste of Paraiba.

MATERIAL AND METHODS

Location and characterization of the study área

The experimental area is located in the experimental station of the Paraiba Company for Research, Rural Extension and Land Regularization - EMPAER, located in the municipality of Alagoinha, in the Agreste mesoregion of the State of Paraíba, under the coordinates 06º57'00" S and 35º32'42" W and 317 m altitude. The region's climate is characterized as As', hot and humid, with autumn-winter rains according to the classification proposed by Koppen-Geiger. The average annual precipitation is 995 mm, with the rainy season covering the months of March to August. The annual average temperature varies between 22 and 26 ºC.

Experiment implementation

The soil of the experimental area was classified as Eutric Planosol with moderate A horizon and sandy loam texture according to SiBCS (SANTOS et al., 2018).

An experiment was installed in July 2015 and the evaluation was carried out in March 2018. The experimental design adopted was in randomized blocks (RBD) with five treatments and four replications (5 x 4). The experimental plots were 38 x 20 m, making a total area of 760 m2. The treatments consisted of: 1) *Gliricidia sepium* (Jacq.) Steud + *Brachiaria decumbens* (GS+BD); 2) *Mimosa caesalpiniaefolia* (Benth)+ *Brachiaria decumbens* (MC+BD); 3) *Tabebuia alba* + *Brachiaria decumbens* (TA+BD); 4) *Zea mays* L. + *Brachiaria decumbens* (ZM+BD); 5) *Brachiaria decumbens* (BD). The forest species were planted in triple rows, with 3 x 2 m spacing at the edges of each plot, adding up to six rows per plot, while the corn was planted under no-tillage system.

The undisturbed soil samples were collected in three layers: 0.00-0.10 m, 0.10-0.20 m and 0.20-0.30 m, in each experimental plot.

Generation and obtaining of pedotransfer functions (PTFs)

Data was submitted to statistical analysis using the statistical software SigmaPlot, where, first, a simple correlation analysis was performed between all variables. Subsequently, multiple regression analysis was performed using the "stepwise" option to obtain the PTFs. In the definition of multiple linear regression equations, to predict the model's attributes, it was established that the behavior of a characteristic in the equation must affect the parameter to be predicted (dependent variable) being consistent with the empirical and theoretical knowledge of the process.

From the existing data in the database, PTFs were generated to estimate each of the points (-33and -1500 kPa) of the water retention curve in the soil. These PTFs were generated through independent variables included in the model, at 5% error probability. The independent variables used in this study were: sand and clay content, flocculation degree, soil density, particle density, macroporosity, microporosity, total porosity and pH in water. The dependent variables were the matrix potential water contents of -33 and -1500 kPa.

RESULTS AND DISCUSSIONS

The pedotransfer functions (PTFs) generated and their respective determination coefficients in the matrix potentials of Ψ-0.3 and Ψ-1.5 (kPa) are shown in Table 1. The composition of the PTFs took into account, mainly, structural and textural variables, in addition to pH. The R^2 values obtained by each model, represent the importance of the structure and texture of the soil in water retention.

Table 1. Pedotransfer functions generated and validated to estimate field capacity (FC) and permanent wilt point (PWP) and their respective statistical indicators (R^2, ME and RSME) in a Planosol under the Integratedcrop-livestock-forest system in the Agreste of Paraíba.

PTFs	R^2	ME	RSME
$\Psi_{-0.033}$= 0.263 + (0.000621 * Clay) - (0.0372 * pH)	0.91	0.00053	0.00207
$\Psi_{-1.5}$ = -1.047 + (0.0000522 * total sand) - (0.630 * PT) - (0.0000408 * GF) + (0.367 * DP) + (0.0782 * DS) + (0.0613 * pH)	0.86	0.00060	0.00233

D_P = particle density; D_S = bulk density; PT = total porosity; R^2 = determination coefficient; ME = average error; RSME = square root of the mean error.

For the matrix potential Ψ-0.033, the ME value (0.0005 cm^3 cm^{-3}) indicated a slight overestimation of the data calculated through the PTFs. The observance of the 1: 1 straight line with RSME value (0.0021 cm^3 cm^{-3}) demonstrated a good fit between the estimated and observed data, with moderate dispersion. The coefficient of determination (R^2) was around 0.90. Thus, 90% of the variation in the water content retained is explained by the model.

In the matrix potential Ψ-1.5, referring to the permanent wilting point of the soil, the statistical indicators showed a slight underestimation in the retained water content estimated by the PTFs (ME = -0,0006 cm^3 cm^{-3}), in addition to a low data dispersion in relation to the 1: 1 line (RSME = 0.0023 cm^3 cm^{-3}). The coefficient of determination (R^2) with a value of 0.86 indicates a good adjustment of data by the model, where 86% of the variations in the water content can be explained by the same.

Both functions presented high R^2 values and low ME and RSME values, denoting the good accuracy of these PTFs in the prediction of water retention values in the soil in all potential matrix tested in the study, referring to a Planosol.

CONCLUSIONS

Points of the water retention curve in the soil can be estimated with reasonable precision, based on the functions of the generated pedotransferences, using the contents of sand and clay, density of the soil and particles, macroporosity, microporosity and total porosity, degree of flocculation and pH.

The generated and validated pedotransfer functions can be applied in simulations to obtain points on the retention curve, considering the adjustments obtained, for the studied Planosol, considering the geographic region, the climate, the hydrology and the use of the soil.

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