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—Scientific Note—

Pedotransfer Function to Estimate Soil Penetration Resistance of the Vegetable Production Areas in Northeast Florida

Judyson de Matos Oliveira[1], Fernando R. Bortolozo[1], Lincoln Zotarelli[1]*, Cássio Antônio Tormena[3], Allan Bacon[2], and Julio Pachon[2]

[1]*Horticulture Science Department, University of Florida/IFAS, Gainesville, FL*

[2]*Soil and Water Sciences Department, University of Florida/IFAS, Gainesville, FL*

[3]*Agronomy Department, State University of Maringá, Maringá, PR, Brazil*

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Northeast Florida (NE) is responsible for 35% of the spring potato production in the United States. The development of tools to assist growers assess soil physical qualities for vegetable production is needed. Penetration resistance (PR) has been used to quantify soil physical conditions related to soil management practices. Potato root development might be limited by PR >1.5 MPa ($PR_{critical}$). PR can be measured in-situ or in a laboratory using penetrometer devices readily available on the market. Correlations between PR and soil water content (θ) and others soil properties (e.g., soil bulk density (Bd) and soil organic matter (SOM) and texture) still need to be considered. Thus, individual PR measurements might not be sufficient to assess soil physics conditions for root growth. Alternatively, soil pedotransfer functions (PTF) have been used as a practical tool to estimate PR as a function of θ and other soil physical properties. This study aimed to develop a PTF to evaluate PR considering θ, Bd, SOM, and particle-size distribution < 250 μm (PSD_{fine}) variation across subirrigated commercial potato fields. The area of interest was located in the vegetable production areas of St. Johns, Flagler, and Putnam counties, NE. Five of 20 representative areas were selected, with PSD_{fine} ranging from 526 (lower) to 937 (upper) $g.kg^{-1}$. Sixty-six undisturbed soil samples were taken from at 0-0.40 m soil depth in each area from which PR, θ, Bd, SOM, and PSD_{fine} were determined. The soil penetration resistance curve (SPRC) was estimated using a multilinear regression approach. The fitted SPRC (Eq.1) explained 91% of the PR variation at the 0–0.20m soil depth. PR was negatively influenced by θ, and positively by Bd, SOM and PSD_{fine}.

$$PR=e^{(-4.9575+0.0676*SOM+0.0009*PSDfine)}*\theta^{(-0.311)}*Bd^{(8.9189)};$$

$$n=292;\ F=531.5;\ P < 0.0001) \qquad [Eq.1]$$

The PR was estimated using Eq.1 for lower and upper PSD_{fine}, considering a Bd range of 1.18–1.58 $g\cdot cm^{-3}$, SOM of 6.00 $g\cdot kg^{-1}$, and θ at field capacity (θ_{FC}) of 0.12 and 0.15 $cm^3\cdot cm^{-3}$ for lower and upper PSD_{fine}, respectively. The average PR ±s tandard deviation was 0.80 ± 0.51 and 1.08 ± 0.70 MPa for lower (Fig. 1A) and upper (Fig. 1B) PSD_{fine}, respectively. There was no $PR_{critical}$ below a Bd of 1.48 and 1.45 $g\cdot cm^{-3}$ for lower and upper PSD_{fine}, respectively, regardless of θ conditions. However, θ lower than θ_{FC} for soils with a Bd higher than 1.48 and 1.45 $g\cdot cm^{-3}$, for lower and upper PSD_{fine}, respectively, can result in $PR_{critical}$, thus limiting potato root growth (Fig. 1A and B). The PTF allowed us to estimate PR using θ and soil physical properties routinely measured in NE. SPRC should be integrated in irrigation recommendation models as an indicator of the soil physics quality for potato root development.

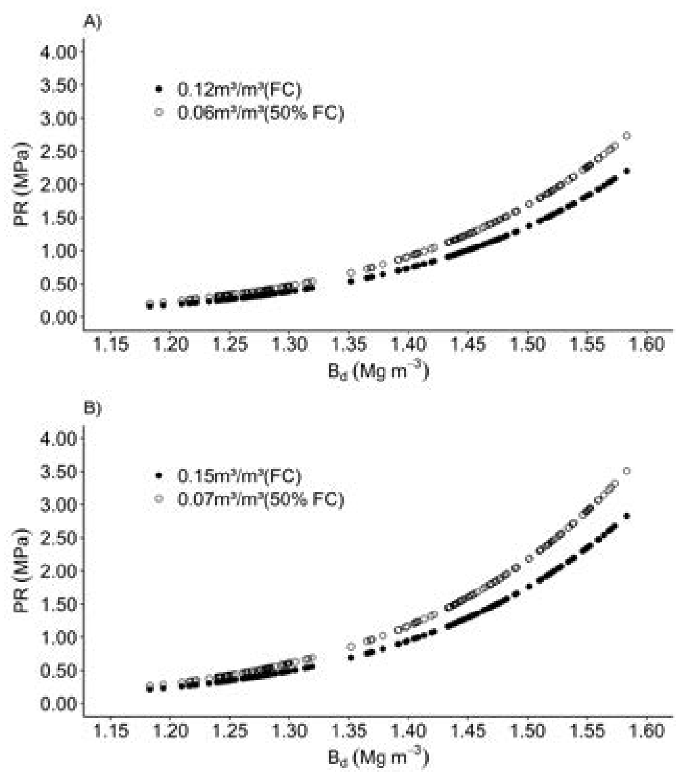

Fig. 1. Soil penetration resistance curve (SPRC) estimated to soils with particle-size distribution (PSD_{fine} < 250 μm); **A**) 526 $g\cdot kg^{-1}$ (lower), and **B**) 937 $g\cdot kg^{-1}$(upper), with soil organic matter content of 6.00 $g\cdot kg^{-1}$, and soil water content at the field capacity (solid circles) and 50% below of the field capacity (open circles) at the 0–0.20 m soil depth layer.

*Corresponding author. Email:lzota@ufl.edu