Chapter 11
Raising the Efficiency of Seohen's Model to Predict Soil Resistance Faced by Chisel Plow

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ABSTRACT

This research was carried out to study the effect of crop factor, which is represented in some plant roots of crops residues (broad bean and wheat) on soil mechanical properties (cohesion strength, C, and internal friction angle, Φ), and thus, the effect of these roots on the power requirements of chisel plow to face the soil resistance was studied. Soil mechanical properties and power requirements of chisel plow (7 blades) were measured in the field directly at various soil depths of (0.05, 0.1, 0.15, and 0.2 m) with and without roots at constant tractor forward speed of about 4 km/h. Moisture content of the soil, broad bean roots, and wheat roots were 21%, 16%, and 14%, respectively, The results showed that the effect of roots of previous crops residues had a significant effect on the soil mechanical properties and power requirements for chisel plow when using the crop factor, which is represented in characteristic of crop residual roots in terms of root mean diameter.

INTRODUCTION

Endo and Tsuruta (1969) reported that soil shear strength increases in proportionto the amount of roots in thesoil. Waldron (1977) reported that when the soil is subject to shear strengths, there is the mobilization of an adding opposition due to the development of tensile strength inside of roots and the whole soil has a greater resistance.

Waldron and Dakessian (1982) mentioned that soil-root shear strength is directly proportional to root cohesion. This means a soil with high root cohesion will increase the soil-shear strength, adding to slope stability. Roots of plants increase soil cohesion by binding to soil particles. Wu (1984) reported that the number, depth, size, and growth patterns of roots affect the soil cohesion. Greenway (1987) reported that in generally accepted that plant roots provide reinforcement to a soil matrix due to the different material

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properties of soil and roots. He also added that several factors could affect the root-reinforcement of a soil, including root density, root branching and tensile strength of the roots. Fitter (1993) appeared that root systems mechanically reinforce soil by transferring shear stress in the soil to tensile resistance in the roots. Ekwue and Stone (1995) proved that soil shear strength is very important in studying draft of tillage tools. In other words, the draft of farm implements is mainly affected by shear strength of soil. Lawrence et al. (1996) carried out shear tests in soil without roots and soil contents roots. The results showed that the increase in soil strength parameters (C and Φ) in the soil with roots compared soil without roots was included between 48% and 56%. Ekanayake et al. (1997) concluded that Field and laboratory shear tests have quantified the shear strength of soils both with and without roots. Roots increase the soil shear strength and the normal components of soil resistance. Goldsmith (1998) presented preliminary findings of increased soil shear strength due to roots of plants. Greenway (1987) and Collins (2001) mentioned that several factors can affect the root-reinforcement of a soil, including root density, root branching, tensile strength of the roots and root moisture content. Operstein and Frydman (2000), and Consoli et al. (2002) reported an increase in internal friction angle of soil reinforced by root sand, an increase in the apparent cohesion with increasing cross-sectional area and tensile strength of the roots. Singh and Huat (2004) appeared that the roots interact with the soil to produce a composite material in which the roots are fibers of relatively high tensile strength and adhesion inherent in a matrix of lower shear strength soil. The main contributor to the increase in shear strength appears to come from the cohesion (an increase of 22-64%) and the angle of shearing resistance (increase of 24-54%). Thorne (1990) and De Baets et al. (2008) mentioned that the mechanical characteristic of roots is that they are strong in tension. Soils, on the other hand, are strong in compression and weak in tension. A combined effect of soil and roots, producing a composite material in which the roots are fibers of relatively high tensile strength and adhesion embedded in a matrix of lower tensile strength soil mass, resulting in a reinforced soil. Therefore, it is the tensile of the roots, which contribute to the overall strength of the soil-root composite. Gerardand Mehta (1971) reported that root crops increased bulkdensity, permeability and strength of soil. Willatt and Sulistyaningsih (1990) showed that rice roots increased both the bearing capacity and shearing resistance of soils and a linear relationship between these strength parameters was observed. Huat et al. (2005) said that the root in soil the main elements which related to soil shear strength. Ali and Osman (2008) showed that root significantly contribute to the increase in soil shear strength. Abdullah et al. (2011) found that the presence of vegetation roots would result in an overall increase in the soil strength. Wu et al. (2014) said that roots play an important role in soil reinforcement has been accompanied by a growing interest in studying the mechanical strength of soil-root composites. Murielle et al. (2014) reported that soil mechanical properties were most influenced by (i) density of roots crossing the shear plane, (ii) branching density throughout the soil profile, (iii) total length of coarse roots above the shear plane and (iv) total volume of coarse roots and fine root density below the shear plane. During failure, fine, short and branched roots slipped through soil rather than breaking. Conclusion Root morphological traits such as density, branching, length, volume, inclination and orientation influence significantly soil mechanical properties. Cohen and Schwarz (2017) showed that the main contribution related to the presence of small roots in the most superficial soil layers, particularly in the first 2.0 m that mobilize their tensile strength by soil-root friction increasing the compound matrix strength. Such an effect has been largely known as root reinforcement. Bordoni et al. (2016) found that different vegetation types have the capacity to modify significantly the structure of the soil and soil mechanical properties. Bordoni et al. (2020) mentioned that root density in soil and root mechanical properties vary significantly