GRADUATE AND POSTDOCTORAL STUDIES

McGILL UNIVERSITY

FINAL ORAL EXAMINATION
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

OF

AHMED AHMED

DEPARTMENT OF BIORESOURCE ENGINEERING

THE INFLUENCE OF WOOD-DERIVED BIOCHAR ON PHYSICOMECHANICAL AND HYDRAULIC CHARACTERISTICS OF AGRICULTURAL SOILS: IMPLICATIONS FOR MACHINE–SOIL INTERACTIONS AND CARBON SEQUESTRATION

July 13th, 2018
10:00 A.M.
Raymond Building, Room R3-045
McGill University, Macdonald Campus

COMMITTEE:
Dr. P.G. Brown (Pro-Dean) (Geography Department)
Dr. V. Orsat (Chair) (Department of Bioresource Engineering)
Dr. G.S.V. Raghavan (Supervisor) (Department of Bioresource Engineering)
Dr. J.F Adamowski (Internal Examiner) (Department of Bioresource Engineering)
Dr. S.O. Prasher (Internal Member) (Department of Plant Science)
Dr. C. Begg (External Member) (Department of Plant Science)
Dr. S. Sadaka (External Examiner) (Department of Bio and Agricultural Engineering, University of Arkansas)

Dr. Josephine Nalbantoglu, Dean of Graduate and Postdoctoral Studies

Members of the Faculty and Graduate Students
are invited to attend
ABSTRACT
Biochar has gained research interest because of its high pore volume and adsorption capacity and—when applied as an agricultural soil amendment—ability to enhance soil nutrient- and water-holding capacities. In addition to increasing soil quality, biochar amendments sequester carbon within the soil. In most applications, crop productivity significantly increases after agricultural soils are amended with biochar. However, the mechanisms behind this increase are not fully understood, nor is the influence of biochar on soil compaction. Therefore, this laboratory study focuses on the influences of wood-derived biochar (WBC) on the physico-mechanical properties of agricultural soils prone to compaction.

First, a screening study was carried out to assess the changes in the physico-mechanical properties of a silt loam soil amended with WBC. The amended soil was more susceptible to compaction due to the increase in plasticity and optimum moisture content; however, the soil mechanical impedance was enhanced by lower penetration resistance and shear strength. The next step was to investigate the influence on the compaction, workability and fertility of two texturally contrasting agricultural soils of WBC amendments of two particle size ranges. Although the clay loam (CL) soil workability decreased with relatively coarser WBC particle size, soil fertility was not enhanced.

The effects of WBC application on the hydraulic characteristics of compacted CL and SL soils were also investigated. Results showed that the saturated hydraulic conductivity of the amended SL soil decreased while in the amended CL soil, the trend was reversed. Further, the water holding capacities of the SL soils increased with 10% amendment of 0.5–420 µm particle size WBC. Further, the soil pore size distribution of the treatments was determined from the soil water retention curves (SWRCs). An increase in the capillary pores was not observed at any WBC amendment level. Alternatively, an increase in the transmission and storage pores were observed when 10% 0.5–420 µm particle size WBC was applied to the CL soil.

A simulation scenario was carried out with a crop simulation model to determine the potential of sequestering carbon in simulated agricultural fields due to changes in soil physical properties. Simulated results indicated that if the hydraulic characteristics and density were enhanced in SL and CL samples based on finding from this study, a net negative carbon emission (carbon sequestration in soil) of 13.3% and 12%, respectively, would be induced.

The main goal of the next study component was to investigate the influence of WBC amendment strength upon compaction for SL and CL soils, which exhibit contrasting behavior in terms of shear parameters. Moreover, the soil consistency limits could predict the compacted soil strength. To theoretically investigate the influence of WBC amendment on the tillage power requirements associated with changes in soil properties, models from the literature were employed to determine the soil failure in front of a tillage tool, tillage draft, and tractor thrust. Amendment of WBC with a particle size range of 0.5–420 µm decreased tillage power requirements in the CL soil and increased tillage power requirements in the SL soil.
CURRICULUM VITAE

UNIVERSITY EDUCATION

2012-2018  Ph.D. In Agricultural Engineering
McGiLL University, Canada

2001- 2004  M.Sc. In Agricultural Engineering
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EMPLOYMENT

2014-2017  Lecturer
McGiLL University, Canada

2013-2017  Research Assistant
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2004-2012  Research Associate
Ministry of Agriculture, Egypt

AWARDS
2013-2016 McGill Graduate Excellence Award- Bioresource Engineering

PUBLICATIONS


