FINAL ORAL EXAMINATION
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

OF

LEONARDO XAVIER LEÓN CASTRO
NATURAL RESOURCE SCIENCES
Soil nitrogen dynamics following green manure plow-down determined by ion exchange membranes and the nitrogen uptake of arugula (Eruca sativa L.)

Monday, June 13, 2016
13:15

Macdonald Stewart Building, Room MS2-022
McGill University, Macdonald Campus

COMMITTEE:
Dr. M. Lefsrud (Pro-Dean) (Bioresource Engineering)
Dr. B. Côté (Chair) (Natural Resource Sciences)
Dr. J. Whalen (Supervisor) (Natural Resource Sciences)
Dr. P. Seguin (Internal Examiner) (Plant Science)
Dr. G. Sunahara (Internal Member) (Natural Resource Sciences)
Dr. G.S.V. Raghavan (External Member) (Bioresource Engineering)

Dr. Josephine Nalbantoglu, Dean of Graduate and Postdoctoral Studies
Members of the Faculty and Graduate Students
are invited to attend
Green manure crop mixtures contain legumes that capture \( N_2 \) from the atmosphere. When green manure is plowed down, the decomposing residues are a source of N fertilizer for the following crop. The challenge is to determine how quickly the green manure releases N and what proportion of the N requirements of the next crop can be met by green manure. Ion exchange membranes (IEMs) hold promise in evaluating the N supplied by green manure, and they act as a sink for plant-available N. The objectives of my thesis were to 1) determine the pattern of N release from field pea-oat green manure under field conditions with IEMs, and relate this to the N demands of arugula (\textit{Eruca sativa} L.); 2) to determine if IEMs could detect small changes in N dynamics in different soil types that were amended with green manure residues having a low C/N ratio; and 3) to determine how tillage practices that reduce the size of green manure residues may accelerate N release from green manure, as determined by IEMs, and meet crop N requirements. In a field experiment, in two soil types in Quebec, Canada, a green manure mixture contributed to the plant-available N concentration and arugula N uptake. The IEM-NO\(_3\)-N supply was greater than arugula N demand, suggesting that growing a second crop or a winter cover crop that would use the residual soil N released by green manure. In an incubation experiment, I validated the use of IEMs by incorporating green manure residues with variable C/N ratios. The green manure residues with C/N = 8 showed immediate N release, whereas residues with C/N = 12 ratio had a delay in releasing plant-available N. The delay suggested that the C/N ratio of green manure residue plus analysis with IEMs was a good indicator of plant-available N dynamics. In addition, the different soil texture (clay loam and sandy loam) modulated the decomposition process and N concentrations. Greater tillage intensity reduced the percentage of residues with larger particle size. While the higher concentration of plant-available N was released with 4 passes, the maximum N uptake by arugula was reached with 2 passes of the cultivator. Residues remaining after the experiment continued to release N, suggesting that residual soil N would be left after arugula harvest. In conclusion, the use of IEMs in situ and in incubation experiments could accurately assess the pattern of N release from green manure. This provides insight about the plant-available N dynamics in soils receiving green manure and when N is available for subsequent crops. Farmers can use this information to select crops that will fully use the plant-available N, thus optimizing the N recovery from green manure crops.
CURRICULUM VITAE

UNIVERSITY EDUCATION

Doctor of Philosophy 2013-present
Macdonald Campus, McGill University, Sainte-Anne-de-Bellevue, Quebec

Master in Horticulture 2009-2011
University of Bologna, Bologna, Italy
University of Natural Resources and Life Sciences, Vienna, Austria
Technical University of Munich, Freising, Germany

- Soil properties and microbial activities in top soil in relation to crop rotation and biogas digestion residues

Engineer in Agricultural Science 1997-2007
Specialisation in Organic Agriculture
Escuela Superior Politécnica del Litoral
Guayaquil, Ecuador

EMPLOYMENT

Lab Assistant, 2005-2008
Biotechnology Research Center of Ecuador, Guayaquil, Ecuador

Student-trainee program, WTFRC*, 2003-2004
*Washington Tree Fruit Research Commission, Wenatchee, WA, USA

AWARDS

2016 Presentation Award at the Canadian Society of Soil Science Annual Meeting
2016 The Centre SÉVE Conference Travel Award
2016 Agriculture Institute of Canada and the Canadian Society of Soil Science Student Travel Award
2009-11 Erasmus Mundus Scholarship Award
PUBLICATIONS


León Castro, L., Whalen, J.K. 2016. Ion exchange membranes are sensitive indicators of ammonium and nitrate released from green manures with low C/N ratios. European Journal of Soil Biology, In review


SELECTED PRESENTATIONS


ACTIVITIES AND SERVICE

Scientific Memberships
CSSS, Canadian Society of Soil Science
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Canadian Journal of Soil Science
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