

CURRICULUM VITAE

Dr. Walter Osorio, Ph.D.

CURRENT AFFILIATION

Associated Professor in Environmental Soil Biotechnology –Plant Soil Nutrient Management
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OVERVIEW

Since 1992, I have a full-time position as professor in Soil Sciences in the National University of Columbia at Medellin. I have a three-way appointment consisting of 50% research, 25% teaching, 25% extension/administration. I enjoy teaching soil sciences courses: Plant-soil nutrient management (undergraduate), Environmental Soil Biotechnology (Graduate). I also conduct research with students, mostly graduate students (M.Sc. and Ph.D. level), for which it is necessary to prepare proposals in order to get grants from public agencies such as COLCIENCIAS, Colombian Ministry of Agriculture, among others. My extension activities are focused in supporting the Soil Laboratory through which farmers can characterize their soils and establish rational practices of soil management. I have had some administrative appointments: Head of the Department of Geosciences (2004-2005), Director of Research (2006-2007), Chairman of the Graduate Programs in Natural Sciences (2009-2011). Also, in the last four years (2007-2011), I have been the Editor of *Suelos Ecuatoriales*, the journal of the Colombian Society of Soil Sciences.

Currently, I am a member of the Soil Science Society of America, Crop Science of America, and American Society of Agronomy, and the Soil Science Society of Colombia.

ACADEMIC INTEREST

I am interested in the Integrated Management of Soil Fertility and Plant Nutrition. It must involve a proper characterization of soil properties and the establishment of rational practices for soil management that combine organic amendments, inorganic fertilizers, and microbial inocula. I focus my research on the study of the effectiveness of mycorrhizal fungi and phosphate solubilizing microorganisms to enhance plant phosphate uptake and growth in soils with different mineralogy, particularly highly weathered soil of the tropics and in those derived from volcanic ash.

EDUCATION

- Ph. D. Soil Science (Soil Microbiology), University of Hawaii, USA (2008)
- M.Sc. Soil Science (Soil Fertility), University of Hawaii, USA (2000)
- Engineer in Agronomy, National University of Columbia (1990)

EMPLOYMENT

- Administrative appointments: Chairman of graduate programs in Natural Sciences (01/2009-present), Director of Research of Medellin Campus (06/2006-08/2007), Head of the Department of Geosciences (02/2004-10/2005).
- 11/2002-present: Associated professor, full-time, National University of Columbia at Medellin.
- 10/2001-06/2002; 09/2007-01/2008: Research assistant, University of Hawaii, Honolulu, USA.
- 01/1995-11/2002: Assistant professor, full-time, National University of Columbia at Medellin.
- 01/1993-01/1995: Associated Instructor, part-time, National University of Columbia at Medellin.
- 01/1995-01/1996: Part-time instructor, University of Antioquia.
- 05/1994-01/1995: Agronomist, Flores del Lago Ltda, Rionegro, Colombia.
- 01/1991-05/1994: Agronomist, Exportaciones Bochica S.A., La Ceja, Colombia.
- 01/1989-12/1990: Teaching assistant in Soil Sciences, National University of Columbia at Medellin

AWARDS

- Award to outstanding professor, Association of Professors of the National university of Columbia at Medellin (APUN), 2005
- Scholarship, Colombian Institute for advancement of Science and Technology (COLCIENCIAS), 1998-2002.
- Scholarship outstanding academic performance for undergraduate students, National University of Columbia at Medellin, 1984, 1985, 1986, 1987, 1988.

PROFESSIONAL SOCIETY MEMBERSHIP

- Soil Science Society of America, American Society of Agronomy, Crop Science Society of America 1999-2002; 2014-
- Colombian Society of Soil Science, 1994- present. 2011-2013: Member of Directive Board.

GRANTS

Title project	Principal investigators	Supporting agency	Amount (US \$)	Dates
Integrated management of vainilla nutrition	M.C. Diez, M. Marín & N.W. Osorio	Colombian Ministry of Agriculture and Rural Development & Nat. Univ. of Columbia at Medellin	540,000	01/2008-01/2012
Agroforestry arrangements for vanilla cropping	M.C. Diez, F.H. Moreno & N.W. Osorio	Colombian Ministry of Agriculture and Rural Development & Nat. Univ. of Columbia at Medellin	540,000	01/2008-01/2012
Development of biotechnological strategies for improvement growth, productivity, and quality of avocado crop	N.W. Osorio	Nat. Univ. of Columbia at Medellin	43,000	01/2009-01/2011
Exponential fertilization of native forestry species of Andean highland	M.C. Diez & N.W. Osorio.	COLCIENCIAS (Colombian Institute for Advancement of Sci. & Technol.) & Nat. Univ. of Columbia at Medellin	129,000	01/2009-12/2011
Management of organic residues from pruning of urban trees in Metropolitan area of Medellin	R. Parra, J.D. Leon & N.W. Osorio	Metropolitan Area of Medellin	50,000	06/2009-06/2010
Nutritional requirements of urban trees at nursery	J.D. Leon & N.W. Osorio	Nat. Univ. of Columbia at Medellin & The nursery for urban trees of Medellin	15,000	06/2009-06/2010
Ectomycorrhizal dependency of three pinus species	J.D. Leon & N.W. Osorio	Nat. Univ. of Columbia at Medellin & St. Helen Nursery	20,000	10/2009-12/2010
Evaluation of the environmental risk and agronomic management of sludge sewage in pastures of Antioquia	R.D. Zapata & N.W. Osorio	EPM (Medellin Public Services Company)	75,000	06/2009-06/2010
Grant for outstanding research groups of the Nat. Univ. Of Columbia	N.W. Osorio & R.D. Zapata	Nat. Univ. of Columbia at Medellin	20,000	06/2007-06/2008
External and internal boron requirement of coffee crop in an Andisol of Colombia	F. Restrepo & N.W. Osorio	Coffee Growers Federation of Columbia & Soil Lab of the Nat. Univ. of Columbia	75,000	06/2005-12/2007
Mycorrhizal dependency of some tropical fruits grown in the highland Andean	N.W. Osorio	Nat. Univ. of Columbia at Medellin	40,000	01/2005-01/2007
Effect of glomalin on soil structure stability of degraded soil by alluvial mining	F. Orozco, O. Ruiz & N.W. Osorio	Nat. Univ. of Columbia at Medellin	25,000	01/2004-02/2006
Effectiveness phosphate solubilizing microorganisms on plant phosphate uptake and growth in tropical soils	N.W. Osorio	COLCIENCIAS (Colombian Institute for Advancement of Sci. & Technol.) & Nat. Univ. of Columbia at Medellin	250,000	06/1998-2008
Total = US \$ 1,822,000				

TEACHING

Soil fertility: undergraduate level, 3-credits, 2 theory-hour/week, 2 practice-hour/week. Teaching include lecturing, lab work, discussion of soil test results, field trips, and greenhouse experiments. Topics: plant nutrition, water and nutrient uptake, soil nutrient availability, soil testing, Soil acidity, Soil nitrogen, phosphate, potassium, calcium, magnesium, sulfur, and micronutrients.

Soil fertility management: graduate level, 4-credits. 4 hours/week. Classes on soil testing and how-to-determine lime and fertilizers requirements for cultivated soils. Discussion sessions and laboratory practices.

Environmental soil biotechnology: graduate level, 4-credits. Topics: soil as habitat for microbes, nutrient and energy requirement of soil microbes, rhizosphere, mycorrhizal association, phosphate solubilizing microorganisms, nitrogen fixation, PGPR, bioremediation of degraded soils.

MANUSCRIPTS RECENTLY SUBMITTED (2)

1. Osorio NW (2014) Arbuscular mycorrhizas and their significance in alleviation of soil phosphate deficiency in the tropics. India. Book Chapter.
2. Moreno J, Leon JD, Osorio NW (2015) Forestry tree seedling growth promotion by dual inoculation with rhizosphere fungi. Acta agronomica.

SELECTED PUBLICATIONS (82)

2014-2015

1. Diez MC, Moreno FH, Osorio NW (2015) Effect of dose and type of fertilization on flowering and fruiting of vanilla plants. Journal of Plant Nutrition 0190-4167 (Print), 1532-4087 (Online). DOI: 10.1080/01904167.2015.1098673 (published online).
2. Mejia E, Osorno L, Osorio NW (2015) Construction waste: an option for soil recovery. Revista EIA 12: 55-60 (ISSN: 1794-1237) doi: <http://dx.doi.org/10.14508/reia.2014.11.E2.55-60>.
3. Ramirez JG, Muñoz M, Osorno L, Osorio NW, Morales JG (2015) Germination and growth of purple passion fruit seedlings under pre-germination treatments and mycorrhizal inoculation. Pesquisa Agropecuaria Tropical 45 (3): 257-265. (e-ISSN 1983-4063). <http://dx.doi.org/10.1590/1983-40632015v45i33273>.
4. Osorio NW, Habte M, Leon JD (2015) Effectiveness of a rock phosphate solubilizing fungus to increase soil solution phosphate impaired by the soil phosphate sorption capacity. Revista Facultad Nacional Agronomía 68 (2): 7627-7636. doi: 10.15446/rfnam.v68n2.50950.
5. Moreno A, González O, Osorio NW (2015) *In vitro* dissolution of acidulated rock phosphate by phosphate solubilizing microorganisms. Acta Biologica Colombiana 20 (2): 65-71. doi: <http://dx.doi.org/10.15446/abc.v20n2.42713>
6. Sierra J, Castro D, Osorio NW (2015) Mycorrhizal dependency of alcaparro at three concentrations of soil solution phosphorus. Rev. Fac. Nac. Agron. 68(1): 7451-7458. doi: <http://dx.doi.org/10.15446/rfnam.v68n1.47831>
7. Restrepo M, Osorio NW, León JD (2014) Assessment of the effectiveness of ectomycorrhizal inocula to promote growth and root ectomycorrhizal colonization in *Pinus patula* seedlings using the most probable number technique. Applied and Environmental Soil Science Volume 2014, Article ID 870616, 6 pages, <http://dx.doi.org/10.1155/2014/870616>
8. Castrillon M, Leon JD, Osorio NW, Carvajal D (2014) Effectiveness of Single and Combined Ectomycorrhizal Inocula on Three Species of Pinus at Nursery. Communications in Soil Science and Plant Analysis 46(2): 169-179. DOI: 10.1080/00103624.2014.967856
9. Osorio NW, Habte M (2015) Effect of a phosphate-solubilizing fungus and an arbuscular mycorrhizal fungus on leucaena seedlings in tropical soils with contrasting phosphate sorption capacity. Plant and Soil. DOI: 10.1007/s11104-014-2357-5.
10. Osorio A, Osorio NW, Diez MC, Moreno FH (2014) Nutrient status and vegetative growth of *Vanilla planifolia* Jacks plants as affected by fertilization and organic substrate composition. Acta Agronomica 63(4): 326- 334. ISSN: 0120-2812 (Print) ISSN: 2323-0118 (Online)
11. Osorio NW (2014-2015) Manejo de Nutrientes en Suelos del Trópico (Nutrient Management in Tropical Soils). Universidad Nacional de Colombia- Editorial LA Vieco, Medellín, 416 p.
12. Alvarez-Lopez C, Osorio-Vega W, Diez-Gómez MC, Montoya-Marin M (2014) Caracterización bioquímica de microorganismos rizosféricos de plantas de vainilla con potencial como biofertilizantes. Agronomía Mesoamericana 25(2):225-241. ISSN: 1021-7444 (versión impresa), ISSN: 2215-3608 (versión on-line).
13. Osorno L, Osorio NW (2014) Effect of carbon and nitrogen source and concentration on rock phosphate dissolution induced by fungi. Journal of Applied Biotechnology 2(2): 32-42. ISSN 2327-0640.
14. Sepulveda Y, Diez MC, Moreno FH, Leon JD, Osorio NW (2014) Caracterización de los síntomas visuales de deficiencias nutricionales en plántulas del roble andino. Revista Agronomía Costarricense, 38(1): 161-173. ISSN:0377-9424.

15. Osorio W, Osorno L (2014) Biofertilization with mycorrhizal fungi and phosphate solubilizing microorganisms enhance effectiveness of phosphate fertilizers in tropical soils (Chapter book). In: Fertilizer Technology Vol. 2: Synthesis. pp. 298-326.
16. Sepulveda Y, Diez MC, Moreno FH, Leon JD, Osorio NW (2014) Effects of light intensity and fertilization on the growth of andean oak seedlings at nursery. *Acta Biologica Colombiana* 19(2):83-92 (ISSN 0120-548X).
17. León JD, Osorio NW (2014) Role of litter turnover in soil quality in tropical degraded lands of Colombia. *The Scientific World Journal*, Volume 2014, Article ID 693981, 11 pages (<http://dx.doi.org/10.1155/2014/693981>) ISSN: 2356-6140 (Print) ISSN: 1537-744X (Online).
18. Ramírez JA, León-Peláez JD, Craven D, Herrera D A, Zapata CM, González-Hernández MI, Gallardo-Lancho J, Osorio W (2014) Effects on nutrient cycling of conifer restoration in a degraded tropical montane forest. *Plant and Soil* 378:215-226. (DOI 10.1007/s11104-014-2024-x). ISSN: 0032-079X (Print) 1573-5036 (Online).
19. Martínez J, Cajas YS, León JD, Osorio NW (2014) Silvopastoral systems enhance soil quality in grasslands of Colombia. *Applied and Environmental Soil Science*. <http://dx.doi.org/10.1155/2014/359736> (Article ID 359736) (ISSN: 1687-7675, Online)
20. Osorio NW, Habte M (2014) Soil phosphate desorption induced by a phosphate solubilizing fungus. *Communications in Soil Science and Plant Analysis*, 45(4):451-460 (ISSN 0010-3624). DOI: 10.1080/00103624.2013.870190.
21. Herrera DA, León JD, Ruiz M, Osorio NW, Correa G, Ricardo RE, Uribe A (2014) Evaluación de requerimientos nutricionales en vivero de especies tropicales empleadas en silvicultura urbana. *Rev. EIA* 11(21): 39-52 (ISSN 1794-1237).
22. Alvarez C, Osorio NW (2014) Silicio: agronomicamente esencial. *Mejorsulfatos-L. Vieco*, Medellín, 102 p.

2013

23. Ramírez JG, Osorno L, Osorio NW, Morales JG (2013) Microbiological alternatives for the improvement of cowpea growth. *Rev. Fac. Nal. Agr. Medellín* 66(2):7035-7044. (ISSN 0304-2847).
24. Tamayo A, Osorio NW (2013) Nutrición y fertilización (Cap. libro), 182-212 pp. In: CORPOICA. Actualización tecnológica y buenas prácticas agrícolas en el cultivo de aguacate. CORPOICA, Bogotá, 410 p. ISBN: 978-958-740-167-7.
25. Leon JD, Castellanos J, Casamitjana M, Osorio NW, Loaiza JC (2013) Alluvial gold-mining degraded soils reclamation using *Acacia mangium* plantations: an evaluation from biogeochemistry. (chapter book). In: Hai, Ren (ed.) *Plantations: Seasonal Variation, Growth and Ecological Impacts*. Nova Science Publishers, New Yoork, NY, USA, 155-176 pp. (ISBN: 978-1-62808-135-0).
26. Restrepo MF, Florez CP, Osorio NW, León JD (2013) Passive and Active Restoration Strategies to Activate Soil Biogeochemical Nutrient Cycles in a Degraded Tropical Dry Land. *ISRN Soil Science Volume 2013*, Article ID 461984 (Open access, ISSN 2090875X). doi: <http://dx.doi.org/10.1155/2013/461984>.
27. Alvarez C, Osorio NW, Marin M (2013) Molecular identification of microorganisms associated to the rhizosphere of vanilla plants in Colombia. *Acta Biológica Colombiana* 18(2):293-306 (ISSN 0120-548X).
28. Loaiza-Usuga JC, Leon-Pelaez JD, Gonzalez-Hernandez MI, Gallardo-Lancho JF, Osorio-Vega W, and Correa-Londoño G (2013) Alterations in litter decomposition patterns in tropical montane forests of Colombia: a comparison of oak forests and coniferous plantations. *Canadian Journal of Forest Research*, 43: 528–533 (ISSN 0045-5067). doi: 10.1139/cjfr-2012-0438
29. Osorio NW, León JD (2013) Role of arbuscular mycorrhizal association on plant nutrition and growth in tropical forestry and agro-forestry (chapter book). In: Hai, Ren (ed.) *Plantations: Seasonal Variation, Growth and Ecological Impacts*. Nova Science Publishers, New Yoork, NY, USA, 127-154 pp. (ISBN: 978-1-62808-135-0)
30. Osorio NW, Habte M (2013). Synergistic effect of a phosphate solubilizing fungus and an arbuscular mycorrhizal fungus on leucaena seedlings in an oxisol fertilized with rock phosphate. *Botany* 91:274-281 (ISSN 1916-2790). doi: 10.1139/cjb-2012-0226.
31. Flórez-Flórez CP, León-Peláez JD, Osorio NW, Restrepo-Llano MF (2013) Dinámica de nutrientes en plantaciones forestales de *Azadirachta indica* (Meliaceae) establecidas para restauración de tierras degradadas en Colombia.

2012

32. Habte M, Osorio NW (2012) Effect of nitrogen form on the effectiveness of a phosphate-solubilizing fungus to dissolve rock phosphate. *Journal of Biofertilizers and Biopesticides*, 3(5):1-4 (ISSN: 2155-6202) <http://dx.doi.org/10.4172/2155-6202.1000127>.
33. Osorio NW, Habte M (2012) Phosphate desorption from the surface of soil mineral particles by a phosphate solubilizing fungus. *Biology and Fertility of Soils* 49:481–486 (ISSN 0178-2762) (DOI 10.1007/s00374-012-0763-5).
34. Serna SL, Osorio NW, Montoya B (2012) Use of soil microorganisms as a biotechnological strategy to enhance avocado-plant phosphate uptake and growth. *Rev. Fac. Nat. Agr. Medellín*, 65:6645-6657 (ISSN 0304-2847).
35. Osorio A, Osorio NW, Diez MC, Moreno FH (2012) Effect of organic substrate composition, fertilizer dose, and microbial inoculation on vanilla plant nutrient uptake and growth. *Acta Horticultura* 964:135-142 (ISSN 0567-7572). http://www.actahort.org/books/964/964_17.htm
36. Alvarez CL, Marin M, Diez MC, Osorio NW (2012) Molecular identification of microorganisms associated to the rhizosphere of vanilla and their potential use as biofertilizers. *Acta Horticultura* 964:107-114 (ISSN 0567-7572). http://www.actahort.org/books/964/964_13.htm
37. Sierra-Escobar JA, Castro-Restrepo D, Osorio-Vega W (2012) Dependencia micorrícica de barcino [Mycorrhizal dependence of barcino (clusiaceae: *Calophyllum brasiliense* Cambess)] *Actualidades Biológicas* 34:199-206 (ISSN 0304-3584)
38. Serna SL, Osorio NW, Montoya B (2012) Monitoreo del pH y fósforo soluble en la rizosfera de arboles de aguacate en el norte y oriente antioqueño [Monitoring soil pH and soluble P in the rhizosphere of avocado trees at the Northern and Eastern Antioquia. *Suelos Ecuatoriales* 42 (2): 93-97 (ISSN 0562-5351).

2011

39. Osorio NW (2011) Effectiveness of Phosphate Solubilizing Microorganisms in Increasing Plant Phosphate Uptake and Growth in Tropical Soils, 65-80 pp. *In: Maheshwari DK (ed). Bacteria in Agrobiolgy: Plant Nutrient Management (Volume III)*. Springer-Verlag Berlin Heidelberg, 345p (ISBN 978-3-642-21060-0).
40. Osorio NW (2011) Editorial. *Suelos Ecuatoriales* 41 (2):92. (ISSN 0562-5351).
41. Osorio NW (2011) Respuesta a la fertilización en vivero de árboles andinos de Colombia, 35 – 52 pp. En: Diez MC et al. (eds) *Fertilización de especies forestales de bosques andinos*. Universidad Nacional de Colombia, Medellín (ISBN: 978-958-761-123-6).
42. Daza PC, Osorio NW (2011) Promoción de crecimiento y absorción de fosforo de plántulas de leucaena por un hongo micorrizal en un suelo degradado por minería de aluvión. *Suelos Ecuatoriales* 41 (2): 144-149. (ISSN 0562-5351).
43. Osorio NW (2011) Crecimiento inicial de plántulas de árboles andinos en campo y su relación con la fertilización en vivero, 53-64 pp. En: Diez MC et al. (eds) *Fertilización de especies forestales de bosques andinos*. Universidad Nacional de Colombia, Medellín (ISBN: 978-958-761-123-6).
44. Osorio NW (2011) Detección de síntomas visuales de deficiencias nutricionales en especies forestales, 65-75 pp. En: Diez MC et al. (eds) *Fertilización de especies forestales de bosques andinos*. Universidad Nacional de Colombia, Medellín (ISBN: 978-958-761-123-6).
45. Osorio NW (2011) Establecimiento y manejo del cultivo de vainilla, 45-58 pp. En: Diez MC et al. (eds) *Cultivo de Vainilla*. Universidad Nacional de Colombia, Medellín (ISBN: 978-958-761-126-7).
46. Alvarez C, Santa C, Ordoñez N, Posada L, Marin M, Osorio NW (2011) Sanidad del cultivo de vainilla, 59-71 pp. En: Diez MC et al. (eds) *Cultivo de Vainilla*. Universidad Nacional de Colombia, Medellín (ISBN: 978-958-761-126-7).
47. Osorio NW, Casamitjana M (2011) Toma de muestras de suelos para evaluar la fertilidad del suelo. *Suelos Ecuatoriales* 41 (1): 23-28. (ISSN 0562-5351).
48. Osorio NW (2011) Microorganismos del suelo y su efecto sobre la disponibilidad de nutrientes en suelos ácidos del trópico. *Suelos Ecuatoriales* 41(1): 74-91. (ISSN 0562-5351).

2010

49. Osorio NW (2010) Editorial. Suelos Ecuatoriales 40 (1):1. (ISSN 0562-5351).
50. Hincapié LF, Osorio NW, Gutiérrez PA (2010) Aislamiento de bacterias degradadoras de hidrocarburos a partir de suelo. Suelos Ecuatoriales 40(1): 51-56. (ISSN 0562-5351).
51. León JD, Osorio NW, Castellanos J, Osorio LF (2010) Recuperación de suelos degradados por minería aluvial de oro con plantaciones de acacia en la región del Bajo Cauca (Antioquia, Colombia). Suelos Ecuatoriales 40(1): 62-67. (ISSN 0562-5351).
52. Zapata R, Osorio NW (2010) La Material Orgánica del Suelo, 357-396 pp. *In:* Burbano H, Silva F (ed) Ciencia del Suelo: principios básicos, Sociedad Colombiana de la Ciencia del Suelo, Bogotá, 594 p. (ISBN 978-958-8598-02-4)

2009

53. Sierra J A, Castro D, Osorio NW (2009) Dependencia micorrizal de laurel. Revista Colombia Forestal 12: 17-24 (ISSN 0120-0739).
54. Osorio NW (2009) Editorial. Suelos Ecuatoriales 39 (2): 107-108. (ISSN 0562-5351).
55. Londoño A, Osorio NW, Ruiz O, Orozco H, González O (2009) Efecto de la inoculación micorrizal sobre el crecimiento del pasto brachiaria y la estabilidad de agregados de suelos degradados por minería de aluvión. Suelos Ecuatoriales 39(2): 119-125 (ISSN 0562-5351).
56. Montoya B, Osorio NW (2009) Mycorrhizal dependency of avocado at different levels of soil solution phosphorus. Suelos Ecuatoriales 39(1): 100-106 (ISSN 0562-5351).
57. Jaramillo S, Osorio NW (2009) Mycorrhizal dependency of coffee seedlings at three levels of soil solution phosphorus. Suelos Ecuatoriales 39(1): 143-147 (ISSN 0562-5351).
58. Osorio NW (2009) Microorganismos del suelo y su efecto sobre la disponibilidad y absorción de nutrientes por las plantas, 43-71 pp. *In:* Materia orgánica, biología del suelo y productividad agrícola. Sociedad Colombiana de la Ciencia del Suelo, Armenia, 136 p. (ISBN 978-958-8598-00-0)
59. Osorio NW, Habte M (2009) Strategies for utilizing arbuscular mycorrhizal fungi and phosphate-solubilizing microorganisms for enhanced phosphate uptake and growth of plants in the soils of the tropics, 325-351 pp. *In:* Khan MS *et al.* (ed). Microbial strategies for crop improvement, Springer-Verlag Berlin Heidelberg (ISBN 978-642-01978-4).

2008

60. Díez MC, Osorio NW, Moreno FH (2008) Evaluation of mycorrhizal dependency of romeron pine (*Nageia rospigliosii* Pilger) under contrasting light conditions. Rev. Fac. Nacional Agronomía Medellín, 61(2): 4554-4563 (ISSN 0304-2847).
61. González O, Osorio NW (2008) Determinación de la dependencia micorrizal del lulo. Acta Biológica Colombiana, 13(2):163-174 (ISSN 0120-548X).
62. Osorio W (2008) Uso de enmiendas orgánicas en el manejo de suelos ácidos del trópico, 189-200 pp. *En:* Jiménez, F. (ed.) Actualización en fertilización de cultivos y uso de fertilizantes. Sociedad Colombiana de la Ciencia del Suelo, Bogotá, 236 p. (ISBN 978-958-96518-6-5)
63. León JD, Osorio W, Pelaez-Silva JA, Barreto LH (2008) Estudio exploratorio de la actividad biológica del suelo en ecosistemas forestales altoandinos de Antioquia, Colombia, 147-178 pp. *En:* León JD (ed) Ecología de bosques andinos: experiencias de investigación. Universidad Nacional de Colombia, Medellín (ISBN 978958728011-1)
64. Osorio W, Díez MC, Sierra J, Paternina L (2008) Consideraciones ecológicas sobre la asociación micorrizal en suelos de la región altoandina, 179-196 pp. *En:* León JD (ed) Ecología de bosques andinos: experiencias de investigación. Universidad Nacional de Colombia, Medellín (ISBN 978958728011-1)

1997-2007

65. Osorio NW (2007) A review on beneficial effects of rhizosphere bacteria on soil nutrient availability and plant nutrient uptake. Rev. Fac. Nac. Agron. 60(1): 3621-3643 (ISSN 0304-2847).
66. Ramírez F, Osorio NW (2005) Efecto de ácidos orgánicos de bajo peso molecular sobre la fijación de fósforo en andisoles. Suelos Ecuatoriales 35 (2): 71-77 (ISSN 0562-5351).

67. Daza PC, Peláez JA, Osorio NW, León JD (2005) Aislamiento y evaluación *in vitro* de microorganismos solubilizadores de fosfatos de bosques altoandinos en Colombia. *Suelos Ecuatoriales* 35(2): 45-52 (ISSN 0562-5351).
68. González O, Osorio NW (2005) Evaluación de la efectividad de inóculos micorrizales. *Suelos Ecuatoriales* 35(2): 19-23 (ISSN 0562-5351).
69. Jaramillo S, Osorio NW (2005). Factores que determinan la dependencia micorrizal de las plantas. *Suelos Ecuatoriales*, 35(2): 34-40 (ISSN 0562-5351).
70. Osorio W (2005) Función de las enmiendas orgánicas en el manejo de la fertilidad del suelo. *Suelos Ecuatoriales* 35 (1):52-58 (ISSN 0562-5351).
71. Pérez JC, Osorio NW, Álvarez C (2004) Crecimiento, absorción de fósforo y morfología de la raíz en espárragos inoculados con hongos micorrizales y *Pseudomonas fluorescences*. *Rev. Fac. Nacional de Agronomía Medellín* 57(2): 2373-2381 (ISSN 0304-2847).
72. Jaramillo SP, Silva JM, Osorio NW (2004). Potencial simbiótico y efectividad de hongos micorrizo arbusculares de tres suelos sometidos a diferentes usos. *Rev. Fac. Nacional de Agronomía Medellín*. 57(1): 2203-2214 (ISSN 0304-2847).
73. Osorio NW (2003) Eficiencia y efectividad de la fertilización en la agricultura colombiana, 177-209 pp. *En: Triana M, Lora R, Gómez MI, Peñalosa G (ed). Manejo Integral de la Fertilidad del Suelo. Sociedad Colombiana de la Ciencia del Suelo, Bogotá, 224 p.*
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75. Posada, C. y N.W. Osorio. 2003. Respuesta del café c.v. Colombia a la fertilización foliar y la aplicación de pulpa de café compostada. *Revista Facultad Nacional de Agronomía* 56(1): 1839-1848 (ISSN 0304-2847).
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77. Osorio NW (2002) Aislamiento y evaluación de microorganismos solubilizadores de fósforo en suelos de Hawaii. *Universidad Nacional de Colombia, Medellín*, 57 p.
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79. Osorio NW, Alzate JM, Ramírez GA (2002) Coffee seedling growth as affected by mycorrhizal inoculation and organic amendment. *Communications in Soil Science and Plant Analysis* 33 (9/10): 1425-1434 (ISSN: 0010-3624).
80. Habte M, Osorio NW (2001) Arbuscular Mycorrhizas: Producing and applying Arbuscular Mycorrhizal Inoculum. *University of Hawaii, College of Tropical Agriculture and Human Resources, Honolulu, HI*, 47 p. (ISBN 1-929325-10-X)
81. Osorio NW, Habte M (2001) Synergistic influence of an arbuscular mycorrhizal fungus and a P solubilizing fungus on growth and P uptake of *Leucaena leucocephala* in a Oxisol. *Arid Land Research and Management* 15: 263-274 (ISSN: 1532-4982).
82. Osorio NW, Franco J (1997) Uso de la porquinaza como fertilizante, 57-99 pp, *In: Asociación Colombiana de Porcicultores, CORNARE, CORANTIOQUIA (ed) Manejo de elementos de la producción que pueden causar efectos ambientales. Universidad Pontificia Bolivariana, Medellín*, 156 p. (ISBN 958-8008-23-9).

CURRENT GRADUATE STUDENTS

1. María Claudia Diez, Forestry Eng., M.Sc. mcdiez@unal.edu.co. Program: Ph.D. in Agricultural Sciences. Project: Integrated Management of vanilla nutrition. Supporting agency: Colombian Ministry of Agriculture and Rural Development.
2. Laura Osorno, Ing. Biológica, M.Sc. lauraosmobedoya@gmail.com, Program: Ph.D. in Biotechnology, Universidad Nacional de Colombia, Sede Medellín. Formulación de inóculos micorrizales. Becaria COLCIENCIAS.
3. Alvaro Tamayo, Agronomy Eng., M.Sc. atamayo@unal.edu.co. Program: Ph.D. in Agricultural Sciences. Project: Integrated management of avocado fertilization. Supporting agency: Colombian Ministry of Agriculture and Rural Development.
4. Magnolia Cano, Agronomist, mpcanoo@unal.edu.co. Program: Ph.D. in Agroecology. Project: "Trofobiosis approach to the *Solanum lycopersicum* – *Macrosiphum euphorbiae* relationship and its symbiont *Buchnera aphidicola*".
5. Erica Mejía, Material Eng., M.Sc. Material eng., ermejiare@unal.edu.co. Program: Ph.D. in Biotechnology. Project: Plant growth promotion in urban-mining degraded soil by bio-acidulated construction and demolition wastes. Supporting agency: COLCIENCIAS, Univ. San Buenaventura, Unive. Nacional de Colombia. Becaria COLCIENCIAS
6. Hernan González, Agronomist, hernan.gonzalez@cafedecolombia.com. Program: Ph.D. in Biotechnology. Project: Biotechnological alternatives to enhance phosphorus supply in coffee crops. Supporting agency: CENICAFE-COLCIENCIAS. Becario COLCIENCIAS
7. Angela Moreno, Biotechnologist, angelamoreno89@hotmail.com. Program: M.Sc. in Soil Science. Project: Dissolution of rock phosphate. Supporting company: SOBIOTECH-ABONAMOS.
8. Carlos Botero, Agronomist, carlosbotero69@hotmail.com. Program: M.Sc. in Soil Science. Project: Mycorrhizal dependency of potato.
9. Manuel Restrepo, Forestry Eng., manuelfernando7@gmail.com. Program: M.Sc. in Soil Science. Project: Effectiveness of ectomycorrhizal fungi to promote growth of pine seedlings.
10. Fabian Hernandez, Forestry Eng., fahegoz@gmail.com Program: M.Sc. in Soil Science. Project: Use of organic urban wastes to promote nutrient uptake and growth of urban silvicultural plant species.

FORMER GRADUATE STUDENTS

1. Judith Martínez, Agricultural Eng., M.Sc., jcmartinez@corpoica.org.co. Program: Ph.D. in Agricultural Sciences. Project: Production and decomposition of litter in multiple- strata-silvopasture systems and the effect on soil biorganic properties at the Sinu Valley. Supporting agency: Colombian Ministry of Agriculture and Rural Development. 2014.
2. Sandra Serna, Agronomy Eng., slsernag@unal.edu.co. Program: M.Sc. in Soil Fertility. Project: Development of biotechnological strategies to enhance avocado plant nutrition, growth, and yield Supporting agency: National University of Columbia. 2014.
3. Laura Osorno, Biological Eng. losorno@unal.edu.co. Program: M.Sc. in Soil Microbiology. Project: Bioacidulation of rock phosphates under in-vitro conditions. 2014.
4. Adriana Osorio, Forestry Eng. aosorio@unal.edu.co. Degree: M.Sc. Forest and Environmental Conservation (2012). Project: Effect of organic amendments, fertilizers, and microbial inoculation on plant nutrition and growth of vanilla. Supporting agency: Colombian Ministry of Agriculture and Rural Development.
5. Paula Gómez, Forestry Eng. pagomez1@unal.edu.co. Degree: M.Sc. in Soil Fertility (2012). Project: Comparison of exponential and conventional fertilization of five native forestry plant species of the Andean highland of Colombia. Supporting agency: COLCIENCIAS (Colombian Institute for Advancement of Sci. & Technol.)
6. Alejandro Londoño, Agronomy Eng. aalondo2@gmail.com. Degree: M.Sc. in Agricultural Sciences (2010). Thesis: Effectiveness of an arbuscular mycorrhizal fungus and a phosphate solubilizing fungus in increasing plant phosphate uptake and growth of leucaena grown in an Oxisol. Supporting agency: Direction of Research & Soil Lab of the Nat. Univ. Of Columbia at Medellín.
7. Paulo Cesar Daza, Forestry Eng. pcdazao@hotmail.com. Degree: M.Sc. in Biotechnology (2010). Thesis: Use of rhizosphere microorganisms to establish *Leucaena leucocephala* in degraded land by alluvial mining. Supporting agency: Direction of Research & Soil Lab of the Nat. Univ. Of Columbia at Medellín.

8. Beatriz Montoya, Agronomy Eng. bemontoy@unal.edu.co. Degree: M.Sc. in Soil Fertility. Thesis: Mycorrhizal dependency of avocado seedlings at three soil solution phosphorus concentrations (2008). Supporting agency: Direction of Research & Soil Lab of the Nat. Univ. Of Columbia at Medellin.
9. Francisco Restrepo, Agronomy Eng. Francisco.Restrepo@cafedecolombia.com. Degree: M.Sc. in Agricultural Sciences (2007). Thesis: Development of biotechnological strategies to enhance avocado plant nutrition, growth, and yield. Supporting agency: Coffee Grower Federation of Colombia & the Soil Lab of the Nat. Univ. of Columbia at Medellin.
10. Sandra P. Jaramillo, Microbiologist. spjarami@unal.edu.co. Degree: M.Sc. in Biotechnology (2006). Thesis: Mycorrhizal dependency of coffee seedlings at three soil solution phosphorus concentrations. Supporting agency: Direction of Research & Soil Lab of the Nat. Univ. Of Columbia at Medellin.
11. Octavio Gonzalez, Agronomy Eng. oagonzal@unal.edu.co. Degree: M.Sc. in Soil Microbiology (2006). Thesis: Mycorrhizal dependency of three fruit plant species at three soil solution phosphorus concentrations. Supporting agency: Direction of Research & Soil Lab of the Nat. Univ. Of Columbia at Medellin.
12. Jorge Sierra, Adm. Agric. jsierra@uco.edu.co. Degree: M.Sc. in Forest Management & Environmental Conservation (2006). Thesis: Mycorrhizal dependency of three native forestry plant species. Supporting agency: COLCIENCIAS (Colombian Institute for Advancement of Sci. & Technol.) & Nat. Univ. of Columbia at Medellin.
13. María Claudia Diez, Forestry Eng. mcdiez@unal.edu.co. Degree: M.Sc. in Forest Management (2006). Thesis: Mycorrhizal dependency of romeron pine at three soil solution phosphorus concentrations and three light intensities Nat. Univ. of Columbia at Medellin.

(Also, I have been thesis advisor of 25 undergraduate students: Agronomy, Animal production, Forestry engineer, Agricultural engineer, Chemistry, Biology).

CONFERENCES/WORKSHOPS

- 17th National Meeting of the Colombian Society of Soil Science, Popayán, 2014.
- 16th National Meeting of the Colombian Society of Soil Science, Riohacha, 2012.
- XVII International Soil Conservation Meeting (ISCO). Medellin. 2013.
- Academic writing course. Particular. Septiembre-octubre de 2012.
- XI Latinoamerican College of Soil Physics, Medellin, 2012.
- IX International workshop on GPCR, SCCS, Medellin, 2012.
- International meeting of medicinal plants, International Society of Horticulture, Guatemala, 2011.
- Writing world class manuscript in horticultural science. Antigua, Guatemala. Nov. 21, 2011.
- 22nd National Meeting of the Argentinean Association of Soil Science, Rosario, Argentina, 2010.
- 15th National Meeting of the Colombian Society of Soil Science, Pereira, 2010 (5 presentations).
- Workshop on Soil Acidity and its Management, Apartado, 2010.
- Workshop on Use of Biosolids in Brazil, Campinas, Sao Paulo, Brazil, 2009.
- Research seminar of CENICAFE, Chinchina, Caldas, 2009.
- Workshop on soil organic matter and microorganisms, Armenia, 2009.
- 14th National Meeting of the Colombian Society of Soil Science, Villavicencio, 2008.
- 13th National Meeting of the Colombian Society of Soil Science, Bogota, 2006.
- National Meeting to celebrate 50 anniversary of the Colombian Society of Soil Science, Medellin, 2005.
- International Workshop on Production of Mycorrhizal Inoculum, Caracas, Venezuela, 2005.
- 12th National Meeting of the Colombian Society of Soil Science, Cartagena, 2004.
- 16th Meeting of the Latinoamerican Society of Soil Science, Cartagena, 2004.
- Workshop on Integrated Soil Management, Bogotá, 2003.
- 2nd Workshop on Swine Production and Environment, Pereira, Bogota, Medellin y Cali, 2003.
- 11th National Meeting of the Colombian Society of Soil Science, Cali, 2002.
- 5th CTHAR Research symposium, University of Hawaii, 2000.
- Workshop on Fertirrigation, Rionegro, 1999.
- Workshop on Academic Curriculum and Teaching Soil Science, Medellin, SCCS, 1998.
- Workshop on Soil Chemistry, Medellin, 1997.
- Workshop on Integrated Soil Management for a Sustainable Agriculture, Neiva, 1997.
- Workshop on the Use of Symbiosis Rhizobio-Legume-Mycorrhizal in Bioremediation of degraded Soil, Medellin, 1997.
- Workshop on Soil Testing, Medellin, 1997 (*chairman*).
- 8th National meeting of the Colombian Society of Soil Science, Santa Marta, 1996.
- Workshop on Mycorrhizal Association, Medellin, 1996.

- Workshop on Use of Organic Residue, 1996 (*chairman*).
- Workshop on Soil Fertility, Villavicencio, 1995.
- Workshop on Soil Fertility and Crop Fertilization, Medellín, 1995 (*chairman*).
- 7th National meeting of the Colombian Society of Soil Science, Bucaramanga, 1994.
- 1st National Workshop on cut flower crop research, Bogotá, 1993.
- Workshop on Soil Fertility: Diagnosis and control, Bogotá, 1993.
- Workshop on Efficient Fertilization of Crops, Medellín, 1993.
- 6th National meeting of the Colombian Society of Soil Science, Manizales, 1992
- 3rd Latinoamerican workshop on volcanic ash soils, Manizales, 1992.
- Workshop on soil salinity and water quality for irrigation, Bogota, 1992.
- Toxic residues in organic manures, Medellín, 1990.
- Agricultural extensionist , Medellín, 1990.
- 5th National meeting of the Colombian Society of Soil Science, Cartagena, 1989.

PRESENTATIONS IN WOKSHOPS/CONFERENCES

- J.G. Ramírez y N.W. Osorio (2014) Presencia de hongos formadores de micorrizas en raíces de cacao. 17^o Congreso Colombiano de la Ciencia del Suelo, Popayán. Organizó: Sociedad Colombiana de la Ciencia del Suelo.
- J.G. Ramírez y N.W. Osorio (2014) Antagonismo entre *Trichoderma harzianum* y *Glomus fasciculatum* en raíces de leucaena y aguacate. 17^o Congreso Colombiano de la Ciencia del Suelo, Popayán. Organizó: Sociedad Colombiana de la Ciencia del Suelo.
- E. Mejía, J.I. Tobón y N.W. Osorio(2014) Caracterización química y mineralógica de residuos de la construcción y demolición para ser usados en remediación de suelos degradados. 17^o Congreso Colombiano de la Ciencia del Suelo, Popayán. Organizó: Sociedad Colombiana de la Ciencia del Suelo.
- L. Osomo y N.W. Osorio (2014) Bioacidulación de rocas fosforicas bajo condiciones in vitro. 17^o Congreso Colombiano de la Ciencia del Suelo, Popayán. Organizó: Sociedad Colombiana de la Ciencia del Suelo.
- E. Mejía, J. I. Tobón, L. Osomo y N.W. Osorio (2013) Caracterización química y mineralógica de residuos de la construcción y demolición para ser usados en remediación de suelos degradados. Universidad Nacional de Colombia, Sede Medellín, Encuentro Nacional de Investigación y Desarrollo (ENID).
- L. Osomo y N.W. Osorio (2013) Bioacidulación de rocas fosforicas bajo condiciones in vitro. Efecto de nitrógeno y carbono. Universidad Nacional de Colombia, Sede Medellín, Encuentro Nacional de Investigación y Desarrollo (ENID).
- N.W. Osorio (2013) Interacciones entre la física del suelo y la actividad microbial. Escuela Latinoamericana de Física del Suelo. Sociedad Colombiana de la Ciencia del Suelo, Medellín.
- Liliana Hoyos-Carvajal, A.M. Cardona, C.R. Bonilla, & W. Osorio (2012). Solubilización de minerales por trichoderma para estimulación de crecimiento en plantas: fenómeno dependiente del tipo de suelo. 16th National Meeting of the Colombian Society of Soil Science, Riohacha.
- L. Osomo & N.W. Osorio (2012). Efecto de la fuente y cantidad de carbono en la bioacidulación in vitro de roca fosfórica por hongos del suelo. 16th National Meeting of the Colombian Society of Soil Science, Riohacha.
- Cluadia.P. Flórez , J.D León, N.W. Osorio, & M.F. (2012). Restrepo Reactivación del ciclaje de nutrientes en suelos degradados mediante plantaciones de nim. 16th National Meeting of the Colombian Society of Soil Science, Riohacha.
- Judith Martinez, N.W. Osorio, & S. Cajas. (2012). Efectividad simbiótica de hongos micorrizo-arbusculares nativos en suelos con diferentes uso y manejo en el valle medio del Río Sinú. 16th National Meeting of the Colombian Society of Soil Science, Riohacha.
- Osorio NW (2010) Uso de hongos micorrizales y microorganismos solubilizadores de fosfato para mejorar la absorción de fosfato y la nutrición de plantas en el trópico. 15th National Meeting of the Colombian Society of Soil Science, Pereira, 2010. Special Conference.
- Sema S, Osorio W, Montoya B (2010) Estudio preliminar de la presencia de microorganismos rizosféricos de plantas de aguacate en el norte y Oriente Antioqueño. 15th National Meeting of the Colombian Society of Soil Science, Pereira, 2010.
- Gómez-López P, Osorio-Vega W, Diez-Gómez M, Moreno F (2010) Efecto de la fertilización en vivero bajo diferentes dosis y formas en plántulas de especies forestales nativas de bosques andinos de Colombia. 15th National Meeting of the Colombian Society of Soil Science, Pereira, 2010.
- Londoño A, Osorio W (2010) Hongo solubilizador de fosforo mejora el crecimiento de leucaena-micorrizal en un oxisol. 15th National Meeting of the Colombian Society of Soil Science, Pereira, 2010.
- Álvarez C, Marín M, Osorio W (2010) Aislamiento e identificación molecular de microorganismos de la rizosfera y del sustrato de crecimiento de plantas de vainilla. 15th National Meeting of the Colombian Society of Soil Science, Pereira, 2010.
- Osorio W, Habte M (2010) Synergistic interaction between a phosphate solubilizing fungus and an arbuscular mycorrhizal fungus in leucaena leucocephala grown in soils with different mineralogies. 15th National Meeting of the Colombian Society of Soil Science, Pereira, 2010.
- Osorio W, Habte M (2010) Soil phosphate desorption induced by a phosphorus solubilizing fungus. 15th National Meeting of the Colombian Society of Soil Science, Pereira, 2010.
- Sierra J, Osorio W (2010) Efectividad micorrizal de suelos con diferentes coberturas vegetales en andisoles del oriente antioqueño. 15th National Meeting of the Colombian Society of Soil Science, Pereira, 2010.
- Osorio NW (2010) Lime requirement of acid soils. Workshop on soil acidity and its management, Apartado, 2010.
- Osorio NW (2008) Dependencia micorrizal de algunas especies vegetales del trópico. Research Seminar at CENICAFE, Chinchina, 2008.
- Osorio NW (2008) Ciclos biogeoquímicos en el suelo y sumideros de gases de impacto global. 14th National Meeting of the Colombian Society of Soil Science, Villavicencio, 2008. Special Conference.
- González O, Osorio W (2008) Determinación de la dependencia micorrizal del lulo, tomate de árbol y uchuva. 14th National Meeting of the Colombian Society of Soil Science, Villavicencio, 2008.

- Jaramillo S, Osorio W (2008) Determinación de la dependencia micorrizal del café. 14th National Meeting of the Colombian Society of Soil Science, Villavicencio, 2008.
- Corredor A H, Osorio W (2008) Dependencia micorriza de la curuba y la granadilla en función de la concentración de fósforo en la solución del suelo. 14th National Meeting of the Colombian Society of Soil Science, Villavicencio, 2008.
- Montoya B, Osorio W (2008) Dependencia micorrizal del aguacate a diferentes niveles de fósforo en solución del suelo. 14th National Meeting of the Colombian Society of Soil Science, Villavicencio, 2008.
- Londoño A, Osorio W, Ruiz O, Orozco H (2008) Efecto de la inoculación micorrizal sobre el crecimiento de *brachiaria decumbens* y la estabilidad de agregados de suelos degradados por minería de aluvión. 14th National Meeting of the Colombian Society of Soil Science, Villavicencio, 2008.
- Osorio NW (2004) Uso de enmiendas orgánicas en el manejo de la fertilidad de suelos del trópico. 16th Meeting of the Latinoamerican Society of Soil Science, Cartagena, 2004. Special Conference.
- Osorio NW (2003) Eficiencia y efectividad de la fertilización en la agricultura colombiana. Workshop on Integrated Soil Management, Bogotá, 2003.
- Osorio NW (2000). Isolation of phosphate solubilizing microorganisms from Hawaiian soils. 5th CTHAR Research symposium, University of Hawaii, 2000.
- Osorio NW, Patiño J, Herron F. Boron Fertilization of chrysanthemum (1992). 6th National meeting of the Colombian Society of Soil Science, Manizales, 1992

JOURNAL REVIEWER 2009-2013

Annals of Microbiology (26/02/2013), Biología Tropical (05/01/2013); Biological Agriculture and Horticulture (10/01/2013); Acta Agronomica (10/17/2012); Agriculture, Ecosystem and Environment (11/21/10); African Journal of Microbiology Research (07/09/10); Biology and Fertility of Soils (05/14/10); International Research Journal of Agricultural Sciences(02/04/10); African Journal of Biotechnology (04/07/10); Acta Agronomica (15/10/10; 15/08/2011); Revista Facultad Nacional Agronomía (01/12/10; 04/23/10; 04/06/10; 03/08/10); Revista Biología Tropical (02/17/10); Archives of Agronomy and Soil Science (10/31/09); Revista Actualidades Biológicas (09/11/09); Revista CENICAFE (0/02/09); Suelos Ecuatoriales (editor).

I have been invited to review Research Projects by COLCIENCIAS (Colombian Institute for the Advancement of Science & Technology), Colombian Ministry of Agriculture and Rural Development, University of Antioquia, University Pontificia Javeriana, Soil Science Society Of Colombian, and the National University of Colombia.

EDITOR

- 2006-2012: Editor-in-chief of SUELOS ECUATORIALES, peer-review journal of the Colombian Society of Soil Science (founded 1956).
- Editor of the 10th National conference of the Colombian Society Soil Science Proceedings, 2000.
- Editor of the workshop proceedings on "Soil Testing" organized by the Colombian Society of Soil Science, 1997.
- Editor of the workshop proceedings on "Management of Organic Residues" organized by the Colombian Society of Soil Science, 1996.
- Editor of the workshop proceedings on "Crop Fertilization" organized by the Colombian Society of Soil Science, 1995.

LANGUAGES

- Spanish: speak, read, and write.
- English: speak, read, and write.
- Portuguese: read.

Up-dated: October 2015