

Name: Idupulapati M. Rao
Position Title: Senior Scientist
Specialty Area: Plant nutrition/Physiology
Current time allocation: 100%

Appointment Date: 1 November 1989

Project	FTE
PE-2	40%
IP-1	30%
IP-5	30%

Education:

Ph.D. Plant Physiology (1978), Sri Venkateswara University, Tirupati, India.
Dissertation Title: Carbon metabolism and water relations of six woody weeds and their modification by paraquat and 2,4,5-T.
M.S., Botany, Plant Physiology (1973), Bhopal University, Bhopal, India
B.S., Botany, Chemistry, Zoology (1971), V.S.R. College, Tenali (Andhra University-Waltair), India

Positions held (since terminal degree):

- Plant Nutritionist/Physiologist, International Center for Tropical Agriculture (CIAT), Cali, Colombia (1989-present.)
- Assistant Specialist, Dept. of Plant and Soil Biology, University of California, Berkeley, California, USA (1984-89).
- Research Associate, Dept. of Plant Biology, University of Illinois, Urbana-Champaign, Illinois, USA (1982-83)
- Visiting Scientist, Environmental Biology, Boyce Thompson Institute for Plant Research, Cornell University, Ithaca, New York, USA (April-May, 1982)
- Research Associate, Dept. of Biological Sciences, University of Illinois at Chicago, Chicago, Illinois, USA (1981-82)
- Plant Physiologist, Pulse Physiology, International Crops Research Institute for Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India (1979-81)

Research Responsibilities (2002 – present):

- Identifying adaptive attributes of common bean and tropical forage species to low fertility acid soils and drought;
- Developing reliable screening methods for common bean germplasm evaluation and improvement for adaptation to low phosphorus supply, aluminum toxicity and drought; and *Brachiaria* germplasm evaluation and improvement for aluminum resistance, drought and waterlogging; and
- Investigating plant-soil relationships with respect to root growth and distribution and recycling of nutrients with emphasis on phosphorus in crop-livestock systems in tropical savannas and hillsides agroecosystems.

Professional Service (2002 – present):

Memberships & services in scientific societies

- Member, American Society of Plant Physiology; American Society of Agronomy; Crop Science Society of America; Soil Science Society of America; New York Academy of Sciences; International Union of Soil Sciences

Service on editorial boards

- 2000-2002 Associate Editor, Journal of Environmental Quality

Contributions to major global/regional initiatives and task forces

- SWNM systemwide program; Water challenge program; Generation challenge program; MIS consortium – Central American Soils Network; PROFRIJOL – Central American Bean Network

Contributions to major international conferences (organizer)

- International workshop on “Advances in improving acid soil adaptation of tropical crops and forages, and management of acid soils” held at Brasilia, Brazil. October 18 to 21, 2005.

Honors and Awards (since terminal degree):

- **1999 Outstanding research publication award from CIAT**
Rao, I.M., V. Borrero, J. Ricaurte, and R. Garcia. 1999. Adaptive attributes of tropical forage species to acid soils. V. Differences in phosphorus acquisition from inorganic and organic phosphorus sources. *Journal of Plant Nutrition* 22 (7): 1175-1196
- **2000 Outstanding principal staff award from CIAT**
Achievement based on a long record of high quality research in the following areas related to CIAT’s mission: (a) defining adaptive attributes of tropical forage grasses and legumes to infertile acid soils; (b) developing a screening procedure to identify aluminum resistant *Brachiaria* hybrids; (c) identifying phosphorus efficient, aluminum and drought resistant common bean genotypes; and (d) defining rooting strategies of tropical crop and forage cultivars and their impact on phosphorus acquisition and cycling in crop-forage-fallow systems. In addition to research achievements, recognition for significant contributions to training young scientists, collaborative research with specialized research organizations and national programs, and representing CIAT in international fora.
- **2003 Outstanding research publication award from CIAT**
Wenzl, P., A. L. Chaves, G. M. Patiño, J. E. Mayer and I. M. Rao. 2002. Aluminum stress stimulates the accumulation of aluminum-detoxifying organic acids in root apices of *Brachiaria* species. *Journal of Plant Nutrition and Soil Science* 165: 582-588.

Graduate Student Advisement (2002 – present):

<u>Degrees completed</u>	<u>Current</u>
M.S. 2	M.S. 1
Ph.D. 3	Ph.D. 4

Refereed journal publications (2002-2006)

- Basamba, T. A., E. Barrios, E. Amézquita, I. M. Rao and B. R. Singh. 2006. Influence of tillage on soil organic matter and phosphorus fractions and maize yield in crop and pasture systems of Colombian savanna Oxisols. *Soil and Tillage Res.* (in press).
- Gómez-Carabalí, A., I. M. Rao, R. F. Beck and M. Ortiz. 2006. Rooting ability and nutrient uptake by tropical forage species that are adapted to degraded andisols of hillsides agroecosystem. *Acta Facultatis Ecologie* Vol. 12 (in press).
- Basamba, T. A., E. Amézquita, B. R. Singh and I. M. Rao. 2006. Effects of tillage systems on soil physical properties, root distribution and maize yield on a Colombian acid-savanna Oxisol. *Acta Agric. Scand.* (in press).
- Watanabe, T., M. Osaki, H. Yano and I. M. Rao. 2006. Internal mechanisms of plant adaptation to aluminum toxicity and phosphorus starvation in three tropical forages. *J. Plant Nutrition* (in press).
- Wenzl, P., A. Arango, A. L. Chaves, M. E. Buitrago, G. M. Patiño, J. Miles and I. M. Rao. 2006. A greenhouse method to screen brachiariagrass genotypes for aluminum resistance and root vigor. *Crop Sci.* 46: 968-973.
- Begum, H. H., M. Osaki, M. Nanamori, T. Watanabe, T. Shinano and I. M. Rao. 2006. Role of phosphoenolpyruvate carboxylase in the adaptation of a tropical forage grass, *Brachiaria* hybrid, to low phosphorus acid soils. *J. Plant Nutrition* 29: 35-57.
- Wagatsuma, T., M. S. H. Khan, I. M. Rao, P. Wenzl, T. Yamamoto, T. Kawamura, K. Hosogoe, S. Ishikawa and K. 2005. Methylene blue stainability of root-tip protoplasts can serve as an

- indicator of aluminum tolerance in a wide range of plant species, cultivars and lines. *Soil Science and Plant Nutrition* 51: 991-998.
- Rangel, A. F., M. Mobin, I. M. Rao and W. J. Horst. 2005. Proton toxicity interferes with the screening of common bean (*Phaseolus vulgaris* L.) for aluminum resistance in nutrient solution. *J. Plant Nutr. Soil Sci.* 168: 607-616.
- Barrios, E., J. G. Cobo, I. M. Rao, R. J. Thomas, E. Amézquita and J. J. Jiménez. 2005. Fallow management for soil fertility recovery in tropical Andean agroecosystems in Colombia. *Agriculture, Ecosystems and Environment* 110: 29-42.
- Ishitani, M., I. Rao, P. Wenzl, S. Beebe and J. Tohme. 2004. Integration of genomics approach with traditional breeding towards improving abiotic stress adaptation: drought and aluminum toxicity as case studies. *Field Crops Res.* 90: 35-45.
- Amézquita, E., R. J. Thomas, I. M. Rao, D. L. Molina and P. Hoyos. 2004. Use of deep-rooted tropical pastures to build-up an arable layer through improved soil properties of an Oxisol in the Eastern Plains (Llanos Orientales) of Colombia. *Agriculture, Ecosystems and Environment* 103: 269-277.
- Nanamori, M., T. Shinano, J. Wasaki, T. Yamamura, I. M. Rao and M. Osaki. 2004. Low phosphorus tolerance mechanisms: Phosphorus recycling and photosynthate partitioning in the tropical forage grass, *Brachiaria* hybrid cultivar Mulato compared with rice. *Plant Cell Physiol.* 45: 460-469.
- Sharrock, R. A., F. L. Sinclair, C. Gilddon, I. M. Rao, E. Barrios, P. J. Mustonen, P. Smithson, D. L. Jones and D. L. Godbold. 2004. A global assessment of mycorrhizal colonization of *Tithonia diversifolia*. *Mycorrhiza* 14: 103-109.
- Zhiping, Q., I. M. Rao, J. Ricaurte, E. Amézquita, J. Sanz and P. Kerridge. 2004. Root distribution and nutrient uptake in crop-forage systems on Andean hillsides. *J. Sust. Agric.* 23 (4): 39-50.
- Kelemu, S., G. Mahuku, M. Fregene, D. Pachico, N. Johnson, L. Calvert, I. Rao, R. Buruchara, T. Amede, P. Kimani, R. Kirkby, S. Kaaria and K. Ampofo. 2003. Harmonizing the agricultural biotechnology debate for the benefit of African farmers. *African Biotechnology Journal* 2: 394-416.
- Phiri, S., E. Amézquita, I. M. Rao and B. R. Singh. 2003. Constructing an arable layer through chisel tillage and agropastoral systems in tropical savanna soils of the llanos of Colombia. *J. Sust. Agric.* 23(1): 5-29.
- Wenzl, P., L. I. Mancilla, J. E. Mayer, R. Albert and I. M. Rao. 2003. Simulating infertile acid soils with nutrient solutions and the effects on *Brachiaria* species. *Soil Sci. Soc. Am. J.* 67: 1457-1469.
- Phiri, S., I. M. Rao, E. Barrios, and B. R. Singh. 2003. Plant growth, mycorrhizal association, nutrient uptake and phosphorus dynamics in a volcanic-ash soil in Colombia as affected by the establishment of *Tithonia diversifolia*. *Journal of Sustainable Agriculture* 21: 43-61.
- Wenzl, P., A. L. Chaves, G. M. Patiño, J. E. Mayer and I. M. Rao. 2002. Aluminum stress stimulates the accumulation of aluminum-detoxifying organic acids in root apices of *Brachiaria* species. *J. Plant Nutrition and Soil Science* 165: 582-588.
- Buehler, S., A. Oberson, I. M. Rao, E. Frossard and D. K. Friesen. 2002. Sequential phosphorus extraction of a ³³P labeled oxisol under contrasting agricultural systems. *Soil Science Society of America Journal* 66: 868-877.
- Wenzl, P., J. E. Mayer and I. M. Rao. 2002. Inhibition of phosphorus accumulation in root apices is associated with aluminum sensitivity in *Brachiaria*. *Journal of Plant Nutrition* 25: 1821-1828.

Invited keynote presentation at major international conferences (2002-2006)

- Rao, I., P. Wenzl, A. Chavez, A. Arango, G. Manrique, M. Buitrago, J. Miles, S. Beebe, P. Kimani, P. Argel, A. Schmidt, M. Peters, J. Tohme, M. Ishitani, A. Rangel, M. Mobin and W. Horst. 2004. Advances in improving acid soil adaptation of tropical crops and forages: The case of common bean and *Brachiaria*. Invited keynote paper presented at the 20th RIB Symposium on

“International Symposium on Frontier Research to Improve Crop productivity on Acid Soils” held at Kurashiki, Japan, pp. 30-32.

- Rao, I., S. Beebe, M. Ayarza, G. Trouche, H. Ceballos, A. Alves, J. Miles, P. Argel, A. Schmidt, M. Peters, F. Holman, M. Lundy, C. Quiros, M. Rondon and H. Córdova. 2004. Strategies for improving crop and forage adaptation to dry conditions of Central America. Invited paper presented at the “International Workshop on Adaptation to Climate Change, Sustainable Livelihoods and Biological Diversity” held at Turrialba, Costa Rica.
- Rao, I., S. Beebe, H. Ceballos, A. Alves, J. Miles, C. Martinez, M. Chatel, G. Trouche, M. Lorieux, M. Blair and M. Ishitani. 2004. Phenotypic evaluation for improving adaptation to drought in common bean, cassava, rice and *Brachiaria*. Invited paper presented at the Generation Challenge Program Workshop on Phenotyping and Water Deficit held at Agropolis, Montpellier, France, p 45.
- Rao, I., P. Wenzl, A. Arango, J. Miles, T. Watanabe, T. Shinano, M. Osaki, T. Wagatsuma, G. Manrique, S. Beebe, J. Tohme, M. Ishitani, A. Rangel and W. Horst. 2005. Advances in developing screening methods and improving aluminum resistance in common bean and *Brachiaria*. Invited paper presented at an international workshop on “Advances in improving acid soil adaptation of tropical crops and forages, and management of acid soils” held at Brasilia, Brazil.

Research Grants (2002 – present):

Funding source	Grant Title (Principal investigators)	Amount US\$	Period
ACIAR, Australia	Integrated nutrient management in tropical cropping systems: Improved capabilities in modeling and recommendations	434,130	1999-2002
BMZ-GTZ, Germany	An integrated approach for genetic improvement of aluminum resistance of crops on low-fertility acid soils	602,916	2001-2004
European Commission, Belgium	Characterization of South American genotypes of bean for optimal use of light under abiotic stress	831,261 (Euros)	2001-2004
BMZ-GTZ, Germany	Bean genomics for improved drought tolerance in Latin America	740,000 (Euros)	2003-2006
SDC-ZIL, Switzerland	Adaptation of <i>Brachiaria</i> grasses to low P soils	346, 300 (Swiss Francs)	2003-2006
Generation Challenge Program	Evaluation and deployment of transgenic drought-tolerant varieties	37,170	2006-2007
BMZ-GTZ, Germany	Fighting drought and aluminum toxicity: Integrating functional genomics, phenotypic screening and participatory research with women and small-scale farmers to develop stress-resistant common bean and <i>Brachiaria</i> for the tropics	1,099,940 (Euros)	2006-2009