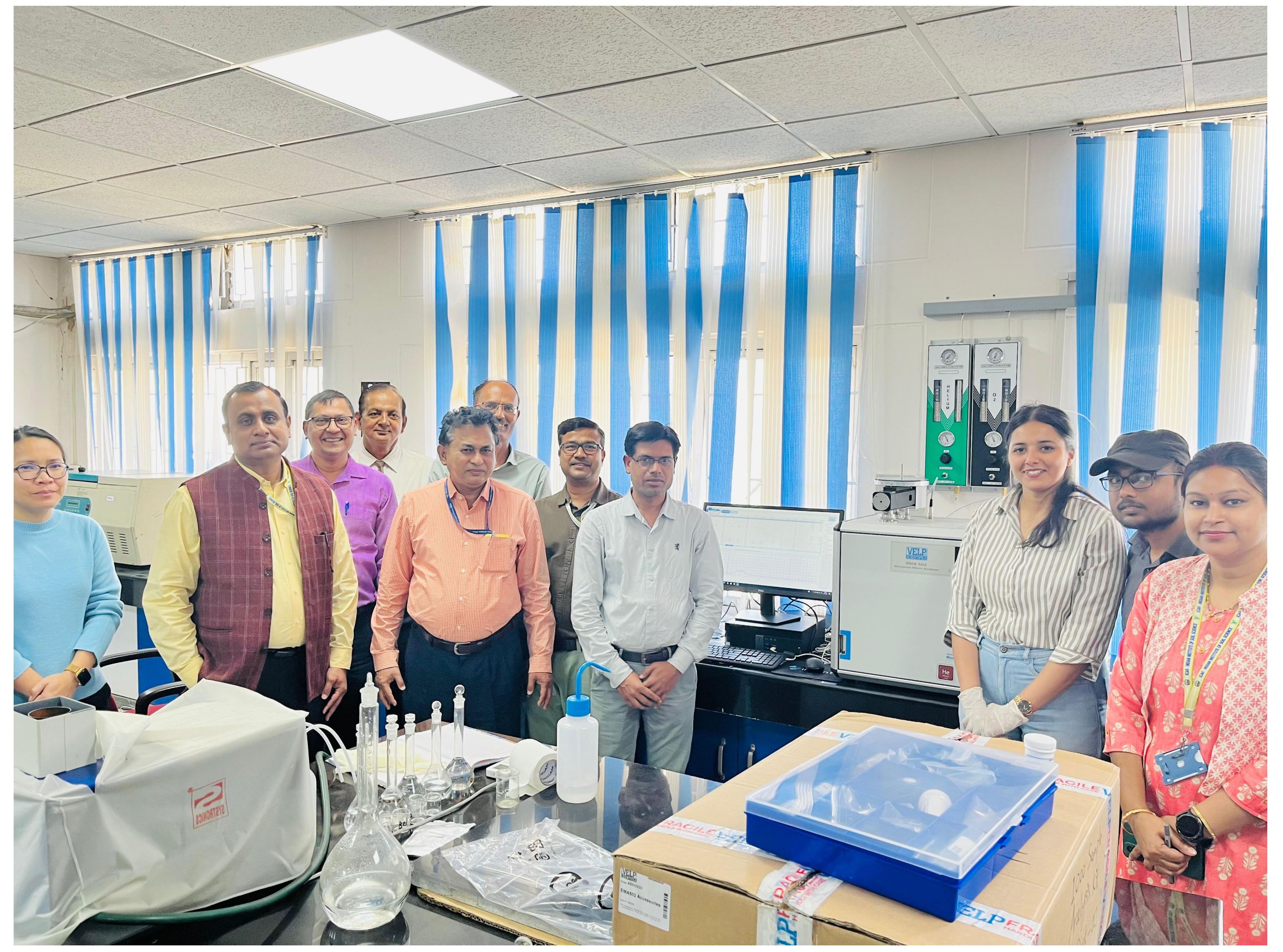


DIVISION OF SOIL CHEMISTRY AND FERTILITY

At A Glance



भाकृअनुप-भारतीय मृदा विज्ञान संस्थान
ICAR-Indian Institute of Soil Science

नबीबाग बैरासिया रोड, भोपाल (म.प्र.)- 462 038

Nabibagh, Berasia Road, Bhopal (MP)- 462038

DIVISION OF SOIL CHEMISTRY AND FERTILITY

Genesis

The Division of Soil Chemistry and Fertility came into existence in the year 1996 by combining the sections on Chemistry, Nitrogen, Phosphorus, Potassium, Micro and Secondary nutrients, and tracer laboratory. The manpower and infrastructure including lab equipments were transferred from these sections into this Division. Dr. K. P. Tomar was the first Head of the Division. Since inception this division has acted as the Flagship Division of the institute and has taken a leading role in the development of Integrated Plant Nutrient Supply System (IPNS) for various crops and cropping systems, conducted significant basic research on the long-term dynamics in soil of essential plant nutrients like N, P, K, Zn and Organic C., and developed improved package of practices for cereals, pulses, oilseed and cotton crops.

Thrust Area

Conduct basic and strategic research on nutrient management and soil fertility improvement under present and future climate scenarios. Use of nanotechnology, precision agriculture, geo-spatial and biotechnological tools for enhancing nutrient use efficiency. Develop strategies towards soil health assessment and improvement, and improved produce quality. Assess and develop new fertilizer products /formulations. Develop strategies for utilization of indigenous/ alternative nutrient and soil amendment sources including biochar. Develop and use simulation models for sustainable crop production. Carbon and nutrient dynamics under conservation agriculture, organic and natural farming and agro-forestry systems. Participatory technology development, assessment, refinement and transfer. Impact assessment and evaluation of ecosystems services of developed technologies.

Mission of the Institute

To provide scientific basis for enhancing and sustaining productivity of soil resources with a view to improve quality and health.

Human Resources

NAME	DESIGNATION	DISCIPLINE
Dr. SANJIB KUMAR BEHERA	PRINCIPAL SCIENTIST & HEAD	SOIL SCIENCE
Dr. SANJAY SRIVASTAVA	PRINCIPAL SCIENTIST	SOIL SCIENCE
Dr. R. ELANCHEZHIAN	PRINCIPAL SCIENTIST	PLANT PHYSIOLOGY
Dr. PRAMOD JHA	PRINCIPAL SCIENTIST	SOIL SCIENCE
Dr. SHINOGI K C	SENIOR SCIENTIST	AGRICULTURAL EXTENSION
Dr. BHARAT PRAKASH MEENA	SENIOR SCIENTIST	AGRONOMY
Dr. SEEMA BHARDWAJ	SENIOR SCIENTIST	SOIL SCIENCE
Dr. NARAYAN LAL	SENIOR SCIENTIST	HORTICULTURE
Dr. KHUSHBOO RANI	SCIENTIST (SS)	SOIL SCIENCE
Dr. ABINASH DAS	SCIENTIST (SS)	SOIL SCIENCE
Ms. ADITI AGRAWAL	SCIENTIST	AGRICULTURAL ECONOMICS
Dr. PRATIK R RAMTEKE	SCIENTIST	SOIL SCIENCE
MR. HARISH KUMAR	TECHNICIAN	-
MR. PRAHLAD RAJAK	TECHNICIAN	-



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Ongoing Projects

- 1) Enhancing nutrient use efficiency, and managing soil health for sustainable crop production and improved produce quality (July 2024 to June 2029, Institute Project)
- 2) Effect of nano urea and DAP, and popularization of its use in crop production (November 2024 to October 2026, Funded by ICFFTR, Noida, UP)
- 3) Evaluation of nano urea on crop productivity and nitrogen use efficiency in diverse Agro-Ecological Zones of India (November 2025 to November 2030, Funded by RCF/NFL/FACT/MFL/IFFCO)
- 4) Ensuring food security, sustainability and soil health through resource conservation based farmer FIRST approach in central India (January 2017 to continuing, Funded by ICAR, New Delhi)
- 5) Microbial based agricultural waste management using vermicomposting (October 2020 to October 2026, Funded by ICAR, New Delhi)
- 6) Assessment of traditional knowledge system of tribal farmers for managing land resources (September 2023 to August 2026, Funded by DBT, New Delhi)
- 7) Evaluation of efficacy of sulphur, magnesium and micronutrients containing complex fertilizers for maximizing yield through balanced nutrition of important crops grown in India (January 2025 to January 2027, Funded by SML Limited, Mumbai)

Future Thrust Area

The division aims to address the challenges of food and nutritional security from shrinking land resources and promote self-reliance in crop fertilization using indigenous minerals and by-products. It will also continue collaborating with other disciplines and AICRPs to maintain soil quality and ecological balance.

Instrumental facilities

Atomic Absorption Spectrophotometer	Total Organic Carbon Analyzer	UV-Visible Spectrophotometer
Kelplus Total Nitrogen Analyzer	Flow Injection Autoanalyzer	CHNS Analyser
Flame Photometer	Refrigerated Centrifuge	Orbital Shaking Incubator
Chlorophyll Fluorometer	pH Meter	EC Meter



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DIVISION OF SOIL CHEMISTRY AND FERTILITY

Important Awards/Recognition Received by Scientists of the Division

Recipient	Fellow/Award	Institute/Organization/Society	Year
Dr. A. Subba Rao	FAI-Silver Jubilee Award	The Fertilizer Association of India, New Delhi	1989
Dr. A. N. Ganeshamurthy	Golden Jubilee Commemoration Young Scientist Award	Indian Society of Soil Science, New Delhi	1990
Dr. A. N. Ganeshamurthy	PPIC-FAI Award	The Fertilizer Association of India, New Delhi	1997
Dr. Ch. Srinivasa Rao	Golden Jubilee Commemoration Young Scientist Award	Indian Society of Soil Science, New Delhi	1997
Dr. Ch. Srinivasa Rao	Young Scientist Award	NAAS, New Delhi	1997
Dr. Ch. Srinivasa Rao & Dr. A. Subba Rao	IPI-FAI Award	The Fertilizer Association of India, New Delhi	1998
Dr. D. Damodar Reddy	Lal Bahadur Shastri Young Scientist Award	ICAR, New Delhi	2001
Dr. D. Damodar Reddy	Golden Jubilee Commemoration Young Scientist Award	Indian Society of Soil Science, New Delhi	2001
Dr. A. Subba Rao	Fellow of NAAS	NAAS, New Delhi	2001
Dr. K. Sammi Reddy	Golden Jubilee Commemoration Young Scientist Award	Indian Society of Soil Science, New Delhi	2002
Dr. T. R. Rupa	Young Scientist Award	NAAS, New Delhi	2003
Dr. T. R. Rupa	Lal Bahadur Shastri Young Scientist Award	ICAR, New Delhi	2003
Dr. T. R. Rupa	Golden Jubilee Commemoration Young Scientist Award	Indian Society of Soil Science, New Delhi	2003
Dr. A. Subba Rao	Fellow of ISSS	Indian Society of Soil Science, New Delhi	2004
Dr. K. Sammi Reddy	TSI-FAI Award	The Fertilizer Association of India, New Delhi	2006
Dr. D. Damodar Reddy	Associate Fellow of NAAS	NAAS, New Delhi	2006
Dr. K. Sammi Reddy	Associate Fellow of NAAS	NAAS, New Delhi	2006
Dr. K. Sammi Reddy	FAI Golden Jubilee Award for excellence	The Fertilizer Association of India, New Delhi	2008
Dr. K. Ramesh	Young Scientist Award	NAAS, New Delhi	2008
Dr. Muneshwar Singh	Fellow of ISSS	Indian Society of Soil Science, New Delhi	2010
Dr. Pramod Jha	ISSS Young Scientist Award	Indian Society of Soil Science, New Delhi	2011
Dr. Pramod Jha	IASWC Young Scientist Award	Indian Association of Soil and Water Conservationists, Dehradun, UK	2011
Dr. A.K. Biswas	Dr. JSP Yadav Memorial Award	Indian Society of Soil Science, New Delhi	2012
Dr. N.K. Lenka	Golden Jubilee Commemoration Young Scientist Award	Indian Society of Soil Science, New Delhi	2013
Dr. N.K. Lenka	Young Scientist Award	Indian Association of Soil and Water Conservationists, Dehradun, UK	2013



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Important Awards/Recognition Received by Scientists of the Division

Recipient	Fellow/Award	Institute/Organization/Society	Year
Dr. Sanjib Kumar Behera	Golden Jubilee Young Scientist Award	Indian Society of Soil Science, New Delhi	2014
Dr. Narayan Lal	Fellow of CHAI	Confederation of Horticulture Associations of India (CHAI), New Delhi	2014
Dr. N K Lenka	Associate Fellow NAAS	NAAS, New Delhi	2015
Dr. Bharat Prakash Meena	Shri Ram Purskar	The Fertilizer Association of India, New Delhi	2016
Dr. Pramod Jha	Dr. BC Deb Memorial Award	Indian Science Congress Association, Kolkata, WB	2016
Dr. Sanjib Kumar Behera	Associate Fellowship	Andhra Pradesh Akademi of Science (APAS), Amaravathi, Guntur, Andhra Pradesh	2016
Dr. R Elanchezhian	Fellowship of National Academy of Biological Sciences (NABS)	NABS, Chennai, TN	2017
Dr. A K Biswas	Fellowship of ISSS	Indian Society of Soil Science, New Delhi	2017
Dr. B L Lakaria	Fellow of IASWC	Indian Association of Soil and water Conservationists, Dehradun, UK	2018
Dr. Pramod Jha	Endeavor Research Fellowship	University of Queensland, Brisbane, St Lucia, Qld, Australia	2018
Dr. Sanjib Kumar Behera	XII International Congress Commemoration Award	Indian Society of Soil Science, New Delhi	2018
Dr. Sanjib Kumar Behera	Young Scientist Award	Mosaic India Private Limited, Gurgaon, Haryana	2019
Dr. Bharat Prakash Meena	ISA-Associate ship Fellow Award	Indian Society of Agronomy (ISA), New Delhi	2021
Dr. Sanjib Kumar Behera	FAI-Award in the field of “Plant Nutrition”	The Fertilizer Association of India, New Delhi	2022
Dr. Bharat Prakash Meena	IASWC-Young Scientist Award	Indian Association of Soil and Water Conservationists, Dehradun, UK	2022
Dr. Narayan Lal	Young Scientist Award	Society for Advancement in Agricultural Technology and Development, Dehradun, UK	2023
Dr. Narayan Lal	Young Horticulturist Scientist Award	Society for Horticultural Research and Development , Gaziabad, UP	2023
Dr. Sanjib Kumar Behera	Fellowship of National Academy of Biological Sciences (NABS)	NABS, Chennai, TN	2023
Dr. Sanjib Kumar Behera	Fellowship of NAAS	NAAS, New Delhi	2024
Dr. Sanjib Kumar Behera	Fellowship of ISSS	Indian Society of Soil Science, New Delhi	2024
Dr. Bharat Prakash Meena	Dr. PS Deshmukh Young Agronomist Award	Indian Society of Agronomy (ISA), New Delhi	2025
Dr. Bharat Prakash Meena	FSRDA Associate Fellow Award	Farming Systems Research and Development Association, Modipuram, Meerut, UP	2025



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Important Research Papers Published (2020-2025)

Title of the papers	NAAS
NAAS rating (>10)	
➤ Meena BP, Biswas AK, Singh M, Das H, Chaudhary RS, Singh AB, Shirale AO, Patra Ak (2021). Energy budgeting and carbon footprint in long-term integrated nutrient management modules in a cereal- legume (Zea mays – Cicer arietinum) cropping system. Journal of Cleaner Production. 314: 127900.	16.00
➤ Rani K, Datta A, Jat HS, Choudhary M, Sharma PC, Jat ML (2023). Assessing the availability of potassium and its quantity-intensity relations under long term conservation agriculture based cereal systems in North-West India. Soil & Tillage Research. 228: 105644.	12.80
➤ Jha P, Hati KM, Dalal RC, Dang YP, Kopittke PM, Menzies NW (2020). Soil carbon and nitrogen dynamics in a Vertisol following 50 years of no tillage, crop stubble retention and nitrogen fertilization. Geoderma. 358: 113996.	12.60
➤ Lenka NK, Lenka S, Thakur JK, Yashona DS, Shukla AK, Elanchezhian R, Singh KK, Biswas AK, Patra AK (2020) Carbon dioxide and temperature elevation effect on crop evapotranspiration and water use efficiency in soybean as affected by different mitigation levels. Agricultural Water Management. 230: 105936.	12.50
➤ Behera SK, Suresh K, Shukla AK, Kamireddy M, Mathur RK, Majumdar K (2021). Soil and leaf potassium, calcium and magnesium in oil palm (Elaeis guineensis Jacq.) plantations grown on three different soils of India: Status, stoichiometry and relations. Industrial Crops and Products. 168: 113589.	12.00
➤ Behera SK, Shukla AK, Pachauri SP, Shukla V, Sikaniya Y, Srivastava PC (2023). Spatio-temporal variability of available sulphur and micronutrients (Zn, Fe, Cu, Mn, B and Mo) in soils of a hilly region of northern India. Catena. 226, 107082.	11.70
➤ Rani K, Biswas DR, Basak BB, Bhattacharyya R, Biswas S, Das TK, Bandyopadhyay KK, Kaushik R, Das A, Thakur JK, Agarwal BK (2024) Exploring waste mica as an alternative potassium source using a novel potassium solubilizing bacterium and rice residue in K deficient Alfisol. Plant and Soil. 509 (1): 611-630.	10.10
NAAS rating (7-10)	
➤ Behera SK, Shukla AK, Prakash C, Tripathi A, Kumar A, Trivedi V (2020). Establishing management zones of soil sulphur and micronutrients for sustainable crop production. Land Degradation & Development. 32: 3614-3625.	9.70
➤ Behera SK, Shukla AK, Suresh K, Manorama K, Mathur RK, Kumar A, Harinarayana P, Prakash C, Tripath A (2020). Oil palm cultivation enhances soil pH, electrical conductivity, concentrations of exchangeable calcium, magnesium and available sulphur and soil organic carbon content. Land Degradation & Development 31(18):2789-2803.	9.70
➤ Jha P (2023). Impact of agro-geotextiles on soil aggregation and organic carbon sequestration under conservation tilled maize-based cropping system in the Indian Himalayas. Frontiers in Environmental Science-Soil Processes.11: 1309106.	9.70
➤ Jha P, Lakaria BL, Vishwakarma AK, Wanjari RH, Mohanty M, Sinha NK, Somasundram J, Dheri GS, Dwivedi AK, Sharma RP, Singh M, Dalal RC, Biswas AK, Patra AK, Chaudhari SK (2021). Modelling the organic carbon dynamics in long-term fertilizer experiments of India using the Rothamsted Carbon Model. Ecological Modelling. 450 (2021) 109562.	9.20
➤ Behera SK, Shukla AK, Singh P, Trivedi V, Patra AK, Rao AS, Singh AK (2021). Zinc application enhances yield and alters micronutrients concentration in pigeonpea (Cajanus cajan L. Millsp.). Nutrient Cycling in Agroecosystems. 119:423-443.	8.70
➤ Shinogi KC, Srivastava S, Radha TK , Rao DLN, Meena BP, Sinha NK, Das H, Rashmi I, Rosin KG, Singh AB, Behera SK, and Mohanty M. (2026) Soil fertility management for yield and income stability in soybean-wheat rotation system under climate variability in subtropical Central India. PLoS One 21(1): e0341035.	
➤ Meena BP, Jha P, Ramesh K, Biswas AK, Elanchezhian R, Das H, Sathyaseelan N, Shirale AO, Patra AK (2022). Agronomic management based on multi-split topdressing increases grain yield and nitrogen use efficiency in rainfed maize in Vertisols of India. Journal of Plant Nutrition. 45 (6): 828-844.	7.70
➤ Lal N, Singh A, Kumar A, Marboh ES, Gupta AK, Pongener A, Nath V, Pandey SD. (2023). Hurdles in developing hybrids: Experience from a decade of hybridization in litchi. Euphytica. 219: 216.	7.70
➤ Lal N, Pandey SK, Nath V (2025). Effect of weather on panicle development, flower morphogenesis and fruit set in litchi cv. Shahi. Plant Physiology Reports. 30 (1): 53-57.	7.60
➤ Lal N, Kumar A, Singh A, Marboh ES, Gupta AK, Pandey SD, Nath V (2023). Standardization of number of flowers to be pollinated per panicle for hybridization in litchi and assessment of effective duration of pollination. Erwerbs-Obstbau. 65: 487–492.	7.40
➤ Lal N, Gupta AK, Marboh ES, Kumar A, Nath V (2021). Effect of mode of pollination on fruit set and fruit characteristics in litchi. Erwerbs-Obstbau. 63: 227-232.	7.40
➤ Behera SK, Shukla AK, Dwivedi BS, Cerda A, Lakaria BL (2020). Alleviating soil acidity: Optimization of lime and zinc use in maize (Zea mays L.) grown on Alfisols. Communications in Soil Science and Plant Analysis. 51(2):221-235.	7.40
➤ Lal N, Kumar A, Marboh ES, Gupta AK, Pandey SD, Nath V (2025). Effect of temperature and duration of storage on seed germination in litchi (Litchi chinensis Sonn.). National Academy of Science Letters. 48 (2): 157-159.	7.30
➤ Rani K, Das A (2022). Overcoming the barriers of utilization of mica waste as a potassic fertilizer. Current Science. 123(2): 141.	7.00



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Scientists Transferred / Promoted from the Division

Name	Period at IISS	Present Designation
Dr. A. Subba Rao	1989	Retired
Dr. K. P. Tomar	1989-1998	Retired
Dr. Muneswar Singh	1989-	Retired
Dr. A. N. Ganeshamurthy	1988-1998	Retired
Dr. S. Kundu	1992	Retired
Dr. A. K. Tripathi	1993	Principal Scientist, Div. of Soil Biology, IISS, Bhopal
Dr. K. Sammi Reddy	1992-2012	Director, NIASM, Baramati, MH
Dr. Ch. Srinivasa Rao	1993-1998	Director, IARI, New Delhi
Dr. K. K. Burman	-	Retired
Dr. D. Damodar Reddy	1995-2009	Principal Scientist, NAARM, Hyderabad
Dr. T. R. Rupa	1996-2005	Principal Scientist, IIHR, Bangalore
Mrs. Vidya Shree Bharti	2005-2007	Scientist (SS), CIFE, Mumbai
Dr. S. Neenu	2009-2014	Senior Scientist, CPCRI, Regional Station, Kayamkulam
Dr. I. Rashmi	2009-2015	Senior Scientist, IISWC, RC Kota
Dr. A. K . Biswas	2009-2025	Retired
Dr. N. K. Lenka	2009-2023	HOD, Soil Physics Division, IISS, Bhopal
Dr. Brijlal Lakaria	2007-2023	HOD, Research Centre, Indian Institute of Soil and Water Conservation, Chandigarh
Dr. A.K. Vishwakarma	2013-2023	Project Coordinator, AICRP Sesame and Niger, Jabalpur, MP
Dr. Ankush L. Kamble	2018-2019	Senior Scientist, CIFE, Mumbai
Dr. Abhay O. Shirale	2015-2022	Senior Scientist, NBSS&LUP, Nagpur
Dr. Priya P. Gurav	2016-2023	Senior Scientist, CRIDA, Hyderabad



Salient Achievements and Technologies Developed in the Division

Salient Achievements

- IPNS package for soybean-wheat system on vertisols.
- Integrated N management in rice-wheat system on vertisols.
- Residual P management in vertisols for soybean-wheat system.
- Soil P maintenance fertilization technology for soybean-wheat system on medium P testing vertisols.
- Developed malachite green method for the estimation of minute quantities of P in various soil extracts.
- Mineralization kinetics and transformations of S under long term use of fertilizers and manures
- Soil test based IPNS as per farmer's resource capacity
- Optimizing P supply in relation to soil moisture regimes.
- Characterizing soil potassium stocks in terms of Biotite in Indian soils.
- Assessment of long term impact of cropping and fertilizer use on soil health.
- Phosphorus solubilisation from rock phosphates using soybean leaf litter.
- Balanced and Integrated Nutrient Management for rainfed cotton.
- Preparation of soil fertility maps of 11 states using GIS and GPS tools.
- Management of mechanical harvest borne wheat residue in soybean-wheat systems
- Zinc dynamics in major benchmark soils of India.
- Evaluation of new fertilizer material such as bentonite sulphur pastiles as source of sulphur.
- Developed region-specific databases on nutrient resources in agriculture and user friendly intelligent data retrieving system for rational and efficient nutrient management
- Carbon pools dynamics in different IPNS modules
- Modified urea fertilizer for higher nitrogen use efficiency

Technologies Developed

- Integrated and balanced nutrient management technologies for soybean - wheat system, cotton, pulses oilseed crops and soybean/maize-wheat cropping systems.
- Residual management in soybean-wheat system.
- On-line fertilizer recommendation systems for different cropping systems.
- GIS based soil fertility maps of major states.
- Mechanical harvest-borne wheat residue management under soybean-wheat system.
- Farmers' resource based integrated plant nutrient supply system for soybean-wheat on Vertisols.
- Nutrient input output and balance of farmyard manure production by farmers through conventional method.
- Integration of broad bed furrow (BBF) and balanced fertilization: An efficient management practice for successful cultivation of soybean on waterlogged fields.



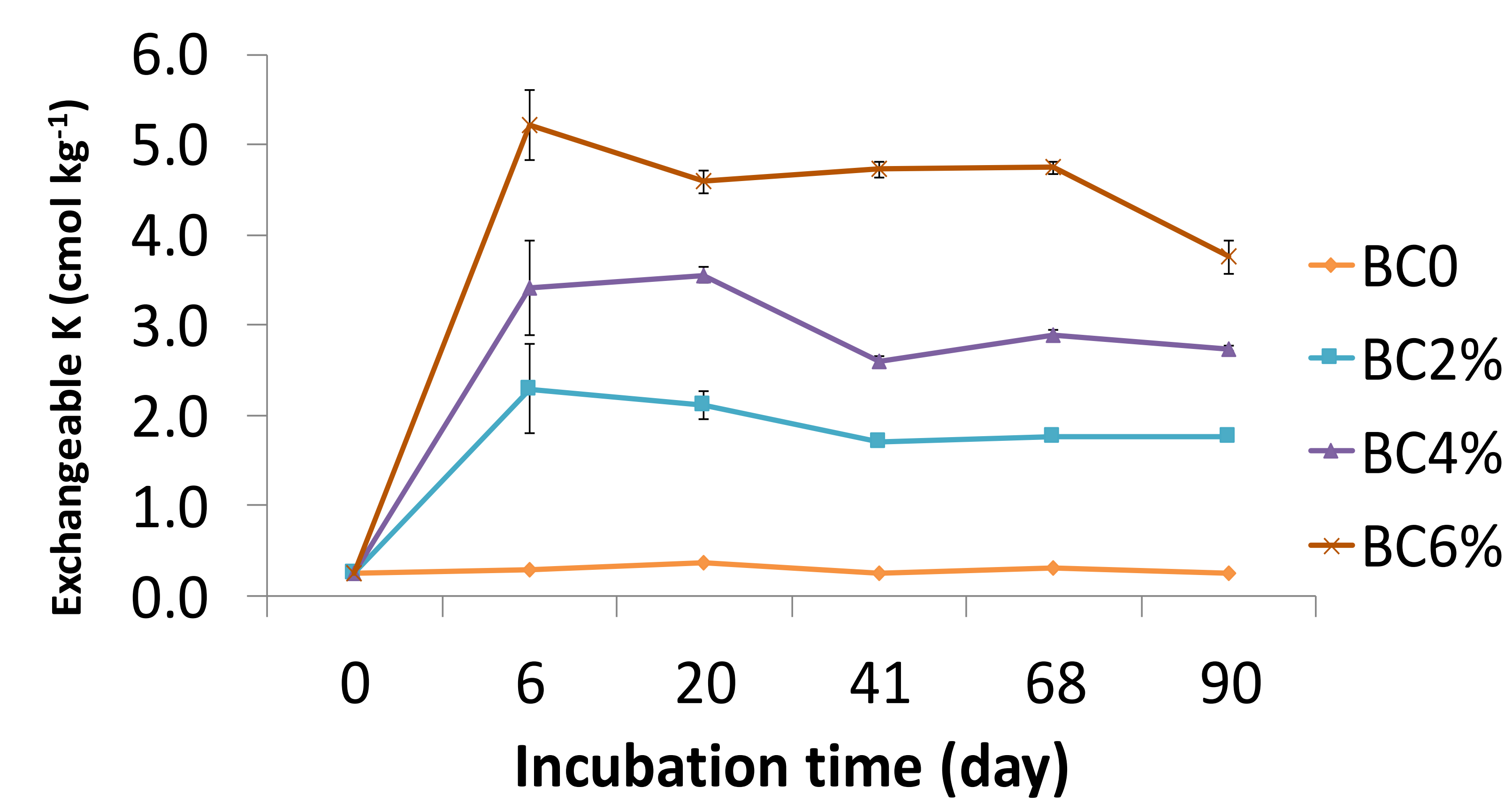
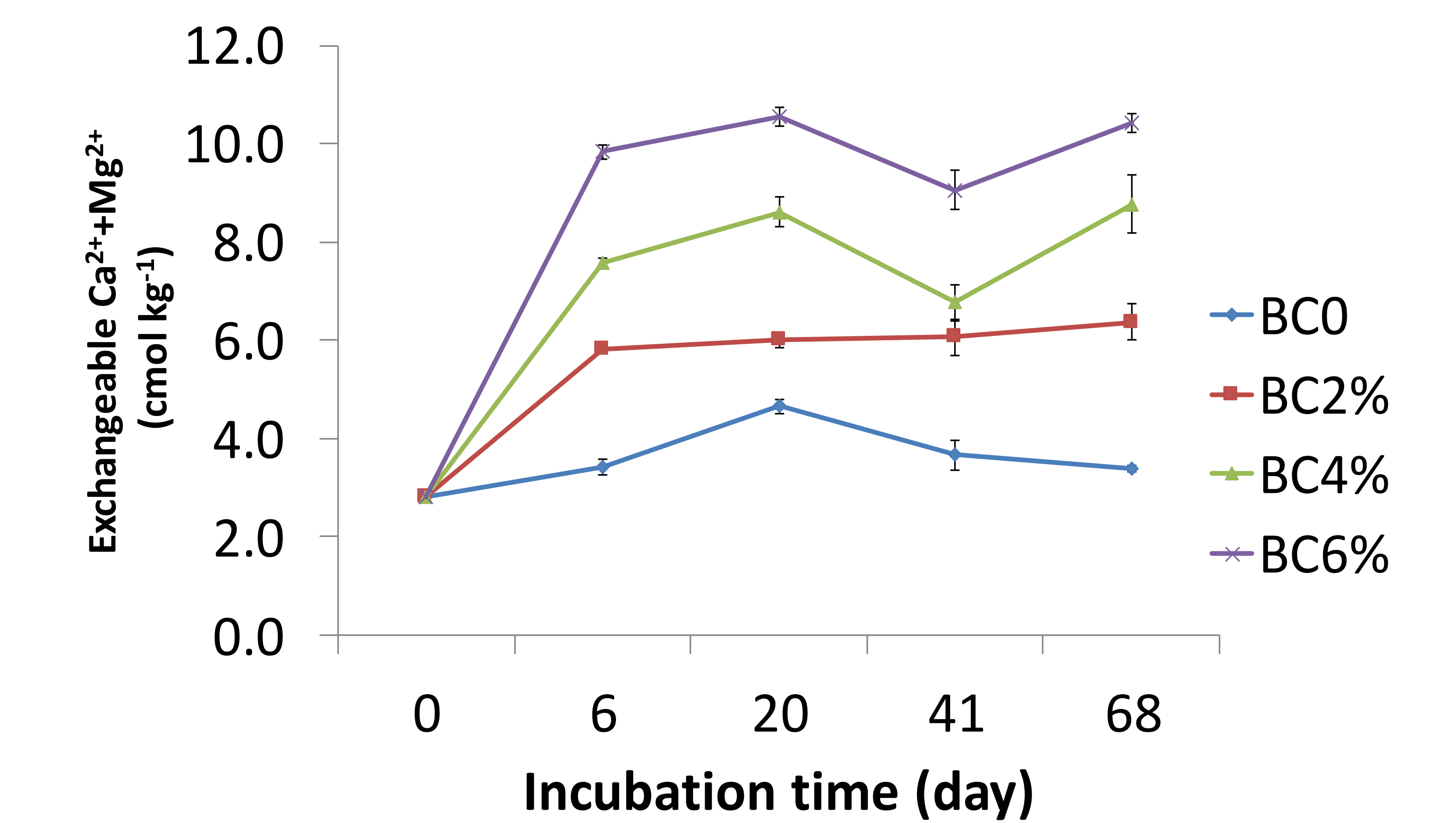
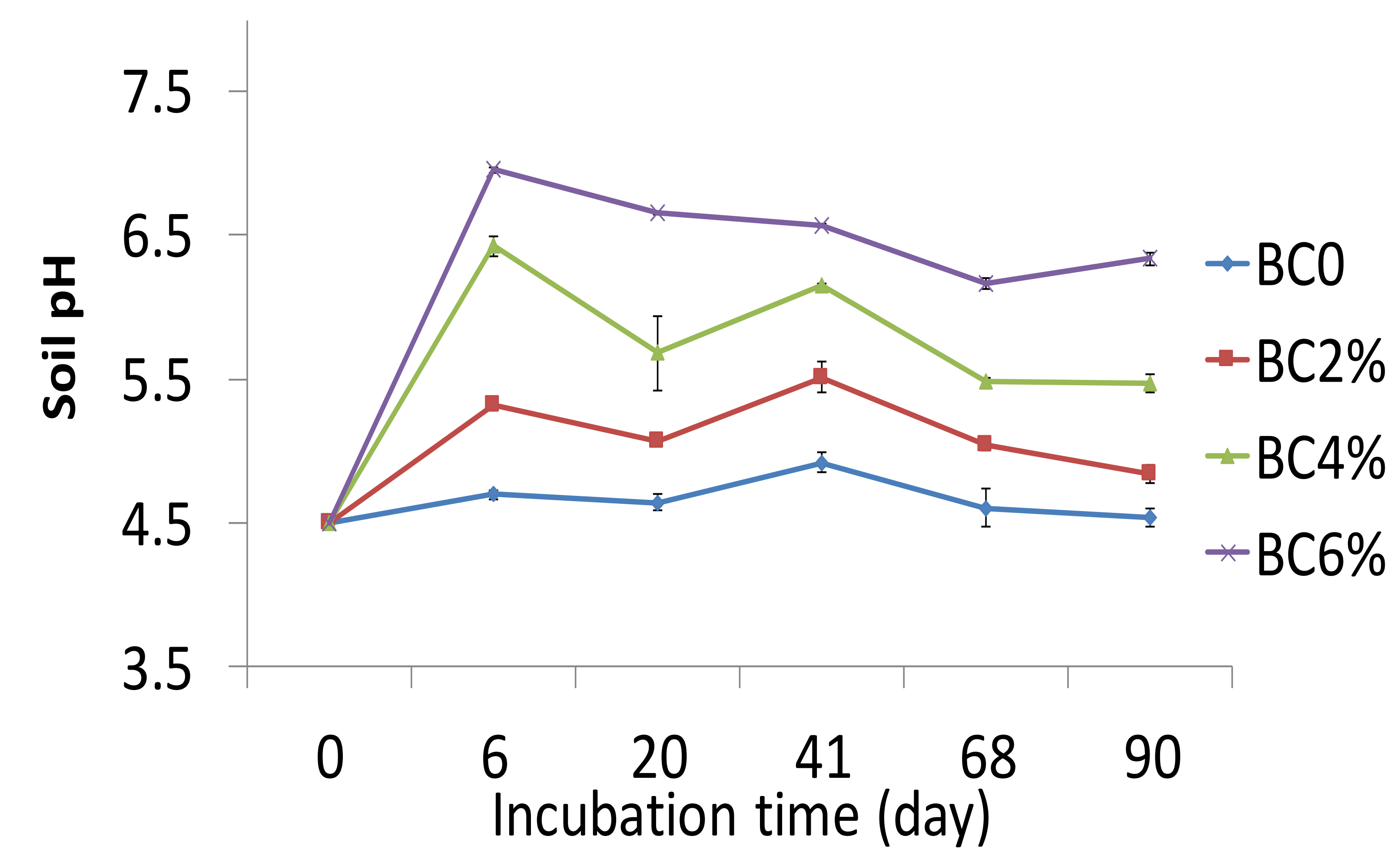
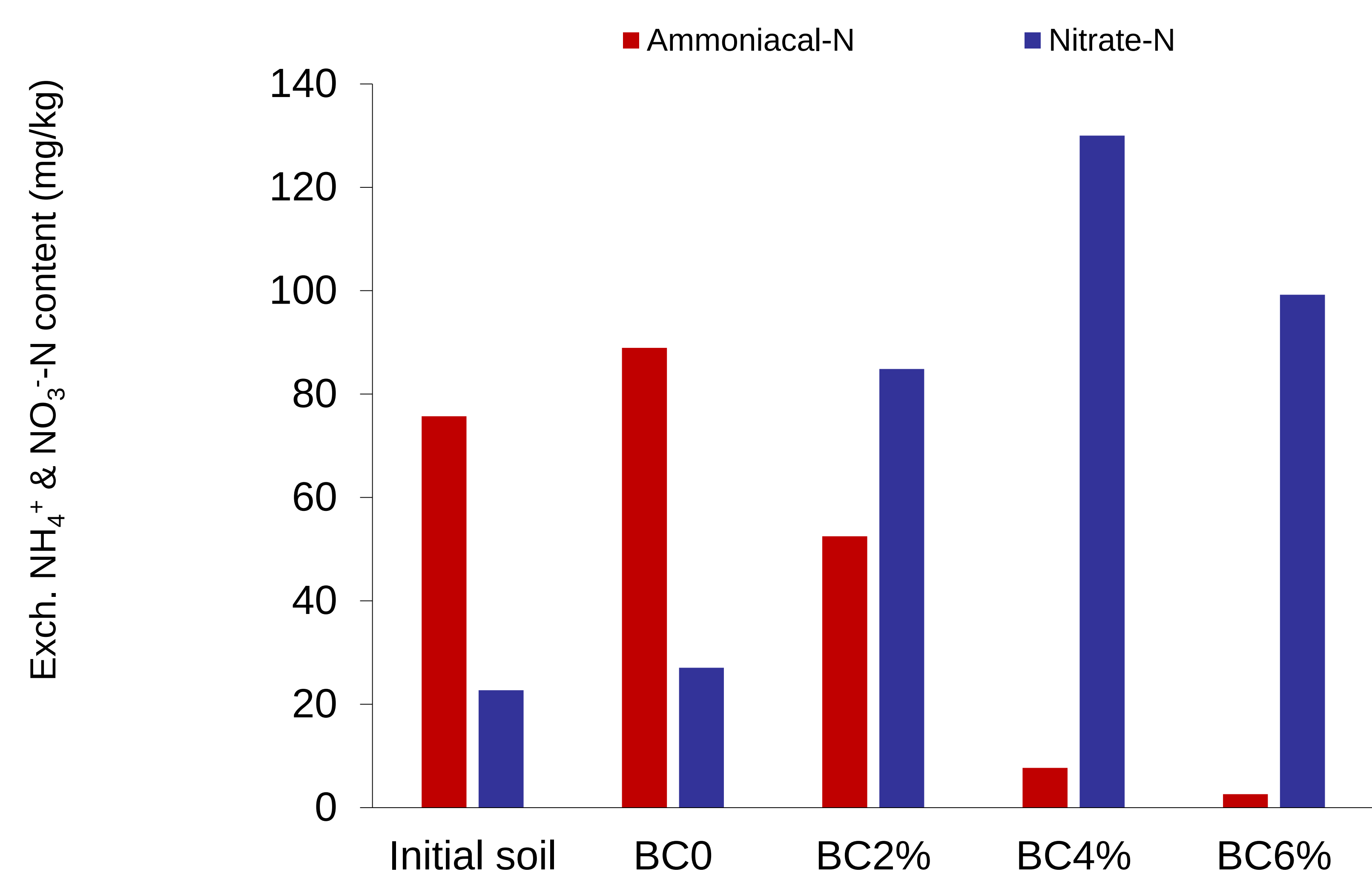
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Biochar as a substitute of lime for amelioration of acid soils

- There is a need to develop alternate liming material for reclamation of acidic soil
- The conversion of *Leucaena* woods and twigs to biochar offers an attractive option for developing amendment for amelioration of acidic soil
- The mean increase in soil pH was 0.65, 1.35, and 2.0 unit at 2%, 4%, and 6% (w/w) of biochar incorporation, respectively
- Application of biochar significantly ($P < 0.01$) reduced ammonium (NH_4^+) content of soil, whereas $\text{NO}_3\text{-N}$ concentration increased by threefold and fivefold by application of 2% and 4% (w/w) of biochar, respectively
- Exchangeable soil potassium (K) and Ca+Mg concentrations increased with the application of biochar
- Application of biochar above 2% (w/w) reduced exchangeable Al concentration to non-detectable limit



Al (cmol kg ⁻¹)					
Treatments	0	6	20	41	68
BC0	3.41	3.55 (0.11)a	3.59(0.23)a	4.47(0.07)a	3.71(0.10)a
BC2%	3.41	0.30 (0.11)b	0.34 (0.12)b	0.34 (0.03)b	0.30 (0.05)b
BC4%	3.41	ND	ND	ND	ND
BC6%	341	ND	ND	ND	ND



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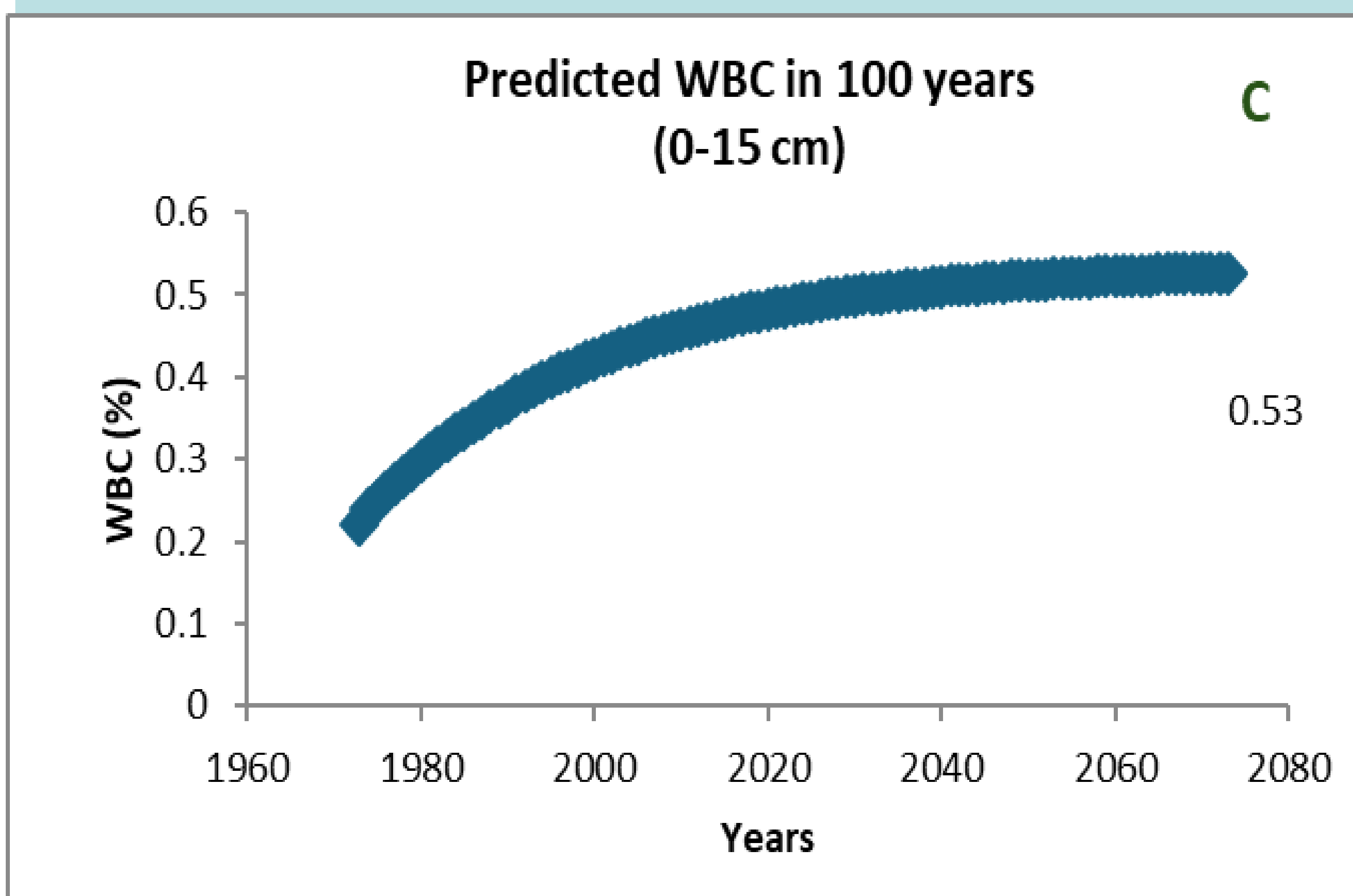
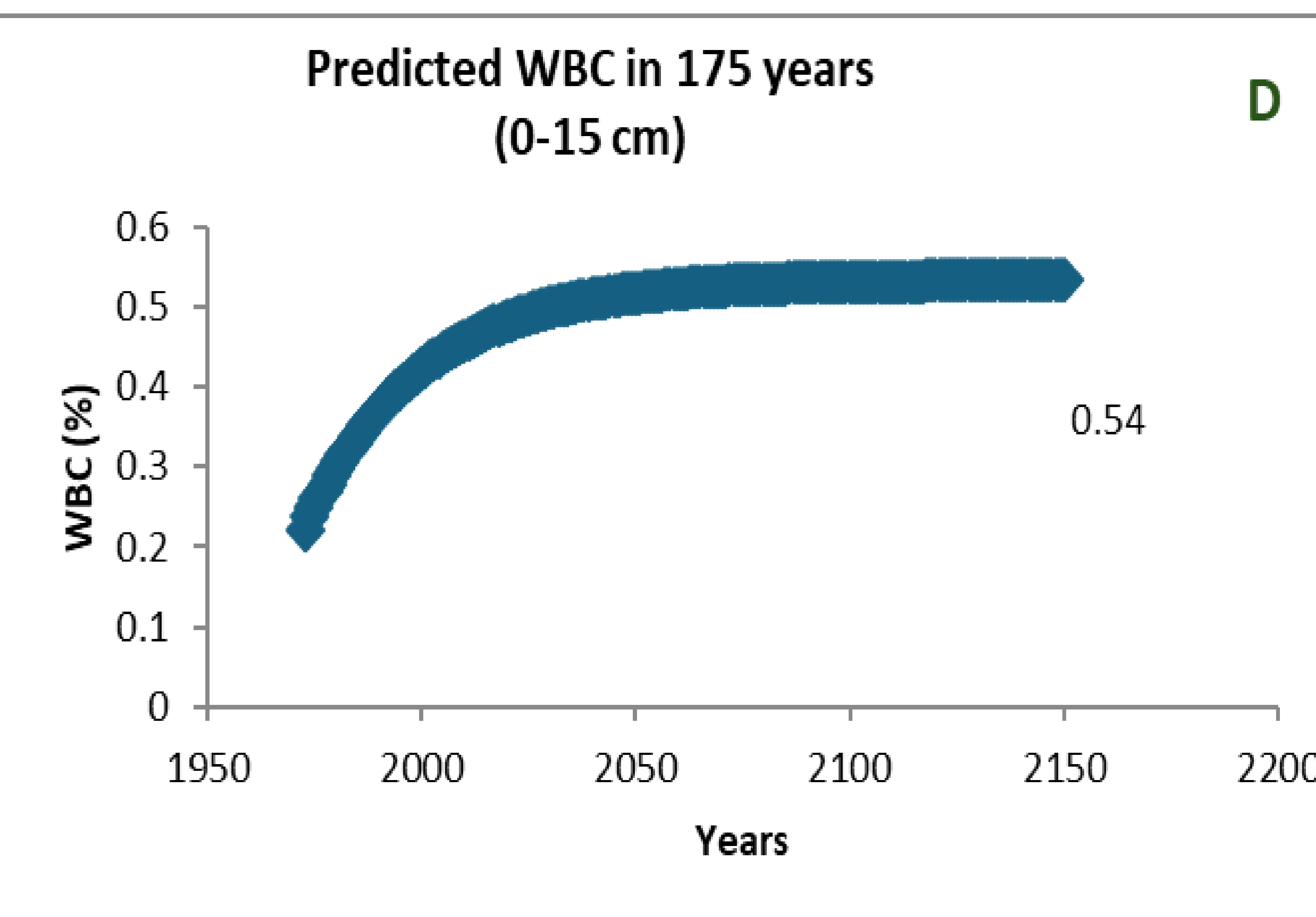
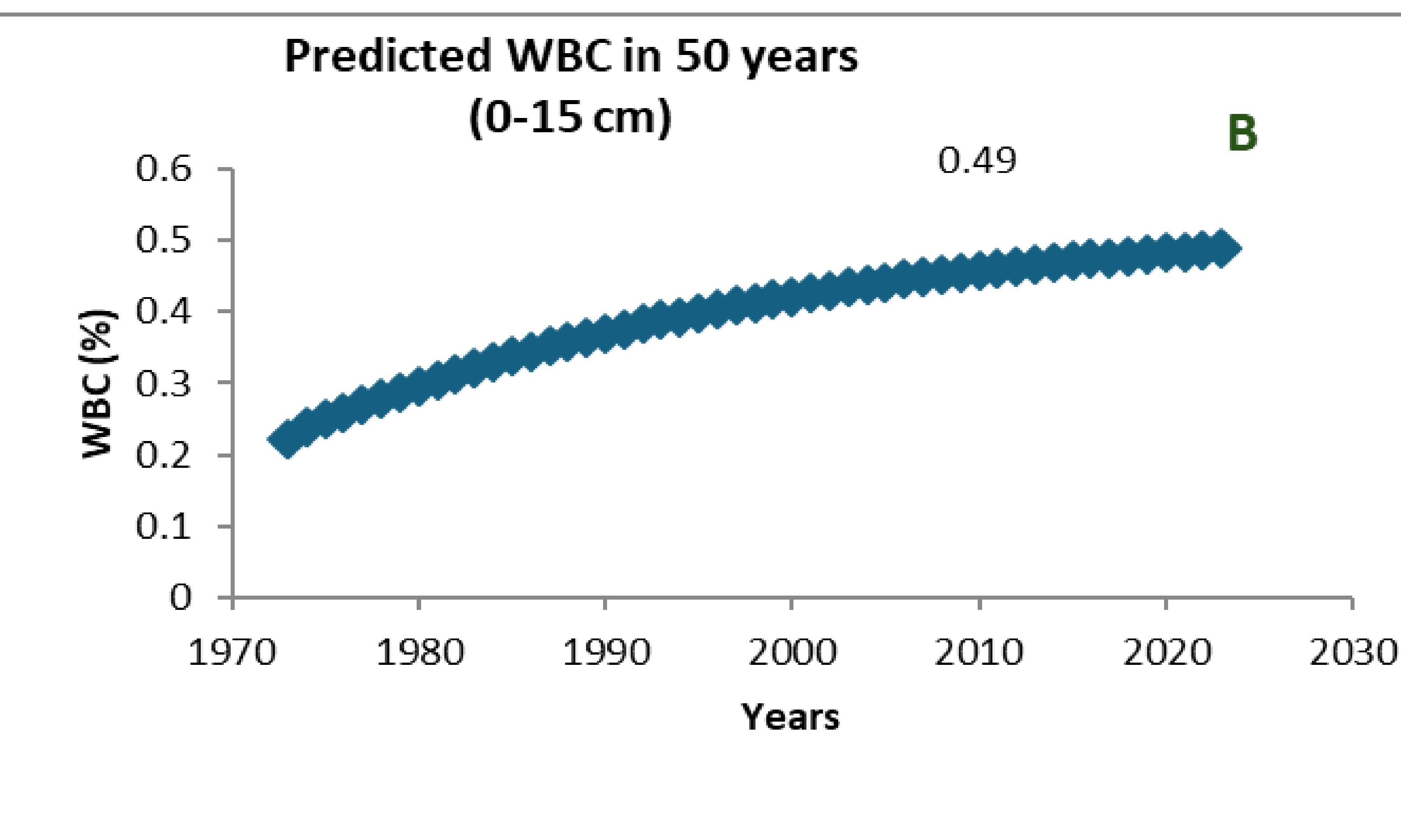
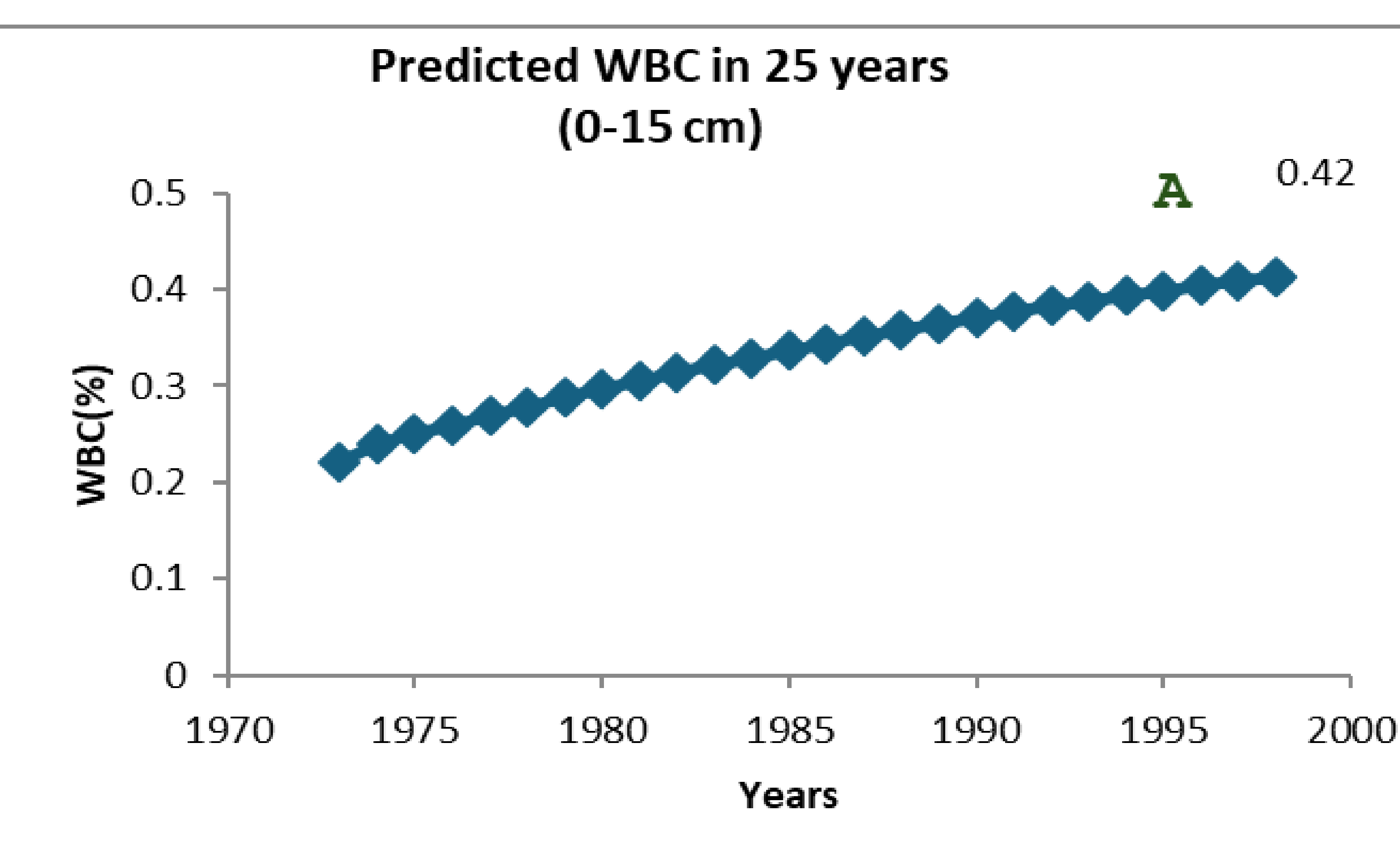
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Soil carbon and nitrogen turnover model

- A new soil carbon and nitrogen turnover model has been developed using the soil and crop dataset of long term fertilizer experiments of India
- Soil carbon and nitrogen prediction model is controlled primarily by net primary production (yield), mean annual rainfall and temperature, texture (sand, silt, clay content), bulk density and soil initial carbon content
- The model simulates soil carbon dynamics for different annual crops and plant communities
- The model computes total organic carbon, Walkley & Black C content, carbon in resistant (passive) and mineralizable (active + slow) pools, carbon stocks, total N and available N
- The model automatically computes the carbon and nitrogen turnover based upon these parameters and model output displayed in excel sheet

The screenshot shows the 'Soil Carbon and Nitrogen Model' interface. It includes a header with the IISc logo and address. Below are input fields for 'Location' (Site Name, Latitude, Longitude), 'Climate' (Mean Annual Rainfall, Mean Annual Temperature), and 'Soil' (Sand, Silt, Clay, Initial SOC, Bulk Density). A 'Simulation' tab is active. The background is a landscape image. A small text at the bottom right credits Dr. Pramod Jha, Sr. Scientist, IISc, Bhopal.

Simulate C dynamics



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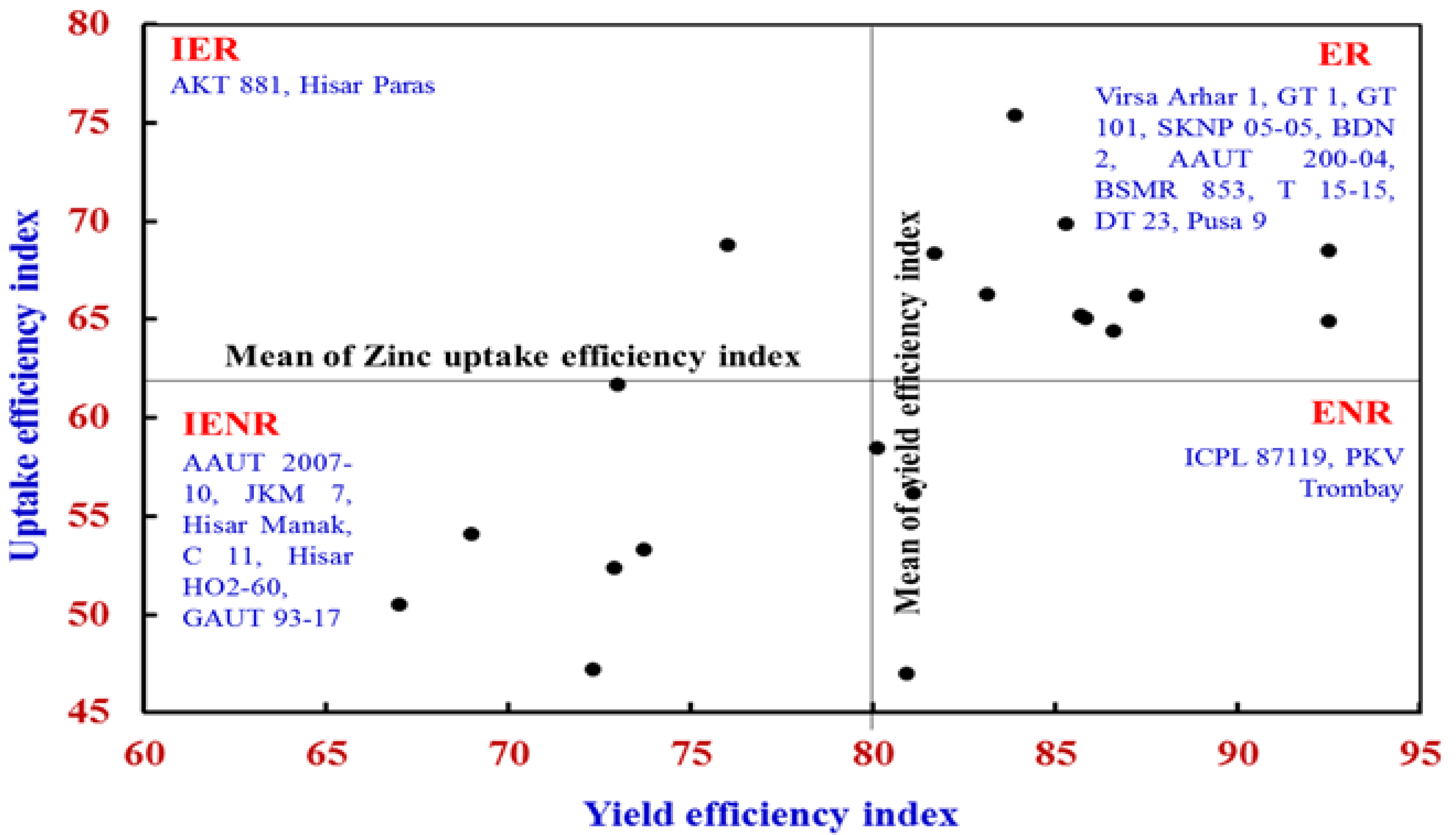
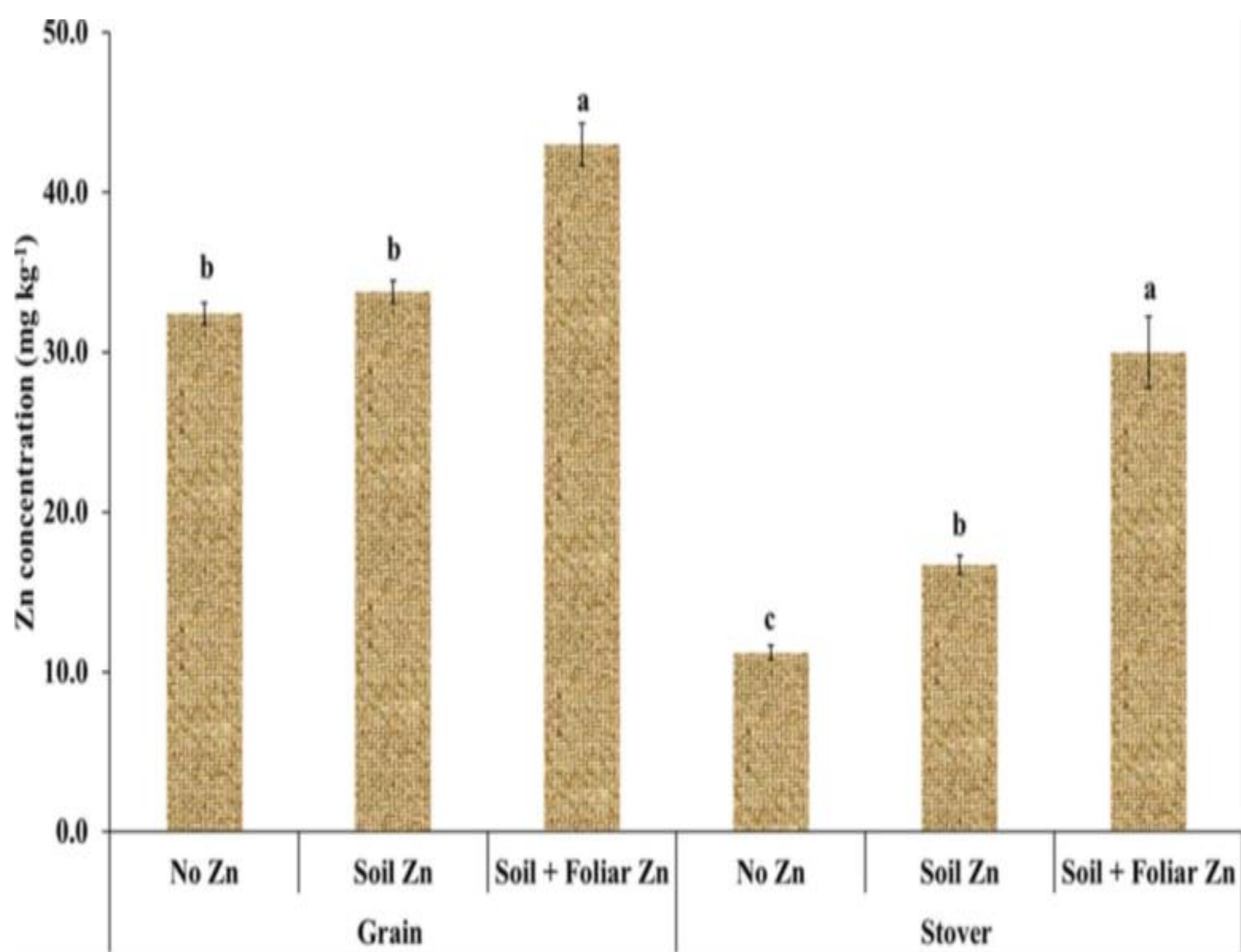
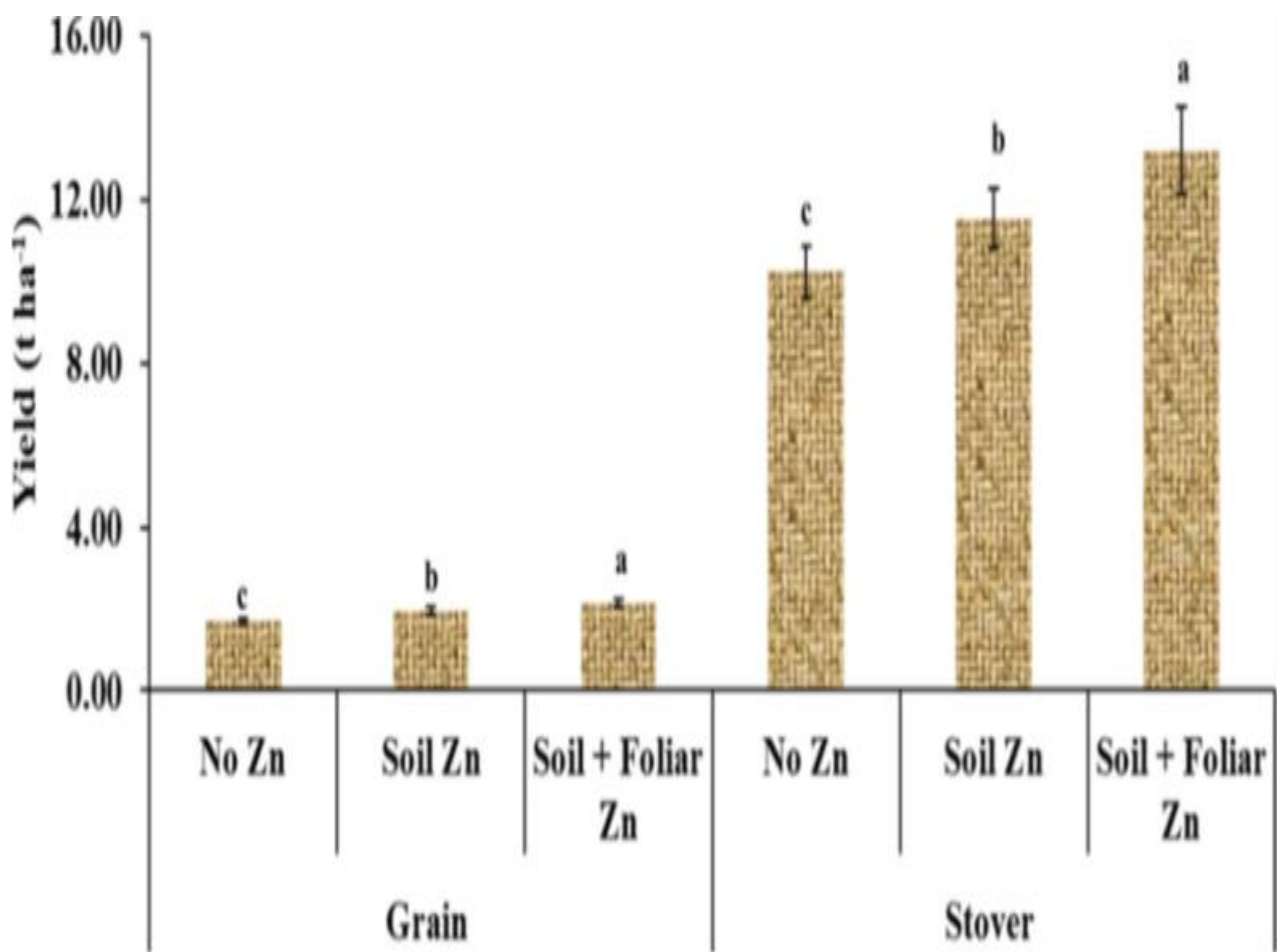
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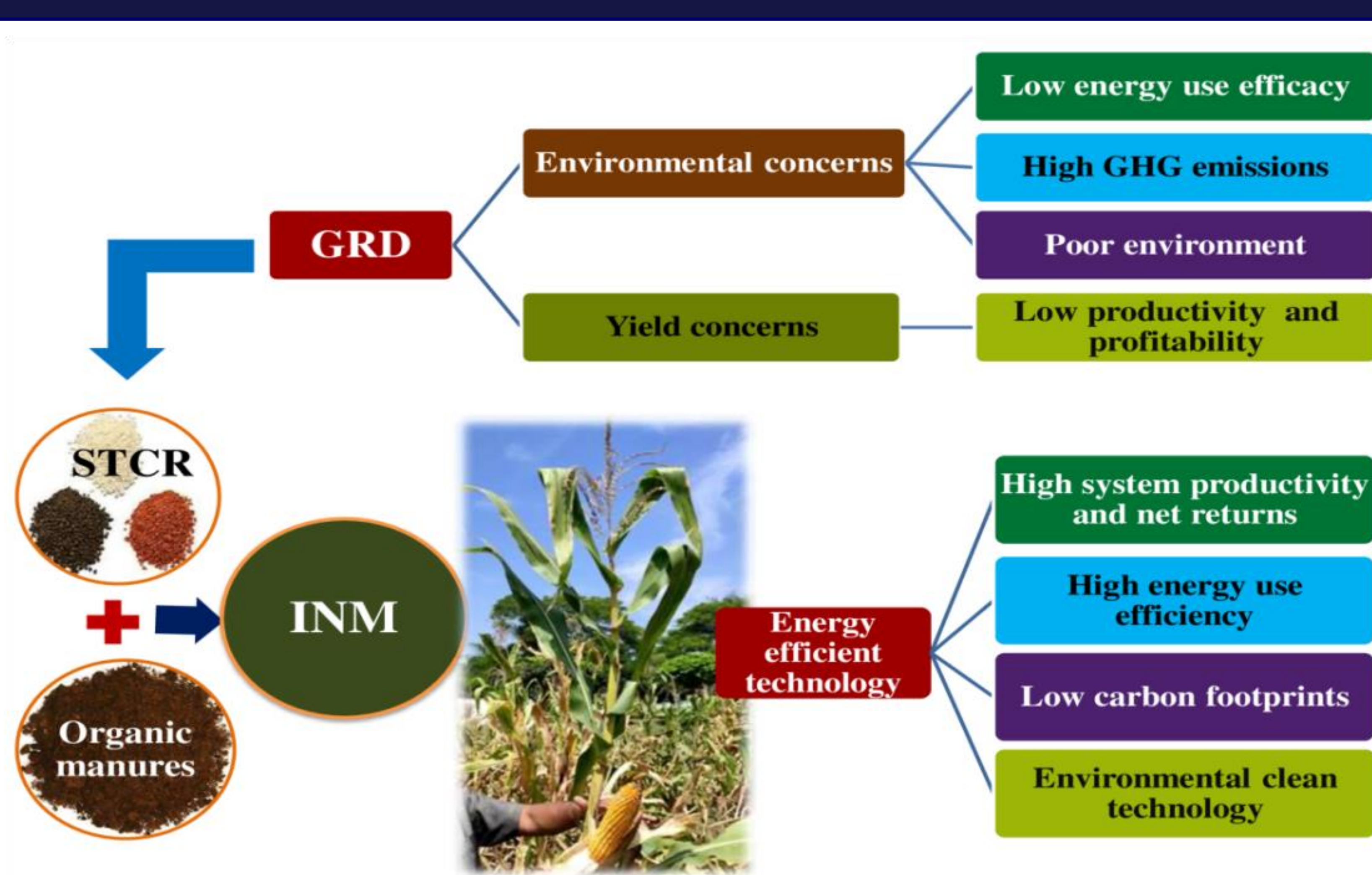
Agronomic biofortification of zinc in pigeonpea genotypes grown on Vertisols

- Twenty different pigeonpea genotypes were evaluated under 3 levels of Zn treatments (no Zn, soil Zn, soil + foliar Zn)
- Soil and soil + foliar application of Zn enhanced mean grain yield by 15 and 24%, respectively over yield obtained under no Zn application
- Further, pigeonpea genotypes were categorized into 4 classes i.e., efficient and responsive (ER), efficient and non-responsive (ENR), inefficient and responsive (IER) and inefficient and non-responsive (IENR) based on grain yield and Zn uptake efficiency indices
- The efficient and responsive genotypes are the most useful ones as they yield well under low soil Zn conditions and also respond to Zn fertilizer application
- The inefficient and responsive genotypes could be utilized for plant breeding programs by plant breeders for identification and utilization of responsive traits

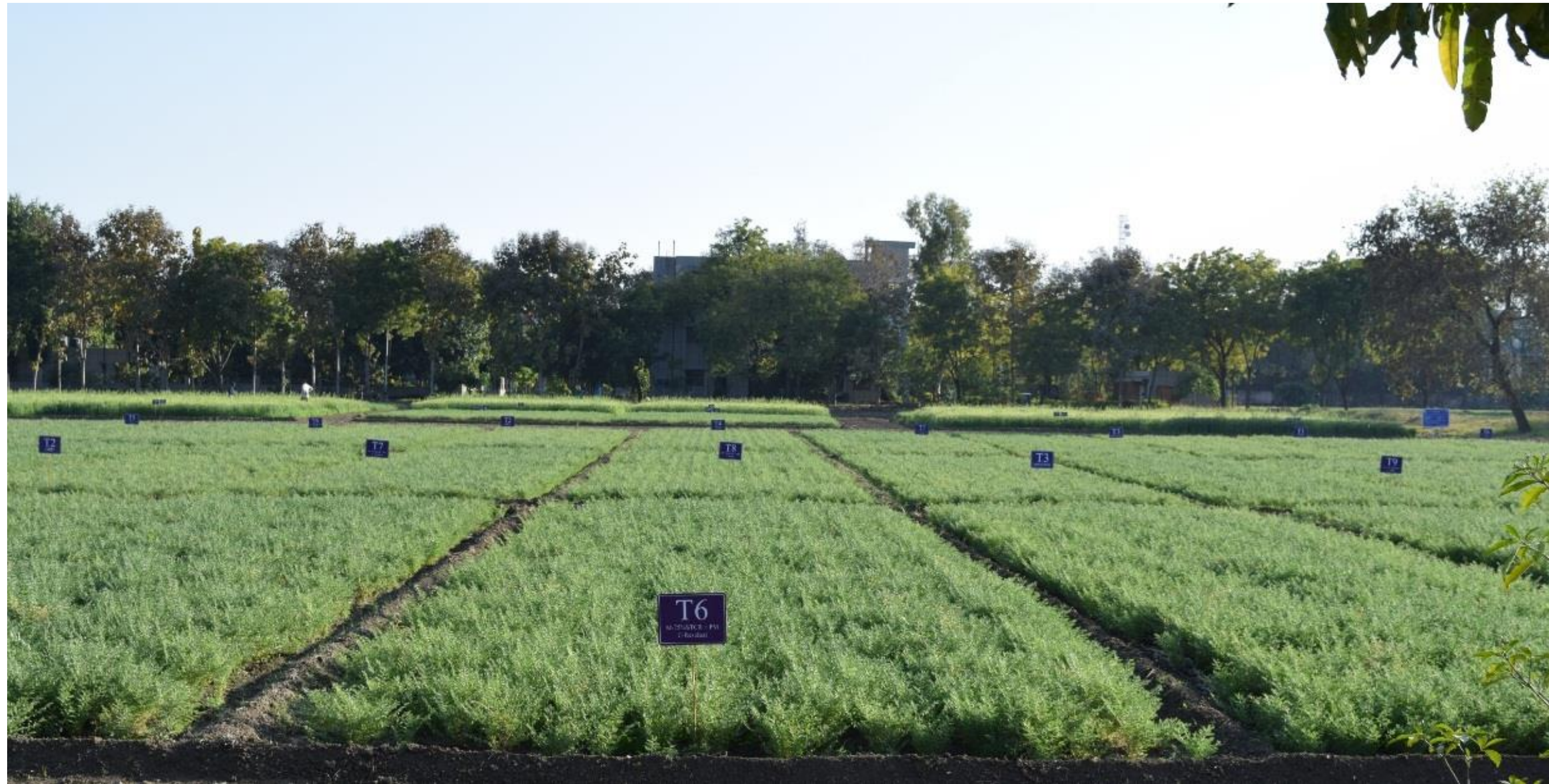
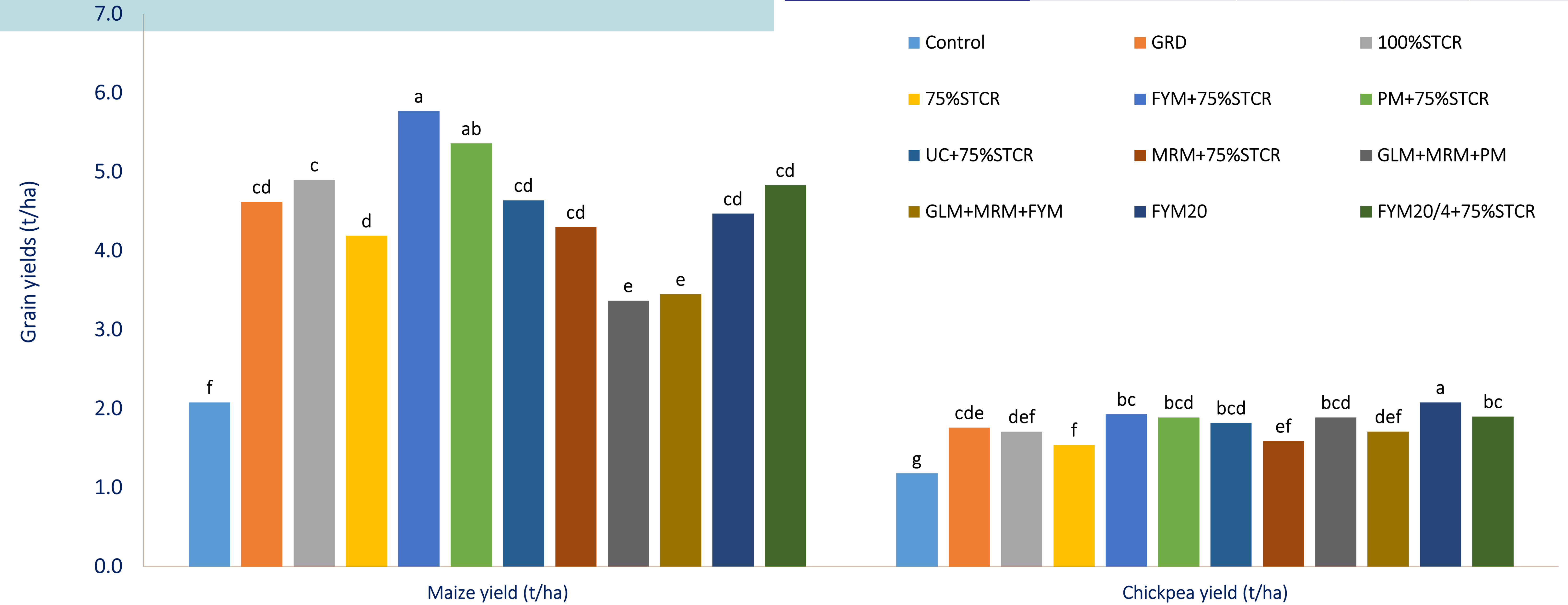


STCR based IPNS-technology for maize-chickpea cropping system in Vertisols

- A long-term field experiment evaluated STCR-based IPNS modules in a maize-chickpea system to develop sustainable and cleaner production technologies
- Twelve IPNS modules combining STCR-based fertilizers, GRD, and organic amendments (FYM, PM, UC, MRM, and GLM) were tested
 - Among the IPNS modules, the STCR-based IPNS module (75% NPK of STCR + FYM @ 5 t ha⁻¹) enhanced system productivity by 17% while reducing energy input by 14% compared to the GRD
 - It increased energy use efficiency (EUE) and carbon sustainability index (CSI) by 28.5% and 21%, respectively, compared to GRD
 - The STCR-based IPNS module markedly enhanced multiple soil health indicators, boosted overall system performance, and recorded the highest benefit-cost (B:C) ratio of 3.85



Treatment	System Yield (t ha ⁻¹)	B:C ratio	EUE (%)	CSI
Control	5.23 ^g	1.94 ^f	11.05 ^{bc}	7.8 ^f
GRD	9.31 ^{de}	3.12 ^{cde}	9.62 ^{cd}	9.9 ^{cde}
100%STCR	9.44 ^{cd}	3.56 ^b	10.73 ^{bc}	10.5 ^{bcd}
75%STCR	8.28 ^f	3.02 ^{de}	10.27 ^{bc}	9.8 ^{de}
FYM+75%STCR	10.89 ^a	3.85 ^a	12.37 ^a	12.0 ^a
PM+75%STCR	10.37 ^{ab}	3.75 ^a	8.48 ^d	11.5 ^{ab}
UC+75%STCR	9.49 ^{bcd}	2.87 ^e	10.90 ^{bc}	10.4 ^{bcd}
MRM+75%STCR	8.52 ^{ef}	3.08 ^{ede}	9.68 ^{cd}	9.5 ^{de}
GLM+MRM+PM	8.40 ^{ef}	3.49 ^{bc}	3.26 ^e	9.7 ^{de}
GLM+MRM+FYM	7.99 ^f	3.09 ^{cde}	3.70 ^e	9.3 ^e
FYM20	10.01 ^b	3.06 ^{de}	11.52 ^b	9.8 ^{cde}
FYM20/4+75%STCR	9.89 ^{bc}	3.30 ^{bcd}	11.13 ^{bc}	10.9 ^{bc}



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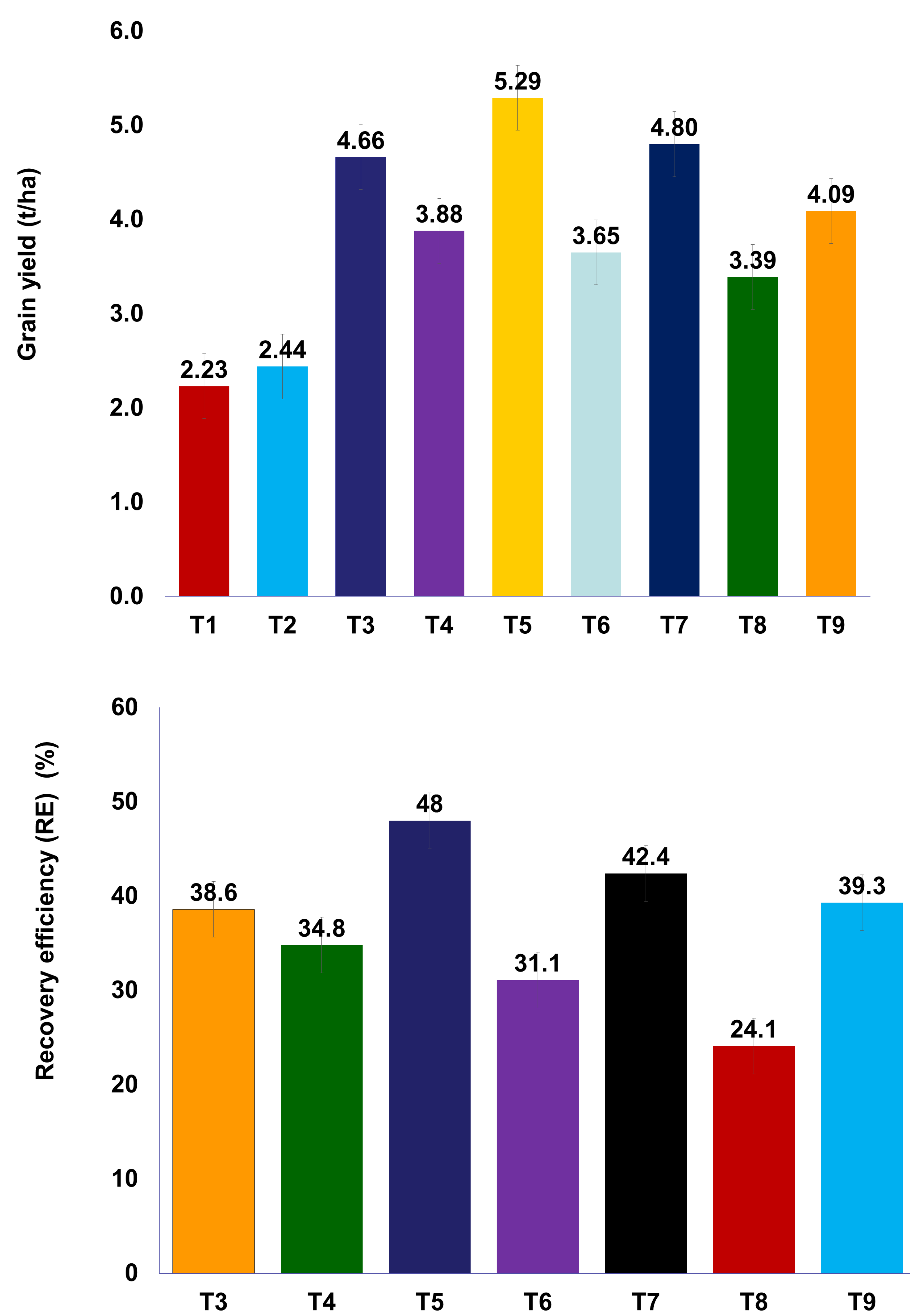
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Top dress based nitrogen application for improving nutrient use efficiency in maize grown on Vertisols

- A field experiment was conducted to optimize maize N rates by evaluating multi-split topdressing at different times using broadcast and band placement methods
- Applying 120 kg N ha⁻¹ in two equal topdress splits at V8 and VT stages (without basal N) increased maize yield by 16.3% over the conventional method
- Topdress N application at V8 and VT stages (skipping basal N) enhanced N uptake, agronomic efficiency (AE), physiological efficiency (PE) and recovery efficiency (RE) as compared to the conventional method
- Highest B:C ratio (3.02) was recorded with top dress based nitrogen in maize crop as compared to conventional fertilizer recommendations (2.57)



Treatments	N uptake (kg ha ⁻¹)	AE (kg kg ⁻¹ N)	PE (kg kg ⁻¹ N)	B:C ratio
T1-Absolute control	48.3f	-	-	1.72 ^{def}
T2-N control	52.3f	-	-	1.55 ^f
T3-N ₆₀ –N ₃₀ –N ₃₀	98.6c	19.5 ^{bc}	47.7 ^{abc}	2.57 ^b
T4-N ₃₀ –N ₃₀ –N ₃₀	83.6d	17.3 ^{cd}	46.0 ^{cd}	1.93 ^d
T5-N ₀ –N ₆₀ –N ₆₀	109.9ab	28.3 ^a	49.1 ^{ab}	3.02 ^a
T6-N ₀ –N ₄₅ –N ₄₅	80.4de	13.6 ^{de}	43.9 ^{de}	1.89 ^{de}
T7-N ₀ –N ₄₀ –N ₄₀ –N ₄₀	103.2bc	19.7 ^{bc}	46.5 ^{bcd}	2.68 ^b
T8-N ₀ –N ₃₀ –N ₃₀ –N ₃₀	74.0e	11.0 ^e	42.0 ^e	1.66 ^{ef}
T9-N ₀ –N ₆₀ –N ₃₀ –N ₀	87.7d	16.9 ^{cd}	45.9 ^{cd}	2.23 ^c



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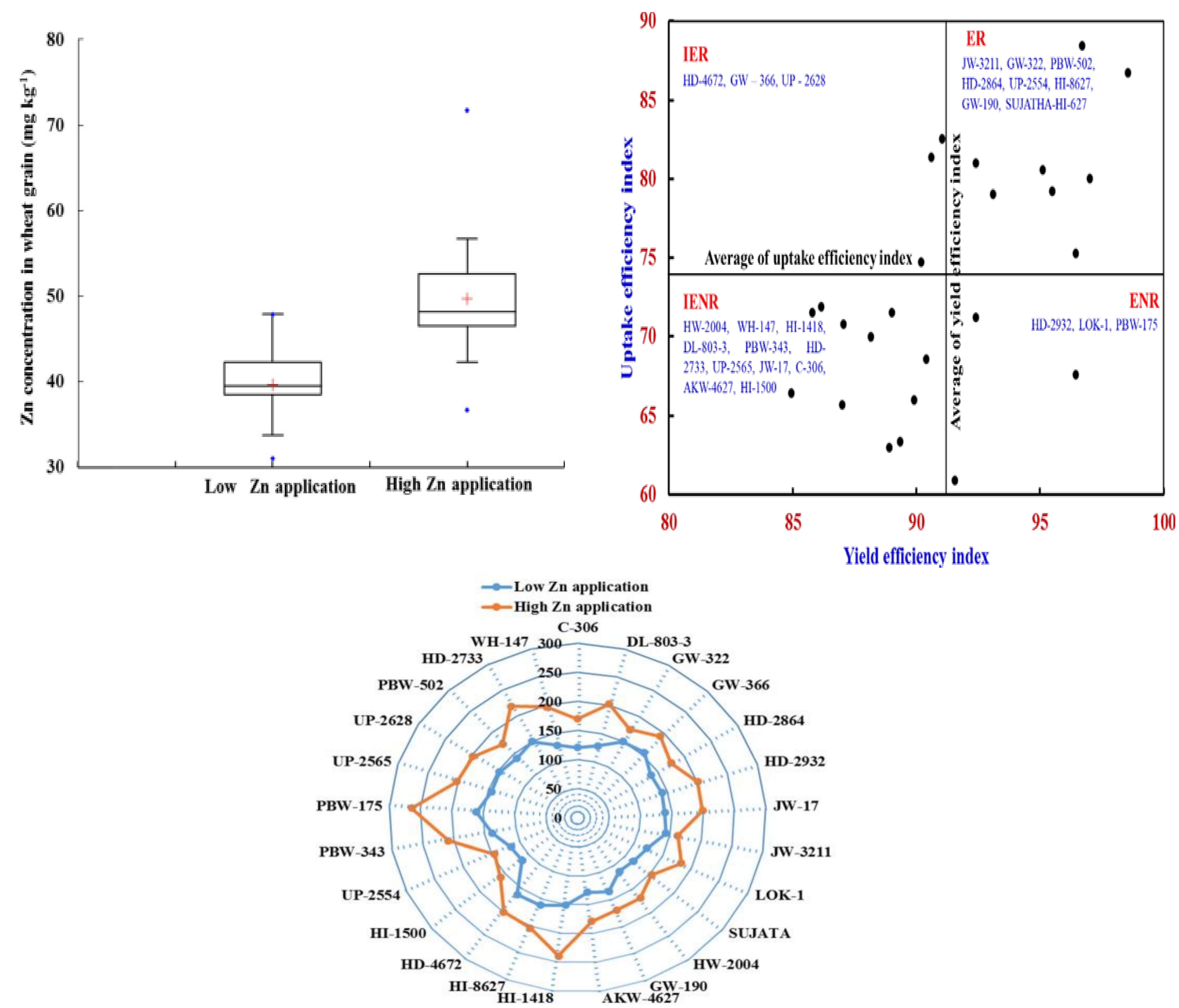
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Agronomic biofortification of wheat with zinc grown on Vertisols

- Twenty-five different wheat genotypes were evaluated by conducting field experiments two levels of Zn, viz., low (no Zn fertilizer) and high (20 kg of Zn ha⁻¹ applied as Zn sulfate heptahydrate (ZnSO₄·7H₂O) (21% Zn)) along with three foliar applications of Zn
- Application of Zn increased the grain yield of wheat genotypes. Though the percent increase in grain yields due to Zn treatment differed among the genotypes, the average increase in grain yield was 10%
- On an average, Zn application enhanced grain Zn concentration by 25%
- Considering grain yield efficiency index and Zn uptake efficiency index, the genotypes were categorized as efficient and responsive, efficient and non-responsive, inefficient and responsive, and inefficient and non-responsive for use by various stakeholders

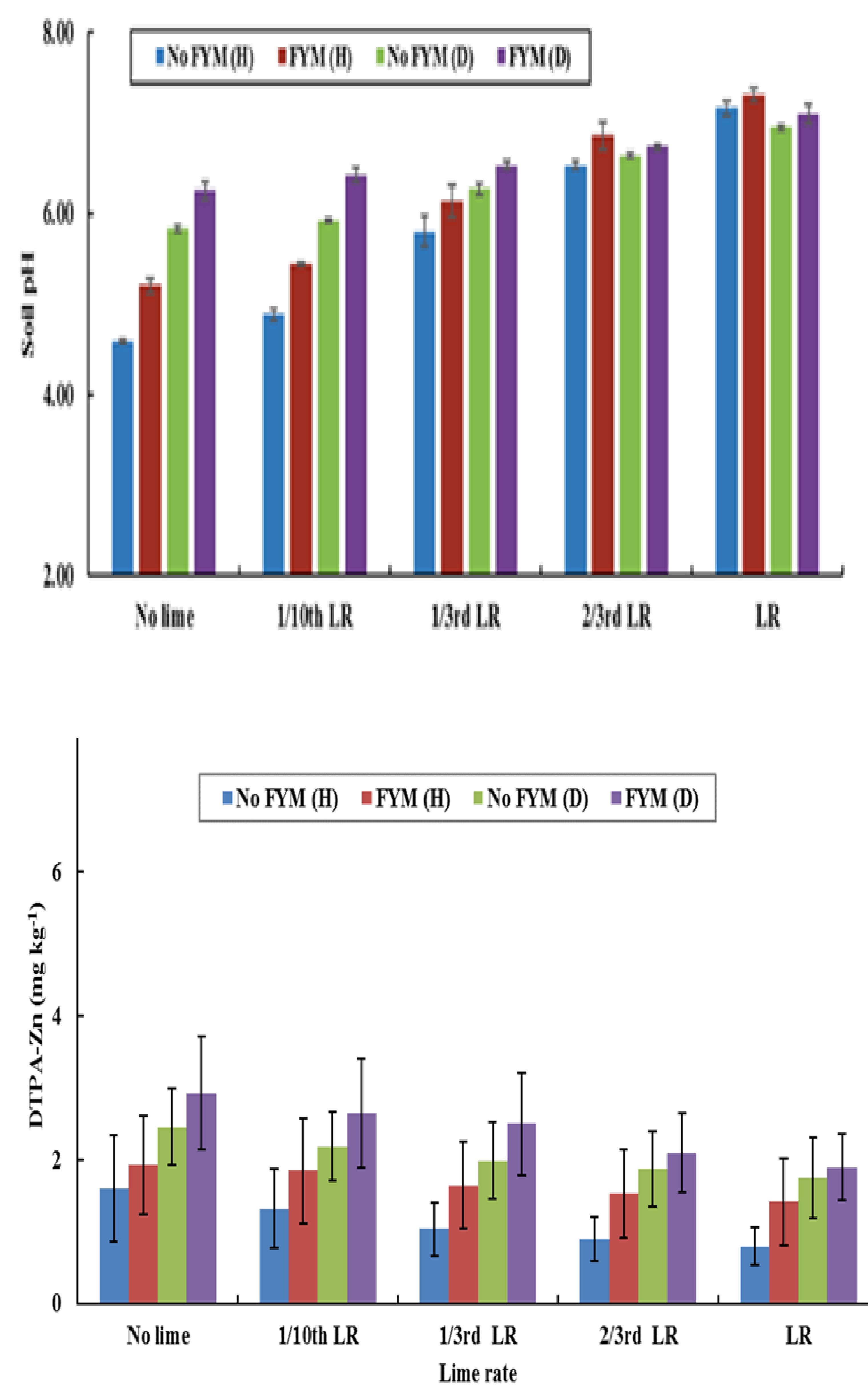


Grain Zn uptake (g ha⁻¹) of wheat genotypes



Zinc amelioration strategy for cultivated acid soils

- Experiment was carried out using two acid soils to optimize lime and Zn application and to understand the impact of FYM and lime application on soil properties, phyto-available Zn, biomass yield of maize, and Zn uptake, for better growth and Zn nutrition of maize
- Lime addition at 1/3rd LR was found optimum as biomass yield enhanced up to this level of liming. FYM addition augmented biomass yield. A higher amount of lime (2/3rd and 1.0 LR) led to a reduction in crop Zn concentration and its uptake
- Correlation analysis revealed that the trend of extraction of zinc in acid soils by DTPA, Mehlich 1, Mehlich 3, 0.1 N HCl and ABDTPA extractants used for this investigation was similar indicating their usefulness for extractions of Zn in acid soils
- Ammonium bicarbonate DTPA (ABDTPA) proved promising extractant for estimation of Zn availability in these acid soils



Pearson’s correlation among the studied parameters									
Hariharapur soil	pH	EC	SOC	Biomass yield	Zn Concentration	Zn uptake	DTPA-Zn	Mehlich 1-Zn	0.1 M HCl-Zn
Biomass yield	-	-	0.221 ^a	1					
Zn concentration	-0.590 ^b	-	0.232 ^a	-	1				
Zn uptake	-0.397 ^b	-	0.294 ^b	0.605 ^b	0.792 ^b	1			
DTPA-Zn	-	-	0.211 ^a	0.391 ^b	0.610 ^b	0.523 ^b	1		
Mehlich 1-Zn	-	-	0.272 ^b	0.281 ^b	0.510 ^b	0.545 ^b	0.897 ^b	1	
0.1 M HCl-Zn	-	-	0.242	0.260 ^a	0.633 ^b	0.626 ^b	0.871 ^b	0.929 ^b	1
AB-DTPA-Zn	-	-	-	0.285 ^b	0.656 ^b	0.673 ^b	0.887 ^b	0.922 ^b	0.923 ^b
Debatoli soil									
Zn concentration	-0.343 ^b	-	-	0.384 ^b	1				
Zn uptake	-0.326 ^b	-	-	0.727 ^b	0.905 ^b	1			
DTPA-Zn	-	-	0.290 ^b	-	0.741 ^b	0.715 ^b	1		
Mehlich 1-Zn	-	-	0.317 ^b	0.330 ^b	0.589 ^b	0.568 ^b	0.811 ^b	1	
0.1 M HCl-Zn	-	-	0.294 ^b	0.333 ^b	0.562 ^b	0.545 ^b	0.822 ^b	0.937 ^b	1
AB-DTPA-Zn	-	-	-	0.419 ^b	0.772 ^b	0.748 ^b	0.889 ^b	0.890 ^b	0.887 ^b



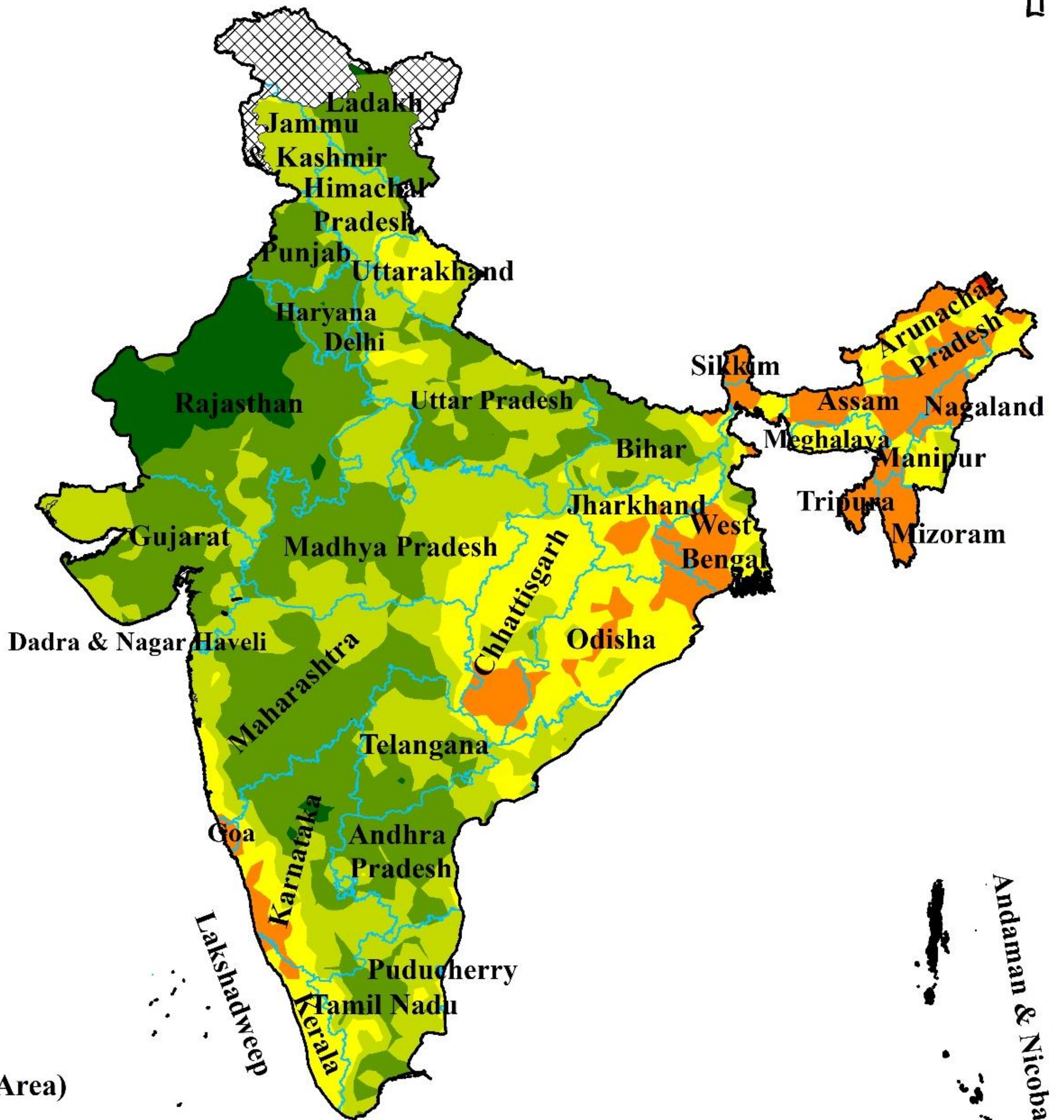
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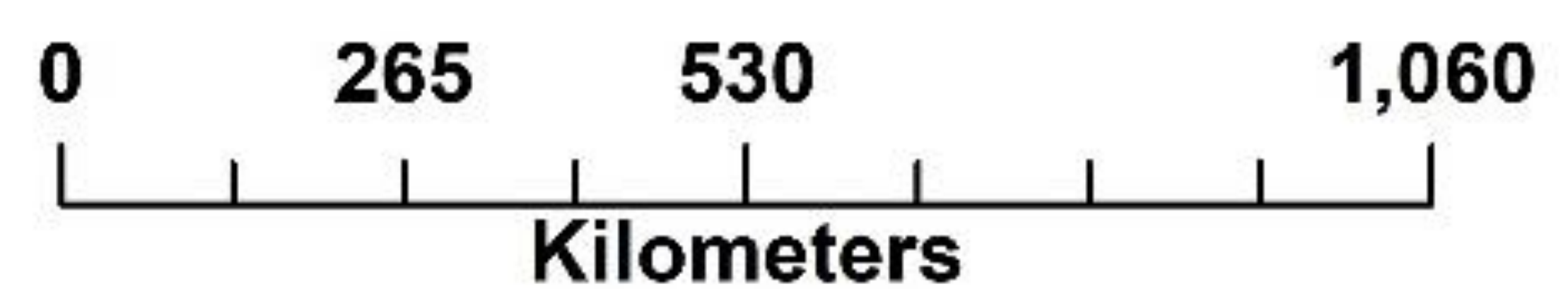
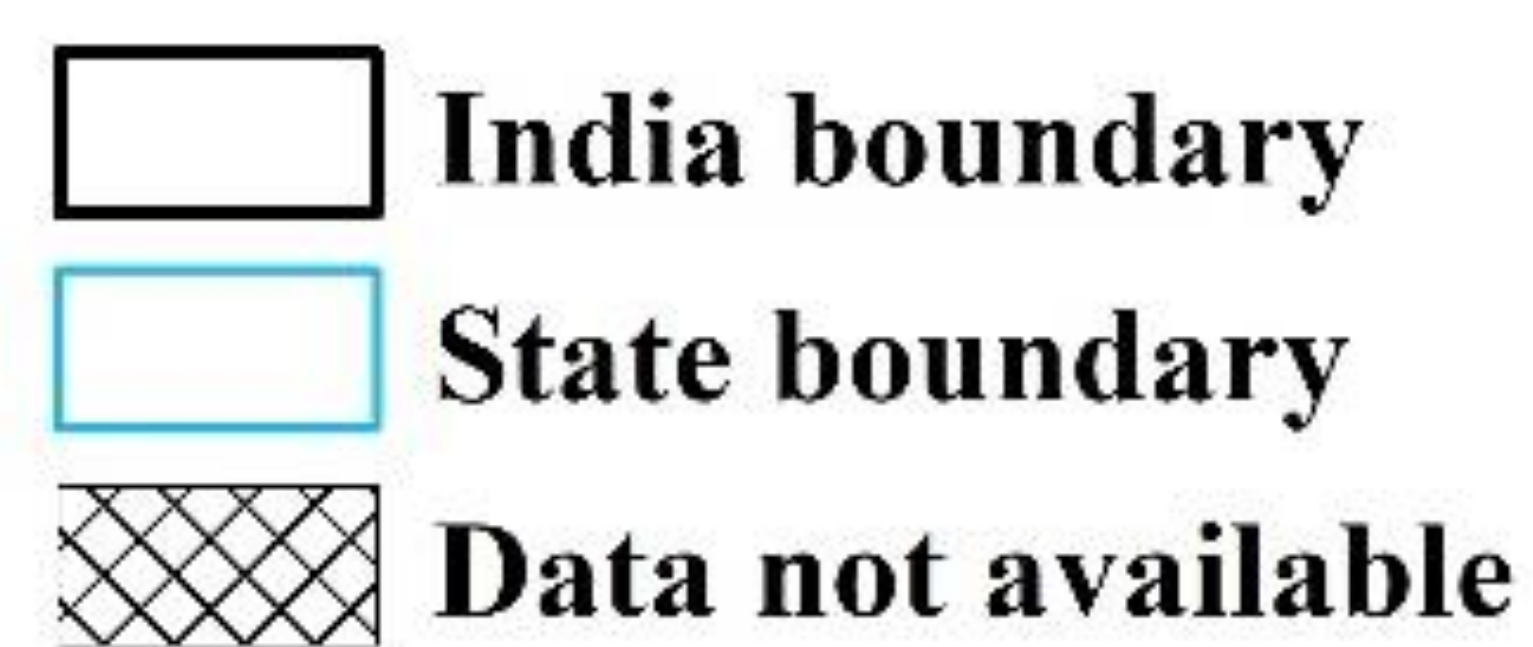
Spatial distribution of surface soil pH in India



Andaman & Nicobar

Legend

Soil pH (% Area)



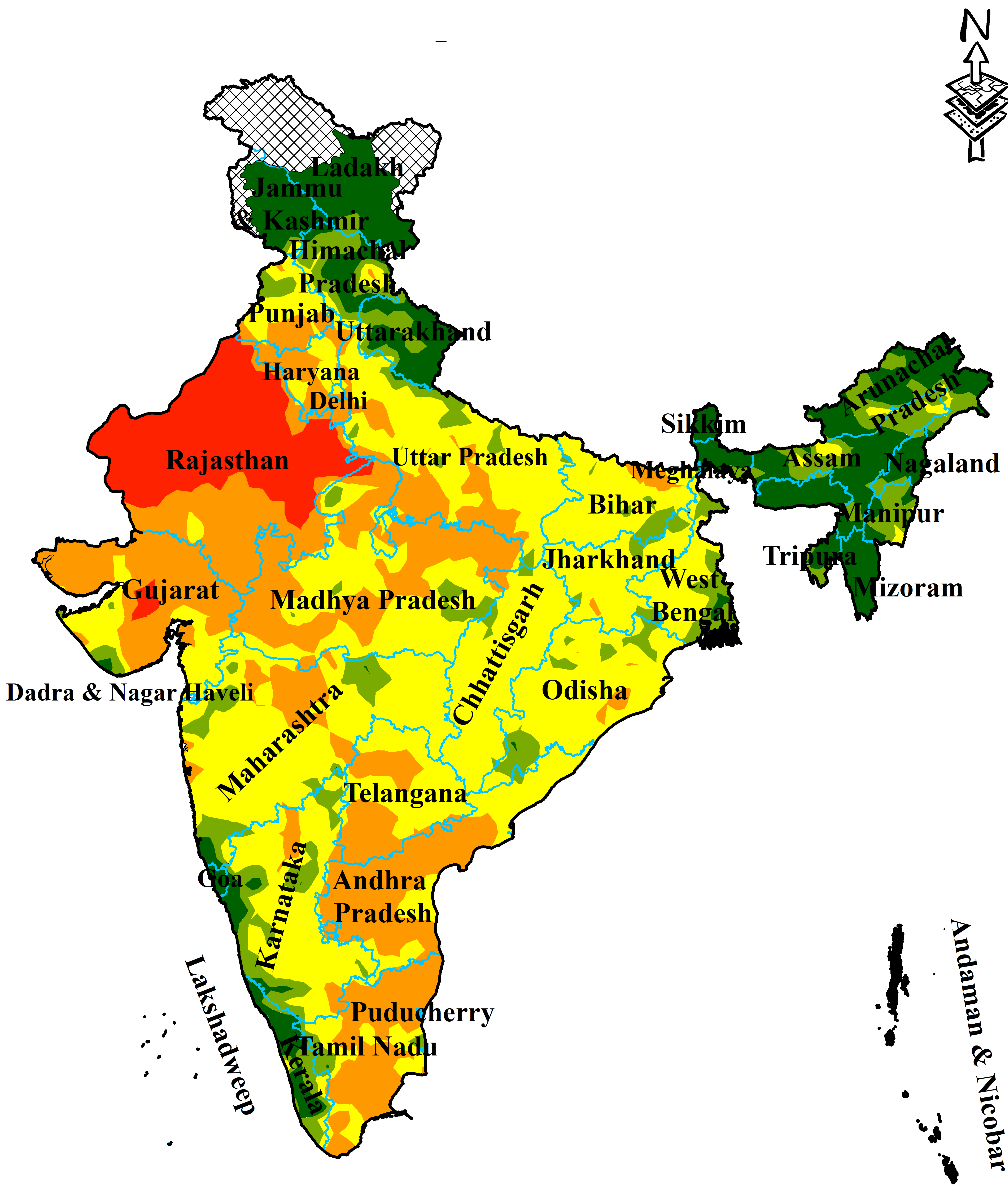
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Spatial distribution of surface soil organic carbon in India



Legend

Soil organic carbon (%) (% Area)

- ≤0.25 (7.5%)
- >0.25 to ≤0.50 (25.5%)
- >0.50 to ≤0.75 (43.5%)
- >0.75 to ≤1.0 (10.8%)
- >1.0 (12.7%)

- India boundary
- State boundary
- Data not available

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Kilometers

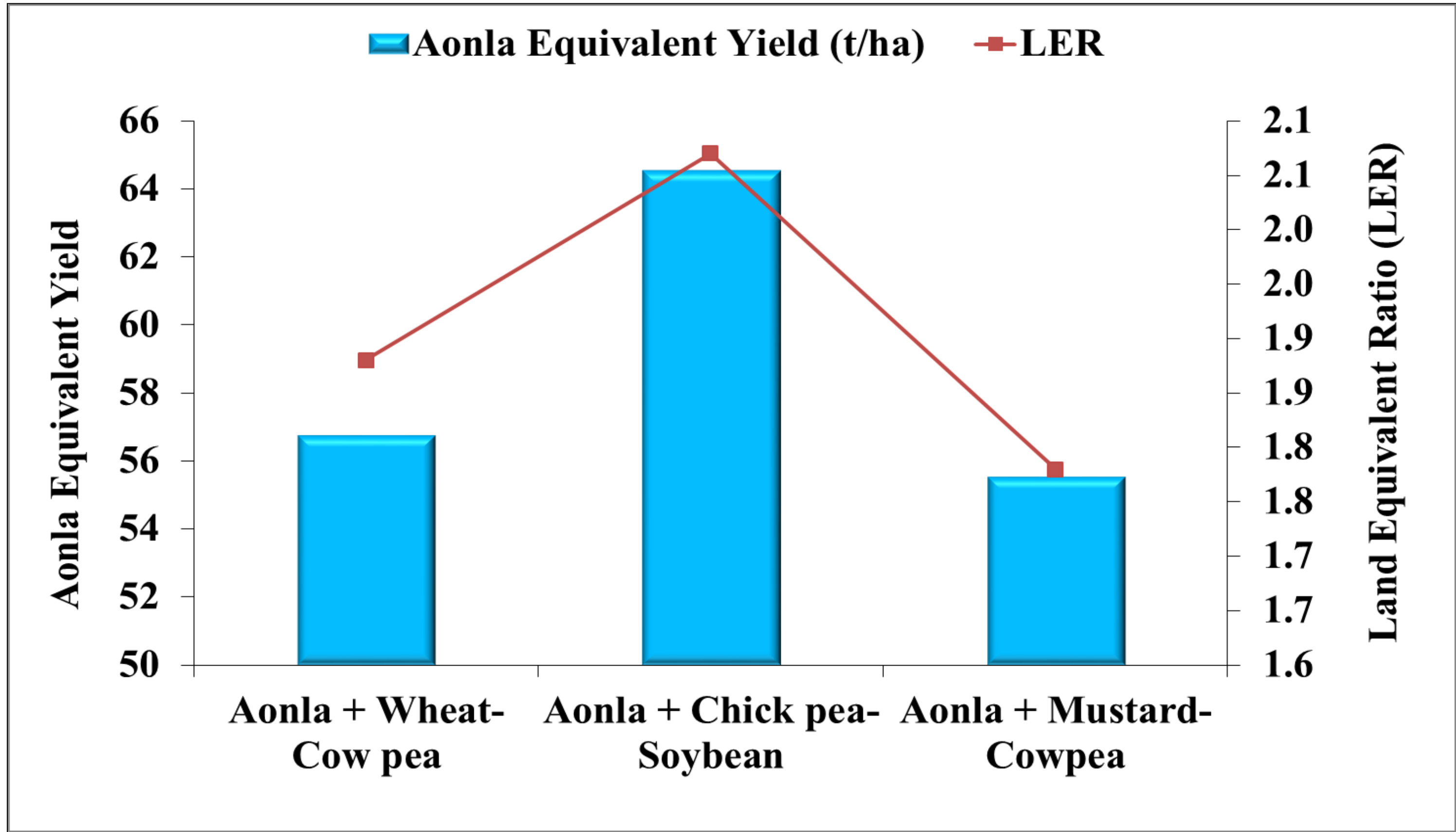
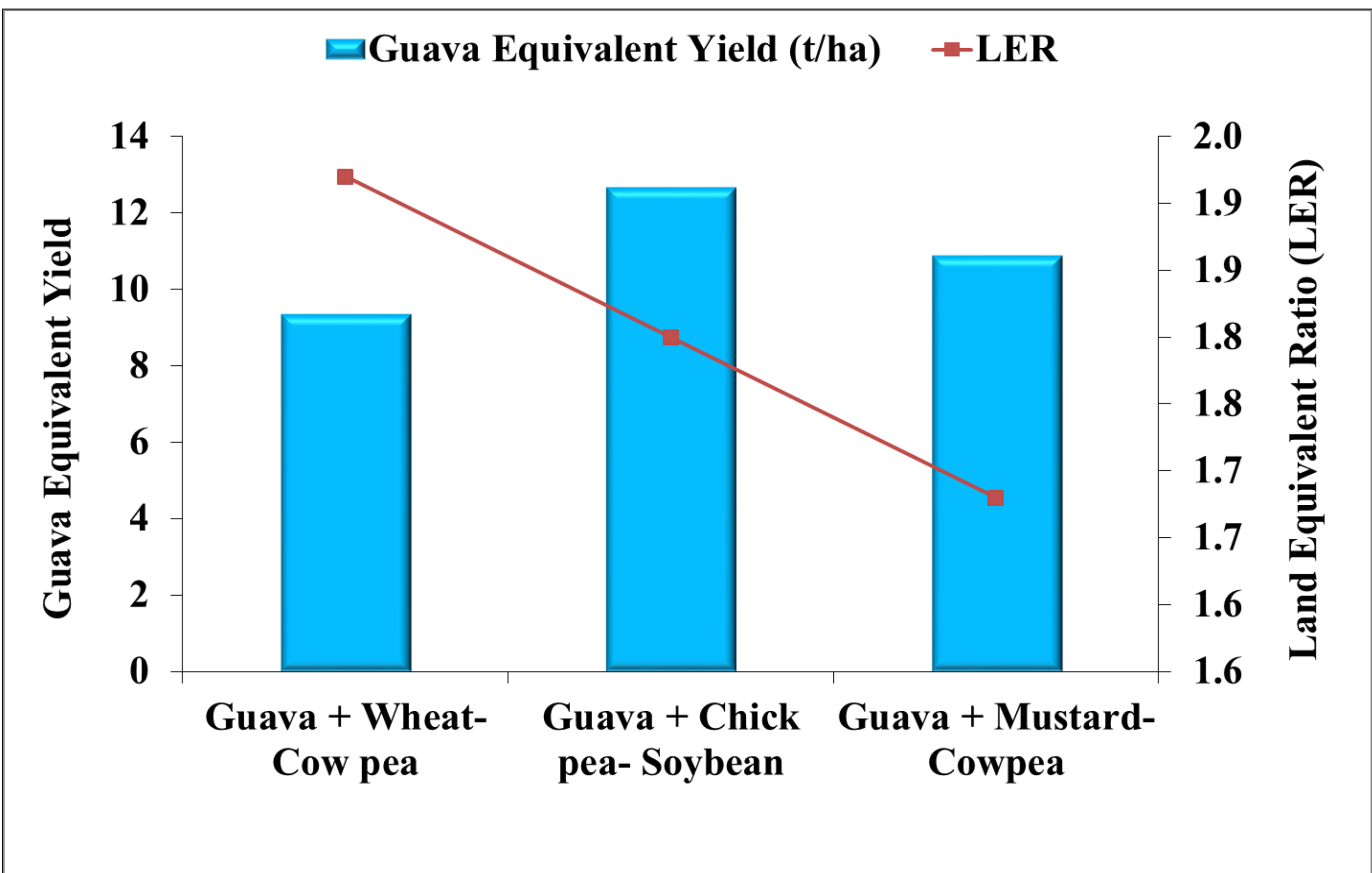
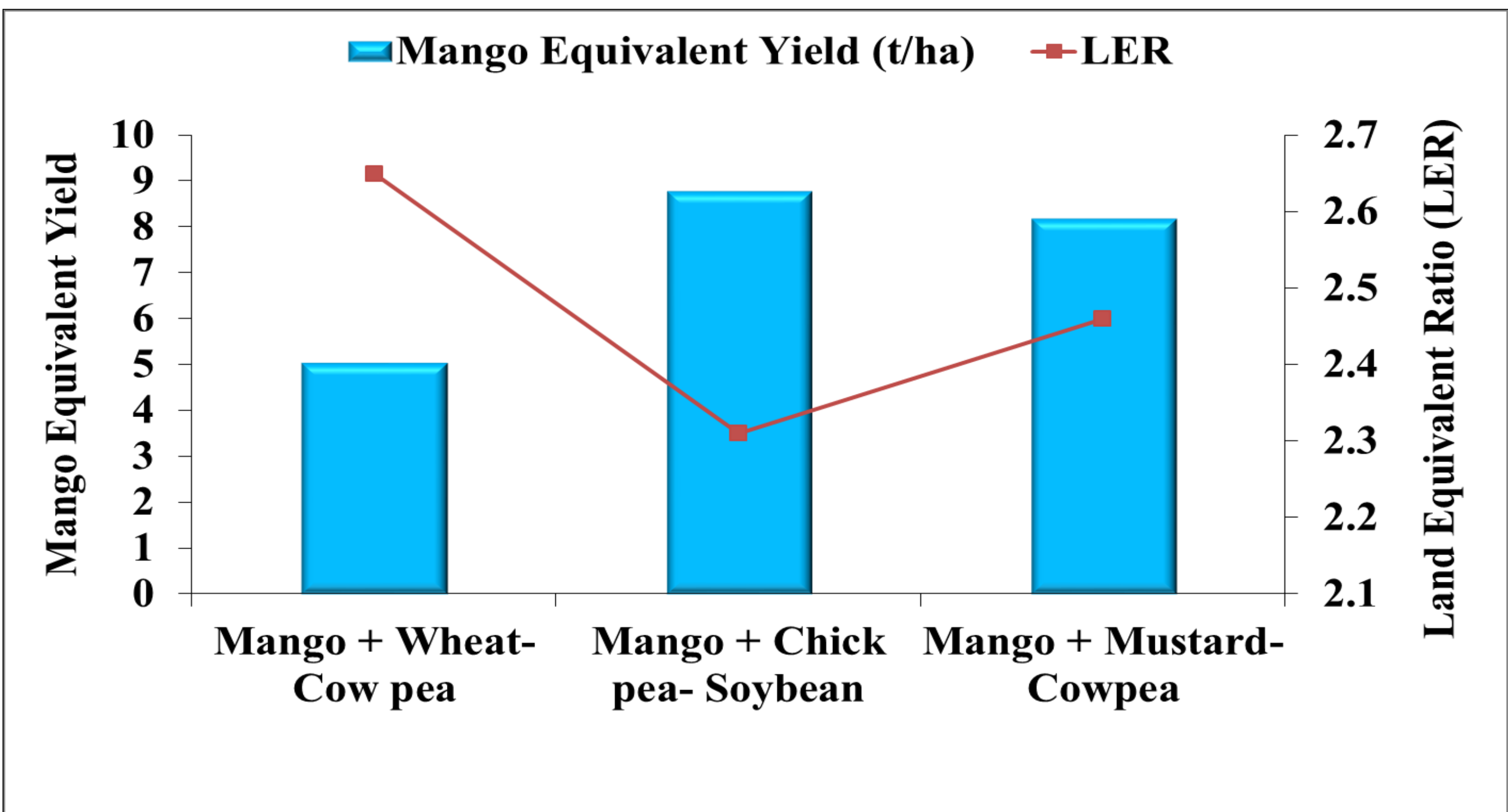
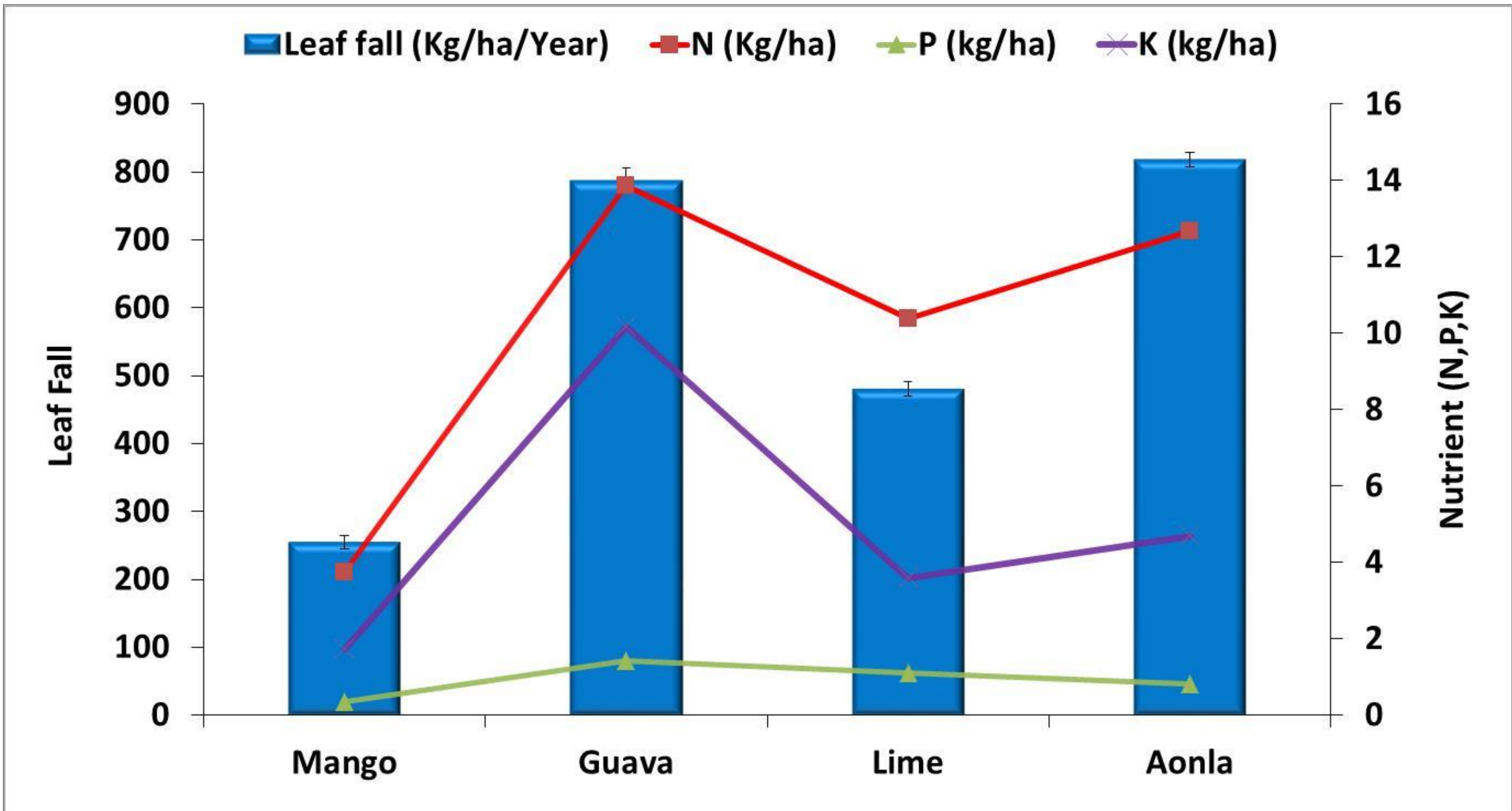
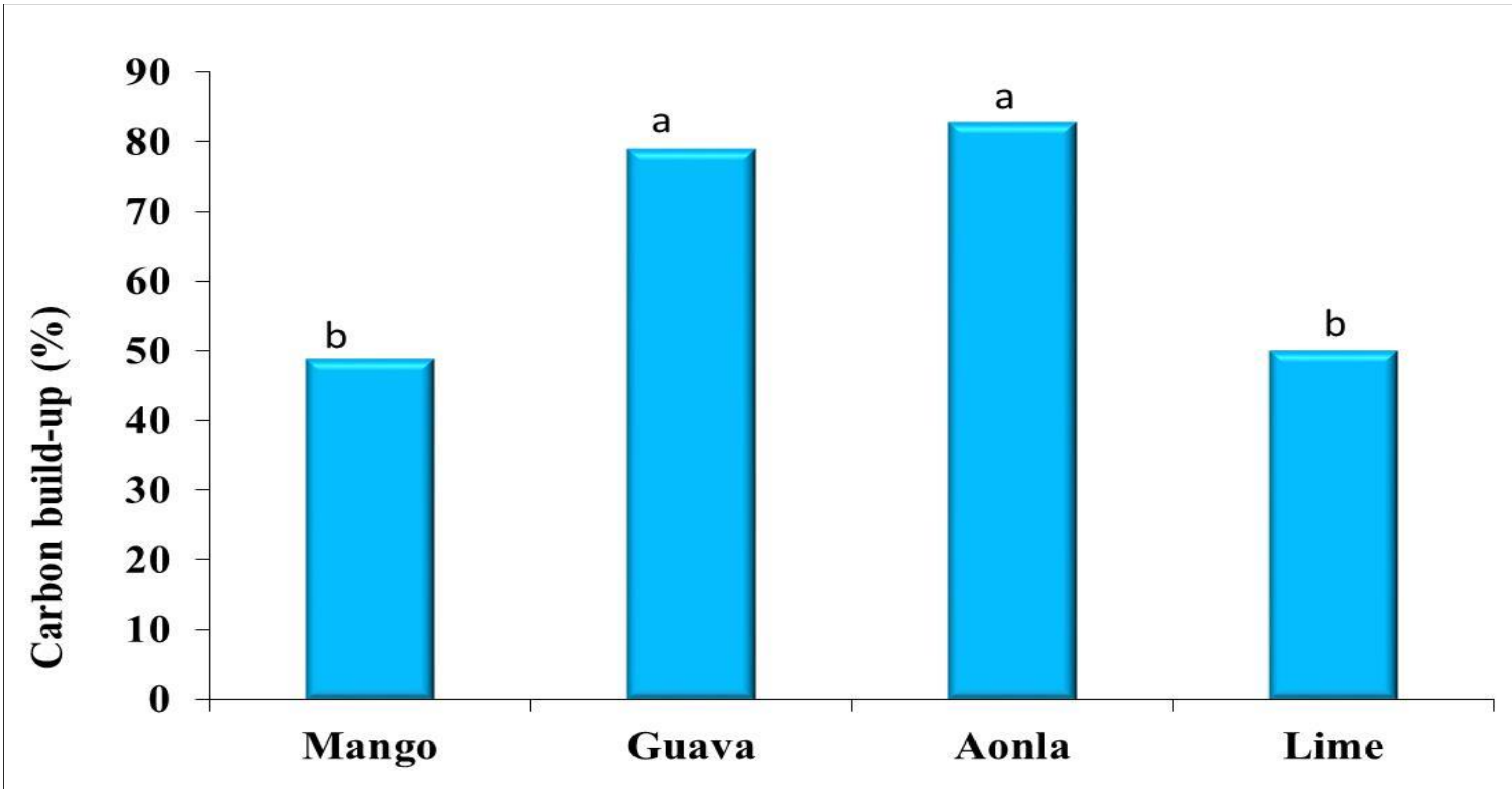
AICRP-MSPE , ICAR-IISS , Bhopal



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Development of agri-horticultural system and its impact on soil health, productivity and produce quality

- Legume based agri-horti system (chick pea – soybean) in mango, guava aonla and lime orchards resulted in good soil health for sustainable crop production
- This system improved nutrients content in soil, leaf and fruit in all the orchards
- Carbon build up rate was the highest in aonla (0.52 t/ha/year) followed by guava (0.51) orchard
- Aonla orchard sequestered maximum carbon in trees (36.5 t/ha) and soil (64.6 t/ha)
- Highest TSS and ascorbic acid, and lowest acidity recorded under chick pea- soybean based model in all the orchards
- LER recorded the highest (2.65) in mango + wheat-cow pea model



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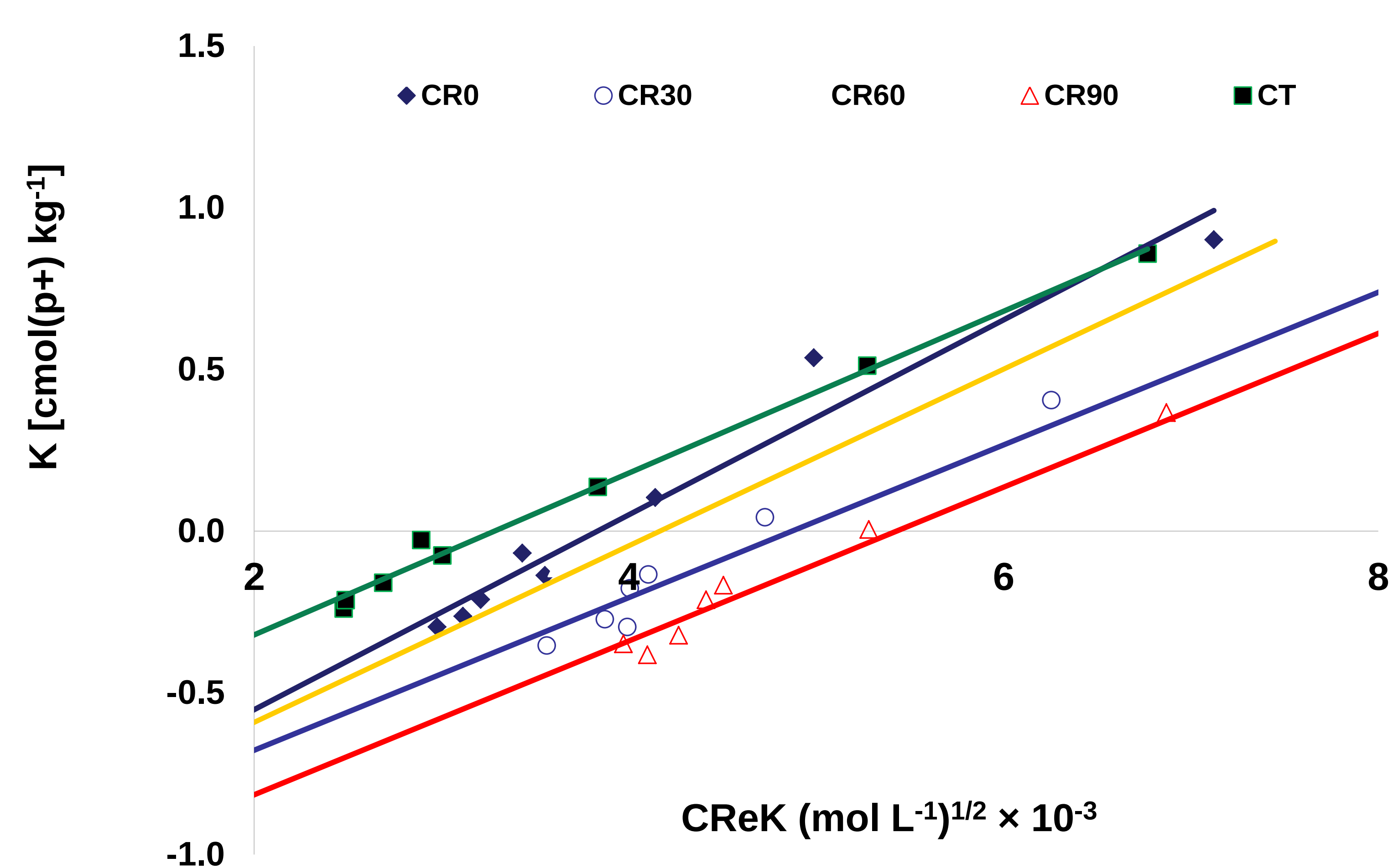
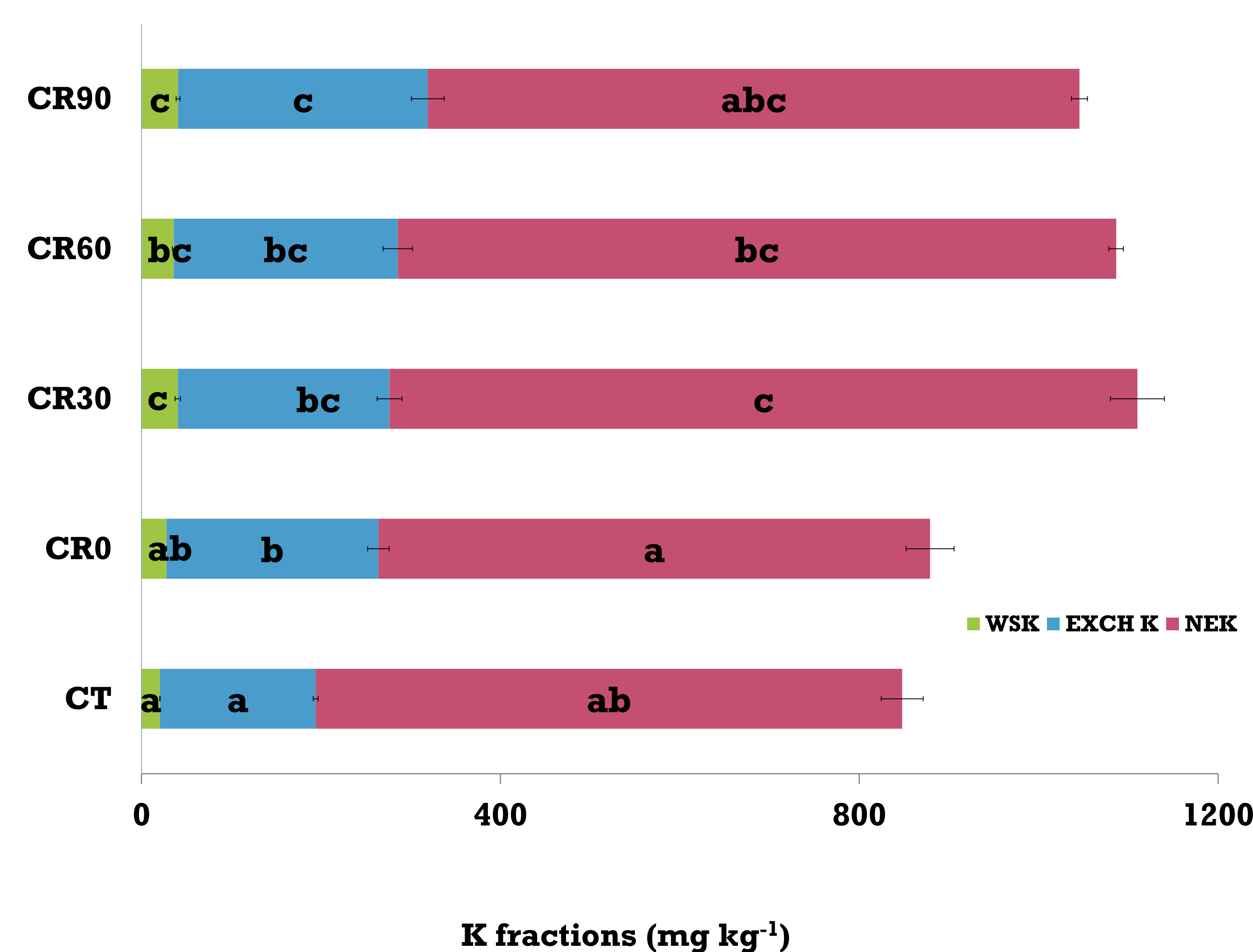
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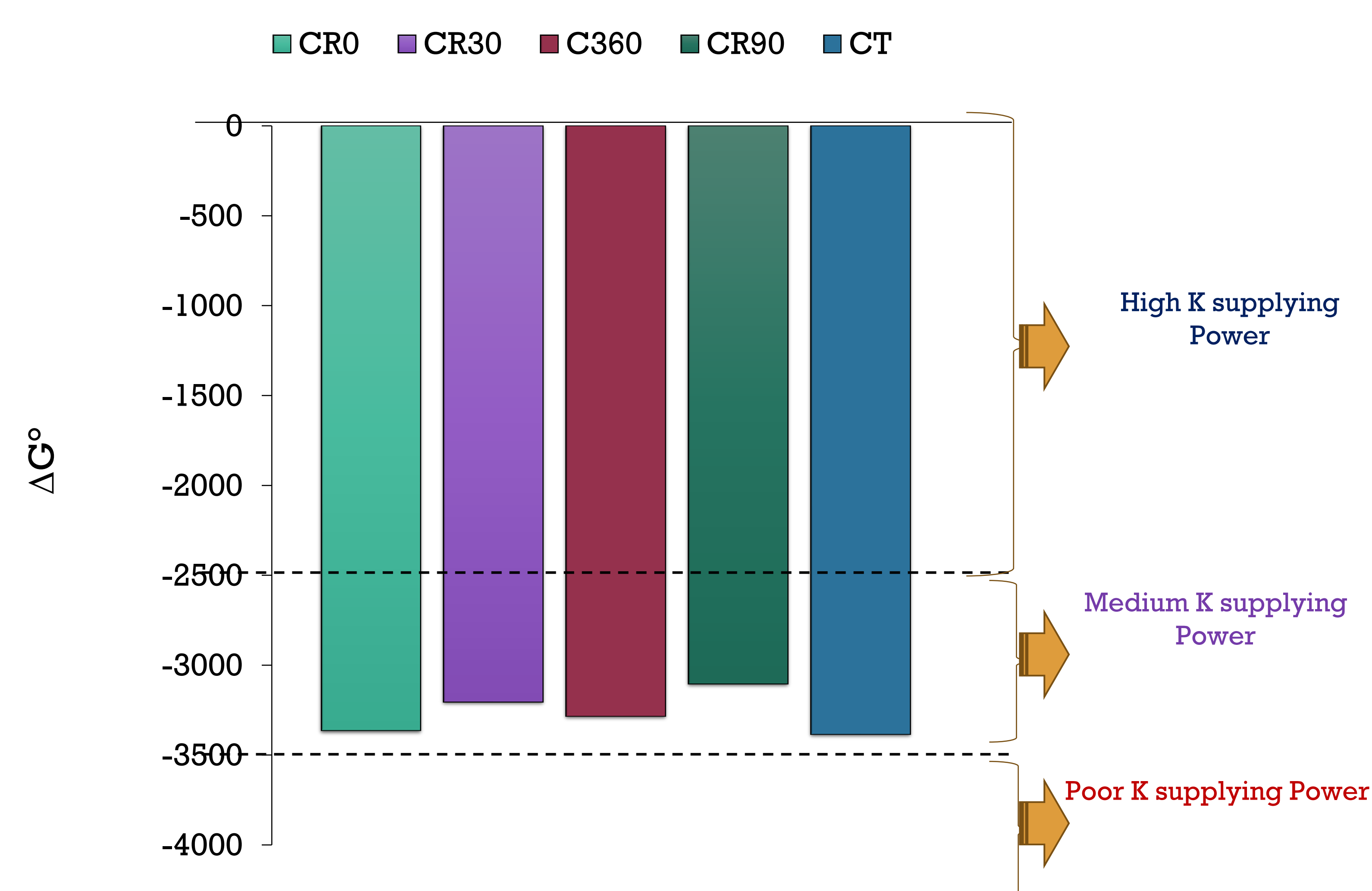
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Impact of levels of residue retention on potassium availability and quantity-intensity relationship under conservation agriculture

- Soil samples (0-10cm depth) were collected after harvest of Maize from consortia research platform on conservation agriculture (CRP on CA). Soil K fractionation and Q-I study was carried out under 5 treatments viz. zero tillage (ZT) with 0%, 30%, 60% and 90% residue retention (CR0, CR30, CR60, CR90) and conventionally tilled plots without residue (CT)
- After 5 years of CA, ammonium acetate extractable K (WSK+EXCH K) and NEK significantly improved with residue addition in CR30, CR60 and CR90 as compared to CT and CR0
- Both immediate and long-term supply of K intensity factor (CRe^{0K}) and quantity factor (labile K, planar K and specifically held K) is improving with increase in residue addition over CT. PBC^K is observed to be almost constant for all treatments
- All CA based treatments was categorized into medium K supplying capacity soils (based on ΔG°) but CR90 with the lowest negative value of ΔG° highlighted its potential to shift towards high K supplying capacity
- While CT was categorized as poor K supplying capacity soils (with highest negative ΔG°) highlighting the importance of residue addition over long term for maintaining K supply



	Planar K (K ₀) (cmol kg ⁻¹)	Specifically held K (K _X) (cmol kg ⁻¹)	Labile K (K _L) (cmol kg ⁻¹)	CRe^{0K*1} 0 ⁻³ [(mol L ⁻¹) ^{1/2}]	PBC^K [cmol kg ⁻¹ (mol L ⁻¹) ^{-1/2}]	ΔG° (cal mol ⁻¹)
CR0	0.832	0.526	1.358	3.36	248	-3361
CR30	0.854	0.782	1.636	4.40	194	-3202
C360	0.921	0.867	1.788	3.85	239	-3280
CR90	1.123	0.794	1.917	5.22	214	-3101
CT	0.797	0.308	1.105	3.25	245	-3380



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Farmer resource–based participatory integrated nutrient management for sustaining soybean–wheat productivity

TECHNOLOGY SUMMARY

- A participatory technology development (PTD) program of ICAR-IISS Bhopal identified low adoption of the recommended Integrated Plant Nutrient Supply (IPNS) package in the soybean–wheat system of Madhya Pradesh due to inadequate availability of farmyard manure (FYM)
- The original IPNS recommendation included
 - Soybean: 5 t ha⁻¹ FYM, Rhizobium biofertilizers (R33 & R34, 4 kg ha⁻¹), and 50% NPK of the General Recommended Dose (GRD)
 - Wheat: PGPR biofertilizers (P3 & P10, 4 kg ha⁻¹) and 75% NPK of GRD
- Farmers were unable to adopt IPNS system mainly because the non availability of required quantity of FYM
- Realizing the on-farm availability of crop residue and other biodegradable farm waste IPNS recommendation was modified integrating enriched compost (IPNS-II)

KEY COMPONENTS OF IPNS-II

- 1) **Residue Recycling:** On-farm crop residues and biodegradable other farm wastes were recycled to produce enriched compost, promoting nutrient reuse and reducing dependence on external organic inputs
- 2) **Soybean Nutrient Management:** Application of enriched compost (2 t ha⁻¹) + biofertilizer (Rhizobium @ 4 kg ha⁻¹) + 50% NPK of GRD as basal
- 3) **Wheat Nutrient Management:** Application of PGPR biofertilizers (@4 kg ha⁻¹) + 75% of GRD NPK application

FIELD EVALUATION

- The participatory technology was evaluated against Farmers' practice (1 t ha⁻¹ FYM + nitrogenous and phosphatic fertilizers) for three consecutive years (2013-2016) across nine farmers' fields in Bhopal district, Madhya Pradesh

RESULTS

- **YIELD**
 - Crop yields improved for soybean and wheat crops with IPNS-II. Soybean seed yield increased by 26% over FP (from 9.2 to 11.6 q ha⁻¹) and Wheat grain yields increased by 19% (from 35.1 to 41.7 q ha⁻¹)
 - The average yield of the soybean-wheat system recorded as 66.3 q ha⁻¹ from IPNS-II and 54.3 q ha⁻¹ from FP, showing an overall yield increase of 22.1% from the cropping system
- **NET INCOME**
 - The average annual net income increase from IPNS-II over FP estimated as 12% for soybean crop and 40.3% for wheat
 - Estimated net income from soybean-wheat system was 68,074 ₹ ha⁻¹ from IPNS-II and 46,668 ₹ ha⁻¹ from FP (31.2% increase over FP)

Table 1. Yield of Soybean and Wheat crops under Enriched Compost-based IPNS and Farmers' Practice

Category	Average Yield (q/ha)			
	Soybean		Wheat	
	IPNS-II	FP	IPNS-II	FP
Farm 1	12.1	10.1	37.0	32.0
Farm 2	8.2	7.2	42.4	31.8
Farm 3	13.0	9.4	40.6	35.3
Farm 4	13.5	13.1	41.6	36.0
Farm 5	11.5	9.3	47.3	39.7
Farm 6	15.4	10.6	46.7	40.9
Farm 7	13.9	10.6	42.7	38.1
Farm 8	6.2	4.5	42.4	31.6
Farm 9	10.4	8.2	34.2	30.0
Mean ± SD	11.6 ± 2.9	9.2 ± 2.4	41.7 ± 4.2	35.1 ± 3.9
CD (5%)	1.06	1.06	1.92	1.92

Category	Average Annual Net Income (₹/ha)	
	IPNS-II	FP
Farm 1	63,019.00	45,216.00
Farm 2	63,416.00	45,415.00
Farm 3	71,787.00	47,218.00
Farm 4	72,767.00	58,378.00
Farm 5	76,189.00	51,808.00
Farm 6	87,183.00	56,704.00
Farm 7	75,789.00	53,279.00
Farm 8	51,723.00	27,188.00
Farm 9	50,796.00	34,982.00



Identification of Nitrogen efficient wheat cultivars for Vertisols

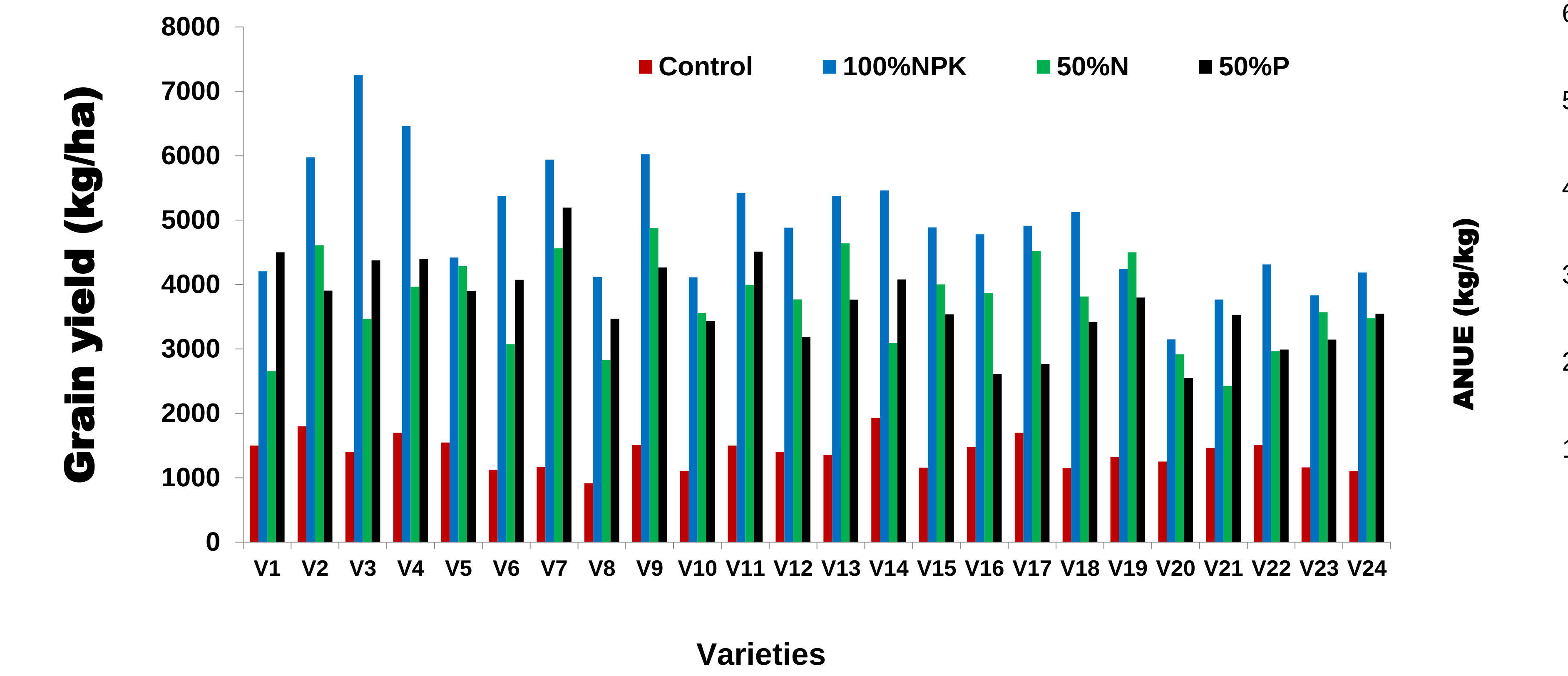
- Wheat genotypes (121 nos) were assessed for nitrogen use efficiency traits including morpho-physiological, growth and yield parameters
- 20 genotypes were selected based on yield and Agronomic Nitrogen Use Efficiency (ANUE) traits and evaluated along with four checks (HI 1544, Lok1, C306 & Sujata) under 0%, 50% and 100% recommended dose of nitrogen
- Higher ANUE (50 kg/kg of applied N) under lower dose of N (50%) was observed in genotypes HI 1605, HI 1531, HI 8498 and DBW 88. ANUE ranged from 16-56 kg/kg in the selected genotypes under low dose of N
- High Intrinsic water use efficiency (>100 µmol/mol) was observed under lower dose of nutrient application in 13 selected genotypes (HI 8663, HI 8737, HI 8713, HI 1563, HI 1544, HI 1605, GW 322, GW 366, Lok1, BWL 5172, HD 2687, Narbada 4, Sujata) (Range: 65-170 µmol/mol)
- The efficient genotypes are the most useful as they yield well under low soil N conditions.

Indigenous and exotic genotypes of wheat					
1 HI8777	21 HD2864	41 NP824	61 MP01259	81 MACS6145	101 HUW206
2 HI8663	22 HI8381	42 IWP72	62 AKW4731	82 WESTONIA	102 DBW43
3 HI8737	23 HD2932	43 PW761	63 BWL4417	83 NP890	103 CHIRYA3
4 HI8713	24 MP3336	44 K9107	64 WH147	84 VL616	104 BWL5233
5 HI8759	25 SUJATA	45 NP710	65 NANJING8611	85 GAMENYA	105 BWL5487
6 HI1563	26 NARMADA 14	46 HD2824	66 WH1022	86 WB2	106 HPW226
7 HI1544	27 GW173	47 NI5439	67 HD1981	87 LUAN	107 GUTHA
8 HI1605	28 HD2930	48 HPW147	68 HD2329	88 NARBADA4	108 BWL4431
9 HD2987	29 A9301	49 PBW723	69 HD2967	89 KENPHAD39	109 BANKS
10 HI1531	30 MP4010	50 K8027	70 HW2004	90 RAJ4102	110 BWL4433
11 C306	31 HD2808	51 HPW155	71 DBW39	91 PBN4364	111 CWCWPRE
12 MALWASHRI	32 NP715	52 PBW343	72 BT SCHMOBURGK	92 WH1105	112 SANSTATE
13 GW322	33 BWL5172	53 HD2833	73 BWL4424	93 RAJ4248	113 HUW318
14 GW366	34 DBW88	54 HPW251	74 GOLDMARK	94 HD2687	114 OLYMPIC
15 HI1612	35 SAFED LERMA	55 PBW725	75 HINDI62	95 MACS6222	115 HD2781
16 HI8498	36 NIAW34	56 UP262	76 NP846	96 PBW502	116 HD3086
17 HI1500	37 DPW62150	57 LOK66	77 BWL5429	97 LIRA/TAN	117 HB208
18 JW1202	38 NI917	58 PWL6195	78 NP792	98 KRICHAUFF	118 WL410
19 HD2932	39 PBW373	59 RAJ1972	79 ATTILA	99 HYB65	119 HD2851
20 LOK1	40 PBW744	60 CRANBROOK	80 PBW394	100 K53	120 HW2045
					121 HD2733

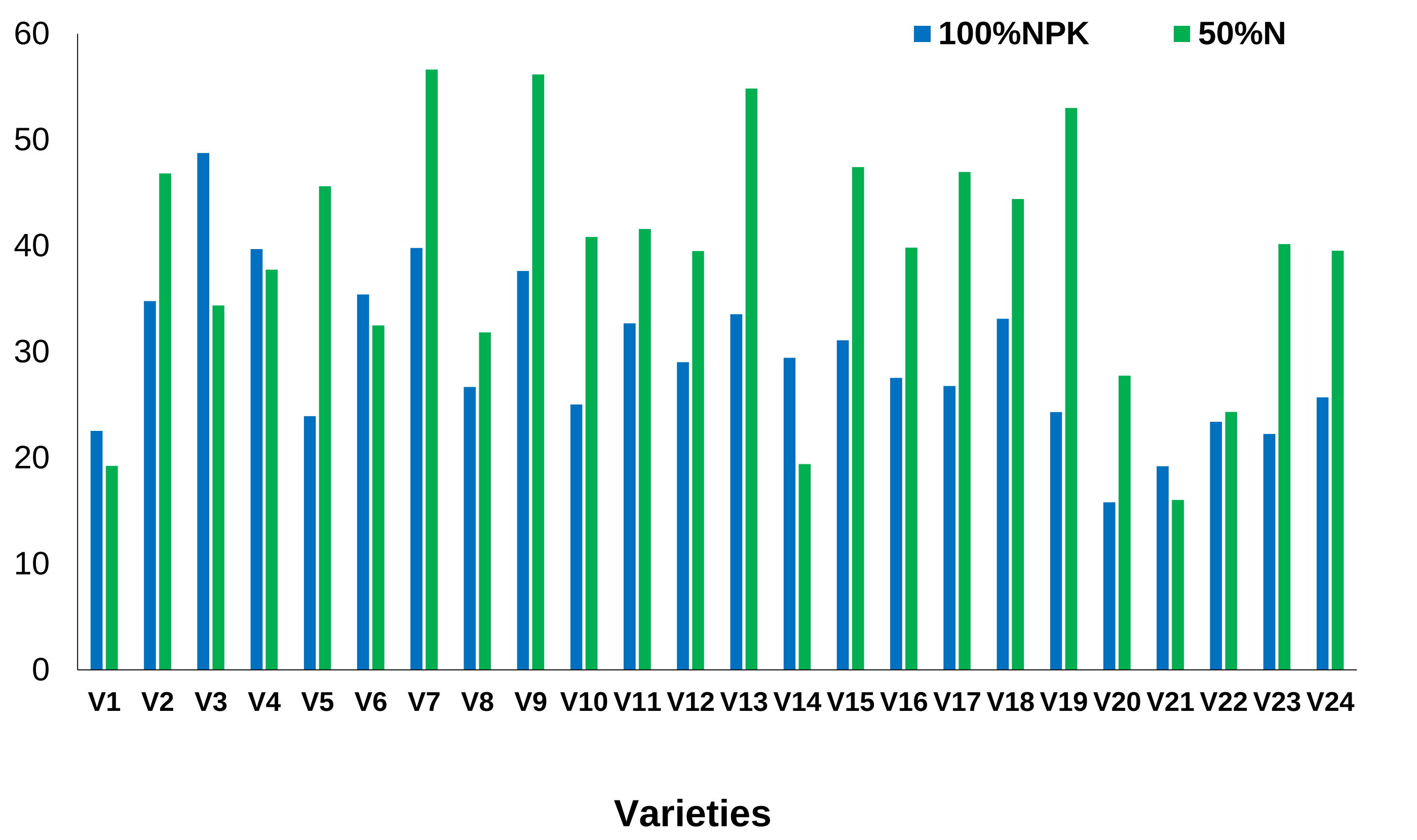
Selected 20 genotypes and four checks

V1	HI 8663	V13	HI 8498
V2	HI 8737	V14	HI 1500
V3	HI 8713	V15	Lok 1
V4	HI 8759	V16	SUJATA
V5	HI 1563	V17	NARMADA 14
V6	HI 1544	V18	BWL 5172
V7	HI 1605	V19	DBW 88
V8	HD 2987	V20	NIAW 34
V9	HI 1531	V21	HINDI 62
V10	C 306	V22	NARBADA 4
V11	GW 322	V23	HD 2687
V12	GW 366	V24	BWL 5233

Source: 1 to 10 IARI RS Indore, 11-20 IISS Bhopal, 21-30 RVSKVV Gwalior, 31-121 IARI New Delhi
T aestivum =112; T durum =9 & Exotic =28



Four checks shown in red colour font



For low N: V2 HI 8737, V3 HI 8713, V4 HI 8759, V5 HI 1563, V6 HI 1544, V7 HI 1605, V9 HI 1531, V11 GW 322, V13 HI 8498, V15 Lok1, V18 BWL 5172 (AE > 30 kg/kg)



भारतीय मृदा विज्ञान संस्थान

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नबीबाग बैरसिया रोड, भोपाल (म.प्र.) - 462 038

Nabibagh, Berasia Road, Bhopal (M.P.) - 462 038

Identification of Phosphorus efficient wheat cultivars for Vertisols

- Wheat genotypes (121 nos) were assessed for phosphorus use efficiency traits including morpho-physiological, growth and yield parameters
- 20 genotypes were selected based on yield and Agronomic Phosphorus Use Efficiency (APUE) traits and evaluated along with four checks (HI 1544, Lok1, C306 & Sujata) under 0%, 50% and 100% recommended dose of phosphorus
- Higher APUE (30 kg/kg of applied P) under lower dose of P (50%) was observed in genotypes HI 8663, HI 8737, HI 8713, HI 1531 and Narmada 14. APUE ranged from 21-60 kg/kg among genotypes under low dose of P
- The efficient genotypes are the most useful as they yield well under low soil P conditions

Indigenous and exotic genotypes of wheat

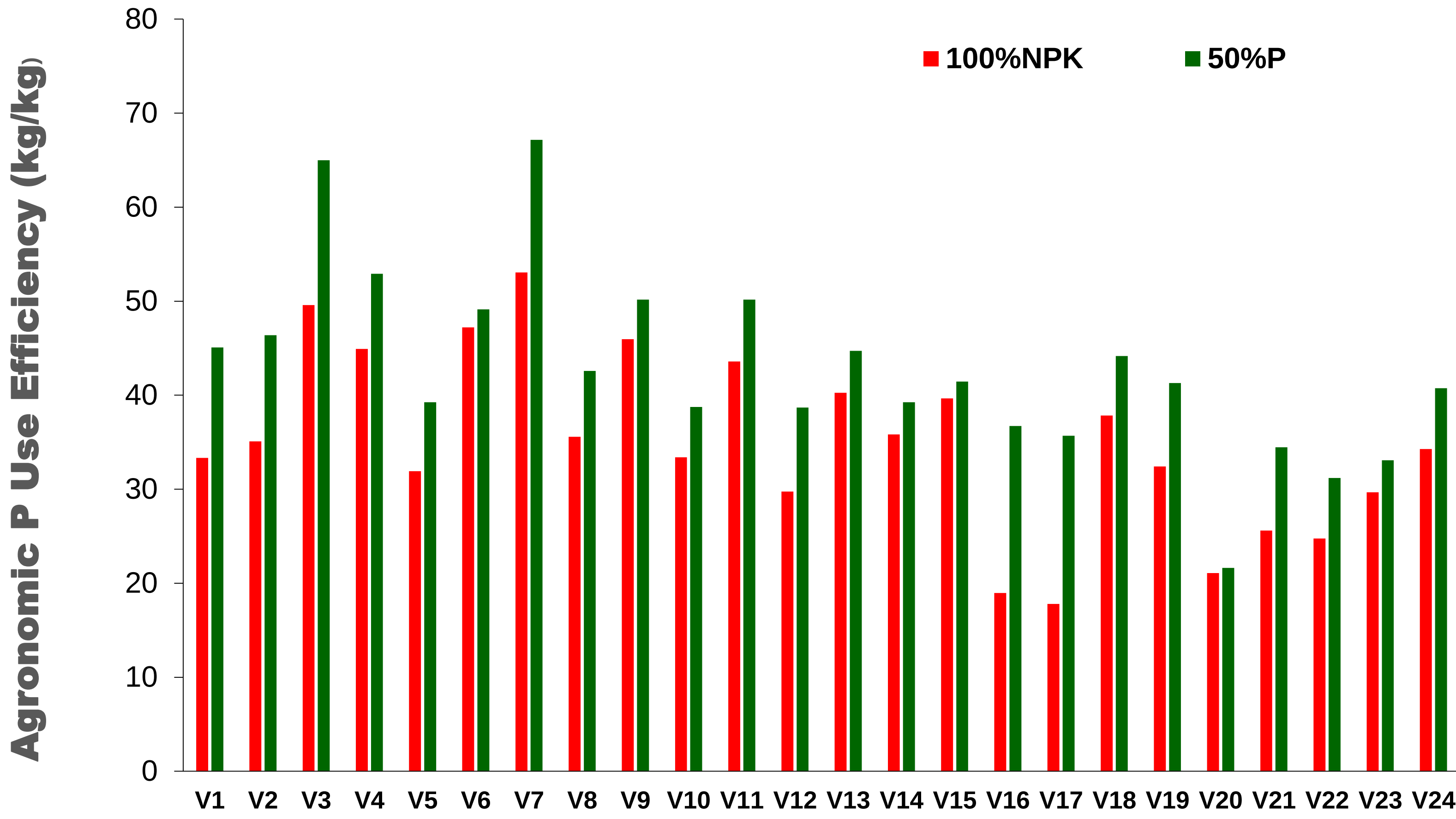
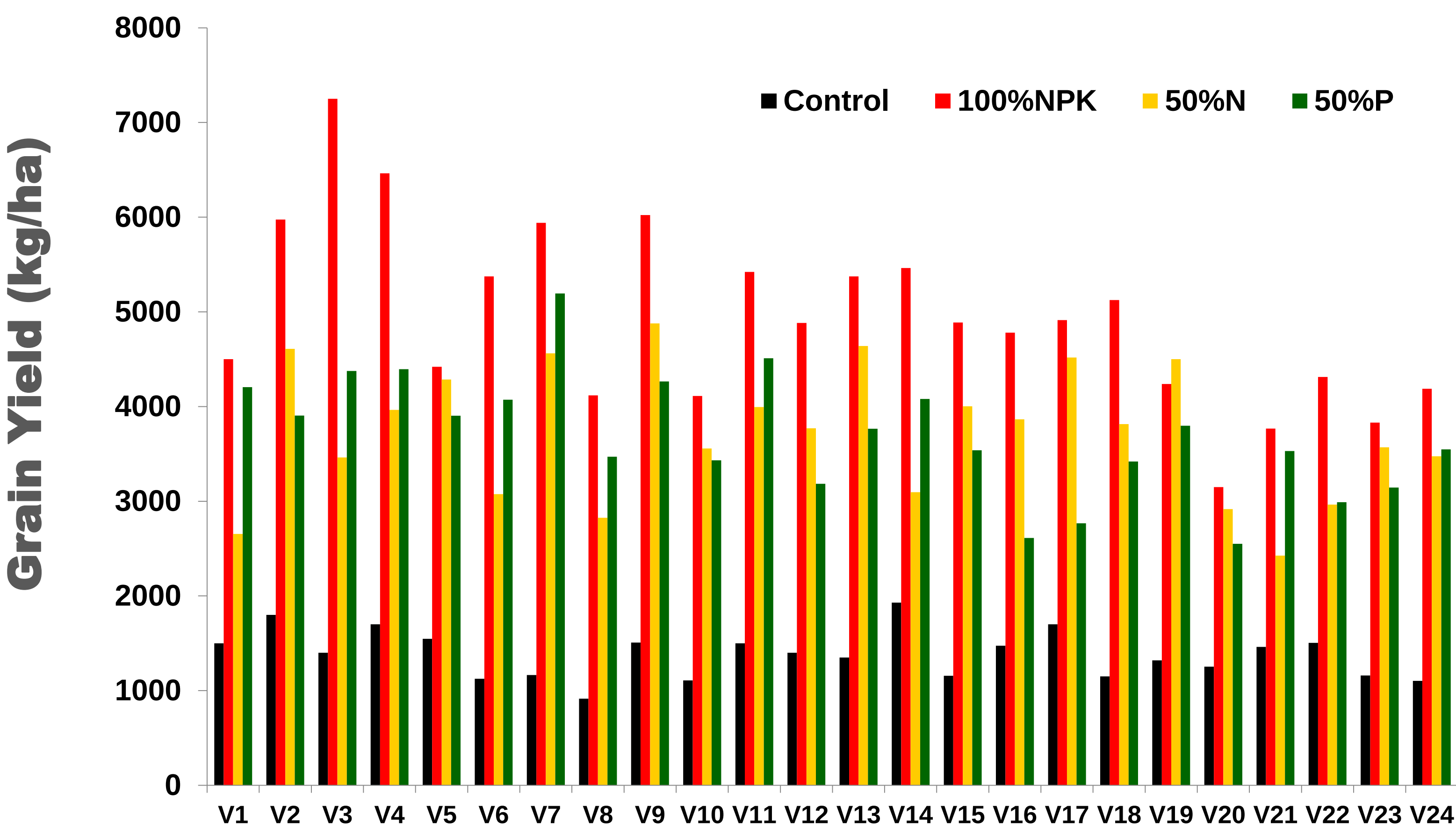
1 HI8777	21 HD2864	41 NP824	61 MP01259	81 MACS6145	101 HUW206
2 HI8663	22 HI8381	42 IWP72	62 AKW4731	82 WESTONIA	102 DBW43
3 HI8737	23 HD2932	43 PW761	63 BWL4417	83 NP890	103 CHIRYA3
4 HI8713	24 MP3336	44 K9107	64 WH147	84 VL616	104 BWL5233
5 HI8759	25 SUJATA	45 NP710	65 NANJING8611	85 GAMENYA	105 BWL5487
6 HI1563	26 NARMADA 14	46 HD2824	66 WH1022	86 WB2	106 HPW226
7 HI1544	27 GW173	47 NI5439	67 HD1981	87 LUAN	107 GUTHA
8 HI1605	28 HD2930	48 HPW147	68 HD2329	88 NARBADA4	108 BWL4431
9 HD2987	29 A9301	49 PBW723	69 HD2967	89 KENPHAD39	109 BANKS
10 HI1531	30 MP4010	50 K8027	70 HW2004	90 RAJ4102	110 BWL4433
11 C306	31 HD2808	51 HPW155	71 DBW39	91 PBN4364	111 CWCWPRE
12 MALWASHRI	32 NP715	52 PBW343	72 BT SCHMOBURGK	92 WH1105	112 SANSTATE
13 GW322	33 BWL5172	53 HD2833	73 BWL4424	93 RAJ4248	113 HUW318
14 GW366	34 DBW88	54 HPW251	74 GOLDMARK	94 HD2687	114 OLYMPIC
15 HI1612	35 SAFED LERMA	55 PBW725	75 HINDI62	95 MACS6222	115 HD2781
16 HI8498	36 NIAW34	56 UP262	76 NP846	96 PBW502	116 HD3086
17 HI1500	37 DPW62150	57 LOK66	77 BWL5429	97 LIRA/TAN	117 HB208
18 JW1202	38 NI917	58 PWL6195	78 NP792	98 KRICHAUFF	118 WL410
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Selected 20 genotypes and four checks

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V7	HI 1605	V19	DBW 88
V8	HD 2987	V20	NIAW 34
V9	HI 1531	V21	HINDI 62
V10	C 306	V22	NARBADA 4
V11	GW 322	V23	HD 2687
V12	GW 366	V24	BWL 5233

(Four Checks shown in red colour font)



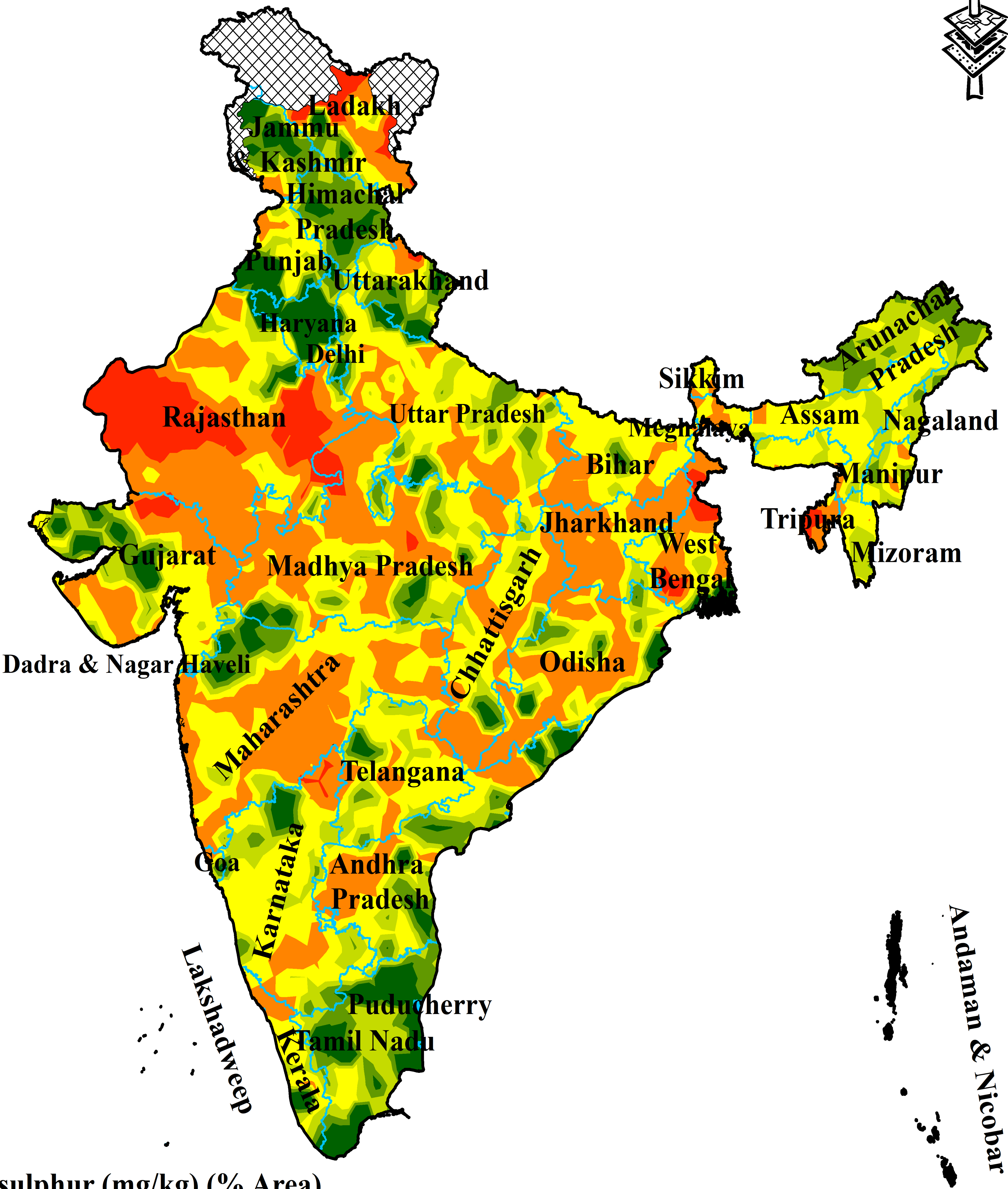
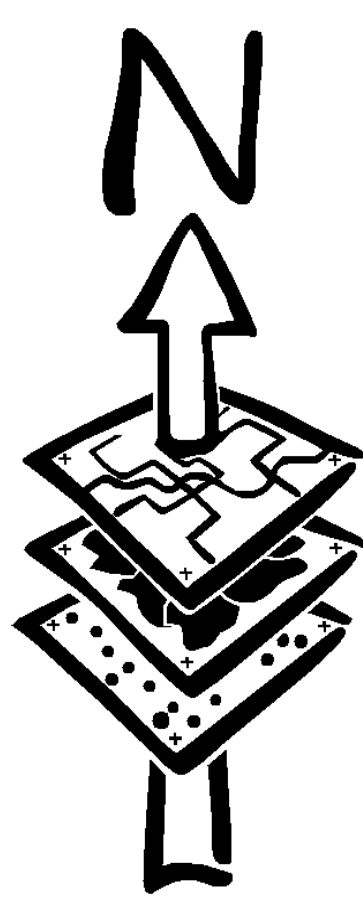
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Spatial distribution of available sulphur
in soils of India

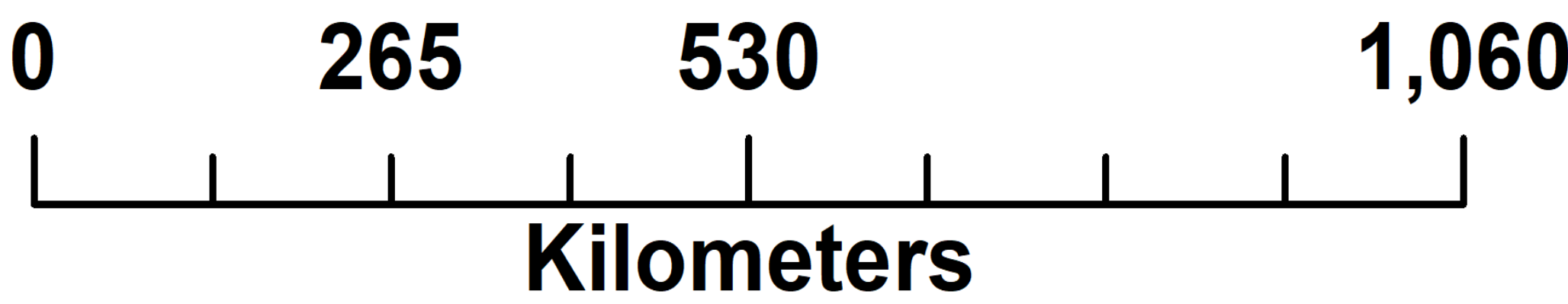


Legend

Available sulphur (mg/kg) (% Area)

- ≤ 7.5 Acute Deficient (4.8%)
- > 7.5 to ≤ 15.0 Deficient (29.6%)
- > 15.0 to ≤ 22.5 Latent Deficient (32.8%)
- > 22.5 to ≤ 30.0 Marginally Sufficient (15.9%)
- > 30.0 to ≤ 40.0 Adequate (10%)
- > 40.0 High (6.9%)

- India boundary
- State boundary
- Data not available



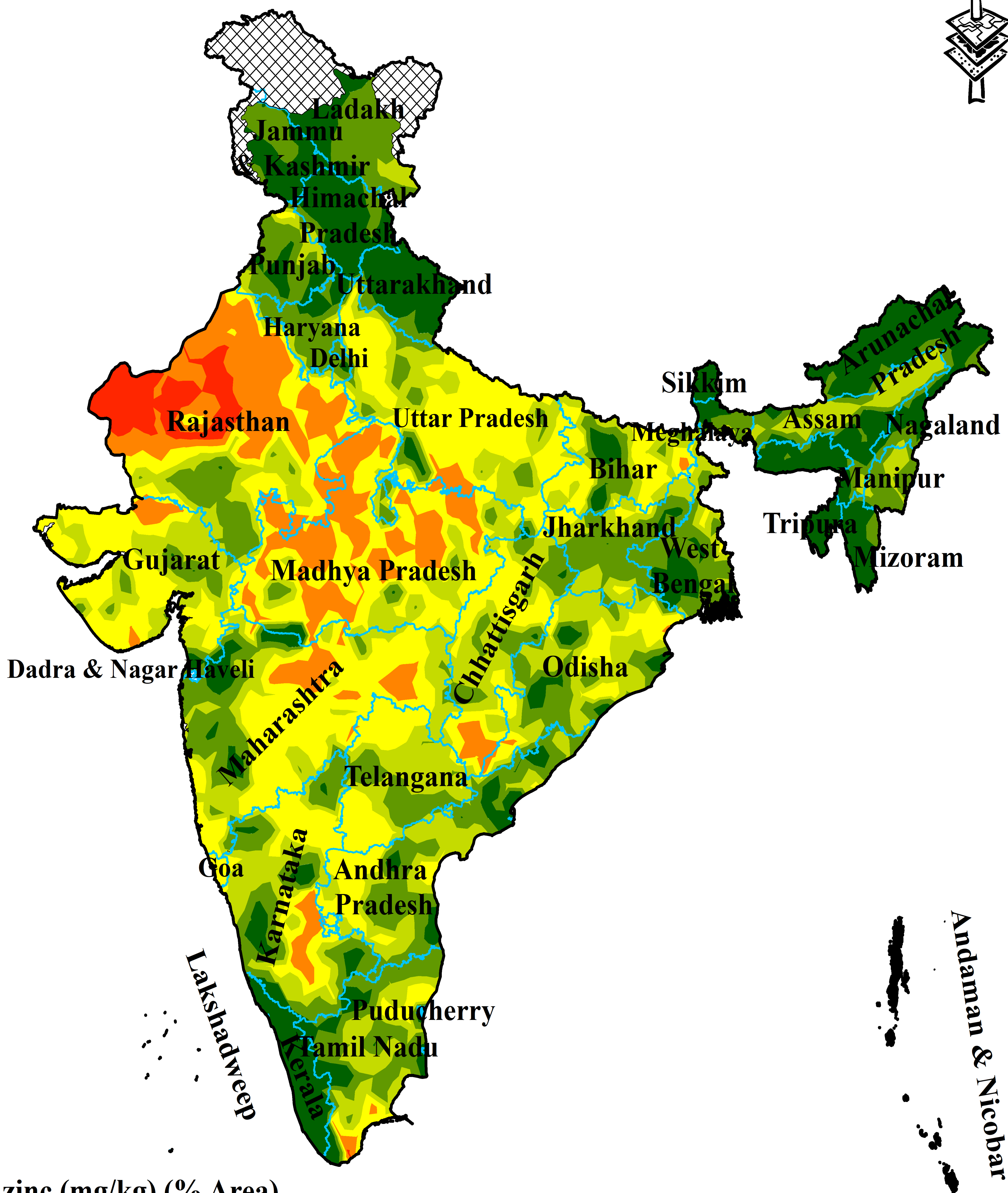
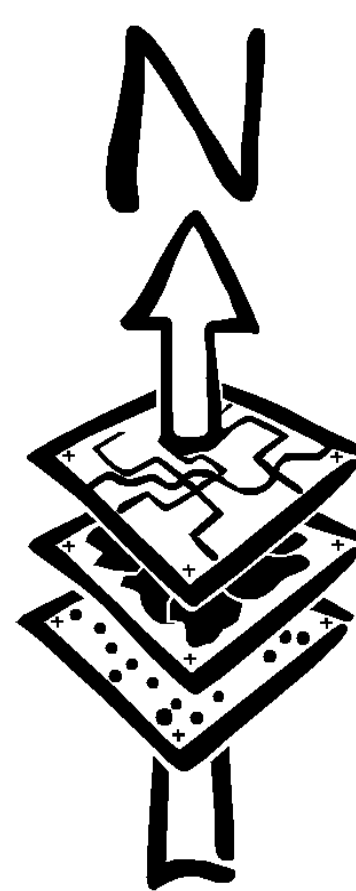
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Spatial distribution of available zinc in soils of in India

Spatial distribution of available zinc in soils of India



Legend

Available zinc (mg/kg) (% Area)

- ≤ 0.3 Acute Deficient (2.0 %)
- > 0.3 to ≤ 0.6 Deficient (9.8%)
- > 0.6 to ≤ 0.9 Latent Deficient (26.4%)
- > 0.9 to ≤ 1.2 Marginally Sufficient (23%)
- > 1.2 to ≤ 1.8 Adequate (23.1 %)
- > 1.8 High (15.7 %)

- India boundary
- State boundary
- Data not available

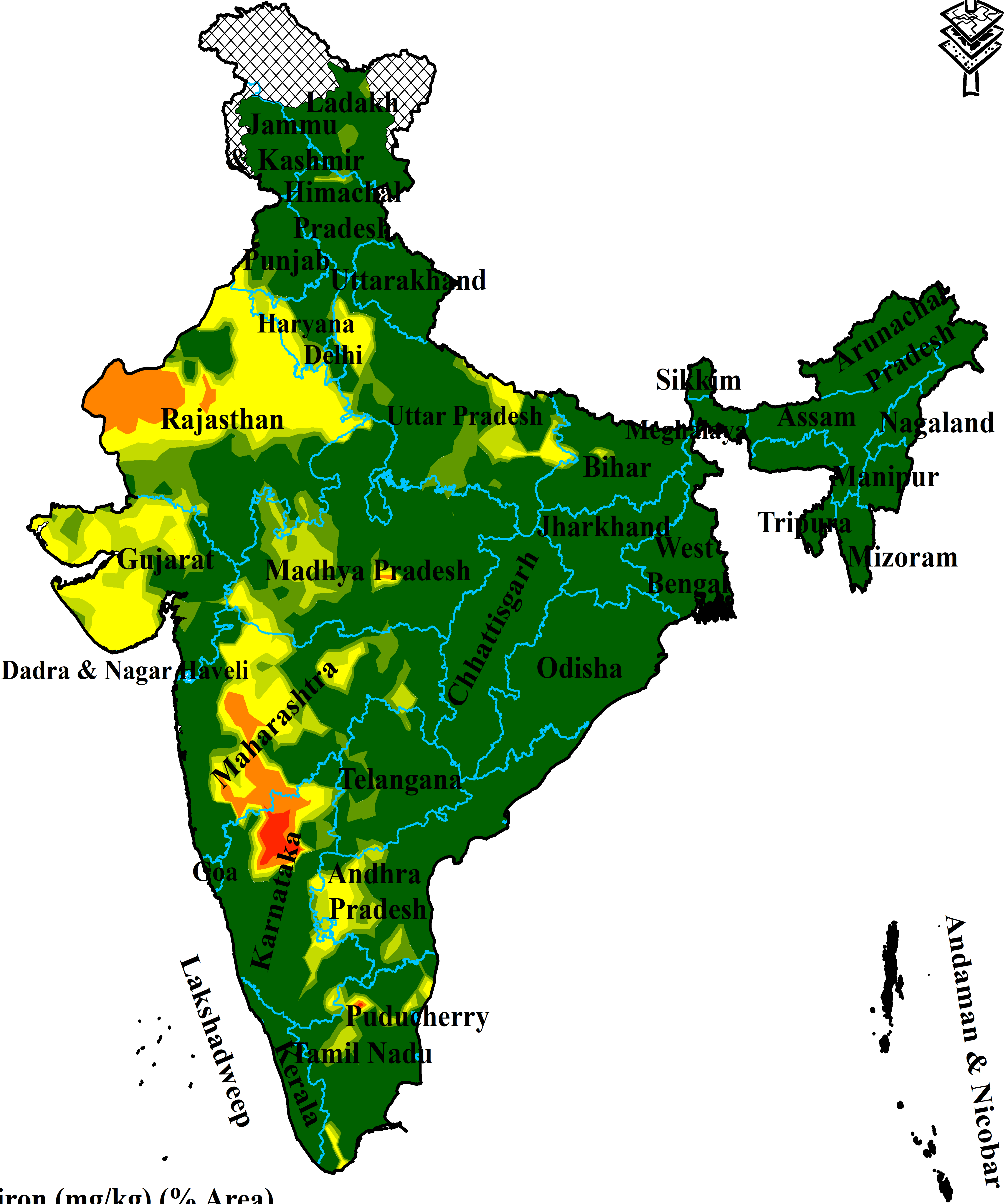
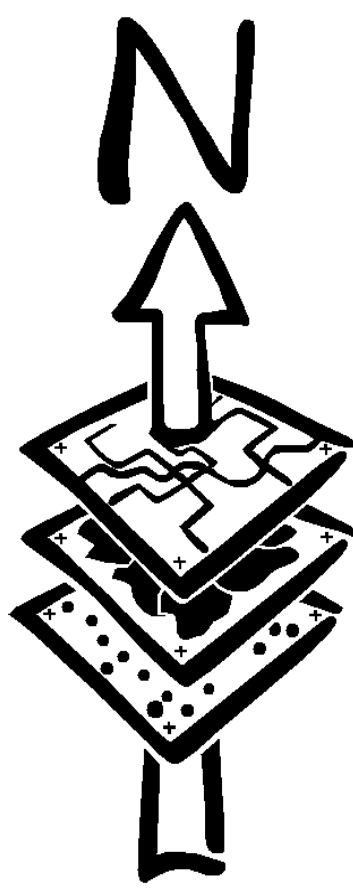
0 265 530 1,060
Kilometers

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Spatial distribution of available iron
in soils of India

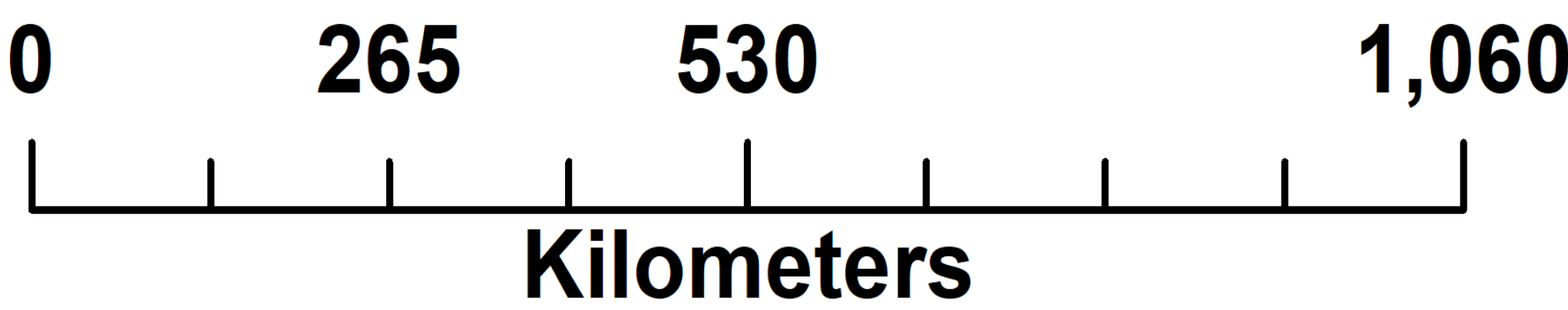


Legend

Available iron (mg/kg) (% Area)

- ≤ 2.5 Acute Deficient (0.3%)
- > 2.5 to ≤ 4.5 Deficient (2.5%)
- > 4.5 to ≤ 6.5 Latent Deficient (9.5%)
- > 6.5 to ≤ 8.5 Marginally Sufficient (6.9%)
- > 8.5 to ≤ 10.5 Adequate (8.3%)
- > 10.5 High (72.5%)

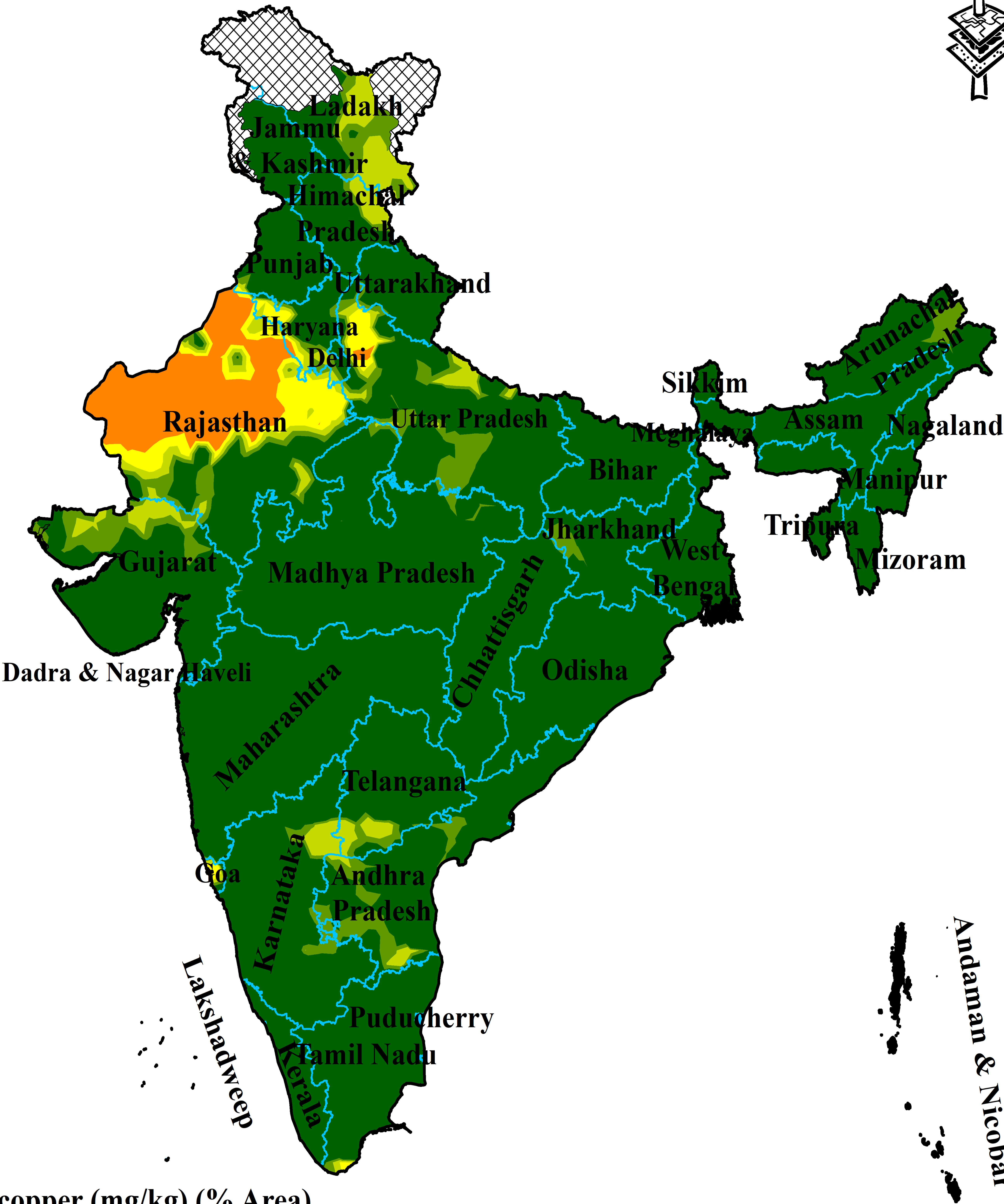
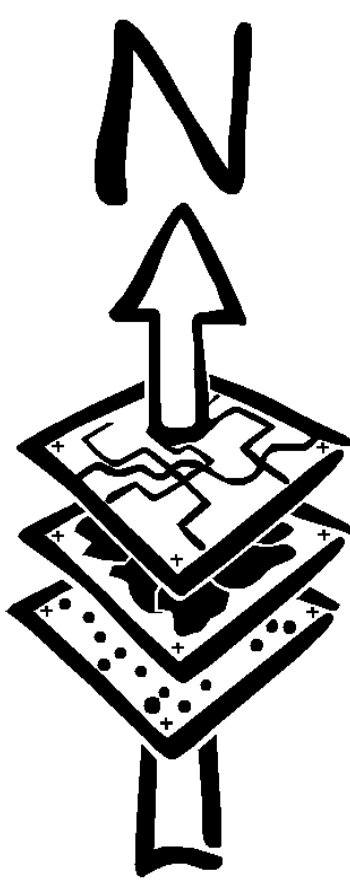
- India boundary
- State boundary
- Data not available



AICRP-MSPE , ICAR-IISS , Bhopal



Spatial distribution of available copper
in soils of India



Legend

Available copper (mg/kg) (% Area)

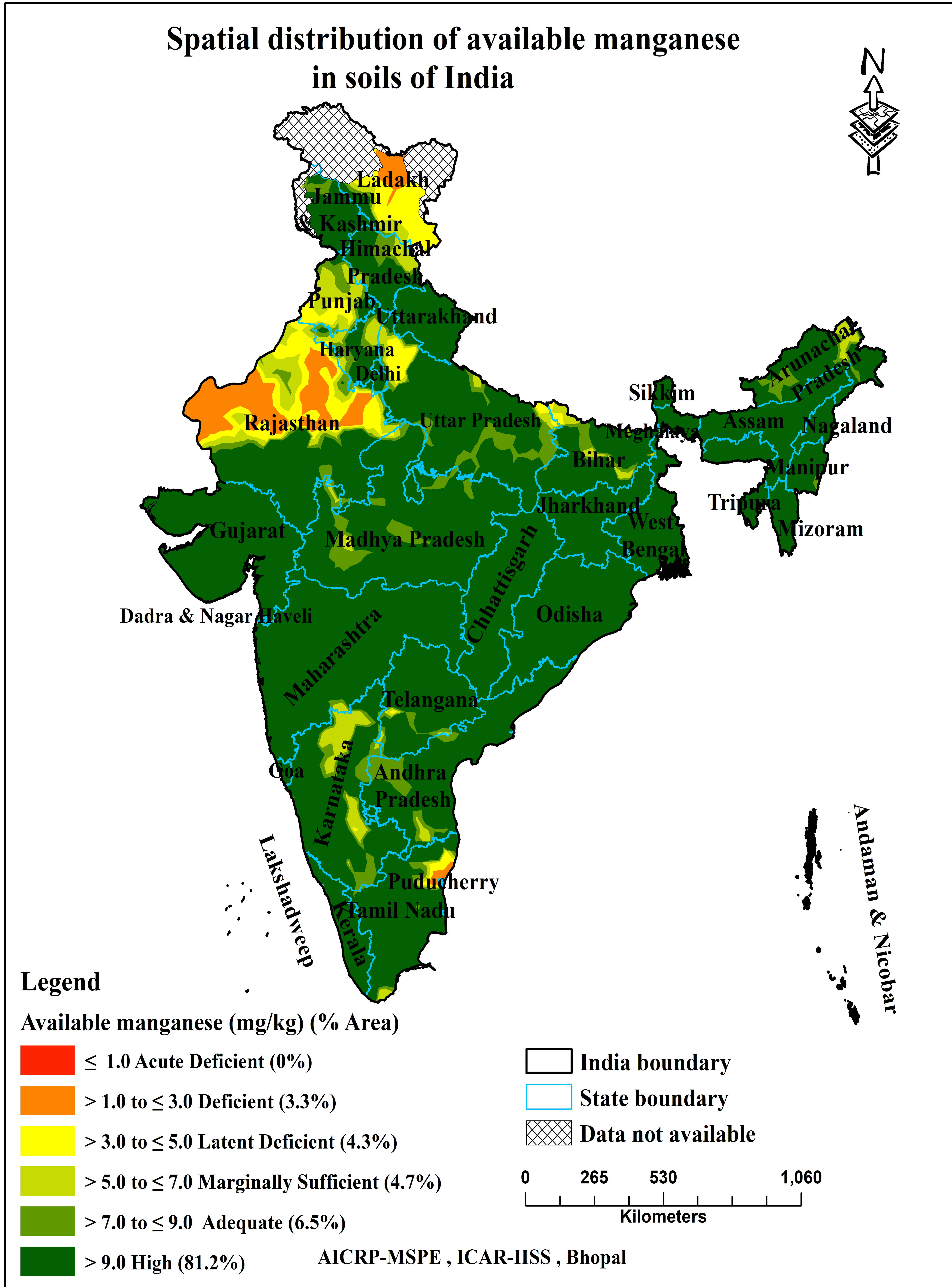
- ≤ 0.2 Acute Deficient (0%)
- > 0.2 to ≤ 0.4 Deficient (4.5%)
- > 0.4 to ≤ 0.6 Latent Deficient (2.2%)
- > 0.6 to ≤ 0.8 Marginally Sufficient (3.7%)
- > 0.8 to ≤ 1.0 Adequate (6%)
- > 1.0 High (83.6%)

- India boundary
- State boundary
- Data not available

0 265 530 1,060
Kilometers

AICRP-MSPE , ICAR-IISS , Bhopal





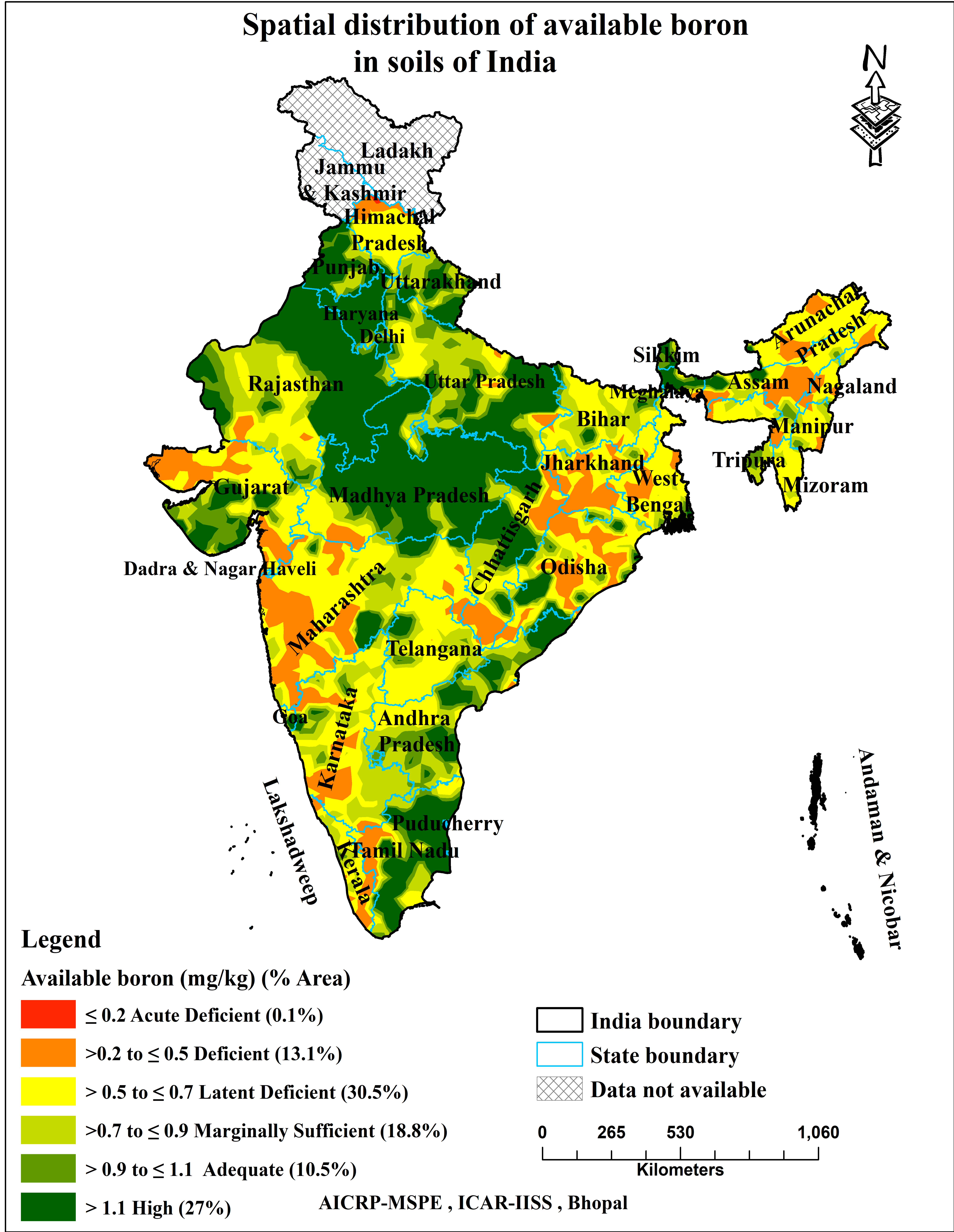
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Spatial distribution of available boron in soils of in India



For More Details Contact

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Fax: 0755-2733310, email: director.iiss@icar.org.in