AICRP - MICRONUTRIENTS

Objectives

1. To reassess micronutrient status of soils in the state of Uttarakhand.
2. To refine critical values of micro and secondary nutrients in soils and standardization of soil test methods.
3. To standardize of concentration and frequency of foliar sprays of micronutrient solutions for combating their deficiency in field and horticulture crops.
4. To study micronutrients in soil-plant-animal continuum.

1. Significant Achievements:

Delineation of micronutrient deficient areas in the state

- GPS based micronutrient status mapping of all districts of Uttarakhand has been completed. Based on this work, a booklet on the status and recommendation of micro- and secondary nutrients in Uttarakhand has also been published.

  डा0 प्रकाश चन्द्र श्रीवास्तव, डा0 सत्य प्रताप पचौरी एव अरविंद कुमार शुक्ला (2018). उत्तराखण्ड में सूक्ष्म एवंगौण–पोषक तत्वों का स्तर और संतुतियाँ, द्वितीय संस्करण, मृदा विज्ञान विभाग, गोविन्द बल्लभ पंत कृषि एव ंप्रौद्योगिक विश्वविद्यालय, पन्तनगर–263145

- In regional survey of litchi orchards of Uttarakhand comprising Nainital, Champawat, U. S.Nagar, Dehradun and Haridwar districts, the leaf nutrient concentrations in fruiting and non-fruiting terminal were determined along with yields. The diagnosis of nutrient imbalance through DRIS indices indicated that S was the most yields limiting nutrient among major nutrients in the low yielding orchards. The DRIS indices also indicated that N and P were limiting yield only in certain orchards. Among the micronutrients, Zn, Mo and B were found to be the most yield-limiting nutrients in FT of different orchards.

  The low content of micronutrients in many orchards could be attributed to the high pH, presence of high calcium carbonate content resulting in low availability of micronutrients. Thus, S was found to be the most common yield-limiting nutrient among the major nutrients followed by micronutrients like Zn, Mo and B.

Nutrient indexing in areas of intensive cropping

- Nutrient indexing of soils and crops in areas of intensive agriculture under different cropping systems and management practices in Nainital district in which rice-wheat and sugarcane-sugarcane cropping systems were undertaken. In general, the removal of N under sugarcane-wheat system was relatively higher due to high use of organic manures and higher yields as compared to other years. The uptake of micronutrients was higher under rice-wheat as compared to sugarcane-wheat rotation possible because of lowland rice cultivation.

Establishment of critical limits of micronutrients in soil and plant

- Critical limits of Zn in rice, wheat and of B in rice, maize, mustard and sunflower have been established.
- Threshold toxic limits of Ni and Cd in french bean, amaranthus, fenugreek, buckwheat have also been established.

Amelioration of micronutrient deficiencies in crops

- A three-year field experiment on developing IPNS technology for ameliorating zinc deficiency in sugarcane- ratoon system at Mundia, Distt. Bareilly showed that the total millable cane yield of both main and ratoon crop combined application

of 2.5 t PMC along with 25.0 kg $ZnSO_4$ /ha produced 194.27 t mill-able cane/ha which was statistically *at par* with the highest mill-able cane yield (196.41 t/ha) recorded for treatment receiving 10 t PMC + 50 kg Zn SO_4/ha.

- Two-year field experiment on enhancement of micronutrient content in seed and straw by foliar feeding of Basmati rice-wheat crops was set-up at Pantnagar in July, 2007. Foliar spray of micronutrients under T2 increased the grain yield of Basmati rice significantly by 15.8% in 07-08 and by 13.1% in 08-09 over the control. In the case of subsequent wheat crop, foliar spray of micronutrients under T4 increased the grain yield of wheat significantly by 19.6% in 07-08 but no yield increase was noted in 08-09 over control.
- Four -year field experiment on developing IPNS technology for ameliorating zinc deficiency with crop residue management in rice-wheat system was set-up at Pantnagar. Among different treatments, application of 25.0 kg $ZnSO_4$ /ha to I year rice crop gave a cumulative grain yield of rice and wheat of 399.17 q/ha during four crop cycles while cycling incorporation of cereal crop residues @ 1.5 t/ha + 25.0 kg $ZnSO_4$ /ha to I year rice crop gave a cumulative grain yield of rice and wheat of 410.58 q/ha during the same period.
- A six-year field experiment on effect of phasing of B application on fate of B pools in mollisols and rice-wheat cropping system was set-up at Pantnagar in July, 2012. On the basis of cumulative grain yields of rice and wheat during six years of experimentation, it may be concluded that application of 1.5 kg B as borax/ha to rice crop on alternate years was the best practice in Mollisols as it resulted in 33.06 t of rice grain and 25.65 t of wheat grain/ha. This practice helped to maintain the optimum level of B in soil.
- A six -year field experiment was initiated in Kharif, 2012 to examine the effect of phasing of Zn application on fate of Zn pools in mollisol and rice-wheat cropping system. On the basis of cumulative grain yields of rice and wheat during six years of experimentation, it may be concluded that application of 7.5 kg Zn as zinc sulphate/ha to rice crop on alternate years was the best practice in Mollisols as it resulted in 34.0 t of rice grain and 27.2 t of wheat grain/ha. This practice helped to maintain the optimum level of Zn in soil.

Improving efficiency of micronutrient utilization by crops:

- Two -year field experiment on increasing Fertilizer use efficiency of Zn-using low doses of organics in rice-wheat rotation in Mollisol of tarai indicated that application of Zn @ 1.25, 2.5 and 5.0 kg Zn combined with 200 kg cowdung/ha increased the pooled grain yield of rice significantly by 17.62, 26.06 and 24.32 per cent over control, respectively. Application of Zn @ 1.25, 2.5 and 5.0 kg Zn combined with 200 kg cowdung/ha increased the pooled straw yield of rice significantly by 21.13, 31.56 and 22.14 per cent over control, respectively. No

  significant response of Zn application was recorded for subsequent wheat crop.

Improving the utilization efficiency of primary nutrient fertilizers through use of micronutrients

- A field experiment on the effect of Zn fertilizer application method on utilization efficiency of phosphatic fertilizer by Basmati rice-wheat crops was carried out. Application of 40 kg P_2O_5/ha and foliar application of 2.0 kg Zn/ha at 30 and 60 d after transplanting/sowing helped in realizing higher grain yields in basmati rice-wheat rotation. Application of Zn; especially foliar spray help in increasing the utilization effeiciency of applied phosphatic fertilizer.
- A field experiment on effect of Zn fertilizer application on utilization efficiency of phosphatic fertilizer by Basmati rice-wheat crops was carried out at Pantnagar. Application of 2.5 kg Zn and 40 kg P_2O_5/ha gave the highest grain yield (1.96 t/ha) as compared to the control (1.58 t/ha) which was 24 percent higher than control. The grain and straw yields of subsequent wheat crop were not significantly influenced by the treatments, however,

the highest grain yield of wheat (5.14 t/ha) was recorded in the treatment receiving 2.5 kg Zn + 40 kg P_2O_5/ha.

- Application of 40 kg K_2O ha^{-1} in rice and 30 kg K_2O ha^{-1} in wheat along with foliar spray of 2 kg Zn ha^{-1} at 30 and 60 d age helped in achieving higher yields of rice and wheat. Application of potassium appeared to have synergistic effect on zinc nutrition of both crops.

Studies on pollutant elements

- Investigations have been undertaken in the project on chemical transformation of pollutant elements under inorganic and sewage sludge sources under varying moisture regimes.
- Laboratory investigations on kinetics of desorption of pollutant elements have been carried out.
- The critical limits of pollutant elements and use of plants for bioremediation of polluted soils have been carried out.
- Sewage irrigation is used for the cultivation of vegetables, especially cauliflower in Rusi village of District Nainital in Uttarakhand. The general properties of sewage water collected at the entry point in the village and also at varying distances in the distribution channels and also of fresh water were examined during 2013-14. Besides, water surface (0-15 cm) soil samples were collected from sewage irrigated and fresh water irrigated fields. Cauliflower plant samples (edible part and foliage) from sewage irrigated fields and wheat plants from fresh water irrigated fields were collected, processed and analyzed for the contents of essential micronutrients and pollutant- elements.
- Studies on micronutrients and pollutant elements in soil-plant-animal continuum were carried out in the villages of Sitarganj block of Utatrakhand. Soil analysis indicated Zn deficiency in Dumkhera. Rest other micronutrient cations were present in sufficient amounts. The contents of micronutrients in plant/animal feed samples indicated that rice and wheat straw were deficient in Zn and Cu, wheat grains from Dumkhera, Kadakhera, Sidha Nabidya were deficient in Fe and wheat straw collected from Pipalianatu and Dumkhera were deficient in Mn. None of the pollutant elements was present in toxic amounts. The content of Zn in blood plasma of cattle indicated that cattle from most of the villages had low Zn content except for Badora village. The content of Cu in blood plasma of cattle indicated that cattle from all villages had low Cu content. The contents of Fe and Mn in blood plasma of cattle from most of the villages had sufficient Fe and Mn content.

Frontline demonstration experiments:

- Many FLD experiments have been carried out on micronutrient (B and Zn) fertilizer applications on different crops including vegetables crops. Under TSP component of AICRP (Micronutrients) field demonstrations have been carried out involving TSP farmers on Zn, B and S in Tharu belt of Sitarganj area.

2. Research Publications:

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3. Thesis Research:

1. Sharma, K.R. (1996). Effect of organic manure on B adsorption-desorption characteristics of soil, yield and boron nutrition of sunflower (Helanthus annuus mill.). Thesis submitted for Ph. D. (Soil Science) under the supervision of Dr. P.C. Srivastava.

2. Singh, A.P. (2005). Water quality and heavy metals load in sediments of natural lakes of Nainital. Thesis submitted for Ph. D. (Soil Science) under the supervision of Dr. P.C. Srivastava.

3. Dwivedi, Rama (2007). Effect of cereal straw incorporation and zinc sulphate application on yields, availability and crop uptake of zinc in rice-wheat rotation. Thesis submitted for Ph. D. (Soil Science) under the supervision of Dr. P.C. Srivastava.

4. Joshi, Ganga (2009). Integrated nutrient and water management under drip irrigation system for litchi orchard. Thesis submitted for Ph. D. (Soil Science) under the supervision of Dr. P.C. Srivastava.

5. Gupta, Shilpi (2010). Determination of critical limits of boron in some crops and soils of *kumaon* region of Uttarakhand. Thesis submitted for Ph. D. (Soil Science) under the supervision of Dr. P.C. Srivastava.

6. Joshi, Dibya (2012). Evaluation of some multinutrient extractants for assessing availability of micronutrient cations in acidic soils of Uttarakhand. Thesis submitted for Ph. D. (Soil Science) under the supervision of Dr. P.C. Srivastava.

7. Savita (2014). Identification of nutrient imbalance in Litchi (Litchi chinensis Sonn.) orchards of Uttarakhand using diagnosis and recommendation integrated system (DRIS) and compositional nutrient diagnosis. Thesis submitted for Ph. D. (Soil Science) under the supervision of Dr. P.C. Srivastava.

8. Rawat, Deepa (2015). Dynamics of zinc uptake and tissue partitioning in rice and wheat varieties of varying zinc sensitivity. Thesis submitted for Ph. D. (Soil Science) under the supervision of Dr. P.C. Srivastava.

9. Bhatt, S.C. (2016). Differential response of some cowpea genotypes to different Zn supply regimes. Thesis submitted for Ph. D. (Soil Science) under the supervision of Dr. P.C. Srivastava.

10. Khan, Ubaid (1998). Effect of zinc application on yield, Zn nutrition and some quality parameters of mustard and rice. Thesis submitted for M. Sc. (Ag.), Soil Science under the supervision of Dr. P.C. Srivastava.

11. Megh Naresh (2001). Effect of zinc application in conjunction with FYM on yields and nutrient uptake of rice-wheat rotation. Thesis submitted for M. Sc. (Ag.), Soil Science under the supervision of Dr. P.C. Srivastava.

12. Haileselassie, B. (2001). Residual effect of zinc fertilizer, FYM and their conjoint use on yields and nutrient uptake of rice-wheat rotation. . Thesis submitted for M. Sc. (Ag.), Soil Science under the supervision of Dr. P.C. Srivastava.

13. Saxena, A.K. (2003). Effect of zinc and FYM application schedule on yields and nutrient uptake of rice-wheat rotation. Thesis submitted for M. Sc. (Ag.), Soil Science under the supervision of Dr. P.C. Srivastava.

14. Joshi, Deepali. (2009). Estimation of critical toxic concentrations of Ni and Cd in leafy vegetables grown in mollisol amended with varying levels of FYM. Thesis submitted for M. Sc. (Ag.), Soil Science under the supervision of Dr. P.C. Srivastava.

15. Joshi, Chhaya (2010). Estimation of critical limits of B in soil and maize (*Zea mays* L.) crop. Thesis submitted for M. Sc. (Ag.), Soil Science under the supervision of Dr. P.C. Srivastava.

16. Ansari, U.I. (2011). Zinc and potassium interaction in rice-wheat rotation in a mollisol. Thesis submitted for M. Sc. (Ag.), Soil Science under the supervision of Dr. P.C. Srivastava.

17. Bhatt, M.K. (2012). Effect of zinc fertilizer application methods on utilization of phosphorus fertilizer under rice-wheat rotation. Thesis submitted for M. Sc. (Ag.), Soil Science under the supervision of Dr. P.C. Srivastava.

18. Dey, Ahana (2018). Periodic release of micronutrients and other ions from different organic amendments. Thesis submitted for M. Sc. (Ag.), Soil Science under the supervision of Dr. P.C. Srivastava.

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20. Arya, R.P. (2015). Status of some macro & micronutrients in soils of Almora district of Uttarakhand. Thesis submitted for M. Sc. (Ag.), Soil Science under the supervision of Dr. S.P. Pachauri.

21. Bungla, P. (2017). Status of some extractable macro and micronutrients in soils of Pithoragarh district of Uttarakhand. Thesis submitted for M. Sc. (Ag.), Soil Science under the supervision of Dr. S.P. Pachauri.

4. Awards/Honours

- S.N. RANADE MEMORIAL AWARD for Junior Scientist of 2013-14 (Presented by IMT Technologies Ltd., Pune) For Excellence in Micronutrient Research
- AGRI INNOVATION AWARD for Excellence in Soil Science on May 3-4,2015 at PJTSAU, Hyderabad (Organized by GKV, Society, Agra)

5. Future Thrusts:

- The reassessment of micro- and secondary nutrients in Garhwal region for updating maps of micro- and secondary nutrients availability in different districts of Uttarakhand.
- Isolation, characterization of Zn and B solubilizer organisms from soils and testing their efficacy in pot and field experiments.
- Laboratory scale investigations on the utilization of biochars as micronutrient source