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Current status of major nutrients (Av. N, P and K) deficiencies in soils of Koriya district of Chhattisgarh

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Abstract
Crop productivity and human health are widely associated with soil health. Sustaining the nature and degree of nutritional deficiency problems is proper in improving the fertilizer recommendations by addition of major nutrients in the fertilization schedule. In order to understand the variation in macronutrient deficiencies in the district, we carried out macronutrient deficiencies delineation studies in soils of Koriya district of Chhattisgarh. The district consists of five taluka *viz.* Bharatpur, Manendragarh, Baikunthpur, Khadgawa and Sonhat and 57 villages were selected randomly. Total 342 surface soil samples (6 samples each village) were collected using global positioning system (GPS). Results revealed that the soils of the Koriya district (over all mean value of all taluka) were mainly deficient in available nitrogen (Av. N) (93.0%), followed by phosphorous (Av. P) (76.0%) and potassium (Av. K) (16.0%) out of 342 surface soils (0-15 cm) samples. The nutrient index value for Av. N and P was ranged from 1.02 to 1.10 and 1.04 to 1.32 with mean value of 1.07 and 1.24 respectively. Over all fertility rating for Av. N and P of all taluka is rated under very low category. Deficiency of Av. N and Av. P was most serious in the soils of Koriya district. Deficiencies of Av. K were almost negligible and are not currently affecting any major threats to the crop production. This study indicates that for sustaining soil and crop productivity, and good quality of harvest, balance fertilization and scheduling essentials to be improved with addition of the major nutrients scarce in Koriya district of Chhattisgarh.

Keywords: GPS, Macronutrients deficiencies, Fertility rating, Nutrient index, Fertility maps

Introduction
Soil is the important component of the lithosphere, performs not only for the production of food, fodder, fiber, fuel and forest but also in the maintenance soil biodiversity and global environmental quality. Indian farmers have been practiced conventional production system that ensured stable crop yields, but decline in soil fertility as well as soil health. Conventional production systems are introduced of high yielding varieties, intensive use of chemical fertilizers and pesticides and extensive tillage operations caused deteriorates soil quality. Soil sustainability of the agricultural production systems is the most crucial issue in current era. A system is sustainable when it improves or at least maintains the quality of soil, water and atmosphere. Application of chemical fertilizers has been rated as one of the most important production factor affecting the sustainability. The increasing has forced farmer to make use of high doses of chemical fertilizers. The unscientific use fertilizers (imbalance applications) are a serious hazard to sustainable agricultural production system.

Soil fertility evaluation of an area or region is an important aspect in context of sustainable agriculture production and macro nutrients governs the fertility of soils and control the yields of crops (Singh and Mishra, 2012) [13]. Import role of soils into supplying plant nutrients is documented since the beginning of agriculture. The concept 'law of the minimum' was more convincingly advocated since Liebig's time around 1840. Soil test- based fertility management is a successive approach for enhancing crop productivity of agricultural soils that have high degree of spatial variability resulting from the cumulative effects of physical, chemical or biological functions (Goovaerts, 1998) [7]. However, major constraints impede wide scale adoption of soil testing in most developing countries. In India, these include the prevalence of small holding systems of farming as well as lack of infrastructural facilities for extensive soil testing (Sen *et. al*., 2008) [12]. Soil testing provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendation for maximum crop yields. The soil fertility status data of various states of India, declined over a period of years (major and micro nutritional deficiencies) will provide the changing pattern of soil fertility down the years (Bajaj and Ramamoorthy, 1969; Ghosh and Hassan, 1980; Motsara, 2002) [1, 6, 10]. Ladha *et al.* (2003) [9] was also reported that decline trends in production of rice – wheat systems due to decline soil fertility. Soil testing program is beneficial to formulated specific fertilizer recommendations.

Material and methods

Study area and soil sampling

Different talukas in Koriya district in state of Chhattisgarh, India. It is positioned at 23° 46.565' latitude, 08° 39.783' longitude with an elevation of 280 m above the mean sea level. The dominant soil orders are Inceptisols, Alfisols, Vertisols and Entisols group of the soil covered under the different villages of different talukas in Koriya district of Chhattisgarh has been taken for fertility assessment on various aspects. Five talukas of Koriya district in the state of Chhattisgarh, and about 91 villages come under this district. For evaluation of the soil fertility status in Alfisol of different blocks, a systematic survey was carried out. Surface (0-15 cm depth) soil samples were collected from each villages and composite soil sample were prepared. Soil samples (15 cm) were collected with the help of soil auger and local spade and air dried processed to pass through 2 mm sieve with proper label for analysis.

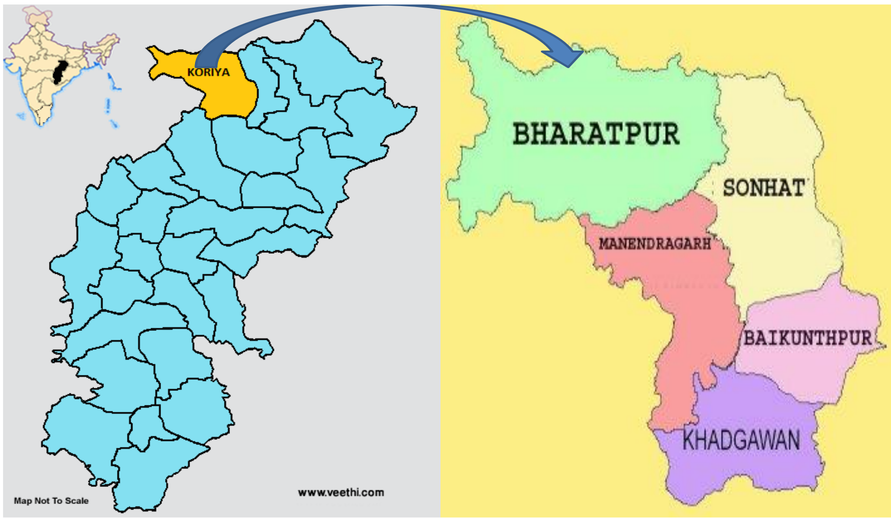

Fig 1: Pictorial delineate of the study area

Analysis of samples

Available nitrogen (Av. N) was estimated by alkaline (0.32%) $KMnO_4$ method (Subbiah and Asija1956) [16], available phosphorus (Av. P) was extracted by 0.5*M* sodium bicarbonate ($NaHCO_3$) solution at pH 8.5 (Olsen *et al*. 1954) [11] and extract was determined by ascorbic acid method (Watanabe and Olsen 1965) [19] and available potassium (Av. K) was extracted by shaking with 1 *N* neutral ammonium acetate (1*N* NH4OAc, pH-7.0) for 5 minutes (Hanway and Heidal 1952) [8] and then K in the extracted was estimated by flame photometer. Chemical analysis of these data over a period of years will provide the changing pattern of soil fertility down the years. Based on the soil test values for different nutrients, soil samples are generally classified into three categories, low, medium and high category (Table 1). Using these fertility classes, nutrient index was calculated as per the following equation.

$$\text{Nutrient index (NI)} = \frac{(N_L \times 1) + (N_M \times 2) + (N_H \times 3)}{N_T}$$

Where,

N_L= number of samples falling in low category nutrient status

N_M = number of samples falling in medium category nutrient status

N_H = number of samples falling in high category nutrient status

N_T = total number of samples analyzed for a given area

Table 1: Limits for the soil test values used for rating the soils

Soil tests	Low	Medium	High
Av. N (kg ha^{-1})	<280	280-560	>560
Av. P (kg ha^{-1})	<12.5	12.5-25	>25
Av. K (kg ha^{-1})	<135	135-335	>335

Results and discussion

Nitrogen fertility status

Results revealed that fertility rating for available N of all five talukas is rated under low category. The Av. N content varied from 68.0 – 312.0 kg ha^{-1} with an average value of 190.0 kg ha^{-1} (Table 2, Fig. 2). Among the different taluka, Sonhat was recorded highest percentage of 'low' available N status (98%) followed by Baikunthpur (94%), Khadgawa (93%) and the lowest were observed in Bharatpur block (90%). The Av. N status was observed to the tune of 100% under low categories (< 280 kg ha^{-1}) in the district. Nutrient index (NI) value for available nitrogen ranged from 1.02 to 1.10 with a mean value of 1.07. Similar results were reported by (Singh and Mishra, 2012; Verma *et al*., 1980) [13, 18]. It is quite obvious that being a mobile nature and low uptake recovery due to its losses through various mechanism like NH_3 volatilization, nitrification, succeeding, denitrification, chemical and microbial fixation, leaching and runoff (De Datta and Buresh, 1989) [4] residual/available N becomes poor in soil.

Table 2: Range and mean values of avilable N (kg ha^{-1}) in different Taluka of Koriya district

S.No	Talukas	Range	Mean	% Samples category			Nutrient Index	Fertility Rating
				Low	Medium	High		
1.	Bharatpur	74-310	185	90	10	0	1.10	Low
2.	Manendragarh	100-312	203	91	9	0	1.09	Low
3.	Baikunthpur	80-307	186	94	6	0	1.06	Low
4.	Khadgawa	76-310	192	93	7	0	1.07	Low
5.	Sonhat	68-290	191	98	2	0	1.02	Low
Over all mean		68-312	190	93	7	0	1.07	Low

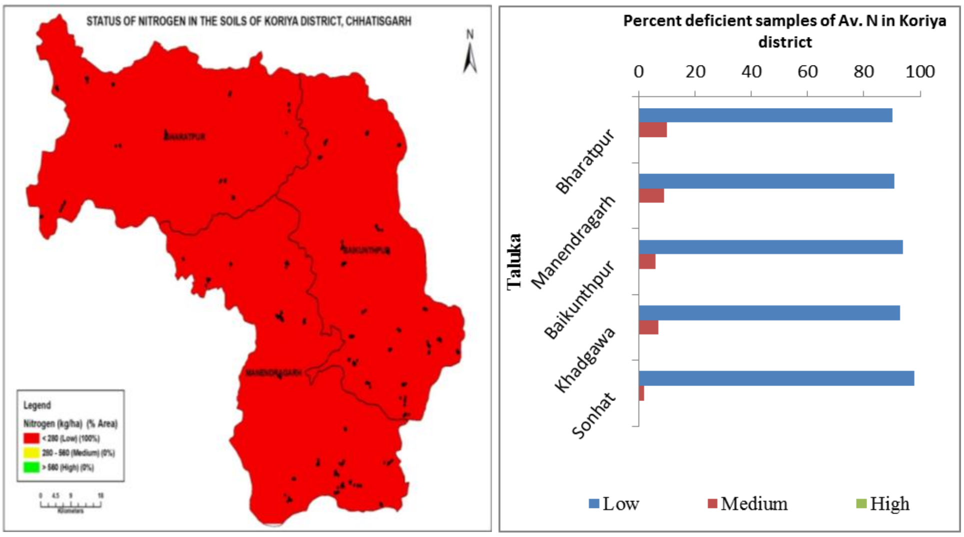

Fig 2: Spatial variation in available N deficiency status in soils of different talukas in Koriya districts of Chhattisgarh

Phosphorous fertility status

Phosphorus deficiency is widespread in soils of India. A wide variation in P dynamic depends on soil types, parent material, organic carbon content and management practices such as addition of P containing fertilizers. The available P varied from 2.87 to 19.0 kg ha^{-1} with over all mean value 13.12 kg ha^{-1} (Table 3, Fig. 3). Distribution of soil samples with respect to available P content indicates that about 76.0% of samples had available P content less than 12.5 kg ha^{-1}% and 24.0% samples had available P content between 12.5-25 kg ha^{-1} (Fig. 3). Nutrient index (NI) value for available P ranged from 1.04 to 1.32 with a mean value of 1.24. Phosphorus is present in soil as fixed farm with varying degree of solubility. Availability of phosphorous depends on concentration of organic carbon in soil. Tisdale *et al.* (1997) [17] was reported that about 50% of Av. P is found organic form and decay of organic matter produce organic acids and humus which forms complexes with Al and Fe cations and protect the P fixation in soil. When water soluble P is added to the soil, it is converted very quickly to insoluble solid phase by reacting with soil constituents. These may include calcium, Fe and Al oxides (Dean and Rubins, 1947 and Chu *et.al.*, 1962) [3, 2] and partly organic matter. Ghosh and Hassan, (1979) [5] was reported that deficiency of Av. P widespread in Indian soils, and about 98% of the districts of India having low or medium in Av. P.

Table 3: Range and mean values of avilable P (kg/ha) in different Taluka of Koriya district

S. No	Talukas	Range	Mean	% Samples category			Nutrient Index	Fertility Rating
				Low	Medium	High		
1.	Bharatpur	2.87-17.29	10.18	68	32	0	1.32	Low
2.	Manendragarh	4.03-17.38	9.15	80	20	0	1.20	Low
3.	Baikunthpur	3.23-18.82	10.14	71	29	0	1.29	Low
4.	Khadgawa	2.96-19.0	9.79	72	28	0	1.28	Low
5.	Sonhat	2.51-13.98	5.80	96	4	0	1.04	Low
Over all mean		2.24-28.94	13.12	76	24	0	1.24	Low

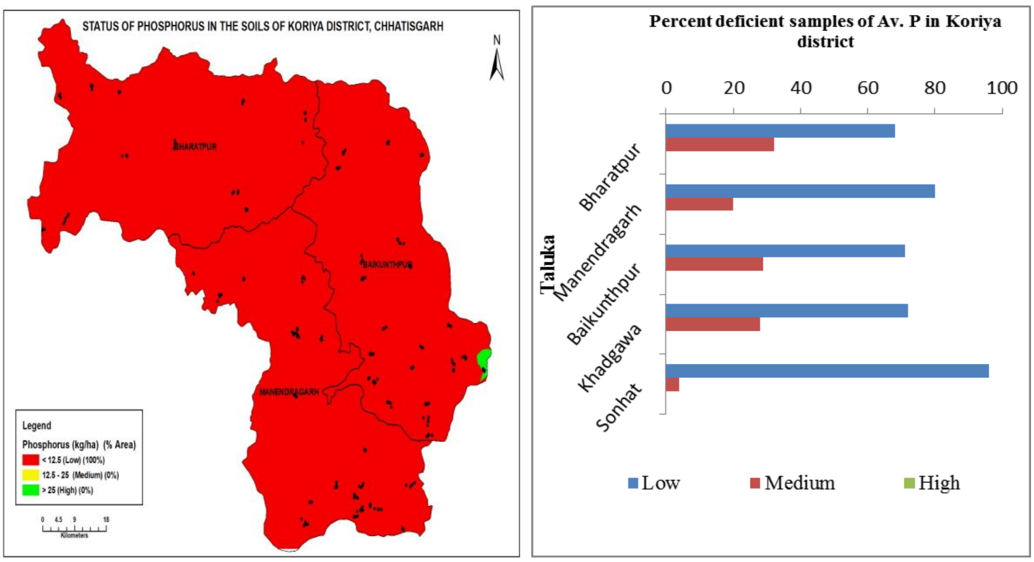

Fig 3: Spatial variation in available P deficiency status in soils of different talukas in Koriya districts of Chhattisgarh

Potassium fertility status

In fact under rainfed agro ecosystems of central India, the soils were characterized by medium to high available potassium status. The potassium fertility was medium to high in most of the talukas in the district of Koriya. The Av. K content (Table 4, Fig. 4) in ranged from 85.0 to 953.0 kg ha^{-1} with an average value 342.0 kg ha^{-1}. The Av. K distribution in soil samples indicates (Table 3) that about 16.0% of samples had available K content less than 135 kg ha^{-1}, 52.0% samples had comes between 135-335 kg ha^{-1} and 31.0% soil samples had higher K content more than 335 kg ha^{-1}. The nutrient index (NI) value for available K ranged from 1.96 to 3.39 with a mean value of 2.15. In general, potassium deficiency was noticed in coarse textured soils, red and lateritic soils and area which adopting continuously high yielding verities without addition of K fertilizers (Srinivasarao, 2000) [14]. The black of central India or Vertisols showed relatively high available K as compared to Inceptisols and Alfisols because of higher clay content and smectitic clay (biotic and muscovite clay minerals). Potassium status of different rainfed agro-ecological sub-regions of central India (Subbarao and Srinivasarao, 1996) [15] indicated that Av. K of varied from low to high depending upon soil type, parent material, texture, mineralogy and management practices.

Table 4: Range and mean values of avilable K (kg/ha) in different Talukas of Koriya district

S.No	Talukas	Range	Mean	% Samples category			Nutrient Index	Fertility Rating
				Low	Medium	High		
1.	Bharatpur	100-770	278	13	63	24	2.12	Medium
2.	Manendragarh	85-670	260	19	59	22	2.04	Medium
3.	Baikunthpur	103-779	276	14	55	31	2.17	Medium
4.	Khadgawa	115-834	348	8	44	47	2.39	High
5.	Sonhat	104-953	285	33	37	30	1.96	Medium
Over all mean		85-953	342	16	52	31	2.15	Medium

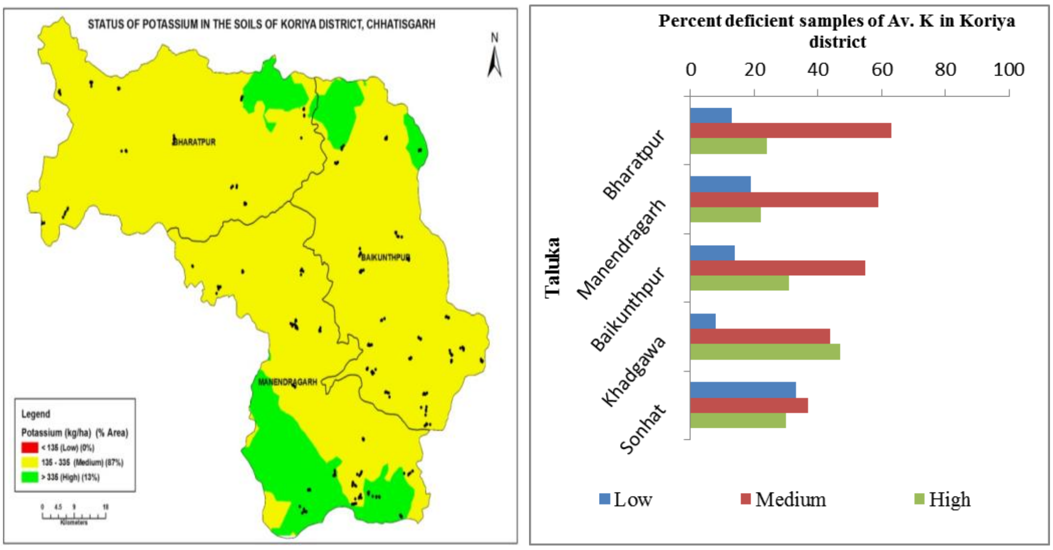

Fig 4: Spatial variation in available K deficiency status in soils of different talukas in Koriya districts of Chhattisgarh

Conclusion

The current status of available macronutrients N, P and K deficiency in soils of the Koriya district has been assessed as 93.0, 76.0 and 16.0%, respectively. Regardless of this deficiency, a substantial share of soils which are characterized presently over the deficiency level needs special alertness because improper management of these soils may again render them in deficient category. As in case of Av. N, this fertilizer may have been result of increased use in N by the farmers of India but application fertilizer P is very low and more fixation on clay complexes. It has been proved that application of macronutrient fertilizers are encouraging in mitigating the deficiency in plants and also helped in yield potential of crops. Nutrients enriched produce has great potential in improving animal and human health. The soils under Koriya district of Chhattisgarh showed low in available N and P, and medium level in available K. Hence, the soils require attention regarding nutrient management practices and regular monitoring of soil health for better and healthy crop production.

References

1. Bajaj JC, Ramamurthy B. Available nitrogen, phosphorus and potassium status of Indian soils. Fertiliser News. 1969; 14:25-28.
2. Chu CR, Moschler WW, Thomas GW. Rock phosphate transformation in acid soils. Soil Sci. Soc. Amer. Proc. 1962; 26:471-478.
3. Dean LA, Rubin EJ. Anion Exchange in Soils. Exchangeable phosphorus and anion exchange capacity. Soil Sci. 1947; 63:37-387.
4. De Datta SK, Buresh RJ. Integrated N management in irrigated rice. Adv. Agronomy. 1989; 10:143-169.
5. Ghosh AB, Hasan R. Phosphorus fertility status of soils of India. In Phosphorus in soils, crops and fertilizers. Bulletin no.12, Indian Soc. Soil Sci., New Delhi, 1979, 1-8.
6. Ghosh AB, Hasan R. Nitrogen fertility status of soils of India. Bulletin No.10. Indian Soc. Soil Sci., New Delhi, 1980.
7. Goovaerts P. Geo-stastical tools for characterizing the spatial variability of microbiology and physic-chemical soil properties. Biol. Fert. Soil. 1998; 27:315-334.
8. Hanway JJ, Heidel H. Soil analysis methods as used in lowa State. College soil testing laboratory. Bulletin. 1952; 57:1-131.

9. Ladha JK, Dawe D, Pathak H, Padre AT, Yadav RL, Bijay Singh *et al*. How extensive are yield declines in long-term rice-wheat experiments in Asia? Field Crops Research. 2003; 81:159-180.
10. Motsara MR. Fertility status of Indian soils. Fertiliser News. 2002; 47(8):15-22.
11. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. USDA, Circ, 1954, 939.
12. Sen P, Majumdar K, Sulewski G. importanceof spatial nutrient variability mapping to facilitate SSNM in small land holding systems. Indian J Fert. 2008; 4(11):43-50.
13. Singh RP, Mishra SK. Available macro nutrients (N, P, K and S) in the soil of Chiraigoan block of district Varanasi (U.P.) in relation to soil characteristics. Indian J Sci. Res. 2012; 3(1):97-100.
14. Srinivasarao, Ch, Subba Rao A, Bansal SK. Relationship of some forms of potassium with neutral normal ammonium acetate extractable K in mineralogically different benchmark soil series of India. J Indian Soc. Soil Sci. 2000; 8:27-32.
15. Subba Rao A, Ch. Srinivasa Rao. Potassium Status and Crop Response to Potassium in the Soils of Agro-ecological Regions of India. IPI Research Topics No.20. International Potash Institute, Basel, Switzerland. 1996, 1-57.
16. Subbiah BV, Asija GL. A rapid procedurefor the determination of available nitrogen in soil. Current Sci. 1956; 25:259-260.
17. Tisdale SL, Nelson WL, Beatom JD, Havlin JL. Soil fertility and fertilizers. 5th edn. Mac Millon Publishing co. New Delhi. 1997; 144:198-201.
18. Verma LP, Tripathi BR, Sharma DP. Organic carbon as an index to assess the nitrogen status of the soils. J. Indian Soc. Soil Sci. 1980; 28:138-140.
19. Watanabe FS, Olsen SR. Test of an ascorbic acid method for determining phosphorus in water and $NaHCO_3$ extracts from the soil. Soil Sci. Soc. Am. J 1965; 29:677-678.