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Initial soil testing analysis under site specific nutrient management in Vertisol and inseptisol of Mungeli district of Chhattisgarh

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Abstract

A pot culture experiment was conducted in the Department of Soil Science and Agricultural Chemistry, BTC College of Agriculture and research Station, Bilaspur, during *Kharif* season 2017-18. The treatments constituted with application of all nutrients applied at optimum level known as All (SSNM dose) while in others, one of the nutrient elements from all the nutrient treatments (All) was omitted. There were eleven treatments for each type of soil and three replications with CRD (completely randomized design). All treatments were common for both the soils except omission of Fe and Mn in case of Vertisol and omission of Ca and Mg in case of Inseptisol were kept keeping the concept of soil reaction. After addition of all treatments, rice (IGKV R-1) was transplanted in three hills/pot with 2 to 3 seedlings in each hill.The soil reaction (pH) of the *Vertisol* was at 7.6 and that of *Inceptisol* exhibited 6.9. Both the soils were low in, organic C, available N, S, and available P, high status in available K, exchangeable Ca and Mg. The micronutrient status of the soils were above critical level specially high status in Fe, Mn and Cu level except B and Zn in *Vertisol and* Inceptisol.

Keywords: inceptisol, vertisol, nutrients, straw

1. Introduction

Site-specific nutrient management is a set of nutrient management principles combined with good crop management practices that will help farmers attain high yield and achieve high profitability both in the short- and medium-term. SSNM provides an approach for the timely application of fertilizers at optimal rates to fill the deficit between the nutrient needs of a high-yielding crop and the nutrient supply from naturally occurring indigenous sources, including soil, crop residues, manures, and irrigation water. SSNM strives to enable farmers to dynamically adjust fertilizer use to optimally fill the deficit between the nutrient needs of a high-yielding crop and the nutrient supply of naturally occurring indigenous sources such as soil, crop residues, manures and irrigation water (Dobermann *et al*. 2002; Buresh *et al.* 2010) [6, 3]. The SSNM approach has shown the potential to improve productivity and profitability in intensive rice cropping systems of Asia and Africa. (Jinger *et al*. 2017) [12].

Rice (Oryza sativa L.) is cultivated in more than hundred countries and undoubtedly a dominant staple food of world and 91 per cent of the world's area and production of rice grown and consumed in Asia (Dobermann and Witt, 2003) [8]. Rice is the most rapidly growing food source in Africa and it is of significant importance to food security in an increasing number of low-income, food-deficit countries (FAO, 2004) [9].

2. Material and methods

2.1 Site description

A pot experiment was conducted in Department of Soil Science and Agricultural Chemistry, BTC College of Agriculture and research Station, Bilaspur, during Kharif season 2017-18. On the basis of 1st season results farmer's field demonstration was also carried out at field of farmer's (from where bulk of soils were collected for pot experiment) during Rabi season 2017-18. The soils used for pot experiment were two type i. e. Inceptisol and Vertisol. Both the soils were collected from two different locations of Mungeli district. Collected soils were air dried and filled in cemented pots.

2.2 Soil type

For *Kharif* season, the bulk of two soils belong to soil order *Inceptisols* and *Vertisols* were collected from two different locations of Mungeli district. The collected bulk soils were brought to BTC College of Agriculture and research Station, Bilaspur and air dried and filled in the cemented pots. In *Rabi season*, frontline demonstration on farmers field were carried out, from where bulk soils were collected. Based on the pot culture experiment, identified limiting nutrients were imposed using wheat crop & compared with Farmers Fertilizers Practice.

2.2.1 *Inceptisols*

These soils are locally called Matasi soil and are considered to be immature soil with poor soil profile features having lighter texture and shallow to moderate depth. Soils are being used exclusive for growing early rice after bunding, puddling and leveling and also for pulses and maize without bunding. They are soft and non-sticky when wet, easily workable under wet cultivation for puddling and biasi operation and therefore, can easily be managed to improve surface water retention for rice cultivation. Under this order the dominating sub-group are typic *haplustept* and vertic *haplustept*. Vertic *haplustept* have clayey texture with clay content varying from 48.0 to 55.0%. Typic haplustept is sandy clay loam to clay and texture with clay content raining from to 33.2 to 50.4% (Kumar *et al*. 2015) [13].

2.2.2 *Vertisols*
These soils are locally known as Kanhar or Gabhar soils. It is clayey in texture, dark brown to black in color, neutral to alkaline in reaction due to presence of lime concretion and is deep (1-1.5 meter). It has a good water holding capacity and therefore possess considerable crop production potential. They have very narrow workable soil moisture regime and become massive when dry and sticky when wet making tillage operation extremely difficult with animal drawn implements normally available with farmers. Thus these soils remain mostly underutilized due to difficulties in management problems. There are sub group under the order, *Vertisols*, i.e. chromic Haplustert and typic Haplustert. Both subgroups were clay in texture with clay content ranging from 45.0 to 50.70 per cent. Very high profile water storage capacity was observed in typic Haplustert and high profile water storage capacity was observed in Chromic Haplustert. (Kumar *et al*., 2015) [13].

2.3 Test Crops
For evaluating the fertility status of soils, rice (*var*. Rajeshwari) was tested in pots during *Kharif* season while, wheat (*var*. GW-273) crop was taken as frontline demonstration on farmer's field during *Rabi* Season of 2017

2.4 Soil Preparation, Planting and Nutrient addition
Collected soil were air dried and filled in cemented pots at the rate of 20 kg per pot. Application of different nutrients were loaded in different pots. Full dose of all the nutrients except nitrogen was added to the soil in solution form. Nitrogen as urea was applied in three splits at transplanting, tillering and panicle initiation stage. The pots were maintained with 3 cm standing water and twenty one days old seedlings of rice (IGKVR-1) were transplanted on 27 July, 2017. Three hills per pot were maintained in all the pots.

2.5 Experimental design
Treatments were laid out in Completely Randomized Design. Treatments were replicated thrice. There was 11 treatments in *Vertisol* and also in *Inceptisol.* All treatments were applied in pots, the treatments for both the soils were same, only two treatments were different.

2.6 Management of the pots
During *kharif* season the pots were maintained with 3 cm standing water. Remaining doses of nitrogen was applied at tillering and panicle initiation stage. Crop was grown till maturity and harvested on 2th November, 2017.

2.7 Experiment design
The Experimental details used in omission pot trails were as follows:

Soil type : *Inceptisols & Vertisols*
Replication : Three
Treatment : Eleven
Design : C.R.D.
Test crop/variety : Rice (IGKVR-1), Wheat (GW-273)
Kind of trial : Pot culture experiment (omission pot trial)
No. of pots : 66
Seasons : *Kharif, 2017* and *Rabi, 2017-187.*

2.8 Treatment Details

Table 1

Vertisols		***Inceptisols***	
Treatment -1 (T_1)	All (N, P, K, S, Fe, Mn, Cu, Zn, B, Mo)	Treatment -1 (T_1)	All (N, P, K, S, Ca, Mg, Cu, Zn, B, Mo)
Treatment -2 (T_2)	All – N	Treatment -2 (T_2)	All – N
Treatment -3 (T_3)	All – P	Treatment -3 (T_3)	All – P
Treatment- 4 (T_4)	All – K	Treatment- 4 (T_4)	All – K
Treatment- 5 (T_5)	All – S	Treatment- 5 (T_5)	All – S
Treatment- 6 (T_6)	All – Fe	Treatment- 6 (T_6)	All – Ca
Treatment- 7 (T_7)	All – Mn	Treatment- 7 (T_7)	All – Mg
Treatment- 8 (T_8)	All – Cu	Treatment- 8 (T_8)	All – Cu
Treatment- 9 (T_9)	All – Zn	Treatment- 9 (T_9)	All – Zn
Treatment- 10 (T_{10})	All – B	Treatment- 10 (T_{10})	All – B
Treatment- 11 (T_{11})	All – Mo	Treatment- 11 (T_{11})	All – Mo

2.9 Statistical Analysis
Statistical analyses of the data in Completely Randomized Design were computed with standard methods of experimental design.

3. Results and discussions
3.1 Initial Soil Analysis
Composite soils collected from different locations were air dried, grounded by wooden rod and passed through 2 mm sieve. The processed soil samples were analyzed in the laboratory for observing the initial status of soils for, pH, electrical conductivity and available nutrient status. Available nutrient status was determined by standard methods as mentioned below, and shown in below Table 2.

Table 2: Initial characteristics of soils

Soil Characteristics	*Vertisols*	*Inceptisols*
Ph	7.6	6.9
EC (dS m^{-1})	0.29	0.16
Available N (kg ha^{-1})	245	215
Available P (kg ha^{-1})	14.23	12.02
Available K (kg ha^{-1})	512	298
Available S (kg ha^{-1})	16.25	22.12
Ca ((kg ha^{-1})	4600	1900
Mg ((kg ha^{-1})	1230	650
Fe (mg kg^{-1})	19.56	25.45
Mn (mg kg^{-1})	6.89	15.12
Cu (mg kg^{-1})	1.06	2.28
Zn (mg kg^{-1})	0.56	0.79
B (mg kg^{-1})	0.45	0.54

Soil pH was determined in 1:2.5 soils - water suspension after stirring for 30 minutes, by glass electrode pH meter as suggested by Black (1965) [2].

Soil pH varies from 7.6 to 6.9 in vertisol and inseptisol. That means vertisols is slitly alkali in nature and inseptisols is slitly acidic in nature.

Electrical conductivity the soluble salts in soils were determined by electrical conductivity method. Solution offers some resistance to passage of electric current through them, depending upon the salt content. Higher the salt content, lower is the resistance to flow of salt concentration. EC varies from 0. 29 to 0.16 dS m^{-1} in Vertisol and inception which is reciprocal of resistance, thus, increases with increases in salt concentration described by Black (1965) [2].

Available nitrogen it was determined by alkaline $KMnO_4$ method as described by Subbiah and Asija (1956) [21]. Available N varied from 245 to 215 kg ha-1 in vertisol and inseptisol. That means available nitrogen in soil is moderat in condition in both soil.

Available phosphorus in soil was extracted by 0.5 M $NaHCO_3$ (pH 8.5) (1:20 soil solution ratio) for 30 minutes as suggested by Olsen *et al.* (1954) and P in the extract was determined by ascorbic acid method of Watanabe and Olsen (1965). Available P varied from 14.23 to 12.02 kg ha-1 in vertisol and incept sol. Phospprous is also present in moderat condition.

Potassium in soil was extracted by neutral normal ammonium acetate and determined with the help of flame photometer. And Available k varied from 512 to 298 kg ha-1. And that is moderat in both soil. Available sulphur in soil was extracted by 0.15 % $CaCl_2.H_2O$ solution (Williams and Steinbergs, 1969) and content was determined by turbidimetric method of Chesnin and Yien (1950).

Available Calcium and Magnesium status in soils were determined by 0.01 N EDTA (Versenate) titration method using ammonium acetate extract as described by Chang and Bray (1951) [4]. And varied from 4600 to 1900 kg ha-1 in vertisol and inseptisol. That is moderat in condition.

Available micronutrients (Zn, Cu, Fe and Mn) were extracted using 0.005 M DTPA (Diethylene Triamine Penta acetic acid), 0.01 M calcium chloride dihydrate and 0.1M triethanol amine buffered at pH 7.3 (Lindsay and Norvell, 1978) [14] and content were analyzed using atomic absorption spectrophotometer (AAS). Available micronutrients Zn 19.56 to 25.45 mg kg^{-1}, Cu 6.89 to 15.12 mg kg^{-1}, Fe 1.06 to 2.28 mg $kg^{-1}$and Mn 0.56 to 0.79 mg kg^{-1} in vertisol and inseptisol

Available Boron

Available boron in soil was extracted by boiling with water and the extracted boron was determined by azomethine-H as described by Gupta (1967) [10, 11]. Available boron varied from 0.45 to 0.54 mg kg^{-1} in vertisol and inseptisol.

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