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Identification of yield limiting plant nutrients based on crop response in *Inceptisol* of Surajpur district of Chhattisgarh

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Abstract
A pot culture experiment was demonstrated at Rajmohini Devi College of Agriculture research station, Ambikapur during Kharif season, 2018 in order study about limiting plant nutrients based on the crop response through nutrient omission technique in one of the major soil type of Surajpur district of Chhattisgarh. The main objective of this experiment was to identify yield limiting plant nutrient with the help of test crop i.e. rice (*Oryza Sativa*) variety MTU-1010 and then to demonstrate the identified limiting nutrient in farmer's field with the help of wheat crop for the comparison of yield different in farmer's filed and site specific nutrient management field. There were total 11 treatments of rice variety in which CRD (Completely randomized design) was used with include 3 replication. It was recorded that there was significant reduction in grain and straw yield of rice with the omission of N, P and S in soil when compared with the treatment that received all the nutrients i.e. SSNM. The reduction in yield was found to be more than 40.69% percent in case of N, 33.87% in case of P and 12.44 % in case of S in Inceptisol. The test was conducted to check limiting nutrients on farmer field where bulk soil sample was collected for pot culture study. The limited nutrient found was corrected by applying optimum dose of SSNM N-120, P2O5-80, K2O-50 and S-30 kg/ha. The percentage yield increase due to application of SSNM applied dose over farmer's practice dose were 33.03-40%. This result conclude that application of N, P and S in Ineptisol and should be applied as per the recommended dose in order to attain maximum crop production.

Keywords: SSNM, inseptisol, nutrient omission technique

Introduction
SSNM enhances or maintains crop yields, by minimizing fertilizer overuse, greenhouse gas emissions can be reduced, in some case up to 50%. It optimizes the supply of soil nutrients over space and time to match crop requirements. Fertilizer application recommendations are often based on crop response data over huge areas, through fields show large variability in terms of nutrient-supply and their response to crop. Blanket fertilizer application recommendation to farmer may lead to over-fertilizer in some parts and under-fertilizer in some other. An alternative to blanket recommendation, Site Specific Nutrient Management aims to optimize the supply of soil nutrient over space and time to match with the requirements of crops through four key principles. The principles, called the "4Rs", date back to1988 and are attributed to the International plant Nutrition Institute (Bruulselma *et al*., 2012) [4]. They are: Right product, Right rate, Right time, Right place. And this site specific nutrient management can be applied to any crop at any field. In India this SSNM is practiced in a large area or else we can say this practice can be seen in different parts of our country. An insufficient or imbalanced use of fertilizer, resulting in low attainable yield. SSNM once we have determined that we are going to implement site specific nutrient management (SSNM) we should follow following thing to carry out a successful extension campaign. First selection of an economic yield so that we can determine the required application rate of N,P and K nutrients only it we know that yield increases we are targeting. Select a yield target of not more then 75-80% of potential yield. Estimate soil nutrient supplies using nutrient omission plot technique. Through this we can estimate from yield in omission plots. Because the deficiency nutrient not supplied with fertilizer limits plant growth and yield and N, P and K nutrient inputs based on fertilizer rates calculated from date gathered earlier.

Due to this imbalance use of fertilizer it has very important to have proper application of fertilizer and also it is very essential to apply nutrients in accordance with their availability in soil and total requirement of crop. This situation has provided a great opportunity for site specific nutrient management program.

Materials and methods

An experiment was conducted with the help of pot based method in which nutrient omission trail was done at Raj mohini devi college of agriculture and research station Ambikapur Chhattisgarh. The experiment was conducted during kharif season 2018 using rice variety MTU-1010. For conducting experiment surface soil sample was collected from farmer's field in bulk amount form sambalpur village. The objective of the study is identification of yield limiting plant nutrients based on crop response in Inceptisol and to demonstrate identified limting nutrient and its comparison with farmer fertilizer practice during rabi season field during rabi season using wheat GW-273 as a test crop. The pot culture experiment was established by using eleven treatments and three replication. In each pot 20 kg soil sample was filled. Three to four, twenty days old seedling of MTU 1010 per hill were transplanted. The treatment that constitute of application of all nutrient applied at optimum level is known as SSNM dose and in rest ten treatment omission of each nutrient from SSNM dose was done by using nutrient omission technique.

Table 1: Treatment details

Treatment No.	*Inceptisol*
(T1)	All (N, P, K, S, Ca, Mg, Cu, Zn, B, Mo)
(T2)	All – N
(T3)	All – P
(T4)	All – K
(T5)	All – Ca
(T6)	All – Mg
(T7)	All – S
(T8)	All – Cu
(T9)	All – Zn
(T10)	All – B
(T11)	All – Mo

Table 2: Source and rates of application of nutrient used in nutrient omission pot trial

Nutrien	Source of nutrient	Rate of application	Amount of fertilizers(gm) to added per pot(20 kg of soil)
N	Urea	150 Kg N/ha	2.82 gm/pot
P	TSP	(100 kg P_2O_5/ha)	1.92 gm/pot
K	MOP	(100 kg K_2O/ha)	1.48 gm/pot
S	Bentonite Sulphur	45	0.44 gm/pot
Ca	$CaCl_2$. $2H_2O$	110	2.72 gm/pot
Mg	MgO	50	0.8 gm/pot
Fe	$FeCl_2$	20	-----nil---------
Mn	$MnCl_2$	15	-----nil---------
Cu	$CuCl_2$.2 H_2O	7.5	0.16 gm/pot
Zn	$ZnCl_2$	7.5	0.127 gm/pot
B	H_3BO_3 (Boric acid)	3	0.15gm/pot
Mo	$H_2MoO_4.2H_2O$	0.75	0.01 gm/pot

Result and discussion

The results was found that effect of omission were significant in reducting of grain and straw yields of rice grown in Inceptisol as influenced by different treatments are illustrated in Table 1Fig. 4.1.1 and 4.1.2. The mean grain and straw yields of rice affected significantly with different treatments in both the soil types (Inceptisol). It was found that the treatment that received all nutrients (SSNM) recorded highest grain yields of 98.26 g/pot in Inceptisol and lowest yields were recorded with the N omitted pot followed by phosphorus omitted from SSNM treatments in both the soils. Nitrogen and Phosphorus omitted from SSNM treatment produced 58.27 and 64.97 g/pot, respectively in Inceptisol and 73.08. Similarly, S omitted pot yielded significantly lower yields of 86.03g/pot in Inceptisol. Reduction in rice yields were recorded under different nutrients omitted pots were in the order (40.69 %) N> (33.87%) *P*> (12.44%) S with Inceptisol of the Surajpur district. Based on these observations, it was found that considerable yield reductions were seen due to N, P and S omission from SSNM treatment in Inceptisol

Mean straw yields of rice also affected significantly with different treatments in soil types. The trends in straw yields with N, P and S omission from SSNM treatment were identical as observed with grain yields. Similarly, K, Mg, Fe, Cu, Zn, B, and Mo omitted pots were statistically at par with that of SSNM treatment. The treatment that received all the nutrients (SSNM) recorded maximum straw yield (118.21g). It is very clear from the result that large reductions in the grain and straw yield of rice were observed with the omission of nitrogen and phosphorus as compared to the other nutrient omission treatments. The yield reductions were more pronounced with N omission. This shows that nitrogen was the most yield- limiting nutrient in both the soils followed by P. Under tropical climatic conditions, low organic C level is due to oxidation loss of organic matter (Singh *et al*., 2011). [10] Since there is a strong positive correlation between organic C and available nitrogen status of soils hence the soils of the area are also dominantly low in respect of available nitrogen. The soils were an inherently lower margin of medium category in available P and hence the omission of P caused more reduction in yields. Based on yield performance the next element which decreased the yields in both the soils was sulphur (S) followed by zinc (Zn). Reduction in yields in S omitted pots may be attributed due to low native sulphur status in both soils. Since the majority of the farmer's community are using S free fertilizer i.e DAP, MOP, nitro phosphate, polyphosphate hence, S deficiency in the major soils are coming up which needs to be supplemented by S fertilizers. Biswas *et al*. (2004) [5] reported that continuous use of DAP and other S free fertilizers in place of SSP and other S containing fertilizers might be attributed in lower S contents in the soil Higher adsorption and immobilization of S (Tiwari *et al*., 2006) [11] might have resulted in lower yields in the soils under study.

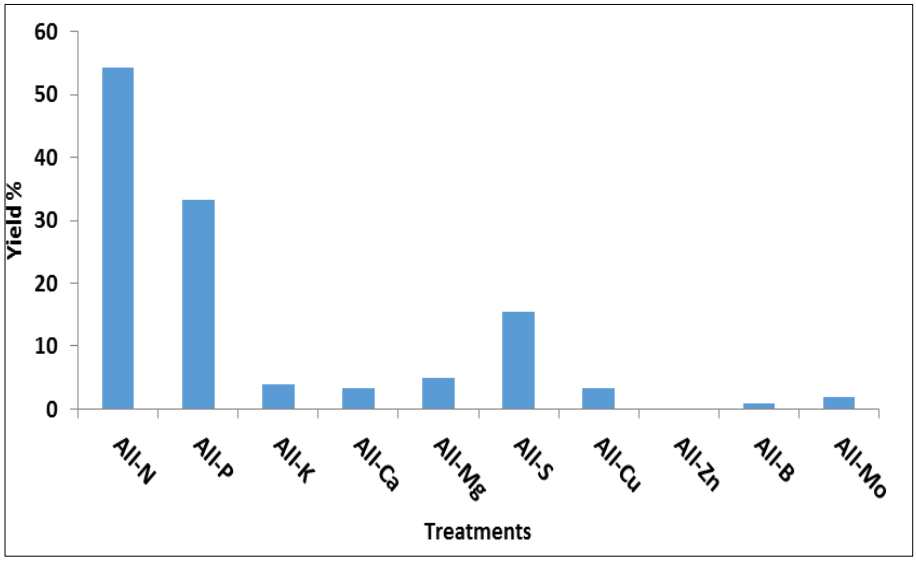

Fig 1: Percentage decrease in rice yield with different nutrient omitted pots over SSNM in Inceptisol of Koriya district

Table 3: Grain and straw yields (g/pot) of rice (MTU-1010) in relation to different treatment Inceptisol

S. No	Treatments	Grain yield (gm pot^{-1})	Straw yield (gm pot^{-1})
T_1	SSNM	98.26	95.05
T_2	SSNM-N	58.27	60.76
T_3	SSNM-P	64.97	68.02
T_4	SSNM-K	94.60	94.21
T_5	SSNM-Ca	94.29	93.93
T_6	SSNM-Mg	93.10	92.85
T_7	SSNM-S	86.03	85.17
T_8	SSNM-Cu	96.17	94.32
T_9	SSNM-Zn	96.41	88.27
T_{10}	SSNM-B	95.75	91.07
T_{11}	SSNM-Mo	93.18	94.14

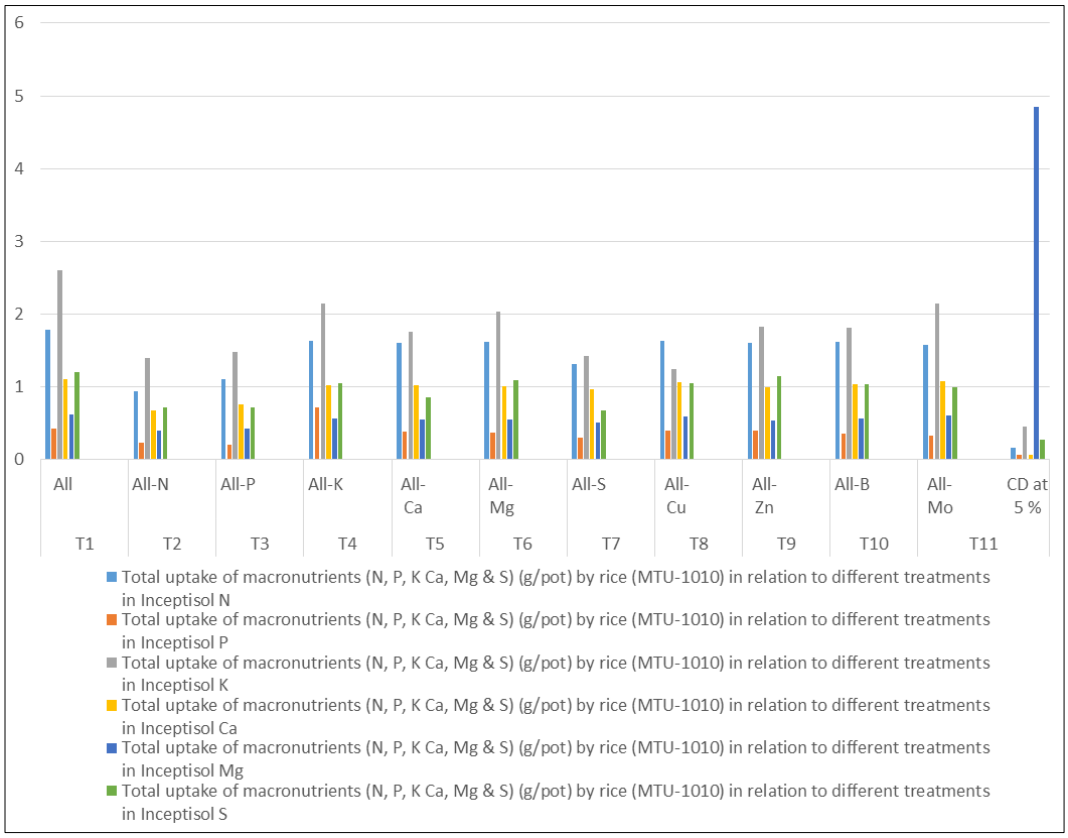

Fig 2: Total uptake of macronutrients (N, P, K Ca, Mg & S) (g/pot) by rice (MTU-1010) in relation to different treatments in Inceptisol

Total uptake of, Zn, Cu and B of rice (mg/pot) in relation to different treatments in Inseptisol of Surajpur district

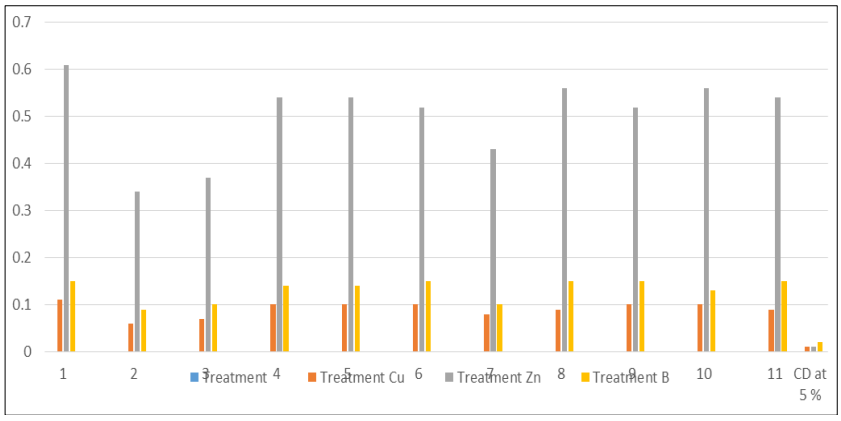

Fig 3: Total uptake of Zn Cu and B of rice (mg/pot) in relation to different treatments in Inseptisol

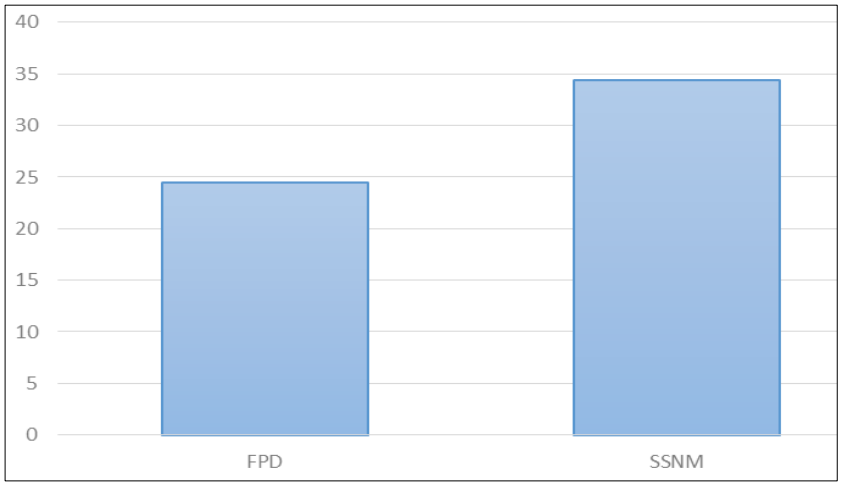

Fig 4: Wheat grain yield in kg/ha of farmer's field in relation to SSNM and farmer pratice dose in Inseptisol

Hence, we can say that other than the common major deficient nutrients i.e. nitrogen and phosphorus, sulphur and zinc elements were also identified as yield- limiting nutrients. The similar were also recorded by Tena and Beyene, (2011), Ahmed *et al*., (2014) and Qureshi, (2016) [12].

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