The Pharma Innovation Journal 2021; 10(10): 649-652

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 649-652

www.thepharmajournal.com
Received: 17-07-2021
Accepted: 30-09-2021

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

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Abstract
A pot culture experiment was conducted at Rajmohini Devi College of Agriculture Research Station, Ambikapur in Kharif season during 2018. The study was made about limiting plant nutrient based on crop response through nutrient omission technique in Alfisol of surajpur district of Chhattisgarh. For pot culture experiment rice crop variety MTU-1010 was taken as a test crop and further for field demonstration wheat crop was used in farmer field in order to have site specific nutrient management in the field. There were total 11 treatment with 3 replication under completely randomized design in pot culture experiment. It was found that there was significant reduction in straw and grain yield of rice with omission of N, P, K and Zn when compared with the treatment that received all the treatment i.e. SSNM. The test was conducted in order to check the limiting nutrient in farmer filed from where the soil sample were collected for pot culture experiment. The limited plant nutrient was corrected by application of as N - 120, P -35 (80 kg P_2O_5), K- 42 (60 kg K_2O), S – 30 and Zn 5 Kg. 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, S and Zn in Alfisol and should be applied as per the recommended dose in order to attain maximum crop production.

Keywords: SSNM, Alfisol, nutrient omission technique, yield

Introduction
World wise use of various fertilizer has made a Site specific nutrient management (SSNM) is a successful approach towards bridging the yield gap to some extent. It enhances crop yields, by minimizing overuse of fertilizer, emission of greenhouse gas can be reduced, in some case up to 50%. It help in optimization and proper utilization of soil nutrient over space and time to match crop requirement. Blanket recommendation given to farmer may leads to over-fertilization in some parts and under-utilization in some other parts. 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. The SSNM approach is being attempted to use 4R Nutrient Stewardship – right source, dose, time and place of nutrient use. 4R Nutrient Gorai *et al*., Stewardship framework promotes to high and sustainable crop productivity, nutrient use efficiency, farmer profitability and environmental safety. Existing farm resources *viz*. crop residues and farm organic manures are also optimally utilized. It also takes concern of secondary and micronutrient fertilization. The benefits of SSNM approach can be amplified through integration with other best management practices (BMP) such as quality seeds, optimum plant density, good water management, integrated pest and disease management. The basic principles of SSNM approach entail components like indigenous nutrient supply (INS) from the soil and crop nutrient requirement for attaining targeted yield. The nutrient gap i.e. the difference between the crop nutrient requirement and INS is managed through application of manures and fertilizers as and when required by the crop during its growth. The SSNM recommendations could be evolved in accordance with solely plant analysis or soil cum plant analysis. Recently, other modern approaches are also being followed for SSNM recommendation.

Material and Method
An experiment was conducted with the help of pot culture method in which nutrient omission trail was conducted at Raj Mohini Devi College of agriculture and research station Ambikapur Chhattisgarh. The experiment was carried out during kharif season 2018 using rice variety

MTU-1010. For experiment surface soil sample was collected from farmer's field form sambalpur village. The major objective of the study is to identify yield limiting plant nutrients based on crop response in Alfisol 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 which contain 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 one nutrient was omitted.

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 – Fe
(T6)	All – Mn
(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 P2O5/ha)	1.92 gm/pot
K	MOP	(100 kg K2O/ha)	1.48 gm/pot
S	Bentonite Sulphur	45	0.44 gm/pot
Ca	CaCl2. 2H2O	110	2.72 gm/pot
Mg	MgO	50	0.8 gm/pot
Fe	FeCl2	20	-----nil---------
Mn	MnCl2	15	-----nil---------
Cu	CuCl2.2 H2O	7.5	0.16 gm/pot
Zn	ZnCl2	7.5	0.127 gm/pot
B	H3BO3 (Boric acid)	3	0.15gm/pot
Mo	H2MoO4.2H2O	0.75	0.01 gm/pot

Result and Discussion

The results was found that effect of omission were significantly reduced in grain and straw yields of rice, grown in Alfisol as influenced by different treatments are illustrated in Table 1 Fig. 1 and 2. The mean grain and straw yields of rice affected significantly with different treatments in Alfisol. It was found that the treatment that received all nutrients (SSNM) recorded highest grain yields of 118.21 g/pot in Alfisol and lowest yields were recorded with the N omitted pot followed by phosphorus omitted pot. Nitrogen and Phosphorus omitted from SSNM treatment produced 73.08 and 79.60 g/pot, respectively. Similarly, S omitted pot yielded significantly lower yields of 85.17g/pot and also Zn reduce the crop yield. Reduction in rice yields were recorded under different nutrients omitted pots were in the order (36.08%) N> (28.44%) P> (10.40%) S> (7.13%) Zn. Based on these observations, it was found that considerable yield reductions were seen due to N, P, S and Zn omission from SSNM treatment.

Mean straw yields of rice also affected significantly with different treatments in soil types. The trends in straw yields with N, P, S and Zn 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 (111.71g). 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 the soils followed by P, S and Zn. 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 and Zn omitted pots may be attributed due to low native sulphur status in soil. Since the majority of the farmer's community are using S and Zn 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 and Zn 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.

Table 3: Show the treatments of grain straw yield

S. No	Treatments	Grain yield (gm pot^{-1})	Straw yield (gm pot^{-1})
T_1	SSNM	118.21	111.71
T_2	SSNM-N	73.08	75.58
T_3	SSNM-P	79.60	81.82
T_4	SSNM-K	115.08	111.40

T_5	SSNM-Fe	114.81	112.04
T_6	SSNM-Mn	111.91	111.84
T_7	SSNM-S	105.63	102.20
T_8	SSNM-Cu	116.66	113.85
T_9	SSNM-Zn	117.95	105.93
T_{10}	SSNM-B	115.46	108.97
T_{11}	SSNM-Mo	114.37	112.42

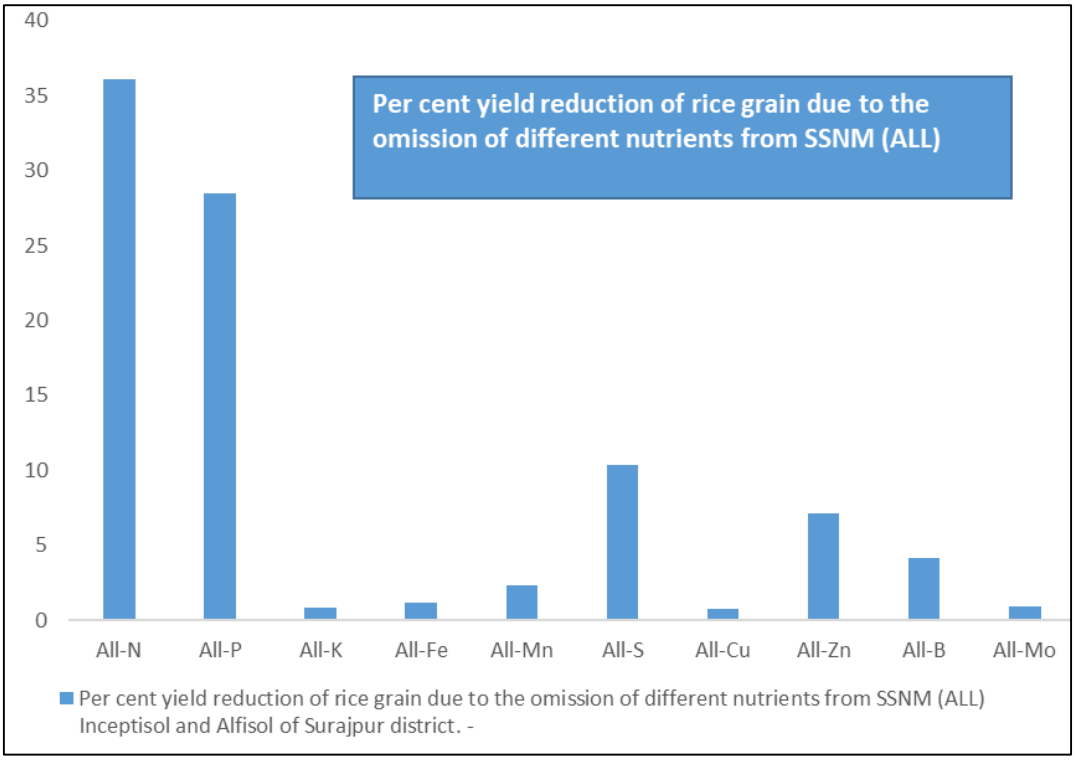

Fig 1: Percentage decrease in rice yield with different nutrient omitted pots over SSNM in Alfisol of Surajpur district

Table 4: Grain yields of wheat in relation to SSNM and FPD in two soils group of Surajpur district

S. No	Soil group	FPD	SSNM	% increase over FPD
1	Alfiisol	27.1	36.15	33.39

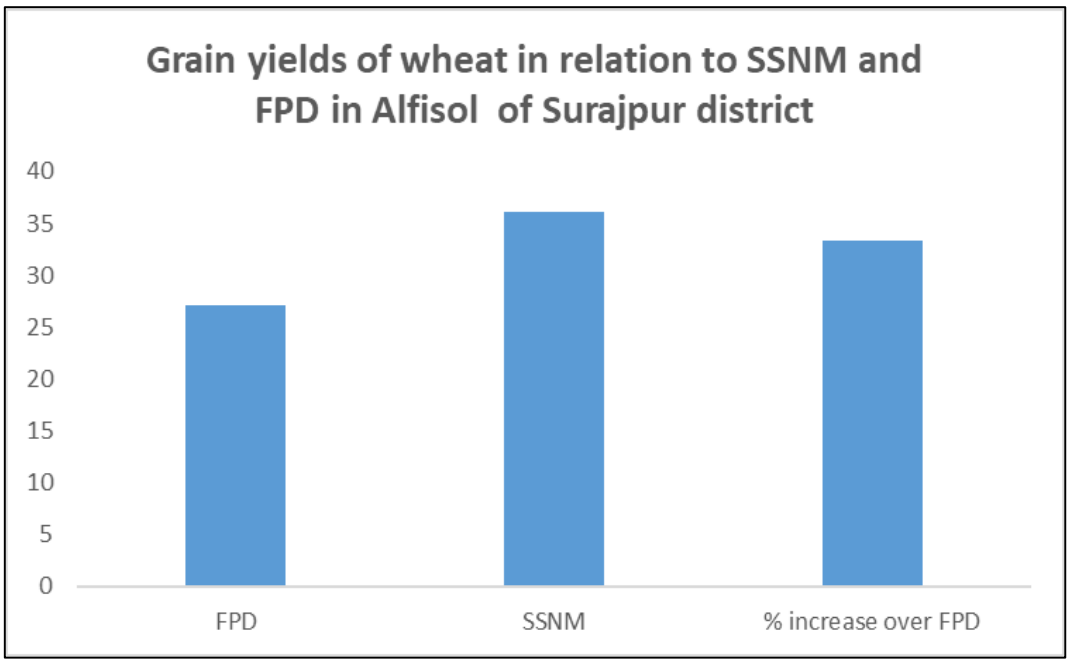

Fig 2: Grain yields of wheat in relation to SSNM and FPD in Alfisol of Surajpur district

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) [12].

Acknowledgment
The author gratefully acknowledges authority of IGKV, Raipur for providing proper guideline, necessary facilities and financial support for conducting the research experiment in the department of soil science and agriculture chemistry, College of Agriculture, Raipur.

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