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Fertilizer economy through under soil- test crop response targeted yield model in maize crop in Chandauli district, Uttar Pradesh

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Abstract
Studies on soil test crop response based integrated nutrient management were conducted for the desired yield targets of Maize, on Alluvial soil of Agricultural Research Farm, Banaras Hindu University, Varanasi during in kharif 2018. Testing of developed fertilizer prescription equation is necessary to demonstrate the effectiveness of technology delivery to the stake holders in need. To assess the validation of fertilizer prescription a series of experiment was setup in five locations of eastern plain zone of Utter Pradesh. Soils of the selected location are analyzed initially for available N, P and K. Treatments include control, farmer practices, general recommended dose of fertilizer and STCR based fertilizer dose for a yield target of 30 and 35q ha^{-1}. The results of the experiments indicated that in all the five locations, the per cent achievement of the targeted yield was within ±10% variation proving the validity of the equations for prescribing integrated fertilizer doses for maize. The highest per cent increment in yield was recorded in the yield target of 35 q ha^{-1} (21.65 per cent) followed by 30 q ha^{-1} (15.40 per cent) over farmer's practice. The highest mean grain yield was recorded in STCR–35 q ha^{-1} (3569 kg ha^{-1}). The highest benefit: cost ratio (3.33) was recorded in STCR 35 q ha^{-1} is followed by STCR 30 q ha^{-1} (3.24). The fertilizer prescription equations developed for maize under IPNMS can be recommended for alluvial Inceptisol of eastern Utter Pradesh for achieving a yield target of 35 q ha^{-1} with higher economic return.

Keywords: Fertilizer prescription, STCR, Maize, B:C ratio, yield target etc.

Introduction
Maize (*Zea mays* L.) is important cereal crop of the world serving as food for man and forage for cattle. It is called as "Queen of Cereals" and "King of Fodder" due to its great importance in human and animal diet. Besides as a food grain crop, maize plays a vital commercial role in Indian economy. It is used as raw material for manufacture of syrup, alcohol, starch, glucose, paper, adhesives, synthetic rubber, resins, acetic acids, lactic acids etc., the demand for which is increasing day by day. The green plant also serves as palatable fodder for cattle. Besides this, the maize produce in our country is being also utilized by poultry industries. A judicious use of fertilizers is essential since the cost of fertilizers has gone up very high in recent years. The targeting of crop yields is of importance so as to obtain varying production levels and to monitor the stress on soil fertility, since exhaustion of the nutrients from the soil are directly proportional to the yield level obtained. This also ensures judicious use of fertilizers and allows altering the profit per unit investment of fertilizers. Targeted yield approach was first developed by (Troug, 1960) [12] and (Ramamoorthy, 1967) [7]. Established theoretical basis and experimental technique to suit Indian conditions. Soil test based fertilizer recommendations result in efficient fertilizer use and maintenance of soil fertility. Soil test and crop response (STCR) approach is based on soil contribution and yield level is used for recommending fertilizer dose. The targeted yield concept which is being widely followed since 1967 in All India Co-ordinated Research Project on STCR, which employs multiple regression equation to study the nutrient interactions. STCR approach appears to be a viable technology to sustain higher crop productivity and assure better soil quality under intensive agriculture system. The IPNS based STCR equations are useful for deciding the appropriate dose of chemical fertilizers in conjunction with the organic manures.

Materials and Methods
To assess the validation of fertilizer prescription equation for Maize developed by STCR model, field experiment were carried out in different locations of five farmers of alluvial soil of eastern plain zone of Utter Pradesh. Experiments were set up at one location Pathraur village in Naugarh block of Chandauli district, Utter Pradesh. Initial soil samples were collected from each location.

Soil and Plant Chemical Analysis

Soil reaction (pH) was measured in a 1:2.5 soil/water suspension using a glass electrode pH meter (Jackson 1967) [3]. Available N was determined by alkaline permanganate method (Subbiah and Asija 1956) [10] available P by Olsen's method (Olsen *et al.* 1954) [5] and available K by neutral normal ammonium acetate extraction method by (AOAC 1970) [1]. Plant analysis (grain and straw) was done by standard procedures of (Jackson 1967) [3]. The initial soil fertility status for different locations is shown in Table 1. Fertilizer prescription equations developed for maize under STCR on eastern plain zone of utter Pradesh, are given below:

Nitrogen dose (kg ha^{-1}) =12.69*T-1.27SN-.59*FYM-N

Phosphorus dose (kg ha^{-1}) = 3.92*T- 0.25* SP-0.67* FYM-P

Potassium dose (kg ha^{-1}) = 6.25*T-0.76*K-0.39*FYM-K

Where, FN, FP_2O_5 and FK_2O are fertilizers N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T=Grain yield target in q ha^{-1}; SN, SP and SK are available N, P and K through soil in kg ha^{-1}, respectively; ON, OP and OK are N, P and K supplied through FYM in kg ha^{-1}. The treatments imposed were as follows: (i) Control, (ii) Farmer's Practices, (iii) General Recommended Dose, (iv) STCR based fertilizer dose for an yield target of 30 q ha^{-1} (v) STCR based fertilizer dose for an yield target of 35 q ha^{-1}. Based on the initial soil test values of available N, P and K and the quantities of N, P_2O_5 and K_2O supplied fertilizer doses were calculated and applied for STCR treatments for various yield targets.

Statistical Analysis

The experimental design was a randomized block design, and the statistical analysis was done by the standard procedures suggested by Gomez and Gomez (1984) [2].

Table 1: Initial soil fertility status of the different locations of Villege - Pathraur, Naugarh block

Locations	Farmers Name	pH	EC (dSm^{-1})	OC (%)	Avai. N (kg ha^{-1})	Avai. P (kg ha^{-1})	Avai. K (kg ha^{-1})
1.	Sri. Lallan S/o. Sri Kishori	7.45	0.51	0.65	220.00	15.00	200.00
2.	Sri. Bullu S/o. Sri Ramsurat	7.52	0.37	0.64	221.00	15.10	200.15
3.	Sri. Sahab S/o. Sri Ramjanam	7.60	0.38	0.76	220.46	15.60	200.12
4.	Sri. Mangru S/o SmtManki	7.30	0.35	0.70	219.92	14.58	196.45
5.	Sri.Srinath S/o Sri Sukhu	7.40	0.37	0.72	221.55	14.62	198.00

Fifty percent of N and full dose of P_2O_5 and K_2O were applied basally and the remaining 50% N was applied on 30 days after sowing and all other packages of practices were carried out periodically. Using the data on grain yield and fertilizer doses applied, the parameters viz., B:C ratio was worked out based on the price of the produce and cost incurred for the cultivation as per the standard procedure.

Table 2: Treatments of fertilizer doses (kg ha^{-1}) imposed under different locations

Treatments	Location 1			Location 2			Location 3			Location 4			Location 5		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farmer's practice	100	35	35	100	35	35	100	35	35	100	35	35	100	35	35
GRD	120	60	60	120	60	60	120	60	60	120	60	60	120	60	60
STCR 30 q ha^{-1}	152	62	43	152	62	43	152	62	43	152	62	43	152	62	43
STCR 35 q ha^{-1}	170	88	80	170	88	80	170	88	80	170	88	80	170	88	80

Where: GRD – General recommended dose, STCR- Soil test crop response target yield

Results and Discussions

The highest mean grain yield among the five farmers were recorded in the treatment STCR 35q ha^{-1}(3569 kg ha^{-1}) followed by STCR 30 q ha^{-1}(2960 kg ha^{-1}), GRD (2532 kg ha^{-1}) and farmer practices (2065 kg ha^{-1}) indicating that the STCR-IPNMS treatment was recorded relatively higher yield over GRD and Farmer's practices (Table 3). Lowest yield recorded in blanket (1420) compare to all other treatments. STCR 35 t ha^{-1} recorded a yield increase of 21.65% over Farmer's practices. All the treatments are significantly different in which STCR 35q ha^{-1} receive highest mean yield. In all the five verification trials, the percent achievement of the targeted yield was within ± 10% variation proving the validity of the equations for prescribing integrated fertilizer doses for maize. The highest net benefit was found in STCR 35q ha^{-1} (Rs.33293) followed by STCR 30 q ha^{-1} (Rs.23540), GRD (Rs.15363) and farmer practices (Rs.7273). Compare to net benefit, highest B:C ratio was recorded in STCR 35 q ha^{-1} (3.33) followed by STCR 30 q ha^{-1} (3.24). So in STCR 35 q ha^{-1} we obtain a higher yield compare to STCR 30 q ha^{-1} but economic return is less. So STCR treatments obtain higher yield, net benefits and B:C ratio compare to control and blanket treatments due to balanced supply of nutrients from fertilizer, efficient utilization of applied fertilizer nutrients in the presence of organic sources and the synergistic effect of the conjoint addition of various sources of nutrients (Sellamuthu *et al.* 2015) [8]; (Muralidharudu *et al.* 2011) [4] and (Singh and Singh, 2014) [9].

Table 3: Grain yield, net benefits and B: C ratio of maize crop under different locations

Treatments	Grain yield (kg ha^{-1}) Locations					Mean (kgha^{-1})	% increme-nt in yield over T_2	Value of additional yield (Rs.)	Cost of fertilizer (Rs.)	Net benefit (Rs.)	B/C ratio
	1	2	3	4	5						
T_1-0 - 0 – 0	1475	1445	1455	1470	1420	1453	-	-		-	-
T_2-100 - 35 – 35	2010	2060	1980	1995	2015	2012	5.95	11900	4627	7273	1.57
T_3-120 - 60 -60	2520	2540	2550	2510	2540	2532	11.20	22400	7037	15363	2.18
T_4-152 - 62 –4 3	2950	2965	2975	2985	2960	2967	15.40	30800	7260	23540	3.24
T_5-170 - 88 – 80	3540	3555	3571	3596	3585	3569	21.65	43300	10007	33293	3.33

Note: Maize @ Rs.20.00 kg^{-1}, N @ Rs.17.39 kg^{-1}, P_2O_5 @ Rs.56.25 kg^{-1}, K_2O @ Rs.26.66

T_1 – Control, T_2 - Farmer's Practices, T_3 - GRD (General recommended Dose), T_4 - Target yield (30 q ha^{-1}), T_5 - Target Yield (35 q ha^{-1})

Post harvest soils value revealed that a sufficient build up and maintenance of SN, SP and SK are found under STCR study compare to farmer practices and general recommended dose. Despite removal of higher amount of nutrient in STCR treatment due to getting a higher yield, higher post harvest soil fertility was observed in STCR plot. Highest post harvest soil nitrogen was found in STCR for 35 q ha^{-1} in location-5, Sri. Srinath S/O Sukhu (232.00 kg ha^{-1}), soil potassium in location-4, Sri. Mangru S/O Smt.Manki (212.00 kg ha^{-1}), soil phosphorus in location-5, Sri. Srinath s/o Sukhu (16.90 kg ha^{-1}). The greater build up of nutrient in STCR treatment was due to balance application of chemical fertilizer in conjunction with organic manure. Combined application of inorganic fertilizers improved the chemical and physical properties, which may lead to enhanced and sustainable production (Tilahun *et al.*, 2013) [11]. Greater profit consistent with maintenance of soil fertility status was realized when fertilizer was applied for appropriate yield targets in succession over years using STCR-IPNMS concept (Ramamoorthy and Velayutham, 2011) [6].

Conclusions

The study will help to make guidelines for the amount of fertilizer used in rice cultivation. The specific yield equation based on soil health will not only ensure sustainable crop production but will also steer the farmers towards economic use of costly fertilizer inputs depending on their financial status and prevailing market price of the crop under consideration.

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