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STCR Recommendation of NPK Fertilizer Levels in Rice Crop in Inceptisol

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Abstract

A field experiment was conducted in Majghawan village, Naugarh block in Chandauli district during 2018–2019 to assess yield, soil, plant and fertilizer nitrogen, phosphorus and potassium (NPK) nutrient relationships and calibrate optimum fertilizer doses for attaining yield targets. The fertilizer adjustment equations are derived by the All India Coordinated Research Project, Institute of Agricultural Science, Banaras Hindu University, Varanasi centre. Results revealed that targeted yield of Rice (40 q ha^{-1}) and (50 q ha^{-1}) have been achieved by using the plant nutrients on the basis of targeted yield concept (soil test crop response technology). The percent increase in yield was 24.30 and 49.19 % in first location, 24.70 and 49.30 % in second location, 25.10 and 49.75 % third location, 24.50 and 49.34 % fourth location and 24.00 and 48.48 % fifth location, over general recommendation dose of fertilizer which were 16.20, 16.50, 16.85, 16.60 and 16.40 q ha^{-1}, respectively. The maximum net returns of rice first location (Rs.9939.00 and Rs.50855.00), second location (Rs.10119.00 and Rs.51575.00), third location (Rs.10209.00 and Rs.51575.00), fourth location (Rs.9579 and Rs.50585.00) and fifth location (Rs.9039.00 and Rs.50675.00) were obtained in treatment where plant nutrients applied as per soil test value (STCR treatment). This technology also maintained the soil available plant nutrients. Thus, for obtaining maximum gain and sustain the soil fertility, application of plant nutrients as per soil test value (STCR technology) is essential. The fertilizer doses were validated for attaining yield targets of 40 and 50 q ha^{-1} in farmer's fields. Rice yield within 10% deviation was attained, which indicated that soil test based fertilizer dose was superior. This approach could be adopted for regions with similar soil and agro-climatic conditions in other parts of the world to increase Rice yields.

Key words: *Target yield, soil test crop response, economics and B:C ratio etc.*

Introduction

Rice is a nutritional staple food which provides instant energy as its most important component is carbohydrate (starch). On the other hand, rice is poor in nitrogenous substances with average composition of these substances being only 8 percent and fat content or lipids only negligible, i.e., 1 per cent and due to this reason it is considered as a complete food for eating. Rice flour is rich in starch and is used for making various food materials. It is also used in some instances by brewers to make alcoholic malt. Likewise, rice straw mixed with other materials is used to produce porcelain, glass and pottery. In fertilizing the crop existing soil fertility and crop requirements should be taken into account. Rice is also used in manufacturing of paper pulp and livestock bedding. The variability of composition and characteristics of rice is really broad and depends on variety and environmental conditions under which the crop is grown. In husked rice, protein content ranges in between 7 to 12 percent. The use of nitrogen fertilizers increases the percentage content of some amino acids.

Materials and Methods

The on farm testing trials were conducted in village–Majhgawan, block - Naugarh of Chandauli district, Uttar Pradesh, India during year *Rabi* 2018-19 on alluvial soil (Inceptisol). Soil samples (0-15 cm in depth) were collected, dried and passed through 2 mm sieve and analyzed for physico chemical properties. Available nitrogen, by the alkaline permanganate method, available phosphorus, by Olsen method and available potassium, by the ammonium acetate method were analysed in soil samples. Five fertilizers treatments viz., Control, Farmers practice, General recommendation dose of fertilizer, Soil test crop response (STCR) for 40 q ha^{-1} and Soil test crop response (STCR) for 50 q ha^{-1} in Rice variety of test crop was HUR 3022 (Hybrid), 40 q ha^{-1} and 50 q ha^{-1} targeted yield were taken. The targeted yield of crop was decided as per yield potential of varieties. Pre sowing soil samples were analyszed according to the standard procedures (Table 1). Soil resource inventory of the study area in given in the table 1. Quantities of nitrogen, phosphorus and potassium were calculated with the help of fertilizer adjustment equations[1].

$$FN = 4.74\ T - 0.49\ SN - 0.34N\ FYM$$

$$FP_2O_5 = 1.53\ T - 0.09\ SP - 0.06P\ FYM$$

$$FK_2O = 2.92\ T - 0.35\ SK - 0.11K\ FYM$$

Where, FN, FP and FK are fertilizer N, P_2O_5 and K_2O (kg ha^{-1}) respectively. FYM is Farm Yard Manure (t ha^{-1}). SN, SP and SK are soil test values (kg ha^{-1}) for potassium permanganate ($KMnO_4$) extractable N, Olsen's P and ammonium acetate extractable K, respectively, and Y is crop yield in q ha^{-1}.

The crop received one third N and full dose of P_2O_5 and K_2O as basal application and remaining half N were applied and 27 days after sowing in rice crop. Remaining nitrogen was applied at panicle initiation stage. Nitrogen was applied through urea and phosphorus through single super phosphate and potassium through muriate of potash. The rice variety of test crop was HUR-3022 (Hybrid). The same variety was used in STCR treatment and other treatments.

Table 1 Physico-chemical properties of the experimental area

Locations	Physico chemical properties			Fertility status		
	pH	EC (dSm^{-1})	OC (%)	Av-N (kg ha^{-1})	Av-P (kg ha^{-1})	Av-K (kg ha^{-1})
Location-I	7.32	0.28	0.55	200.00	10.60	180.00
Location-II	7.45	0.37	0.49	202.15	10.50	180.30
Location-III	7.70	0.34	0.62	201.30	10.60	181.22
Location-IV	7.40	0.29	0.44	202.80	10.34	181.48
Location-V	7.30	0.39	0.46	203.27	10.27	179.39

***** Av = Available

Table 2 Economics of Verification Trails for Rice crop

Treatments	Fertilizer dose NPK (kg ha^{-1}) and FYM (t ha^{-1})	Actual mean yield (kg ha^{-1})	Actual mean straw yield (kg/ha)	Additional yield (kg ha^{-1})	Value of additional yield (Rs.)	Cost of fertilizer (Rs.)	Net benefit (Rs.)	B/C ratio
	Location - I: Name – Smt.Paramshila H/O.Rampyare , Village-Majhgawan							
T_1-Control	0-0-0	1620	2430	-	-	-	-	-
T_2 – FP	100-35-35	2430	3645	810	14580	4640.85	9939	2.14
T_3 – GRD	120-60-60	3140	5275	1520	27360	7061.40	20299	2.87
T_4 – 40q/ha	91-60-54	3960	6653	2340	42120	6397.13	35723	5.58
T_5 – 50q/ha	139-76-83	4940	8447	3320	59760	8904.99	50855	5.71
	Location - II: Name – Smt.Shyamrathi , Village- Majhgawan							
T_1-Control	0-0-0	1650	2722	-	-	-	-	-
T_2-FP	100-35-35	2470	4075	820	14760	4640.85	10119	2.18
T_3-GRD	120-60-60	3185	5414	1535	27630	7061.40	20569	2.91
T_4-40 q ha^{-1}	91-60-54	3990	6783	2340	42120	6397.13	35723	5.58
T_5-50 q ha^{-1}	139-76-83	5010	8517	3360	60480	8904.99	51575	5.79
	Location - III: Name and Tribe – Smt.Hirawati , Village- Majhgawan							
T_1-Control	0-0-0	1685	2527	-	-	-	-	-
T_2-FP	100-35-35	2510	3765	825	14850	46401	10209.15	2.20
T_3-GRD	120-60-60	3210	5457	1525	27450	7061	20388.60	2.89
T_4-40 q ha^{-1}	91-60-54	4020	6834	2335	42030	6397	35632.87	5.57
T_5-50 q ha^{-1}	139-76-83	5045	8576	3360	60480	8905	51575.01	5.79
	Location - VI: Name and Tribe – Smt.Vimla Singh, Village – Majhgawan							
T_1-Control	0-0-0	1660	2656	-	-	-	-	-
T_2-FP	100-35-35	2450	3920	790	14220	4640.85	9579	2.06
T_3-GRD	120-60-60	3170	5072	1510	27180	7061.4	20119	2.85
T_4-40 q ha^{-1}	91-60-54	3950	7110	2290	41220	6397.13	34823	5.44
T_5-50 q ha^{-1}	139-76-83	4965	8937	3305	59490	8904.99	50585	5.68
	Location – V: Name and Tribe –Sri. Ram chander, Village – Majhgawan							
T_1-Control	0-0-0	1640	2427	-	-	-	-	-
T_2-FP	100-35-35	2400	3552	760	13680	4640.85	9039	1.95
T_3-GRD	120-60-60	3130	5665	1490	26820	7061.4	19758	2.80
T_4-40 q ha^{-1}	91-60-54	3940	7131	2300	41400	6397.13	35003	5.47
T_5-50 q ha^{-1}	139-76-83	4950	8960	3310	59580	8904.99	50675	5.69

Note: Rice@Rs.20.00/kg, N@Rs.17.39/kg P_2O_5@Rs.56.25/kg, K_2O@Rs.26.66/kg.

A miner modification was made in the ready reckoner, FP: Farmers practice i.e. the fertilizer doses the farmers generally applied in the area, GRD: General recommendation of agricultural department of the district on the basis of soil test value, B: C ratio: benefit cost ratios

Results and Discussion

Yield targeting of Rice based on soil test

Experimental data on follow up trails as frontline demonstration, for each location during the period 2018-19 were conducted in farmers field and are given in Table 2. From the field experiment the basic data on nutrient requirement for producing one quintal grain yield of rice, percent contribution of nutrients from soil (%CS) and fertilizer (%CF) were evaluated. These basic parameters were used for developing the fertilizer prescription equations under NPK alone.

The nutrient requirement of N, P_2O_5 and K_2O were 6.26, 1.12 and 3.78 kg q h^{-1} of grain yield, respectively. The percent contribution of nutrients from soil and fertilizers were found to be 25.41 and 117.03 for N, 40.99 and 35.42 for P_2O_5 and 19.67 and 45.47 for K_2O, respectively. It was noted that contribution of potassium from fertilizer for wheat was higher in comparison to soil. This high value of potassium could be to the interaction effect of higher doses of N, P coupled with priming effect of starter K doses in the treated plots, which might have caused the release of soil potassium form, resulting in the higher uptake from the native soil sources by the crop.

Target yield of 40 and 50 q ha^{-1} has been achieved with comparatively lower application of N and P_2O_5 fertilizers but higher application of K_2O, in comparison to doses applied in farmer's practice and soil based recommendations. As for example in the alluvial soil of West Bengal, In the winter season highest rice yield was 6.0 t/ha^{-1} regardless of the N level used but could be raised to 7.4 t/ha^{-1} with increased application of K fertilizers. This is probably due to the higher N use efficiency as well as increased N recovery by crop under increased K application. Yield targets of 40 and 50 q ha^{-1} for Rice HUR – 3022 (Hybrid) were achieved in table 2 from the expected yield targets in all the cases. In all sites, grain yields of rice through general recommendation (GRD) of fertilizers lagged behind the yield obtained at 40 and 50 q ha^{-1} fixed target. Confirming the findings of earlier workers[1,2]. Between the two targets tried, targeting for 45 q ha^{-1} recorded relatively higher response ratio than with 35 q ha^{-1} though it has also recorded higher yields. This might be due to the better use efficiency of applied NPK fertilizers at low yield target levels [2, 3].

However for efficient utilization of applied fertilizer some other parameters like soil pH, organic carbon status etc. should also be considered, since these are the major determining factors of soil nutrient retention. This is for the development of an effective fertilizer schedule as well as nutrient supply source in view of the better nutrient absorption and assimilation by the plants.

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