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Increased Rice Yield and Economic Benefits by Improved Crop Production Technology in Jhrigawan village, Chandauli District in an Inceptisol

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Abstract

The present study was conducted in five locations of Naugarh block in Chandauli district during the year 2022-23, to study the soil test crop response technology on yield and economics of rice in Jhrigawan village, Chandauli district in an Inceptisoil. 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 (38 q ha^{-1}) and (43 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 17.00 and 32.61 % in first location, 14.78 and 31.10 % in second location and 16.12 and 29.74 % third location over farmer prectise dose of fertilizer which were 37.85 and 42.90, 37.75 and 43.12, 38.18 and 42.66 q ha^{-1}, respectively. The maximum net returns of rice first location (Rs.36037.89 and Rs.44932.88), second location (Rs.35417.89 and Rs.44952.88) and third location (Rs.36877.89 and Rs.44632.88) 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.

Key words: Soil test crop response, target yield, economics and B:C ratio etc.

Introduction

Rice (*Oryza sativa*) is the staff of life for the population in Asia, particularly in South and Southeast Asia where more than 90 percent of Rice is produced and consumed. It is also a major source of livelihood for more than 250 million households. Providing adequate food entitlements, safeguarding public health, and at the same time preventing deforestation and conserving the environment are daunting challenges in the new millennium for countries in Asia, especially India where the population has already crossed the billion mark. Rice is the major source of calorie intake and also contributes to the total agricultural income in most of the Asian countries. World-wide, Rice is grown over 153.76 M ha^{-1}. In Asia, Rice is grown in 136.64 M ha$^{-1.}$ India has the largest area (44.6 M ha^{-1}) under Rice in the world and is second only to China in terms of Rice production. It is the staple food of 65 percent of the total population in India. It constitutes ca. 52

percent of the total food grain production and 55 percent of total cereal production. Over the pasts three decades, the advent of modern high yielding Rice varieties and associated green revolution technologies have almost doubled the Rice production in South and Southeast Asia. Several countries in the region have not only achieved self-sufficiency in Rice production, but also a few of them, including India, have become net exporters of Rice. However, with the growing population, the demand for rice will also continue to grow. A challenge in the future would be that more rice would have to be produced from less land, with less water, less labour, and lesser use of pesticides. This would require innovative research and technologies and policies that promote increased rice production. Here we analyse the current status of rice production and review the constraints, opportunities, and advances in Rice research and developments as well as some emerging concerns to meet the targeted production of Rice in South Asia, especially India.

Materials and Methods

The on farm testing trials were conducted in village– Jhrigawan, 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 as described (Jackson, 1973)[3]. Available nitrogen, by the alkaline permanganate method (Subbiah and Asija, 1956) [10], available phosphorus, by Olsen method (Olsen *et al.*, 1954) [5] and available potassium, by the ammonium acetate method (Hanway and Heidal, 1952) [2] as described (Jackson, 1973)[3]. Five fertilizers treatments viz., Control, Farmers practice, General recommendation dose of fertilizer, Soil test crop response (STCR) for 38 q ha^{-1} and Soil test crop response (STCR) for 43 q ha^{-1} in Rice variety of test crop was (HUR-917, Malviya Sugandha Dhan 917). The targeted yield of crop was decided as per yield potential of varieties. Pre sowing soil samples were analyszed according to the standard procedures. 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 as follow.

$FN = 4.74\ T – 0.49\ SN- 0.34ON$

$FP_2O_5 =1.53\ T –0.09\ SP- 0.06OP$

$FK_2O = 2.92\ T – 0.35\ SK- 0.11OK$

Where - T = Yield target (t ha^{-1})

F.N. = Fertilizer N (kg ha^{-1})

$F.P_2O_5$ = Fertilizer P (kg ha^{-1})

$F.K_2O$ = Fertilizer K (kg ha^{-1})

SN = Soil available nitrogen (kg ha^{-1})

SP = Soil available phosphorus (kg ha^{-1})

SK = Soil available potassium (kg ha^{-1})

ON = Amount of Nitrogen thorough FYM (kg ha^{-1})

OP = Amount of Phosphorus thorough FYM (kg ha^{-1})

OK = Amount of Potassium thorough FYM (kg 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-917, Malviya Sugandha Dhan 917). 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	7.59	0.34	0.55	210.00	17.00	185.00
Location-II	7.45	0.38	0.52	205.00	16.10	180.11
Location-III	7.58	0.37	0.49	205.00	15.00	180.00

* Av = Available

Table 2 Economics of Verification Trails for Rice (HUR-917, Malviya Sugandha Dhan 917)

Treatments	Fertilizer dose NPK (kg ha^{-1}) and FYM (t ha^{-1})	Actual mean yield (kg ha^{-1})	Additional yield (kg ha^{-1})	Value of additional yield (Rs.)	Cost of fertilizer (Rs.)	Net benefit (Rs.)	B/C ratio
	Location - I: Name – Smt. Vinod kumar S/O. Sri Balishun, Village- Jharigawan						
T_1-Control	0-0-0	1670	-	-		-	-
T_2 – FP	100-35-35	2434	764	15280	4626.85	10653.15	2.30
T_3 - GRD	120-60-60	3255	1585	31700	7037.40	24662.60	3.50
T_4 – 38q/ha	74-56-46-2	3840	2170	43400	6644.82	36755.18	5.53
T_5 – 43q/ha	98-64-60-2	4310	2640	52800	7879.82	44920.18	5.70
	Location - II: Name – Smt.Girja W/O . Shri Mewa, Village- Jharigawan						
T_1-Control	0-0-0	1635	-	-		-	-
T_2 – FP	100-35-35	2430	795	15900	4626.85	11273.2	2.44
T_3 - GRD	120-60-60	3315	1680	33600	7037.40	26562.6	3.77
T_4 – 38q/ha	76-57-47-2	3783	2148	42960	6762.11	36197.9	5.35
T_5 – 43q/ha	100-64-62-2	4266	2631	52620	7967.12	44652.9	5.60
	Location - III: Name – Sri. Govind S/O Sri. Rampyare, Village- Jharigawan						
T_1-Control	0-0-0	1605	-	-		-	-
T_2 – FP	100-35-35	2460	855	17100	4626.85	12473.15	2.70
T_3 - GRD	120-60-60	3305	1700	34000	7037.40	26962.60	3.83
T_4 – 38q/ha	76-57-47-2	3815	2210	44200	6762.11	37437.89	5.54
T_5 – 43q/ha	100-64-62-2	4305	2700	54000	7967.12	46032.88	5.78

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

Soil characteristics

The soil was alluvial (Inceptisol) in reaction with pH varying from 7.45 - 7.59. The organic carbon content varied from 0.49-0.55 soils were medium in available nitrogen (ranging from 205.00-210.00 kg ha^{-1}), low to medium in available phosphorus (ranging from 15.00-17.00 kg ha^{-1}) and medium to high in available potassium (ranging from 180.00-185.00 kg ha^{-1}) in table 1. Though these soils are considered to be most fertile, they are deficient in nitrogen and humus but moderately supplied with phosphorus and potassium.

Yield targeting of rice based on soil test

Experimental data on follow up trails as frontline demonstration, for each location during the period 2022-23 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^{-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[6]. Similar type of higher efficiency of potassic fertilizer was also reported for rice by[1] in alluvial soils.

Target yield of 38 and 43 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[11]. This is probably due to the higher N use efficiency as well as increased N recovery by crop under increased K application[4]. Yield targets of 38 and 43 q ha^{-1} for Rice **(**HUR-917, Malviya Sugandha Dhan 917) 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 38 and 43 q ha^{-1} fixed target[7, 8]. Between the two targets tried, targeting for 43 q ha^{-1} recorded relatively higher response ratio than with 38 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[8,9].

3.2 Post harvest soil fertility status

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 38 and 43 q ha^{-1} in location-1, Smt. Vinod kumar S/O. Sri Balishun, Village- Jharigawan (245.00 and 248.00 kg ha^{-1}), soil potassium in location-3, – Sri. Govind S/O Sri. Rampyare, Village- Jharigawan (215.00 and 222.00 kg ha^{-1}), soil phosphorus in location-1, Smt. Vinod kumar S/O. Sri Balishun, Village- Jharigawan (20.10 and 21.50 kg ha^{-1}) in table 3. 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. 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 concept.

Table 3 Post harvest soil fertility status of various treatments under different locations of Villege- Hadahi, Naugarh block in district Chandauli.

Treatments	Location 1			Location 2			Location 3		
	N	P	K	N	P	K	N	P	K
Control	205	17.0	186	220	16.44	174	218	15.44	172
Farmer's practice	226	18.1	188	227	17.30	181	224	16.30	180
GRD	232	19.2	198	233	18.00	191	230	17.00	190
STCR 38 q ha^{-1}	245	20.1	210	238	19.50	210	23	19.10	215
STCR 43 q ha^{-1}	248	21.5	216	239	20.50	220	239	21.20	222
CD at 5%	1.39	1.15	0.53	0.59	1.05	0.71	0.69	1.85	0.74

Where: GRD – General recommended dose and STCR-Soil teat crop response

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.

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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