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# Effect of Soil Test Crop Response Technology on Productivity and Economics of Rice crop of Varanasi district of Uttar Pradesh

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## Abstract

*The present study was conducted in four locations of Varanasi district during the year 2013, to study the effect of soil test crop response technology on productivity and economics of rice crop. The fertilizer adjustment equations are derived by the All India Coordinated Research Project, Institute of Agricultural Science, B.H.U., Varanasi centre. Results revealed that targeted yield of rice (45 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 44.50 and 48.00 % in first location, 44.33 and 48.66 % in second location, 44.63 and 47.10 % third location and 45.50 and 47.66 % in fourth location over farmers practice which were 33.33, 29.50, 31.00 and 30.00 q $ha^{-1}$, respectively. The maximum net returns of rice first location (Rs.18947.75 and Rs.21539.49), second location (Rs.16873.25 and Rs.18956.09), third location (Rs.19623.10 and Rs.21206.20) and fourth location (Rs.19843.10 and Rs.21085.20) 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:** Rice, target yield, soil test crop response and FYM etc.

## Introduction

The important crops include rice is the major crop in Uttar Pradesh and is grown in about 5.90 mha which comprises of 13.5% of total rice in India. Rice provides 21% of global human per capita energy and 15% of per capita protein. Although rice protein ranks high in nutritional quality among cereals, protein content is modest. Rice also provides minerals, vitamins, and fiber, although all constituents except carbohydrates are reduced by milling. Uttar Pradesh is the leading producer of rice and rank 3rd in the country. Annual rice production is around 12 metric ton in state. Rice is cultivated mainly in Kharif season (wet season) in around 5.90 million hectare followed by zaid (summer season) 35000-40000 hectare only. Farmers are using excess chemical fertilizers to achieve higher yield but the decision on fertilizer use requires knowledge of the expected crop yield and response to nutrient application. It is a function of crop nutrient needs, supply of nutrients from indigenous sources and the short- and long-term fate of the applied fertilizer nutrients (Dobermann *et al*. 2003). One of the reasons for lower production is imbalanced use of fertilizers by the farmers without knowing soil fertility status and nutrient requirement of crops causes adverse effects on soil and crop both in terms of nutrient toxicity and deficiency (Ray *et al*. 2000). Micro situation level specific fertilizer recommendations are possible for soils of varying fertility resource conditions of farmers and levels of targeted yield and for similar soil classes and environment (Ahmed *et al.*, 2002). Field specific balanced amounts of primary nutrients (N.P and K) were prescribed based on crop based estimates of the supply of N,P and K and by modelling the expected yield response as a function of nutrient interaction (Ramamurthy *et al.*, 2009). These equations are developed after establishing significant relationship between soil test values and the added fertilizer. Keeping the above facts in view and non availability of STCR data for rice in eastern Uttar Pradesh this study was conducted.

The objective of this study was to evolve the sound basis of fertilizer prescriptions for rice crop in alluvial soil (Inceptisol) at different soil fertility levels under the conditions of fertilizer scarcity and to ensure maximum fertilizer use efficiency. The study also intended to find the relationship between the nutrients supplied by the soil and added by organic and inorganic sources, their uptake and to develop a guideline for judicious application of fertilizer for desired yield target of rice by using STCR model.

**Materials and Methods**

The on farm testing trials were conducted in villages viz., Khewashipur, Shravanpur, Loharpur and Khewashipur of Varanasi district, Uttar Pradesh, India during year *kharif* 2013 on alluvial soil (Inceptisol). Soil samples (0-20 cm in depth) were collected, dried and passed through 2 mm sieve and analyzed for physico chemical properties as described by Jachson (1973). Available nitrogen, by the alkaline permanganate method (Subbiah and Asija, 1956); available phosphorus, by Olsen *et al*. (1954) and available potassium, by the ammonium acetate method (Hanway and Heidal, 1952) as described by Jackson (1973). Five fertilizers treatments viz., Control, Farmers practice, General recommendation dose of fertilizer, Soil test crop response (STCR) for 45 q ha$^{-1}$ and Soil test crop response (STCR) for 50 q ha$^{-1}$ in rice (hybrid super moti) 45 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. Soil resource inventory of the study area is given in the table 1. Quantities of nitrogen, phosphorus and potassium were calculated with the help of fertilizer adjustment equations as follow.

$FN = 4.74\ T – 0.49\ SN$

$FP_2O_5 = 1.53\ T – 1.41\ SP$

$FK_2O = 2.92\ T – 0.35\ SK$

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$^{-1}$)

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 25 days after transplanting 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 hybrid super moti. The same variety was used in STCR treatment and other treatments.

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 7.0 - 8.5. The organic carbon content varied from 0.25 - 0.42 soils were medium in available nitrogen (ranging from 160-180 kg ha$^{-1}$), low to medium in available phosphorus (ranging from 10-20 kg ha$^{-1}$) and medium to high in available potassium (ranging from 160-180 kg ha$^{-1}$) in Table 2. Available micronutrient status showed that experimental soil was well supplemented with micronutrients. 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 2013 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 2.56, 0.56 and 2.21 kg q$^{-1}$ of grain yield, respectively. The percent contribution of nutrients from soil and fertilizers were found to be 26.35 and 54.03 for N, 51.17 and 36.35 for $P_2O_5$ and 26.14 and 75.68 for $K_2O$, respectively. It was noted that contribution of potassium from fertilizer for rice 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

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 | 7.5-8.5 | 0.21-0.29 | 0.25-0.35 | 180 | 20 | 180 |
| Location-II | 7.3-8.4 | 0.30-0.40 | 0.28-0.36 | 180 | 10 | 160 |
| Location-III | 7.0-7.8 | 0.50-0.68 | 030-0.42 | 160 | 15 | 180 |
| Location-IV | 7.0-7.8 | 0.25-0.39 | 0.30-0.42 | 160 | 15 | 180 |

* Av = Available

Table 2: Economics of Verification Trails for Rice crop

| Treatments | NPK (kg $ha^{-1}$)and FYM (t $ha^{-1}$) | Actual mean yield(kg $ha^{-1}$) | Additional yield (Rs.) | Value of additional yield(kg $ha^{-1}$) | Cost of fertilizer (Rs.) | Net benefit(Rs.) | B/C ratio |
|---|---|---|---|---|---|---|---|
| Location - I : Name - Arjun Kumar Patel, Village-Khewashipur | | | | | | | |
| $T_1$-Control | 0-0-0 | 2033 | - | - | - | - | - |
| $T_2$-FP | 100-60-60 | 3333 | 1300 | 14300 | 6713.60 | 7586.40 | 1.13 |
| $T_3$-GRD | 120-50-60 | 3666 | 1633 | 17963 | 6498.90 | 11464.10 | 1.76 |
| $T_4$-45 q $ha^{-1}$ | 109-38-64 & 10 | 4550 | 2517 | 27687 | 8739.25 | 18947.75 | 2.17 |
| $T_4$-50 q $ha^{-1}$ | 133-46-79& 10 | 4900 | 2867 | 31537 | 9997.51 | 21539.49 | 2.15 |
| Location - II : Name - Pawan Kumar Yadav, Village- Shravanpur | | | | | | | |
| $T_1$-Control | 0-0-0 | 2133 | - | - | - | - | - |
| $T_2$-FP | 100-40-30 | 2950 | 817 | 9537 | 4788.80 | 4748.20 | 0.88 |
| $T_3$-GRD | 120-60-60 | 3633 | 1500 | 16500 | 7061.40 | 9438.60 | 1.34 |
| $T_4$-45 q $ha^{-1}$ | 109-52-64 & 10 | 4533 | 2400 | 26400 | 9526.75 | 16873.25 | 1.77 |
| $T_4$-50 q $ha^{-1}$ | 133-60-79& 10 | 4966 | 2833 | 31163 | 12206.91 | 18956.09 | 1.55 |
| Location - III: Name - Kailash Pal, Village-Loharapur | | | | | | | |
| $T_1$-Control | 0-0-0 | 1933 | - | - | - | - | - |
| $T_2$-FP | 100-60-60 | 3100 | 1067 | 12837 | 6713.6 | 6123.40 | 0.91 |
| $T_3$-GRD | 120-60-60 | 3633 | 1700 | 18700 | 7061.40 | 11638.60 | 1.65 |
| $T_4$-45 q $ha^{-1}$ | 119-45-64 & 10 | 4563 | 2630 | 28930 | 9306.90 | 19623.10 | 2.11 |
| $T_4$-50 q $ha^{-1}$ | 143-53-79& 10 | 4810 | 2877 | 31647 | 10440.80 | 21206.20 | 2.03 |
| Location - IV: Name - Bhaiyalal Patel, Village -Khewashipur | | | | | | | |
| $T_1$-Control | 0-0-0 | 2000 | - | | | | |
| $T_2$-FP | 120-50-50 | 3000 | 1000 | 11000 | 6232.30 | 4767.70 | 0.76 |
| $T_3$-GRD | 120-60-60 | 3300 | 1300 | 14300 | 7061.40 | 7238.60 | 1.03 |
| $T_4$-45 q $ha^{-1}$ | 119-45-64 & 10 | 4650 | 2650 | 29150 | 9306.90 | 19843.10 | 2.13 |
| $T_4$-50 q $ha^{-1}$ | 143-53-79& 10 | 4866 | 2866 | 31526 | 10440.8 | 21085.20 | 2.02 |

**Note:** Paddy@Rs.11.00/kg, N@Rs.17.39/kg, $P_2O_5$@Rs.56.25/kg, $K_2O$@Rs.26.66/kg, FYM.@ Rs.3.00/kg

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 (Ray *et al.* 2000). Similar type of higher efficiency of potassic fertilizer was also reported for rice by Ahmed *et al.* (2002) in alluvial soils and for finger millet by Kadu and Bulbule (2007).

Target yield of 45 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 regardless of the N level used but could be raised to 7.4 t/ha with increased application of K fertilizers (Tiwari, 2002). This is probably due to the higher N use efficiency as well as increased N recovery by crop under increased K application (Marschner, 1995).Yield targets of 45 and 50 q $ha^{-1}$ for rice (hybrid super moti) 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 45 and 50 q $ha^{-1}$ fixed target. These results accorded with the findings of Ray *et al.* (2000) and Avtari *et al.,* (2010). Between the two targets tried, targeting for 45 q $ha^{-1}$ recorded relatively higher response ratio than with 50 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 (Santhi *et al.,* 2002).

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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