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*Short Communication*

# EFFECT OF SITE SPECIFIC NUTRIENT MANAGEMENT ON NUTRIENT UPTAKE AND USE EFFICIENCY OF RICE IN TUNGABHADRA PROJECT AREA

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**ABSTRACT**
A field experiment was conducted in vertisols at Agricultural Research Station, Siruguppa during *rabi* to study the nutrient uptake and nutrient use efficiency in site specific nutrient management (SSNM) approach. The experiment consisted of seven treatments with application of different category of nutrients including control and Farmers Fertilizers Practice (FFP). The maximum uptake of N, P and K was observed in SSNM-major + secondary + micronutrients (T6). The increase in uptake of N, P and K in $T_6$ was to an extent of 1.0, 30.5 and 16.4 per cent when compared to Farmers' Fertilizers Practice (FFP). The uptake of micronutrients was also maximum in $T_6$. The agronomic and physiological use efficiency of nutrients was higher in $T_6$ when compared to rest of the treatments.

**KEYWORDS**: Rice, Agronomic, Physiological, Nutrient use efficiency and Nutrient budget)

## INTRODUCTION

The rice yield could be raised from the present level by the several ways. One such option is Site Specific Nutrient Management (SSNM), which advocates application of nutrients at right amount needed by the crop to achieve target yields. The SSNM strategies includes site and season specific knowledge of crop nutrient requirements and indigenous nutrient supplies are required to increase productivity, yields and nutrient use efficiency in irrigated rice. The gain in production potential of any newly developed variety can be achieved only when it is properly matched with the rate of fertilizer application. It is generally advocated that overall consumption of N: $P_2O_5$: $K_2O$ should progress in the ratio of 4: 2: 1 for balanced fertilizer use in India. But now the recommended ratio has become 8.5: 2.5: 1 due to indiscriminate use of nitrogenous fertilizer (Siddiq 1999).

It is well known that the soils of different rice growing belts are not uniform in their fertility status. It is better to apply the nutrients based on soil test recommendation. Soil testing approach for fertilizer application is reported to establish a proper balance of nutrients and eliminates any nutrient deficiency in soil (Prasad and Prasad 1994). On the other hand, application of fertilizer on adhoc basis does not take into account the inherent fertility status of the soil and as such application of fertilizer might cause imbalance of nutrients in soils causing antagonistic nutrient interaction with resultant reduction in response of the crop to fertilizer application (Saikia and Pathak 1997). Hence the present investigation is carried out to study the uptake and use efficiencies of nutrients in SSNM approach.

## MATERIALS AND METHODS

The experiment was conducted on vertisols, at Agricultural Research Station, Siruguppa, Bellary district during *rabi* season. The experiment was laid out in randomised block design and replicated four times with seven treatments *viz.*, $T_1$ - Control (No NPK), $T_2$ - RDF (150: 75: 75 N $P_2O_5$ $K_2O$ kg $ha^1$) + FYM @ 10 t $ha^{-1}$, $T_3$ - SSNM (250: 125: 125 N $P_2O_5$ $K_2O$ kg $ha^{-1}$), $T_4$- $T_3$ + FYM @ 10 t $ha^{-1}$, $T_5$ - $T_3$ + Secondary nutrients (Mg @ 45.6 kg $ha^{-1}$ and S @ 39 kg $ha^{-1}$), $T_6$ - $T_5$ + Micronutrients (Fe @ 5.0 kg $ha^{-1}$, Mn @ 6.0 kg $ha^{-1}$, Zn @ 6.0 kg $ha^{-1}$, Cu @ 2.0kg $ha^{-1}$ and Mo @ 0.5 kg $ha^{-1}$ and B @ 0.6 kg $ha^{-1}$) and $T_7$ - Farmers' Fertilizer Practice (282: 77: 56 N $P_2O_5$ $K_2O$ kg $ha^{-1}$). Fifty per cent nitrogen, full dose of phosphorus and potassium were applied at the time of transplanting as per the treatment in the form of urea for nitrogen, DAP for nitrogen and phosphorus and muriate of potash for potassium. FYM, secondary nutrients and micronutrients were applied as described in the treatment details. The first top dressing of N (one-third quantity) was done at the tillering stage and second top dressing of N (one-third quantity) was applied at the panicle initiation stage. BPT-5204 (136 days) was transplanted on October with 2-3 seedlings $hill^{-1}$ with a spacing of 20 cm x 10 cm. The crop was harvested in February.

### Calibration of Nutrient Uptake, Budgeting and Nutrient Use Efficiency

After harvest of the crop, grain and straw sample from each plot collected and analyzed for various elements *i.e.*, Macronutrients, secondary nutrients and Micronutrients. From the results of chemical analysis, nutrient uptake and budgeting were calculated as indicated below. Agronomic and physiological nutrient use efficiency of rice was calculated by using the formula suggested by (Venugopalan and Prasad 1992).

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient concentration (\%)} \times \text{weight of dry matter (kg ha}^{-1})}{100}$$

$$\text{Nutrient budget} = \Sigma \text{ inputs} - \Sigma \text{ outputs}$$

$$\text{ANUE} = \frac{\text{Rice yield in treated plot (kg ha}^{-1}) - \text{rice yield in control plot (kg ha}^{-1})}{\text{Nutrient applied (kg ha}^{-1})}$$

$$\text{PNUE} = \frac{\text{Rice yield (kg ha}^{-1})}{\text{Nutrient absorbed (kg ha}^{-1})}$$

Where; ANUE = Agronomic Nutrient Use Efficiency
PNUE = Physiological Nutrient Use Efficiency

**RESULTS AND DISCUSSION**

Application of nutrients based on SSNM approach significantly influence, the grain yield, straw yield and harvest index of rice in the present investigation. Application of all the essential nutrients *viz.,* major, secondary and micronutrient in the SSNM treatment ($T_6$) produced significantly higher grain yield (56.7 q ha$^{-1}$), straw yield (72.2 q ha$^{-1}$ ) and harvest index (0.45) (Table 1). However, it was on par with application of major + secondary nutrients in SSNM ($T_5$) and other SSNM treatments ($T_3$ and $T_4$) compared to farmer's fertilizer practice ($T_7$).

**TABLE- 1.** Grain yield, straw yield and harvest index of rice as influenced by different treatments

| Treatments | Grain yield (q ha$^{-1}$) | Straw yield (q ha$^{-1}$) | Harvest index |
|---|---|---|---|
| $T_1$ | 18.0 | 26.8 | 0.39 |
| $T_2$ | 48.7 | 66.4 | 0.42 |
| $T_3$ | 50.2 | 67.2 | 0.43 |
| $T_4$ | 52.8 | 70.6 | 0.43 |
| $T_5$ | 53.3 | 71.1 | 0.44 |
| $T_6$ | 56.7 | 72.2 | 0.45 |
| $T_7$ | 43.4 | 59.1 | 0.41 |
| S.Em± | 2.17 | 1.64 | 0.006 |
| CD at 5% | 6.45 | 4.87 | 0.016 |

$T_1$ - Control (No NPK),
$T_2$ - RDF (150: 75: 75 N $P_2O_5$ $K_2O$ kg ha$^{-1}$) + FYM @ 10 t ha$^{-1}$,
$T_3$ - SSNM (250: 125: 125 N $P_2O_5$ $K_2O$ kg ha$^{-1}$),
$T_4$ - $T_3$ + FYM @ 10 t ha$^{-1}$,
$T_5$ - $T_3$ + Secondary nutrients (Mg @ 45.6 kg ha$^{-1}$ and S @ 39 kg ha$^{-1}$),
$T_6$ - $T_5$ + Micronutrients (Fe @ 5.0 kg ha$^{-1}$, Mn @ 6.0 kg ha$^{-1}$, Zn @ 6.0 kg ha$^{-1}$, Cu @ 2.0kg ha$^{-1}$ and Mo @ 0.5 kg ha$^{-1}$ and B @ 0.6 kg ha$^{-1}$) and
$T_7$ - Farmers' Fertilizer Practice (282: 77: 56 N $P_2O_5$ $K_2O$ kg ha$^{-1}$).

Application of major nutrients + FYM @ 10 t ha$^{-1}$ ($T_2$), recorded higher uptake of N (142.40 kg ha$^{-1}$), P (30.80 kg ha$^{-1}$) and K (144.30 kg ha$^{-1}$) over FFP to an extent of 1.0, 30.5 and 16.4 per cent when compared to FFP in (Table 2). The increased uptake might be due to the improved synchrony between plant N demand and supply from soil and fertilizer. Dobermann *et al.,* 2002, observed similar increase in uptake of N, P and K in SSNM approach in rice. Further, in the present study the maximum uptake of secondary nutrients *viz.,* Mg (42.20 kg ha$^{-1}$) and S (14.40 kg ha$^{-1}$) and micronutrients *viz.,* Zn (1.90 kg ha$^{-1}$), Cu (1.20 kg ha$^{-1}$), Mn (4.80 kg ha$^{-1}$) Fe (4.80 kg ha$^{-1}$), B (0.41 kg ha$^{-1}$) and Mo (0.024 kg ha$^{-1}$) were recorded with SSNM: major + secondary + micronutrients ($T_6$) when compared to FFP and control in (Table 2). This might be due to well balanced nutrition and absence of other stress factor in SSNM approach (Witt *et al.,* 1999). The practice of balanced fertilization, one nutrient increases the efficiency of other through synergestic effect.

**TABLE- 2.** Nutrient uptake (kg ha$^{-1}$) by rice at harvest as influenced by different treatments

| Treatments | N | P | K | Ca | Mg | S | Zn | Cu | Mn | Fe | B | Mo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | 52.80 | 16.20 | 68.80 | 12.80 | 6.50 | 9.60 | 0.66 | 0.26 | 1.00 | 1.60 | 0.12 | 0.016 |
| $T_2$ | 120.60 | 27.90 | 135.80 | 36.50 | 12.80 | 12.80 | 0.88 | 0.50 | 2.00 | 3.10 | 0.15 | 0.019 |
| $T_3$ | 132.30 | 26.60 | 137.10 | 37.80 | 21.20 | 12.10 | 0.81 | 0.60 | 1.90 | 2.90 | 0.14 | 0.018 |
| $T_4$ | 142.40 | 30.80 | 144.30 | 40.50 | 23.40 | 14.10 | 0.89 | 0.62 | 2.10 | 3.90 | 0.19 | 0.021 |
| $T_5$ | 134.20 | 27.30 | 140.60 | 38.50 | 40.20 | 13.80 | 0.87 | 0.60 | 1.90 | 3.30 | 0.18 | 0.018 |
| $T_6$ | 138.50 | 27.80 | 142.00 | 39.40 | 42.20 | 14.40 | 1.90 | 1.20 | 4.80 | 4.80 | 0.41 | 0.024 |
| $T_7$ | 140.20 | 23.60 | 124.00 | 28.70 | 18.60 | 10.50 | 0.75 | 0.48 | 1.80 | 2.70 | 0.14 | 0.017 |
| S.Em± | 0.68 | 0.69 | 1.51 | 0.75 | 0.87 | 0.44 | 0.04 | 0.07 | 0.19 | 0.37 | 0.07 | 0.002 |
| C.D. (5%) | 2.04 | 2.05 | 4.50 | 2.24 | 2.59 | 1.30 | 0.01 | 0.20 | 0.58 | 1.11 | NS | NS |

NS - Non significant
$T_1$ - Control (No NPK)
$T_2$ - RDF (N $P_2O_5$ $K_2O$ @ 150:75:75 kg $ha^{-1}$) + FYM @ 10 t $ha^{-1}$)
$T_3$ - SSNM (N $P_2O_5$ $K_2O$ @ 250:125:125 kg $ha^{-1}$)
$T_4$ - $T_3$ + FYM @ 10 t $ha^{-1}$
$T_5$ - $T_3$ + Secondary nutrients (Mg S 45.6, 39.0 kg $ha^{-1}$)
$T_6$ - $T_5$ + Micronutrients (Zn Mn Cu Fe Mo B 6.0, 6.0, 2.0, 5.0, 0.5, 0.6 kg $ha^{-1}$, respectively)
$T_7$ - Farmers' fertilizer practice (N $P_2O_5$ $K_2O$ @ 282:77:56 kg $ha^{-1}$)

In the present study, maximum ANUE (15.5), PNUE (40.9), PPUE (203.9) and PKUE (39.9) were found in SSNM treatment with the application of major + secondary + micronutries except agronomic phosphorus use efficiency and agronomic potassium use efficiency (Table 3). The increased nutrient use efficiencies might be due to plant based nutrient management with SSNM which increased the recovery of applied fertilizer nutrients (Dobermann *et al.* 2000).

**TABLE- 3**. Agronomic and physiological use efficiency of N, P and K as influenced by different treatments

| Treatments | ANUE | APUE | AKUE | PNUE | PPUE | PKUE |
|---|---|---|---|---|---|---|
| $T_1$ | 0.0 | 0.0 | 0.0 | 34.1 | 111.1 | 26.1 |
| $T_2$ | 15.3 | 30.7 | 24.6 | 40.4 | 174.5 | 35.8 |
| $T_3$ | 12.9 | 25.8 | 25.8 | 37.9 | 188.7 | 36.6 |
| $T_4$ | 11.6 | 23.2 | 19.9 | 37.1 | 171.4 | 36.5 |
| $T_5$ | 14.1 | 28.2 | 28.3 | 39.7 | 195.2 | 37.9 |
| $T_6$ | 15.5 | 31.0 | 31.0 | 40.9 | 203.9 | 39.9 |
| $T_7$ | 9.0 | 33.0 | 45.3 | 30.9 | 183.9 | 35.0 |
| S.Em± | 0.73 | 0.82 | 0.86 | 1.74 | 7.97 | 1.63 |
| C.D. (5%) | 2.16 | 2.45 | 2.56 | 5.18 | 23.67 | 4.85 |

$T_1$ - Control (No NPK)
$T_2$ - RDF (N $P_2O_5$ $K_2O$ @ 150:75:75 kg $ha^{-1}$) + FYM @ 10 t $ha^{-1}$)
$T_3$ - SSNM (N $P_2O_5$ $K_2O$ @ 250:125:125 kg $ha^{-1}$) $T_4$ - $T_3$ + FYM @ 10 t $ha^{-1}$
$T_5$ - $T_3$ + Secondary nutrients (Mg S 45.6, 39.0 kg $ha^{-1}$)
$T_6$ - $T_5$ + Micronutrients (Zn Mn Cu Fe Mo B 6.0, 6.0, 2.0, 5.0, 0.5, 0.6 kg $ha^{-1}$, respectively)
$T_7$ - Farmers' fertilizer practice (N $P_2O_5$ $K_2O$ @ 282:77:56 kg $ha^{-1}$)

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