Evaluate the effect of SSNM on yield and yield attributing parameters of rice in vertisol

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Abstract
A field experiment was carried out during the kharif season (June–October) of 2016 at the Research Farm of the Indira Gandhi Agricultural University, Raipur (C.G.), India to study the “Evaluate the effect of SSNM on yield and yield attributing parameters of rice in vertisol”. The experiment was laid out in a Randomized block design with three replications and eight treatments namely i.e. RDF(100:60:40:5 NPK and Zn kg ha−1), SSNM based on nutrient expert (120:60:60:5, NPK & Zn kg ha−1), SSNM based on leaf color chart (60:60:60:5, NPK & Zn kg ha−1, rest 50% N based on LCC), SSNM-N, SSNM-P, SSNM-K, Control (N 0, P 0, K 0) and Farmer Fertilizer Practices (N 80, P 40, K 0). The results obtained in this study showed that the T2-SSNM based on nutrient expert performed significantly better than the other treatments for yield attributing characters viz. number of tillers 400, number of panicle 350, panicle length 24.30 cm, filled grain per panicle 145, test weight of 1000 seeds of rice 28.8 gm, grain yield 50.2 q ha−1 and straw yield 82.8 q ha−1 and lowest was found under control treatments at harvest stage of rice. SSNM Treatment based on nutrient expert (NE) recommendations proved superiority over applied different treatments on yield involved balance removal as required by rice as well sustaining soil available nutrient status.

Keywords: Rice, Nitrogen, Leaf Color chart, site specific nutrient management

Introduction
Rice (Oryza sativa L.) is cultivated in more than hundred countries and undoubtedly a dominant staple food of world and 91 per cent of the world’s area and production of rice grown and consumed in Asia (Dobermann and Witt, 2003) [2]. Rice is grown in a wide range of climatic conditions viz., temperature ranging from 17 to 33°C, rainfall 100 to 5100 mm with an altitude of 2600 meters from mean sea level. Demand for rice is growing every year and it is estimated that by 2025 AD the requirement would be 140 million tonnes. In India, rice occupies an area of 42 million hectare with production of 103.04 million tonnes with an average productivity of 2137 kg per hectare, which is half of the global average. In Chhattisgarh, rice occupies an area of 3.7 million ha with production of 7.65 million tonnes with an average productivity of 1322 kg ha−1 (Department of Agriculture, Raipur, 2015-16). Demand for rice is growing every year and it is estimated that by 2025 AD the requirement would be 140 million tonnes. To sustain present food self-sufficiency and to meet future food requirements, India has to increase its rice productivity by 3 per cent per annum.

Nutrient management is a major component of a soil and crop management system. Knowing the required nutrients for all stages of growth and understanding the soil’s ability to supply those needed nutrients is critical to profitable crop production. Site specific nutrient management is applying those concepts to areas within a field that are known to require different management from the field average. Site specific management includes practices that have been previously associated with maximum economic yield management, best management practices as well as general agronomic principles. SSNM aims at dynamic field-specific management of N, P, and K fertilizer to optimize the balance between supply and demand of nutrients. SSNM, a decision support system provides – before planting – a pattern for splitting an estimated total N fertilizer requirement among pre-set application times (Dobermann, and Witt 2003) [2]. Fertilizer P and K recommendations with SSNM are based on the indigenous supply of these nutrients from soil, organic materials, and irrigation water considering nutrient removal with grain and straw.

Nutrient Expert (NE) is as a computer-based decision support tool having nutrient decision support software that uses the principles of site-specific nutrient management (SSNM) and
enables to develop fertilizer recommendations tailored to a specific field or growing environment. The parameters needed in SSNM are usually measured in nutrient omission trials. With NE, parameters can be estimated using proxy information, which allows developing location specific fertilizer guidelines without data from field trials. The optimum use of N can be achieved by matching N supply with crop demand. A simple and quick method for estimating plant N demand is LCC i.e. leaf is easy to use and an inexpensive diagnostic tool for monitoring the relative greenness of a rice leaf as an indicator for the plant N status and can be used as an alternative to chlorophyll meter. Use of LCC for N management has consistently increased grain yield and profit in comparison to the farmers’ fertilizer practice in Bangladesh. (Sen et al., 2011) [10].

Methods & Materials
A field experiment was carried out during the kharif season (June–October) of 2016 at the Research Farm of the Indira Gandhi Agricultural University, Raipur (C.G.), India to study the “Evaluate the effect of SSNM on yield and yield attributing parameters of rice in vertisol”. The experiment was laid out in a Randomized block design with three replications and eight treatments namely i.e. RDF (100:60:40:5 NPK and Zn kg ha⁻¹), SSNM based on nutrient expert (120:60:60:5, NPK &Zn kg ha⁻¹), SSNM based on leaf color chart (60:60:60:5, NPK& Zn kg ha⁻¹, rest 50% N based on LCC), SSNM-N, SSNM-P, SSNM-K, Control (N₀, P₀, K₀) and Farmer Fertilizer Practices (Nᵢ₀, Pᵢ₀, Kᵢ₀). The soil (black soil) was clay loam in texture with alkaline pH (7.3.). It was non-saline (EC 0.23 dS m⁻¹) and high in organic carbon content (0.51%). The soil was low in available nitrogen (180 kg ha⁻¹) (Subbiah and Asija 1956), high in available phosphorus (14.35 kg P₂O₅ ha⁻¹) (Olsen et al. 1954) and high in available potassium (387 kg K₂O ha⁻¹). Available zinc content (1.0 mg kg⁻¹) was above the critical level (0.7 mg kg⁻¹). The treatment means were compared using least significant differences at 5% level of significance (Gomez and Gomez 1984) [3].

Results & Discussion
Number of total tillers m⁻²
Tillering is an important agronomic trait for grain yield, but the emergence and development of tillers are greatly influenced by factors such as nitrogen supply, solar radiation and temperature (Murata and Matsushima, 1975). The data on number of tillers m⁻² at as influenced by SSNM treatments have been presented in Table 1 and also illustrated graphically through Fig. 1. The number of tillers m⁻² differed significantly with different SSNM treatments. Among the applied treatments T2- SSNM (Nutrient expert) recorded significantly higher number of tillers (400 m⁻²) followed by T₃-SSNM LCC based treatment (383 m⁻² ) and T₁- RDF based nutrient management practices compared to other SSNM treatments and lowest number of tillers (217 m⁻²) occurred in the treatment devoid of fertilizer application (control-T₁). SSNM aims at dynamic field-specific management of N, P, and K fertilizer to optimize the balance between supply and demand of nutrients. The plants need for N, P, or K fertilizer are determined from the gap between the supply of a nutrient from indigenous sources, as measured with a nutrient omission plot, and the demand of the rice crop for that nutrient, as estimated from the total nutrient required by the crop to achieve a yield target for average climatic conditions. Similar results have been reported by Nath et al. (2012) [8] who observed that SSNM as nutrient expert

increased the total number of tillers as well as grain yield of transplanted rice.

Number of panicle (m⁻²)
The data on panicle length of rice as influenced by different SSNM treatments have been shown in Table 1. It is evident from the data that number of panicles per meter square was significantly influenced by the applied different SSNM treatments. The highest number of panicle per meter2 (350) was recorded under the treatment T₈- SSNM based on Nutrient expert followed by T₇-SSNM based on LCC (333), T₄ –SSNM-N treatment (317) and T₁- RDF (300) the lowest number of panicles per meter square (267) was found under T₇-Control (N₀, P₀, K₀) treatment. Similar results have also been reported by Nath et al. (2012) [8] observed all applied nutrients were best performances which increase the growth and numbers of panicle hill⁻¹, numbers of grains panicle⁻¹. The results are in conformity with the findings of Laharia et al. (2015) obtained more number of productive tillers hill⁻¹ under the SSNM nutrient expert treatment as the important yield attributing characters.

Panicle length (cm)
The data pertaining to panicle length (cm) of rice are presented in Table 1. The maximum panicle length of 24.30 cm was recorded in T₂ - SSNM based on Nutrient expert which stood on par with those recorded under T₅- RDF (23 cm) and T₅-SSNM-P (23) treatments while proved significantly better compared to all other treatments. The lowest panicle length of 21.3 cm was measured under the treatment T₇ - control. Similar results were also reported by Feng et al. (2007) and Sridhara (2008).

Filled grains panicle⁻¹
Data on filled grains/panicle as influenced by different SSNM treatments are summarized in Table 1. It is obvious from the data that number of filled grains per panicle of rice did not influenced significantly due to fertilizer application. However, treatment T₂ - SSNM based on nutrient expert recorded the higher number of filled grains (145/panicle) followed by T₅-SSNM- P treatment (142/panicle) and T₇ - SSNM based on LCC (139/panicle) and lowest number of filled grains (123/panicle) was recorded under T₈- Farmer practices. Feng et al. (2007) were also reported on filled grains per panicle may be due to genotypes than nutrient management.

Test weight of Rice (1000 grain weight in g)
The data on test weight of rice as influenced by different SSNM treatments have been presented in Table 1. It is quite clear from the data that test weight of rice grain varied from 27.2 to 28.8 g based on the treatments. The 1000-grain weight of rice remained unaffected due to fertilizer application. However, treatment SSNM based on Nutrient expert (T₂) resulted in heavier test weight of 28.8 g followed by T₁ - RDF (28.6) and T₃ -SSNM based on LCC (28.7) as compared to T₇ -Control (27.2 gm) treatment. In contrast to these findings, Biradar et al. (2006) [1] found that SSNM resulted in significantly higher test weight over FP (Farmer's Practice) and RDF (Recommended Dose of Fertilizer) in rice crop.

Grain yield of rice (q ha⁻¹)
The data pertaining to grain yield of rice grown as influenced by different SSNM treatments is presented in Table 2. It is evident from the data that grain yields of rice varied significantly due to various SSNM treatments. Application of
fertilizer enhanced the yield of rice significantly compared to the unfertilized crop. The highest grain yield of rice (50.2 q ha\(^{-1}\)) was recorded in T2- SSNM (NE) being significantly superior over control (T7), FFP (T8), RDF (T1), SSNM-N (T4), SSNM (T6) but remained at par with the grain yield obtained under SSNM (T3) and SSNM-P(T5) treatments. Grain yield advantage with treatment T1 was higher over other SSNM treatments. Treatment omitting either N, P or K resulted in a marked yield loss, indicating the significance of replenishment of these nutrients for achieving high yield targets. Compared with SSNM (NE), yield reductions were 6.6, 2.9 5.0 q/ha in –N, -P and –K plots, respectively. Although, treatments receiving recommended doses of N, P and K were superior over control (T7), FFP (T8), RDF (T1), SSNM-N (T4), SSNM-K (T6), SSNM-P (T5) treatments. Compared with SSNM (NE), yield reductions were 6.6, 2.9 5.0 q/ha in –N, -P and –K plots, respectively. Although, treatments receiving recommended doses of N, P and K were superior over control treatments. Omission of N, P and K reduced the straw yield of rice significantly over SSNM based on NE and LCC approaches. The unfertilized control plots (T7) recorded the lowest straw yield (56.1 q ha\(^{-1}\)) being significantly lower than those produced through SSNM approach. The average yield increase due to SSNM over RDF was 35 per cent and was 50 per cent over FP. Similar result reported by Mishra et al. (2007) have also reported in grain and straw yield of rice.

**Table 2:** Grain and straw yield (q ha\(^{-1}\)) of rice as influenced by different SSNM treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Grain yield (q ha(^{-1}))</th>
<th>Straw yield (q ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 RDF</td>
<td>45.6</td>
<td>73.8</td>
</tr>
<tr>
<td>T2 SSNM (NE)</td>
<td>50.2</td>
<td>82.8</td>
</tr>
<tr>
<td>T3 SSNM (LCC)</td>
<td>48.7</td>
<td>78.8</td>
</tr>
<tr>
<td>T4 SSNM –N</td>
<td>43.6</td>
<td>69.3</td>
</tr>
<tr>
<td>T5 SSNM-P</td>
<td>47.3</td>
<td>77.5</td>
</tr>
<tr>
<td>T6 SSNM-K</td>
<td>45.2</td>
<td>73.6</td>
</tr>
<tr>
<td>T7 (C)</td>
<td>35.1</td>
<td>56.1</td>
</tr>
<tr>
<td>T8 FFP</td>
<td>44.4</td>
<td>70.5</td>
</tr>
<tr>
<td>CD (P=0.05%)</td>
<td>3.58</td>
<td>5.73</td>
</tr>
</tbody>
</table>

**Reference**