Research Article

Influence of different water regimes and nutrient management practice for rice production

K. COUMARA VEL AND A. BASKAR

Introduction

Rice is life for major populations of the world and it is deeply embedded in the cultural heritage of societies. Rice is the staple food for more than half of the world populations. India is the one among the countries to develop and commercialize the rice production technology. Scarcity of fresh water resources has threatened the production of the flood-irrigated rice crop. By 2025, 15 out of 75 million hectare of Asia’s flood-irrigated rice crop will experience water shortage (Tuong and Bouman, 2003). To reduce water use of irrigated rice, water saving regimes can be introduced, that aim to reduce non-beneficial water flows from rice field during crop growth namely seepage, percolation and evaporation by alternate wetting and drying (AWD) irrigation and aerobic rice system (Bouman et al., 2005). Nearly 50 per cent gain in food grain productivity seen in recent times has come through adoption of fertilization practices alone. Although the performance of rice was studied under submerged conditions for yield, minimal efforts have been made to study its performance in different soil ecosystems viz., submerged, saturated and aerobic conditions. Therefore, the present investigation was undertaken to study the effect of different nutrient levels on rice production under various rice soil eco-systems.

Resources and Research Methods

The study was carried out in the Eastern farm of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, during Kharif season of 2008-2009 with an objective to assess the effect of different water regimes and nutrient management practices on yield, yield attributes and uptake of nutrients. Among the different rice eco systems, crop grown under saturated water condition had recorded the highest grain, straw yield and panicle weight whereas rice transplanted under continuous submergence condition had recorded the highest N uptake but rice transplanted under saturated water regimes had recorded highest phosphorus and K uptake. The rice sown under aerobic condition under dry ploughed soil had recorded the lowest grain and straw yield. The higher grain yield was recorded by application NPK @ 120:60:40 kg ha⁻¹ and lowest yields were reported by absolute control.

Summary

Field experiments were conducted in the Eastern farm of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, during Kharif season of 2008-2009 with an objective to assess the effect of different water regimes and nutrient management practices on yield, yield attributes and uptake of nutrients. Among the different rice eco systems, crop grown under saturated water condition had recorded the highest grain, straw yield and panicle weight whereas rice transplanted under continuous submergence condition had recorded the highest N uptake but rice transplanted under saturated water regimes had recorded highest phosphorus and K uptake. The rice sown under aerobic condition under dry ploughed soil had recorded the lowest grain and straw yield. The higher grain yield was recorded by application NPK @ 120:60:40 kg ha⁻¹ and lowest yields were reported by absolute control.

Key words: Nutrient levels, Submergence, Saturation and aerobic rice eco system

on dry ploughed soil (M3). Ten graded levels of fertilizers viz., N<sub>0</sub>P<sub>0</sub>K<sub>0</sub> (T<sub>1</sub>), N<sub>0</sub>P<sub>60</sub>K<sub>80</sub> (T<sub>2</sub>), N<sub>60</sub>P<sub>60</sub>K<sub>80</sub> (T<sub>3</sub>), N<sub>120</sub>P<sub>60</sub>K<sub>80</sub> (T<sub>4</sub>), N<sub>180</sub>P<sub>60</sub>K<sub>80</sub> (T<sub>5</sub>), N<sub>120</sub>P<sub>0</sub>K<sub>80</sub> (T<sub>6</sub>), N<sub>120</sub>P<sub>30</sub>K<sub>80</sub> (T<sub>7</sub>), N<sub>120</sub>P<sub>60</sub>K<sub>0</sub> (T<sub>8</sub>), N<sub>120</sub>P<sub>60</sub>K<sub>40</sub> (T<sub>9</sub>) and N<sub>180</sub>P<sub>90</sub>K<sub>120</sub> (T<sub>10</sub>) were tried in the subplots. The cultivar ADT-43 was planted with the spacing of 20 x 10 cm.

### Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been presented under the following headings.

#### Yield and yield attributes:

**Effect of water regimes:**

Data in Table 1 revealed that, among the different water regimes, the crops grown under saturated conditions had recorded significantly higher grain yield (3.84 t ha<sup>-1</sup>) followed by the rice plant transplanted under continuous submergence (3.03 t ha<sup>-1</sup>) which may be due to the favourable environment provided by these water regimes and the availability nutrient to the rice crop were also enhanced by these water regimes. Similar findings were also obtained by Shibu and Ghuman (2001). But rice sown under dry ploughed and unpuddled aerobic condition recorded the lowest yield (1.71 t ha<sup>-1</sup>), which may be due to losses of N by denitrification. Rice and Smith (1983) also observed that the rate of denitrification is higher in no tilled soils, thus would reduced gaseous exchange. It was opined by Aulakh et al. (1984) that the amount of N that can be lost through denitrification was found to be higher in the surface soil than in the subsurface soil, due to the abundance of denitrifiers in this zone (Doran, 1980). Hence, under continuous flooding conditions, the anaerobic condition prevents the applied N to be nitrified and result in the conversion of N into NH<sub>4</sub> + which might have been retained by the soil clay, thereby reducing the loss of N by leaching. Similar trend of

### Table A: Characteristics of initial surface soil sample of the experimental field

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Properties</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Physical properties</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Sand (per cent)</td>
<td>72.1</td>
</tr>
<tr>
<td>2.</td>
<td>Silt (per cent)</td>
<td>10.5</td>
</tr>
<tr>
<td>3.</td>
<td>Clay (per cent)</td>
<td>13.3</td>
</tr>
<tr>
<td>4.</td>
<td>Texture</td>
<td>Sandy loam</td>
</tr>
<tr>
<td></td>
<td>Physico chemical properties</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>pH</td>
<td>7.6</td>
</tr>
<tr>
<td>2.</td>
<td>EC (dS m&lt;sup&gt;-1&lt;/sup&gt;)</td>
<td>0.30</td>
</tr>
<tr>
<td>3.</td>
<td>CEC (c mol (p&lt;sup&gt;+&lt;/sup&gt;) kg&lt;sup&gt;-1&lt;/sup&gt;)</td>
<td>28.3</td>
</tr>
<tr>
<td></td>
<td>Chemical properties</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>KMnO&lt;sub&gt;4&lt;/sub&gt; – N (kg ha&lt;sup&gt;-1&lt;/sup&gt;)</td>
<td>121</td>
</tr>
<tr>
<td>2.</td>
<td>Organic carbon (g kg&lt;sup&gt;-1&lt;/sup&gt;)</td>
<td>3.5</td>
</tr>
<tr>
<td>3.</td>
<td>Olsen-P (kg ha&lt;sup&gt;-1&lt;/sup&gt;)</td>
<td>31.0</td>
</tr>
<tr>
<td>4.</td>
<td>NH&lt;sub&gt;4&lt;/sub&gt;OAc – K (kg ha&lt;sup&gt;-1&lt;/sup&gt;)</td>
<td>175</td>
</tr>
</tbody>
</table>

### Table 1: Effect of different water and fertilizer regimes on yield and yield components of rice (ADT-43)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Grain yield (t ha&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>Straw yield (t ha&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>Panicle weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water regimes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous submergence</td>
<td>3.03</td>
<td>5.88</td>
<td>411</td>
</tr>
<tr>
<td>Saturated condition</td>
<td>3.84</td>
<td>6.66</td>
<td>439</td>
</tr>
<tr>
<td>Aerobic cultivation</td>
<td>1.71</td>
<td>4.31</td>
<td>322</td>
</tr>
<tr>
<td>C.D. (0.05)</td>
<td>0.08</td>
<td>0.62</td>
<td>12.0</td>
</tr>
<tr>
<td>Nutrient regimes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt; N&lt;sub&gt;0&lt;/sub&gt;P&lt;sub&gt;0&lt;/sub&gt;K&lt;sub&gt;0&lt;/sub&gt;</td>
<td>2.24</td>
<td>6.07</td>
<td>397</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt; N&lt;sub&gt;0&lt;/sub&gt;P&lt;sub&gt;60&lt;/sub&gt;K&lt;sub&gt;80&lt;/sub&gt;</td>
<td>2.35</td>
<td>5.44</td>
<td>402</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt; N&lt;sub&gt;60&lt;/sub&gt;P&lt;sub&gt;60&lt;/sub&gt;K&lt;sub&gt;80&lt;/sub&gt;</td>
<td>2.99</td>
<td>5.10</td>
<td>369</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt; N&lt;sub&gt;120&lt;/sub&gt;P&lt;sub&gt;60&lt;/sub&gt;K&lt;sub&gt;80&lt;/sub&gt;</td>
<td>3.10</td>
<td>5.50</td>
<td>413</td>
</tr>
<tr>
<td>T&lt;sub&gt;5&lt;/sub&gt; N&lt;sub&gt;180&lt;/sub&gt;P&lt;sub&gt;60&lt;/sub&gt;K&lt;sub&gt;80&lt;/sub&gt;</td>
<td>2.95</td>
<td>5.35</td>
<td>373</td>
</tr>
<tr>
<td>T&lt;sub&gt;6&lt;/sub&gt; N&lt;sub&gt;120&lt;/sub&gt;P&lt;sub&gt;0&lt;/sub&gt;K&lt;sub&gt;80&lt;/sub&gt;</td>
<td>2.78</td>
<td>6.24</td>
<td>386</td>
</tr>
<tr>
<td>T&lt;sub&gt;7&lt;/sub&gt; N&lt;sub&gt;120&lt;/sub&gt;P&lt;sub&gt;30&lt;/sub&gt;K&lt;sub&gt;80&lt;/sub&gt;</td>
<td>2.08</td>
<td>5.73</td>
<td>369</td>
</tr>
<tr>
<td>T&lt;sub&gt;8&lt;/sub&gt; N&lt;sub&gt;120&lt;/sub&gt;P&lt;sub&gt;60&lt;/sub&gt;K&lt;sub&gt;0&lt;/sub&gt;</td>
<td>2.87</td>
<td>5.64</td>
<td>388</td>
</tr>
<tr>
<td>T&lt;sub&gt;9&lt;/sub&gt; N&lt;sub&gt;120&lt;/sub&gt;P&lt;sub&gt;60&lt;/sub&gt;K&lt;sub&gt;40&lt;/sub&gt;</td>
<td>3.24</td>
<td>5.56</td>
<td>393</td>
</tr>
<tr>
<td>T&lt;sub&gt;10&lt;/sub&gt; N&lt;sub&gt;180&lt;/sub&gt;P&lt;sub&gt;90&lt;/sub&gt;K&lt;sub&gt;120&lt;/sub&gt;</td>
<td>3.00</td>
<td>5.57</td>
<td>416</td>
</tr>
<tr>
<td>C.D. (0.05)</td>
<td>0.21</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Grand mean</td>
<td>2.86</td>
<td>5.62</td>
<td>391</td>
</tr>
</tbody>
</table>
Table 2: Effect different water and fertilizer regimes on nutrient uptake of rice

<table>
<thead>
<tr>
<th>Treatments</th>
<th>N uptake (kg ha⁻¹)</th>
<th>P uptake (kg ha⁻¹)</th>
<th>K uptake (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water regimes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous submergence</td>
<td>112.1</td>
<td>29.9</td>
<td>72.7</td>
</tr>
<tr>
<td>Saturated condition</td>
<td>99.2</td>
<td>30.8</td>
<td>91.6</td>
</tr>
<tr>
<td>Aerobic cultivation</td>
<td>73.7</td>
<td>14.2</td>
<td>67.6</td>
</tr>
<tr>
<td>C.D. (0.05)</td>
<td>12.3</td>
<td>5.0</td>
<td>13.5</td>
</tr>
<tr>
<td>Nutrient regimes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₁</td>
<td>N₀P₀K₀</td>
<td>95.3</td>
<td>26.8</td>
</tr>
<tr>
<td>T₂</td>
<td>N₀P₀K₄₀</td>
<td>97.0</td>
<td>23.1</td>
</tr>
<tr>
<td>T₃</td>
<td>N₆₀P₆₀K₄₀</td>
<td>80.2</td>
<td>22.7</td>
</tr>
<tr>
<td>T₄</td>
<td>N₁₂₀P₆₀K₄₀</td>
<td>87.0</td>
<td>29.2</td>
</tr>
<tr>
<td>T₅</td>
<td>N₁₈₀P₆₀K₄₀</td>
<td>90.7</td>
<td>23.9</td>
</tr>
<tr>
<td>T₆</td>
<td>N₁₂₀P₀K₈₀</td>
<td>101.0</td>
<td>28.2</td>
</tr>
<tr>
<td>T₇</td>
<td>N₁₂₀P₆₀K₈₀</td>
<td>96.4</td>
<td>23.8</td>
</tr>
<tr>
<td>T₈</td>
<td>N₁₂₀P₆₀K₄₀</td>
<td>97.2</td>
<td>24.0</td>
</tr>
<tr>
<td>T₉</td>
<td>N₁₀₀P₆₀K₈₀</td>
<td>107.4</td>
<td>23.4</td>
</tr>
<tr>
<td>T₁₀</td>
<td>N₁₈₀P₉₀K₁₂₀</td>
<td>97.9</td>
<td>24.6</td>
</tr>
<tr>
<td>C.D.</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Grand mean</td>
<td>95.0</td>
<td>25.0</td>
<td>77.3</td>
</tr>
</tbody>
</table>

results were obtained for straw yield and panicle weight.

**Effect of fertilizer regimes**:

The grain yield increased linearly with the increase in dose of fertiliser from zero levels of N, phosphorus and K to 180:90:120 kg NPK ha⁻¹. The significantly higher grain yield (3.24 t ha⁻¹) was recorded at 120:60:40 kg of NPK ha⁻¹ which means that the rice crop could respond well for all the three major nutrients up to 120:60 and 40 for N, P₂O₅ and K₂O, respectively due to the fact that the response of rice crop with respect to its grain yield depends on the ability of the crop to translocate its photosynthates to the economic part. The lowest yield was obtained with the application of N₀P₀K₀ kg ha⁻¹ (Table 1) emphasizing the significance of N, phosphorus and K and balanced use of all the three macronutrients. Similar response was also obtained of rice crop to N application up to 120 kg N ha⁻¹ by Budhar et al. (1987) and Rammohan et al. (2000).

**Uptake of nutrients**:

**Effect of water regimes**:

The highest N uptake (112.1 kg ha⁻¹) was recorded by the crop grown under continuous submergence but the phosphorus (30.8 kg ha⁻¹) and K (91.6 kg ha⁻¹) uptake were improved by the crops grown under saturated condition (Table 2). The lowest NPK uptake was recorded under aerobic conditions. It could be attributed to the enhancement in the availability of nutrient to the crop by these water regimes which in turn effected on the nutrient uptake.

**Effect of fertiliser regimes**:

The statistical scrutiny of nutrient uptake revealed that the nutrient uptakes were unaltered due to application different levels of nutrients though the numerically higher N was reported at N₁₂₀P₆₀K₄₀ kg NPK ha⁻¹ and for K N₁₂₀P₀K₈₀ kg NPK ha⁻¹, respectively, which clearly shows that the rice crop had positive response nutrient uptake up to the higher levels of N (120 kg ha⁻¹) : phosphorus (60 kg ha⁻¹) fertilization and K (80 kg ha⁻¹) (Table 2). The different levels of nutrients significantly influenced the N, phosphorus and K uptake values, which might possibly due to the increased dry matter production as well as increase in the concentration of nutrients in the plant parts.

**Literature Cited**


