Influence of liming to green manure crop and different sources of phosphorus in lowland rice of Odisha

K. KUSUMAVATHI, S. SARKAR, D. SETHI AND A. K. MOHAPATRA
Orissa University of Agriculture and Technology,
Bhubaneswar, Odisha -751003

ABSTRACT

An experiment was carried out to study the impact of liming to green manure crop and different sources of phosphorus in lowland rice of Odisha consisting of STBF (Soil test based fertilizer) 100 kg N + 40 kg P₂O₅ + 50 kg K₂O ha⁻¹, STBF + green manuring with Sesonbia and STBF + green manuring with Sesbania + liming @ 0.2 LR to green manure crop as main plots, three sources of fertilizers in sub plots such as urea + SSP + MOP, DAP as basal and urea as top dressing + MOP, urea as basal and DAP as top dressing + MOP and replicated thrice following the split plot design. The highest yield of grain (4.85 t ha⁻¹) and straw (6.39 t ha⁻¹) were recorded in STBF + green manuring with Sesbania + liming @ 0.2 LR to green manure crop along with DAP as basal and urea as top dressing + MOP treatment due to the highest (341.16) number of effective tillers per m² and the lowest nutrient uptake by weeds as liming is an effective ameliorative practice that integrated in the acid soil management program to raise and maintain a near neutral pH range for optimal crop growth and yield potential.

Keywords: Grain yield, liming, lowland rice, soil test based fertilizer

In Odisha the total productivity of rice during 2017- 18 (MAFW, GOI) was 1739 kg ha⁻¹ where as in India was 2576 kg ha⁻¹. Rice is generally grown by transplanting seedlings into puddled soil and field kept inundated with water for most part of the growing season. The puddled soil ensures good crop establishment, weed control with standing water, and reduces deep-percolation losses. Singh et al., 2016. Indiscriminate use of chemical fertilizers for increasing the crop yield elicted many problems such as increasing crop weed competition, reducing soil fertility and crop productivity unsustainable.

Weeds grow profusely in the rice fields, accumulate a large amount of biomass in a very short period, which hampers the growth of rice plants and reduce crop yields drastically. According to Manhas et al. (2012) uncontrolled weed growth caused 33-45 per cent reduction in grain yield of rice. Losses due to weeds are the foremost importance to be concentrated in rice production systems, as they interfere with all the activities involved in the field throughout crop growing period. The competition between crop and weed initiate when the supply of any of the growth factor is restricting and falls below the demand of both the crop and weed, when they grow in close vicinity. Weeds remove a large amount of nutrients from soil. An estimate shows that weeds can deprive the crops by 47% nitrogen, 42% phosphorus, 50% potassium, 39% calcium and 24% magnesium of their nutrient uptake as well as reduce the yield potential by accommodating number of crop pests (Balasubramaniyan and Palaniappan, 2001). The main aim of nutrient management with green manure crop sesbania is to enhance not only nutrient uptake and productivity but also to reduce weed growth. The present paper investigates on the importance of incorporating sesbania, liming to sesbania in fostering sustainability and moreover our results can support a choice for increasing rice productivity.

MATERIALS AND METHODS

A field experiment was conducted at agronomy main research farm of Odisha University of Agriculture and Technology (OUAT), Bhubaneswar during kharif 2017. The experimental site was located in Agro-climatic zone of East and South Eastern plains zone of Orissa with latitude of 20°15'N, longitude of 85°52'E and altitude of 25.9 m above mean sea level (MSL). The experimental design was split plot consisting of three replications...
RESULTS AND DISCUSSION

Influence of liming to green manure crop and different sources of phosphorus on weed flora in lowland rice.

The higher weed growth will absorb the nutrients from the soil, so that the growth of the rice plant will be disrupted. The C₄-type weeds have a very low efficiency of photosynthesis and wasteful in the water use, which causes weeds to absorb a lot of water and nutrients from the soil than rice plants. According to Caton et al. (2010) C₄-type weeds become protruding due to high speed of growth through vegetative propagation. Many ecological and crop production principles influence the type of weed flora and its intensity in rice fields. The rice crop is generally infested with a variety of weeds due to favorable agro-climatic condition for the growth of both, crops and weeds. Diversified weeds such as *Echinochloa colonum*, *E. crusgalli*, *Cyperus irria*, *C. rotundus*, *Altematheara sessilis*, *Digitaria spp*, *Phyllanthus niruri* and *Commlina communis* were the major weeds found in rice field.

Influence of liming to green manure crop and different sources of phosphorus on nutrient content of weeds at 25 and 45 DAT of lowland rice.

The nitrogen, phosphorus and potassium content of weeds was increased from 25 DAT to 45 DAT of rice with irrespective of all the treatments. The highest nitrogen, phosphorus and potassium content of weeds at 25 DAT (0.58, 0.32 and 1.82%) and 45 DAT (0.91, 0.41 and 2.01%) of rice was recorded in M₃S₂ treatment respectively. The lowest nitrogen and phosphorus content of weeds at 25 DAT (0.34 and 0.16%) and 45 DAT (0.61 and 0.25%) of rice was recorded in M₁S₁ treatment respectively.

The lowest potassium content of weeds was recorded in M₃S₃ treatment at 25 DAT (1.47%) of rice and in M₃S₂ treatment at 45 DAT (1.81%) of rice. The highest Ca and Mg content of weeds recorded in M₃S₁ treatment at 25 DAT (0.49 and 0.25%) and at 45 DAT of rice (0.52 and 0.23%) whereas the lowest Ca and Mg content of weeds recorded in M₃S₁ treatment at 25 DAT (0.36 and 0.17%) and at 45 DAT of rice (0.28 and 0.17%). The highest Sulphur content of weeds in M₃S₂ treatment at 25 and 45 DAT of rice was 0.25 and 0.43 per cent respectively. This could be due to better utilization of applied phosphorus through as SSP and application of...
Table 1: Initial physico-chemical properties of experimental soil

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameter</th>
<th>Status</th>
<th>Methods employed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Physical properties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Soil textural class</td>
<td>Sandy Loam</td>
<td>Bouyoucos hydrometer method</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sand - 88%</td>
<td>(Piper, 1950).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Silt - 4%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clay - 12%</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>BD (g cm⁻³)</td>
<td>1.59</td>
<td>Core sampler (Black et al., 1965)</td>
</tr>
<tr>
<td>3.</td>
<td>PD (g cm⁻³)</td>
<td>2.40</td>
<td>Pycnometer (Black et al., 1965)</td>
</tr>
<tr>
<td>4.</td>
<td>Porosity (%)</td>
<td>33.75</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>WHC (%)</td>
<td>34</td>
<td>Keen’s box (Black et al., 1965)</td>
</tr>
<tr>
<td></td>
<td>Chemical Properties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>pH (1:2.5)</td>
<td>5.42</td>
<td>Digital pH meter (Jackson, 1973).</td>
</tr>
<tr>
<td>7.</td>
<td>EC (dSm⁻¹)</td>
<td>0.13</td>
<td>Conductivity meter (Jackson, 1973).</td>
</tr>
<tr>
<td>8.</td>
<td>OC (g kg⁻¹)</td>
<td>6.62 (Medium)</td>
<td>Walkley and Black (Jackson,1973)</td>
</tr>
<tr>
<td>9.</td>
<td>LR (t CaCO₃ ha⁻¹)</td>
<td>2.63</td>
<td>Woodruff Buffer method</td>
</tr>
<tr>
<td>10.</td>
<td>Available N (kg ha⁻¹)</td>
<td>253.5 (Low)</td>
<td>Alkaline potassium permanganate (KMnO₄) method (Subbiah and Asija, 1956)</td>
</tr>
<tr>
<td></td>
<td>Available P (kg ha⁻¹)</td>
<td>12 (Medium)</td>
<td>Olsen method (Jackson, 1973)</td>
</tr>
<tr>
<td>12.</td>
<td>Available K (kg ha⁻¹)</td>
<td>59 (Low)</td>
<td>Flame photometer method(Jackson, 1973)</td>
</tr>
<tr>
<td>13.</td>
<td>Available S (kg ha⁻¹)</td>
<td>11 (Low)</td>
<td>Monocalcium phosphate method</td>
</tr>
<tr>
<td>14.</td>
<td>Exch. Ca (meq/100g soil)</td>
<td>3.60 (Adequate)</td>
<td>EDTA (Versenate) complex metric titration</td>
</tr>
<tr>
<td>15.</td>
<td>Exch. Mg (meq/100g soil)</td>
<td>0.3 (Low)</td>
<td>EDTA (Versenate) complex metric titration</td>
</tr>
</tbody>
</table>

Table 2: Effect of liming to green manure crop and different sources of phosphorus on nutrient uptake by weeds at 25 and 45 DAT in lowland rice

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Nitrogen content</th>
<th>Phosphorus content</th>
<th>Potassium content</th>
<th>Calcium content</th>
<th>Magnesium content</th>
<th>Sulphur content</th>
</tr>
</thead>
<tbody>
<tr>
<td>M₃S₁</td>
<td>0.58</td>
<td>0.91</td>
<td>0.32</td>
<td>0.41</td>
<td>1.82</td>
<td>2.01</td>
</tr>
<tr>
<td>M₃S₂</td>
<td>0.53</td>
<td>0.86</td>
<td>0.28</td>
<td>0.35</td>
<td>1.75</td>
<td>1.96</td>
</tr>
<tr>
<td>M₃S₃</td>
<td>0.57</td>
<td>0.90</td>
<td>0.30</td>
<td>0.39</td>
<td>1.81</td>
<td>1.94</td>
</tr>
<tr>
<td>M₃S₄</td>
<td>0.50</td>
<td>0.83</td>
<td>0.29</td>
<td>0.36</td>
<td>1.69</td>
<td>1.91</td>
</tr>
<tr>
<td>M₃S₅</td>
<td>0.40</td>
<td>0.77</td>
<td>0.24</td>
<td>0.32</td>
<td>1.67</td>
<td>1.91</td>
</tr>
<tr>
<td>M₃S₆</td>
<td>0.46</td>
<td>0.81</td>
<td>0.27</td>
<td>0.34</td>
<td>1.64</td>
<td>1.92</td>
</tr>
<tr>
<td>M₃S₇</td>
<td>0.41</td>
<td>0.65</td>
<td>0.22</td>
<td>0.31</td>
<td>1.52</td>
<td>1.84</td>
</tr>
<tr>
<td>M₃S₈</td>
<td>0.34</td>
<td>0.61</td>
<td>0.16</td>
<td>0.25</td>
<td>1.52</td>
<td>1.81</td>
</tr>
<tr>
<td>M₃S₉</td>
<td>0.37</td>
<td>0.65</td>
<td>0.18</td>
<td>0.29</td>
<td>1.47</td>
<td>1.85</td>
</tr>
</tbody>
</table>

Days After Transplanting

| SEm (±) | 0.015 | 0.014 | 0.007 | 0.006 | 0.023 | 0.021 | 0.007 | 0.021 | 0.004 | 0.005 | 0.010 | 0.012 |
| LSD(0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

The highest Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca) and Magnesium (Mg) uptake of weeds at 25 DAT of rice recorded in Mₛₛ treatment was 2.93, 1.63, 9.14, 2.03 and 1.05 kg ha⁻¹ respectively and at 45 DAT of rice recorded in the same treatment was 1.75, 0.80, 3.88, 0.75 and 0.39 kg ha⁻¹ respectively. The lowest N, P, K, Ca and Mg uptake by weeds at 25 DAT of rice was recorded in M₃S₃ treatment was 0.39, 0.19, 1.77, 0.52 and 0.27 kg ha⁻¹ respectively and at 45 DAT of rice recorded in Mₛₛ treatment was 0.49, 0.22, 1.42, 0.28 lime provide favorable microclimate for the weeds to compete with rice crop for nutrients.

Influence of liming to green manure crop and different sources of phosphorus on nutrient uptake by weeds at 25 and 45 DAT in lowland rice

The highest Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca) and Magnesium (Mg) uptake of weeds at 25 DAT of rice recorded in Mₛₛ treatment was 2.93, 1.63, 9.14, 2.03 and 1.05 kg ha⁻¹ respectively and at 45 DAT of rice recorded in the same treatment was 1.75, 0.80, 3.88, 0.75 and 0.39 kg ha⁻¹ respectively. The lowest N, P, K, Ca and Mg uptake by weeds at 25 DAT of rice was recorded in M₃S₃ treatment was 0.39, 0.19, 1.77, 0.52 and 0.27 kg ha⁻¹ respectively and at 45 DAT of rice recorded in Mₛₛ treatment was 0.49, 0.22, 1.42, 0.28

J. Crop and Weed, 16(1)
Table 3: Effect of liming to green manure crop and different sources of phosphorus on nutrient uptake (kg ha\(^{-1}\)) by weeds at 25 and 45 DAT of lowland rice.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>M1S1</td>
<td>2.93</td>
<td>1.75</td>
<td>1.63</td>
<td>0.80</td>
<td>9.14</td>
<td>3.88</td>
<td>2.03</td>
<td>0.75</td>
<td>1.05</td>
<td>0.39</td>
<td>0.95</td>
<td>0.55</td>
</tr>
<tr>
<td>M1S2</td>
<td>1.20</td>
<td>0.98</td>
<td>0.64</td>
<td>0.40</td>
<td>3.98</td>
<td>2.23</td>
<td>0.86</td>
<td>0.41</td>
<td>0.42</td>
<td>0.21</td>
<td>0.28</td>
<td>0.32</td>
</tr>
<tr>
<td>M1S3</td>
<td>1.98</td>
<td>1.35</td>
<td>1.02</td>
<td>0.58</td>
<td>6.07</td>
<td>2.91</td>
<td>1.21</td>
<td>0.43</td>
<td>0.58</td>
<td>0.26</td>
<td>0.46</td>
<td>0.41</td>
</tr>
<tr>
<td>M2S1</td>
<td>1.06</td>
<td>1.25</td>
<td>0.60</td>
<td>0.54</td>
<td>3.57</td>
<td>2.86</td>
<td>0.93</td>
<td>0.66</td>
<td>0.48</td>
<td>0.33</td>
<td>0.54</td>
<td>0.64</td>
</tr>
<tr>
<td>M2S2</td>
<td>0.80</td>
<td>0.84</td>
<td>0.48</td>
<td>0.35</td>
<td>3.35</td>
<td>2.11</td>
<td>0.86</td>
<td>0.46</td>
<td>0.44</td>
<td>0.23</td>
<td>0.48</td>
<td>0.46</td>
</tr>
<tr>
<td>M2S3</td>
<td>1.40</td>
<td>0.97</td>
<td>0.82</td>
<td>0.41</td>
<td>4.97</td>
<td>2.31</td>
<td>1.27</td>
<td>0.50</td>
<td>0.63</td>
<td>0.22</td>
<td>0.66</td>
<td>0.44</td>
</tr>
<tr>
<td>M3S1</td>
<td>0.80</td>
<td>0.68</td>
<td>0.44</td>
<td>0.32</td>
<td>3.01</td>
<td>1.91</td>
<td>0.96</td>
<td>0.53</td>
<td>0.49</td>
<td>0.24</td>
<td>0.35</td>
<td>0.25</td>
</tr>
<tr>
<td>M3S2</td>
<td>0.39</td>
<td>0.61</td>
<td>0.19</td>
<td>0.25</td>
<td>1.77</td>
<td>1.81</td>
<td>0.52</td>
<td>0.44</td>
<td>0.27</td>
<td>0.21</td>
<td>0.17</td>
<td>0.20</td>
</tr>
<tr>
<td>M3S3</td>
<td>0.52</td>
<td>0.49</td>
<td>0.26</td>
<td>0.22</td>
<td>2.07</td>
<td>1.42</td>
<td>0.60</td>
<td>0.28</td>
<td>0.30</td>
<td>0.14</td>
<td>0.16</td>
<td>0.14</td>
</tr>
</tbody>
</table>

SEm(±) 0.084 0.111 0.033 0.051 0.300 0.243 0.062 0.072 0.036 0.031 0.039 0.045
LSD(0.05) 0.260 NS 0.102 NS 0.925 NS 0.191 NS 0.112 NS 0.121 NS

Table 4: Effect of liming to green manure crop and different sources of phosphorus on yield and yield attributes of lowland rice.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>ET per m(^2)</th>
<th>Sterility (%)</th>
<th>Test weight (g)</th>
<th>Grain yield (t ha(^{-1}))</th>
<th>Straw yield (t ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1S1</td>
<td>284.52</td>
<td>13.80</td>
<td>22.05</td>
<td>3.25</td>
<td>5.12</td>
</tr>
<tr>
<td>M1S2</td>
<td>292.56</td>
<td>11.15</td>
<td>22.15</td>
<td>3.75</td>
<td>5.33</td>
</tr>
<tr>
<td>M1S3</td>
<td>289.56</td>
<td>12.14</td>
<td>21.89</td>
<td>4.00</td>
<td>5.48</td>
</tr>
<tr>
<td>M2S1</td>
<td>295.2</td>
<td>11.08</td>
<td>22.05</td>
<td>4.52</td>
<td>6.13</td>
</tr>
<tr>
<td>M2S2</td>
<td>315.72</td>
<td>10.11</td>
<td>22.16</td>
<td>4.22</td>
<td>5.94</td>
</tr>
<tr>
<td>M2S3</td>
<td>301.32</td>
<td>10.88</td>
<td>21.69</td>
<td>4.03</td>
<td>5.86</td>
</tr>
<tr>
<td>M3S1</td>
<td>300.36</td>
<td>11.07</td>
<td>22.19</td>
<td>4.85</td>
<td>6.39</td>
</tr>
<tr>
<td>M3S2</td>
<td>341.16</td>
<td>9.54</td>
<td>22.45</td>
<td>4.37</td>
<td>6.21</td>
</tr>
<tr>
<td>SEm(±)</td>
<td>4.267</td>
<td>0.25</td>
<td>0.310</td>
<td>0.039</td>
<td>0.065</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td>13.149</td>
<td>0.78</td>
<td>NS</td>
<td>0.120</td>
<td>0.201</td>
</tr>
</tbody>
</table>

and 0.14 kg ha\(^{-1}\) respectively. The biomass weeds were recorded highest in M\(_1\)S\(_1\) treatment than in all the treatments. This is due to the absence of liming and application of phosphorus through SSP. The correction of the soil pH by liming influences the bioavailability of plant nutrients and thereby providing favorable environment to increase the yield potential of the crops whereas the weeds can grow with irrespective of the situation. These findings corroborated with the findings of Karalic et al. (2013). The findings also prove that practice of green manuring not only increase the yield and maintain the soil fertility in the long run but also suppress the weeds.

The rice grain and straw yield recorded higher in M\(_3\)S\(_2\) treatment (3.25 t ha\(^{-1}\)) and (5.12 t ha\(^{-1}\)) yield was recorded in M\(_1\)S\(_1\) treatment due to the lowest number of effective tillers per m\(^2\) (284.52) and the highest nutrient uptake by weeds. The research findings prove the importance of green manuring and liming to green manure crop over Soil test based fertilizer in increasing the rice yields by reducing the weeds growth and neutralizing the soil pH which enhances the plant nutrient availability thus providing a favorable microclimate for rice.

It may be concluded from the above experiment that the lime application to acid soil elevate the soil pH and favours the desired growing environment for the microbes and crop plants, which also influences the nutrient availability and maintains soil health in long run.
ACKNOWLEDGEMENT

The author would like to thank to Department of Agronomy, College of Agriculture, OUAT, Bhubaneswar for providing the financial assistance for both field experiment and laboratory facility.

REFERENCES


