Effect of Organic Sources of Nitrogen on Rice (*Oryza sativa*) and Soil Carbon Pools in Inceptisols of Jammu

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Abstract

A pot experiment was conducted during Kharif season, 2005 to ascertain the response of different organic sources viz., wheat straw, farm yard manure (FYM), vermicompost and poultry manure to rice (*Oryza sativa*) and also to monitor the effect of manuring on soil carbon pools. Application of poultry manure and vermicompost along with chemical fertilizers for supply of nitrogen, phosphorus and potassium (NPK) resulted in highest grain yield rice. Soil carbon, labile carbon and water soluble carbon contents also improved with application of organic sources of N application.

*Keywords*: Grain yield; Labile carbon; Organic sources; Soil carbon; Water soluble carbon

1. Introduction

The level of organic matter in the soil is broad indicator of soil condition and its concentration in the soil is largely determined by the addition manures crop material and the rate at which microbes breakdown organic compounds. The level of organic matter in the soil is affected by land management history, although, climate, drainage, soil type and land form also influence the level of soil carbon. Organic matter is a key component in assessing soil fertility, stability, catchment health and soil condition. Declining soil carbon content and resultant decline in soil fertility are problems for many of the world’s agricultural production system (Oldemum, 1990).

Soil plays significant role in Global carbon cycle. It was estimated that soils have contributed as much as 55 to 78 billion tonnes of carbon to the total atmospheric CO₂ (Kimble et al., 2002). The total soil carbon consists of the soil organic carbon and inorganic carbon, estimated to be approximately over 2250 billion tons in the top 1 meter depth (Batjes, 1996). A key process in many
unsustainable agricultural systems is degradation of soils through loss of soil organic carbon (SOC). With cultivation soils may lose 50% or more of their organic carbon content, depending on soil conditions and agricultural practices.

To safeguard the environment from further degradation and to maintain the purity of air, water and food we have to opt for judicious use of chemicals and shift from chemical ecological agriculture for building up strong organic base to fertilize the fields. The use of organic manures such as Farm yard manure, Vermicompost, Poultry manure, crop residues, Spent Wash, Mushroom Compost etc is put forth for sustenance of soil fertility and crop productivity at a satisfactory level. Keeping this in view, the present study was conducted to assess the effect of integrated use of organic sources of N along with the chemical fertilizers on performance of rice and effect on soil properties especially soil C pools.

2. Materials and Methods

A pot experiment was conducted during kharif 2005 to ascertain the response of different organic sources viz., wheat straw, farm yard manure (FYM), vermicompost and poultry manure to rice (*Oryza sativa*) and also to monitor the effect of manuring on soil carbon pools. The amount of organic sources were calculated on the basis of amount of C supplied through FYM @15 tonnes/ha. The C: N ratio of wheat straw was wider 86.5:1 while that of poultry manure, vermicompost and FYM was 18.8:1, 22.5:1 and 24.4:1, respectively. The change in soil carbon pools was monitored periodically.

Organic carbon was determined according to the wet dichromate oxidation procedure (Walkley and Black, 1934). Water soluble organic carbon was determined in soil using oxidation method proposed by McGill et al. (1986). Freshly drawn soil sample was taken in 50 ml polyethylene centrifuge tubes and shaken on rotator shaker with distilled water (1:2 :: soil : water) for 60 min followed by 30 min centrifugation. The suspension was then filtered and 5 ml aliquot was taken in conical flask and treated with 0.07 N K$_2$Cr$_2$O$_7$, H$_2$SO$_4$ and orthophosphoric acid as given by McGill et al. (1986). The sample was mixed carefully and digested at 150$^\circ$ C for 30 min on hot plate and cooled at room temperature, it was then titrated against 0.035 N ferrous ammonium sulphate solution using diphenylamine indicator till the appearance of dark green colour as end point. A blank was also run simultaneously WSOC in percent was then calculated using normality of ferrous ammonium sulphate solution and weight of soil taken.

Labile fractions of organic matter can rapidly change in carbon supply and are important indicators of soil quality (Jinbo et al., 2006). Labile carbon is the most biologically active soil carbon and is also closely related to biologically mediated soil properties. It was estimated by the method given by Blair et al. (1995). The soil sample was weighed into 50 ml polyethylene centrifuge tubes and 33 mM KMnO$_4$ was added to each tube. Blank samples containing no soil and samples of reference soil were analyzed in each run. The tubes were shaken on an end to end shaker (tubes lying on its side) for 6 hours and then centrifuge at 3000 rpm for 30 min. The absorbance for the supernatant and standards were read on spectrophotometer at 565 nm. The change in the concentration of KMnO$_4$ was used to estimate the amount of carbon oxidised and the results were expressed as mg C/g soil. Dry combustion method of Houba et al. (1995) a modification of method given by Ball (1964) was employed for soil total C estimation. Soil sample was subjected to dry combustion in a muffle
furnace at 550 degree centigrade for 3 hours. The weight was treated as the loss of organic matter and this converted to C.

3. Results and Discussion

Significantly highest grain yield of rice to the tune of 11.74 and 11.2 g/pot was observed with the application of poultry manure and vermicompost along with chemical fertilizers for nitrogen, phosphorus and potassium (NPK). Increase in grain yield was observed to be 10.9, 21.8, and 28.5 % higher with the conjunctive use of farm yard manure (FYM), vermicompost and poultry manure with NPK respectively, as compared to no manure treatment (Table 1). Further, it was observed that as compared to control, straw yield of rice was 3.7, 15.9 and 20.7 % higher when applied with wheat straw, FYM, vermicompost and poultry manure, respectively. As compared to wheat straw application, grain yield was 4.1, 14.3 and 20.6 per cent higher under soils treated with poultry manure while wheat straw treatment was statistically at par with control in grain production of rice (Table 1). Vermicompost and poultry manure amendments were statistically non-significant among themselves in respect of grain yield of rice. With the application of only NPK (no manure), the straw yield of rice was observed to be 22.61 g/pot while addition of organic sources of nutrients viz., wheat straw, FYM, vermicompost and poultry manure increased the straw yield by 0.8, 1.5, 3.6 and 4.7g/pot (Table 1). Further it was observed that as compared to control, straw yield of rice was 3.7, 6.6, 15.9 and 20.7 per cent higher when applied with wheat straw, FYM, vermicompost and poultry manure, respectively. The increase in yield can be attributed to the additional supply of macro and micro nutrients through organic materials as well as improvement in soil properties. The results of the present study are in line to those reported by Jeyabal and Kuppuswamy (2001) who observed 15.9 per cent increase in rice yield through integrated application of vermicompost and fertilizer N over fertilizer N alone.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Grain yield (g/pot)</th>
<th>Straw yield (g/pot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No manure</td>
<td>9.13</td>
<td>22.61</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>9.73</td>
<td>23.46</td>
</tr>
<tr>
<td>FYM</td>
<td>10.13</td>
<td>24.10</td>
</tr>
<tr>
<td>Vermicompost</td>
<td>11.12</td>
<td>26.20</td>
</tr>
<tr>
<td>Poultry manure</td>
<td>11.74</td>
<td>27.30</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>0.99</td>
<td>1.93</td>
</tr>
</tbody>
</table>

The soil organic carbon content increased by 8.0, 9.6, 12.9 and 19.3 % in wheat straw, vermicompost, FYM and poultry manure treated soils, respectively, as compared to control (no manure). Organic carbon build up was maximum in organic manure amended soils during 15 to 60 days after incorporation and thereafter declining trend was observed. Application of FYM to rice and wheat increased organic carbon status of soil (Chettri et al., 2003). Similarly, Rogasik et al. (2004) indicated that combination of organic and mineral fertilizers increased soil organic carbon content compared to exclusive mineral fertilizers. Labile carbon content ranged from a minimum of 3.70 mg/kg in no manure treatment and maximum of 5.32 mg/kg in the soil amended with vermicompost. Incorporation of wheat straw, FYM, poultry manure and vermicompost increased labile carbon content by 13.5, 31.1, 41.6 and 43.7 % respectively, over control (Table 2).
carbon content was maximum (39.73 g/kg) in wheat straw amended soil followed by FYM (37.58 g/kg) treatment. The increase in soil organic carbon and labile C content with the application of organic sources might be due to decomposition of the carbon rich organic materials.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>WSOC (mg/kg)</th>
<th>Organic C (g/kg)</th>
<th>Labile C (mg/g)</th>
<th>Total C (g/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No manure</td>
<td>26.2</td>
<td>6.20</td>
<td>3.70</td>
<td>32.02</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>31.5</td>
<td>6.70</td>
<td>4.20</td>
<td>39.73</td>
</tr>
<tr>
<td>FYM</td>
<td>36.2</td>
<td>7.00</td>
<td>4.85</td>
<td>37.58</td>
</tr>
<tr>
<td>Vermicompost</td>
<td>43.0</td>
<td>6.80</td>
<td>5.32</td>
<td>36.88</td>
</tr>
<tr>
<td>Poultry manure</td>
<td>47.2</td>
<td>7.40</td>
<td>5.24</td>
<td>37.35</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>2.01</td>
<td>0.40</td>
<td>0.36</td>
<td>6.5</td>
</tr>
</tbody>
</table>

WSOC = Water Soluble Organic Carbon; Organic C = Organic Carbon

Water soluble organic carbon (WSOC), an active pool of soil organic matter, varied from 36.2 mg/kg in control to 57.2 mg/kg in the soil receiving poultry manure as amendment along with chemical fertilizers for NPK (Table 2). Application of FYM and vermicompost resulted in increase of 33.2 and 46.4%, respectively, as compared to WSOC content in no manure treatment. Application of NPK from chemical sources along with farm yard manure increased water soluble organic carbon by 32 to 41 per cent as compared to NPK through chemical fertilizers only (Singh et al., 2003).

4. Conclusion

Application of poultry manure and vermicompost along with inorganic sources of NPK resulted in highest grain yield of rice. Soil organic carbon, labile carbon and water soluble organic contents also improved with the application of organic sources in conjunction to chemical fertilizers. The study thus shows that for better soil management as well as optimizing crop yields and environmental security, organic amendments needs to be added along with use of chemical fertilizers.

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