Economics and productivity of two crop rotations and their integrated nutrient management of irrigated areas in south-western Rajasthan

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ABSTRACT

A 4-year field experiment was conducted during 1994–98 to compare the 2 crop rotations under 8 different nutrient-management practices at Keshwana, Jalore, Rajasthan, India, grown under assured irrigated conditions. Clusterbean [Cyamopsis tetragonoloba (L.) Taubert]–mustard [Brassica juncea (L.) Zernj. & Cosson]–greengram (Phaseolus radiatus L.) rotation gave significantly higher greengram-equivalent yield (GEY), gross income, net income and benefit:cost ratio than sesame (Sesamum indicum L.)–wheat (Triticum aestivum L. emend. Fiori & Paol.)–greengram rotation at all the levels of nutrient management. Treatment of 100% NPK through chemical fertilizer + 2.5 tonnes gypsum provided the maximum greengram-equivalent yield, net income and benefit:cost ratio in both the crop rotations. Other treatments of 100% NPK through chemical fertilizer and 75% NPK through chemical fertilizer + 25% through FYM were also comparable to the above treatment. Farmer’s practice of applying 100% NPK through chemical fertilizer + 10 tonnes FYM recorded higher yields and gross income but lesser net income and benefit:cost ratio.

Key words: Crop rotation, INM, Farmyard manure, Chemical fertilizer, Gypsum, Economics

Clusterbean–mustard–greengram and sesame–wheat–greengram are the 2 major crop rotations of irrigated areas of the south-western Rajasthan. Comparing the different crop rotations have become imperative to realize the increased agricultural production for meeting the ever-increasing food demand of burgeoning population of the country. But nutrient mining by continuous cropping had led to the impoverishment of soil fertility and decline in crop productivity (Raju and Reddy, 2000). Response of crops and crop rotations to different nutrient-management practices differ in terms of productivity and profitability (Saxena et al., 2003). Therefore, the present investigation was undertaken with an objective to compare the productivity and profitability of above-mentioned 2 crop rotations and to identify their most suitable integrated nutrient-management practice for sustaining the crop productivity and improving the soil health.

MATERIALS AND METHODS

The study was initiated during the rainy seasons of 1994 and continued for consecutive 4 years up to summer 1998 at the Agricultural Research Station, Rajasthan Agriculture University, Keshwana, Jalore, Rajasthan, India. The soil was silty loam with pH 8.2, EC 0.17 dS/m, organic carbon 0.25%, available phosphorus 8.6 kg P/ha and available potash 479.7 kg K/ha. The experiment was conducted in randomized block design with 8 fertilizer treatments and 2 crop rotations (clusterbean–mustard–greengram and sesame–wheat–greengram), replicated 3 times. The details of the fertilizer treatments (fertilizer dose equivalent to N, P2O5, K2O and FYM) are: T1, 50% recommended dose of fertilizer (RDF) of NPK through chemical fertilizer; T2, 75% RDF of NPK through chemical fertilizer; T3, 100% RDF of NPK through chemical fertilizer; T4, 50% RDF of NPK through chemical fertilizer + 50% through FYM; T5, 75% RDF of NPK through chemical fertilizer + 50% through FYM; T6, 75% RDF of NPK through chemical fertilizer + 25% through FYM; T7, 100% RDF of NPK through chemical fertilizer + 2.5 tonnes gypsum/ha; T8, 100% RDF of NPK through chemical fertilizer + 10 tonnes FYM/ha; and T9, control.

All these treatments were applied only in the rainy and winter season crops of the 2 rotations. No fertilizer was given to the greengram crop of these rotations. All the phosphorus and potash and 50% N dose were applied as basal and 50% N as top-dressing at 28–30 days stage. Quantity of FYM was applied on the basis of N content

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only. In the clusterbean–mustard–greengram rotations clusterbean cv. ‘Suvidha’ (1994) or ‘RGC 936’ (1995–97) were sown during the third to fourth week of July with 15 kg seed rate, 30 cm row distance, 20, 40 and 0 kg/ha as 100% NPK (N, P₂O₅, K₂O) and harvested in October during all the 4 years of study. Mustard cv. ‘T 59’ (1994) and ‘RH 30’ (1995–97) was sown during the second–third week of November with 4 kg seed rate at 30 cm row distance, 60:40:0 as 100% NPK and harvested during second–third week of March. In the sesame–wheat–greengram rotation, sesame cv. ‘RT 46’ was sown during third–fourth week of July with 3 kg seed rate, 30 cm row distance, 40:25:0 as 100% NPK and harvested during second–third week of October. Wheat cv. ‘Raj 1482’ (1994 and ‘Raj 3077’ (1995–97) were sown during third–fourth week of November with 100 kg seed rate, 22.5 cm row distance, 120:40:0 as 100% NPK and harvested during the second–third week of March to first week of April. In both the above crop sequences greengram cv. ‘K 851’ was sown during middle of April with 15 kg seed rate, 30 cm row distance, without any fertilizer and harvested during middle of July. Economics was calculated with the market price of single superphosphate Rs 3.0, urea Rs 3.8, gypsum Rs 2.0, FYM Re 0.2, clusterbean Rs 21, mustard Rs 13, greengram Rs 22, sesame Rs 23 and wheat Rs 5.5.

RESULTS AND DISCUSSION

System yield

The average yield of all the crops of the clusterbean–mustard–greengram and sesame–wheat–greengram rotations was affected significantly by different fertilizer treatments. Clusterbean–mustard–greengram rotation gave substantially higher average greengram-equivalent yield (GEY) than sesame–wheat–greengram rotation at all the levels of fertilizer treatments (Tables 1, 2).

Nutrient management

In the crop rotation of clusterbean–mustard–greengram (rotation I), the highest average clusterbean yield was recorded under 100% RDF of NPK through chemical fertilizer, followed by 100% RDF of NPK + 10 tonnes FYM which were statistically at par with the 100% RDF of NPK through chemical fertilizer + 2.5 tonnes gypsum

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (ql/ha) of rotation I crops</th>
<th>Greengram-equivalent yield (ql/ha)</th>
<th>Cost of production (Rs)</th>
<th>Gross income (Rs)</th>
<th>Net income (Rs)</th>
<th>Benefit: cost ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>Clusterbean 8.90 mustard 10.62 greengram 12.48</td>
<td>26.1 29.0 32.0</td>
<td>12,542 13,081 13,619</td>
<td>57,376 63,756 70,358</td>
<td>44,834 50,675 56,739</td>
<td>3.57 3.87 4.17</td>
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<tr>
<td>T₂</td>
<td>Clusterbean 12.57 mustard 17.45 greengram 10.79</td>
<td>29.4 32.0 35.0</td>
<td>14,142 13,881 13,881</td>
<td>64,753 67,113 67,113</td>
<td>50,614 56,739 56,739</td>
<td>3.58 3.83 3.83</td>
</tr>
<tr>
<td>T₃</td>
<td>Clusterbean 10.94 mustard 13.35 greengram 11.41</td>
<td>34.3 33.5 33.5</td>
<td>14,569 18,019 18,019</td>
<td>75,440 73,682 73,682</td>
<td>60,871 55,663 55,663</td>
<td>4.18 3.09 3.09</td>
</tr>
<tr>
<td>T₄</td>
<td>Clusterbean 11.19 mustard 13.25 greengram 11.97</td>
<td>27.6 25.1 25.1</td>
<td>16,465 18,982 18,982</td>
<td>81,698 85,152 85,152</td>
<td>22,233 21,222 21,222</td>
<td>1.35 1.91 1.91</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>1.60 1.23 1.25</td>
<td>1.49</td>
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</tbody>
</table>

Details of treatments are given in text

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (ql/ha) of rotation II crops</th>
<th>Greengram-equivalent yield (ql/ha)</th>
<th>Cost of production (Rs)</th>
<th>Gross income (Rs)</th>
<th>Net income (Rs)</th>
<th>Benefit: cost ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>Sesame 3.95 wheat 4.61 greengram 6.27</td>
<td>17.7 20.3 23.6</td>
<td>13,172 13,878 14,582</td>
<td>39,013 44,741 51,955</td>
<td>25,931 30,863 37,373</td>
<td>1.97 2.22 2.56</td>
</tr>
<tr>
<td>T₂</td>
<td>Sesame 4.62 wheat 5.02 greengram 6.27</td>
<td>20.0 25.1 26.1</td>
<td>16,372 15,478 15,582</td>
<td>44,044 47,390 57,365</td>
<td>27,672 31,912 41,783</td>
<td>1.69 2.06 2.68</td>
</tr>
<tr>
<td>T₃</td>
<td>Sesame 5.91 wheat 6.37 greengram 7.02</td>
<td>25.1 31.4 33.5</td>
<td>18,982 17,763 18,982</td>
<td>55,152 49,992 55,152</td>
<td>36,170 30,863 41,783</td>
<td>1.91 1.13 1.13</td>
</tr>
<tr>
<td>T₄</td>
<td>Sesame 1.92 wheat 1.78 greengram 1.30</td>
<td>11.4 11.4 11.4</td>
<td>11,763 11,763 11,763</td>
<td>24,992 24,992 24,992</td>
<td>13,229 13,229 13,229</td>
<td>1.13 1.13 1.13</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>0.83 1.78 1.30</td>
<td>1.43</td>
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Details of treatments are given in text
treatment (Table 1). Mustard yield of this rotation was the highest under 100% RDF of NPK through chemical fertilizer + 2.5 tonnes gypsum treatment which was significantly higher than 100% RDF of NPK through chemical fertilizer treatment but at par with the 100% RDF of NPK + 10 tonnes FYM. Greengram crop yield of the rotation I was also recorded highest under 100% RDF of NPK through chemical fertilizer + 2.5 tonnes gypsum, followed by 100% RDF of NPK through chemical fertilizer + 10 tonnes FYM treatments which were significant higher than 100% RDF of NPK through chemical fertilizer treatment. Average greengram-equivalent yield of the rotation was 7.2% higher under 100% RDF of NPK through chemical fertilizer + 2.5 tonnes gypsum and 4.2% higher under 100% RDF of NPK through chemical fertilizer + 10 tonnes FYM than the average greengram-equivalent yield of 100% RDF of NPK through chemical fertilizer treatment. Kathiresan and Manoharan (2003) also reported increase in yield owing to addition of gypsum. However, increase in yield with the addition of FYM to the recommended dose of NPK might be owing to the increased availability of P and K (Nambiar and Abrol, 1989), increase in built up of organic carbon (Katyal et al., 2001) and production of higher root biomass (Lal and Mathur, 1989). Treatment of 75% RDF of NPK through chemical fertilizer + 25% through FYM resulted in average greengram-equivalent yield and average yield of all the 3 crops of the rotation I, statistically at par with 100% RDF of NPK through chemical fertilizer treatment. Treatments of 50% RDF of NPK through chemical fertilizer + 50% through FYM, 75% RDF of NPK through chemical fertilizer and 50% RDF of NPK through chemical fertilizer resulted in average greengram-equivalent yield and average yield of clusterbean and mustard crops of the rotation I significantly less than the 100% RDF of NPK through chemical fertilizer treatment. It might be due to the inadequate nutrient supply to the crops of the rotation I under these treatments. All the nutrient-management treatments resulted in significantly higher average yields of all the crops and average greengram-equivalent yield of the rotation I than the control treatment.

Economics

Higher average greengram-equivalent yield at all the levels of nutrient management under rotation I, i.e. clusterbean–mustard–greengram, was associated with higher gross income, net income and benefit: cost ratio when compared with rotation II, i.e. sesame–wheat–greengram (Tables 1, 2). It was owing to higher yield and profitability of clusterbean than sesame and higher profitability of mustard on account of higher market price than wheat besides very high yields of mustard under clusterbean–mustard–greengram rotation. In both the crop rotations, the highest gross income, net income and benefit: cost ratio were recorded under the treatment 100% RDF of NPK through chemical fertilizer + 2.5 tonnes gypsum. Treatment of 100% RDF of NPK through chemical fertilizer + 10 tonnes FYM recorded higher gross income but substantially lesser net income and benefit: cost ratio when compared with 100% RDF of NPK through chemical fertilizer treatment in both the crop rotations. It might be due to the increased cost of production owing to the higher cost of FYM. In both the crop rotations, 75% RDF of NPK through chemical fertilizer + 25% through FYM treatment recorded gross income, net income and benefit: cost ratio comparable to 100% RDF of NPK through chemical fertilizer treatment. Thus 25% recommended dose of chemical fertilizer may be replaced by FYM basing N content without sacrificing

sum and 100% RDF of NPK through chemical fertilizer + 10 tonnes FYM treatment were statistically at par among themselves but recorded 10.4 and 6.2% higher average greengram-equivalent yield than the 100% RDF of NPK through chemical fertilizer treatment. Treatments of 75% RDF of NPK through chemical fertilizer + 25% through FYM resulted in average greengram-equivalent yield and average yield of wheat and greengram of the rotation II at par with the 100% RDF of NPK through chemical fertilizer treatment. Though with respect to sesame average yield, these 2 treatments were at par among themselves. Treatments of 50% RDF of NPK through chemical fertilizer + 50% through FYM, 50% RDF of NPK through chemical fertilizer and 75% RDF of NPK through chemical fertilizer resulted in average greengram-equivalent yield and average yield of sesame and wheat of the rotation II significantly less than the 100% RDF of NPK through chemical fertilizer treatment. It might be due to the inadequate nutrient supply to the sesame and wheat crops of the rotation II under these treatments. All the nutrient-management treatments resulted in significantly higher average yields of all the crops and average greengram-equivalent yield of the rotation II than the control treatment.
yield and profit. Treatments of 50% RDF of NPK through chemical fertilizer + 50% through FYM, 75% RDF of NPK through chemical fertilizer and 50% RDF of NPK through chemical fertilizer recorded substantially less gross income, net income and benefit : cost ratio as compared to 100% RDF of NPK through chemical fertilizer in both the crop rotations. Least gross income, net income and benefit : cost ratio were recorded under control conditions.

Clusterbean–mustard–greengram rotation was found substantially more productive and profitable than sesame–wheat–greengram. Higher production as well as profit might be achieved by addition of gypsum @ 2.5 tonnes/ha to the recommended dose of NPK in the 2 rotations crops in the zone IIb of Rajasthan. Integrated nutrient-management practice of 75% RDF of NPK through chemical fertilizer + 25% through FYM in both the crop rotations may be recommended as an alternate to the 100% RDF of NPK through chemical fertilizer to sustain the crop productivity.

REFERENCES


