Response of Nutrient Management to Growth, Yield and Economics of Pigeonpea+Radish Intercropping System in Odisha

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Abstract
A field experiment was conducted to study the growth and productivity of pigeonpea + radish intercropping system under different nutrient management practices for two consecutive years during kharif seasons of 2013 and 2014 at Instructional Farm, RRTTS, Gumusur Udayagiri, OUAT, Kandhamal, Odisha, India. The treatments were Pigeonpea (100% RDF)+Radish (100% RDF), Pigeonpea (100% RDF)+Radish (75% RDF), Pigeonpea (100% RDF)+Radish (50% RDF), Pigeonpea (100% RDF)+Radish (25% RDF), Pigeonpea (100% RDF)+Radish (0% RDF ), Pigeonpea (75% RDF)+Radish (100% RDF), Pigeonpea (50% RDF)+Radish (100% RDF ), Pigeonpea (25% RDF)+Radish (100% RDF), Pigeonpea (0% RDF)+Radish (100% RDF), Pigeonpea (0% RDF)+Radish (0% RDF) as control, sole Pigeonpea (100% RDF) and Sole Radish (100% RDF). The twelve treatments were replicated thrice in a randomized block design. Among the intercropping systems, the treatment 100% RDF was applied to the base crop (pigeonpea) and 100% RDF to the intercrop (radish) almost all the growth parameters as well as yield components showed highest values. Sole crop of pigeonpea with 100% RDF produced the highest seed yield (1.20 t ha\(^{-1}\)) and stover yield (4.56 t ha\(^{-1}\)). Sole radish crop with 100% RDF achieved the highest root yield (17.70 t ha\(^{-1}\)) and leaf yield (4.02 t ha\(^{-1}\)) over other treatments followed by pigeonpea + radish with 100% RDF to base crop+100% RDF to intercrop. Sole radish exhibited the highest net return (\(\text{₹} 73773\text{ ha}^{-1}\)) and return rupee \(^{-1}\) investment (3.28) with 100% RDF though the highest gross return (\(\text{₹} 125890\text{ ha}^{-1}\)) was obtained from pigeonpea +radish intercropping system with 100% RDF to both the crops.

Keywords: Pigeonpea, radish, intercropping, recommended dose, yield

1. Introduction
Pigeonpea an important crop amongst pulses is relatively less yielder because of its slow initial growth rate and low harvest index; therefore it is grown as intercrop which helps in efficient utilization of available resources for enhancing the productivity and profitability (Rao and Willey, 1980). In India, it is grown in an area of 5.40 m ha with an annual production of 4.78 mt and productivity of 885 kg ha\(^{-1}\) (Anonymous, 2017). The species of contrasting habit, both morphologically and physiologically would together be able to exploit the total environment more effectively than monoculture (Donald, 1963), though there is a significant amount of intercrop competition (Willey, 1979). Beets (1982) reported that crop insurance was a major principle of intercropping system. The competitive
ability of intercropping was enhanced by the high plant population pressure provided by the component species together (Rao and Shetty, 1976). Intercropping system as a whole intercepts more solar radiation and thus has higher potential for photosynthesis than single crop stands (Reddy and Reddy, 1981). Thakur et al. (1998) reported that the intercrop entails better utilization of soil moisture, nutrients and solar radiation than sole cropping. Further it augments the utilization of available resources, viz., light, nutrients and moisture, with reference to the production per unit of applied inputs (Ahlawat et al., 2005). This significantly not only influence yield of intercrops (Reddy et al., 2007), but it would ensure low yield fluctuations than sole cropping even under unfavourable conditions (Anderson and Williams, 1954; Oguntowara and Norman, 1974). Pigeonpea offers a good scope for intercropping with fast growing early maturing and shallow rooted crops. Intercropping of pigeonpea with suitable intercrops brings stability in the yield and improves the total production. Aiyer (1949) reported that the resources with regard to plant nutrients present in the soil or added to it as manures were utilized to the fuller extent in mixed stand than when component crops were grown separately. Singh and Singh (1992) had reported that the production efficiency of pigeonpea is higher when it is grown as intercrop rather than the sole crop. Radish is easily grown as a companion crop or intercrop between the rows of tall growing pulses. Radish is a popular choice for cultivation, as they are fairly easy to grow and is a rapidly maturing crop with many varieties, and reach maturity within 60 days. Radish is useful in the treatment of liver, gall bladder troubles, sleeplessness, chronic diarrhoea, neuralgic headaches, urinary complaints, piles and gastrodynia (Sadhu, 1993). There is no need of irrigation for radish if sown in rainy season. To reduce the drought risks, pigeonpea+radish intercropping system has been recommended for the rainfed areas (Behera et al., 1998). The system maximizes the yield per unit area in good rainfall years and stabilizes the yield by minimizing the drought risks in bad rainfall years. With this view, the present experiment was carried out to study the nutrient management on growth, yield and economics of pigeonpea+radish intercropping system in Odisha.

2. Materials and Methods

The field experiment was conducted at Instructional Farm, Regional Research and Technology Transfer Station (RRTTS), Gumusur Udayagiri, Odisha University of Agriculture and Technology, district Kandhamal, Odisha state, India during kharif seasons, 2013 and 2014. The experiment consisted of twelve treatments (ten paired row arrangements 30/90 cm), number of primary branches plant\(^{-1}\) (17.3), dry matter accumulation( 96.76 g plant\(^{-1}\)), crop grow rate (CGR) during 60–90 DAS (1.60 g plant\(^{-1}\) day\(^{-1}\)) and LAI at 90 DAS (4.64) on pooled data basis. Among the intercropping systems, the highest plant height (174.9 cm), number of primary branches plant\(^{-1}\) (15.3), LAI at 90 DAS (4.39), dry matter accumulation (95.47 g plant\(^{-1}\)) and CGR during 60–90 DAS (1.59 g plant\(^{-1}\) day\(^{-1}\)) of pigeonpea was recorded with P\(_{100}\) RDF+R\(_{100}\) RDF and this was followed by the treatment P\(_{75}\) RDF+R\(_{100}\) RDF, P\(_{50}\) RDF+R\(_{100}\) RDF and P\(_{100}\) RDF+R\(_{75}\) RDF. These results were in conformity with the findings of Parmila Rani and Reddy (2010), Kumawat et al. (2013), Nagar et al. (2015). Pal et al. (2015), Nagar et al. (2016).

3. Results and Discussion

3.1. Pigeonpea

3.1.1. Growth attributes

Sole pigeonpea (P\(_{100}\) RDF) produced highest plant height (179 cm), number of primary branches plant\(^{-1}\) (17.3), dry matter accumulation( 96.76 g plant\(^{-1}\)), crop grow rate (CGR) during 60–90 DAS (1.60 g plant\(^{-1}\) day\(^{-1}\)) and LAI at 90 DAS (4.64) on pooled data basis. Among the intercropping systems, the highest plant height (174.9 cm), number of primary branches plant\(^{-1}\) (15.3), LAI at 90 DAS (4.39), dry matter accumulation (95.47 g plant\(^{-1}\)) and CGR during 60–90 DAS (1.59 g plant\(^{-1}\) day\(^{-1}\)) of pigeonpea was recorded with P\(_{100}\) RDF+R\(_{100}\) RDF and this was followed by the treatment P\(_{75}\) RDF+R\(_{100}\) RDF, P\(_{50}\) RDF+R\(_{100}\) RDF and P\(_{100}\) RDF+R\(_{75}\) RDF. These results were in conformity with the findings of Parmila Rani and Reddy (2010), Kumawat et al. (2013), Nagar et al. (2015). Pal et al. (2015), Nagar et al. (2016).

3.1.2. Yield components and Yield

Sole pigeonpea receiving 100% RDF showed highest number of filled pods plant\(^{-1}\) (135.3), number of seeds pod\(^{-1}\) (5.0) and 1000-seed weight (82.16 g). This was at par with the intercropping systems with P\(_{100}\) RDF+R\(_{100}\) RDF and P\(_{75}\) RDF+R\(_{100}\) RDF. Similar results were recorded by Malik et al. (2013) and Pandey et al. (2013) (Table 1).

Sole pigeonpea with 100% RDF produced highest seed yield of 1.20 t ha\(^{-1}\) and stover yield of 4.56 t ha\(^{-1}\) and was at par with full dose of fertilizers to P\(_{100}\) RDF+R\(_{100}\) RDF with seed yield of 1.16 t ha\(^{-1}\) and stover yield of 4.36 t ha\(^{-1}\) and superior to other treatments. Similar results have been reported by
Table 1: Response of nutrient management on growth, yield attributes and yields of pigeonpea in pigeonpea+radish intercropping system (Pooled data of two years)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Growth attributes</th>
<th>Pigeonpea</th>
<th>Yield components</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plant height (cm) at harvest</td>
<td>LAI at 90 DAS (g plant⁻¹)</td>
<td>DMA 60-90 DAS (g plant⁻¹)</td>
<td>CGR 60-90 DAS (g plant⁻¹ day⁻¹)</td>
</tr>
<tr>
<td>P₁₀₀% RDF+R₁₀₀% RDF</td>
<td>174.9</td>
<td>4.39</td>
<td>95.47</td>
<td>1.59</td>
</tr>
<tr>
<td>P₁₀₀% RDF+R₇₅% RDF</td>
<td>166.4</td>
<td>4.24</td>
<td>92.29</td>
<td>1.57</td>
</tr>
<tr>
<td>P₁₀₀% RDF+R₅₀% RDF</td>
<td>156.1</td>
<td>4.14</td>
<td>87.65</td>
<td>1.56</td>
</tr>
<tr>
<td>P₁₀₀% RDF+R₂₅% RDF</td>
<td>151.5</td>
<td>4.13</td>
<td>86.08</td>
<td>1.56</td>
</tr>
<tr>
<td>P₁₀₀% RDF+R₀% RDF</td>
<td>146.4</td>
<td>4.06</td>
<td>78.79</td>
<td>1.55</td>
</tr>
<tr>
<td>P₇₅% RDF+R₁₀₀% RDF</td>
<td>170.4</td>
<td>4.33</td>
<td>94.82</td>
<td>1.59</td>
</tr>
<tr>
<td>P₅₀% RDF+R₁₀₀% RDF</td>
<td>169.2</td>
<td>4.26</td>
<td>93.42</td>
<td>1.57</td>
</tr>
<tr>
<td>P₂₅% RDF+R₁₀₀% RDF</td>
<td>165.2</td>
<td>4.20</td>
<td>91.53</td>
<td>1.56</td>
</tr>
<tr>
<td>P₀% RDF+R₁₀₀% RDF</td>
<td>161.2</td>
<td>4.16</td>
<td>88.99</td>
<td>1.56</td>
</tr>
<tr>
<td>Sole pigeonpea (P₁₀₀% RDF)</td>
<td>179.0</td>
<td>4.64</td>
<td>96.76</td>
<td>1.60</td>
</tr>
<tr>
<td>Sole radish (R₁₀₀% RDF)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

SEm± 5.20 0.05 2.09 0.027 0.46 2.78 0.22 1.65 0.029 0.084
CD (p=0.05) 10.78 0.10 4.33 0.080 0.95 5.77 0.46 NS 0.060 0.174

Vishwanatha et al. (2012).

3.2. Radish

3.2.1. Growth attributes

Sole radish with application of 100% RDF recorded highest plant height (43.0 cm), number of leaves plant⁻¹ (15.22), LAI (1.49); dry matter accumulation (56.21 g plant⁻¹) and CGR at 20-30 DAS (1.58 g plant⁻¹ day⁻¹). This was followed by intercropping system with P₁₀₀% RDF+R₁₀₀% RDF with plant height of 37.2 cm, number of leaves plant⁻¹ (12.2), LAI of 1.28, dry matter accumulation of 45.1 g plant⁻¹. The treatment with pigeonpea+radish intercropping system having no fertilizers resulted in lowest plant height (21.1 cm), number of leaves plant⁻¹ (5.73), leaf area index (0.53), dry matter accumulation (25.83 g plant⁻¹) and CGR (0.68 g plant⁻¹ day⁻¹) in pooled analysis. These results were in accordance with the findings of Brintha and Seran (2009).

3.2.2. Yield components and yield

Highest value of root length (29.01 cm) and root girth (13.0 cm) was recorded with sole radish (R₁₀₀% RDF) which was significantly higher than all other treatments. Among the intercropping systems, P₁₀₀% RDF+R₁₀₀% RDF resulted higher value of root length (22.8 cm) and girth of roots (9.82 cm) and it was followed by P₇₅% RDF+R₁₀₀% RDF and P₅₀% RDF+R₁₀₀% RDF which were found to be at par. These results were in conformity with the findings of Brintha and Seran (2009) and Thavaprakaash et al. (2005).

The highest root yield (17.70 t ha⁻¹) and leaf yield (4.02 t ha⁻¹) of radish was obtained from sole crop of radish with 100% RDF and was significantly higher than all other intercropping treatments. Among the intercropping systems, application of 100% RDF to base crop+100% RDF to intercrop resulted in higher root yield of radish (13.22 t ha⁻¹) and leaf yield (3.71 t ha⁻¹) followed by P₇₅% RDF+R₁₀₀% RDF. Similar results were reported by Brintha and Seran (2009) and Islam et al. (2011) (Table 2).

4. Economics

The highest net returns (₹ 73773 ha⁻¹), return rupee⁻¹ investment (3.28) was achieved from the treatment where 100% RDF was applied to sole radish. This was followed by intercropping system with 100% RDF to base crop+100% RDF to intercrop (net return of ₹ 71,915 ha⁻¹ and return rupee⁻¹ investment of 2.33). The highest gross return was obtained from intercropping system of P₁₀₀% RDF+R₁₀₀% RDF (₹ 1,25,890) followed by P₇₅% RDF+R₁₀₀% RDF and P₅₀% RDF+R₁₀₀% RDF These findings were in accordance with the results reported by Kasbe and Karanjikar (2009) and Vishwanatha et al. (2012) (Table 3).
Table 3: Response of nutrient management on economics in pigeonpea and radish intercropping system (Pooled data of two years)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Economics</th>
<th></th>
<th>Gross return (₹ ha⁻¹)</th>
<th>Cost of cultivation (₹ ha⁻¹)</th>
<th>Net return (₹ ha⁻¹)</th>
<th>Return rupee⁻¹ investment (₹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>P₁₀₀% RDF+R₁₀₀% RDF</td>
<td></td>
<td>37.2</td>
<td>12.2</td>
<td>1.28</td>
<td>45.10</td>
</tr>
<tr>
<td>T₂</td>
<td>P₁₀₀% RDF+R₇₅% RDF</td>
<td></td>
<td>34.4</td>
<td>10.1</td>
<td>1.05</td>
<td>43.43</td>
</tr>
<tr>
<td>T₃</td>
<td>P₁₀₀% RDF+R₅₀% RDF</td>
<td></td>
<td>29.5</td>
<td>8.6</td>
<td>0.92</td>
<td>40.65</td>
</tr>
<tr>
<td>T₄</td>
<td>P₁₀₀% RDF+R₂₅% RDF</td>
<td></td>
<td>28.7</td>
<td>8.0</td>
<td>0.91</td>
<td>40.08</td>
</tr>
<tr>
<td>T₅</td>
<td>P₁₀₀% RDF+R₀% RDF</td>
<td></td>
<td>26.6</td>
<td>7.6</td>
<td>0.87</td>
<td>38.42</td>
</tr>
<tr>
<td>T₆</td>
<td>P₇₅% RDF+R₁₀₀% RDF</td>
<td></td>
<td>35.5</td>
<td>11.0</td>
<td>1.07</td>
<td>44.38</td>
</tr>
<tr>
<td>T₇</td>
<td>P₅₀% RDF+R₁₀₀% RDF</td>
<td></td>
<td>34.6</td>
<td>10.6</td>
<td>1.07</td>
<td>44.10</td>
</tr>
<tr>
<td>T₈</td>
<td>P₂₅% RDF+R₁₀₀% RDF</td>
<td></td>
<td>32.5</td>
<td>9.6</td>
<td>0.98</td>
<td>42.74</td>
</tr>
<tr>
<td>T₉</td>
<td>P₀% RDF+R₁₀₀% RDF</td>
<td></td>
<td>31.5</td>
<td>8.0</td>
<td>0.91</td>
<td>41.41</td>
</tr>
<tr>
<td>T₁₀</td>
<td>P₀% RDF+R₀% RDF</td>
<td></td>
<td>21.1</td>
<td>5.7</td>
<td>0.53</td>
<td>25.83</td>
</tr>
<tr>
<td>T₁₁</td>
<td>Sole pigeonpea (P₁₀₀% RDF)</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>T₁₂</td>
<td>Sole radish (R₁₀₀% RDF)</td>
<td></td>
<td>43.0</td>
<td>15.2</td>
<td>1.49</td>
<td>56.21</td>
</tr>
</tbody>
</table>

SEm± 1.70 0.47 0.04 0.45
CD (p=0.05) 3.53 0.97 0.08 0.93

Sethy et al., 2019
5. Conclusion

Sole crop of radish with 100% RDF produced the highest yield (17.70 t ha⁻¹), net return (₹ 73773 ha⁻¹) and return rupee⁻¹ investment (3.28) when compared with other intercropping systems. Among different intercropping systems application of 100% recommended fertilizer dose with pigeonpea and radish performed best.

6. Reference


