Effect of cropping systems and integrated nutrient management practice on yield and yield components of rainfed castor

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ABSTRACT: The seed yields of castor were significantly high under alley cropping during both the years of 1996 (659 kg/ha) and 1997 (684 kg/ha) over sole cropping. Leucaena greenleaf manure had resulted in higher seed yield of castor with values of 626 (1996) and 704 kg/ha (1997) followed by Albizia and Dalbergia greenleaf manures. Significantly lower yields were recorded without greenleaf manure (511 and 526 kg/ha). Significantly increased seed yields were observed at 80 kg N/ha (728 and 814 kg/ha during 1996 and 1997, respectively). Interaction effects were found significant with higher seed yield under alley cropping with Leucaena greenleaf manure at 40 kg N/ha in both the years of 1996 (760 kg/ha) and 1997 (828 kg/ha) than no green leaf manure at 80 kg N/ha (588 and 725 kg/ha). Harvest index followed similar trend with increased values of 50.32% (1996), 53.99% (1997) under alley cropping, with leucaena greenleaf manuring (53.05 and 54.71%) and 80 kg N/ha (54.63 and 52.65%). Interaction of alley cropping with Leucaena GLM at 40 kg N/ha had resulted in more harvest index in both the years. All the yield components viz., number of spikes / plant, spike length, number of capsules / spike, test weight and seed yield / plant were significantly high under alley cropping, Leucaena GLM and 80 kg N/ha. However, among interaction effect, alley cropping with Leucaena GLM at 40 kg N/ha produced yield components which were comparable with the values obtained at 80 kg N/ha without green leaf manuring.

The production and productivity of castor are very low in Andhra Pradesh. Impoverished soils, low efficiency of applied fertilizers coupled with poor management practices in drylands are attributing for low yields of castor. The demand for oilseed is increasing day by day due to burgeoning population and the farmers are bound to apply fertilizers indiscriminately to enhance crop productivity which may deteriorate soil health and cause other environmental problems. In order to improve the productivity of castor, there is a need to use the inorganic fertilizer and organic sources in conjunction. The freely available tree leaves which are eco-friendly serves as alternate organic sources, have immense potential to increase the efficiency of applied fertilizer. Alley cropping one of the agro forestry methodology is the best system approach, as the trees are lopped during cropping and lopped foliage is used as green leaf manure. It was reported that application of 10 t/ha of greenleaf material of Leucaena is equivalent to 100 kg N/ha (Kang et al., 1981). Greenleaf manures obtained from Leucaena alley cropping when applied in conjunction with 50% recommended dose of nitrogen boosted the yields of castor (Bheemaiah et al. 1998). Hence, the present study was initiated.
Materials and Methods

During kharif season of 1996 and 1997, the field experiment entitled “Response of rainfed castor to application of greenleaf manures and nitrogen levels alley cropped with Dalbergia sissoo” was conducted at Student’s Farm, College of Agriculture, Hyderabad. Two cropping systems viz., sole cropping (SC) and alley cropping of castor (AC) as main plots, four organic sources of N like, no greenleaf manure (GLM₀), Leucaena greenleaf manure (GLM₁) Albizia greenleaf manure (GLM₂) and Dalbergia green leaf manure (GLM₃) as sub-plots and three levels of inorganic sources of N i.e., 0, 40 and 80 kg N/ha as sub-sub plots are the treatments. Double split plot design was employed with three replications. Open area was low in organic carbon (0.25%) and available nitrogen (175 kg/ha), while, alley cropped area was medium in both in organic carbon and available nitrogen (0.65%) and 280 kg/ha respectively). Green leaf manures of Leucaena and Albizia were obtained from nearby stands while Dalbergia GLM was obtained in situ by pollarding trees at 2 m height and all were incorporated both in alley cropped and sole cropped area in respective plots 15 days before sowing by opening furrows @ 5 t/ha. Recommended dose of P was applied along with greenleaf manures for better decomposition. Nitrogen was applied in two split doses as per the treatments. The plot size was 8 m x 4 m and 4 m x 4 m in alley and sole crop area, respectively, castor variety, aruna was sown both in alley and sole cropped areas on 17.7.1996 and 14.7.1997 and harvested on 15.10.1996 and 30.10.1997.

Table 1  Yield components of castor as influenced by cropping systems, greenleaf manures and nitrogen levels.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>No. of Spikes/plant</th>
<th>Spike length (cm)</th>
<th>No.of capsules/spike</th>
<th>Test weight (g)</th>
<th>Seed yield/plant (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main treatments</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sole cropping (SC)</td>
<td>3.91</td>
<td>3.47</td>
<td>12.2</td>
<td>17.9</td>
<td>13.2</td>
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<tr>
<td>Alley cropping (AC)</td>
<td>4.43</td>
<td>4.21</td>
<td>14.8</td>
<td>18.1</td>
<td>16.8</td>
</tr>
<tr>
<td>CD (rp 0.05)</td>
<td>0.52</td>
<td>0.62</td>
<td>1.66</td>
<td>2.0</td>
<td>2.99</td>
</tr>
<tr>
<td><strong>Sub- treatments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No green leaf manuring (GLM₀)</td>
<td>3.97</td>
<td>3.76</td>
<td>12.7</td>
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<td>13.5</td>
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<tr>
<td>Leucaena leaf manuring (GLM₁)</td>
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<td>4.02</td>
<td>14.9</td>
<td>19.3</td>
<td>15.7</td>
</tr>
<tr>
<td>Albizia leaf manuring (GLM₂)</td>
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<td>3.92</td>
<td>13.6</td>
<td>17.5</td>
<td>15.5</td>
</tr>
<tr>
<td>Dalbergia leaf manuring (GLM₃)</td>
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<td>3.64</td>
<td>12.9</td>
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<td>15.4</td>
</tr>
<tr>
<td>CD (rp 0.05)</td>
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<td>0.29</td>
<td>0.74</td>
<td>0.97</td>
<td>0.72</td>
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<td><strong>Sub-sub treatments</strong></td>
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<tr>
<td>0 kg N/ha (N₀)</td>
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<td>3.15</td>
<td>11.5</td>
<td>15.5</td>
<td>13.5</td>
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<tr>
<td>40 kg N/ha (N₄₀)</td>
<td>4.17</td>
<td>3.78</td>
<td>13.7</td>
<td>18.6</td>
<td>15.1</td>
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<tr>
<td>80 kg N/ha (N₈₀)</td>
<td>5.21</td>
<td>4.59</td>
<td>15.4</td>
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<td>16.6</td>
</tr>
<tr>
<td>CD (P 0.05)</td>
<td>0.47</td>
<td>0.47</td>
<td>1.20</td>
<td>1.53</td>
<td>0.63</td>
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</table>
Results and Discussion

i) **Yield components**

a) **Number of spikes / plant**: Data in table 1 showed that alley cropping resulted in significantly more number of spikes / plant with values of 4.4 (1996) and 4.2 (1997) over sole cropping. Greenleaf manuring of Leucaena leaves (GLM1) had produced more number of spikes of 4.44 (1996) and 4.02 (1997) followed by GLM2 and GLM3 and GLM0. Nitrogen with 80 kg/ha had significantly high number of spikes during both the years of 1996 (5.21) and 1997 (4.59).

b) **Spike length**: Spike length was found more under alley cropping (14.8 and 18.1 cm during 1996 and 1997, respectively). Increased spike length of 14.9 cm (1996) and 19.3 cm (1997) was noticed with Leucaena GLM which was significantly superior over GLM0(12.7 and 17.8 cm). Spike length recorded was markedly high with 80 kg N/ha with values of 15.4 cm (1996) and 19.6 cm (1997) over other levels of nitrogen.

c) **Number of capsules / spike**: Significant influence was observed in spike length by cropping systems with more number of capsules/spike under alley cropping in both the years of 1996 (16.8) and 1997 (25.2). Among the green leaf manures, the number of capsules / spike found were higher with Leucaena GLM with values of 15.7(1996) and 24.8 (1997). The differences were significant due to nitrogen application with much higher number of capsules of 16.6 (1996) and 25.6 (1997) with 80 kg N/ha.

d) **Test weight**: Alley cropping head higher test weight of 152.3 g (1996) and 157.7 g (1997) over sole cropping (151.7 and 154.1 g) and differences were found significant. During second year of study only the greenleaf manures had significant influence on test weight of wherein it was 158.1g and 157.5g with Leucaena and Albizia GLM, respectively. However, during first year of 1996 also application of greenleaf manures proved beneficial. Significantly more test weight of 160.8 g (1996) and 160.8 g (1997) were recorded with 80 kg N/ha.

e) **Seed yield per plant (g)**: Perusal of data in Table 1 showed that alley cropped castor had significantly high yield / plant of 32.4 g (1996) and 36.4 g (1997) over sole cropped castor (22.3 and 26.4 g). Similarly Leucaena GLM resulted in more yield / plant in both the years of 1996 (30.8g) and 1997 (34.8g) which was superior to GLM0 and comparable with GLM2 and GLM3. Differences were significant in yield per plant due to nitrogen application with higher values of 32.8 g (1996) and 37.8 g (1997) at 80 kg N/ha.

All the yield components were influenced by the interaction effects of treatments under study. More often than not the yield components were found better under sole cropping than alley cropping. Nevertheless, alley cropping, Leucaena GLM with 40 kg N/ha had resulted in increased values of yield components. Enriched site with more organic matter coupled with timely release of nutrients due to better microbial activity might have lead to good growth of castor and more values of yield components under alley cropping, greenleaf manuring with nitrogen in conjunction. From an alley...
Table 2  Harvest index (HI) of castor as influenced by cropping systems, greenleaf manures and nitrogen levels

<table>
<thead>
<tr>
<th>Treatments</th>
<th>1996</th>
<th></th>
<th></th>
<th></th>
<th>1997</th>
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<tbody>
<tr>
<td></td>
<td>N₀</td>
<td>N₄₀</td>
<td>N₈₀</td>
<td>Mean</td>
<td>N₀</td>
<td>N₄₀</td>
<td>N₈₀</td>
<td>Mean</td>
</tr>
<tr>
<td>Sole cropping (SC)</td>
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<tr>
<td>GLM₀</td>
<td>37.89</td>
<td>48.21</td>
<td>50.99</td>
<td>45.69</td>
<td>38.25</td>
<td>47.13</td>
<td>48.77</td>
<td>44.71</td>
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<tr>
<td>GLM₁</td>
<td>44.65</td>
<td>57.98</td>
<td>54.97</td>
<td>52.52</td>
<td>42.10</td>
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<td>56.79</td>
<td>51.94</td>
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<tr>
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<td>42.45</td>
<td>56.71</td>
<td>56.18</td>
<td>51.78</td>
<td>40.12</td>
<td>48.27</td>
<td>48.25</td>
<td>45.54</td>
</tr>
<tr>
<td>GLM₃</td>
<td>45.64</td>
<td>48.70</td>
<td>52.64</td>
<td>48.99</td>
<td>40.25</td>
<td>48.27</td>
<td>48.92</td>
<td>45.81</td>
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<td>42.64</td>
<td>52.90</td>
<td>53.70</td>
<td>49.75</td>
<td>40.18</td>
<td>50.15</td>
<td>50.68</td>
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<tr>
<td>GLM₀</td>
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<td>48.93</td>
<td>51.00</td>
<td>47.32</td>
<td>43.73</td>
<td>47.83</td>
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<td>48.27</td>
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<tr>
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<td>45.17</td>
<td>54.17</td>
<td>59.39</td>
<td>52.91</td>
<td>56.97</td>
<td>53.53</td>
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<td>54.86</td>
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<td>55.10</td>
<td>49.50</td>
<td>58.63</td>
<td>52.99</td>
<td>54.37</td>
<td>55.33</td>
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<tr>
<td>Mean</td>
<td>44.94</td>
<td>50.46</td>
<td>55.57</td>
<td>50.32</td>
<td>54.34</td>
<td>52.98</td>
<td>54.62</td>
<td>53.99</td>
</tr>
</tbody>
</table>

Overall means of M.T. – Cropping system, S.T. – Green leaf manures, S.S.T – Nitrogen levels

M.T. 49.75 50.32 47.00 53.99
S.T. 46.50 53.05 52.36 42.91 46.49 54.71 50.20 50.37
S.S.T. 43.79 51.68 54.63 47.26 51.56 52.65

<table>
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<tr>
<th>Interaction</th>
<th>SEd± CD (P 0.05)</th>
<th>SEd± CD (P 0.05)</th>
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</thead>
<tbody>
<tr>
<td>M.T.</td>
<td>2.27 5.24</td>
<td>2.03 4.68</td>
</tr>
<tr>
<td>S.T.</td>
<td>2.28 5.15</td>
<td>2.94 6.65</td>
</tr>
<tr>
<td>M.T. x S.T.</td>
<td>3.60 7.79</td>
<td>4.14 9.23</td>
</tr>
<tr>
<td>S.S.T.</td>
<td>1.79 NS</td>
<td>1.05 NS</td>
</tr>
<tr>
<td>M.T. x S.S.T.</td>
<td>3.07 6.73</td>
<td>2.36 5.29</td>
</tr>
<tr>
<td>S.T. X S.S.T</td>
<td>3.71 7.91</td>
<td>3.40 7.51</td>
</tr>
<tr>
<td>M.T. x S.T. x S.S.T.</td>
<td>4.16 9.23</td>
<td>4.31 9.71</td>
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</table>
cropping studies with subabul Madusudhan (1997) and Bheemaiah et al. (1998) reported similar results.

**ii) Harvest index**

Data in Table 2 showed that alley cropped castor had higher harvest index of 50.32% (1996) and 53.99% (1997) which was significantly superior over harvest index recorded in sole cropping during 1997 only (47%). More economic yield with enriched site are the reasons attributed for higher harvest index under alley cropping. Srinivas Rao et al. (2000) obtained similar results.

Harvest index of castor was significantly influenced by application of green leaf manures. Leucaena GLM had resulted in 53.05% (1996) and 54.71% (1997) harvest index which was superior over GLM0 (46.5 and 46.49%) and comparable with GLM2 and GLM3. Increased organic matter with timely mineralization of nutrients might have resulted in greater economic yield. Madhusudhan (1997) reported similar results with greenleaf manuring to castor under subabul alley cropping.

Differences were insignificant in harvest index due to nitrogen application with higher values of 51.68% (1996) and 51.56% (1997) at 80 kg N/ha which were similar to the harvest index obtained at 40 kg N/ha indicating higher dose of nitrogen lead to more biological yield rather than economic yield.

Interaction effects were found significant during both the years of study. Alley cropping and Leucaena GLM with 40 kg N/ha produced much greater harvest index with values of 56.22% (1996) and 56.47% (1997) over GLM0 at 80 kg N/ha (51.0% and 48.27%). The results of present study are in agreement with the findings of Solomon (2000).

**iii) Seed yield:** Perusal of data in table 3 indicated that seed yield of castor was significantly higher under alley cropping during both the years of 1996 (659 kg/ha) and 1997 (689 kg/ha) over sole cropping (505 and 607 kg/ha). Similar results were reported by Kang et al. (1981) from an alley cropping studies.

Application of greenleaf manures had significant influence on the seed yield of castor. Leucaena GLM produced much more seed yields of 626 kg/ha (1996) and 704 kg/ha (1997) followed by GLM2 (600 and 691 kg/ha) and GLM3 (590 ad 671 kg/ha) and all were found superior over GLM0 (511 and 526 kg/ha). Less fibre, lignin content and more concentration of ‘N’ in Leucaena GLM lead to synchrony in release nutrients resulting in higher yields, as reported by Kayande et al. (1995).

Seed yield of castor differed significantly to application of nitrogen with values of 728 kg/ha (1996) and 814 kg/ha (1997) at 80 kg N/ha due to more values of yield components.

Interaction effects of all the treatments under study influenced the seed yield of castor. Alley cropping with greenleaf manuring, alley cropping with 80 kg N/ha and greenleaf manuring with 80 kg N/ha have registered higher seed yields. However, alley cropping Leucaena GLM with 40 kg N/ha produced seed yields of 760 kg N/ha (1996) and 828 kg/ha (1997) which was found significantly higher over GLM0 at 80 kg N/ha (745 and 725 kg/ha). Higher organic matter available ‘N’ and lower C/N ratios were reasons attributed for increased yield with the Leucaena loppings. The results of the study confirms the findings of Tomer et al. (1992) and Bheemaiah et al. (1998).

The findings of the study apparently indicated that productivity of castor in terms of yield and yield components can be boosted substantially with integrated use of greenleaf manures and nitrogen by alley cropping under drylands.
Table 3  Seed yield (kg/ha) of castor as influenced by cropping systems, greenleaf manures and nitrogen levels

<table>
<thead>
<tr>
<th>Treatments</th>
<th>1996</th>
<th>1997</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N₀</td>
<td>N₄₀</td>
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<tr>
<td><strong>Sole cropping (SC)</strong></td>
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<td>643</td>
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<td>Mean</td>
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<td>735</td>
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*Overall means of M.T. – Cropping system, S.T. – Green leaf manures, S.S.T – Nitrogen levels*

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<thead>
<tr>
<th>Interaction</th>
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<th>SEd±</th>
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<td>M.T. x S.T. x S.S.T.</td>
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<td>30.90</td>
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References


