Performance of Direct Seeded Rice under Various Planting Distances of Dhanicha (Sesbania aculeata L.)

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Abstract: The on-farm trial was carried out to know the effect of inter-cropping Dhanicha (Sesbania aculeata L.) with direct seeded upland rice for two consecutive years. Sole aus rice with four various populations of S. aculeata was evaluated on the basis of productivity and economic return. The results showed that although the yield of aus rice slightly reduced when S. aculeata were grown, but its seed and stick value increased much higher economic return. On the other hand, unseen benefit of S. aculeata regarding the improvement of soil health and control of insect in the rice field was emphasized. So, in the aus rice field, the population of S. aculeata (3,333 to 6,666 plants ha⁻¹) could be grown successfully.

Key words: Direct seeded upland rice, Sesbania aculeata, inter-cropping, higher productivity

Introduction

Multiple-cropping (mixed or inter-cropping) is an important crop production technique advocated for subsistence agriculture (Willey, 1979). Several studies indicated that this practice offers considerable yield advantage over sole cropping due to efficient utilization of growth resources. Mixed-cropping, a method of crop intensification is commonly practiced in densely populated countries to produce more food grains from a small and/or same piece of land. Through crop intensification, farmers can make the best use of their land resource and produce more to supplement their needs. Direct seeded rice in upland condition (locally known as aus rice) is low yielding and is grown extensively in rainy conditions. A few farmers of south-west part of Bangladesh used to follow mixed-cropping practices in their land. They usually grow aus rice with other crops like jute (Corchorus olitorius), maize (Zea mays) and mesta (Hibiscus sabdariffa) which can give them higher productivity and net return compared with sole cropping of aus rice (Hossain and Wahab, 1980; Sobhan, 1981; Quayyum and Jahiruddin, 1985).

Aus rice-fallow-winter crops viz. lentil (Lens culinaris) mustard (Brassica campestris) chickpea (Cicer arietinum) etc. is the main cropping pattern in rainfed highland of Khulna district. After harvest of aus rice, the land remains fallow for a long period (July to October). So, Sesbania aculeata (locally known as Dhanicha) could be grown as mixed crop with aus rice where farmers can get seed of S. aculeata for cattle feed and sticks for fuelwood and/or supporting materials for trallies of their creeper vegetables. During winter and spring seasons, creeper vegetables like bitter gourd (Momordica charantia), bottle gourd (Lagenaria siceraria), pumpkin (Cucurbita moschata), ash gourd (Bonocisca hispida), teesle gourd (Momordica dioica), cucumber (Cucumis sativus) are growing by the farmers for commercial purpose. They used to buy sticks of jute and S. aculeata from the market to support their creeper vegetables.

In Bangladesh, very limited information is available on appropriate plant population for mixed cropping of S. aculeata where aus rice is the main crop. The present study was, therefore, undertaken to find out the optimum number (population) of S. aculeata per unit area where aus rice yield may not be reduced but total productivity increased substantially.

Materials and Methods

The experiment was conducted during two consecutive kharif season (1997 and 1998) in the farmer’s field of village Sajira under Dumuria thana (local administrative unit of Bangladesh) under Khulna district. The land was high and there was no irrigation facility. The soil was slightly alkaline in nature (pH 8.1). The average rainfall of that area is about 2000 to 2200 mm. The monsoon usually starts late March or early April. Four different populations of S. aculeata along with mono-cropping aus rice were evaluated each year.

The tested treatments are as follows:

- T1 = Sole aus rice,
- T2 = T1 + 10 hills in each plot (6 x 5 m²) at the spacing of 1.00 x 3.00 m²,
- T3 = T2 + 20 hills of S. aculeata in each plot (6 x 5 m²) at the spacing of 1.00 x 1.50 m²,
- T4 = T3 + 24 hills of S. aculeata in each plot (6 x 5 m²) at the spacing of 1.00 x 1.25 m²,
- T5 = T3 + 30 hills of S. aculeata in each plot (6 x 5 m²) at the spacing of 1.00 x 1.00 m².

The experiment was laid out in a randomized complete block design with four replications. The size of each unit plot was 6 x 5 m². The experimental plot was fertilized by 80, 40 and 40 kg N, P₂O₅ and K₂O per hectare respectively. The sources of N, P₂O₅ and K₂O were urea, triple superphosphate and muriate of potash respectively. All fertilizers were applied as basal i.e. during final land preparation and mixed by the country plough and made a good tilth soil. Aus rice seeds (var. BR 21) were broadcasted (120 kg ha⁻¹ i.e. 360 g plot⁻¹) and covered by laddering during second week of April in both years. After completion of aus rice sowing, hills for S. aculeata were prepared as per treatment and three seeds of S. aculeata sown in each hill but after 25 days of germination (aus rice) only one plant was allowed to grow in each hill. The aus rice was harvested during first week of August but seeds and sticks of S. aculeata were harvested in fourth week of October. Data on different yield parameters of aus rice were recorded and analyzed statistically. The total labour hours used for different operations were recorded along with cost of variable inputs to compute the total variable cost (TVC) under different combinations. The cost and return analysis was done for each treatment on hectare basis where land tenure was not included because it was assumed that in all treatments land cost was same and fixed.

Aus rice equivalent yield (AREY) was calculated based on the prevailing market price of the crops (aus paddy, seed and stick of...
results and discussion

Effect of different populations of *S. aculeata* on aus rice: The highest number of effective panicles per square meter was observed from the sole aus rice plot (200 and 212 in the year 1997 and 1998, respectively). In the first year (1997), the effective panicles of sole aus rice significantly differed among all other tested treatments. On the other hand, in the second year (1998), the effective panicles of *T._1* (sole aus rice) had no significant variation with *T._2* (where 10 plants of *S. aculeata* were allowed to grow in a unit plot). In both years, all intercropping treatments produced significantly lower number of effective panicle than the sole aus rice crop except *T._3* and *T._4* in the year 1998. In both years, the minimum effective tillers were found from the plot where 24 and 30 plants of *S. aculeata* were allowed to grow, respectively. It might be the shading effect of *S. aculeata* as well as inter species competition for nutrient, light and air.

The filled grain in each panicle had non significant variation among the tested treatments, because the only variety of aus rice (BR 21) was grown in both the years. Although there were non significant differences, but the highest number of filled grains was recorded from sole aus rice and was followed by the treatment where 10 plants of *S. aculeata* in plot (3333 ha⁻¹) were allowed to grow (*T._2*). In both the years, filled grain had non-significant variation there was steady decrease due to increased number of *S. aculeata* population.

Inter-crop treatments exhibited significant influence on grain yield of aus rice in 1997 and 1998 (Table 1). The highest grain yield of aus rice was obtained from sole aus rice in both the years. (2.38 and 2.76 t ha⁻¹ in 1997 and 1998 respectively). The treatment *T._2* gave aus rice yield of 2.136 and 2.21 t ha⁻¹ in 1997 and 1996 respectively and there was non significant variation between *T._1* and *T._2* in both the years. The gradually increased number of *S. aculeata* plots significantly varied and decreased the aus rice yield in both years. This result is partially agreed with the findings of OFRID (1992), where it has been mentioned that in transplanted aman rice (wet land rice) yield slightly reduced where *S. aculeata* was grown. In the concept of integrated pest management (IPM), growing *S. aculeata* in the rice field is more effective for the control of insects because birds can fly over the field and prey insects all over the field and sometimes they can take rest on the *S. aculeata* plants. The highest grain yield of sole aus rice in both the years could be due to the maximum number of panicles, filled grain per panicle. In the year 1997, the treatments *T._1* and *T._2* had non significant variation but *T._3* and *T._4* varied significantly among each other. The same trend was followed in the second year’s result.

The seed and stick production of *S. aculeata* varied significantly and was directly related with its population. The seed yield and fuel yield differed significantly due to population but according to the increased population, yield of seed and stick was not increased in the same manner. Seed yield and stick yield increased progressively with the increase *S. aculeata* population in both the years.

Akhtar et al. (1994) conducted an experiment on transplanted aman rice (wet land rice during monsoon) where they produced dhaincha (*S. aculeata*) through transplantation of raised dhaincha seedlings and reported that substantial quantity of *S. aculeata* seeds could be produced at the dhaincha’s spacing of 3 x 3m² without significant reduction of rice yield. Ramamurthy et al. (1997) reported that direct seeded rice (DSR) and black gram (*Vigna mungo) inter-cropping at the row ratios of 4:1 produced the highest rice equivalent yield of 5.84 ton ha⁻¹ and the highest return than that of DSR and soybean (*Glycine max*) and DSR and green gram (*V. radiata*). Schulte-Kraft and Cardenas (1993) concluded that there is a wide range of forage species suitable for pasture establishment in the upland Llanos Orientalis of Colombia through mixed cropping with upland rice. Dutta et al. (1996) mentioned that direct seeded upland rice (DSR) and cow pea (*Vigna unguiculata*) intercrop with row ratios of 3:1 produced the highest rice grain equivalent yield of 2.08 ton ha⁻¹ and the highest net returns.

Table 1: Yield and yield parameters of aus rice, seed and stick production of *S. aculeata* as affected by *S. aculeata* intercropping under various spacing (population)

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<tr>
<td><em>T._1</em></td>
<td>200.0a</td>
<td>212.0a</td>
<td>66a</td>
<td>72a</td>
<td>2.376a</td>
<td>2.547a</td>
<td>162c</td>
<td>183c</td>
<td>2170c</td>
<td>2352c</td>
<td>3604c</td>
<td>3798b</td>
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<tr>
<td><em>T._2</em></td>
<td>176.0b</td>
<td>182.0ab</td>
<td>58a</td>
<td>65a</td>
<td>2.135ab</td>
<td>2.210ab</td>
<td>167c</td>
<td>185c</td>
<td>2106c</td>
<td>2326c</td>
<td>3634c</td>
<td>3786b</td>
</tr>
<tr>
<td><em>T._3</em></td>
<td>152.0bc</td>
<td>165.0bc</td>
<td>56a</td>
<td>63a</td>
<td>1.871bc</td>
<td>1.960bc</td>
<td>279b</td>
<td>292c</td>
<td>3096c</td>
<td>3348c</td>
<td>3604c</td>
<td>3798b</td>
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<tr>
<td><em>T._4</em></td>
<td>143.0c</td>
<td>156.0bc</td>
<td>55a</td>
<td>60a</td>
<td>1.371c</td>
<td>1.504c</td>
<td>314b</td>
<td>351b</td>
<td>4108b</td>
<td>4239b</td>
<td>4108b</td>
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<tr>
<td>CV (%)</td>
<td>9.1</td>
<td>9.8</td>
<td>NS</td>
<td>6.2</td>
<td>6.9</td>
<td>5.2</td>
<td>4.8</td>
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<td>6.6</td>
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NS = Non significant, In a column, means followed by the same letter (a) do not differ significantly at LSD (P<0.05)

Table 2: Aus rice (paddy) equivalent yield (AREY), gross return (GR), total variable cost (TVC), net return (NR) and benefit:cost ratio (BCR) as affected by *S. aculeata* intercropping under various spacing (population)

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<tr>
<td><em>T._1</em></td>
<td>2.376</td>
<td>2.547</td>
<td>0.1880</td>
<td>1.2735</td>
<td>60.15</td>
<td>85.51</td>
<td>58.65</td>
<td>41.85</td>
<td>1.97</td>
<td>1.49</td>
<td>1.73</td>
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<tr>
<td><em>T._2</em></td>
<td>2.135</td>
<td>2.210</td>
<td>15.755</td>
<td>19.985</td>
<td>63.66</td>
<td>89.51</td>
<td>63.50</td>
<td>89.51</td>
<td>2.47</td>
<td>2.29</td>
<td>2.38</td>
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<tr>
<td><em>T._3</em></td>
<td>1.871</td>
<td>1.960</td>
<td>17.865</td>
<td>18.645</td>
<td>67.71</td>
<td>93.50</td>
<td>62.55</td>
<td>89.51</td>
<td>2.66</td>
<td>2.19</td>
<td>2.33</td>
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<tr>
<td><em>T._4</em></td>
<td>1.371</td>
<td>1.504</td>
<td>16.420</td>
<td>17.925</td>
<td>68.15</td>
<td>95.10</td>
<td>96.05</td>
<td>84.15</td>
<td>2.41</td>
<td>1.88</td>
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<td><em>T._5</em></td>
<td>3.467</td>
<td>3.778</td>
<td>17.335</td>
<td>18.890</td>
<td>70.15</td>
<td>97.50</td>
<td>103.20</td>
<td>91.40</td>
<td>2.47</td>
<td>1.93</td>
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Market price of products (Tk. kg⁻¹):

| Aus rice (paddy) | 5.00 |
| *S. aculeata* (seed) | 20.00 |
| *S. aculeata* (stick) | 0.80 |
Aus rice equivalent yield (AREY): Based on the prevailing market price of the products (aus rice, seed and stick yield of *S. aculeata*) the AREY has been calculated and the highest AREY (3.572 t ha⁻¹) was recorded from T₃ (6,666 plants ha⁻¹ of *S. aculeata* with aus rice) in 1997 but in the year 1998, the highest AREY (3.978 t ha⁻¹) was from T₃ (6,868 plants ha⁻¹ of *S. aculeata* with aus rice). The minimum AREY was from T₁ (sole aus rice) in both the years (2.376 and 2.547 t ha⁻¹ in 1997 and 1998 respectively). The treatment T₃ gave 60 and 46% higher AREY in 1997 and 1998 respectively compared with T₁. On the other hand, T₂ gave 56 and 46% higher AREY in 1997 and 1998 respectively compared with T₁. The other tested treatments like T₄ and T₅ gave comparatively lower AREY than T₂ and T₃ in the two years.

Economic performance: Treatments T₃ (6,666 *S. aculeata* plants ha⁻¹ with aus rice) and T₄ (3,333 *S. aculeata* plants ha⁻¹ with aus rice) gave the highest gross return of Tk. 17,866 and 19,895 ha⁻¹ in 1997 and 1998 respectively. The net return of Tk. 11,150 and 10,945 ha⁻¹ was also obtained from T₂ and T₃ in 1997 and 1998 respectively. Benefit cost ratio of 2.66 and 2.29 was recorded from T₃ and T₄ in 1997 and 1998 respectively.

In both the years (Table 2), total variable cost increased with the increased number of *S. aculeata* population due to its higher labour requirement for planting *S. aculeata*. The lowest gross return, net return and benefit cost ratio was obtained from sole aus rice (T₁) in both the years. Two years averaged data of benefit cost ratio showed that the highest benefit cost ratio (2.38) was obtained from T₂ and the minimum was from T₁ (1.73). The highest BCR was found in case of T₃ and T₄ in 1997 and 1998 respectively than other tested treatments.

The above results and foregoing discussion suggested that *S. aculeata* is a very much beneficial crop in aus rice filled in all tested populations of *S. aculeata*. It can help the economy, as well as environment because aus rice need not any insecticide for pest control measure. On the other hand, the deep root system of *S. aculeata* can help to change the soil physical properties and its nodule in the root can fix nitrogen for the soil where aus rice could be benefited. By considering the results, treatment T₃ (3,333 *S. aculeata* plants ha⁻¹ with aus rice) and T₄ (6,666 *S. aculeata* plants ha⁻¹ with aus rice) could be grown for higher productivity as well as economic return.

References


