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Performance of Direct Seeded Rice under Various Planting Distances of Dhaincha (*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 up land condition (locally known as aus rice) is low yielding and is grown extensively in rainfed 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 (*Hibicus 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 aurietinum*) 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 Dhaincha) could be grown as mixed crop with aus rice where farmers can get seed of *S. aculeata* for cattle feed and sticks for fulewood and/or supporting materials for traillies 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 (*Bonincasa hispida*), teasle gourd (*Momordica dioica*), cucumber (*Curcumis sativus*) are growing by the farmers for commercial purpose. They used to buy sticks of jute and/or *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 substantiality.

Materials and Methods

The experiment was conducted during two consecutive kharif season (1997 and 1998) in the farmer's field of village Sajiara 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:

T_1 = Sole aus rice,
T_2 = T_1 + 10 hills in each plot (6 x 5 m^2) at the spacing of 1.00 x 3.00 m^2,
T_3 = T_1 + 20 hills of *S. aculeata* in each plot (6 x 5 m^2) at the spacing of 1.00 x 1.50 m^2,
T_4 = T_1 + 24 hills of *S. aculeata* in each plot (6 x 5 m^2) at the spacing of 1.00 x 1.25 m^2,
T_5 = T_1 + 30 hills of *S. aculeata* in each plot (6 x 5 m^2) at the spacing of 1.00 x 1.00 m^2.

The experiment was laid out in a randomized complete block design with four replications. The size of each unit plot was 6 x 5 m^2. The experimental plot was fertilized by 60, 40 and 40 kg N, P_2O_5 and K_2O per hectare respectively. The sources of N, P_2O_5 and K_2O 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. aculeate* 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

S. aculeata) and computed as:

where,
AREY = aus rice equivalent yield (t ha^{-1})
SSy = *S. aculeata* seed and stick yield (kg ha^{-1})
SSp = *S. aculeata* seed and stick price (Tk. kg^{-1})
ARy = aus rice yield (kg ha^{-1})
ARp = aus rice price (Tk. kg^{-1})

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 inter-cropping treatments produced significantly lower number of effective panicle than the sole aus rice crop except T_1 and T_2 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 2.75 t ha $^{-1}$ in 1997 and 1998 respectively). The treatment T_2 gave aus rice yield of 2.135 and 2.21 t ha $^{-1}$ in 1997 and 1998 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 OFRD, (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, T_4 and T_5 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 $3m^2$ without significant reduction of rice yield. Ramamoorthy *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 5.54 ton ha^{-1} and the highest return than that of DSR and soybean (*Glycin max*) and DSR and green gram (*V. radiata*). Schultze-Kraft and Cardenas (1993) concluded that there is a wide range of forage species suitable for pasture establishment in the upland Lianos 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* inter-cropping under various spacing (population)

	Aus rice						*S. aculeata*			
	No. of effective panicle m^{-2}		No. of filled grains $panicle^{-1}$		Grain yield (t ha $^{-1}$)		Seed yield (kg ha^{-1})		Stick yield (kg ha^{-1})	
Treatments	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998
T_1	200.0a	212.0a	66a	72a	2.376a	2.547a	--	--	--	--
T_2	176.0b	182.0ab	58a	65a	2.135ab	2.210ab	167c	183c	2170c	2352c
T_3	152.0bc	165.0bc	56a	63a	1.871b	1.960b	279b	292c	3664b	3758b
T_4	143.0c	156.0c	55a	60a	1.371c	1.504c	314b	351b	4108b	4233b
T_5	137.0c	165.0bc	53a	61a	1.089d	1.139d	410a	468a	4612a	4795a
CV (%)	9.1	9.8	NS	NS	6.2	6.9	5.2	4.8	6.3	6.6

NS= Non significant, In a column, means followed by the same letter (s) do not differ significantly at LSD ($P \leq 0.05$)

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

	AREY (t ha^{-1})		GR (Tk. ha^{-1})		TVC (Tk. ha^{-1})		NR (Tk. ha^{-1})		BCR		
Treatments	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998	Mean
T_1	2.376	2.547	11880	12735	6015	8550	5865	4185	1.97	1.49	1.73
T_2	3.150	3.797	15750	19895	6365	8950	9385	10945	2.47	2.29	2.38
T_3	3.573	3.729	17865	18645	6715	9350	1150	9295	2.66	1.99	2.33
T_4	3.284	3.585	16420	17925	6815	9510	9605	8415	2.41	1.88	2.15
T_5	3.467	3.778	17335	18890	7015	9750	10320	9140	2.47	1.93	2.20

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. aculeate*) the AREY has been calculated and the highest AREY (3.572 t ha^{-1}) was recorded from T_3 (where 6,666 plants ha^{-1} of *S. aculeata* with aus rice) in 1997 but in the year 1998, the highest AREY (3.979 t ha^{-1}) was from T_2 (where 3,333 plants ha^{-1} of *S. aculeata* with aus rice). The minimum AREY was from T_1 (sole aus rice) in both the years (2.376 and 2.547 t ha^{-1} in 1997 and 1998 respectively). The treatment T_3 gave 50 and 46% higher AREY in 1997 and 1998 respectively compared with T_1. On the other hand, T_2 gave 56 and 46% higher AREY in 1997 and 1998 respectively compared with T_1. The other tested treatments like T_4 and T_5 gave comparatively lower AREY than T_2 and T_3 in the two years.

Economic performance: Treatments T_3 (6,666 *S. aculeata* plants ha^{-1} with aus rice) and T_2 (3,333 *S. aculeata* plants ha^{-1} with aus rice) gave the highest gross return of Tk. 17,865 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 T_2 and T_3 in 1997 and 1998 respectively. Benefit cost ratio of 2.66 and 2.29 was recorded from T_3 and T_2 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 (T_1) in both the years. Two years averaged data of benefit cost ratio showed that the highest benefit cost ratio (2.38) was obtained from T_2 and the minimum was from T_1 (1.73). The highest BCR was found in case of T_3 and T_2 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 filed 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 T_2 (3,333 *S. aculeata* plants ha^{-1} with aus rice) and T_3 (6,666 *S. aculeata* plants ha^{-1} with aus rice) could be grown for higher productivity as well as economic return.

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