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Effect of planting variables on the growth and yield of shola pith [*Aeschynomene aspera* L.] – a non-conventional value-added wetland crop of West Bengal

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In India, during rainy season every year, a vast low-lying geographical area is heavily waterlogged leading to swampy/marshy condition and almost get turned to out of cultivation. Not systematically, but in scattered ways these fairly fertile and productive lands are used by the farmers for growing several aquatic food crops like deep water paddy, *Colocasia*, *Xanthosoma*, *Trapa*, *Euryale ferox* etc.; non- food crops like *Aeschynomene aspera*, *Cyperus tegetum, Typha elephantiana, Clinogyne dichotoma*, and aquatic medicinal plants like *Bacopa, Eclipta alba, Hygrophila, Centella asiatica* etc.

Aeschynomene sp. (Family- Fabaceae), commonly known as 'Shola' in Bengali, 'Sola' in Hindi, 'Nir Jiluga' in Telegu, 'Attu neddi' in Tamil and 'Bendu' in Karnataka is suitable for Indian wetlands. Generally, three species *A. aspera*, *A. indica* and *A. americana* occur in India. But more common and the soft plant pith of superior quality and high economic value is *A. aspera.* It is a sub-floating hydrophyte with heavy nodulation in both stem and root resulting into high nitrogen content (Biswal *et al.*,1987). The soft very light spongy pith is used to manufacture various types of art materials for room decoration, marriage and different rituals. The pith is used extensively in making solar helmets, toys, artificial flowers, ear-tops, different idols or models, swimming jackets, life vests, fishing nets. It has commercial use in the paper industry as raw material (Puste ,2004) and in the pharmaceutical industry for preparing enzymes, bottle corks and surgical lint. Ghosh and Basu (1999) reported that mature stem nodules of *A. aspera* contained high amount of IAA (2.54 micro g/g fresh weight). The plant may be useful as green manure as well as fodder also. In the villages, the dried non-usable part of the plant is used as fuel. The seeds produce oil (7%). As the nodules are nitrogen and carbon fixers, it restores soil fertility also. In the present context of eco-agriculture, the practice of growing *kharif* (*Aman*) rice along with *A. aspera* in a mixed/intercropping system can highly be explored.

With a view to standardize the most feasible method of planting, a field experiment was conducted on a local variety of the crop in the University Farm at Coochbehar, West Bengal during July to October, 2006. Sowing in the nursery bed was done in the middle of May. Transplanting of seedlings in the main field was done in July. The experiment was fitted in Randomised Block Design with four replications and five treatments each. The treatments were T_1 : direct seeding, T_2 : transplanting with spacing 50 x 50 cm, T_3 : 70 x 70 cm, T_4 : 90 x 90 cm and T_5 : 110 x 110 cm.

Number of branches plant^{-1}

The observation of this parameter (Table 1) indicated that significant variations were there for number of branches plant^{-1} by different methods of planting. Transplanting with a spacing 110 x 110 cm (T_5) promoted maximum number of branches (18.77) being statistically at par with T_4 (17.80) *i.e.*, transplanting with a spacing 90 x 90 cm. T_5 and T_4 significantly differed from T_3 *i.e.* transplanting with spacing 70 x 70 cm (13.74) and T_2 *i.e.* transplanting with spacing 50 x 50 cm (13.02). Direct seeding (T_1- spacing with 30 x 30 cm) exhibited lowest number of branches plant^{-1} (9.40).

Plant height

Data in the table-1 showed that different planting methods influenced the plant height in a very significant manner. Transplanting with spacing 70 x 70 cm spacing performed the best (304.29) being statistically higher than all other treatments. Higher results were also obtained from T_4 (253.60) and T_5 (236.86). The direct seeding where 30 x 30 cm spacing was maintained registered the lowest plant height (160.11).

Basal diameter

It was noted from table- 1 that highest basal diameter (46.55) was obtained from the treatment T_3 *i.e.* transplanting with 70 x 70 cm spacing. T_3 was significantly superior to other treatments. T_4 *i.e.* transplanting with spacing 90 x 90 cm and T_5 *i.e.* transplanting with a spacing 110 x 110 cm showed 38.44 and 36.56 respectively being at par with each other. T_1 (24.55) performed the worst.

Numbers of nodules plant^{-1}

It was revealed from the data presented in table-1 that highest number of nodules plant^{-1} (1655.13) was recorded from transplanting with a spacing 110 x 110 cm being significantly different

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from all other treatments. The second good treatment was transplanting with spacing 90 x 90 cm (1572.18). Minimum number of nodules plant^{-1} (847.40) was obtained from direct seeding (spacing 30 x 30 cm).

Table 1: Effect of planting methods on the growth and yield attributes of shola

Treatments	Growth attributes at harvest			Yield attributes		
	Branches plant^{-1}	Plant height (cm)	Basal diameter (mm)	Nodules plant^{-1}	Dry weight (g plant^{-1})	Marketable yield (kg ha^{-1})
T_1	9.40	160.11	24.55	847.40	106.60	2368.97
T_2	13.02	201.93	30.45	1032.04	171.82	2749.14
T_3	13.74	304.29	46.55	1445.05	215.27	3075.66
T_4	17.80	253.60	38.44	1572.18	238.91	2064.94
T_5	18.77	236.86	36.56	1655.13	248.04	1434.92
SEm (±)	**0.33**	**3.77**	**0.697**	**6.57**	**4.57**	**4.89**
LSD (0.05)	**1.07**	**12.32**	**2.27**	**21.43**	**14.89**	**15.95**

Dry weight

Dry weight (g plant^{-1}) was significantly influenced by various methods of planting of Shola. Highest dry weight (248.04) was visualized with the treatment T_5 i.e. transplanting with a spacing 110 x 110 cm being statistically at par with transplanting with spacing 90 x 90 cm (238.91). Transplanting with spacing 70 x 70 cm (T_3) also exhibited a bit higher result (215.27). Least dry weight (106.60) was obtained from direct seeding (spacing 30 x 30 cm).

Yield

According to table-1 yield of Shola significantly varied with various methods of planting. Highest yield (3075.66) was obtained from transplanting with spacing 70 x 70 cm being significantly different from all other treatments. The next better treatment was transplanting with spacing 50 x 50 cm (2749.14) followed by direct seeding (2368.97). Poorest yield (1434.92) was observed from the treatment with highest spacing (transplanting with spacing 110 x 110 cm). Puste in 2004 recommended that seedling should be transplanted at a distance of 1.0-1.25 m row to row and 0.75-1.0 m plant to plant spacing.

It had been observed that more spacing led to more number of branches. This might be due to the fact that with increasing spacing, number of plants for a constant area got decreased. At higher spacing plants got much more space leading to less competition among the plants for space, light and nutrients which ultimately resulted into the overall higher vigour of the plants. Plants in case of direct seeding with a spacing of 30 x 30 cm suffered badly due to the availability of all inputs in sub-optimal rate to the plants and showed inferior stature.

But in case of plant height and basal diameter transplanting with spacing 70 x 70 cm performed the best closely followed by T_4 and T_5. It has been noted that with spacing increasing up to 70 x 70 cm plant height and basal diameter increased. But, spacing beyond that decreased height of the plants and basal diameter in a significant manner. This might be due to the fact that plants with a higher spacing had more number of branches. Naturally, a major portion of photosynthate and energy was partitioned or utilized for the growth of the branches which in turn hampered the growth of the main stem or main economic part of the Shola plant.

With increasing spacing the overall vigour or stature of the plants was increased, dry weight (g plant^{-1}) also increased in the similar fashion. But interestingly, when final economic marketable yield was worked out it was seen that increasing spacing up to 70 x 70 cm enhanced yield. But beyond 70 x70 cm spacing economic yield decreased gradually. Transplanting with spacing 70 x 70 cm expressed the best performance (3075.66) and transplanting with a spacing 110 x 110 cm *i.e.* highest spacing the worst (1434.92).

This might be attributed to two reasons. Firstly, in case of T_5 (110 x 110 cm) due to higher spacing number of plants was very less than in other treatments leading to poor yield. Secondly, in case of T_4 and T_5 *i.e.* spacing beyond 70 x70 cm number of branches significantly increased. In case of Shola, long, robust, stout, thick, erect stem with as low as possible number of branches is preferred in the market. For being marketed, the diameter of main stem and branches should be of minimum 20 mm. In case of the treatment T_4 and T_5 it was seen that though total dry matter (kg ha^{-1}) was much more, functional or marketable or economic yield was less. At least, 30- 40% of the total dry matter or harvest was to be discarded at the time of calculating final marketable yield.

Table 2: Effect of various planting methods on the economics of shola

Treatments	Cost of cultivation (₹ha^{-1})	Gross return (₹ha^{-1})	Return : cost ratio
T_1: Direct seeding (30 x 30 cm)	14483.90	18951.73	1.31:1
T_2: Transplanting with spacing 50 x 50 cm	15134.90	21993.09	1.45:1
T_3: Transplanting with spacing 70 x 70 cm	15134.90	24605.25	1.63:1
T_4: Transplanting with spacing 90 x 90 cm	15134.90	16519.52	1.09:1
T_5: Transplanting with spacing 110 x110 cm	15134.90	11479.39	0.76:1

Economic analysis

So far as the cost of cultivation was concerned, T_2, T_3, T_4 and T_5 got the highest cost (₹15134.90 ha^{-1}). But as yield was higher in case of T_3 *i.e.* transplanting with spacing 70 x 70 cm and T_2 i.e. transplanting with spacing 50 x 50 cm, the gross return and return: cost ratio were more in these treatments. T_4 and T_5 i.e. treatments with higher spacing got higher cost and at the same time lower yield. So, in T_4 and T_5 gross return as well as return: cost ratio was reduced. T_1 *i.e.* direct seeding with gross return (₹18951.73 ha^{-1}) and return: cost ratio 1.3:1 exhibited better performance than T_4 *i.e.* transplanting with spacing 90 x 90 cm and T_5 i.e. transplanting with spacing 110 x 110 cm because of the two factors occurring simultaneously low cost of cultivation and higher economic yield.

Thus, from the present findings it can be concluded that raising of nursery and transplanting in the main field with a spacing 70 x 70 cm may be advocated for maximization of profit and higher return-cost ratio of 1.63:1. Approximately, ₹9500.00 ha^{-1} can be earned net from the cultivation of Shola and that's why the crop should be recommended for cultivation in wetlands in our country through which poor marginal and sub marginal farmers can be benefited.

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