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Strip-cropping of legumes with jute (*Corchorus olitorius*) in jute-paddy-lentil cropping system

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Tossa jute (*Corchorus olitorius* L.) is a very important cash crop and the main fibre crop of eastern India especially for West Bengal (72% area, 78% production). It is already established that day-by-day the probability of getting timely onset of monsoon and the quantum of rainfall receiving are reducing in the country, in general and in the jute growing belt, in particular. Being a traditionally considered rain-fed crop, jute at the early phase of growth suffers from severe moisture stress and faces even drought like situation often due to such aberration in the monsoon behaviour. In some extreme years of moisture stress, crop failure can not be ruled out. Vast majority of jute farmers are small and marginal having poor resource base and therefore, they are not in a position to cope up the situation of crop failure. To overcome the uncertainty, strip cropping of carefully chosen legumes can be practiced which may act as insurance against partial or even complete failure of jute crop. Legumes are considered as essential components of a viable cropping system, particularly for its role as a fixer of atmospheric nitrogen in soil and as a potent source of edible protein through pulses. Besides, legume being a fast growing cover crop with low water requirement able to smother weeds effectively and can reduce the cost towards manual weeding. The present investigation is aimed at utilizing the kharif legumes like cowpea [*Vigna unguiculata* (L.) Walp.], green gram [*Vigna radiate* (L.) Wilczek], black gram [*Vigna mungo* (L.) Hepper] and rice bean [*Vigna umbellate* (Thunb.)] as companion crops in strips (20% area) with jute without reducing its population to augment jute fibre equivalent yield and reduce the cost towards weeding in particular. This practice may also encourage the production of more number of jute plants with reduced basal diameter to yield superior fibre quality (Pal *et al*., 1981).

The field experiment was conducted for consecutive two years from 2006 to 2007 at the main farm of Central Research Institute for Jute and Allied Fibres (22.75°N, 88.43°E, 3.14 m AMSL) The experimental soil was Typic Ustochrept with sandy-loam texture having neutral *p*H 7.23 (1:2.5 w/v), organic carbon 5.50 g kg^{-1}, medium in fertility (available N, P and K were 332, 33 and 148 kg ha^{-1} respectively). Legumes were grown as strips of 1.5 m width with jute by narrowing jute inter-row spacing from 25 cm to 20 cm and allocating the additional space (20%) for legumes without sacrificing plant density of the main crop

The treatment combinations were:

T_1: Jute (20 cm row) in 80% area + cowpea as grain crop in 20% area; T_2: Jute (20 cm row) in 80% area + green gram as grain crop in 20% area; T_3: Jute (20 cm row) in 80% area + black gram as fodder crop in 20% area; T_4: Jute (20 cm row) in 80% area + rice bean as fodder crop in 20% area; T_5: Jute (20 cm row) alone; and T_6: Jute (25 cm row) alone. In strip cropping treatments, jute: legumes area was in 4:1 ratio.

The intercrop varieties were Pusa Kamal (cowpea), PS 16 (green gram), T9 (black gram) and K1 (rice bean). The varieties for the succeeding crops were B 77 (lentil) and Khitish (paddy). The experiment was laid in RBD with 4 replications. Both black gram and rice bean were sown as broadcast for fodder, while green gram and cowpea were sown in lines spaced 30 cm apart for grain production. The legumes as fodder was harvested at 60 days crop age. Weed dry matter was recorded at 21 days after sowing. The jute equivalent yield of different crop was calculated.

Plant height, basal diameter and yield of jute

The plant height of jute varied significantly when grown in different strip-cropped system with legumes (Table 1). The highest jute plant height in black gram treatment (227 cm) was at par with cowpea (221 cm) and rice bean (217 cm). Like plant height, similar trends were also observed in case of basal diameter of jute. The general trend of reduction in basal diameter of plants grown with reduced inter-row spacing of 20 cm proved beneficial for quality jute fibre production due to more uniform retting. The fibre yield of jute (grown alone) in 20 cm row spacing (29.6 q ha^{-1}) and in 25 cm rowed crop (28.1 q ha^{-1}) were at par. Earlier it was reported that growth and yield performance of pepper can be enhanced in mixture with jute at a plant population of 0.1 million per ha (Loveth, 2006). The fibre yield of jute was not varied significantly among the different treatments.

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Table 1: Impact of strip-cropping of legumes with jute in jute-paddy-lentil cropping system

Treatments	Plant height of jute (cm)	Basal diameter of jute (cm)	Weed dry weight (g m^{-2})	Yield of jute (q ha^{-1})	Yield of intercrop (q ha^{-1})*	JEY (q ha^{-1})	Yield of succeeding crops (q ha^{-1})		Total system JEY (q ha^{-1})
							Paddy	Lentil	
T_1 :Jute at 20 cm (80%) + cowpea (20%)	221	1.20	22.6	28.36	-	28.36	44.7	4.68	55.85
T_2 :Jute at 20 cm (80%) + Green gram (20%)	201	0.95	21.1	26.44	-	26.44	42.7	4.48	52.71
T_3 :Jute at 20 cm (80%) + black gram (20%)	227	1.23	23.7	27.44	70.2	33.68	41.8	4.35	59.35
T_4 :Jute at 20 cm (80%) + rice bean (20%)	217	1.20	24.1	27.47	64.1	33.17	44.0	4.43	60.00
T_5 :Jute at 20 cm	205	1.03	18.4	29.59	-	29.59	41.3	4.40	55.08
T_6 :Jute at 25 cm	208	1.10	22.4	28.09	-	28.09	42.1	4.05	53.52
LSD (0.05)	**20.5**	**0.13**	**NS**	**NS**	**-**	**1.65**	**NS**	**NS**	**3.13**

*Note: * Fresh fodder yield from the strip-cropped area***,** *Market price (INR per q) used for calculation of jute equivalent yield - jute fibre: 2250; legume fodder: 200; paddy 1080; lentil: 2900 per quintal of produce.*

Jute equivalent yield (JEY) of strip-cropping

During both the years of experimentation, the grain legumes of cowpea and green gram growth were good during the early phase, but afterwards both were vulnerable to recurring insect-pest and disease incidence during the rainy season despite possible precautionary measures. Later, growth, flowering and pod formation of cowpea and green gram were affected in the system and the meagre yield with poor quality obtained from these two crops were ignored while calculating the JEY. Earlier, Patel and Mitra (1977) found that intercropping of moong and jute in a multiple cropping system of jute-rice-potato increased the fibre yield of jute and gave additional seed yield of moong. In Africa, kenaf and cowpea were compatible for intercropping. The kenaf variety Ifekan 100 was the most suitable for intercropping with cowpea as it produced the maximum fibre yield of 1.57 t ha^{-1} (Raji, 2007).

However, the legume crops (black gram and rice bean) for fodder were grown satisfactorily and the average productivity were 7.02 and 6.41 t ha^{-1} for black gram and rice bean, respectively. Both the legumes as fodder, therefore, significantly increased the JEY. The highest JEY (33.68 q ha^{-1}) was recorded in black gram stripped jute plots followed by rice bean stripped treatment (33.17 q ha^{-1}). Strip-cropping of black gram (20% area) with jute increased the JEY by 13.8% and rice bean strip cropping enhanced the JEY by 12.1% as compared to the jute yield in 20 cm spaced sole crop (29.6 q ha^{-1}). As said earlier, the meagre yield obtained from cowpea and green gram could not influence the JEY in those treatments. Ojeifo and Lucas (1987) reported that when tomato was grown with jute (as leafy vegetable), the growth and development of tomato were suppressed by jute. But the jute growth was not affected much when grown with tomato and the best combination for good overall return was 1 row of jute with 2 tomato rows. Researcher from Bangladesh reported that jute + green gram in 3:2 row arrangement were most appropriate followed by 2:2 pattern of jute + green gram (mung) and 3:2 pattern of jute + cowpea mixture (Rabbany and Islam, 1996). It was also reported that soyabean-jute (1:1 and 2:1) as intercrop gave higher soyabean equivalent yield (Billore *et al*., 2000).

Yield of succeeding crops

After jute, paddy and lentil were grown as succeeding crops in the *kharif* and *rabi* season, respectively. There were not much variation in the succeeding paddy crop yield, which ranged between 4.13 and 4.47 t ha^{-1}. Similarly, the lentil yield was also varied between the narrow range of 405 and 468 kg ha^{-1}. Paddy is the traditionally preferred crop by the majority farmers after jute. However, incorporation of lentil in the jute system after paddy had several advantages as the crop (lentil) required no irrigation, pest and disease incidence was virtually absent and the higher monetary value of the produce in the market increased the total system JEY in all the cases.

Total system JEY

The different strip-cropping of legumes with jute considered in this experiment had additive effect on the total system JEY. The higher system JEY (60 and 59.3 q ha^{-1}) were recorded in jute + black gram – paddy – lentil and jute + rice bean – paddy – lentil system, respectively. The said systems gave 8.9 (rice bean) and 7.8% (black gram) more total system JEY. Ghosh (2011) reported that intercropping rice with white jute (*Corchorus capsularis*) at 4:1 stand ratio with 40 kg N ha^{-1} enhanced total productivity and profitability of the rainfed lowland rice production system.

From the two years experiment, it may be inferred that strip-cropping of black gram or rice bean (in 20% area) for fodder with fibre crop of jute (80% area) grown in 20 cm row spacing without sacrificing the effective plant density (of jute) can enhance the JEY of the system upto 13.8%. Inclusion of paddy (*kharif*) and lentil (*rabi*) in the jute based system can increase and produce the total system JEY of 60 q ha^{-1}.

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