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Production Potential and Economic Feasibility of Growing Medicinal and Aromatic Plants in Jute Based Cropping System

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A field experiment was conducted at the research farm of the Central Research Institute of Jute and Allied Fibres during 2013-14 to study the production potential and economic feasibility of growing medicinal and aromatic plants in Jute based cropping system. The experiment was laid out in split plot design, Jute was cultivated during pre-*kharif* followed by *kharif* rice. It was followed by sowing of five medicinal and aromatic plants [asalio (*Lepidium sativum*), ashwagandha (*Withania somnifera*), isabgol (*Plantago ovata*), menthol mint (*Mentha arvensis*) and senna (*Senna angustifolia*)] and one traditional crop potato. Among the medicinal and aromatic plants, ashwagandha gave the highest net return of Rs. 98,771 followed isabgol (Rs. 95,964). The analysis of system economics recorded the highest BC ratio of 2.28 in ashwagandha followed by asalio. Though the gross return in case of potato was highest (Rs.2,41,000) but the BC ratio is quite less (1.41). So ashwagandha is more economical compared to traditional crop potato in jute based cropping system. The interaction effect of the crop and nutrient was also significant in case of ashwagandha which is found as the best cropping sequence.

(***Key words:*** *Ashwagandha, Aromatic plants, Economics, Jute based cropping system, Jute equivalent yield, Medicinal plants*)

Jute (*Corchorus* sp.) known as golden fibre and India and Bangladesh have a strong heritage of jute cultivation. After cotton, it is the second most important natural fibre and eco-friendly and bio-degradable. It has capacity of higher CO_2 assimilation rate in era of environmental concern. India ranks first in area and production of jute and is one of the major commercial crops of eastern and north eastern states of India. It is grown in about 1.0 million hectares of land providing livelihood security to 5.0 million people. Though there is two fold increase in productivity of Jute since independence, the area is stagnant & even declining over last two decades. However the increased cost of cultivation and fluctuating market price affects the farmers' income. But on the other hand there is necessity for production of food, fuel, fibre and feed from limited natural resources to meet the challenges of ever growing population. So the only option is to increase the cropping intensity and production by multiple and intensive cropping. It is grown as a pre-*Kharif* (summer) season crop in succession with *K*harif (rainy) season crops mainly rice and *Rabi* (winter) season crops, viz mustard and pulses (Mahapatra *et al*., 2012). Jute farmers cannot forego the cultivation of rice as it is the staple food of the region. So under the present scenario there is necessity to make the jute farming most profitable to meet the challenges of competition from synthetic fibres with integration of high value crops in the jute based system. So to enhance the profitability of jute farming we have to introduce high value crops such as medicinal and aromatic plants (MAP) as components of jute based cropping system besides extending their cultivation to nontraditional areas.

So there is necessity for crop diversification to medicinal and aromatic plants which is considered as productive, profitable and ecologically sustainable. This is more relevant and feasible in the jute cropping system and it is estimated that 300 kg nitrogen per hectare can be recycled through jute crop residue such as leaves, roots, thinned plants and twigs which also increases water holding capacity of the soil. Cultivation of economically viable MAPs can improve the socio-economy of farmers. It has been shown that medicinal and aromatic plants can be successfully incorporated in crop rotations, intercropping systems, agro forestry and plantation crop systems. The inclusion of a variety of MAPs in existing cropping system in rotation or as inter crop with adaption of good agricultural practices is the key areas for further agronomic research which is the need of the hour (Rao, 2009). Cultivation of MAPs with traditional crops as intercropping is emerging as a better enterprise. (Singh *et al*., 2008). Medicinal plants have attained high

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significance in recent years due to its demand for industrial use and alluring market price (Lubbe and Verpoorte, 2011). Hence cultivation of suitable medicinal plant holds a great promise in jute based cropping system. Presently potato-jute-rice is the most profitable jute based cropping system in West Bengal (Mukhopadhyay and Ray, 2000) which was also confirmed by Gangawar and Katyal (2001). So an attempt was made for crop diversification with medicinal and aromatic plants comparing the traditional crop potato as control.

MATERIALS AND METHODS

The present experiment was conducted at Experimental Farm of the ICAR-Central Research Institute for Jute and Allied Fibres during 2013-14 to study the economic feasibility and production potential of growing spices and medicinal crops in jute (fibre) based cropping system. The experimental site is located at 88° 26´ E longitude and 22° 35´ N latitude 9m above mean sea level. The experiment was laid out in split plot design with three replications and two fertility levels i.e. Recommended dose of fertilizer (60-30-30 kg N-P_2O_5 - K_2O ha^{-1}) and RDF + 5t FYM. The experimental soil was sandy loam in texture with pH 6.8, medium in organic carbon 0.66%, medium in available nitrogen (290 kg ha^{-1}), high in available P_2O_5 (36 kg ha^{-1}) and potash (234 kg ha^{-1}). The jute variety JRO-204 was sown during April followed by transplanting of rice in the month of August. The jute was sown at a spacing of 30 x 10 cm whereas paddy seedling was transplanted at a spacing of 20 X 10 cm. 28 days paddy seedling was transplanted with recommended dose of fertilizer. After harvest of paddy, MAPs were grown. The required nutrient were given in the form of urea, single super phosphate and muriate of potash. In order to assess the most profitable jute (fibre)-*kharif* rice-MAPs sequence, five medicinal crops viz [asalio (*Lepidium sativum*), ashwagandha (*Withania somnifera*), isabgol (*Plantago ovata*), menthol mint (*Mentha arvensis*) and senna (*Senna angustifolia*)] were evaluated along with potato as prevailing traditional crop. The jute equivalent yield of fibre cum seed was calculated by the following formula:

JEY= Economic Yield of crop x (Price of crop / Price of Jute)

The Production efficiency was calculated by the following formula (Tomar and Tiwari, 1990)

$$\text{Production Efficiency} = \frac{\text{Total Jute Equivalent Yield (kg ha}^{-1})}{\text{Total Duration of crop in cropping system (days)}}$$

The resource use efficiency of the system was assessed by calculating the Land use efficiency. (Tomar and Tiwari, 1990)

The Land use efficiency was calculated by the following formula :

$$\text{Land Use Efficiency (\%)} = \frac{\text{Total Duration of crop in cropping system}}{\text{Total number of days in a year (365)}} \times 100$$

The cost of cultivation was calculated basing upon the prevailing market price of different inputs used.

Table 1. *Jute Equivalent yield of various crops in jute based cropping system (t ha^{-1})*

Treatments	Jute fibre yield	Rice yield	Rice JEY	MAPs Yield	MAP JEY	Total JEY yield
C1=Jute-*kharif* rice-asalio	3.42	4.22	2.28	0.05	1.16	6.86
C2=Jute-*kharif* rice-ashwagandha	3.47	4.20	2.27	0.06	1.58	7.32
C3=Jute-*kharif* rice-isabgol	3.44	4.35	2.36	0.06	1.79	7.59
C4=Jute-*kharif* rice-menthol mint	3.23	4.20	2.27	0.01	1.82	7.32
C5= Jute-*kharif* rice-senna	3.36	4.36	2.36	0.05	0.57	6.29
C6=Jute-*kharif* rice- potato	3.49	4.41	2.39	19.98	4.16	10.04
CD (0.05)	0.145	0.169	0.092	0.065	0.109	0.128
Fertility Levels						
F1 : RDF (60-30-30 kg N-P_2O_5-K_2O ha^{-1})	3.49	4.36	2.36	2.41	1.25	7.21
F2 : RDF + 5t FYM ha^{-1}	3.42	4.27	2.31	4.31	2.44	7.34
CD (0.05)	0.07	0.036	0.019	0.991	0.118	0.002
Interaction (C x F)						
CD (0.05)	0.019	0.089	0.048	2.43	0.29	0.05
CV (%)	0.31	1.15	1.16	1.4	4.61	0.39

Table 2. *Economic yield, jute equivalent yield of component crops, system productivity, production efficiency and land use efficiency of different jute based cropping systems*

Treatments	Economic Yield (t ha^{-1})			Total JEY yield (t ha^{-1})	Total duration of cropping sequence (days)				Production Efficiency (kg ha^{-1} day^{-1})	Land Use Efficiency (%)
	Summer	Rainy	Winter		S*	R	W	T		
C1=Jute-*kharif* rice-asalio	3.42	2.28	1.16	6.86	110	100	115	325	21.11	89.04
C2=Jute-*kharif* rice-ashwagandha	3.47	2.27	1.58	7.32	110	100	145	355	20.63	97.26
C3=Jute-*kharif* rice-isabgol	3.44	2.36	1.79	7.59	110	100	120	330	22.99	90.41
C4=Jute-*kharif* rice-menthol mint	3.23	2.27	1.82	7.32	110	100	140	350	20.92	95.89
C5= Jute-*kharif* rice-senna	3.36	2.36	0.57	6.30	110	100	120	330	19.08	90.41
C6=Jute-*kharif* rice- potato	3.49	2.39	4.16	10.04	110	100	115	325	30.89	89.04

*S : Summer, R : Rainy, W : Winter, T : Total

Similarly the minimum support price and local market price was taken into account for calculating the gross return.

RESULTS AND DISCUSSION

Economic yield of component crops and jute equivalent yield

The maximum jute yield of 3.49 t ha^{-1} was obtained in case of jute-*kharif* rice-potato. Residual effects of high doses of fertilizer and soil aeration during harvesting of potato resulted in maximum jute fibre yield in case of potato. In case of medicinal and aromatic plants, the yield was highest for ashwagandha (3.47 t ha^{-1}) and lowest for menthol mint (32.27%).

The jute equivalent yield of rice was maximum in potato (2.39 t ha^{-1}) in case of conventional crop and 2.36 t ha^{-1} in senna in case of medicinal and aromatic crops followed by isabgol (2.36 t ha^{-1}).

The yield of the component crops were converted into equivalent jute yield. The highest yield was recorded in jute-*kharif* rice-potato (4.16 t ha^{-1}) which was 56% and 62% higher than that of menthol mint (1.82 t ha^{-1}) and ashwagandha (1.58 t ha^{-1}) respectively.

In jute-kharif rice-medicinal and aromatic plants cropping sequence, the highest total jute equivalent yield of 7.59 t ha^{-1} was obtained in jute-rice-asalio followed up by jute-rice-ashwagandha (7.32 t ha^{-1}) and jute-rice-menthol mint (7.32 t ha^{-1}). The traditional crop potato recorded the maximum jute equivalent yield of 10.04 t ha^{-1} (Table 1).

Resource use efficiency

The production efficiency of jute-*kharif* rice-potato was maximum (30.89 kg ha^{-1} day^{-1}) which was followed by jute-*kharif* rice-isabgol (22.99 kg ha^{-1} day^{-1}). Jute-kharif rice-senna exhibited the lowest production efficiency of (19.08 kg ha^{-1} day^{-1}). The Land use efficiency (LUE) of 97.26% was the highest in jute-rice-ashwagandha followed by jute-*kharif* rice-menthol mint (95.89%) (Table 2). Jute-*kharif* rice-potato and jute-*kharif* rice-asalio expressed the lowest LUE of 89.04%. The duration of different component crops governed the LUE of systems as duration of jute and *kharif* rice was common to all the systems.

System Economics

Considering the economics of the system highest gross return was recorded in case of isabgol (Rs. 1,82,156) followed up by jute-*kharif* rice-ashwagandha (Rs. 1,75,816) and jute-*kharif* rice-menthol mint (Rs. 1,75,792) in case of MAPs. However there is an increased gross return of Rs. 241000. Among the MAPs, ashwagandha gave the highest net return of Rs. 98,771 followed isabgol (Rs. 95,964) (Table-3). The analysis of system economics recorded the highest BC ratio of 2.28 in ashwagandha followed by asalio. Though the gross return in case of potato was highest (Rs. 2,41,000) but the B-C ratio is quite less (1.41). These results are in close conformity with the findings of Behera *et al*. (2013). Several medicinal plants like Ashwagandha can be commercially grown in India as its climate and soil suit their cultivation (Chandraprakash,

Table 3. *System economics of various crops in jute based cropping system*

Treatments	Total JEY (t ha^{-1})	Gross Return (Rs)	Net Return (Rs)	BC Ratio
C1=Jute-*kharif* rice-asalio	6.86	1,64,728	89,628	2.19
C2=Jute-*kharif* rice-ashwagandha	7.32	1,75,816	98,771	2.28
C3=Jute-*kharif* rice-isabgol	7.59	1,82,156	95,964	2.11
C4=Jute-*kharif* rice-menthol mint	7.32	1,75,792	81,032	1.85
C5= Jute-*kharif* rice-senna	6.30	1,51,140	77,098	2.03
C6=Jute-*kharif* rice- potato	10.04	2,41,000	71,106	1.41
CD (0.05)	0.13	3,093	3,093	0.05
Fertility Levels				
F1 : RDF (60-30-30 kg N-P_2O_5-K_2O ha^{-1})	7.21	1,72,962	76,100	1.90
F2 : RDF + 5t FYM ha^{-1}	7.34	1,76,102	79,287	1.93
CD (0.05)	0.002	490	490	0.002
Interaction (C x F)				
CD (0.05)	0.05	1,201	1,202	0.014
CV (%)	0.39	10.39	0.87	0.46

Table 4. *Interaction effect of cropping sequence and nutrient management on BC ratio*

Treatments	C1	C2	C3	C4	C5	C6	Mean
F1	2.22	2.22	2.13	1.85	2.06	1.51	1.99
F2	2.16	2.34	2.08	1.84	2.01	1.32	1.96
Mean	2.19	2.28	2.11	1.85	2.03	1.41	
CD (0.05) = 0.014							

2005). The interaction of cropping sequence and nutrient management on net return and BC ratio were found significant. So ashwagandha is more economical compared to traditional crop potato in jute based cropping system.

CONCLUSION

Thus study indicated that cultivation of medicinal crop ashwagandha in the existing jute-rice cropping system is more remunerative and can be adapted by jute growing farmers for crop diversification.

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