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Research Paper

Influence of fertilizer levels on productivity, seed quality and economics of tossa jute (*Corchorus olitorius*)

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) season of 2017–2019 on medium black soils at Rahuri, Maharashtra, to find out the suitable dose of farmyard manure (FYM) along with chemical fertilizers for enhancing productivity, seed quality and economics of tossa jute (*Corchorus olitorius* L.). The experiment was laid out in factorial randomized block design with 4 replications The Factor-A comprised organic manure levels, i.e. M_1, control and M_2, FYM @ 5 t/ha, and Factor-B comprised 5 fertilizer doses (N : P : K kg/ha), i.e. F_0, control; F_1, 60 : 13 : 25 kg/ha; F_2, 60 : 26 : 50 kg/ha; F_3, 80 : 17.5 : 33.3 kg/ha; and F_4, 80 : 26 : 50 kg/ha, with 10 combinations of FYM and fertilizer doses with tossa jute variety 'JRO 524'. The results indicated that, the application of FYM 5 t/ha recorded significantly higher seed yield (1.39 t/ha) than the control (1.24 t/ha) during pooled mean of 3 years. Similarly, it also ensued significantly higher net returns (` 77.6 × 10^3/ha) and benefit : cost (2.43) than control as per pooled mean of 3 years. Tossa jute crop gave significantly higher seed yield (1.56 t/ ha) with 80 : 17.5 : 33.3 kg/ha of N : P : K than control, 60 : 13 : 25, 60 : 26 : 50 kg/ha, but it was at par with 80 : 26 : 50 kg/ha of level (N : P : K of in pooled mean of 3 years. A similar trend was recorded for growth and yield attributes. Application of N : P : K at 80 : 26 : 50 kg/ha recorded significantly higher net monetary returns (94.1 × 10^3/ha) and benefit: cost (2.78) than rest of all treatments in pooled mean. On the basis of results, it can be concluded that the application of FYM (5 t/ha) along with fertilizer dose of 80 : 17.5 : 33.3 N : P : K kg/ha may be recommended for enhancement of production in seed yield, quality and economics of tossa jute on medium deep soil in *kharif* season.

Key words: Economics, Fertilizer levels, Growth attributes, Seed yield and quality, Tossa jute

In twenty-first century, jute, once known as *'The golden fibre of India'* is becoming valuable not only as a natural alternative to petrochemical-derived synthetic fibres, but also as a component of automobiles interiors, fibre composites and other diversified products. In comparison to major crops like rice and wheat, jute is more energy-efficient, producing more biomass and fixing higher carbon dioxide (Singh *et al*., 2018). Surely, demand for jute will increase in near future. Globally, India is the largest of both raw jute (jute and mesta) and jute products with a share of 53 and 62%, respectively, in global production. Jute fibre contributes nearly 7,000 crore (0.4%) to India's value of output from agriculture. Jute industry, on the other hand, is a mean of sustenance to poor people, providing direct employment to 0.37 million workers and livelihood security to 4.0 million jute farm families. Only 72% quality jute seed is supplied by national and state agencies and private seed companies. To fulfil 100% target, emphasis on quality seed production should be given. The National Seed Corporation and Mahabeej had initiated organized jute seed production in Maharashtra in 1968 with introduction of varieties 'JRO 524'. Recently newly released varieties like 'JRO 8432' (Shakti), 'JRO 204' (Suren), 'JRO 2407' (Sampti), and 'KRO 4' (Gouranga), 'BCC O6' (Kisan Pat), 'NJ 7010' (Rani) and 'JRMU 1' are promising and released this year (Pande *et al.*, 2020). To increase the area of jute and productivity of jute fibre, seed availability of these varieties are essential and for gaining importance of farmer as well. The farmers of West Bengal do not grow a separate jute crop for seed production, as it requires long crop period (April to December–January) which hampers transplanting of *aman* rice and winter season (*rabi*) crops. At present seed crop is cultivated mainly in Guntur and Prakasham districts of Andhra Pradesh; Belly and Raichur districts of Karnataka; Jalgaon, Akola and Buldhana districts of Maharashtra (Bidhan Roy, 2013).

Quality seed is directly related to the balance nutrition to jute seed crop. This balancing plant nutrition takes place not only through chemical fertilizers but organic manures

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are also essential to maintain soil health (Mandal *et al.,* 2015). The organic fertilizers are added along with chemical fertilizers are beneficial to increase physical, chemical and microbial properties of soil (Vennila *et al.,* 2019). In fact, 50% of the total increase in yield comes from the use of fertilizer alone and the rest from all other factors combined together (Alam *et al.,* 2002). A limited work has been done on the effect nitrogen and potassium on seed production of jute by different methods, but no systematic work has been done on graded levels of fertilizer along with FYM for production of seed production of jute. Therefore, the present investigation was carried out to find out the suitable dose of FYM along with chemical fertilizers for qulity seed production of tossa jute.

MATERIALS AND METHODS

The experiment was conducted at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri (19° 48' N and 19° 57' N, 74° 32' E and 74° 19' E, 495 to 569 m above mean sea-level) during 2017–2019. The soil of the experimental site is clay loam in texture (clay, 47.45%; silt-34.21%; and sand, 17.43%), having *p*H 8.2 and electrical conductivity EC 0.29 dS/m and organic carbon 0.56% in top of 15 cm soil. The-soil available nitrogen, phosphorus and potassium were 178.11, 17.02, 423.0 kg/ha respectively. Soil was moderate in Fe, Mn, Zn and Cu, being were 6.59, 9.51, 0.62 and 3.41 µg/g soil respectively. The field capacity, bulk density and permanent wilting point of the surface (0–15 cm) soil were 33.23% on volume basis, 1.36/Mg^3 and 16.71%, respectively. The average annual rainfall at Rahuri was 520 mm. The rainfall received from south-west monsoon from May to November was 641.4, 307.0 and 693.8 mm and rainy days were 34, 15 and 43 during 2017, 2018 and 2019, which is beneficial for crop growth and seed development. The average mean annual maximum and minimum temperature ranged from 33° to 43°C and 6° to 18°C respectively. The average relative humidity during morning and evening hours were 59 and 35%, respectively. The experiment was laid out in factorial randomized block design during the rainy (*kharif*) season in 4 replications The Factor-A comprises of organic manure levels i.e. M_1- Control and M_2- FYM @ 5 t/ha and Factor-B comprised 5 fertilizer doses (N : P : K kg/ha), i.e. F_0, control; F_1, 60 : 13 : 25 kg/ha; F_2, 60 : 26 : 50 kg/ha; F_3, 80 : 17.5 : 33.3 kg/ha; and F_4, 80 : 26 : 50 kg/ha with 10 combinations of FYM and fertilizer doses with tossa jute variety 'JRO 524'. The gross plot size was 5.0 m × 4.0 m and net plot sizes were 4.35 m × 2.40 m. Fertilizer doses of N, P_2O_5 and K_2O were applied treatment-wise–full dose of P_2O_5 and K_2O at the time of sowing and N was given in split application of 30% at sowing, 35% at 30 days after sowing and 35% at 65 days after sowing.

Jute crop was sown at wider spacing of 60 cm × 10 cm to increase branches and reduce the height of plant. It also topped at 45 days after sowing to develop more branching and pods for increasing the seed yield. The data on growth and yield-attributing characters recorded from randomly selected plants at from each plot. The crop was harvested at physiological maturity of pods and threshed after sun-drying. Seed yield was obtained treatment-wise from net plot and converted into t/ha. The gross returns were calculated by multiplying the prevalent market price of grain and stalk with their respective yields, and net returns were calculated by subtracting cost of cultivation from the gross returns. The net returns per rupee invested (B : C) was calculated by dividing the gross returns with cost of cultivation under the respective treatment. Statistical analysis was done as per randomized block design (Gomez and Gomez, 1984) and the treatment means were compared at 5% level of significance.

RESULTS AND DISCUSSION

Effect of organic manure on growth and yield

On the basis of pooled analysis of three years, application of FYM @ 5.0 t/ha resulted in significantly higher growth and yield attributes, viz. plant height, number of branches, basal diameter, number of pods/plant and 1,000-seed weight than the control treatment. Similarly, higher growth and yield attributes resulted into significantly higher seed yield of *tossa* jute were 1.42, 1.32, 1.43 and 1.39 t/ha during 2017, 2018, 2019 and pooled mean (Tables 1 and 2). Muzumdar *et al.* (2014) and Naik *et al.* (2015) clearly indicated that, application of FYM to the jute crop significantly increased higher residual status of organic carbon, available N, P and K in soil and increased sustainable jute fibre production and maintenance of soil microbial health and fertility status.

Effect of organic manure levels on seed-quality parameters

Application of FYM @ 5 t/ha recorded significantly higher radical length (1.67 cm), fresh weight (47.5 mg) and dry weight (3.31 mg) of radicle than control during pooled mean of 3 years (Table 3).

Effect of organic manure levels on economics

The pooled 3 years data stated that the economic indices like gross monetary returns (131.9 × 10^3/ha), net monetary returns (77.6 × 10^3/ha) and B : C (2.43) was significantly superior with application of FYM @ 5.0 t/ha than the control treatment (Table 2). These results are also in close conformity with the findings of Paikaray *et al.* (2006) and Mitra *et al.* (2010).

Table 1. Effect of organic manure and chemical fertilizers on growth and yield attributes of tossa jute (pooled data of 3 years)

Treatment	Plant height (cm)	Branches/plant	Basal diameter (cm)	Pods/plant	1,000-seed weight (g)
Organic manure					
M_1, Control	246.34	13.26	1.64	54.43	4.05
M_2, FYM 5.0 t/ha	259.26	15.18	1.76	62.24	4.44
SEm±	3.61	0.59	0.03	2.00	0.09
CD (P=0.05)	10.72	1.74	0.08	5.95	0.25
NPK (kg/ha)					
F_0, Control	207.51	7.69	1.31	32.19	3.69
F_1, 60 : 13 : 25	249.18	12.07	1.57	51.89	4.10
F_2, 60 : 26 : 50	268.05	15.12	1.78	60.79	4.16
F_3, 80 : 17.5 : 33.3	270.90	17.56	1.91	72.56	4.62
F_4, 80 : 26 : 50	268.35	18.67	1.92	74.26	4.65
SEm±	5.71	0.93	0.05	3.17	0.13
CD (P=0.05)	16.96	2.76	0.13	9.41	0.39
Interaction (M × F)					
SEm±	8.07	1.31	0.06	4.48	0.21
CD (P=0.05)	NS	NS	NS	NS	NS

Table 2. Influence of organic manure and chemical fertilizers on seed yield and economics of tossa jute (pooled data of 3 years)

Treatment	Seed yield (t/ha)			Pooled mean (t/ha)	Gross monetary returns (× 10^3 ₹/ha)	Cost of cultivation (× 10^3 ₹/ha)	Net monetary returns (× 10^3 ₹/ha)	Benefit: cost ratio
	2017	2018	2019					
Organic manure								
M_1, Control	1.27	1.20	1.25	1.24	117.9	50.3	67.5	2.34
M_2, FYM 5.0 t/ha	1.42	1.32	1.43	1.39	131.9	54.2	77.6	2.43
SEm±	0.01	0.01	0.01	0.01	0.98	–	0.98	–
CD (P=0.05)	0.03	0.03	0.03	0.03	2.91	–	2.92	–
NPK (kg/ha)								
F_0, Control	0.72	0.81	0.82	0.78	73.9	45.2	28.7	1.63
F_1, 60 : 13 : 25	1.36	1.18	1.31	1.28	121.6	48.8	72.8	2.49
F_2, 60 : 26 : 50	1.51	1.32	1.44	1.42	134.9	50.7	82.2	2.66
F_3, 80 : 17.5 : 33.3	1.59	1.48	1.56	1.55	146.9	52.8	94.1	2. 78
F_4, 80 : 26 : 50	1.57	1.52	1.58	1.56	147.2	54.3	92.9	2.62
SEm±	0.02	0.01	0.02	0.02	1.55	–	1.55	–
CD (P=0.05)	0.06	0.04	0.05	0.05	4.61	–	4.62	–
Interaction (M × F)								
SEm±	0.03	0.02	0.03	0.04	2.28	–	2.20	–
CD (P=0.05)	0.08	0.06	0.07	0.12	6.84	–	NS	–

Effect of fertilizer levels on growth and yield

On the basis of pooled data, the application of fertilizer levels (N : P : K) of 80 : 26 : 50 to the tossa jute recorded significantly higher seed yield of 1.57, 1.52, 1.58 and 1.56 t/ha than application of fertilizer levels of the control, 60 : 13 : 25, 60 : 26 : 50 kg/ha, but it was at par with fertilizer levels (N : P : K) of 80 : 17.5 : 33.3 kg/ha (1.59, 1.48, 1.56 and 1.55 t/ha) during 3 years and pooled mean respectively. Maji *et al*. (2014) and Muzumdar *et al.* (2014) clearly stated that, the population of beneficial microbes and enzymatic activities, viz. dehydrogenase, urease, fluorescein diacetate hydrolyzing activity, acid and alkaline phosphatase, in jute rhizosphere 60 days after sowing were significantly higher with 100% NPK + 10 t FYM/ha over all treatments including 100 and 150% NPK.

On the basis of pooled data, among the fertilizer levels, the application of 80 : 26 : 50 kg/ha (N : P : K) recorded significantly higher growth and yield attributes, viz. branches/plant (18.67), basal diameter (1.92 cm), pods/plant (74.26) and 1,000-seed weight (4.65 g) than compared to all treatments, but it was at par with fertilizer levels (N : P : K) of 80 : 17.5 : 33.3 kg/ ha during 3 years and pooled mean respectively. Mandal *et al.* (2015) reported that, NPK along with FYM proved best not only in influencing highest growth and yield but also in balancing soil nutrients.

Table 3. Seed-quality parameters of jute seed production as affected by organic manure and chemical fertilizers (pooled data of 3 years)

Treatment	Germination (%)	Length of radicle (cm)	Fresh weight of radicle (mg)	Dry weight of radicle (mg)
Organic manure				
M_1, Control	98.08	1.64	42.6	2.63
M_2, FYM 5.0 t/ha	98.15	1.67	47.5	3.31
SEm±	0.17	0.01	0.94	0.11
CD (P=0.05)	NS	0.02	2.73	0.32
NPK (kg/ha)				
F_0, Control	97.88	1.44	41..3	1.61
F_1, 60 : 13 : 25	98.22	1.57	44.8	1.80
F_2, 60 : 26 : 50	98.33	1.71	45.6	1.83
F_3, 80 : 17.5 : 33.3	98.36	1.87	46.1	1.96
F_4, 80 : 26 : 50	98.12	1.72	45.9	1.90
SEm±	0.27	0.01	1.25	0.10
CD (P=0.05)	NS	0.03	NS	0.31
Interaction (M × F)				
SEm±	0.38	0.01	2.80	0.26
CD (P=0.05)	NS	NS	NS	NS

Effect of fertilizer levels on seed-quality parameters

The application of different fertilizer levels to the jute crop had significant effect on seed quality parameters during 3 years and pooled mean (Table 3). The application of fertilizer dose of 80 : 17.5 : 33.3 kg N : P : K/ha resulted in the maximum values of seed quality parameters, viz. gerimation (98.36%), length of radicle (1.87 cm), fresh weight (46.1 mg) and dry weight (1.96 mg) than rest of all treatments, but it was at par with fertilizer dose of (N : P : K) of 80 : 26 : 50 kg/ha during 2017, 2018, 2019 and pooled mean. Our results confirm the findings of Mazumdar *et al.* (2014), who reported the population of beneficial microbes and enzymatic activities, viz. dehydrogenase, urease, fluorescein diacetate hydrolyzing activity, acid and alkaline phosphatase in jute rhizosphere after 60 days of sowing was significantly higher with 100% NPK+10 tonnes of FYM/ha to over all treatments and which are useful to increase quality parameters.

Effect of fertilizer levels on economics

Different fertilizer levels had significant effect on seed yield and economic returns during 3 years and pooled mean (Table 2). The higher seed yield of jute is converted into higher economic returns. The application of highest fertilizer dose of (N : P : K) of 80 : 26 : 50 kg/ ha to the jute crop increased the cost of cultivation and reduced the net profit in jute seed production. The application fertilizer dose of 80 : 17.5 : 33.3 kg/ha (N : P : K) recorded significantly higher gross (146.9×10^3/ha), net monetary returns (94.1×10^3/ha) and B : C ratio (2.78) than rest of all treatments, but it was at par with fertilizer dose of (N:P:K) of 80:26:50 kg/ ha during pooled mean of 3 years (Table 2). This result is in agreement with findings of Saha *et al.* (2008) and More *et al.* (2018).

Interaction effect

The interaction effect between applications of different

Table 4. Interaction effect between organic manures and fertilizer levels on seed yield (t/ha) of tossa jute during 2017, 2018, 2019 and pooled mean

Organic manure level	Seed yield (t/ha)							
	2017		2018		2019		Pooled mean	
Fertilizer levels	M_1- Control	M_2- FYM 5.0 t/ha	M_1- Control	M_2- FYM 5.0 t/ha	M1- Control	M_2- FYM 5.0 t/ha	M_1- Control	M_2- FYM 5.0 t/ha
F_0, Control	0.59	0.84	0.77	0.85	0.65	0.98	0.67	0.89
F_1, 60:13:25	1.24	1.48	1.15	1.21	1.24	1.37	1.21	1.35
F_2, 60:26:50	1.47	1.56	1.22	1.41	1.38	1.49	1.36	1.49
F_3, 80:17.5:33.3	1.55	1.61	1.42	1.58	1.47	1.66	1.48	1.62
F_4, 80:26:50	1.53	1.57	1.45	1.59	1.51	1.66	1.50	1.61
SEm±	0.026		0.019		0.023		0.041	
CD (P=0.05)	0.078		0.057		0.068		0.122	

Table 5. Interaction effect between organic manures and fertilizer levels on seed yield (t/ha) of tossa jute during pooled mean of 3 years

Organic manure level	Gross monetary returns (₹× 10^3/ha)	
Fertizer levels	M_1, Control	M_2, FYM 5.0 t/ha
F_0, Control	63.4	84.3
F_1, 60:13:25	114.7	128.5
F_2, 60:26:50	128.7	141.2
F_3, 80:17.5:33.3	140.6	153.2
F_4, 80:26:50	142.0	152.3
SEm±	2.28	
CD (P=0.05)	6.84	

organic manure level with fertilizer level showed significant effect in seed yield and gross monetary returns of tossa jute (Tables 4 and 5). The interactive effect between FYM 5 t/ha with fertilizer levels of 80 : 17.5 : 33.3 kg N : P : K/ ha was significant effect on seed yield (1.61, 1.54, 1.66 and 1.62 t/ha) of tossa jute than control, 60 : 13 : 25 kg/ha, 60 : 26 : 50 kg N : P_5 : K/ha, but it was at par with fertilizer dose of 80:26:50 kg N:P:K/ ha along with FYM 5 t/ha during 2017, 2018, 2019 and pooled mean of 3 years. Similar results were recorded for economics–interaction effect between application of organic manures of FYM 5 t/ha combined with fertilizer levels 80 : 17.5 : 33.3 N : P : K kg/ha recorded significant effect in gross monetary returns (153.2 × 10^3/ha) during three years and pooled mean. Saha *et al.* (2008), Majumdar *et al.* (2014), Naik *et al.* (2015) and Sarkar (2017) stated that, application of recommended dose of fertilizer with 10 t FYM/ ha had proved the best possible option for sustainable jute fibre production and maintenance of soil microbial health and fertility status.

On the basis of the results of the experiment, it could be concluded that the application of FYM 5 t/ ha along with fertilizer dose 80 : 40 : 40; N : P_2O_5 of K_2O kg/ha may be recommended for enhancement of seed production, quality and economics of tossa jute (*Corchorus olitorius* L.) on medium deep soil in *kharif* season.

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