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Response of ramie (*Boehmeria nivea*) cultivars to nutrient management and planting methods

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ABSTRACT

A field experiment was conducted at Pundibari, Cooch Behar in West Bengal during 2003-05 to study the response of ramie [*Boehmeria nivea* (L.) Gaud.] cultivars ('R 1411' and 'R 67-34') to different planting methods (ridge and flat-bed methods) and nutrient management [100 and 150% NPK supplied through chemical fertilizer, 50% N with 100% PK from chemical fertilizer + 50% N through ramie waste (1,339 kg/ha), and 50% N with 100% PK from chemical fertilizer + 50% N through vermicompost (828 kg/ha)]. Based on four cuttings, ramie cultivar 'R 1411' recorded higher fibre yield and net income under ridge-bed planting when supplied with 150% NPK through chemical fertilizer, which was on a par with that of 50% N with 100% PK from chemical fertilizer + 50% N through ramie waste. Integrated use of chemical fertilizer and ramie waste improved the pH and NPK status of the soil. 'R 1411' proved suitable with either sole application of 150% NPK of chemical fertilizer or combined use of chemical fertilizer and ramie waste under ridge-bed planting method to get optimum yield.

Key words: Economics, Fibre yield, Nutrient management, Nutrient uptake, Planting methods, Ramie cultivars

Ramie produces the strongest bast fibre, which is considered as a valuable textile fibre for its high tenacity, enhanced strength on wetting and microbial resistivity (Biswas, 2002). Ramie fibre is a substitute for flax. Extension of ramie cultivation and establishment of ramie-based cottage industry will generate employment opportunities in the rural areas. Ramie crop is raised through rhizome and is a heavy feeder of nutrients. Indiscriminate and continuous use of high level of chemical fertilizers often leads to nutritional imbalance, particularly of the micronutrients. Integrated use of chemical fertilizers and organic resources like ramie waste and vermicompost, therefore, has a greater significance for cultivation of ramie. Keeping this in view, an experiment was conducted to evaluate the productivity and economics of ramie cultivars under different nutrient management and planting methods and its influence on residual soil-fertility status.

MATERIALS AND METHODS

The experiment was carried out at Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, during 2003-05. The soil was sandy to sandy loam, with pH 6.07, 0.58% organic C, and 228.3, 23.6 and 175.3 kg/ha available N, P and K respectively. Sixteen treatment combinations were replicated thrice in split-split plot design of permanently fixed plots. The two cultivars, viz. 'R 1411' and 'R 67-34', were assigned to main plots, whereas planting methods (ridge and flat bed) were assigned to subplots. Four nutrient-management treatments 100 and 150% NPK supplied through chemical fertilizer, 50% N with 100% PK from chemical fertilizer + 50% N through ramie waste (1,339 kg/ha), and 50% N with 100% PK from chemical fertilizer + 50% N through vermicompost (828 kg/ha) were assigned to sub-subplots. Recommended fertilizer dose for ramie was 30 kg N, 15 kg P and 15 kg K/ha. The entire dose of NPK was applied basal before taking each cutting. As the nutrient management treatments were accomplished by supplementing 50% fertilizer N through vermicompost and ramie waste, the N content of these organic resources was analysed and their required amounts were applied after each cutting. The N, P and K content of ramie waste and vermicompost was 1.12, 0.14 and 1.74, and 1.81, 0.88 and 0.92% respectively. Ramie crop was raised through rhizomes with a spacing of 60 cm × 30 cm for flat-bed method and 50 cm × 30 cm for ridge-bed method. Bed width was 1 m in the

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latter method. The crop was sown during the last week of November 2003 and staging-back operation was carried out during the last week of April 2004. Each cutting was made at 60 days after previous cutting. First cutting was made after staging-back operation in 2004. Then the crop was damaged due to heavy rainfall in August-September 2004. Therefore, the second cutting was made during February-March 2005 after gap filling. The third and fourth cuttings were made successively after staging-back operation during the last week of April 2005. Irrigation was given as and when required. Fibre yield was calculated for each cutting and the economics of treatments was based on the prevailing market price. Soil was analysed after fourth cutting to assess residual soil fertility. Composite soil and plant samples from all replications were used to assess the soil-fertility status and nutrient uptake.

RESULTS AND DISCUSSION

Growth parameters and fibre yield

Planting methods and nutrient-management practices significantly influenced the growth parameters of ramie cultivars. Cultivar 'R 1411' recorded higher value of growth parameters in terms of plant height, canes/clump, basal diameter and bark thickness in ridge-bed planting method under nutrient-management treatment in which 150% NPK was applied through chemical fertilizer (Table 1). Fibre yield obtained under this nutrient-management treatment was statistically on a par with the treatment in which 50% N was substituted by ramie waste (1,339 kg/ha) (Table 2). In the second cutting the yield was low due to poor crop growth owing to unfavourable climatic condition of low night temperature (12-17°C) and low humidity during February and March 2005, which was also reported by Saha *et al.* (2002). The extent of increase in fibre yield under the treatment 150% NPK from chemical fertilizer and combined application of 50% N with 100% PK from chemical fertilizer + 50% N through ramie waste was 19.8 and 18.6% over 100% NPK, respectively. Menon *et al.* (1990) reported similar findings, and Sajwan (1995) also reported that nutrient availability during growth period increased under combined application of organic manure and chemical fertilizer than with chemical fertilizer alone. 'R 1411' gave 9.6% higher fibre yield than 'R 67-34' owing to higher nutrient-uptake capacity (Table 2), leading to higher growth rate. Ridge-bed planting method was better than flat-bed planting method, giving 17.8% more yield in heavy-rainfall areas of

Table 1. Effect of cultivar, planting method and nutrient management on growth parameters of ramie at harvest of each cutting

Treatment	Plant height (cm)				Canes/clump				Basal diameter (cm)				Bark thickness (mm)			
	First	Second	Third	Fourth	First	Second	Third	Fourth	First	Second	Third	Fourth	First	Second	Third	Fourth
Cultivar																
'R 67-34'	139.7	70.5	111.9	105.0	9.07	15.14	16.78	15.02	1.45	1.12	1.12	1.34	1.37	1.20	1.17	1.33
'R 1411'	142.8	79.2	118.7	119.1	10.77	15.65	16.84	17.66	1.53	1.15	1.16	1.41	1.42	1.25	1.21	1.35
SEm±	1.3	1.2	1.1	1.9	0.16	0.35	0.25	0.21	0.03	0.02	0.02	0.01	0.01	0.02	0.01	0.002
CD (P=0.05)	NS	7.2	NS	11.3	0.99	NS	1.52	1.29	NS	NS	NS	0.04	0.03	NS	0.03	0.01
Planting method																
Flat bed	140.7	74.1	105.7	105.2	9.40	14.65	16.06	15.51	1.46	1.12	1.11	1.34	1.35	1.20	1.18	1.32
Ridge bed	141.9	75.6	124.9	118.9	10.44	16.14	17.56	18.17	1.51	1.15	1.18	1.41	1.44	1.25	1.20	1.36
SEm±	1.9	0.8	1.7	1.3	0.16	0.14	0.30	0.32	0.01	0.02	0.01	0.01	0.003	0.03	0.02	0.002
CD (P=0.05)	NS	NS	6.5	5.1	0.63	0.53	1.18	1.25	0.05	NS	0.06	0.03	0.01	NS	NS	0.01
Nutrient management																
100% NPK of RD	133.3	70.7	105.6	102.7	9.03	14.24	15.69	14.70	1.44	1.09	1.06	1.29	1.34	1.14	1.10	1.29
150% NPK of RD	148.4	80.1	126.4	122.9	10.61	17.23	19.05	19.11	1.52	1.15	1.25	1.47	1.45	1.33	1.33	1.43
50% N with 100% PK of RD + VC	138.8	73.3	110.9	108.1	9.62	14.86	15.70	15.98	1.48	1.12	1.07	1.30	1.36	1.20	1.15	1.31
50% N with 100% PK of RD + RW	144.7	75.4	118.2	114.6	10.42	15.25	16.80	17.56	1.51	1.18	1.19	1.44	1.43	1.23	1.19	1.33
SEm±	2.0	1.4	2.2	1.8	0.20	0.23	0.39	0.22	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.004
CD (P=0.05)	5.8	3.9	6.4	5.1	0.57	0.93	1.14	0.63	0.06	0.04	0.05	0.04	0.05	0.06	0.05	0.01

RD = Recommended dose (30, 15 and 15 kg NPK ha), VC = vermicompost @ 50% N of recommended dose, RW = ramie waste @ 50% N of recommended dose

Table 2. Fibre and total biomass yields, economics and nutrient uptake of ramie production as influenced by cultivar, planting method and nutrient management

Treatment	Fibre yield (kg/ha)				Total biomass yield (t/ha)				Economics		Nutrient uptake at third cutting (kg/ha)			Nutrient uptake at fourth cutting (kg/ha)		
	First cutting	Second cutting	Third cutting	Fourth cutting	First cutting	Second cutting	Third cutting	Fourth cutting	Net profit (Rs/ha)	Benefit : cost : ratio	N	P	K	N	P	K
Cultivar																
'R 67-34'	570	255	496	490	24.03	9.11	21.81	20.90	59,844	1.42	76.79	12.58	51.16	63.72	11.52	47.25
'R 1411'	610	295	544	532	25.74	10.72	23.91	22.77	69,543	1.65	86.09	14.02	57.33	71.28	12.78	51.94
SEm±	3	13	2	4	0.53	0.25	0.21	0.04			0.86	0.13	0.54	0.50	0.04	0.07
CD (P=0.05)	14	NS	6	18	NS	1.07	0.91	0.16			3.71	0.55	2.34	2.15	0.19	0.31
Planting method																
Flat bed	579	252	495	485	24.32	9.06	21.77	20.71	59,936	1.42	76.07	12.45	50.82	62.71	11.32	46.14
Ridge bed	600	297	545	537	25.46	10.67	23.95	22.97	68,541	1.59	86.81	14.15	57.67	72.29	12.98	53.05
SEm±	5	3	11	9	0.41	0.12	0.39	0.21			1.38	0.23	0.94	0.80	0.13	0.51
CD (P=0.05)	14	7	31	24	1.13	0.32	1.09	0.60			3.84	0.64	2.61	2.21	0.36	1.42
Nutrient management																
100% NPK of RD	538	250	472	468	23.10	8.92	21.01	19.99	55,382	1.06	69.51	11.22	47.23	57.29	10.36	43.41
150% NPK of RD	644	299	549	555	27.14	10.99	24.45	23.89	76,456	2.00	90.55	15.33	60.08	78.05	13.96	56.07
50% of N with 100% PK of RD + VC	557	253	498	477	23.50	9.22	21.67	20.35	60,750	1.65	76.09	11.84	51.92	60.70	10.41	45.44
50% N with 100% PK of RD + RW	620	296	560	544	25.81	10.52	24.31	23.11	72,833	1.74	89.59	14.82	57.75	73.96	13.88	53.46
SEm±	15	9	11	12	0.38	0.24	0.35	0.34			1.24	0.20	0.83	1.14	0.19	0.76
CD (P=0.05)	30	19	23	24	0.80	0.49	0.71	0.69			2.56	0.42	1.72	2.34	0.39	1.57

Details of symbols are given with Table 1

tarai region having annual average rainfall of 3,000 mm, because ramie plant is very much sensitive to waterlogged condition, which significantly affects the plant height, stalk weight and dry-fibre yield. Buendia *et al.* (1990) also reported similar observations. In interaction effect of the cultivars and nutrient management and the planting methods and nutrient managements on fibre yield, 'R 1411' with the nutrient management of 150% NPK through chemical fertilizer under ridge-bed planting method proved superior in all the cuttings without having any significant difference with other interaction effects on fibre yield (Table 4).

Economics

Among the nutrient-management treatments, 150% NPK applied through chemical fertilizer registered the maximum net profit of Rs 76,456/ha with benefit : cost ratio of 2.00, mainly due to higher fibre yield. It was closely followed by 50% N with 100% PK from chemical fertilizers + 50% N supplied through ramie waste, giving Rs 72,833/ha net profit and 1.74 benefit : cost ratio. Higher fibre yield of 'R 1411' gave higher net profit (Rs 69,543/ha) as also the ridge-bed planting method (Rs 68,541/ha), with benefit : cost ratio 1.65 and 1.59 respectively (Table 2).

Soil-fertility status

Integrated use of plant nutrients improved the nutrient (NPK) status of soil after fouth cutting. Use of 100 and 150% NPK through chemical fertilizer, however, reduced the N and P status of the soil. Among the organic sources, application of ramie waste @ 1,339 kg/ha to substitute 50% N resulted in maximum improvement of NPK status in the soil compared with other nutrient-management practices (Table 3). Application of organic matter (vermicompost and ramie waste applied in conjunction with chemical fertilizer) increased the soil pH; ramie waste had a greater effect. Mandal *et al.* (1974) reported that ramie crop removed 15.21 kg N, 3.57 kg P_2O_5, 9.29 kg K_2O, 27.43 kg CaO and 6.57 kg MgO besides other micronutrients to produce 100 kg undegummed fibre. It shows that ramie plant is a rich source of N, P, K, Ca, and Mg. From the report mentioned above, it was revealed that the application of ramie waste in

Table 3. Soil-fertility status after fourth cutting of ramie as influenced by cultivar, planting method and nutrient management

Treatment	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	Organic C (%)	Soil pH
Cultivar					
'R 67-34'	224.34	24.01	198.03	0.79	6.10
'R 1411'	221.10	22.26	195.13	0.73	6.02
Planting method					
Flat bed	227.68	24.68	196.21	0.77	5.86
Ridge bed	230.21	27.11	202.14	0.80	6.09
Nutrient management					
100% NPK of RD	209.77	19.82	189.32	0.68	5.75
150% NPK of RD	220.12	22.78	195.37	0.70	5.59
50% of N with 100% PK of RD + VC	227.40	26.54	200.48	0.81	5.96
50% N with 100% PK of RD + RW	239.12	29.50	206.97	0.87	6.14
Initial value	228.30	23.58	175.30	0.58	6.07

Details of symbols are given with Table 1

Table 4. Fibre yield of ramie as influenced by interaction effect of cultivar and planting method with nutrient management

Treatment	Fibre yield (kg/ha) at			
	First cutting	Second cutting	Third cutting	Fourth cutting
V_1N_1	520	244	460	453
V_1N_2	615	277	529	532
V_1N_3	534	224	469	461
V_1N_4	613	272	526	511
V_2N_1	556	264	484	482
V_2N_2	675	321	594	577
V_2N_3	581	276	528	493
V_2N_4	628	312	579	576
SEm±	18	17	12	16
CD (P=0.05)	NS	NS	NS	NS
P_1N_1	534	227	464	457
P_1N_2	628	271	525	516
P_1N_3	556	238	479	464
P_1N_4	597	272	523	502
P_2N_1	542	262	491	478
P_2N_2	662	327	597	593
P_2N_3	560	279	518	490
P_2N_4	643	320	581	578
SEm±	19	13	12	17
CD (P=0.05)	NS	NS	NS	NS

V_1 = 'R 67-34', V_2 = 'R 1411', P_1 = flat bed, P_2 = ridge bed; N_1 = 100% NPK of RD, N_2 = 150% NPK of RD, N_3 = 50% N with 100% PK of RD + 50% N of RD through vermicompost, and N_4 = 50% N with 100% PK of RD + 50% N of RD through ramie waste; RD = recommended dose (NPK 30, 15 and 15 kg /ha).

soil added huge amount of Ca and Mg in addition to other nutrients and thereby increased the soil pH as well the organic carbon content. Nutrient (NPK) status, organic carbon and pH of the soil after fourth cutting was lower under 'R 1411' than under 'R 67-34' due to its higher nutrient uptake capacity. Improvement in nutrient (NPK) status, organic carbon and pH were higher due to better decomposition of organic matter caused by less soil compaction and better aeration under ridge-bed planting method.

Chemical fertilizers at 100% NPK for each cutting did not prove sufficient to get the optimum yield of ramie under *tarai* zone of West Bengal. 'R 1411' may be suitable either with the sole application of 150% NPK of the chemical fertilizer or the combined use of chemical fertilizer and ramie waste under ridge-bed planting method to get optimum yield. Future investigation needs to be carried out on optimization of NPK fertilization, use of rock phosphate and possibility of growing suitable quick-growing crops in the intercropping system, especially during winter season because the growth of ramie crop becomes stunted during that period.

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