Environment & Ecology 27 (3A) : 1208—1212, 2009
 ISSN 0970-0420

Improvement on Soil Fertility, Partial Factor Productivity of Nutrients and Nutrient Uptake Through Nutrient Management Practices in Ramie (*Boehmeria nivea* L.) under Terai Region of West Bengal

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Abstract

A field experiment was conducted during 2003-04 to 2004-05 to study the response of ramie cultivars viz. R-67-34 and R-1411 to different planting methods like flat bed and ridge bed methods and nutrient management practices viz. 100% NPK of recommended dose supplied through chemical fertilizer, 150% NPK of recommended dose supplied through chemical fertilizer, 50% N with 100% PK of recommended dose from chemical fertilizers + 50% N of recommended dose through vermicompost and 50% N with 100% PK of recommended dose from chemical fertilizers + 50% N of recommended dose through ramie waste. Ramie cultivar R-1411 recorded higher fiber yield under ridge bed planting method during all the four cutting with the nutrient management treatment where 150% NPK of recommended dose supplied through chemical fertilizer and became at par with the nutrient management treatment of 50% N with 100% PK of recommended dose from chemical fertilizers + 50% N of recommended dose through ramie waste. Integrated use of chemical fertilizer and ramie waste significantly improved NPK uptake, partial factor productivity of nutrients, soil pH and soil NPK status.

Key words : Ramie cultivars, Nutrient management practices, Nutrient uptake, Partial factor productivity of nutrients.

Ramie the most promising strongest bast fiber crop has got a great scope in its use in the textile industry in our country. It grows extensively as a wild plant in many parts of India, particularly, in the north-eastern states and also in Kangra valley and Nilgiri hills (Biswas 2002). Ramie is a heavy nutrient depleting crop, thereby, application of large quantity of fertilizers are needed for its cultivation. But continuous and indiscriminate use of chemical fertilizers mostly N, P and K often leads to nutritional imbalance which ultimately cause deterioration of soil physico-chemical properties and steadily decreases crop yield (Nambiar 1994).To overcome this problem, it becomes imperative to develop a suitable plant nutrient system. Keeping these in view, systemic investigation was carried out for integrating organic and inorganic sources of plant nutrients in ramie cultivation.

Methods

The field experiment was carried out during 2003-04 and 2004-05 on nutrient management practices in ramie cultivation at the research farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal.The soil was sandy loam in texture with pH 6.07, 0.58% organic carbon and 228.3, 23.6 and 175.3 kg/ha of total nitrogen, phosphorus and potassium respectively. Sixteen treatment combinations were replicated thrice in split-split plot design of permanently fixed plots. The two cultivars viz. R-67-34 and R-1411 were assigned to main plots, two planting methods viz. flat and ridge bed methods assigned to sub-plots and four nutrient management treatments viz. 100% NPK of recommended dose supplied through chemical fertilizer, 150% NPK of recommended dose supplied through chemical fertilizer, 50% N with 100% PK of recommended dose from chemical fertilizers + 50% N of recommended dose through vermicompost and 50% N with 100% PK of recommended dose from chemical fertilizers + 50% N of recommended dose through ramie waste were assigned to sub-sub plots. The recommended fertilizer dose was 30 kg N, 15 kg

Table 1. Nutrient uptake of ramie as influenced by cultivars,planting methods and nutrient managements during third and fourth cutting.

	Third cutting								
	N (kg/ha)			P (kg/ha)			K (kg/ha)		
Treatments	Cane	Leaf	Total	Cane	Leaf	Total	Cane	Leaf	Total
Cultivars									
R-67-34	24.29	52.50	76.79	5.97	6.61	12.58	30.25	20.91	51.16
R-1411	27.67	58.42	86.09	6.72	7.30	14.02	33.08	24.25	57.33
CD (*P*=0.05)	0.68	3.03	3.71	0.17	0.38	0.55	1.03	1.31	2.34
Planting Methods									
Flat bed	24.25	51.82	76.07	5.92	6.53	12.45	29.92	20.90	50.82
Ridge bed	27.71	59.10	86.81	6.77	7.38	14.15	33.41	24.26	57.67
CD (*P*=0.05)	1.32	2.53	3.84	0.32	0.32	0.64	1.56	1.06	2.61
Nutrient Management									
100% NPK of RD	20.52	48.99	69.51	5.33	5.89	11.22	27.51	19.72	47.23
150% NPK of RD	29.84	60.71	90.55	7.09	7.73	14.82	33.51	24.24	57.75
50% N with 100% PK of RD + VC	24.27	51.82	76.09	5.42	6.42	11.84	30.25	21.67	51.92
50% N with 100% PK of RD + RW	29.27	60.32	89.59	7.54	7.79	15.33	35.39	24.69	60.08
CD (*P*=0.05)	0.89	1.76	2.56	0.22	0.22	0.42	1.06	0.72	1.72

Table 1. Continued.

	Fourth cutting								
	N (kg/ha)			P (kg/ha)			K (kg/ha)		
Treatments	Cane	Leaf	Total	Cane	Leaf	Total	Cane	Leaf	Total
Cultivars									
R-67-34	21.61	42.11	63.72	6.11	5.41	11.52	29.93	17.32	47.25
R-1411	24.57	46.71	71.28	6.83	5.95	12.78	31.53	20.41	51.94
CD (*P*=0.05)	0.59	2.74	2.15	0.15	0.34	0.19	0.81	1.11	0.31
Planting Methods									
Flat bed	21.33	41.39	62.71	5.98	5.34	11.32	28.76	17.38	46.14
Ridge bed	24.85	47.44	72.29	6.96	6.02	12.98	32.69	20.36	53.05
CD (*P*=0.05)	0.77	1.82	2.21	0.21	0.24	0.36	0.94	0.77	1.42
Nutrient Management									
100% NPK of RD	18.34	38.95	57.29	5.57	4.79	10.36	27.07	16.34	43.41
150% NPK of RD	27.21	50.85	78.05	7.33	6.33	13.66	33.00	20.46	53.46
50% N with 100% PK of RD + VC	20.79	39.91	60.70	5.35	5.06	10.41	28.06	17.38	45.44
50% N with 100% PK of RD + RW	26.02	47.94	73.96	7.63	6.55	14.18	34.77	21.30	56.07
CD (*P*=0.05)	0.90	2.02	2.34	0.25	0.26	0.39	1.20	0.84	1.57

$P_2O_5$and 15 kg K_2O/ha and the entire dose of NPK was applied as basal to the first crop as well as after each cutting of the crop in succeeding crop seasons. The N-P-K content of ramie waste (RW) and vermicompost (VC) were 1.12-0.14-1.74% and 1.81-0.88-0.92%, respectively. 13.39 q/ha ramie waste and

Table 2. Correlation of N, P and K uptake (kg/ha) with fiber and total biomass yield during third and fourth cutting.

Attributes	Third cutting N	P	K
Fiber yield (kg/ha)	Y = –21.3 + 0.20x *r* = 0.95**	Y = –5.8 +0.04x *r* = 0.94**	Y = –10.7 + 0.12x *r* = 0.96**
Total biomass yield (t/ha)	Y = –29.2 + 4.86x *r* = 0.98**	Y = –7.25+ 0.90x *r* = 0.96**	Y = –14.51 + 3.01x *r* = 0.96**

Table 2. Continued.

Attributes	Fourth cutting N	P	K
Fiber yield (kg/ha)	Y = –23.98 + 0.18x *r* = 0.94**	Y = –5.42 + 0.03x *r* = 0.94**	Y = –7.40 + 0.11x *r* = 0.93**
Total biomass yield (t/ha)	Y = –29.72 + 4.45x *r* = 0.97**	Y = –6.39 + 0.85x *r* = 0.96**	Y = –10.7 + 2.76x *r* = 0.96**

8.28 q/ha vermicompost were applied on the basis of N content for supplementing 50% N of recommended dose. The crop was planted with rhizome during last week of November, 2003. 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 during August—September, 2004. Therefore, second cutting was made during February—March, 2005 after gap filling. Third and fourth cuttings were made successively after staging back operation during the last week of April, 2005. Fiber yield was calculated for each cutting and economics of treatments was based on prevailing market price. NPK uptake by the plant was recorded during third and fourth cutting. Soil was analyzed after fourth cutting to assess residual soil fertility. Composite soil and plant samples from all replications were used to assess soil fertility status and nutrient uptake analysis. Partial factor productivity was calculated by using the following formula.

$$\text{PFP} = \frac{\text{Total fiber yield of four cutting (kg)}}{\text{Total amount of nutrient applied for four cutting (kg)}} \times (\text{kg fiber yield/kg nutrient applied})$$

Results and Discussion

Nutrient Uptake

The uptake of N, P and K by cane and leaf was higher under the cultivar R-1411 as compared to R-67-34 (Table 1). With respect to the planting methods, ridge bed planting recorded higher uptake of all the nutrients than that of flat bed planting. Among the nutrient management practices, application of 150% NPK of recommended dose through chemical fertilizers recorded NPK uptakes which were comparable with the integrated use of 50% N with 100% PK through chemical fertilizers + remaining 50% N through ramie waste during third cutting, whereas the highest uptake of N was recorded under 150% NPK of recommended dose applied through chemical fertilizers during fourth cutting closely followed by integrated nutrient management including ramie waste. In P and K uptake, higher uptake was recorded under integrated use of chemical fertilizers and ramie waste at third and fourth cutting.

Correlation Between NPK Uptake with Fiber and Biomass Yield

Positive correlation having higher value of *r* between fiber and total biomass yield with total N, P and K uptake confirmed growth and yield improvement due to greater availability of nutrients to the plant under integrated use of chemical fertilizers and ramie waste (Table 2).

Partial Factor Productivity of Nutrients

Among the nutrient management treatments

Table 3. Soil fertility status after fourth cutting, partial factor productivity of nutrients and fiber yield of ramie as influenced by cultivar, planting methods and nutrient managements.

Treatment	Soil fertility status: Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)	Organic carbon (%)	Soil pH
Cultivars					
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
CD (*P*=0.05)					
Planting Methods					
Flat bed	227.68	24.68	196.21	0.77	5.86
Ridge bed	230.21	27.11	202.14	0.80	6.09
CD (*P*=0.05)					
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% 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
CD (*P*=0.05)					
Initial value	228.30	23.58	175.30	0.58	6.07

Table 3. Continued.

Treatment	Partial factor productivity of nutrients (kg fiber yield /kg nutrient applied): N	P_2O_5	K_2O	Fiber yield (q/ha): First cutting	Second cutting	Third cutting	Fourth cutting
Cultivars							
R-67-34	15.09	30.18	30.18	5.70	2.55	4.96	4.90
R-1411	16.51	33.02	33.02	6.10	2.95	5.44	5.32
CD (*P*=0.05)				14.24	NS	6.70	18.12
Planting Methods							
Flat bed	15.09	30.18	30.18	5.79	2.52	4.95	4.85
Ridge bed	16.49	32.98	32.98	6.00	2.97	5.45	5.37
CD (*P*=0.05)				14.03	7.52	31.69	24.07
Nutrient Management							
100% NPK of RD	14.40	28.80	28.80	5.38	2.50	4.72	4.68
150% NPK of RD	11.37	22.74	22.74	6.44	2.99	5.49	5.55
50% N with 100% PK of RD +VC	29.75	29.75	29.75	5.57	2.53	4.98	4.77
50% N with 100% PK of RD + RW	33.67	33.67	33.67	6.20	2.96	5.60	5.44
CD (*P*=0.05)				30.33	19.22	22.69	24.18

higher partial factor productivity of N, P and K were recorded under integrated use of chemical fertilizer and ramie waste (33.67, 33.67 and 33.67 of N, P and K, respectively) and these values were statistically at par with integrated nutrient management containing vermicompost (29.75, 29.75 and 29.75 of N, P and K, respectively). Higher partial factor productivity of nutrients obtained in integrated nutrient management

practices containing ramie waste and vermicompost over chemical fertilization was due to substitution of N through biosolid. Lowest partial factor productivity of nutrients (11.37, 22.74 and 22.74 of N, P and K, respectively) were recorded under the treatment where 150% NPK was applied through chemical fertilizers (Table 3). The cultivar R-1411 recorded higher value of partial factor productivity (16.51, 33.02 and 33.02 of N, P and K, respectively) under ridge bed planting method (16.49, 32.98 and 32.98 of N, P and K, respectively) and this was due to better uptake of nutrients by the cultivar R-1411 under ridge bed planting method as compared to conventional flat bed method.

Soil Fertility Status

Data on soil fertility status revealed that after fourth cutting soil nutrient content was improved with the integrated use of plant nutrients. Application of 100 and 150% NPK through chemical fertilizer however reduced N and P status of soil after fourth cutting. Maximumim provement of soil pH and NPK status were recorded in integrated use of chemical fertilizers and ramie waste (Table 3) closely followed by combined use of vermicompost and chemical fertilizers as compared to other nutrient management treatments (Sudhakar et al. 2002, Singh and Ghosh 1999). Ramie plant is a rich source of N, P, K, Ca and Mg (Mandal et al. 1974). Therefore, application of ramie waste added huge amount of Ca and Mg in addition to other nutrients into the soil which in turn increases soil pH and NPK status. Improvement of organic carbon might be due to the addition of organic matter through ramie waste. Soil pH, NPK status and organic carbon after fourth cutting were lower under the cultivar R-1411 than R-67-34 due to its higher nutrient uptake capacity. An improvement of soil NPK status, organic carbon and pH was higher as a result of better decomposition of organic matter due to less soil compaction and better aeration under ridge bed planting method.

Conclusion

Integrated nutrient management containing ramie waste with the principle of 50% N substitution in the cultivar R-1411 under ridge bed planting method could become effective in terms of improving soil health, partial factor productivity of nutrients and fiber yield under terai agro-climatic situation of West Bengal.

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