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Effect of fertility levels and plant population on yield and uptake of nitrogen, phosphorus and potassium in finger millet (*Eleusine coracana*) in lateritic soil of West Bengal

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ABSTRACT

An experiment was conducted at the Regional Research Sub-Station, Sekhampur, Birbhum, West Bengal, during the rainy season of 1994 and 1995 to study the effect of nitrogen and phosphorus at different plant densities on grain yield and N, P and K uptake by 'WR 5' finger millet [*Eleusine coracana* (L.) Gaertn.]. Grain and straw yields were significantly increased by increasing the dose of nitrogen and phosphorus. The combined application of nitrogen and phosphorus did not show any significant effect on grain yield of finger millet, although the application of N along with @ 60 kg/ha gave higher yield, it was at par with grain yield recorded by single application of N @ 60 kg/ha. The wider spacing of 25 cm × 10 cm had significant effect on grain yield with or without nitrogen or phosphorus compared with closer spacing of 25 cm x 8 cm or 25 cm x 6 cm. However, combined application of N and P at different spacing levels did not show any significant results on straw yield. Uptake of N, P and K by grain and straw was also significantly increased with the increase in N and P. The higher dose of nitrogen @ 60 kg/ha at wider spacing of 25 cm x 10 cm increased NPK content in grain and straw than the same dose at closer spacing of 25 cm x 6 cm of finger millet.

Key words : Finger millet, Yield, N, P and K uptake, Lateritic soil

A sound knowledge on the nutrient absorption pattern of the plant, and its efficient utilization of the applied nutrients is necessary for obtaining the economical returns. Phosphorus is one of the major nutrients needed in adequate quantity in available from for the growth and reproduction of cereals. Very little work has been done on finger millet crop to increase and stabilize its productivity in lateritic red soil of West Bengal. Hence the present investigation was carried out to study the N,P and

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K uptake and grain yield as affected by different levels of nitrogen and phosphorus under different plant densities in lateritic soil of West Bengal.

MATERIALS AND METHODS

The experiment was conducted at the Regional Research Sub-Station of Bidhan Chandra Krishi Viswavidyalaya, Birbhum, during 1994 and 1995. Seedlings of variety 'WR5' were planted at 3 different plant densities (400,000;500,000 and 660,000 plants/ha) with all combinations of 3 levels of nitrogen (0,30 and 60 kg N/ha) and levels of phosphorus (0,30 and 60 kg P_2O_5/ ha). Seedlings of 30 days old uprooted and transplanted in the mainifield in line at a spacing of 25 cm × 10 cm, 25 cm × 8 cm and 25 cm × 6 cm using 1 seedling/hill to maintain the plant densities as per treatment. Full dose of P as single superphosphate and half dose of N as urea were applied as basal. The remaining N was top-dressed 25 days after transplanting (just after first weeding). A general dose of 20 kg potash was applied in each plot as basal. The experiment was conducted in 33 partial confounded design. The experimental soil was clay loam in texture, well-drained, poor in organic carbon (0.42%) and phosphorus (17.3 kg/ha) and medium in available nitrogen (248.6 kg/ha) and potash (193.2 kg/ha), with pH 5.8.

The total rainfall received during the crop season was 1,288.3 mm in 1994 and 1,617.5 mm in 1995 and was higher than normal rainfall of 1,225.5 mm.

Representative samples of grain and straw at harvest from different treatments were analysed for N,P and K by standard methods. The uptake of N, P and K was determined on the basis of dry matter of grain and straw production in different treatments. The test the significance between treatments was followed as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Grain and straw yield

The yield in the second year was much higher than that recorded in first year owing to higher rainfall received during the crop growth and maturity periods in 1995. The grain yield increased significantly with increasing doses on N or P (Table 1). Nitrogen or phosphorus at 60 kg /ha recorded significantly higher grain yield. However, the combined application of N and P showed better effect than that of their single application. Thus $N_{60}P_{60}$ recorded significantly higher grain yield compared to 60 kg N/ha, but it was statistically at par with that of $N_{60}P_{30}$. The similar trend was observed for straw yields. The results confirm findings of Singh and Arya (1991). Again, irrespective of nitrogen or phosphorus, the wider spacing of 25 cm × 10 cm with 400,000 plants gave significantly higher grain yield than closer spacing of 25 cm × 6 cm or 660,000 plant/ ha. The reduction in yield of finger millet at higher population might be due to overcrowding of plants, increase of nutrient competition; decrease in functional ears/m^2, weight of grains/ear and 1,000-grain weight. The results corroborate the findings of Rao *et al.* (1991). The interaction effect between plant population and N or P showed significant variation on grain yield but straw yield did not show significant variation.

Table 1. Yield of finger millet as influenced by plant population and fertility levels

Treatment	Grain yield (kg/ha)			Straw yield (kg/ha)		
	1994	1995	Pooled	1994	1995	Pooled
N (kg/ha)						
0	811.6	842.4	827.0	1,349.5	1,468.0	1,431.2
30	1,038.1	1,105.7	1,071.9	1,753.5	1,942.8	1,848.2
60	1,144.4	1,221.7	1,183.1	1,940.0	2,130.4	2,035.2
CD (P=0.05)	66.0	66.6	32.9	108.7	101.1	47.6
P_2O_5 (kg/ha)						
0	949.0	1,012.1	980.5	1,627.5	1,779.5	1,703.5
30	1,010.8	1,069.7	1,040.3	1,710.2	1,864.6	1,787.4
60	1,034.3	1,088.1	1,061.2	1,850.3	1,897.6	1,873.9
CD (P=0.05	66.0	66.6	32.9	108.7	101.1	47.6
Plant population/ha						
400,000	1,098.2	1,176.0	1,137.0	1,865.1	2,074.8	1,970.0
500,000	1,034.0	1,090.2	1,062.1	1,763.3	1,884.8	1,824.1
660,000	862.1	903.7	882.9	1,459.6	1,581.5	1,520.6
CD (P=0.05)	66.0	66.6	32.9	108.7	101.1	47.6
Interaction						
Nitrogen × phosphorus			NS			NS
Nitrogen × population			NS			NS
Phosphorus × population			NS			NS

NS, Not significant

Economical dose

The regression analysis showed that the trend of response to N or P were linear and were best fitted to equations as indicated:

$Y = 1{,}126.3 + 197\ x - 21.6\ X^2$ (pooled) (for N)

$Y = 943.5 + 35.5\ x - 6.33\ X^2$ (pooled) (for P)

where Y, expected yield (kg/ha) at unit of N and P (1 unit = 1 kg N or P).

The computed economic optimum dose of nitrogen and phosphorus were 35.5 and 27.2 kg/ha respectively.

NPK uptake

Higher production of dry matter and NPK uptake by finger millet were recorded (Table 2) with increasing dose of N and P from 0 to 60 kg/ha. In general, the uptake of K was more in straw and nitrogen in grain. Application of N, P alone or in combination at higher doses increased the NPK uptake in plants. The results are in conformity with the findings of Rao *et al.* (1986). The treatment $N_{60}P_{60}$ resulted in maximum NPK uptake, followed by $N_{60}P_{30}$, which was also

Table 2. N, P and K uptake of finger millet grain and straw as influenced by plant population and fertility levels

Treatment	N uptake (kg/ha)						P uptake (kg/ha)						K uptake (kg/ha)					
	Grain			Straw			Grain			Straw			Grain			Straw		
	1994	1995	Pooled	1994	1995	Pooled	1994	1995	Pooled	1994	1995	Pooled	1994	1995	Pooled	1994	1995	Pooled
Nitrogen (kg/ha)																		
0	14.0	14.92	14.46	10.52	11.23	10.87	3.60	3.81	3.70	4.55	4.95	4.75	13.92	16.67	15.29	25.86	30.74	28.30
30	19.92	22.18	21.05	14.44	16.55	15.49	4.86	5.31	5.08	6.52	7.60	7.06	19.23	23.74	21.48	37.20	45.22	41.21
60	23.51	26.88	25.19	17.21	19.67	18.44	5.49	6.07	5.78	8.08	9.15	8.61	22.52	27.77	25.14	45.89	53.46	49.67
CD (P=0.05)	0.73	1.08	0.90	0.75	0.89	0.84	0.21	0.24	0.17	0.24	0.31	0.28	0.79	1.20	0.84	1.57	2.02	1.99
P_2O_5 (kg/ha)																		
0	17.66	19.84	18.75	13.00	17.90	13.95	4.39	4.79	4.59	5.92	6.72	6.32	17.32	21.27	19.29	33.70	40.36	37.03
30	19.27	21.59	20.43	14.27	15.98	15.12	4.72	5.13	4.92	6.44	7.34	6.89	18.80	23.07	20.93	36.74	43.81	40.27
60	20.49	22.55	21.52	14.89	16.57	15.73	4.84	5.27	5.05	6.78	7.64	7.21	19.55	23.82	21.68	38.62	45.24	41.88
CD (P=0.05)	0.73	1.08	0.90	0.75	0.89	0.84	0.21	0.24	0.17	0.24	0.31	0.28	0.79	1.20	0.84	1.57	2.02	1.99
Plant population/ha																		
400,000	21.88	24.78	23.33	16.45	19.03	17.74	5.17	5.83	5.50	7.53	8.96	8.24	20.94	25.70	23.32	42.50	50.20	46.35
500,000	20.06	21.79	20.29	14.77	16.34	15.55	4.86	5.22	5.04	6.39	7.31	7.0	19.32	23.42	21.97	36.92	44.72	40.82
600,000	15.49	17.41	16.45	10.94	12.07	11.50	3.91	4.13	4.02	4.93	5.43	5.84	15.41	19.06	17.23	29.55	34.50	32.02
CD (P=0.05)	0.73	1.08	0.90	0.75	0.89	0.84	0.21	0.24	0.17	0.24	0.31	0.28	0.79	1.20	0.84	1.57	2.02	1.99
Interaction																		
N × P			1.37			1.17			0.313			0.485			1.405			3.07
N × P			1.37			1.17			0.313			0.485			1.405			3.07
P × population			1.37			1.17			0.313			0.485			1.405			3.07

reflected by greater vigour of plants and better values of yield-attributing characters of finger millet. Further, the application of higher dose of N with wider spacing having 400, 000 plants/ha significantly increased the N and P content and NPK uptake by grain and straw than the same dose of N with closer spacing (660,000 plants/ha). The interaction effect on NPK uptake was significantly different and that might be due to higher production of dry matter under wider spacing owing to reducing of nutrient competition. Thus , the treatment $N_{60}P_{30}$ at wider spacing (25 cm x 10 cm) with 400, 000 plants/ha appeared the best treatment for finger millet as $N_{60}P_{30}$ was found at par with $N_{60}P_{60}$.

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