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Effect of nutrient-management practices on growth and yield of pearl millet (*Pennisetum glaucum*)

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ABSTRACT

An experiment was conducted for 2 years (2002 and 2003) at Dryland Research Farm of Indian Agricultural Research Institute, New Delhi, to evaluate the effect of nutrient-management practices on growth and yield of pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz.]. Nutrient-management practices comprised the control, 30 kg N/ha + 20 kg P_2O_5/ha, 60 kg N/ha + 40 kg P_2O_5/ha, 5 tonnes FYM/ha + bio-fertilizer (*Azotobacter* + vesicular arbuscular mycorrhizae), 10 tonnes FYM/ha + bio-fertilizer (*Azotobacter* + VAM), 30 kg N/ha + 20 kg P_2O_5/ha + 5 tonnes FYM/ha + bio-fertilizer, 30 kg N/ha + 20 kg P_2O_5/ha + 10 tonnes FYM/ha + bio-fertilizer and 60 kg N/ha + 40 kg P_2O_5/ha + 10 tonnes FYM/ha + bio-fertilizer in randomized block design with three replications. The total rainfall received during *kharif* season of 2002 and 2003 was 405.5 mm and 823.0 mm respectively. Application of 60+40 kg/ha of N + P_2O_5 along with 10 t FYM/ha and biofertilizer gave significantly higher grain yield and N, P uptake by pearlmillet than control and FYM (5 or 10 t/ha) + biofertilizers use.

Key words: Nitrogen, Phosphorus, Farmyard manure, Bio-fertilizers

Pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz.] is a staple foodgrain crop of the arid and semi-arid regions of India. To sustain long-term productivity of this crop, integrated nutrient supply through inorganic and organic sources is important. Pearl millet has a variety of nitrogen-fixing bacteria in its rhizosphere, which may release growth-promoting substances like indoleacetic acid, gibberellin and cytokinin. Wani *et al.* (1985) reported increase in grain yield and dry matter of pearl millet due to inoculation. In the light of these observations, an experiment was laid out to know the effect of nutrient-management practices on pearl millet growth and yield.

MATERIALS AND METHODS

A field experiment was conducted during the rainy (*kharif*) seasons of 2002-03 and 2003-04 at Dryland Research Farm of Indian Agricultural Research Institute, New Delhi. Treatments comprising nutrient management practices [control, 30 kg N/ha + 20 kg P_2O_5/ha, 60 kg N/ha + 40 kg P_2O_5 /ha, 5 tonnes farmyard manure (FYM)/ha + bio-fertilizer (*Azotobacter* + vesicular arbuscular mycorrhizae (VAM), 10 t FYM/ha + bio-fertilizer, 30 kg N/ha + 20 kg P_2O_5/ha + 5 tonnes FYM/ha + bio-fertilizer, 30 kg N/ha + 20 kg P_2O_5/ha + 10 tonnes FYM/ha + bio-fertilizer, 60 kg N/ha + 40 P_2O_5 /ha + 5 tonnes FYM/ha + bio-fertilizer and 60 kg N/ha + 40 kg P_2O_5/ha + 10 tonnes FYM/ha + bio-fertilizer] were allotted in randomized block design with three replications. The pearl millet hybrid 'Pusa 415' was sown in rows 50 cm a part using a seed rate of 5 kg/ha. The recommended dose of potassium (30 kg/ha) was applied basal through muriate of potash. The N and P doses were applied through urea, single superphosphate and organic sources, as per treatment. The soil was sandy clay-loam, having soil pH 7.2, medium for organic carbon (0.50%), available N (250 kg N/ha), phosphorus (24 kg P_2O_5/ha) and high available potassium (267 kg K_2O/ha).

RESULTS AND DISCUSSION

Growth parameters and yield attributes

The application of 60 kg N/ha + 40 kg P_2O_5/ha + 10 tonnes FYM/ha + bio-fertilizer showed best performance for all the growth and yield contributing characters (Table 1). This treatment proved superior because FYM application improves the soil-physical properties, hydraulic conductivity of the soil and also the availability of NPK which increased the plant growth. The superiority of this treatment over the rest of the combinations of fertilizers might also be due to higher availability of NO_3-N and production of growth-promoting substances. These results are in close conformity with those of Gautam and Kaushik (1987).

Table 1. Growth parameters and yield attributers of pearl millet as affected by nutrient-management practices

Nutrient-management practice	Plant height (cm)		Tillers/m row length		Ear length (cm)		Ears/m row length	
	2002	2003	2002	2003	2002	2003	2002	2003
Control	149.4	174.5	14.4	15.9	21.3	23.4	9.6	11.9
30 kg N/ha + 20 kg P_2O_5/ha	163.8	206.6	17.9	22.4	26.4	29.2	13.9	13.9
60 kg N/ha + 40 kg P_2O_5/ha	169.0	213.9	19.2	24.8	27.5	30.3	14.5	16.5
5 t FYM/ha + bio-fertilizer*	168.5	194.8	17.0	20.8	24.4	27.7	12.5	14.7
10 t FYM/ha + bio-fertilizer	160.5	200.1	17.7	21.9	24.9	27.8	12.6	15.0
30 kg N/ha + 20 kg P_2O_5/ha + 5 t FYM/ha + bio-fertilizer	167.8	209.6	19.3	23.7	27.0	29.9	14.4	16.5
30 kg N/ha + 20 kg P_2O_5/ha + 10 t FYM/ha + bio-fertilizer	169.2	215.7	19.4	24.7	27.8	30.5	14.8	16.8
60 kg N/ha + 40 kg P_2O_5/ha + 5 t FYM/ha + bio-fertilizer	170.2	216.8	19.5	25.0	28.5	30.8	15.3	17.2
60 kg N/ha + 40 kg P_2O_5/ha + 10 t FYM/ha + bio-fertilizer	170.4	217.0	19.5	25.2	28.7	31.0	15.5	17.4
CD (P=0.05)	8.9	13.8	1.7	2.8	2.5	2.2	1.8	1.7

*Bio-fertilizer = *Azotobacter* + vesicular arbuscular mycorrhizae (VAM)

Table 2. Effect of integrated nutrient-management treatments on grain and stover yields and N and P uptake by grain of pearl millet and net returns in terms of pearl millet-grain equivalent

Nutrient-management practice	Grain yield (q/ha)			Stover yield (q/ha)			N uptake (kg/ha)		P uptake (kg/ha)		Net returns (Rs/ha)	
	2002	2003	Pooled	2002	2003	Pooled	2002	2003	2002	2003	2002	2003
Control	18.1	20.2	19.2	65.3	72.3	68.8	29.2	34.1	9.2	10.7	21,855	27,081
30 kg N/ha + 20 kg P_2O_5/ha	24.0	27.9	25.9	86.3	102.6	94.4	41.6	52.5	13.3	16.1	26,342	33,231
60 kg N/ha + 40 kg P_2O_5/ha	26.8	30.4	28.6	94.9	108.6	101.8	48.6	58.3	15.3	17.7	27,382	34,512
5 t FYM/ha + bio-fertilizer	21.8	25.6	23.7	79.3	94.8	87.0	37.6	46.1	11.9	14.3	24,353	30,880
10 t FYM/ha + bio-fertilizer	22.2	26.6	24.4	80.8	95.8	88.3	38.8	49.5	12.2	15.0	23,941	30,743
30 kg N/ha + 20 kg P_2O_5/ha + 5 t FYM/ha + bio-fertilizer	25.7	29.8	27.7	91.0	107.4	99.2	46.3	56.3	14.7	17.6	26,235	34,744
30 kg N/ha + 20 kg P_2O_5/ha + 10 t FYM/ha + bio-fertilizer	26.8	30.8	28.8	95.0	111.3	103.1	48.2	59.2	15.5	18.3	27,441	34,574
60 kg N/ha + 40 kg P_2O_5/ha + 5 t FYM/ha + bio-fertilizer	26.9	31.2	29.0	96.6	112.1	104.3	49.4	59.9	15.7	18.5	28,445	35,740
60 kg N/ha + 40 kg P_2O_5/ha + 10 t FYM/ha + bio-fertilizer	27.0	31.3	29.1	97.4	115.0	106.2	49.6	60.4	16.0	18.6	28,371	35,576
CD (P=0.05)	3.6	3.7	3.4	11.2	12.8	11.5	8.2	10.7	2.6	3.3		

Yield, nutrient uptake and net return

Grain and stover yields increased significantly due to various combinations of chemical fertilizer, FYM and bio-fertilizer during both the years of experimentation. 60 kg N/ha + 40 kg P_2O_5/ha + 10 tonnes FYM/ha + bio-fertilizer recorded significantly higher grain yield over. the control, 5 or 10 tonnes FYM/ha + bio-fertilizer (Table 2). The supply of nitrogen is related with carbohydrate utilization. When nitrogen supply is sufficient, fewer carbohydrates are deposited in vegetative parts, and the source-sink relationship becomes proper. The increased grain and stover yields by FYM application with chemical fertilizer might be due to effect of FYM on improvement of physical properties of soil and availability of nutrients to the plants (De and Gautam, 1987). Bhagchand and Gautam (2000) reported that the use of bio-fertilizer (*Azospirillum* + VAM) led to higher availability of N and P that promoted growth and development, and ultimately resulting in higher yield. For stover yield also showed a similar trend as grain yield. The nitrogen uptake varied significantly due to nutrient-management practices. The highest total nitrogen uptake was recorded under 60 kg N/ha + 40 kg P_2O_5/ha + 10 tonnes FYM/ha + bio-fertilizer, that was markedly higher than that of control, 30 kg N/ha + 20 kg P_2O_5/ha + 5 tonnes FYM/ha + bio-fertilizer. Nitrogen and phosphorus uptake significantly increased in all the treatments over the control in both the years (Table 2). It was highest with 60 kg N/ha + 40 kg P_2O_5/ha + 10 tonnes FYM/ha + bio-fertilizer, and lowest with the control. Higher N, P uptake might be due to effective root system and increased concentration of nutrients in the soil solution. Cisse (1988) observed that the application of organic manure in pearl millet increased the uptake of major nutrients (N, P, K, Ca and Mg) than control. The maximum net returns was obtained with 60 kg N/ha + 40 kg P_2O_5/ha + 5 tonnes FYM/ha + bio-fertilizer. This was mainly because of low cost, higher productivity and better market prices. These findings support those of Kumpawat and Rathore (1995).

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