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Effect of moisture conservation and nutrient management practices on growth and yield of pearlmillet (*Pennisetum glaucum*) under rainfed conditions

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ABSTRACT

An experiment was conducted for 2 years (2001 and 2002) at Dryland Research Farm of Indian Agricultural Research Institute, New Delhi, to evaluate the effect of moisture conservation and nutrient management practices on growth and yield of pearlmillet [*Pennisetum glaucum* (L.) R.Br. emend. Stuntz.]. Moisture conservation treatments comprised paired row (PR) + legume as mulch and PR + crop residue mulching (wheat straw @ 5 tonnes/ha) in main plots and nutrient management treatments comprised control, FYM @ 5 tonnes/ha FYM @ 5 tonnes/ha in combination with 30, 60 and 90 kg N/ha, FYM @ 5 tonnes/ha + biofertilizer (*Azospirillum* + PSB) and its combination with 30, 60 and 90 kg N/ha and recommended dose of N (60 kg N/ha) in subplots were laid out in split-plot design with 3 replications. The total rainfall received during the rainy (*kharif*) season 2001 and 2002 was 522 mm and 300 mm respectively. During 2002, monsoon was delayed by 1 month, therefore, pearlmillet seed was sown on 2 August. The yield of pearlmillet increased significantly due to moisture conservation (mulching) and combined application of FYM, biofertilizer and fertilizer N. The grain yield increased with increase in nitrogen levels. Application of FYM and FYM + biofertilizer also resulted significantly higher yield over the conrol. The seed inoculation with biofertilizer (*Azospirillum* + PSB) resulted an increased grain yield over uninoculated treatment.

Key words : Mulching, FYM, Biofertilizer (*Azospirillum* + PSB), Nitrogen, Pearlmillet

Pearlmillet is an indispensable rainfed cereal crop of arid and semi-arid regions. It generally encounters soil moisture deficit during critical growth stages, such as active tillering, flowering and grain development which results in significant reduction in grain yield (Begg and Turner, 1976). The chemical fertilizers are quite expensive, and the small and marginal farmers are unable to use these fertilizers in required quantities in these moisture deficit areas. Therefore, it is important to explore an alternative to chemical fertilizers that can be used by farmers. It is reported that pearlmillet has a variety of nitrogen fixing bacteria in its rhizosphere which may release growth promoting substances like indole acetic acid, gibberellin and cytokinin. These substances help in increasing root biomass. Wani *et al.* (1985) reported increase in grain yield and dry matter of pearlmillet due to inoculation. Verma *et al.* (1988) also recorded a 3–5% increase in yield due to inoculation in pearlmillet. In the light of these observations, an experiment was laid out to know the effect of moisture conservation and nutrient management practices on pearlmillet growth and yield.

MATERIALS AND METHODS

A field experiment was conducted during the rainy season (*kharif*) 2001 and 2002 at Dryland Research Farm of Indian Agricultural Research Institute, New Delhi. Treatments comprising all possible combinations of moisture conservation practices (uniform row, paired row + legume as mulch and paired row + crop residue as mulch) in main plots and nutrient management practices (control, FYM @ 5 tonnes/ha, FYM @ 5 tonnes/ha in combination with 30, 60 and 90 kg N/ha, FYM @ 5 tonnes + biofertilizer (*Azospirillum* + PSB) and its combination with 30, 60 and 90 kg N/ha and recommended dose of nitrogen) in subplots, were alloted in split-plot design with 3 replications. The pearlmillet hybrid 'Pusa 605' was sown in rows 50 cm apart @ 5 kg/ha on 26 June 2001 and 2 August in 2002. Two lines of urdbean (var. 'T 9') was sown 30 cm apart in between paired row and incorporated into upper soil layer at about 40 days after sowing. During same period, crop residue (wheat straw @ 5 tonnes/ha) was spread on soil surface for mulching as per treatment. The recommended dose of phosphorus (30 kg P_2O_5/ha) was applied basally through single superphosphate having 16% P_2O_5. The N doses through urea was applied at the time of sowing, as per treatment. The soil of experimental site was sandy clay loam having neutral pH (7.0), medium organic carbon (0.50%), medium available N (250

Table 1. Growth parameters as affected by moisture conservation and nitrogen management practices of pearlmillet

Treatment	Plant height (cm)		Tillers/m row length		Dry matter/plant (g)		Days of 50% flowering	
	2001	2002	2001	2002	2001	2002	2001	2002
Moisture conservation practice								
Uniform row	198.51	158.29	21.61	16.50	55.53	45.35	46.43	41.60
PR + legume as mulch	211.19	168.80	22.18	18.03	56.50	48.42	47.87	43.50
PR + Crop residue as mulch	210.10	171.78	22.42	18.31	57.22	48.79	48.00	43.23
CD (P=0.05)	7.95	7.78	NS	NS	NS	NS	NS	1.58
Nutrient management practice								
Control	182.59	150.11	16.70	14.33	45.13	39.33	45.80	38.56
FYM @ 5 tonnes/ha	193.15	157.85	18.70	15.60	48.77	42.36	45.67	39.78
FYM @ 5 tonnes/ha + 30 kg N/ha	208.19	164.67	22.00	17.59	55.78	47.83	46.56	42.56
FYM @ 5 tonnes/ha + 60 kg N/ha	215.85	170.78	23.74	18.81	59.68	49.95	48.22	44.56
FYM @ 5 tonnes/ha + 90 kg N/ha	217.22	172.59	25.74	19.07	61.30	50.17	48.67	44.78
FYM @ 5 tonnes/ha + BF	197.41	162.66	20.89	15.89	50.53	44.39	46.33	40.33
FYM @ 5 tonnes/ha + BF + 30 kg N/ha	213.11	169.29	23.59	18.63	60.29	50.09	48.56	44.33
FYM @ 5 tonnes/ha + BF + 60 kg N/ha	217.41	172.15	24.22	19.18	62.44	51.28	48.56	45.44
FYM @ 5 tonnes/ha + BF + 90 kg N/ha	219.74	173.41	25.44	18.26	63.40	51.65	49.67	45.67
Recommended dose (60 kg N/ha)	201.33	169.37	20.04	17.78	56.40	48.15	46.11	41.78
CD (P=0.05)	11.07	10.85	2.75	3.32	3.64	2.41	2.83	2.96

PR, Paired row; BF, biofertilizer (*Azospirillum* + phosphate-solubilizing bacteria)

Table 2. Yield attributes of pearlmillet as affected by moisture conservation and nutrient management practices

Treatment (g)	Ear length (cm)		Ears/m		Grain weight/ear (g)		1,000-grain weight	
	2001	2002	2001	2002	2001	2002	2001	2002
Moisture conservation practice								
Uniform row	28.73	24.19	14.49	13.02	10.95	8.63	6.50	6.32
PR + legume as mulch	30.05	26.21	15.53	14.46	11.97	10.83	6.79	6.61
PR + crop residue as mulch	30.40	26.40	15.97	14.56	12.07	10.98	6.80	6.63
CD (P=0.05)	1.19	1.90	NS	0.68	0.63	0.52	NS	NS
Nutrient management practice								
Control	25.38	22.33	10.93	9.60	9.35	8.73	6.48	6.25
FYM @ 5 tonnes/ha	26.73	23.88	12.85	11.26	10.23	9.08	6.57	6.31
FYM @ 5 tonnes/ha + 30 kg N/ha	29.11	25.73	15.78	14.74	11.93	10.32	6.73	6.58
FYM @ 5 tonnes/ha + 60 kg N/ha	30.98	26.67	16.59	15.22	12.27	10.57	6.77	6.62
FYM @ 5 tonnes/ha + 90 kg N/ha	31.35	27.00	17.30	15.30	12.41	10.63	6.69	6.61
FYM @ 5 tonnes/ha + BF	28.15	24.09	13.63	12.52	10.88	9.87	6.63	6.43
FYM @ 5 tonnes/ha + BF +30 kg N/ha	31.57	26.87	16.85	15.19	12.48	10.54	6.74	6.67
FYM @ 5 tonnes/ha + BF + 60 kg N/ha	32.34	26.91	17.41	15.63	12.73	10.69	6.81	6.59
FYM @ 5 tonnes/ha + BF + 90 kg N/ha	32.22	26.81	17.59	15.67	12.70	10.67	6.80	6.62
Recommended dose (60 kg N/ha)	29.41	25.70	14.37	15.00	11.65	10.35	6.71	6.55
CD (P=0.05)	1.67	2.31	1.94	1.89	1.13	1.05	NS	NS

PR, Paired row; BF, biofertilizer (*Azospirillum* + phosphate-solubilizing bacteria)

kg N/ha), medium phosphorus (24 kg P_2O_5/ha) and fairly high available potassium (265 kg K_2O/ha).

RESULTS AND DISCUSSION

Growth

A significant variation in plant height in both the years and days to 50% flowering in 2002 was recorded due to mulching. The effect of both mulching practices was at par. This could be attributed to the extended period of moisture availability to crop specially during water stress period (Kaushik and Gautam, 1994). The application of FYM + fertilizer N and FYM + BF + fertilizer N brought out a significant variation in all growth components. The combined application of FYM, biofertilizer and chemical fertilizer was significantly superior to all other treatments. Treatment FYM 5 tonnes/ha + BF + 90 kg N/ha was the next best treatment.

Table 3. Yield of pearlmillet as affected by moisture conservation and nutrient management practices

Treatment	Grain yield (q/ha)		Stover yield (q/ha)		Harvest index (%)	
	2001	2002	2001	2002	2001	2002
Moisture conservation practice						
Uniform row	26.67	20.73	90.21	78.51	22.42	20.85
PR + legume as mulch	29.23	24.44	99.21	81.69	22.71	22.94
PR + crop residue as mulch	28.59	24.72	96.66	81.61	22.74	23.19
CD (P=0.05)	0.93	1.19	2.70	NS	NS	0.86
Nutrient management practice						
Control	18.24	14.60	67.83	60.36	21.18	19.46
FYM @ 5 tonnes/ha	22.98	17.45	77.77	65.12	22.80	21.18
FYM @ 5 tonnes/ha + 30 kg N/ha	29.17	24.37	99.37	84.97	22.69	22.34
FYM @ 5 tonnes/ha + 60 kg N/ha	30.92	25.89	104.19	83.15	22.77	23.76
FYM @ 5 tonnes/ha + 90 kg N/ha	31.19	26.05	105.43	87.28	22.82	22.95
FYM @ 5 tonnes/ha + BF	23.22	18.64	80.03	67.93	22.49	21.54
FYM @ 5 tonnes/ha + BF + 30 kg N/ha	30.77	26.95	101.46	86.55	23.27	23.79
FYM @ 5 tonnes/ha + BF + 60 kg N/ha	32.65	27.19	109.86	90.30	22.91	23.49
FYM @ 5 tonnes/ha + BF + 90 kg N/ha	32.77	27.33	110.96	93.53	22.80	22.64
Recommended dose (60 kg N/ha)	27.07	24.52	95.48	86.80	22.51	22.06
CD (P=0.05)	3.31	2.49	12.20	10.73	0.80	1.71

PR, Paired row; BF, biofertilizer (*Azospirillum* + phosphate-solubilizing bacteria)

Yield attributes

Yield attributes such as tillers/m row length, ear length and grain weight/ear improved remarkably due to the moisture-conservation practices (Table 2). Mulching practices were distinctly superior to uniform row system. The highest values of ear length, ears/m and grain weight/ear in 2001 and 2002, respectively, were recorded with PR + crop residue mulching. The improvement could be ascribed to the extended period of available moisture and, hence improved photosynthetic activity (Kaushik and Lal, 1997). The remarkable improvement in ear/length, tillers/m and grain weight/ear due to different combinations of FYM, biofertilizer and fertilizer N was observed in both the years. The highest value for ear length and grain weight/ear in 2001 and 2002, respectively, were recorded with FYM @ 5 tonnes/ha + BF in combination with 60 kg N/ha, whereas number of ears/m during 2001 and 2002, respectively, were obtained with FYM @ 5 tonnes/ha + BF + 90 kg N/ha. These findings revealed that the use of fertilizer N alone or in combination with FYM and biofertilizer could be able to improve all yield attributes over control. Gautam and Kaushik (1982). also reported improvement in yield attributes due to FYM, biofertilizer and N levels.

Yield

Grain yield in 2 years of experimentation showed a significant variation due to moisture conservation treatments. Stover yield in 2001 only showed significant variation. In both the mulching practices were found at par. The highest grain yield was obtained with PR + crop residue mulching. The extended period of moisture availbility due to mulching resulted in higher dry matter accumulation and hence yield (Kaushik and Lal 1997).

Grain and stover yields increased significantly with various combinations of FYM, biofertilizer and chemical fertilizer. The treatments of FYM, biofertilizer and different levels of fertilizer N recorded almost identical yield. However, the maximum grain yield was recorded with higher dose of fertilizer N in combination with FYM and biofertiizer. The combination of FYM and biofertilizer was found significant superior to FYM alone. De and Gautam (1987), Sharma *et al.* (1999) and Bhagchand and Gautam (2000) also reported similar results.

The harvest index was also influenced significantly due to nutrient management practices. The highest value of harvest index was recorded with FYM @ 5 tones/ha + BF + 30 kg N/ha). However, significant influence of moisture conservation practices was recorded only in 2002. The higher value of harvest index could be attributed to relatively higher grain yield under these treatments.

On the basis of the results obtained from the experiment, it can be concluded that moisture conservation practices such as legume incorporation and crop residue mulching proved most effective in increasing growth and yield of pearlmillet. Use of combination of FYM, biofertilizer and inorganic fertilizer proved better compared to inorganic fertilizer alone in increasing growth and yield of pearlmillet.

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