

Grain yield, water use and water-use efficiency of pearl millet (*Pennisetum glaucum*) hybrids under variable nitrogen application

MANOJ KUMAR, HARBIR SINGH, R.S. HOODA, ANIL KHIPPAL AND T. SINGH

Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar 125 004

Received : July 2002

ABSTRACT

A field experiment was conducted during the rainy (*kharif*) season of 2000 and 2001 on sandy-loam soil at Hisar, to study the response of pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz] hybrids to nitrogen levels. Pearl millet 'HHB 94' showed significantly higher grain yield (30.74 q/ha), higher seasonal water use (273.5 mm) and water-use efficiency (11.30 kg/ha-mm) than rest of the hybrids. Application of 120 kg N/ha, being at par with 150 kg N/ha, resulted in higher grain yield, water use and water-use efficiency than rest of the nitrogen levels. The economic optimum dose of N for 'HHB 94', 'HHB 67', 'HHB 60', 'HHB 117' and 'HHB 146' was 101.5, 105.8, 91.1, 82.3 and 142.5 kg/ha respectively.

Key words : Economic optimum dose, Nitrogen, Pearl millet hybrids, Water use, Water-use efficiency

Pearl millet is a staple foodgrain crop of the arid and semi-arid regions of India. Its productivity is low because of lack of high-yielding cultivars and insufficient supply or sub-optimal use of nutrients in general and nitrogen in particular. Nitrogen fertilization increases the yield of high-yielding, short duration pearl millet hybrids or cultivars (Tomar *et al.*, 1995). Information on response of newly evolved or released high-yielding, short-duration hybrids under irrigated conditions is meagre. Hence present experiment was conducted to study the response of irrigated pearl millet hybrids to nitrogen.

MATERIALS AND METHODS

The field experiment was conducted during the rainy (*kharif*) seasons of 2000 and 2001 at the Crop Research Farm, Chaudhary Charan Singh Haryana Agricultural University, Hisar. The soil, a sandy loam, consisted of 64.75% sand, 16.88% silt and 18.87% clay in 0–90 cm soil profile. It contained soil moisture 19.4% at – 0.03 MPa and 7.8% at – 1.5 MPa on gravimetric basis with bulk density 1.42 to 1.45 g/cc. The soil contained 181.0 kg available N, 11.8 kg available P and 385.0 kg K/ha and had slightly alkaline reaction (pH 7.94). Total rainfall of 88.9 mm, spread over 12 rainy days, was received during crop season of 2000. The corresponding values for total rainfall and rainy days for crop season 2001 were 95.1 mm and 15 days respectively. The experiment was laid out in split-plot design in 3 replications with 4 hybrids ('HHB 94', 'HHB 67', 'HHB 60' and 'HHB 117' during

2000, and 'HHB 94', 'HHB 67', 'HHB 60' and 'HHB 146' during 2001) in main plots and 6 nitrogen levels (0, 30, 60, 90, 120 and 150 kg N/ha) in subplots. The pearl millet crop was sown on 22 June 2000 and 4 July 2001 by drilling seed in rows 45 cm apart. Half of the nitrogen as per treatment was applied at the time of sowing and remaining half was top-dressed 20 days after sowing (DAS). The crop was harvested on 18 and 28 September in 2000 and 2001 respectively. The water-use efficiency was worked out as grain yield (kg/ha) ÷ seasonal water use (water added + effective rainfall + Δ soil water).

RESULTS AND DISCUSSION

Grain yield and its components

Pearl millet hybrid 'HHB 94' gave significantly higher grain yield than rest of the hybrids, being 15.06, 3.75 and 2.21% higher than 'HHB 67', 'HHB 60' and 'HHB 117' in 2000, and 10.63, 9.13 and 0.17% higher than 'HHB 67', 'HHB 60' and 'HHB 146' in 2001 (Table 1). Significantly more ear length and higher grain yield/plant remained with hybrid. The 'HHB 94' and this could be attributed higher grain yields recorded with this hybrid. These results corroborate the findings of Verma (1993).

Highest grain yield was recorded with 150 kg N/ha which, however, did not differ significantly from grain yield with 120 kg N/ha. The mean of 2 years data revealed that grain yield of pearl millet was 29.15, 46.96, 62.40, 81.32 and 82.94% higher with 30, 60, 90, 120 and 150 kg

N/ha, respectively, than no-nitrogen (control). The response of pearl millet to applied nitrogen might be ascribed to the favourable effect of N application on plant growth and yield-attributing characters (Table 2). Lal and Hooda (1993) also reported higher grain yield of pearl millet at higher levels of nitrogen application.

Seasonal water use and water-use efficiency

The seasonal water use of pearl millet was higher during the second year than during the first year due to wet season. Pearl millet hybrids 'HHB 94' and 'HHB 117' or 'HHB 146' recorded relatively higher values for seasonal water use (260 or 287 mm and 255 or 286 mm

Table 1. Grain yield (q/ha) and response of pearl millet hybrids to levels of nitrogen application

Treatment	Grain yield (q/ha)			Equation	R ²	Economic optimum dose (kg N/ha)
	2000	2001	Mean			
<i>Hybrid</i>						
'HHB 94'	31.85	29.64	30.75	$Y = 20.33 + 0.202x - 0.000574x^2$	0.8684	101.5
'HHB 67'	27.68	26.79	27.23	$Y = 18.53 + 0.149x - 0.000301x^2$	0.9481	105.8
'HHB 60'	30.70	27.16	28.93	$Y = 19.62 + 0.183x - 0.000535x^2$	0.8952	91.1
'HHB 117'	31.16		31.16	$Y = 20.92 + 0.242x - 0.000963x^2$	0.8281	82.3
'HHB 146'		29.59	29.59	$Y = 18.98 + 0.177x - 0.000321x^2$	0.8842	142.5
SEm ±	0.98	0.82		Mean $Y = 19.60 + 0.186x - 0.000515x^2$	0.8915	97.6
CD (P=0.05)	3.38	2.80				
<i>Nitrogen (kg/ha)</i>						
0	20.28	18.69	19.48			
30	26.56	23.77	25.16			
60	30.84	26.43	28.63			
90	33.17	30.12	31.64			
120	35.83	35.33	35.33			
150	35.86	35.43	35.64			
SEm ±	1.89	1.76				
CD (P=0.05)	5.40	5.04				

Table 2. Effect of hybrids and nitrogen levels on grain yield components, seasonal water use and water-use efficiency of pearl millet

Treatment	Ears/plant		Ear length (cm)		1,000-grain weight (g)		Grain yield/plant (g)		Seasonal water use (mm)		Water-use efficiency (kg/ha-mm)	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
<i>Hybrid</i>												
'HHB 94'	1.9	1.9	24.4	23.9	6.9	7.1	18.70	15.85	260	287	12.26	10.33
'HHB 67'	1.7	1.8	22.3	21.6	9.1	7.8	15.70	14.42	245	279	11.30	9.60
'HHB 60'	1.8	1.8	23.1	22.1	6.8	7.3	17.10	15.63	259	282	11.85	9.63
'HHB 117' or 'HHB 146'	1.8	1.9	23.3	22.6	6.6	7.0	17.80	15.73	255	286	12.22	10.34
SEm ±	0.05	0.06	0.28	0.26	0.06	0.22	0.25	0.23				
CD (P=0.05)	NS	NS	0.97	0.90	0.20	NS	0.86	0.77				
<i>Nitrogen (kg/ha)</i>												
0	1.6	1.7	20.8	20.3	7.1	6.8	11.80	10.85	220	240	9.22	7.79
30	1.7	1.8	21.6	21.2	7.1	7.3	15.50	14.18	245	270	10.84	8.80
60	1.8	1.9	22.9	22.4	7.2	7.5	17.70	16.00	255	284	12.10	9.30
90	1.8	1.9	23.6	23.3	7.4	7.7	18.60	16.73	265	298	12.52	10.10
120	1.9	1.9	24.6	23.9	7.6	7.8	19.50	17.20	272	306	12.99	11.53
150	2.0	2.0	25.2	24.3	7.7	7.9	20.00	17.50	275	307	13.05	11.54
SEm ±	0.06	0.06	0.34	0.32	0.07	0.12	0.18	0.15				
CD (P=0.05)	0.17	0.14	0.99	0.91	0.91	0.33	0.53	0.42				

respectively) than 'HHB 67' (245 or 279 mm) and 'HHB 60' (259 or 282 mm). The variation in the seasonal consumptive water was probably due to slightly longer duration and relatively greener foliage of the former hybrids up to harvest. An increase in the level of N was probably due to better crop growth and root ramification for utilization of moisture from different soil layers. Tomar *et al.* (1995) also reported similar findings.

Water-use efficiency (kg grain yield/ha-mm water use) was higher with 'HHB 94' and 'HHB 117' than 'HHB 67' and 'HHB 60' (Table 2). Verma (1993) also reported variations in the values of seasonal consumptive water use and water-use efficiency of pearl millet hybrids. Increasing levels of N application markedly improved the water-use efficiency. This might be attributed to relatively higher increase in grain yield than seasonal water use resulting from nitrogen application. These results corroborate the findings of Tomar *et al.* (1995).

Response to nitrogen

Response of various pearl millet hybrids, viz. 'HHB 94', 'HHB 67', 'HHB 60' (mean of 2000–2001 and 2001–2002, 'HHB 117' (2000–2001 only) and 'HHB 146'

(2001–2002 only), to varying levels of N application was quadratic (Table 1). The economic optimum dose of nitrogen for 'HHB 94', 'HHB 67', 'HHB 60', 'HHB 117' and 'HHB 146' was found to be 101.5, 105.8, 91.1, 82.3 and 142.5 kg N/ha respectively. The mean optimum dose (averaged over hybrids) for irrigated pearl millet was computed to be 97.6 kg N/ha (Table 1).

Based on the findings of 2-year study, it may be concluded that hybrid 'HHB 94' be grown and fertilized with 101.5 kg N/ha, so as to achieve higher grain yield under the agro-climatic conditions of Hisar (Haryana).

REFERENCES

- Lal, R. and Hooda, I.S. 1993. Effect of different sources and levels of N on yield and yield attributes of pearl millet in pearl millet-wheat cropping system. *Farming Systems* 9 (3, 4) : 111–114.
- Tomar, S.S., Sharma, R.K., Yadav, N.S., Verma, O.P. and Kushwaha, P.S. 1995. Response of pearl millet to irrigation and nitrogen under Chambal Command area of Madhya Pradesh. *Agriculture Science Digest* 15 (3) : 132–134.
- Verma, O.P.S. 1993. Response of pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz] hybrids to irrigation applied at different physiological stages of crop growth. *Indian Journal of Agronomy* 38 (2) : 214–217.