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Performance of grain sorghum (*Sorghum bicolor*) genotypes under rainfed conditions at varying fertility levels

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ABSTRACT

A field experiment was carried out during rainy season of 1992–93 at Livestock Research Centre, Pantnagar, to study the performance of grain sorghum [*Sorghum bicolor* (L.) Moench] genotypes under rainfed conditions at varying fertility levels. At harvest, all growth and yield parameters, grain and stover yields, net returns and benefit : cost ratio improved significantly with increased level of N and P, except 1,000-seed weight during both the years. N_{100} P_{50} (N @ 100 kg/ha + P @' 50 kg/ha) gave the highest values of all characters and also recorded an average of 32.4, 14.5, 22.3, 41.8, 32.6, 39.0 and 10.5% higher panicle weight/plant, grains/panicle, grain weight/plant, grain yield, stover yield, net returns/ha and benefit : cost ratio respectively compared with N_{20} P_{10}. Hybrid 'PJH 58' out-yielded all other genotypes. 'PJH 58' and 'PJH 55' could be used for maximum grain and stover yields with the application of 80–100 N/ha and 40–45 kg P_2O_5/ha.

Sorghum [*Sorghum bicolor* (L.) Moench] is a premier crop of the semi-arid tropics and a major staple food in several parts of the world. Since the possibility of increasing land under sorghum crop is quite limited, the high-yielding varieties including hybrids and fertilizers are the answer to increase the sorghum productivity for sustained production. In general, crops require minimum fertilizers in rainfed areas and also it has been established that the use of nitrogen and phosphorus in combination has more positive effect on yield than the use of either of these nutrients singly for crop production. Hence the present investigation was initiated to study the performance of different sorghum genotypes under rainfed conditions at varying fertility levels.

MATERIALS AND METHODS

The experiment was conducted at the Livestock Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, on light silty clay-loam having pH 6.7 during the rainy season of 1992–93. The soil was rich in organic matter (1.05%), medium in available phosphorus (60.43 kg P_2O_5/ha) and high in available potassium (423.23 kg K_2O/ha).

The experiment was laid out in split-plot design having 5 fertility levels (N, P), F_1, N_{20} P_{10}; F_2, N_{40} P_{20}; F_3, N_{60} P_{30}; F_4, N_{80} P_{40}; and F_5, N_{100} P_{50} as main-plot treatments and 5 sorghum genotypes 'PJH 58', 'PJH 55', 'CSH 11', 'CSV 13' and 'SPV 1025' as sub-plot treatments with 25 treatment combinations replicated thrice. 'PJH 58', 'PJH 55'

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Table 1. Plant height, total dry weight/plant, days taken to maturity, panicle weight, number of grains/panicle and 1,000-seed weight of sorghum genotypes as influenced by N and P fertilization

Treatment	Plant height/ plant (cm)		Total dry weight/plant (g)		Days taken to maturity		Panicle weight/ plant (g)		Grains/ panicle		1,000-grain weight (g)	
	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
Fertility (kg/ha)												
N_{20} P_{10}	196.3	198.9	85.0	85.7	110.3	110.6	41.9	43.5	1,257	1,286	28.84	29.96
N_{40} P_{20}	200.5	201.5	89.7	91.5	111.9	112.6	48.3	48.2	1,378	1,400	28.84	29.88
N_{60} P_{30}	205.1	207.9	94.4	95.9	112.5	113.6	49.8	50.6	1,409	1,454	28.19	29.24
N_{80} P_{40}	210.7	218.3	99.9	103.2	115.3	114.4	53.3	54.4	1,420	1,473	27.95	28.76
N_{100} P_{50}	216.4	218.4	104.5	112.1	118.9	116.7	55.5	57.5	1,420	1,440	27.64	28.53
CD (P = 0.05)	12.5	14.0	5.9	8.0	2.8	3.1	4.2	5.0	85.4	110.4	NS	NS
Genotype												
'PJH 58'	197.3	198.8	96.8	100.3	111.8	111.3	54.1	55.1	1,435	1,487	30.01	31.88
'PJH 55'	199.3	201.6	96.8	99.7	111.9	112.5	52.9	54.6	1,426	1,470	29.41	30.50
'CSH 11'	205.2	208.4	94.9	99.1	112.4	113.1	50.7	51.8	1,379	1,427	28.12	28.96
'CSV 13'	211.8	213.7	93.0	94.7	113.3	116.0	45.5	47.8	1,348	1,384	27.35	28.05
'SPV 1025'	215.3	222.6	92.6	94.6	114.5	115.0	44.5	45.5	1,296	1,334	26.54	26.99
CD (P = 0.05)	8.0	12.1	NS	NS	NS	NS	4.1	3.6	56.8	59.7	2.01	2.37

and 'CSH 11' are hybrids and 'CSV 13' and 'SPV 1025' are composite sorghum variety. 'CSH 11' was used as a check cultivar during both the years. The seed was sown on 3 July 1992 and 7 July 1993 by opening shallow furrows with the help of manually-operated plant junior-furrow opner at the distance of 45 cm with recommended seed rates, i.e. 12 kg/ha. Thinning was done 15 days after sowing (DAS) to keep intra-row spacing of 12 cm in both the years. Urea and single superphosphate were used as the source of nitrogen and phosphorus respectively. Half of the nitrogen and full dose of phosphorus was applied at the time of sowing as basal dressing. One-fourth of the total nitrogen as per treatment was applied 1 month after sowing and remaining one-fourth 20 days after the second application of nitrogen by top-dressing. The plant protection was adopted as the crop required. The growth parameters, yield attributes and grain yield were recorded at harvest and harvest index, net returns and benefit : cost ratio were worked out on different treatments.

RESULTS AND DISCUSSION

Grain and stover yields, yield attributes and growth parameters

Effect of NP fertilization : The grain and stover yields increased significantly with increasing NP fertilization in both the years (Table 2). N_{100} P_{50} gave the highest grain and stover yields followed by N_{80} P_{40} for grain and stover yields in both the years. Panwar *et al.* (1987) and Patil *et al.* (1978) also supported the above facts. The higher yield of grain and stover at higher fertility levels was due to higher yield attributes and growth parameters. N_{100} P_{50} recorded an average of 10.2, 26.9, 30.4, 14.5 and 22.3% higher plant height, total dry-matter accumulation and panicle weight/plant, grains/panicle and grain yield/plant respectively over N_{20} P_{10}. Rajput *et al.* (1983) also reported that NPK fertilization affected the growth and yield parameters significantly and increase in plant height due to NP fertilization may be due to increase in cell-division. The 1,000-seed weight remained non-significant due to NP fertilization in both the years (Levitt, 1969).

Effect of genotypes : Amongst the genotypes, 'PJH 58' outyielded all other genotypes and it was significantly on a par with 'PJH 55' in both the years and with 'CSH 11' in 1993 only. The sotver yield also showed the simlar trend as that of grain yield in both the years. In general, higher grain and stover yields were recorded in hybrids than varieties during both the years. The hybrids showed higher growth and yield characters than varieties owing to their hybrid vigour and genetic make-up. Cripps and Matocha (1987) also reported similar findings. 'CSV 13' and 'SPV 1025' did not differ significantly to each other for grain and stover yields and gave the lower values than hybrids due to poor growth and yield-contributing characters during both the years.

Maturity period

The maturity period was also affected significantly by NP fertilization during both the years (Table 1). N_{100} P_{50} took the maximum days to mature the crop and it was significantly at par with N_{80} P_{40} and N_{60} P_{30} in both the years. The delay in maturity with higher NP fertilization is due to delay in senescence by nitrogen as reported by Richmond and Lang (1957). The maturity period did not differ significantly due to different genotypes; however, in general, the hybrids matured earlier than varieties during both the years (Table 1). This fact was also supported the report of AICSIP (1992).

Table 2. Grain weight/plant, seed yield, stover yield, harvest index, gross returns, net returns and benefit : cost ratio of sorghum genotypes as influenced by N P fertilization

Treatment	Grain weight/plant (g)		Seed yield (q/ha)		Stover yield (q/ha)		Harvest index (%)		Gross return (Rs/ha)		Net returns (Rs/ha)		Benefit : cost ratio	
	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
Fertility (kg/ha)														
N_{20} P_{10}	33.73	34.58	27.46	28.55	72.33	73.26	27.4	28.0	15,148	15,913	11,063	11,514	2.64	2.62
N_{40} P_{20}	35.93	37.86	28.82	30.18	77.73	79.67	26.8	27.4	15,689	16,394	11,352	12,087	2.66	2.63
N_{60} P_{30}	38.06	40.53	33.25	32.50	80.46	82.06	29.3	29.8	17,089	18,763	13,142	13,854	2.88	2.86
N_{80} P_{40}	39.53	42.53	35.96	30.14	87.40	89.80	29.1	29.5	19,194	20,307	14,295	15,169	2.94	2.93
N_{100} P_{50}	40.00	43.53	38.56	40.91	95.20	97.86	26.3	29.3	20,469	21,625	15,235	16,144	2.45	2.94
CD (P = 0.05)	3.98	4.08	2.45	4.42	6.44	6.53	NS	NS	749	1,114	852	928	0.18	0.19
Genotype														
'PJH 58'	40.33	42.66	37.47	37.65	87.14	88.87	30.7	29.7	19,396	19,759	14,773	15,508	3.20	3.17
'PJH 55'	38.93	41.20	35.59	37.46	85.60	87.40	29.3	30.1	18,643	19,867	14,059	14,793	3.08	2.96
'CSH 11'	39.20	41.53	33.85	35.26	81.40	83.40	29.2	29.7	17,907	19,057	13,297	13,921	2.88	2.87
'CSV 13'	35.13	37.58	29.19	30.06	80.00	81.80	26.5	26.0	16,313	17,517	11,694	12,348	2.53	2.53
'SVP 1025'	33.67	36.09	27.96	29.86	79.00	81.20	26.1	26.8	15,900	16,808	12,280	12,051	2.44	2.47
CD (P = 0.05)	3.38	3.35	3.19	4.44	5.15	5.35	2.6	2.5	1,104	1,102	1,166	1,123	0.23	0.08

Harvest index

The harvest index did not differ significantly amongst fertility levels in both years, as NP fertilization, the grain yield did not increase proportionately to stover yield with increasing fertilization. The increase in stover yield was higher than grain yield. Similar results were reported by Lal (1991). The genotypes affected harvest index significantly in both years (Table 2). The highest harvest index of 30.7 in 1992 and 29.7% in 1993 was obtained in 'PJH 58', which was significantly at par with 'PJH 55' and 'CSH 11' in both years. Varieties yielded poor harvest index. Lal (1991) reported higher harvest index in hybrids than varieties.

Economics

Net returns and benefit : cost ratio were affected significantly by NP fertilization as well by sorghum genotypes during both the years (Table 2). N_{100} P_{50} gave the highest and an average of 39.0 and 10.5% higher net returns and benefit : cost ratio respectively, than N_{20} P_{10} and it was also at par with N_{80} P_{40} and N_{60} P_{30} for both values during the experimental years. Amongst the genotypes, the highest net returns and benefit : cost ratio were recorded in 'PJH 58' which was significantly at par with 'PJH 55', whereas the varieties, i.e. 'CSV 13' and 'SPV 1025', gave statistically similar net returns and benefit : cost ratio, during both the years. The higher net returns and benefit : cost ratio were the result of higher grain and stover yields, recorded in the respective treatment in both the years.

Therefore 'PJH 58' and 'PJH 55' could be grown for higher grain and stover yields with the application of 80–100 kg N/ha and 40–50 kg P/ha in the rainfed conditions of *tarai* belt of Uttar Pradesh.

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