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Response of promising rainy-season sorghum (*Sorghum bicolor*) genotypes to nitrogen and phosphorus fertilization

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ABSTRACT

A field investigation was conducted at Pantnagar, Uttaranchal during the rainy (*kharif*) seasons of 1998 and 1999, to study the pattern of growth and nutrient uptake by sorghum [*Sorghum bicolor* (L.) Moench] genotypes to varying fertility levels. Genotype 'SPH 960' proved superior in producing higher number of green leaves/plant, leaf-area index and dry-matter accumulation than other genotypes. In 'SPH 960', increase in panicle, length, panicle diameter, panicle weight and grains/panicle resulted in significant increase of grain yield than rest of the genotypes. This genotype also removed more phosphorus and nitrogen from the soil. However, genotype 'SPH 792' recorded maximum stover yield, fresh fodder yield and potassium uptake. The net return and benefit : cost ratio were also highest in 'SPH 960'. Application of 80 kg N + 40 kg P_2O_5/ha not only increased the growth and yield attributes but also increased the grain yield, stover yield, harvest index, fresh fodder yield, uptake of N, P and K significantly which resulted in higher net return and benefit : cost ratio.

Key words : Fertility levels, Growth, Sorghum genotype, Uptake, Yield

Sorghum is a premier crop of semi arid tropics and a major staple food in several parts of world. Since the possibility of increasing land under sorghum crop is limited in India, high-yielding cultivars 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 fact 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 present investigation was initiated to study the response of rainy-season sorghum of nitrogen and phosphorus under rainfed condition.

MATERIALS AND METHODS

A field investigation was conducted at the Livestock Research Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, during rainy (*kharif*) seasons of 1998 and 1999. The soil was silty clay loam, with pH 6.9 and 7.0, organic carbon 1.007 and 1.001%, available nitrogen 216.3 and 212.3 kg/ha, available phosphorus 21.8 and 20.4 kg/ha and available potassium 269.7 and 266.0 kg/ha during 1998 and 1999 respectively.

The experiment was laid out in split-plot design with 15 sorghum genotypes ('CSV 15', 'CSH 9', 'CHS 14', 'SPV 1022', 'SPV 1328', 'SPV 1333', 'SPH 660', 'SPH 792', 'SPH 815', 'SPH 840', 'SPH 960', 'SPH 966', 'SPH 975', 'SPH 976' and 'SPH 1002') as main plant treatments and 2 fertility levels, i.e. 40 kg N + 20 kg P_2O_5/ha and 80 kg N + 40 kg P_2O_5/ha as sub-plot treatments with 3 replications. The seed was sown on 23 June 1998 and 24 June 1999 by opening shallow furrows with the help of manually operated plant junior-furrow opener at the distance of 45 cm with recommended seed rate, i.e. 10 kg/ha. Thining was done at 15 days after sowing to keep intra-row spacing of 12 cm in both the years. Urea and diammonium phosphate were used as the source of nitrogen and phosphorus. Half dose of N and full dose of P was applied as a mixture, a day before sowing, as basal dressing. One-fourth of the total N as per treatment, was applied about 1 month after sowing and the remaining one-fourth after 20 days after the first top-dressing of nitrogen.

RESULTS AND DISCUSSION

Genotypes

On the basis of pooled data, 'SPH 960' (46.5 q/ha) significantly out yielded all the other genotypes. This may be

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attributed its better growth and higher yield attributes (Table 1) mainly green leaves/plant, leaf-area index, panicle length, panicle diameter, panicle weight and grains/panicle compared to the other genotypes (Table 1). These results are in accordance with the finding of Chouhan and Dighe (1999).

However, contrarily to grain yield, the stover and fresh fodder yields were significantly higher in genotype 'SPH 792' (Table 2) than all other genotypes except 'SPV 1022' 'SPH 960' and 'SPV 1328' which were at par (Table 2). This might be owing to more plant height and dry-matter accumulation in whole plant and low partitioning ability of genotype 'SPH 792'. Similar findings have reported by Pal *et al.* (1995).

Genotype 'SPH 792' required significantly minimum number of days to mature (96 days) than the other genotypes (Table 1), may be due to its faster growth and development. Similar to grain, stover and fresh fodder yields, harvest index also differed significantly among the genotypes (Table 2). Significantly highest harvest index (31.7%) was recorded in 'SPH 960' than all the other genotypes, but it was on a par with that of 'SPH 975', 'SPH 976' and 'SPH 660'. The higher value of harvest index in 'SPH 960' may be owing to its better source to sink supply than in the other genotypes.

The uptake of nitrogen, phosphorus and potassium by crop differed significantly among the various genotypes (Table 2). The uptake of nitrogen and phosphorus was significantly more in 'SPH 960' followed by genotype 'SPH 792' but the uptake of potassium was significantly higher in 'SPH 792' than rest of the genotypes. 'SPV 1333' recorded significantly lowest nitrogen, phosphorus and potassium uptake. This might be due to the higher grain production by 'SPH 960' more stover yield by 'SPH 792' and lowest biomass production by 'SPV 1333'.

Significantly highest net returns and benefit : cost ratio were recorded in 'SPH 960' (Table 2). The higher net return and benefit : cost ratio were the resultant of higher economic yield recorded in respective genotype and hence all economic constituents vary among different genotypes.

Fertility levels

Different levels of fertility, in general, influenced the grain, stover and fresh fodder yield significantly (Table 2). The higher fertility level improved the grain, stover and fresh fodder yield by 14.1, 9.5 and 13.3% over lower fertility level respectively. Combined application of 80 kg N+ 40 kg P_2O_5/ha fertilizer realized 6.4, 13.0, 10.0, 11.0 and 10.3% more plant height, leaf-area index, total dry-matter accumulation, panicle weight and grains/panicle, respectively, over 40 kg N + 20 kg P_2O_5/ha, which inturns had direct bearing on the grain, stover and fresh fodder yield

Table 1. Growth and yield components of sorghum as affected by genotypes and fertility levels (pooled over 2 years)

Treatment	Plant height (cm)	Green leaves/ plant	Leaf-area index	Dry-matter accumulation in whole plant (g)	Maturity period (days)	Panicle length (cm)	Panicle diameter (cm)	Panicle weight (g)	Grains/ panicle
Genotype									
'CSV 15'	234	9.5	5.1	87.1	113	24	8.2	38.4	1,218
'CSH 9'	194	9.5	5.4	75.9	105	26	9.0	36.8	1,236
'CSH 14'	177	10.8	6.1	87.4	109	26	9.3	41.1	1,288
'SPV 1022'	237	10.3	5.8	88.8	116	23	8.6	40.0	1,209
'SPV 1328'	233	9.2	5.0	83.0	116	19	7.7	36.9	1,097
'SPV 1333'	172	8.8	4.7	65.6	113	18	7.6	32.9	1,197
'SPH 660'	182	11.5	6.3	88.8	108	27	9.3	42.3	1,385
'SPH 792'	243	10.1	5.7	95.1	96	23	9.1	37.8	1,066
'SPH 815'	175	11.6	6.3	92.6	104	24	9.1	42.4	1,215
'SPH 840'	212	11.2	6.2	88.5	113	24	8.9	42.5	1,382
'SPH 960'	218	11.6	6.4	94.6	107	27	9.7	47.0	1,494
'SPH 966'	206	9.1	5.0	75.5	106	21	7.9	34.3	1,114
'SPH 975'	176	10.5	6.1	82.0	105	24	8.6	42.0	1,399
'SPH 976'	200	11.3	6.2	90.1	112	24	9.2	44.5	1,393
'SPH 1002'	219	9.1	4.8	79.8	106	25	7.7	34.5	1,157
CD (P=0.05)	17	1.0	0.5	6.3	6	2	0.8	3.3	122
Fertility level (kg/ha)									
40 N + 20 P_2O_5	199	10.0	5.3	80.9	106	23	8.5	37.6	1,195
80 N + 40 P_2O_5	212	10.6	6.0	89.0	111	24	8.8	41.8	1,318
CD (P=0.05)	7	0.3	0.2	1.5	2	NS	NS	1.1	57

NS, Non-significant

Table 2. Grain and stover yield, harvest index, fresh fodder yield, uptake of nitrogen phosphorus and potassium, net return and benefit : cost ratio of sorghum genotypes as influenced by fertility levels (pooled over 2 years)

Treatment	Grain yield (q/ha)	Stover yield (q/ha)	Harvest index (%)	Fresh fodder yield (q/ha)	Nitrogen uptake (kg/ha)	Phosphorus uptake (kg/ha)	Potassium uptake (kg/ha)	Net return (Rs/ha)	Benefit : cost ratio
Genotype									
'CSV 15'	32.9	104.1	24.0	300.6	120.8	32.6	144.8	8936	1.25
'CSH 9'	34.3	82.7	29.2	261.0	108.6	28.6	118.5	8928	1.24
'CSH 14'	39.8	96.5	29.2	288.6	124.6	33.1	137.7	11,511	1.61
'SPV 1022'	37.5	105.0	26.2	331.0	129.0	34.9	148.3	10,820	1.51
'SPV 1328'	31.6	101.6	23.7	323.7	117.5	31.4	141.4	8,353	1.16
'SPV 1333'	27.3	71.3	27.7	216.7	87.4	23.4	100.4	5,821	0.81
'SPH 660'	41.8	95.7	30.3	265.1	124.3	30.8	138.1	12,268	1.71
'SPH 792'	35.2	124.3	22.0	351.0	137.7	36.5	170.0	10,410	1.45
'SPH 815'	40.9	100.2	28.9	300.5	125.8	34.1	143.2	12,055	1.68
'SPH 840'	40.6	96.2	29.6	302.7	126.2	33.9	138.3	11,818	1.65
'SPH 960'	46.5	99.9	31.7	328.0	140.6	37.3	146.5	14,277	2.00
'SPH 966'	31.6	85.7	26.9	269.4	105.3	28.1	120.5	7,909	1.10
'SPH 975'	38.8	85.0	31.3	256.0	113.8	30.5	123.3	10,770	1.50
'SPH 976'	42.2	95.7	30.5	288.3	130.1	34.1	138.8	12,363	1.72
'SPH 1002'	31.5	90.0	25.9	267.5	108.6	28.9	126.4	8,017	1.12
CD (P=0.05)	3.2	6.9	1.7	29.1	8.5	1.6	7.6	1,389	0.19
Fertility level (kg/ha)									
40 N + 20 P_2O_5	34.4	91.3	27.4	271.9	112.3	29.6	126.1	9,520	1.39
80 N + 40 P_2O_5	39.3	99.9	28.2	308.1	127.8	34.6	145.4	11,048	1.48
CD (P=0.05)	1.2	2.8	0.6	9.0	3.4	0.6	3.4	5,47	0.07

NS, Non significant

by way of influencing the vegetative growth and general vigour of the plants (Table 1). The improvement in vegetative and reproductive growth can be ascribed to the beneficial effects of nitrogen and phosphorus on plant height, dry-matter accumulation and leaf-area index. The results are in conformity with there of Niranjan and Arya (1992), Pal *et al.* (1996) and Khatik *et al.* (1999).

Higher fertility level (80 kg N + 40 kg P_2O_5/ha) enhanced the maturation period of sorghum for on an average 4 days (Table 1) than when fertilized under lower fertility level (40 kg N + 20 kg P_2O_5/ha), and the delay in maturation period might be mainly attributed to delay in senescence caused due to nitrogen application. At higher fertility level, harvest index was more than at lower fertility level (Table 2). This may be due to efficient translocation of photosynthates from source, i.e. leaf and stem to sink, i.e. panicle and grains at higher fertility level compared to lower fertility level. These results confirm the findings of Chouhan and Dighe (1999).

Significantly more uptake of nitrogen, phosphorus and potassium by different genotypes were recorded under higher fertility level than under lower fertility level (Table 2). The higher uptake of nitrogen, phosphorus and potassium at higher fertility level may be owing to more yield of grain and stover and ultimately biological yield. These results confirm the findings of Hirpara *et al.* (1992) and Chouhan and Dighe (1999).

Higher fertility level recorded significantly higher net return and benefit : cost ratio than lower fertility level (Table 2). Application of 80 kg N + 40 kg P_2O_5/ha resulted on an average of 16.0 and 6.5% higher net return and benefit : cost ratio, respectively, than 40 kg N + 20 kg P_2O_5/ha. This might be owing to the more yield under higher fertility level.

Interaction of genotypes and fertility

The interaction between genotypes and fertility levels on the grain yield of sorghum were non-significant but the genotypes 'SPH 960' at higher level (80 kg N + 40 kg P_2O_5/ha) gave the higher grain yield (49.2 q/ha) than other genotypes. This clearly indicates that genotype 'SPH 960' is a high yielding besides it requires more fertility level to optimize the yield.

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