Annals of Arid Zone 35(2) : 129-132, 1996

Effect of Nitrogen and Phosphorus Levels on Sorghum Varieties Grown in Semi-rabi Conditions

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Abstract : The effect of 0-0, 40-8.6, 60-17.2 and 80-17.2 kg ha^{-1} of nitrogen (N) and phosphorus (P) levels on sorghum varieties, GJ-36, GJ-9, Swati and GSH-1 under stored moisture conditions during semi-*rabi* season was studied. Increased grain and stover yields, total N and P uptake and consumptive water use and water-use efficiency (WUE) were recorded with increasing N and P levels for all varieties. GJ-9 was the best due to its highest yield, lowest consumptive water use and highest WUE at the 80 N-17.2 P kg ha^{-1} level.

Key words : Sorghum varieties, nitrogen, phosphorus, fertilizer uptake, consumptive water use, water-use efficiency.

Sorghum is a staple food crop in south Gujarat and is extensively grown in semi-*rabi*, stored moisture conditions. Although variation exists amongst sorghum genotypes in water-use efficiency (Maliwal *et al.*, 1988), it has been shown that WUE can be increased by raising the level of fertility (Umrani and Narkhede, 1982). Hence, an experiment was undertaken to determine the optimum level of fertility and WUE for newly released sorghum genotypes.

Materials and Methods

Four combinations of N and P viz., 0-0, 40-8.6, 60-17.2 and 80-17.2 kg ha^{-1}, were used with four sorghum genotypes viz., GJ-36, GJ-9, Swati, and GSH-1. The trial was conducted during semi-*rabi* season in 1992-93. A split plot design with four replications was used. The varieties were used in the main plots and fertility levels in the subplots. The soil at the experimental site belonged to the great group Vertic Ustochrept, was low in total

Table 1. Effect of N and P levels on grain and stover yields of sorghum varieties

Varieties	Grain yield (kg ha^{-1})					Stover yield (kg ha^{-1})				
	N-P levels					N-P levels				
	0-0	40-8.6	60-17.2	80-17.2	Mean	0-0	40-8.6	60-17.2	80-17.2	Mean
GJ-36	423	1202	1844	2617	1522	1563	3417	562	7792	4600
GJ-9	527	1331	1979	2735	1643	1667	3792	5771	8063	4823
Swati	410	1025	1865	2544	1461	1792	2854	5042	7208	4224
GSH-1	381	971	1569	2450	1343	1750	3833	4750	7333	4417
Mean	435	1132	1814	2587	–	1693	3474	5297	7599	–
			CD (5%)					CD (5%)		
Varieties			191					234		
N-P levels			204					678		
V x N-P			NS					NS		

N (0.038%) and Olsen-P (9.2 kg ha^{-1}), rich in available K (632 kg ha^{-1}) with no problem of salinity or sodicity. The moisture retention in the soil at field capacity (FC) and permanent wilting point (PWP) varied between 46.4 and 46.8% and 27.5 and 27.6%, respectively. The bulk density (Bd) varied between 1.31 and 1.33 g cc^{-1} up to a depth of 60 cm. All fertilizer treatments were applied in the furrows at the time of sowing in the form of DAP and urea. The crop was sown at a distance of 45 cm between rows at a seed rate of 15 kg ha^{-1}. Soil moisture content up to a depth of 60 cm at sowing was between 40.4 and 43.3%. No rain was received during the growth period. Soil moisture at sowing and at harvest was determined up to a depth of 60 cm by gravimetric method (Black, 1965) and was used to calculate the consumptive water use. The crop was harvested at maturity and the N and P were determined in grain and stover adopting standard procedures (Jackson, 1967).

Results and Discussion

Effect on yield

The grain and stover yields significantly increased with increasing N and P levels (Table 1). The grain yield at fertility level 0-0 was the lowest (435 kg ha^{-1}), while at 80 N-17.2 P treatment, the grain yield was the highest (2587 kg ha^{-1}). For stover, the corresponding yields were 1693 and 7599 kg ha^{-1}. Among the varieties, GJ-9 out yielded other varieties though it was not significantly higher than GJ-36 and Swati for grain yield and GJ-36 for stover yield. The variety x fertility interactions in both the cases were not significant. These findings suggest that the use of 80 kg N and 17.2 kg P ha^{-1} as optimal for the sorghum genotypes studied. These findings are in agreement with those of Patel *et al.* (1989) for sorghum GJ-37.

Effect on total N and P uptake

The fertilizer treatments were significantly different and the total N uptake increased with increase in N and P levels (Table 2). The total N uptake was minimum (17.1 kg ha^{-1}) at 0-0 levels of N-P, while at 80-17.2 level, the uptake was maximum (90.9 kg ha^{-1}). Varieties as well as variety x fertility interactions were not significant in spite of variations in total N uptake among different combinations.

Total P uptake also showed a significant increase with each increase in fertility. Thus the 0 N-0 P fertility level had the lowest

Table 2. Effect of N and P levels on total N and P up take by sorghum varieties

Varieties	N uptake (kg ha^{-1})					P uptake (kg ha^{-1})				
	N-P levels					N-P levels				
	0-0	40-8.6	60-17.2	80-17.2	Mean	0-0	40-8.6	60-17.2	80-17.2	Mean
GJ-36	14.7	38.2	62.9	93.9	52.4	1.7	4.3	7.6	10.9	6.1
GJ-9	20.4	43.4	70.3	82.0	54.0	2.0	5.3	8.1	11.1	6.6
Swati	17.1	36.4	59.4	96.0	52.2	1.9	4.1	6.9	9.4	5.6
GSH-1	16.1	40.9	58.8	91.8	51.9	1.6	4.3	7.0	10.5	5.9
Mean	17.1	39.7	62.9	90.9	–	1.8	4.5	7.4	10.5	–
			CD (5%)					CD (5%)		
Varieties			NS					1.5		
N-P levels			5.8					1.5		
V x N-P			NS					NS		

Table 3. Effect of N and P levels on consumptive water use (mm) and water-use efficiency

Variety	N-P levels (kg ha^{-1})	Consumptive water use	Water-use efficiency	
			Grain	Stover
GJ - 36	0-0	74.5	5.7	21.0
GJ - 36	40-8.6	89.2	13.5	38.3
GJ - 36	60-17.2	94.0	19.6	59.8
GJ - 36	80-17.2	101.6	25.8	76.7
GJ - 9	0-0	62.5	8.4	26.7
GJ - 9	40-8.6	70.9	18.8	53.5
GJ - 9	60-17.2	78.4	25.2	73.6
GJ - 9	80-17.2	81.4	33.6	99.1
Swati	0-0	65.7	6.2	27.3
Swati	40-8.6	77.2	13.3	37.0
Swati	60-17.2	83.9	22.2	60.1
Swati	80-17.2	88.9	28.6	81.1
GSH - 1	0-0	76.4	5.0	22.9
GSH - 1	40-8.6	83.8	11.6	45.7
GSH - 1	60-17.2	93.5	16.8	50.8
GSH - 1	80-17.2	97.6	25.1	75.1

value of 1.8 kg ha^{-1} total P uptake and 80-17.2 level had a significantly higher value of 10.5 kg ha^{-1} for total P uptake. There was a significant variation in total P uptake amongst varieties. The variety GJ-9 had the highest value for total P uptake (6.6 kg ha^{-1}) and was at par with GJ-36. There were no significant differences between the remaining varieties. Interactions between fertility levels and varieties were not significant. Increasing uptake values due to increased N and P application have been reported by Hirpara *et al.* (1992). In this investigation both nutrients showed a significant increase in total uptake. The varieties did show significant variations in case of only total P uptake. The increasing order observed was : GJ-9 > GJ-36 > GSH-1 > Swati.

The requirement of N and P for production of one tonne of grain was calculated by : total N or P uptake (kg ha^{-1})/grain yield (t ha^{-1}). It was observed that for the production of one tonne grain, varieties GSH-1, Swati, GJ-36 and GJ-9 required 38.6, 35.7, 34.4 and 32.9 kg N ha^{-1}, respectively. Similarly, 4.4, 4.0, 4.0 and 3.8 kg ha^{-1} of P was needed for the production of one tonne of grain, respectively, by GSH-1, GJ-9, GJ-36 and Swati varieties.

Effect on WUE

The experiment was conducted on stored moisture conditions for studying the WUE by varieties, as well as for increasing the WUE by increase in levels of N-P application. The consumptive water use (Table 3) to a rhizosphere depth of 60 cm and WUE by grain and stover increased with increasing N-P levels for all varieties. The results are in accordance with those of Ghugare *et al.* (1982) and Umrani and Narkhede (1982). Amongst the varieties studied, GJ-9 was the highest moisture user and had a relatively low values for consumptive water use at any given N-P level and highest

values of WUE by grain and stover components. Based on data for consumptive water use by varieties, the moisture requirement for producing one tonne of grain was calculated. It was observed that 68.5, 61.7, 56.8 and 46.5 mm of moisture was needed for production of one tonne grain by GSH-1, GJ-36, Swati and GJ-9 varieties, respectively.

It was observed that growing GJ-9 under semi-*rabi* condition with a fertilizer dose of 80 kg N and 17.2 kg P ha^{-1} produced the highest yield, and had the lowest consumptive water use and highest WUE.

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