

Effect of Graded Levels of Nitrogen and Phosphorus on Yield and Nutrients Uptake by Hybrid Fodder Sorghum under Rainfed Situation

A. Das, M.S. Jakasaniya, K.H. Patel and P.T. Patel

Regional Research Station, Gujarat Agricultural University, Arnej 382 230, India

Abstract: A field experiment was conducted during the rainy season (*kharif*) of 1995 to 1997, to evaluate the response of hybrid fodder sorghum (variety GFSH-1) to graded levels of nitrogen and phosphorus fertilizers on Vertic Ustochrept of Bhal agroclimatic zone in Gujarat. Individual effects of N and P were significant on the fodder yield. Increasing nitrogen application from 0 to 20, 40 and 60 kg N ha⁻¹ gave increased green fodder yield by 56.7, 105.7 and 120.8% and dry fodder yield by 61.5, 117.3 and 128.8%, respectively, on pooled basis. Successive increase in phosphorus level from 0 to 10 and 20 kg P₂O₅ ha⁻¹ gave increased green fodder yield by 10.9 and 17.6% and dry fodder yield by 9.4 and 15.3%, respectively, on pooled basis. However, the fodder yield under 40 kg N ha⁻¹ was at par with that under 60 kg N ha⁻¹, while the yield under 10 kg P₂O₅ ha⁻¹ was at par with that under 20 kg P₂O₅ ha⁻¹. The effect of N on the uptake of N, P₂O₅ and K₂O by fodder sorghum was significant in all the years. So far as net ICBR is concerned, 40 kg N ha⁻¹ was superior to 60 kg N ha⁻¹ treatment, and 10 kg P₂O₅ ha⁻¹ was superior to 20 kg P₂O₅ ha⁻¹ treatment. 40 kg N + 10 kg P₂O₅ ha⁻¹ was found to be the optimal fertilizer dose.

Key words: Hybrid fodder sorghum, nitrogen, phosphorus, forage yield.

Crop productivity in Bhal zone of Gujarat is low and uncertain because of constraints like erratic rainfall, drought, waterlogging, Vertisol and Inceptisol soils and brackish ground water. On many occasions, farmers use very little or no fertilizer for fodder crop. However, to meet the demand of cattle-feed, and also for the survival of cattle during drought period, farmers of this zone are required to produce sufficient fodder, which can be possible through proper management of fertilizers. Studies in different parts of India have revealed that nitrogen fertilization significantly increased the fodder yield of sorghum (Patel *et al.*, 1992a,b) but the crop response to applied P was either low or nil (Singh and Gill, 1976; Patel *et al.*, 1992b).

Hybrid fodder sorghum (variety GFSH-1), a newly released variety for Gujarat, has been found most suitable for its higher yield. The requirement of nitrogen and phosphorus for optimum yield of this hybrid fodder sorghum has not been worked out for Bhal zone so far. So, a study was undertaken to find out the effects of graded levels of nitrogen and phosphorus fertilizers on yield, content of nutrients and their uptake by fodder sorghum GFSH-1 on Vertic Ustochrept under rainfed situation.

Material and Methods

A field experiment was carried out during the rainy season (*kharif*) of 1995, 1996 and 1997 on Vertic Ustochrept at Gujarat Agricultural University, Arnej farm, with

Table 1. Effect of graded levels of nitrogen and phosphorus on green and dry fodder yield of sorghum

Treatment	Yield (q ha ⁻¹)							
	Green fodder				Dry fodder			
	1995	1996	1997	Pooled	1995	1996	1997	Pooled
N (kg ha⁻¹)								
0	108	92	117	106	51	34	71	52
20	161	137	194	164	85	49	119	84
40	210	181	262	218	114	63	161	113
60	223	206	273	234	121	70	167	119
CD (P=0.05)	18	31	24	26	10	12	15	29
P₂O₅ (kg ha⁻¹)								
0	175	131	188	165	92	45	118	85
10	172	160	216	183	92	58	129	93
20	179	171	231	194	94	59	141	98
CD (P=0.05)	NS	27	21	12	NS	11	13	6
N x P	NS	NS	NS	NS	NS	NS	NS	NS

hybrid fodder sorghum GFSH-1. The soil of the experimental field is clayey and low in available nitrogen and phosphorus, but high in available potassium (188 and 188 kg N ha⁻¹, 25 and 16 kg P₂O₅ ha⁻¹, and 419 and 377 kg K₂O ha⁻¹ at 0-15 cm and 15-30 cm depth, respectively). Twelve combination treatments, comprising of four levels of nitrogen (0, 20, 40 and 60 kg N ha⁻¹) and three levels of phosphorus (0, 10 and 20 kg P₂O₅ ha⁻¹) were followed in a factorial randomized block design with three replications. Urea and single super phosphate were used as sources of nitrogen and phosphorus, respectively. In 1995 the sowing was done on July 23, and harvesting on November 2. In 1996 the dates for the above operations were July 4 and October 3, respectively, while in 1997 the dates were July 7 and October 15, respectively. Total rainfall received during monsoon season of 1995, 1996 and 1997 was 876.2, 405.3 and 562.8 mm, respectively. Dry matter was analyzed for

content of N, P₂O₅ and K₂O following the standard procedures (Jackson, 1973), and uptake of nutrients was computed therefrom.

Results and Discussion

Fodder yield

Effect of nitrogen fertilizer: Application of nitrogen fertilizer significantly increased the fodder yield of sorghum (Table 1). Increasing N levels from 0 to 20, 40 and 60 kg ha⁻¹ gave increased green fodder production by 54.7, 105.7 and 120.8% and dry fodder production by 61.5, 117.3 and 128.8%, respectively, on pooled basis (Table 1). Application of 40 and 60 kg N ha⁻¹ significantly increased the yield attributes like plant height, girth and number of leaves (data not shown), and the yield of green as well as dry fodder over control and 20 kg N ha⁻¹ in all the individual years as well as on pooled basis (Table 1). However, the differences in yield between

Table 2. Effect of graded levels of nitrogen and phosphorus on N content (%) and its uptake (kg ha⁻¹) by dry fodder sorghum

Treatments	N content (%)			N uptake (kg ha ⁻¹)		
	1995	1996	1997	1995	1996	1997
N (kg ha⁻¹)						
0	1.33	0.82	0.88	68.0	28.1	63.7
20	1.45	0.88	1.13	124.0	42.2	137.8
40	1.47	0.88	1.15	171.9	52.4	185.3
60	1.50	1.00	1.19	181.8	71.5	196.3
CD (P=0.05)	NS	NS	0.23	21.5	13.3	33.7
P₂O₅ (kg ha⁻¹)						
0	1.29	0.89	1.04	119.7	40.4	130.1
10	1.46	0.91	1.09	136.8	53.6	143.3
20	1.55	0.89	1.13	152.8	51.7	163.9
CD (P=0.05)	0.17	NS	NS	18.6	NS	NS
N x P	NS	NS	NS	Sig.	NS	NS

40 and 60 kg N ha⁻¹ were similar. Similar increase in green and dry matter production was reported by Patel *et al.* (1992 a,b), Hirpara *et al.* (1992), and Patel *et al.* (1994 a,b). The increased yield of green fodder and dry matter with increase in N application might be due to low availability of initial nitrogen in the soil. Therefore, addition of nitrogen increased yield attributes and green foliage. The results are in agreement with those reported by Gill *et al.* (1972), Patel *et al.* (1992b) and Patel *et al.* (1994b).

Effect of phosphorus fertilizer: The application of phosphorus fertilizer significantly boosted the yield during 1996 and 1997, and on pooled basis (Table 1). Increasing phosphorus level from 0 to 10 and 20 kg P₂O₅ ha⁻¹ gave increased green fodder by 10.9 and 17.6%, respectively, and dry fodder by 9.4 and 15.3%, respectively, on pooled basis. Significantly, higher fodder yield was obtained under 20 kg P₂O₅ ha⁻¹, but the yield was at par with that under 10 kg P₂O₅ ha⁻¹. The

results confirm the findings of Rai *et al.* (1984) and Patel *et al.* (1994b). The increased fodder yield, with increase in phosphorus fertilizer, was mainly due to low availability of soil phosphorus. However, the response of crop to applied phosphorus was low because of moderate to high P-fixing capacity of these soils.

Interaction effect of nitrogen and phosphorus: Interaction effects of nitrogen and phosphorus all through were non-significant on the yield of sorghum (Table 1). This result supports the findings of Patel *et al.* (1992b) for clayey soil in Gujarat.

Nutrient content and uptake

Nitrogen: Application of nitrogen fertilizer significantly increased the N content (%) over control only during 1997 (Table 2). Nitrogen uptake (kg ha⁻¹) by dry fodder, under 40 and 60 kg N ha⁻¹, was significantly higher than those of control and under 20 kg N ha⁻¹. However, the differences of N-uptake under 40 and 60

Table 3. Effect of graded levels of nitrogen and phosphorus on P_2O_5 content (%) and its uptake ($kg\ ha^{-1}$) by dry fodder sorghum

Treatment	P_2O_5 content (%)			P_2O_5 uptake ($kg\ ha^{-1}$)		
	1995	1996	1997	1995	1996	1997
N ($kg\ ha^{-1}$)						
0	0.27	0.23	0.16	14.1	7.7	11.5
20	0.30	0.26	0.24	24.2	12.7	28.1
40	0.29	0.26	0.19	33.2	16.6	31.3
60	0.29	2.27	0.19	35.5	18.6	31.7
CD (P=0.05)	NS	NS	0.05	5.3	5.1	6.6
P_2O_5 ($kg\ ha^{-1}$)						
0	0.26	0.24	0.17	23.8	10.5	20.2
10	0.30	0.25	0.20	26.8	14.3	25.2
20	0.31	0.27	0.22	29.7	16.8	31.6
CD (P=0.05)	0.04	NS	0.04	4.6	4.4	5.7
N x P	NS	Sig.	NS	NS	NS	NS

$kg\ ha^{-1}$ were at par (Table 2). Similar results were obtained by Raj and Patel (1989), Patel *et al.* (1993) and Trivedi *et al.* (1996). The higher N-uptake, with successive increase in nitrogen level, might be ascribed to both the higher N-content and higher dry fodder yield.

The effect of phosphorus fertilizer was significant on N content (%) and uptake ($kg\ ha^{-1}$) only during 1995 (Table 2). Increased N-uptake, with application of phosphorus, might be due to higher dry fodder yield.

Interaction effect of nitrogen and phosphorus was significant only in 1995.

Phosphorus: The effect of nitrogen was significant on P_2O_5 content only during 1997. However, the uptake of P_2O_5 increased significantly in all the individual years (Table 3) with the application of nitrogen. These findings are in conformity with those of Raj and Patel (1989) and Patel and Patel (1994).

Application of phosphorus fertilizer significantly increased the content of P_2O_5 in all the years (Table 3). Higher P_2O_5 uptake was registered under 20 $kg\ P_2O_5\ ha^{-1}$ treatments, which was significantly higher over control and that under 10 $kg\ P_2O_5\ ha^{-1}$ in 1997, and was at par with that under 10 $kg\ P_2O_5\ ha^{-1}$ treatment in 1995 and 1996.

Interaction effects of nitrogen and phosphorus on the uptake of P_2O_5 did not reach the level of significance.

Potassium: Application of nitrogen significantly increased the uptake of K_2O by dry fodder in all the years (Table 4). K_2O content gradually increased with N application upto 40 $kg\ N\ ha^{-1}$, and declined thereafter. However, K_2O uptake under 40 and 60 $kg\ N\ ha^{-1}$ was similar. The result corroborates the findings of Patel and Patel (1994).

Application of phosphorus significantly increased the K_2O content in 1995 and its uptake in all the years (Table 4). Higher

Table 4. Effect of graded levels of nitrogen and phosphorus on K₂O content (%) and its uptake (kg ha⁻¹) by dry fodder

Treatments	K ₂ O content (%)			K ₂ O uptake (kg ha ⁻¹)		
	1995	1996	1997	1995	1996	1997
N (kg ha⁻¹)						
0	1.73	1.51	1.42	86.8	51.3	99.8
20	1.92	1.62	1.50	163.6	80.9	177.5
40	1.97	1.87	1.41	226.2	124.4	227.2
60	1.76	1.64	1.37	218.2	112.5	228.4
CD (P=0.05)	NS	NS	NS	32.6	29.9	25.2
P₂O₅ (kg ha⁻¹)						
0	1.71	1.58	1.40	156.6	72.8	164.8
10	1.86	1.64	1.40	170.1	95.8	178.2
20	1.97	1.75	1.48	194.4	108.2	206.7
CD (P=0.05)	0.20	NS	NS	28.2	25.9	21.8
N x P	NS	NS	NS	NS	NS	NS

K₂O uptake with increasing level of phosphorus might be ascribed to higher dry fodder yield coupled with higher K₂O content.

Economics

Application of 40 and 60 kg N ha⁻¹ fetched additional net profit of Rs. 5792 and Rs. 6238 per hectare, respectively. So

Table 5. Economics of yield of fodder sorghum under varying levels of nitrogen and phosphorus

Treatments	Yield of fodder sorghum (q ha ⁻¹)	Addl. yield (q ha ⁻¹) over control	Addl. profit (Rs. ha ⁻¹) over control	Add. cost (Rs. ha ⁻¹) over control	Addl. net profit (Rs. ha ⁻¹) over control	ICBR	
						Gross.	Net
N (kg ha⁻¹)							
0	52	-	-	-	-	-	-
20	84	32	3200	154	3046	1:20.78	1:19.78
40	113	61	6100	308	5792	1:19.81	1:18.81
60	119	67	6700	462	6238	1:14.50	1:13.50
P₂O₅ (kg ha⁻¹)							
0	85	-	-	-	-	-	-
10	93	8	800	194	606	1:4.12	1:3.12
20	98	13	300	380	920	1:3.42	1:2.42

Price (Rs. kg⁻¹): Urea = 3.54, SSP = 3.10, Dry fodder sorghum = 1.0.

Content and uptake of K₂O by dry fodder were not significant due to interaction effect of nitrogen and phosphorus fertilizers.

far as net ICBR is concerned, 40 kg N ha⁻¹ was superior to 60 kg N ha⁻¹ treatment (Table 5). Application of 10 and 20 kg

Table 1. Grain and fodder yield (kg ha^{-1}) of foxtail millet as influenced by levels of nitrogen and phosphorus under rainfed conditions

Treatments	Grain yield			Fodder yield		
	1991	1992	Pooled	1991	1992	Pooled
Nitrogen kg ha^{-1}						
0	198.0	165.0	182.0	391.0	1487.0	939.0
15	316.0	372.0	344.0	692.0	1593.0	1142.0
30	447.0	396.0	421.0	1061.0	1593.0	1326.0
45	626.0	404.0	516.0	1305.0	1666.0	1485.0
S.Em \pm	3.4	42.6	29.8	99.7	63.5	59.1
C.D. at 5%	9.9	124.6	87.1	291.6	NS	172.8
Phosphorus kg ha^{-1}						
0	399.0	316.0	358.0	870.0	1551.0	1210.0
15	436.0	327.0	381.0	845.0	1662.0	1233.0
30	357.0	360.0	358.0	872.0	1580.0	1226.0
S.Em \pm	2.94	36.0	25.8	86.38	55.0	51.2
C.D. at 5%	8.6	NS	NS	NS	NS	NS

NS = Non-significant.

first fortnight of October during both the years. The crop, during growing period, received a total rainfall of 500.9 mm and 237.5 mm during 1991 and 1992, respectively.

Results and Discussion

Effect of nitrogen

The grain yield of foxtail millet differed significantly due to different levels of nitrogen during both the years as well as on pooled basis (Table 1). During 1991 the fodder yield was increased with the increasing level of N to 45 kg N ha^{-1} . Grain yield was increased significantly during both 1991 and 1992. In pooled data, application of 45 kg N ha^{-1} increased the grain yield by 184, 632 and 23% over the application of 0, 15 and 30 kg N ha^{-1} , respectively. Umrani and Bhoi (1982), Hosmani *et al.* (1975) and Intodia (1994)

also observed linear response to application of nitrogen upto 40 and 60 kg ha^{-1} , respectively. The increased grain yield was mainly attributed to improvement in yield contributing characters, viz., plant height, ear head length and number of tillers per plant with increasing levels of nitrogen (Table 2). Intodia (1994) reported that the crop fertilized with 40 and 60 kg N ha^{-1} significantly increased the ear length, ear girth and plant height, when compared to application of 0 and 20 kg N ha^{-1} .

Effect of phosphorus

Application of phosphorus did not increase the fodder yield of foxtail millet significantly during both the years as well as on pooled basis (Table 1). Except during 1991, the grain yield did not differ significantly due to P_2O_5 levels. However, during 1991, application of 15 $\text{kg P}_2\text{O}_5$

Table 2. Plant height, ear head length and no. of effective tillers/plant of foxtail millet as influenced by levels of nitrogen and phosphorus under rainfed conditions

Treatments	Plant height (cm)			Ear head length (cm)			No. of effective tillers/plant		
	1991	1992	Pooled	1991	1992	Pooled	1991	1992	Pooled
Nitrogen kg ha⁻¹									
0	76.0	94.0	84.9	10.2	14.3	12.3	3.6	5.6	4.61
15	81.0	94.0	87.8	11.1	14.9	13.0	3.8	6.7	5.30
30	78.0	93.0	85.4	11.3	16.1	13.7	3.6	7.9	5.77
45	82.0	97.0	89.5	11.5	16.2	13.8	3.6	6.9	5.27
S.Em±	1.65	1.92	1.27	0.37	0.56	0.34	0.22	0.57	0.31
C.D. at 5%	4.8	NS	NS	NS	NS	0.99	NS	NS	NS
Phosphorus kg ha⁻¹									
0	78.0	95.0	86.5	10.9	15.2	13.1	3.5	7.0	5.27
15	78.0	94.0	85.9	11.1	15.6	13.4	3.8	6.8	5.33
30	82.0	95.0	88.4	11.1	15.3	13.2	3.6	6.6	5.11
S.Em±	1.43	1.66	1.09	0.32	0.48	0.29	0.19	0.49	0.27
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

ha⁻¹ provided significantly higher grain yield of 436 kg ha⁻¹ over control. Application of 30 kg P₂O₅ ha⁻¹ had significant adverse effect on grain yield. Subramanian and Ganesaraja (1992) also reported similar findings. The yield attributing characters did not differ significantly during the year 1991 and 1992 due to application of phosphorus (Table 2).

Interaction effect

The interaction effects of nitrogen and phosphorus on grain and fodder yields due to nitrogen and phosphorus were found non-significant during both the years.

References

- Hosmani, M.M., Gidnavar, V.S., Hugar, P.V. and Shetty, T.K. 1975. Response of Navane to nitrogen and phosphorus application. *Journal of Agronomy* 20: 173-174.
- Intodia, S.K. 1994. Response of foxtail millet (*Setaria italica*) genotypes to levels of nitrogen and phosphorus under rainfed conditions. *Indian Journal of Agricultural Sciences* 64: 861-862.
- Subramanian, P. and Ganesaraja, V. 1992. Responses of *Setaria italica* to different management practices under dryland farming. *Annals of Arid Zone* 31: 269-271.
- Umrani, N.K. and Bhoi, P.G. 1982. Responses of *Setaria italica* to nitrogen and phosphorus under two rainfall situations. *Indian Journal of Agronomy* 27: 61-63.