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Response of Forage Sorghum (cv. CSV 21F) to Seed Rate and Fertilizer Level

M.M. Talpada, G.B. Vekariya, G.S. Sutaria and V.D. Vora

Dry Farming Research Station, AICRP for Dryland Agriculture
Junagadh Agricultural University, Targhadia-360 003, Gujarat

Email: rsdfrjt@yahoo.in

ABSTRACT: A field experiment was conducted at Dry Farming Research Station, Junagadh Agricultural University, Targhadia (Dist: Rajkot, Gujarat) during *kharif* seasons of 2009-2012 to determine the effect of seed rate (three levels: 40, 50 and 60 kg/ha and fertilizer levels (three: 60:30, 80:40 and 100:50NP kg/ha) fertilizer dose for getting maximum fodder yield of sorghum CSV-21F. Increase in seed rate significantly decreased the number of leaves per plant, length of leaves and leaves breadth. Green and dry fodder yield increased significantly with an increase in seed rate (40 to 60 kg/ha). Plant height, number of leaves per plant, length and breadth of the leaves as well as green and dry fodder yield recorded a marked increase with increase in fertilizer levels from 60:30, 80:40 and 100:50 NP kg/ha. Higher values of crude protein and fiber contents in the fodder of sorghum were recorded with lower seed rate and also with NP fertilizers at the rate of 100:50 kg/ha. Application of NP fertilizer significantly enhanced the status of available N, P_2O_5 and K_2O in the soil at harvest of crops. The results revealed that a seed rate of 40 kg/ha and application of 100:50 NP kg/ha may be used for realizing palatable and higher yield of *kharif* fodder sorghum.

Key words: Fodder sorghum, seed rate, fertilizer, growth, yield

Introduction

Sorghum (*Sorghum bicolor* L.) locally known as Jawar or Chari is an important *kharif* season crop which is grown both for fodder and grains. Sorghum fodder is considered as one of the essential feeds for livestock if properly cured as silage with a little supplement of protein, can maintain cattle in good health conditions during the winter with little or no grain supplement. Sorghum fodder contains more than 50% digestible nutrients with 8% protein, 2.5% fat and 45% nitrogen-free extract (NFE). Its nutritional value is equivalent to that of corn.The animals relish well due to its palatability and succulent nature (Wheeler, 1950).

Fertilizer application is one of the principle factors that markedly increase the fodder yield. An adequate supply of nutrients at each growth stage is essential for optimum growth and development of fodder sorghum. Nutrients are important for physiological, growth and yield point of view (Alloway, 2008) but at the same time optimum plant stand is equally important to get maximum yield (Reddy *et al.,* 2010). Therefore, there is a need to evaluate the effect of seed rate and fertilizer level on the growth and yield of *kharif* forage sorghum.

Materials and Methods

The field experiments were conducted on forage sorghum [*Sorghum bicolor*(L) Moench] in the *kharif* season at Main Dry Farming Research Station, Junagadh Agricultural University, Targhadia (Rajkot), Gujarat during 2009 to 2012 to determine the effect of seed rate and fertilizer level on growth, yield and quality of fodder sorghum under rainfed condition. The soils of experimental field were clayey in texture, moderately alkaline ($pH_{2.5}$-7.98), non-saline ($EC_{2.5}$-0.36 dS/m), and low in available N 103.5 (mg/kg) $P_2O_5$15.6 (mg/kg) and high in K_2O, 151 (mg/kg). The experiment was laid out with nine treatment combinations comprising of three seed rate (S) levels (40, 50 and 60 kg seed/ha) and three fertilizer (F) levels (60:30, 80:40 and 100:50 NP kg/ha in factorial randomized block design with three replications using forage sorghum variety CSV 21f was test crop. The net plot size measured 5.4 × 3 m². The crop was sown at 30 cm row to row distances using bullock drawn seed drill. Urea and diammonium phosphate were used as fertilizer source. The full amount of phosphorus was applied at the time of sowing, while half of the N quantity was applied at the time of sowing and the remaining half was top dressed at 30 days after sowing. Recommended agricultural practices were done throughout the crop seasons. The crop was harvested at 50% heading and green fodder yield was recorded. Dry fodder yield was recorded after 15 days of sun drying. The protein content of the dry forage was computed by multiplying N content in the forage dry matter by 6.25, assuming 16% N in the protein. Crude fibre percentage was determined by using methods recommended by AOAC (AOAC, 1984). The soils were analyzed for available N by Kjeldahl method, available P (Olsen *et al.,* 954) and K as described by Jackson, 1973. The data was statistically analyzed as per procedure outlined by Panse and Sukhatme (2000). Treatment means were compared at 5% level of significance using least significant difference (LSD). Economics was calculated based on price of green forage prevailing in the market.

Results and Discussion

Rainfall

Rainfall during the cropping season varied from 404.5 to 1144.5 mm in 17 to 46 rainy days with a standard deviation of -36.6 to +91.3% (Table 1). The distribution of rainfall was uneven during 2009 and 2012 and was uniform in 2010 and 2011. Onset of monsoon varied from 22th to 27th std. week, while, withdrawal of monsoon was between 35th to 39th Std. weeks. Long dry spells were recorded during the years 2009 and 2012. Heavy

Table 1 : Rainfall feature during experimentation period

Year	Seasonal rainfall (mm)	Rainy days	% Deviation to normal	On set of monsoon	Rainfall distribution	Dry spell	Withdrawn of monsoon	Event
2009	458.2 (-)*	17	-26.1	25th Std. week	Uneven	27th July to 29th August	35th Std. week	Heavy rainfall on 18th July 112.0 mm
2010	1144.5 (60)	46	+91.3	22th Std. week	Even	-	37th Std. week	-
2011	1044.3 (18.0)	33	+79.7	27th std. week	Even	-	39th std. week	Heavy rainfall on 9th 145 mm & 18th July 200 mm
2012	404.5 (-)	21	-36.6	24th std. week	Uneven	18th June to 2nd July and 14th July to 24th August	38th std. week	-

Indicated pre or post seasonal rainfall

rain storms of 112, 200 and 300 mm were recorded during the year 2009 and 2011, respectively. The wide variation in total quantity and distribution of annual rainfall. This variation in rainfall affected the sorghum fodder yield and hence, in yield was observed significant difference in different years.

Growth parameters

Plant height increased with increase in seed rate (S_{40}, S_{50} and S_{60}) irrespective of the fertilizer levels and maximum height of 172 cm was recorded with seed rate @ of 60 kg/ha (Table 2). However, number of leaves per plant, length and breadth of leaves decreased with increase in seed rates (S_{40}, S_{50} and S_{60}) irrespective of the fertilizer levels. Higher growth was recorded at lower seed rate, i.e. 40 kg/ha. Average of growth parameters like, plant height, number of leaves per plant, length and breadth of leaves across seed rate have shown that increase growth parameters significantly with increasing levels of fertilizer. Significantly, higher values of all the growth parameters were observed with higher level of fertilizer (F_3:100:50 NP kg/ha) which was statistically at par in case of length of leaves with fertilizer level (F_2). The similar significant increase was observed in plant height, stem diameter and number of leaves per plant by Khalid Mahmud *et al.* (2003).

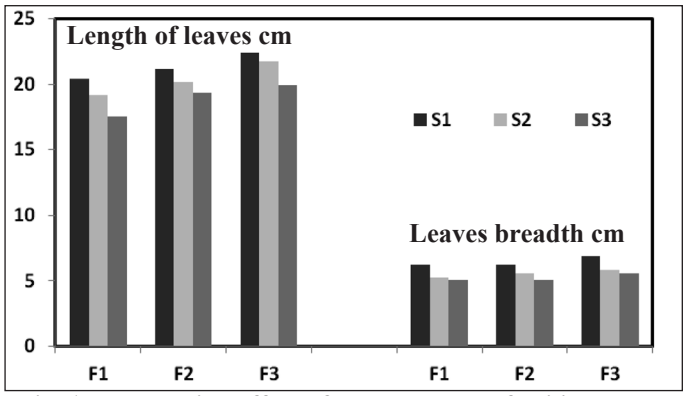

Fig. 1 : Interaction effect of seed rates and fertilizer doses on growth of sorghum

The interaction effect of seed rates and fertilizer doses on the length and breadth of the leaves of sorghum was found significant (Figure 1). The significantly higher value of the length and breadth of the leaves was recorded with S_1 (seed rate @ of 40 kg/ha) in combination of fertilizer level F_3 (100:50 NP kg/ha).

Fodder yield

The results showed that the irrespective of the fertilizer levels, green fodder yield of sorghum significantly differed due to the seed rate during all four years and in pooled result (Table 3). The data further indicated that the green fodder yield of sorghum increased with an increasing seed rate (S_{40}, S_{50} and S_{60}). The maximum value of green fodder yield of sorghum 28829 kg/ha was recorded with seed rate @ of 40 kg/ha in pooled result might be due to higher values of growth parameters viz. number of leaves per plant, length and breadth of leaves. Bahadur Singh *et al.* (2012) also reported that green fodder yield increased significantly with an increase in seed rate 40 to 45 kg/ha compare to 30 and 35 kg/ha. Significant differences were also observed among different combinations of NP fertilizer application during all the years and in pooled result. It was observed that there was a gradual increase in green fodder yield with N and P application. The application of NP fertilizers at the rate of 100:50 kg/ha (F_3) resulted in maximum green fodder yield (30137, 35103, 31735, 16597 and 28393 kg/ha) in all four years and pooled, respectively, while the minimum green fodder yield was obtained in F_1 (60:30 kg/ha) in all the years and also in pooled. The increase in green fodder yield with fertilizer application may be due to greater plant height, number of leaves per plant, length and breadth of the leaves.

The interaction effect of seed rates and fertilizer doses on green fodder yield of sorghum was found significantly during 2009-10 and 2010-11 (Table 4). Significantly higher green fodder yield of sorghum (35510 and 37009 kg/ha) during 2009-10 and 2010-11 was recorded with S_1 (seed rate @ of 40 kg/ha) in combination of fertilizer level F_3 (100:50 NP kg/ha), respectively.

Table 2 : Effect of seed rates and fertilizer doses on growth of forage sorghum

Treatments	Plant height cm	No, of leaves/plant	Length of leaves cm	Leaves breadth cm
Seed rates (kg/ha) (S)				
S_1	152	9.12	21.27	6.46
S_2	170	8.62	20.41	5.49
S_3	172	8.01	18.97	5.23
SEm.±	3.7	0.16	0.48	0.13
CD @ 5%	12.7	0.44	1.44	0.39
Fertility levels (NPK kg/ha) (F)				
F_1	155	8.08	19.06	5.51
F_2	166	8.59	20.23	5.57
F_3	173	9.09	21.36	6.10
SEm.±	3.7	0.16	0.48	0.13
CD @ 5%	12.7	0.44	1.44	0.39
Interaction (S x F)				
SEm.±	4.1	0.19	0.83	0.22
CD @ 5%	NS	NS	2.51	0.67

Table 3 : Effect of seed rates and fertilizer doses on green fodder yield (kg/ha) of forage sorghum

Treatments	2009	2010	2011	2012	Pooled
Seed rates (kg/ha) (S)					
S_1	33594	34945	30403	16374	28829
S_2	27551	33299	29881	16689	26855
S_3	22257	31502	27757	15949	24366
SEm.±	372	577	590	430	1114
CD @ 5%	1115	1729	1768	1289	3856
Fertility levels (NPK kg/ha) (F)					
F_1	26475	31310	24590	15331	24426
F_2	26790	33333	31716	17084	27231
F_3	30137	35103	31735	16597	28393
SEm.±	372	577	590	430	860
CD @ 5%	1115	1729	1768	1289	3856
Interaction (S x F)					
SEm.±	644	999	1021	745	-
CD @ 5%	1930	2995	NS	NS	-
	Y	Y x S	Y x F	S x F	Y x S x F
SEm.±	1287	501	501	1883	868
C.D.at 5%	4453	1416	1416	NS	2452

Table 4 : Interaction effect of seed rates and fertilizer doses on green fodder yield (kg/ha) of sorghum

Treatments	F_1	F_2	F_3	F_1	F_2	F_3
					Year 2010-11	
S_1	32498	32774	35510	32510	35391	37009
S_2	26190	26597	29867	31572	34568	34708
S_3	20700	20879	25011	29848	30041	33466
SEm.±		644			1002	
CD @ 5%		1929			3004	

Dry fodder yield was significantly differed due to the seed rate during all the four years and in pooled result irrespective of the fertilizer levels (Table 5). Dry fodder yield was decreased with increasing seed rate (S_{40}, S_{50} and S_{60}). Higher values of dry fodder yield of sorghum were obtained with seed rate @ of 40 kg/ha in all the years and in pooled. Dry fodder yield significantly differed due to levels of fertilizer application during the study period and in pooled result. In pooled result, 9.6 and 26.9% higher dry fodder yield was recorded due to F_3 (100:50 NP kg/ha) in comparison to F_2 (80:40 NP kg/ha) and F_1 (60:30 NP kg/ha), respectively. The significant effect of N and P application on dry matter was also reported by Malik *et al*. (1992) and Rathod *et al.* (2002). The higher yields could be accredited to positive contribution of a combination of fodder yield components like number of leaves per plant, plant height, length and breadth of the leaves which were improved with fertilizer application.

The interaction effect of seed rates and fertilizer doses on dry fodder yield of sorghum was found significantly during 2009-10 and 2010-11 (Table 6). Significantly higher dry fodder yield of sorghum (16164 and 15382 kg/ha) during 2009-10 and 2010-11 was recorded with S_1 (seed rate @ of 40 kg/ha) in combination of fertilizer level F_3 (100:50 NP kg/ha), respectively.

Fodder quality

The data presented in table 7, showed that crude protein and fiber contents in the fodder of sorghum were significantly differed due to seed rate. A progressive decrease in crude protein content was observed with increased seed rate controversy to this fiber content increased with increasing seed rate. The maximum values of crude protein (10.94%) and fiber (33.86%) contents were observed at seed rate @ of 40 and 60 kg/ha, respectively. Significant differences were also observed among different

Table 5 : Effect of seed rates and fertilizer doses on dry fodder yield (kg/ha) of forage sorghum

Treatments	2009	2010	2011	2012	Pooled
Seed rates (kg/ha) (S)					
S_1	14863	13882	13889	9454	12603
S_2	14171	13059	12654	9239	12281
S_3	11109	12743	12211	8865	11652
SEm.±	282	268	287	360	352
CD @ 5%	846	803	860	1081	1219
Fertility levels (NPK kg/ha) (F)					
F_1	12617	12051	10810	7169	10662
F_2	12826	13128	13819	9599	12343
F_3	14700	14506	14125	10789	13530
SEm.±	282	268	287	360	326
CD @ 5%	846	803	860	1081	1219
Interaction (S x F)					
SEm.±	488	464	496	624	
CD @ 5%	1465.00	1391.00	NS	NS	
	Y	Y x S	Y x F	S x F	Y x S x F
SEm.±	407	301	301	335	522
C.D.at 5%	1408	852	852	NS	1476

Table 6 : Interaction effect of seed rates and fertilizer doses on dry fodder yield (kg/ha) of sorghum

Treatments	F_1	F_2	F_3	F_1	F_2	F_3
					Year 2010-11	
S_1	13662	14780	16164	12366	13971	15382
S_2	13399	13761	15346	10606	13560	15021
S_3	10174	10148	12879	13580	11852	12716
SEm.±		513			492	
CD @ 5%		1538			1474	

Table 7 : Effect of seed rates and fertilizer doses on fodder quality and post harvest soil fertility

Treatments	Crude Protein %	Crude Fibre %	Available nutrients mg/kg		
			N	P_2O_5	K_20
Initial value	-	-	103.5	15.6	151.2
Seed rates (kg/ha) (S)					
S1	10.94	30.62	107.3	17.96	143.2
S2	9.74	32.37	108.4	18.32	147.0
S3	9.02	33.86	111.2	18.47	149.1
SEm.±	0.20	0.71	2.26	0.69	2.1
CD @ 5%	0.61	2.13	NS	NS	NS
Fertility levels (NPK kg/ha) (F)					
F1	8.99	30.43	104.7	15.52	150.0
F2	9.93	32.29	108.6	17.52	147.2
F3	10.78	33.62	113.7	21.68	140.4
SEm.±	0.20	0.71	2.26	0.69	2.1
CD @ 5%	0.61	2.13	6.77	15.52	150.0
Interaction (S x F)					
SEm.±	0.45	2.47	3.9	2.11	6.4
CD @ 5%	NS	NS	NS	NS	NS

Table 8 : Economics of spacing and fertilizer treatment combinations (Pooled basis)

Treatments	Green fodder yield (kg/ha)	Gross return (₹/ha)	Cost of cultivation (₹/ha)	Net return (₹/ha)	B:C ratio
S_1F_1	25393	50786	17521	33265	1.90
S_1F_2	30264	60529	18163	42366	2.33
S_1F_3	31395	62790	18805	43985	2.34
S_2F_1	26425	52850	18088	34762	1.92
S_2F_2	27597	55193	18730	36463	1.95
S_2F_3	26390	52780	19371	33409	1.72
S_3F_1	21461	42922	18654	24268	1.30
S_3F_2	23831	47663	19296	28367	1.47
S_3F_3	27395	54789	19938	34851	1.75

combinations of NP fertilizer application. It was observed that there was a gradual increase in crude protein and fiber contents with N and P application. The application of NP fertilizers @ 100:50 kg/ha (F_3) resulted in maximum crude protein (10.78%) and fiber contents (33.62%) in fodder sorghum. The increase in protein contents with NP application has also been reported by Patel *et al.,* 1994.

Post harvest soil fertility

Data in table 7 indicated that the irrespective of seed rates, applying NP levels increasingly (60:30, 80:40 and 100:50 NP kg/ha), significantly enhanced the status of available N, P_2O_5 and K_2O in the soil at harvest of crop and the highest values being obtained at F_3 (100:50 NP kg/ha). Similar results were obtained by Abou-Amer and Kewan (2014).

Economic

A treatment combination of 40 kg seeds/ha and 100 kg N and 50 kg P_2O_5/ha was recorded significantly (Table 8) higher green fodder yield (31395 kg/ha), gross returns (₹ 62790/ha), net returns (₹ 43985/ha) and B:C ratio (2.34) compared to other treatment combinations along with improving in fodder quality and soil fertility.

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