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Research Article

YIELD AND ECONOMICS OF SINGLE CUT SORGHUM GENOTYPES AS INFLUENCED BY DIFFERENT FERTILIZER LEVELS

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Abstract: The present field study was carried out at two locations *viz*. Punjab Agricultural University, Ludhiana and CCS Haryana Agricultural University, Hisar during rainy season (*kharif*) 2017 to evaluate seven entries/varieties of forage sorghum with three levels of fertility (75, 100 and 125 percent of RDF). The experiment was laid out in factorial randomised block design and replicated thrice at both the locations. The results revealed that CSV 21F out yielded the remaining varieties for green fodder yield and dry matter yield on location mean basis. It was also superior over other varieties with respect to growth characteristics such as plant height, tillers and leaf: stem ratio. The green fodder yield, dry matter yield and growth characteristics of sorghum increased significantly with the increasing fertility level up to 125 percent RDF (Recommended Dose of Fertilizer) at both the locations and on pooled basis. Highest gross returns, net returns and benefit cost ratio on pooled basis of both the locations was recorded in the genotype CSV 21F followed by SPH 1822, SPV 2387 and SPV 2388.

Keywords: *Sorghum, Green fodder, Dry matter, Fertilizer levels and economics*

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Introduction

Sorghum is an important *kharif* cereal fodder crop grown widely to meet the fodder requirement of the livestock. A fast-growing crop, sorghum provides nutritious and palatable fodder to the animals particularly during the lean periods of mid-summer. Although adequate fertility and soil moisture is required for maximizing sorghum yield it can tolerate drought quite well. "When soil moisture is not sufficient sorghum plant does not wilt but become dormant. Once moisture conditions improve growth starts again. Compared to other cereals, drought, soil toxicity and temperature extremes tolerance of sorghum is high. These qualities make sorghum a valuable fodder and preferred over other fodders in high temperatures or dry conditions. India supports 512.05 million livestock, being the leader in cattle (16%) and buffalo (5.5%) population [1]. Dairy industry has been the driving force in the region of Punjab, Haryana, Uttarakhand, Uttar Pradesh, Rajasthan and Gujarat. Sorghum as a source of feed and fodder has the potential to meet the demand set by dairy industry. Currently, India is facing a net deficit of 61.1 percent green fodder and 21.9 percent dry crop residues due to increasing population of livestock [2]. This gap in green fodder can be narrowed down by growing high yielding varieties. Apart from the location specific genotypes, adequate fertilization is another important factor to realize the potential forage sorghum production. Therefore, the present study was undertaken to find out the suitable single-cut forage sorghum genotypes under different fertilizer levels in a multi-location trial.

Material and methods

The field experiment was conducted during rainy (*kharif*) season at research farm of Punjab Agricultural University, Ludhiana, 141004, Punjab and at Forage Section Research Farm of CCS Haryana Agricultural University, Hisar, Haryana. While, Ludhiana is situated at 30°54'N latitude and 75°48'E longitude with an altitude of 247.0 m above the mean sea level, Hisar is situated at 29°10' N latitude of 75°46' E longitude, at an average elevation of 215.2 m above mean sea level. Both the experimental sites have semi-arid and sub-tropical climate with hot dry summer and severe cold winter. The weekly meteorological data of the two locations during the crop season is presented in [Fig-1] and [Fig-2]. The soil of the experimental field was sandy loam in texture at both the locations with pH 7.8 and 7.9, available nitrogen 184 and 154 kg/ha, available phosphorus 16.8 and 10.0 kg/ha and available potassium 246 and 240 kg/ha, respectively at Ludhiana and Hisar. The experiment consisted of 21 treatment combinations comprising seven single-cut forage sorghum genotypes (SPH 1822, SPV 2316, SPV 2387, SPV 2388, CSH 13, CSV 21F and CSV 30F) and three fertility levels *viz*. 75, 100 and 125 percent of recommended dose of fertilizer (RDF). These treatments were tested in factorial randomized block design with three replications. The crop was sown on 22 June 2017 and on 18 July 2017 at Ludhiana and Hisar, respectively in opened furrows at 25 cm apart. The recommended dose of fertilizer (100%) for forage sorghum is 100 kg N, 20 kg P_2O_5 and 25 kg K_2O (in potassium deficient soils) per hectare at Ludhiana and 75 kg N, 15 kg P_2O_5/ha and 0 kg K_2O per hectare at Hisar. Under Ludhiana conditions, half dose of nitrogen and full dose of phosphorus were applied as basal according to treatment levels. Remaining half dose of nitrogen was top-dressed after first irrigation 30 days after sowing (DAS). Under Hisar conditions, 50 kg N + 15 kg P_2O_5 was applied basal at sowing and remaining 25 kg N was applied 30 DAS. The crop received uniform irrigation as per requirement. All the other standard agronomic practices of the respective state Agricultural Universities were followed uniformly in all the treatments for the cultivation of forage sorghum [3] and [4]. The crop was harvested at 50% flowering stage, which coincided with 85-90 days. The data on growth characters *viz*., plant height, number of tillers and leaf-stem ratio and yield (green fodder and dry matter) were recorded at the time of harvest. The economics of different treatments was calculated at the prevailing market rates of labour wages, inputs and outputs.

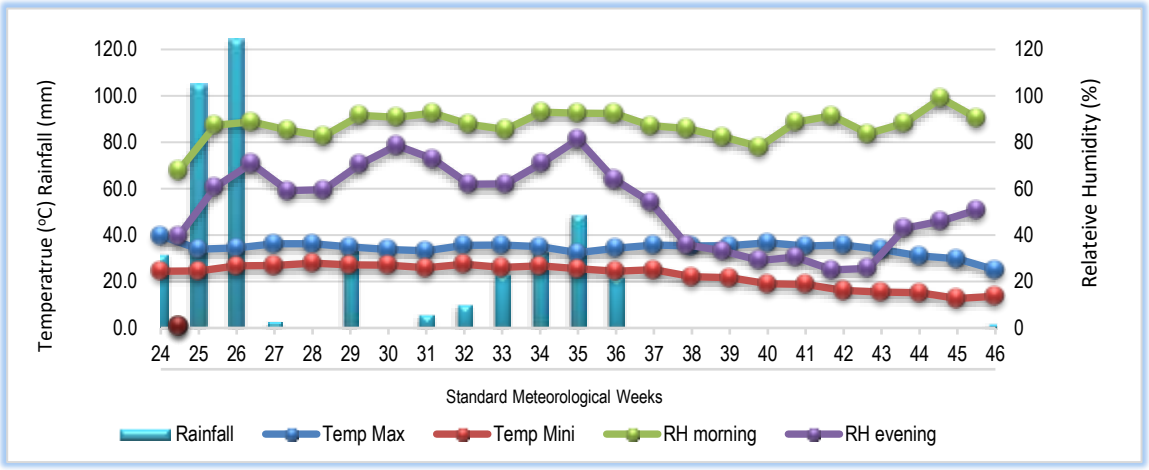

Fig-1 Weekly weather parameters *viz*., temperature (°C), relative humidity (%) and rainfall (mm) of Hisar location

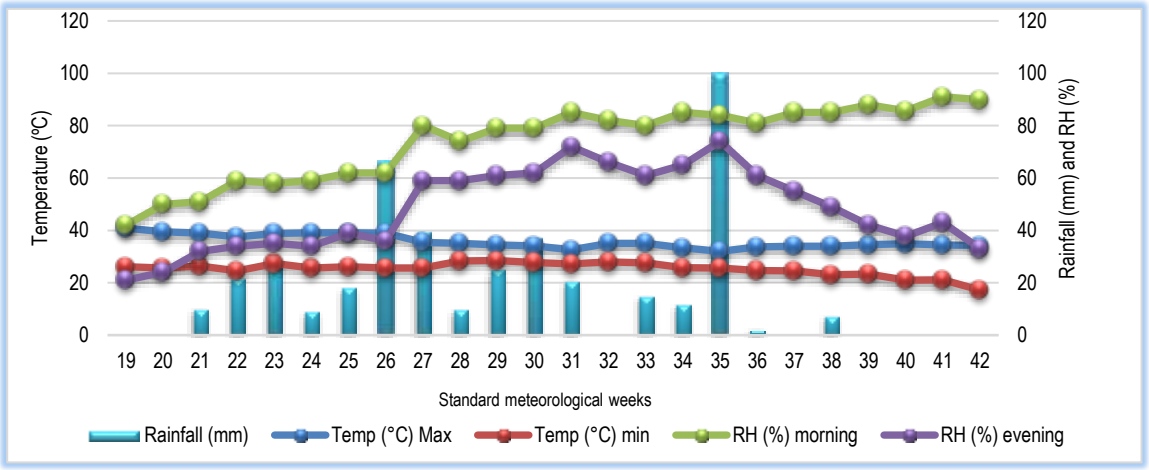

Fig-2 Weekly weather parameters *viz*., temperature (°C), relative humidity (%) and rainfall (mm) of Ludhiana location

The pooled data of the two sites on yield and economics was statistically analysed for interpreting the results. Data were analyzed by using OPSTAT software available on CCS Haryana Agricultural University website [5]. The results are presented at five percent level of significance (P=0.05) for making comparison between treatments.

Results and discussion

Genotypes

The different entries tested varied significantly among themselves for green fodder yield, dry matter, growth attributes *viz*. plant height, number of tillers, leaf: stem ratio. A perusal of the data in [Table-2] reveal that genotype SPH 1822 recorded highest green fodder yield (606.0 q/ha) at Ludhiana.

Table-1 *Growth parameters of forage sorghum as influenced by different treatments at Ludhiana and Hisar*

Treatments	Tillers/mrl at harvest		Plant height (cm)		L:S Ratio	
	Ludhiana	Hisar	Ludhiana	Hisar	Ludhiana	Hisar
A Fertility Levels						
75% RDF	10.2	9.4	235.0	221.1	0.42	0.25
100% RDF	11.2	10.1	242.0	235.5	0.47	0.27
125% RDF	12.4	10.9	246.8	246.5	0.52	0.27
CD (P=0.05)	0.6	1.0	8.5	10.1	0.03	0.02
B Genotypes						
SPH 1822	15.3	9.2	250.2	244.4	0.42	0.26
SPV 2316	11.3	9.6	243.5	190.8	0.58	0.28
SPV 2387	9.9	11.2	249.5	253.8	0.41	0.25
SPV 2388	8.5	10.2	241.2	242.5	0.44	0.26
CSH 13	12.7	8.8	250.3	200.2	0.47	0.27
CSV 21F	12.8	11.5	249.9	251.0	0.45	0.26
CSV 30F	8.3	10.2	204.4	257.9	0.53	0.27
CD (P=0.05)	0.9	1.5	13.0	15.5	0.05	NS

The genotypes CSH 13 and CSV 21F obtained green fodder yield which was comparable to SPH 1822 and significantly lowest green fodder yield was recorded by CSV 30F. However, at Hisar highest green fodder yield was recorded in SPV 2387 (458.9 q/ha) and it was at par with SPV 2388, CSV 21F and CSV 30F. This could be attributed to higher number of tillers and plant height of these genotypes at the respective locations [Table-1]. Mean performance of the genotypes across the locations revealed that CSV 21F was the stable variety at both the locations with highest green fodder yield followed by SPH 1822, SPV 2387 and SPV 2388 while significantly lowest green fodder yield was given by CSV 30F. Further, from the results it is clear that, irrespective of any variety the yield was higher at Ludhiana than at Hisar. A similar trend was observed in dry matter yield.

Table-2 *Fodder yield of forage sorghum as influenced by different treatments at Ludhiana and Hisar*

Treatment	Green fodder yield (q/ha)			Dry matter yield (q/ha)		
	Ludhiana	Hisar	Pooled	Ludhiana	Hisar	Pooled
A Fertility Levels						
75% RDF	475.7	370.0	422.8	109.0	98.0	103.5
100% RDF	529.1	410.8	470.0	118.7	109.4	114.0
125% RDF	573.0	444.0	508.5	129.0	117.9	123.4
CD (P=0.05)	26.2	32.7	25.6	6.8	7.5	5.1
B Genotypes						
SPH 1822	606.0	391.1	498.5	135.8	105.0	120.4
SPV 2316	553.4	372.0	462.7	126.0	98.6	112.3
SPV 2387	530.7	458.9	494.8	122.6	123.2	122.9
SPV 2388	523.0	424.8	473.9	118.7	113.8	116.3
CSH 13	585.0	354.3	469.7	139.2	88.6	113.9
CSV 21F	583.9	442.1	513.0	129.2	113.8	121.5
CSV 30F	299.5	414.7	357.1	60.7	116.3	88.5
CD (P=0.05)	40.0	50.0	39.1	10.4	11.4	7.9

Table-3 *Economics of forage sorghum genotypes as influenced by different fertilizer levels at Ludhiana and Hisar*

Treatments	Cost of cultivation (Rs./ha)			Gross returns (Rs./ha)			Net returns (Rs./ha)			B:C ratio		
	Ludhiana	Hisar	Pooled	Ludhiana	Hisar	Pooled	Ludhiana	Hisar	Pooled	Ludhiana	Hisar	Pooled
A Fertility Levels												
75% RDF	14030	33921	23975	38053	46251	42152	24023	12331	18177	1.71	1.36	1.54
100% RDF	14562	34305	24434	42328	51351	46840	27766	17046	22406	1.91	1.50	1.72
125% RDF	15094	34696	24895	45841	55498	50669	30747	20802	25774	2.04	1.60	1.82
CD (P=0.05)	NS	NS	13	2096	4088	2732	2096	4088	2732	0.14	0.12	0.12
B Genotypes												
SPH 1822	14562	34307	24435	48477	48882	48680	33915	14575	24245	2.32	1.42	1.87
SPV 2316	14562	34307	24435	44274	46504	45389	29712	12197	20954	2.04	1.35	1.69
SPV 2387	14562	34307	24435	42458	57365	49912	27896	23058	25477	1.91	1.67	1.79
SPV 2388	14562	34307	24435	41838	53096	47467	27276	18789	23033	1.87	1.55	1.71
CSH 13	14562	34307	24435	46804	44283	45544	32242	9976	21109	2.21	1.29	1.75
CSV 21F	14562	34307	24435	46710	55268	50989	32148	20960	26554	2.20	1.61	1.91
CSV 30F	14562	34307	24435	23956	51835	37896	9394	17528	13461	0.64	1.51	1.07
CD (P=0.05)	NS	NS	NS	3202	6244	4173	3202	6244	4173	0.22	0.18	0.18

Several workers have also observed variation among the sorghum varieties for forage and ancillary characters. The variation in varieties could be due to the differences in their genetic constituents. The differential behaviour of these genotypes could also be explained solely by variation in their genetic constituent [6].

Fertilizer Levels

Plant height, tillers per meter row length, green fodder yield and dry matter yield of sorghum increased with successive increase in fertility level. The application of 125 percent of RDF produced 8.2 and 20.3 percent higher green fodder and 8.2 and 19.2 percent higher dry matter over 100 and 75 percent RDF, respectively on pooled data basis. At both the locations, highest green fodder and dry matter yields were recorded at 125% RDF which was significantly superior over the lower doses of fertilizers. This could be due to the increased availability and absorption of nitrogen at higher doses which resulted in increased vegetative growth due to taller plants, more tillers which finally reflected in increased forage yield at both the locations and on mean basis. The similar increase in green fodder and dry matter yield was also reported by Satpal *et al*. (2015) [7].

Economics

The data on economics in [Table-3] reveal that CSV 21F due to highest green fodder yield recorded highest gross returns, net returns and benefit cost ratio on pooled basis of the two locations. The cost of cultivation increased with increase in fertilizer doses from 75 to 125 % of RDF but due to higher yield, net returns and benefit cost ratio were higher at higher dose of fertilizers.

Conclusion

Based on the results, it is concluded that CSV 21F was the stable variety at both the locations with highest green fodder yield followed by the one test hybrid (SPH 1822) and two test varieties (SPV 2387 and SPV 2388). The pooled data of both the locations indicate that significantly highest fodder yield was recorded at 125% RDF. For realizing the potential fodder yield of single-cut forage sorghum, the recommended dose of fertilizer should be 93.75 kg N+25 kg P_2O_5+31.25 kg K_2O/ha for Ludhiana and 93.75 kg N+18.75 kg P_2O_5+31.25 kg K_2O/ha for Hisar. Sorghum being an exhaustive crop, responded to higher fertilizer levels (up to 125% RDF) at both the locations.

Application of Research: The study is important for finding the best location specific genotype and fertilizer dose for realizing the fodder yield potential of single-cut forage sorghum for Punjab and Haryana.

Research Category: Agronomy

Abbreviations: RDF: Recommended Dose of Fertilizer, B:C-Benefit Cost Ratio

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Research project name or number: All India Coordinated Research Project on Sorghum, Ludhiana and Hisar Centre

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Research farm of Punjab Agricultural University, Ludhiana, 141004, Punjab and Forage Section Research Farm of CCS Haryana Agricultural University, Hisar, Haryana

Cultivar / Variety name: Sorghum (*Sorghum bicolor*) SPH 1822, SPV 2316, SPV 2387, SPV 2388, CSH 13, CSV 21F and CSV 30F

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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