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Effect of Fertilizer Levels on Fodder Productivity and Quality of Multi-cut Sorghum Genotypes

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Abstract

A field experiment was conducted at Udaipur (Rajasthan) to study the effect of fertility levels on productivity and quality of multi-cut forage sorghum genotypes. The experiment was laid out in a randomized block design with 3 replications. The treatments consisted of seven multi-cut forage sorghum genotypes (SPV 2242, SPH 1700, SSG 59-3, CSH 20 MF, CSH 24 MF, MP Chari and CoFS-29) and four fertility levels viz., 50, 75, 100 and 125% recommended dose of fertilizers (RDF). Result showed that multi-cut forage sorghum genotype SPH 1700 produced highest green (58.08 t ha^{-1}) and dry fodder (17.97 t ha^{-1}) yield in first cut, however genotype CoFS-29 produced highest green and dry fodder yield in second cut. Maximum crude protein yield was recorded in CoFS-29 (2017 kg ha^{-1}) followed by SPH 1700. Similarly, total digestible nutrients (sum of both cuts) was recorded in CoFS-29 (13.0 t ha^{-1}) followed by SPV 2242 and least in MP Chari (11.13 t ha^{-1}). Among fertilizer levels, application of 125% RDF increased green and dry fodder yield by 8.8 and 9.6% over 100% RDF. Graded application of fertilizer also improved quality of fodder in terms of crude protein, ether extract and mineral ash resulted highest total digestible nutrients (14.1 tha^{-1}) under 125% RDF. Findings of our study shows that growing of sorghum multi-cut variety 'CoFS-29' with application of 125% RDF (100 kg N and 50 kg P_2O_5 and 50 kg K_2O ha^{-1}) improved fodder production and their quality.

Keywords: Fertility levels, fodder yield, multi-cut sorghum, quality

1. Introduction

India supports nearly 15% of the world's livestock being the leader in cattle (16%) and buffalo (55%) population. The livestock sector contributes 25.6% of the agricultural output (Anonymous, 2014). There is tremendous pressure of livestock on fodder, as the arable land for forage production is becoming scarce and fallow land and communal property resources available for grazing are declining. The ever-rising demand for fodder and feed for sustaining livestock production can be met through increasing productivity of fodder and utilizing untapped feed resources. The productivity of milk and other livestock products is about the lowest in the world because of huge gap between demand and supply of feed and fodders. Deficiency in feed and fodder has been identified as one of the major components in achieving the desired level of livestock production. At present, India faces a net deficit of 35.6% green

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fodder, 10.9% dry crop residues and 44% feed (Anonymous, 2013). Continuous supply of well-balanced nutritive forage is essential to the milch animals for enhancing milk productivity. Sorghum is an important crop widely grown throughout the year with high fodder production (Meena and Nepalia, 2018). It is fast growing, adaptive to vast environmental condition and provides palatable nutritious fodder to the animals. It is the most important food and fodder crop of dry land agriculture. Considering this, multi-cut genotypes of sorghum were developed for continuous supply of fodder for longer period. Being an exhaustive crop, yield and quality of sorghum fodder suffer heavily if proper amount of fertilizer is not applied (Midha et al., 2014). Therefore, these new multi-cut genotypes were grown to get information ontheir nutritive value under different fertility levels.

2. Materials and Methods

A field experiment was conducted during *kharif* season of 2015 at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India situated at 24°34' N latitude, 74º42' E longitude and altitude of 582.17 m above mean sea level. The soil of the experimental field was sandy clay loam in texture, slightly alkaline in reaction (pH 8.2), medium in available nitrogen (281.4 kg ha^{-1}) and phosphorus (21.5 kg ha^{-1}), while high in available potassium (315.4 kg ha^{-1}). The experiment consisted of 28 treatment combinations comprising seven multi-cut forage sorghum genotypes (SPV 2242, SPH 1700, SSG 59-3, CSH 20 MF, CSH 24 MF, MP Chari and CoFS-29) and four fertility levels *viz.,* 50, 75, 100 and 125 per cent recommended dose of fertilizers (RDF). The recommended dose of fertilizer for sorghum was 80 kg N+40 kg P_2O_5+40 kg K_2O ha^{-1} for this region. These treatments were tested in randomized block design with three replications. As per treatment, full dose of phosphorus and potassium and one-third dose of nitrogen was applied at the time of sowing. The remaining nitrogen dose was split into two equal parts, the first half was applied at the knee-high stage, while second half after first cut. The sorghum genotypes were sown on 28 June 2015 in opened furrows at 30 cm apart. The crop was irrigated at 10-15 days interval depending on rainfall. Standard agronomic and plant protection measures were adopted. The first cut of sorghum was taken 60 days after sowing and second cut on 45 days after first cut. Random chopped samples of green fodder were sun-dried and placed in the oven at 65°C for 72 hrs to estimate dry-matter percentage and then it was multiplied with respective green fodder yield to calculate dry fodder yield. Oven-dried samples were used for forage quality analysis. Crude protein, crude fibre, ether extract and mineral ash were determined by the method described by AOAC (2012). Total digestible nutrients (TDN) in percentage were calculated by the formula given by Moore et al. (1953).

TDN content (%)=Digestible crude protein (%)+Digestible crude fibre (%)+Digestible nitrogen free extract (%)+ [Digestible ether extract (%)×2.25]

Crude protein yield was calculated by multiplying crude protein content with dry-matter yield. The results were analysed using standard statistical procedure given by Gomez and Gomez (2010).

3. Results and Discussion

3.1. Growth parameters

The growth parameters of multi-cut forage sorghum were influenced significantly with genotypes and fertility levels (Table 1). In general, taller plant of sorghum were observed in first cut than second cut while thicker stem in second cut. Among genotypes, 'SPH 1700' produced tallest (2.99 m) and thicker plants during first cut whereas 'CoFS-29' in second cut. Furthermore, the maximum leaf to stem ratio was recorded in 'SPV 2242' and 'CSH 20 MF' during first and second cut, respectively. The differential behavior of these varieties could also be explained solely by the variation in their genetic makeup and high vigour in their growth parameters. Similar results were also obtained by Rana et al. (2013).

Graded application of fertilizers significantly increased plant height and stem girth of sorghum in both the cuts while leaf to stem ratio increased in first cut only (Table 1). The tallest (2.79

Table 1: Effect of genotypes and fertility levels on growth parameters of multi-cut forage sorghum

Treatments	Plant height (m)	Stem girth (cm)	Leaf to stem ratio	Plant height (m)	Stem girth (cm)	Leaf to stem ratio
	I Cut			II Cut		
Genotypes						
SPV 2242	2.40	0.74	0.42	2.43	0.85	0.30
SPH 1700	2.99	0.91	0.31	2.28	1.34	0.28
SSG 59-3	2.60	0.73	0.32	2.46	0.97	0.20
CSH 20 MF	2.66	0.82	0.28	2.10	1.37	0.33
CSH 24 MF	2.68	0.84	0.28	2.30	1.40	0.30
MP Chari	2.59	0.71	0.23	2.38	0.97	0.32
Co FS-29	2.47	0.73	0.28	2.48	0.79	0.25
SEm±	0.05	0.01	0.01	0.06	0.01	0.01
CD (p=0.05)	0.13	0.02	0.03	0.16	0.03	0.02
Fertilizer levels						
50% RDF	2.51	0.70	0.26	2.25	0.97	0.28
75% RDF	2.55	0.72	0.29	2.31	1.08	0.28
100% RDF*	2.67	0.77	0.32	2.36	1.14	0.28
125% RDF	2.79	0.92	0.34	2.48	1.20	0.29
SEm±	0.04	0.01	0.01	0.04	0.01	0.01
CD (p=0.05)	0.10	0.02	0.02	0.12	0.02	NS

and 2.48 m) and thicker (stem girth 0.92 and 1.20 cm) plants were observed under 125% RDF in both the cuts. Leaf to stem ratio was also improved with fertilizer levels in first cut only. In general, improvement in growth of sorghum plants with fertilizers appears to be on account of enrichment of soil with nutrients to the level of sufficiency. Further, extensive root system of crops helps in exploiting the maximum nutrients and water from soil for growth and development of plant right from early stage to maturity. Thus, better nutritional environment of soil might have resulted in greater synthesis of amino acid and other growth promoting substances which seems to have enhanced the meristematic activities in the plant thereby increased division, enlargement and elongation of cells resulting in higher plant growth (Choudhary and Prabhu, 2016; Mubeena et al., 2019).

3.2. Fodder yield

The result of this study revealed that the green and dry fodder yield of multi-cut sorghum was significantly influenced by genotypes and fertilizers (Table 2). The highest green (58.08 t ha^{-1}) and dry fodder (17.97 t ha^{-1}) yield were recorded in genotype 'SPH 1700' during first cut, however genotype 'CoFS-29' produced highest green and dry fodder yield in second cut. Furthermore, genotype 'CoFS-29' produced significantly highest total green (74.78 t ha^{-1}) and dry (23.77 t ha^{-1}) fodder yield and registered increases of 8.72, 11.24 and 17.41 per cent in total green fodder yield and 8.78, 11.28 and 16.80 per cent in total dry fodder yield over the genotypes 'CSH 24 MF', 'CSH 20 MF' and 'MP Chari', respectively. Genotypes 'SPV 2242', 'SSG 59-3' and 'SPH 1700' were found at par with 'CoFS-29'. The highest fodder yield of genotype 'CoFS-29' could mainly be attributed to comparatively higher plant height, stem girth and ratoonability of genotype. Several workers have also noticed the variation among the genotypes of sorghum for fodder yield and growth (Singh et al., 2010; Rana et al., 2013).

Green and dry fodder yield were increased significantly with each successive level of fertilizers up to 125% RDF in both the cuts (Table 2). Application of 125% RDF enhanced the total green and dry fodder yield by 8.8 and 9.6 per cent over recommended dose of fertilizer (100% RDF), respectively. The significant increase in fodder yield with increase in fertility levels might be due to build-up of soil fertility that led to increased nutrient availability that accelerating the process of cell division, enlargement and elongation which in turn showed luxuriant vegetative growth and resulted in higher fodder yield. Similar results were also obtained by Singh et al. (2010), Jat et al. (2013) and Sumeriya and Singh (2014).

3.3. Fodder quality

Various fodder quality parameters were influenced significantly with different sorghum genotypes and fertilizer levels (Table 3). Maximum crude protein (CP) content (8.7%) was found

Table 2: Effect of genotypes and fertility levels on green and dry fodder yield of multi-cut sorghum

	Green fodder yield (t ha^{-1})			Dry fodder yield (t ha^{-1})		
Treatments	I cut	II cut	Total	I cut	II cut	Total
Genotypes						
SPV 2242	45.32	28.00	73.32	14.22	8.97	23.19
SPH 1700	58.08	12.38	70.45	17.97	4.50	22.47
SSG 59-3	47.30	23.69	70.98	14.79	7.70	22.50
CSH 20 MF	52.28	14.94	67.22	16.26	5.10	21.36
CSH 24 MF	52.98	15.80	68.78	16.47	5.38	21.85
MP Chari	41.25	22.45	63.69	13.01	7.34	20.35
Co FS-29	44.84	29.94	74.78	14.07	9.70	23.77
SEm±	1.47	0.89	1.90	0.45	0.34	0.62
CD (p=0.05)	4.18	2.53	5.39	1.27	0.96	1.77
Fertilizer levels						
50% RDF	42.84	16.24	59.08	12.83	4.96	17.79
75% RDF	46.75	20.07	66.82	14.95	6.75	21.70
100% RDF*	50.74	22.85	73.58	16.01	7.54	23.55
125% RDF	55.12	24.95	80.07	17.25	8.57	25.82
SEm±	1.11	0.67	1.44	0.34	0.26	0.47
CD (p=0.05)	3.17	1.92	4.09	0.97	0.73	1.34

Table 3: Effect of multi-cut forage sorghum genotypes and fertility levels on fodder quality (%) on dry matter basis

Treatments	CP	CF	MA	EE	NFE	TDN
Genotypes						
SPV 2242	7.85	31.17	7.20	1.73	52.06	54.79
SPH 1700	8.53	31.51	7.25	1.67	51.03	54.62
SSG 59-3	8.53	28.63	7.14	1.68	54.03	54.72
CSH 20 MF	7.66	30.03	7.17	1.70	53.42	54.83
CSH 24 MF	8.59	30.11	7.20	1.66	52.44	54.65
MP Chari	8.70	29.81	7.11	1.64	52.74	54.68
Co FS-29	8.58	30.32	7.19	1.68	52.23	54.66
SEm±	0.11	0.16	0.02	0.01	0.18	0.02
CD (p=0.05)	0.32	0.45	0.07	0.02	0.51	NS
Fertilizer levels						
50% RDF	7.77	28.73	7.05	1.63	54.83	54.88
75% RDF	8.05	29.85	7.20	1.67	53.23	54.75
100% RDF*	8.54	30.78	7.23	1.70	51.74	54.65
125% RDF	9.05	31.54	7.24	1.71	50.46	54.56
SEm±	0.08	0.12	0.02	0.01	0.13	0.02
CD (p=0.05)	0.24	0.35	0.05	0.01	0.38	0.05

CP: Crude protein; CF: Crude fibre; MA: Mineral ash; EE: Ether extract; NFE: Nitrogen free extract; TDN: Total digestible nutrient in sorghum genotype 'MP Chari' while crude protein yield in 'CoFS-29' (Figure 1). However, lowest crude fibre, ether extract and nitrogen free extract was reported in 'SSG 59-3', MP Chari and 'SPH 1700', respectively. Almost similar total digestible nutrient content was observed in different genotypes but highest total digestible nutrient (13.0 t ha^{-1}) was computed in 'CoFS-29' (Figure 2). The increase in crude protein yield and total digestible nutrient in 'CoFS-29' was mainly owing to production of higher biomass in this genotype. Choudhary et al. (2018) also reported significant differences in crude protein content among guinea grass genotypes.

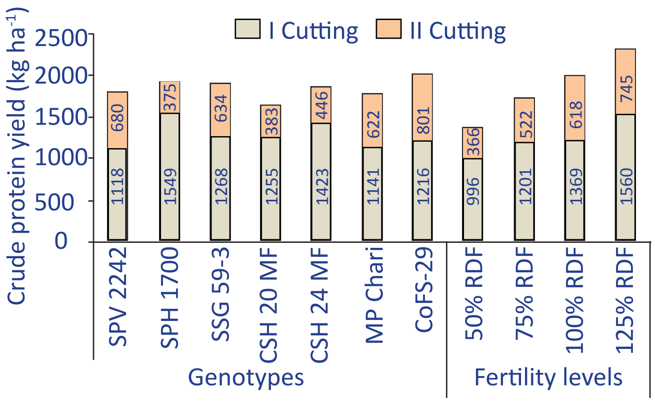

Figure 1: Effect of multi-cut sorghum genotype and fertility levels on crude protein yield

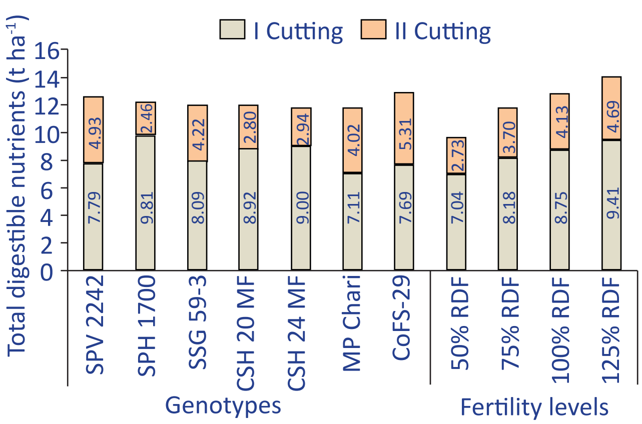

Figure 2: Effect of multi-cut sorghum genotype and fertility levels on total digestible nutrients

Successive increase in fertilizer levels significantly improved crude protein, crude fibre, mineral ash and ether extract content while nitrogen free extract and total digestible nutrient decreased with fertilizer rate. The improvement in crude protein content with increasing fertilizer levels may be the results of enhancement in amino acid formation. Our result confirms the findings of Choudhary and Prabhu (2014). Furthermore, increase in protein content in fodder resulted in reduction in NFE content.

4. Conclusion

Sorghum multi-cut variety 'CoFS-29' in conjunction 125% RDF (100 kg N and 50 kg P_2O_5 and 50 kg K_2O ha^{-1}) improved fodder production, crude protein yield and total digestible nutrients. SPV 2242 was found second better alternative genotype with respect to fodder yield and total digestible nutrients. Overall, varietal selection coupled with fertilization may prove as best for enhancing fodder productivity and quality of sorghum in Southern Rajasthan.

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