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EFFECT OF VARIETIES AND FERTILITY LEVELS ON GROWTH AND YIELD OF SINGLE-CUT FORAGE SORGHUM DURING SUMMER SEASON

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SUMMARY

A field experiment was conducted during summer season of 2023 at Hisar, Haryana to assess the effect of fodder sorghum varieties under different fertility levels. Four varieties (CSV 53F, HJ 541, HJ 513 and HC 308) were tested at four fertility levels (control, 75, 100 and 125% recommended dose of fertiliser) in factorial RBD with three replications. Among varieties, CSV 53F performed best in terms of growth parameters as well as in yield. The highest plant height, LAI, chlorophyll content, green fodder and dry fodder yield (52.44 t/ha and 13.46 t/ha, respectively) was recorded in CSV 53F which was statistically at par with HJ 541. The highest crude protein yield and digestible dry matter yield (DDMY) was also recorded in variety CSV 53F. Among fertility levels, application of 125% RDF gave significantly higher green fodder and dry fodder yield (56.41 t/ha and 14.69 t/ha, respectively) among lower fertiliser levels but was found statistically at par with 100% RDF (75 kg N + 30 kg P_2O_5 + 30 kg K_2O per ha). In nutshell, use of CSV 53F or HJ 541 performed better and application of 100% RDF was the most suitable fertilization practice to achieve maximum yield under semi-arid conditions of Haryana.

Keywords: Sorghum, fertility levels, green and dry fodder yield, LAI, DDMY

India holds the top position globally in livestock population (536 million) but India's milch animal productivity (1538 kg/year) is significantly lower than the global average (2238 kg/year) (Vijay *et al*., 2018). This is due to lower fodder production and productivity. Fodder crops are grown only in 8.6 mha *i.e*. 4.89 per cent of the total cultivated area and that too on marginal lands, with a yearly fodder production of 866.6 mt (400.6 mt green and 466 mt dry fodder). Presently, country is facing net deficit of 35.6 % green fodder and 10.95% dry fodder (IGRI Vision, 2050). So, there is a need to give emphasis on increasing the fodder production.

Sorghum [*Sorghum bicolor* (L.) Moench] is one of the most important fodder crops of North India during summer and *kharif* season and is increasingly recognized for its potential to enhance livestock nutrition and improve agricultural sustainability. In India, the area under sorghum is approximately 7.38 mha with an annual production of 8.71 million tonnes (Anonymous, 2022). Single cut forage sorghum yields about 400-500 and 100-150 q/ ha of green and dry fodder with good management practices and this can be further increased when improved agro-technologies are involved (Satpal *et al*., 2020).

Fodder sorghum is a vital component of India's livestock feed and it plays an essential role in supporting the country's agricultural economy. It has ability to thrive in arid and semi-arid regions, this drought-resistant crop offers farmers a reliable source of high-quality forage that can withstand challenging climatic conditions (Toor, 2020). As demand for animal feed continues to rise, the cultivation of fodder sorghum is becoming increasingly important, providing a sustainable solution to enhance livestock productivity while ensuring food security across rural communities. The increasing focus on sustainable practices in agriculture highlights the significance of fodder sorghum, as it not only supports livestock health but also contributes to soil conservation and improved biodiversity (Rao, 2019).

The introduction of sorghum in any region has been evaluated based on key growth parameters such as plant height, leaf area index and biomass production, which are critical indicators of overall health and yield. The relationship between growth parameters and yield in fodder sorghum is significant, as these parameters directly influence the plant's ability to photosynthesize, accumulate biomass and ultimately produce a higher quantity of forage. By understanding how these growth parameters interact can help farmers to optimise their cultivation practices that will lead to improved yield and better quality fodder for livestock (Patel *et al*., 2019). The choice of location-specific varieties and appropriate fertiliser levels can further enhance the growth parameters, ensuring that fodder sorghum is well-suited to the local environment and thus maximising nutrient availability for optimal plant development. By selecting the right combination of varieties and fertiliser levels, farmers can tailor their approach to meet the specific needs of their soil and climate. This ultimately results in healthier plants that are more resilient to pests and diseases (Kumar *et al*., 2018). This tailored approach not only boosts productivity but also contributes to sustainable agricultural practices by optimising resource use and reducing the adverse environmental impact of farming.

Keeping this in view, the field investigation was carried out to evaluate the production, productivity and quality of single-cut varieties of forage sorghum under different fertility levels.

MATERIALS AND METHODS

The field experiment was carried out during summer season of 2023 at Research Farm, Department of Agronomy, CCS Haryana Agricultural University, Hisar (29° 10' N of 75° 46' E, with an average elevation of 215.2 m above mean sea level). It has a semi-arid and sub-tropical climate with hot dry summer with severe cold winters. Average annual rainfall of the region is about 450 mm. The meteorological data for the crop season on standard meteorological week basis, as obtained from meteorological observatory of the Haryana Agricultural University are presented in Table 1. The crop received a total rainfall of 136.2 mm. The soil texture was sandy loam with pH of 7.8 and available N, P and K were 132, 12 and 280 kg/ha, respectively. The experiment consisted of 16 treatment combinations comprising four single-cut forage sorghum genotypes (CSV 53F, HJ 541, HJ 513 and HC 308) with four fertiliser levels *viz*. control, 75, 100 and 125 per cent of recommended dose of fertiliser (RDF). These treatments were tested in factorial randomized block design (RBD) and each treatment was replicated thrice. Recommended dose of fertiliser (RDF) is 75 kg N + 30 kg P_2O_5 + 30 kg K_2O per ha and its application is: full dose of phosphorus and potassium + 50 kg nitrogen per ha was applied as basal dose and 25 kg N/ha was top dressed at 30 days after sowing (DAS). Sorghum varieties as per treatment were sown manually on 10 April 2023 (standard week 15) on a well prepared seed bed with row spacing of 25 cm apart and using seed rate of 50 kg/ha. All the other standard agronomic practices were followed as per the package of practices for *kharif* crops of CCS Haryana Agricultural University, Hisar (Anonymous, 2021). At 50 per cent flowering stage the crop was harvested and the data on green fodder yield and yield attributes were recorded. The plant samples collected after harvest were sun dried and then completely dried in hot air oven till a constant weight was obtained. This dried plant material was finely grounded and sieved (2 mm sieve size) using Willy grinder and was used for the estimation *in-vitro* dry matter digestibility (IVDMD) as per Barnes *et al.* (1971) method. Digestible dry matter yield (q/ha) was calculated by multiplication of IVDMD with dry matter yield (q/ha). Chlorophyll content was measured by using Nitrogen Balance Index (NBI) meter. Data was analyzed by using OPSTAT software available at CCS Haryana Agricultural University website (Sheoran *et al*., 1998). The results are presented at five per cent level of significance (P=0.05) for making comparison between the treatments.

RESULTS AND DISCUSSION

Varieties

Data (Table 2) reveals that among varieties, plant population at harvest did not differ significantly and an average of 13.25 plants per metre row length was recorded. The highest plant height (261.33 cm) was recorded in CSV 53 F at harvest which was on a par with HJ 541. Leaf area index (LAI) was significantly higher in CSV 53 F (6.34) and was statistically at par with HJ 541. The maximum dry matter accumulation (DMA) was recorded in CSV 53 F (113.83 g/plant) but it remained at par with HJ 541. Leaf blade length and width at harvest was found highest in variety CSV 53F (83.18 cm and 7.08 cm, respectively) and was found statistically at par with HJ 541. The highest chlorophyll content was recorded

TABLE 1
Mean weekly weather parameters during summer season of 2023 recorded at experimental area, CCS HAU, Hisar

Standard week	Temperature (°C)		Relative humidity (%)		Rainfall (mm)
	Maximum	Minimum	7 a.m.	7 p.m.	
15	36.5	16.4	67	17	0.0
16	38.1	19.3	58	23	0.0
17	35.1	19.3	50	29	0.0
18	31.1	19.7	79	44	1.3
19	38.9	19.5	48	14	0.0
20	39.6	22.8	61	27	6.4
21	39.4	22.9	63	35	36.0
22	31.7	21.4	79	51	16.0
23	38.1	24.6	61	33	0.0
24	38.5	26.1	66	42	6.2
25	39.1	28.3	72	44	0.0
26	34.7	26.8	88	73	12.6
27	37.3	27.0	85	63	15.1
28	33.7	26.3	83	69	11.1
29	34.6	27.7	90	72	31.5

with CSV 53F (42.09%) which was significantly higher over other varieties except that of HJ 541 with which it was statistically at par. The differences in the genetic makeup might be responsible for the differential behavior in growth parameters of these varieties (Meena *et al.*, 2012). Earlier findings of Oberoi and Kaur (2020) and Satpal *et al.* (2020) corroborated with these results.

Perusal of data in Table 3 reveal that the maximum green and dry fodder yield (52.44 and 13.46 t/ha) were recorded in CSV 53F and was found statistically at par with HJ 541 and both of these were superior over rest of the varieties. The differential yields by sorghum varieties could be ascribed to their genetic makeup (Satpal *et al.*,2016; Kishor, 2017 and Gurjar *et al.*, 2019). Maximum per day productivity (PDP) of green fodder yield (5.81 q/ha/day) was produced by HJ 541 which was found statistically at par with CSV 53F, while PDP of dry fodder yield (1.482 q/ha/ day) was recorded in CSV 53F which was on a par with HJ 541. Highest digestible dry matter yield (DDMY) was recorded in CSV 53F (69.03 q/ha) which was found statistically at par with HJ 541. Maximum crude protein yield was found in CSV 53F (11.24 q ha^{-1}) which was statistically on par with HJ 541.

Fertility levels

Perusal of the data from Table 2 depicts that fertility levels had significant influence on growth, yield and quality in fodder sorghum. The plant population did not show any significant difference under different fertility levels. Maximum plant height (266.25 cm) and LAI (7.22) was recorded with 125% RDF which was statistically at par with 100% RDF. The increase in fertility levels from control to 100% RDF tended to significantly increase dry matter accumulation from 99.17 to 113.00 g/plant, but further increase in fertility levels failed to exhibit significant response. The maximum leaf blade length and width (88.10 and 7.78

TABLE 2
Growth of forage sorghum varieties as influenced by different fertility levels

Treatment	Plant population at harvest	Plant height (cm) at harvest	LAI at harvest	DMA (g/ plant) at harvest	Leaf length at harvest (cm)	Leaf width at harvest (cm)	Chlorophyll content (%) at harvest
(A) Varieties							
CSV 53F	13.50	261.33	6.34	113.83	83.18	7.08	42.09
HJ 541	13.33	252.58	6.20	110.33	80.94	6.91	41.78
HJ 513	13.17	237.67	5.63	104.17	77.80	6.48	40.62
HC 308	13.00	242.08	5.79	107.83	79.42	6.27	40.02
SEm±	0.31	3.63	0.16	1.83	1.05	0.10	0.47
CD (P=0.05)	NS	10.53	0.47	5.31	3.05	0.30	1.36
(B) Fertility levels							
Control	13.17	215.50	4.26	99.17	67.56	4.85	35.13
75% RDF	13.25	249.75	5.61	107.58	79.80	6.55	41.11
100%RDF	13.25	262.17	6.86	113.00	85.89	7.57	43.94
125%RDF	13.33	266.25	7.22	116.42	88.10	7.78	44.33
SEm±	0.31	3.63	0.16	1.83	1.05	0.10	0.47
CD (P=0.05)	NS	10.53	0.47	5.31	3.05	0.30	1.36

100% RDF is 75:30:30 :: N:P2O5:K2O kg/ha.

TABLE 3
Yield of forage sorghum varieties as influenced by different fertility levels

Treatment	Green fodder yield (t/ ha)	Dry matter yield (t/ ha)	PDP of GFY (q/ ha/ day)	PDP of DFY (q/ ha/ day)	DDMY (q/ ha)	Crude protein yield (q/ha)
(A) Varieties						
CSV53F	52.44	13.46	5.76	1.482	69.03	11.24
HJ 541	51.56	13.06	5.81	1.475	66.39	10.83
HJ 513	47.21	11.96	5.37	1.361	59.50	9.61
HC 308	47.55	12.23	5.20	1.339	61.91	9.55
SEm±	0.55	0.18	0.06	0.020	0.97	0.18
CD (P=0.05)	1.60	0.51	0.18	0.058	2.80	0.52
(B) Fertility levels						
Control	37.83	8.91	3.90	0.918	41.72	5.79
75% RDF	49.70	12.74	5.53	1.419	63.07	9.62
100%RDF	54.83	14.36	6.23	1.633	74.98	12.64
125%RDF	56.41	14.69	6.48	1.687	77.06	13.18
SEm±	0.55	0.18	0.06	0.020	0.97	0.18
CD (P=0.05)	1.60	0.51	0.18	0.058	2.80	0.52

cm, respectively) at harvest was recorded in 125% RDF but was statistically at par with 100% RDF. Similar findings were reported by Meena *et al.* (2017) and Chongtham *et al.* (2018). The maximum chlorophyll content (44.33%) was recorded at 125% RDF at harvest which was significantly superior over 75% RDF and control but was at a par with 100% RDF.

Data in Table 3 reveal that the highest green and dry fodder yields (56.41 and 14.69 t/ha, respectively) were recorded with 125% RDF and was statistically at par with 100% RDF. The increase in green and dry fodder yields were 49.11, 13.50, 2.88 and 64.87, 15.31, 2.30 per cent with 125% RDF over control, 75% and 100% RDF, respectively. Similar results were also reported by Sujathamma *et al.* (2015), Kubsad (2018) and Satpal *et al.* (2019). Per day productivity (PDP) of green fodder yield (6.48 q/ ha/day) was significantly higher with 125% RDF over lower fertiliser doses. This clearly indicates that with increasing fertility levels from 100% to 125% RDF, there was significant improvement in fodder production and productivity. But, for PDP of dry fodder yield it significantly increased up to 100% RDF (1.633 q/ha/ day). Satpal *et al.* (2016) also reported increase in per day productivity of green fodder up to 100% RDF and up to 125% RDF in dry matter. The maximum DDMY (77.06 q/ha) was recorded with the application of 125% RDF and was statistically at par with 100% RDF. Oberoi and Kaur (2019) reported that increased levels of nitrogen in fodder oats have increased the IVDMD content and thus there was increase in DDMY. The highest CP yield (13.18 q/ha) were estimated with 125% RDF over rest of the fertility levels. This could be ascribed due to increase in CP content with increase in fertiliser levels (Joshi *et al.*, 2009).

CONCLUSION

Based on the above findings, it can be inferred that application of 100% RDF and varieties CSV 53F and HJ 541 performed better during summer season. Among varieties, CSV 53F gave best results in terms of green fodder, dry fodder and digestible dry matter yield (52.44, 13.46 and 6.90 t/ha, respectively) and was statistically at par with HJ 541. Varieties HJ 541 and CSV 53F were found to be the most efficient in terms of per day productivity for green fodder and dry matter yield. Also, they are equally good in quality parameters like DDMY and CPY. Among fertiliser levels, though 125% RDF reported best results but was equally good as 100% RDF in terms of green and dry fodder yield as well as growth parameters like plant height, LAI and leaf length and width. So, to achieve maximum fodder yield with better quality use of varieties CSV 53F and HJ 541 with application of 100% RDF (75 kg N + 30 kg P_2O_5 + 30 kg K_2O /ha) should be recommended.

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