Forage Res., **51**(4) : pp. 566-575 (2026) **http://forageresearch.in**

PERFORMANCE OF SINGLE CUT HYBRIDS, BROWN MID RIB (BMR) AND HURDA SORGHUM GENOTYPES UNDER VARYING LEVELS OF NPK FERTILIZER

SATPAL[1]*, B. GANGAIAH[2], S. DEVI[3], N. KHAROR[1], K. K. BHARDWAJ[4], P. KUMARI[1] AND B. L. SHARMA[1]

[1]Department of Genetics & Plant Breeding (Forage Section), [3]Department of Botany & Plant Physiology, [4]Department of Soil Science
CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India
[2]ICAR - Indian Institute of Millets Research, Hyderabad-500030 (Telangana), India
**(e-mail : satpal.fpj@gmail.com)*
(Received: 11 March 2026; Accepted: 30 March 2026)

SUMMARY

A field experiment was conducted to study the impact four graded levels of recommended dose of fertilizers (RDF) in main plot i.e. 0, 50, 100 and 150% with 80.0-17.5-33.2 kg N-P-K/ha as RDF on fodder productivity, quality and economics of six sorghum [*Sorghum bicolor* (L.) Moench] genotypes (2 single cut non-BMR forage hybrids *i.e.* SPH 2057 with CSH 40F as check and 2 brown mid rib (BMR) genotypes i.e. SPV 3089 with CSV 43BMR as check and 2 Hurda sorghum genotypes i.e. PKV Ashwini and PDKV Kartiki) in sub-plot at Hisar (Haryana), India during *kharif* season of 2025 using Split plot design with two replications. Results revealed that non-BMR hybrid 'SPH 2057' with 41.6 and 9.9 t/ha of green and dry fodder yields has excelled all the other types of genotypes but on a par with hybrid check 'CSH 40F' only and was promising from crude protein and net income point of view also. Among BMR genotypes, 'SPV 3089' with 29.2 and 6.9 t/ha of green and dry fodder yields has excelled its check 'CSV 43BMR' by 43.8 and 38.0%, respectively. Higher fodder yield of 'SPV 3089' over its check was due to its tall plants and more leaf to stem ratio. HCN content was the least in 'SPH 2057' (35.82 µg/g) and the highest (65.36 µg/g) in 'PKV Ashwini'. Highest fodder producing genotype (SPH 2057) was more depletive of soil nutrients (NPK). Among RDF levels, significant improvement was seen in chlorophyll content (SPAD units) values only with 150% RDF application over RDF and thus RDF was best for realizing not only the fodder yield but also returns. Fertilizers (RDF) have contributed to 63.4, 58.5 and 46.4% green, dry fodder yield and B:C enhancements at the test site as compared to 0% RDF *i.e.* unfertilized control (21.6, 5.3 t/ha and 1.12). Inherent soil fertility (0% RDF) has contributed to 68.3-5.5-57.6 kg/ha N-P-K uptake of forage sorghum crop producing highest dry fodder/kg NPK uptake (77.6-963.8-91.8 kg fodder / kg N-P-K) and uptake increased 2.06-3.27-1.82 times with RDF use. HCN content increased from 36.04 to 67.40 µg/g as RDF increased from 0 to 150%. It is concluded that single cut forage sorghum hybrid 'SPH 2057' and 'CSH 40F' are promising while 'SPV 3089' and 'PDKV Kartiki' are promising among BMR and hurda genotypes, respectively for fodder production. Application of 100% RDF (80.0-17.5-33.2 kg/ha N-P-K) was recommended for higher fodder yield, quality and income. Study proves that scope lies for selecting hybrids for higher crude protein yields at lower fertilizer levels.

Key words: Sorghum, single-cut, forage, brown mid rib (BMR), hurda sorghum, genotypes, fertilizer levels, fodder yield, HCN and crude protein

Sorghum [*Sorghum bicolor* (L.) Moench] is the widely grown cereal fodder crop of India (2.6 m ha) and single cut sorghums account for 23.1% of this (PrabhakarBabu, 2018). Single cut sorghum's ability to produce high biomass (Satpal *et al.*, 2020), generally harvested during 65 to 95 DAS on the attainment of 50% flowering stage or at 80 DAS when flowering is delayed. The crop performs well under wide edapho-climatic conditions across the country including Andaman & Nicobar Islands (Gangaiah and Kundu, 2020), under salt affected conditions (Devi *et al.*, 2021) and also during summer season. Continuous efforts are being made to improve the fodder productivity and quality under All India Coordinated Sorghum Improvement Project (AICSIP). For this, promising new genotypes of the breeding program

(AVT-II) are tested for agronomic performance against the check cultivars. In recent past, brown mid rib (BMR) sorghum cultivars with lower NDF, ADF, cellulose, lignin content, higher digestibility, intake, feed efficiency and animal performance (Singh *et al.*, 2023) have been evolved and thus may replace white midrib single cut forage sorghums. Hurda sorghums are dual purpose sorghums with sweet grains harvested at soft dough stage while the green biomass serves as quality fodder for livestock (Gangaiah *et al.*, 2025). High productivity of fodder sorghums results in removal of huge quantity of primary nutrients (Satpal *et al.*, 2021); it is established that besides N, the supply of P and K fertilizers also have additive effects on forage sorghum yield and income (Satpal *el al.*, 2025). High productivity of forage sorghums results in removal of huge quantity of primary nutrients (NPK) which is evident from the fact that a silage producing sorghum crop removed 13-4.6-15 kg N-P_2O_5-K_2O per tonne of biomass produced (Nathan *et al.*, 2020). Such high nutrient removal by fodder sorghum calls for adequate supply both through fertilizer and manure application.

Indian soils are deficient in primary nutrients which is clear from the report of more than 50 million soil samples from across the country analysed during 2015-16 to 2018-19 in the government-approved laboratories. The soil test results indicate that 85, 97, 83 and 71 % samples were found to be deficient in organic carbon, available N, P and K (Kumar, 2022). In Haryana, the situation was more precarious as 99, 24.8 and 10 % of the 1.4 million soil samples analyzed were very low for available N, P and K while 31.7 and 19.0% of samples were low for available P and K. Thus, 99-56.5-29% samples were deficit for soil fertility and can't support high yield levels without fertilizer use. In this context, there is need to assess recommended fertilization schedules of crops keeping in view their increasing nutrient requirements, depleting soil supplies and reduced fertilizer use. Selection of high yielding but low fertilizer requiring crop cultivars also needs due attention. In this context, the present study was conducted to assess the response of new single-

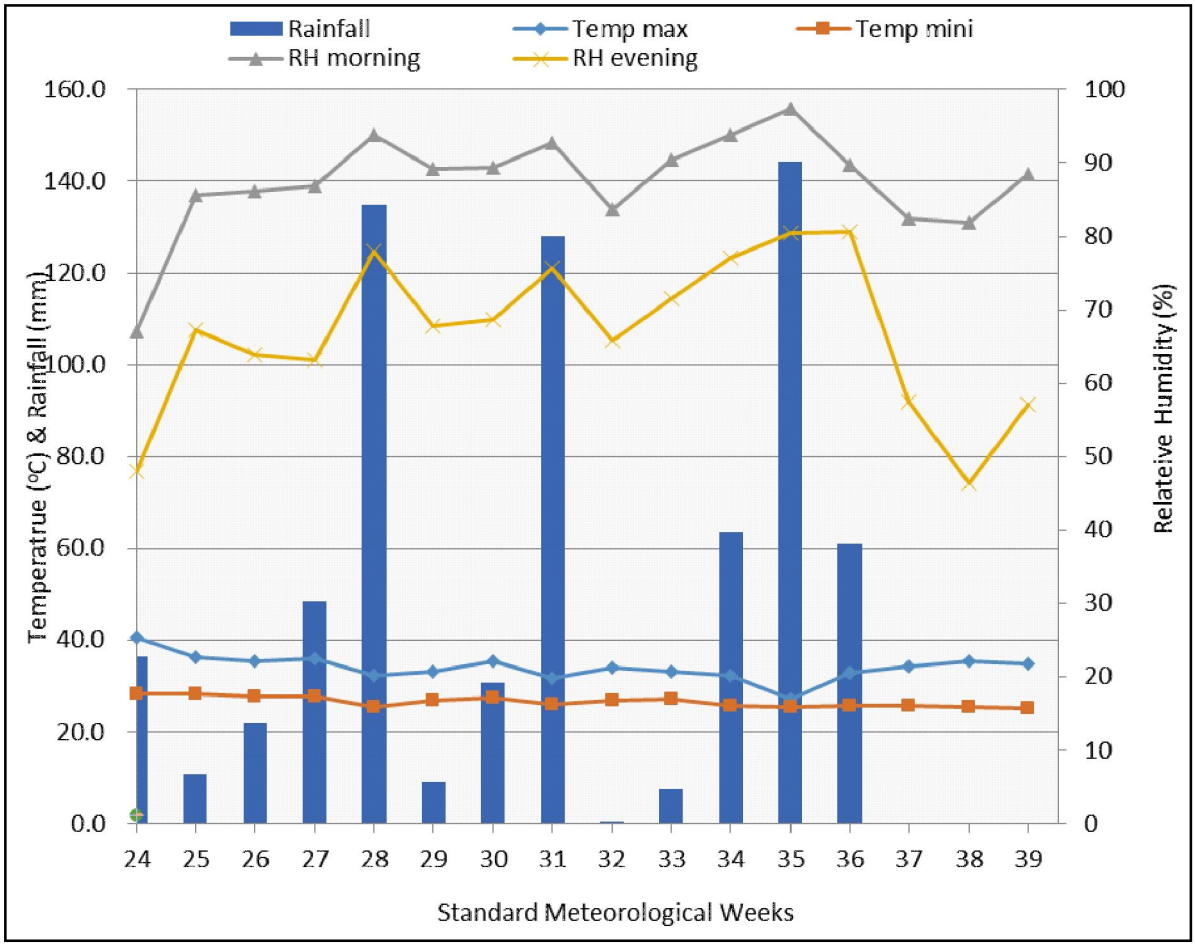

Fig. 1. Weekly weather data during the crop period *kharif* 2025.

cut forage sorghum hybrids, BMR (along with their checks) and hurda types to graded levels of primary nutrient (NPK) fertilization.

MATERIALS AND METHODS

A field experiment was conducted during rainy (*kharif*) season of 2025 at Forage Section Research Area, Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar (29° 10' N of 75° 46' E, at an average elevation of 215.2 m above mean sea level) having semi-arid and sub-tropical climate with hot dry summer and severe cold winters and receives 450 mm precipitation per annum. A rainfall of 458.2 mm was received during crop duration (80 day). Weekly weather parameters *i.e*. temperature (°C), relative humidity (%) and rainfall (mm) during the crop duration are given Fig. 1. The experimental sandy-loam soil samples drawn from plough layer at the start of study with pH 7.8 was rated as low for organic carbon (0.42%), available N (120.5 kg/ha), and medium for available P and K (13.2 and 227.6 kg/ha). Twenty-four treatments formed by combination of six single-cut forage sorghum genotypes (two hybrids *i.e*. CSH 40F, SPH 2057, two BMR varieties *i.e*. SPV 3089, CSV 43 BMR and two hurda sorghum genotypes *i.e*. PKV Ashwini and PDKV Kartiki) and four recommended dose of fertilizer (RDF, 80.0-17.5-33.2 kg/ha N-P-K) levels (control, 50 % RDF, 100% RDF and 150% RDF) were evaluated in split plot design with two replications, keeping fertilizer levels in main plot and genotypes in sub plot. Entire P and K along with $^1/_2$ N was applied basal at the time of sowing in last ploughing and remaining $^1/_2$ N was top dressed at 30 days after sowing (DAS). Crop was sown manually on June 21, 2025 in rows at 25 cm apart and were harvested at 80 DAS (September 9, 2025) but days to 50 per cent flowering stage were recorded in leftover two rows per plot. All the other package of practices for *kharif* crops of CCS Haryana Agricultural University, Hisar, were followed for forage sorghum culture (Anonymous, 2023).

The samples for estimation of HCN were taken at 30 DAS from the portion of the plant immediately below the uppermost leaf collar and HCN content was estimated as per Hogg and Ahlgren (1942). The amount of HCN (µg/g) was calculated on fresh weight basis with the help of standard curve. For standard curve, different concentration of KCN were taken and absorbance at 515 nm was recorded using spectrophotometer. Total nitrogen content was estimated in dried and grinded samples (2 mm sieve size) collected at 50 per cent flowering stage according to the Kjeldahl method (FOSS Kjeltec 8100) (AOAC, 2016). The crude protein content (CPC) was based on total nitrogen (N) multiplied by 6.25. *In-vitro* dry matter digestibility (IVDMD) was estimated by FOSS NIRS DS3 feed analyzer instrument. Crude protein and digestible dry matter yield (kg/ha) were calculated by multiplication of CPC and IVDMD with dry matter yield (q/ha) divided by 100, respectively. Neutral detergent fiber (NDF), and acid detergent fiber (ADF) concentrations were determined using a FOSS Fibertech 8000. Phosphorus was determined by the vanado-molybdo-phosphoric yellow color method as described by Koenig and Johnson (1942), while potassium content was estimated using the flame photometric method described by Richards (1954). Data were 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 treatments.

RESULTS AND DISCUSSION

Genotypes

Data (Table 1) reveals significant differences in days to 50% flowering (DFF), plant height, Leaf Area Index (LAI) and Leaf : Stem (L/S) ratio on fresh weight basis. Among hybrids, test hybrid (SPH 2057) took significantly more number of days (93.6) to attain 50% flowering than its check (CSH 40F). Among BMR genotypes, test entry (SPV 3089) took significantly more number of days (95.4) to attain 50% flowering stage than check genotype (CSV 43 BMR). Among hurda sorghum varieties (PKV Ashwini and PDKV Kartiki), no significant difference was observed in days to 50% flowering. Overall, all the genotypes attain days to 50% flowering > 90 days except CSV 43 BMR. Plant height of both hybrids (test and check) and both BMR genotypes were on a par with each other. However, among hurda sorghum varieties, 'PDKV Kartiki' recorded significantly taller plant heights (226.6) than 'PKV Ashwini'. On fresh weight basis, the L/S ratio of both hybrids (test and check) and hurda sorghum varieties were on a par with each other. However, BMR genotypes significantly differed with each other for LS ratio with highest values in 'SPV 3089'. LAI of both hybrids (test and check) were on a par with each other at 40 DAS and at harvest. Among hurda sorghums, 'PDKV Kartiki' has recorded significantly higher LAI (4.74 and 5.75) than 'PKV

TABLE 1
Performance of single cut forage sorghum genotypes to different fertilizer levels

Treatments	Days to 50% flowering	Plant height (cm)	No of plant/ m^2	Green fodder yield (t/ha)	Dry fodder yield (t/ha)	Per day productivity of GF (kg/ha)	Per day productivity of DM (kg/ha)
Fertilizer Levels							
0% RDF	95.0	176.4	62.2	21.6	5.3	227.5	55.4
50% RDF	93.6	207.2	60.6	29.7	7.1	317.4	76.0
100% RDF	92.3	226.8	60.9	35.3	8.4	382.0	90.9
150% RDF	90.8	235.4	62.3	37.1	8.8	407.2	96.5
SEm±	0.5	4.9	0.8	0.7	0.2	8.4	2.0
C.D. (P=0.05)	2.4	22.6	NS	3.4	0.8	39.3	9.4
Genotypes							
CSH 40F*	91.3	234.6	61.8	38.7	9.3	426.1	102.5
SPH 2057	93.6	238.5	61.5	41.6	9.9	445.7	106.6
SPV 3089	95.4	203.0	65.3	29.2	6.9	307.2	72.5
CSV 43 BMR*	86.3	195.8	59.2	20.8	5.0	242.2	57.8
PDKV Ashwini	95.3	170.0	60.3	22.4	5.3	236.1	56.3
PDKV Kartiki	95.8	226.6	60.8	32.8	7.9	343.7	82.5
SEm±	0.6	3.7	1.7	1.1	0.3	11.5	2.9
C.D. (P=0.05)	1.7	11.1	NS	3.2	0.8	34.3	8.5
B at same level of A							
SEm±	1.3	11.9	1.9	1.8	0.4	20.6	4.9
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS
A at same level of B							
SEm±	1.2	8.4	3.1	2.1	0.5	22.7	5.6
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS
C.V.%	1.7	5.00	6.71	10.0	10.3	9.8	10.1

*Checks.

Ashwini' at 40 DAS and at harvest. However, among BMR varieties, 'SPV 3089' attained significantly higher LAI (4.73 and 5.78) than 'CSV 43 BMR' at 40 DAS and at harvest.

Both green and dry fodder yields of 'SPH 2057' were highest among all the other genotypes except 'CSH 40F'. Tall stature of plants and high LAI values of 'SPH 2057' were the reasons for its yield superiority.

Among all the genotypes, hybrids performed superior in green fodder and dry matter yield. Most promising genotype was a test hybrid 'SPH 2057' with highest GFY (41.6 t/ha) and DMY (9.9 t/ha) though it was at par with 'CSH 40F'. Among BMR genotypes, SPV 3089 has excelled the check 'CSV 43 BMR' for green and dry fodder yields but 'PDKV Kartiki' was at par on higher side. Poor performance of BMR check (CSV 43 BMR) and Hurda variety (PKV Ashwini) was ascribed to their shorter plant height and lower LAI values.

Among hurda sorghum genotypes (PKV Ashwini and PDKV Kartiki), per day green and dry fodder productivity was significantly higher in 'PDKV Kartiki'. Per day green and dry fodder productivity too, fared badly for check with significantly lower values than the test genotype of 'BMR SPV 3089' (Per day productivity of GFY and DMY 307.2 and 72.5 kg/ha/day, respectively). But in case of hybrids, both test genotype and check being at par with each other performed better among all the genotypes, for per day green and dry fodder productivity, with higher values with 'SPH 2057' (Per day productivity of GFY and DMY 445.7 and 106.6 kg/ha/day, respectively).

Superior per day productivity of 'SPH 2057' was ascribed to its higher plant height and LAI and higher yield although its days to 50% flowering were >90 days. BMR genotypes has recorded significantly lower per day productivity. Low per day productivity of these genotypes was due to lesser plant height & LAI and further longer duration for flowering / harvest stage (>90 days) which render them unfit for Hisar location. The differential values of SCFS genotypes could be ascribed to their genetic makeup (Meena *et al*., 2012).

Quality parameters data was presented in Table 4. Genotypes differed for HCN contents and they remained below critical limit (200 µg/g at 30 days). 'SPH 2057' has the significantly lowest HCN content, however 'SPV 3089', 'PDKV Kartiki' (<50 µg/g), while 'CSH 40F', 'CSV43 BMR' and 'PKV Ashwini' (50-75 µg/g) levels of HCN. Yield superiority of 'SPH

TABLE 2
Physiological parameters of single cut sorghum genotypes at different fertilizer levels

Treatments	Leaf to stem ratio		Leaf area index		Chlorophyll content (SPAD units)		
	On fresh weight basis	On dry weight basis	At 40 DAS	At harvest	At 25 DAS	At 40 DAS	At harvest
Fertilizer Levels							
0% RDF	0.30	0.13	2.74	4.77	10.07	17.10	22.16
50% RDF	0.34	0.15	4.74	5.64	15.73	22.83	29.23
100% RDF	0.36	0.15	5.51	6.42	18.31	24.66	32.49
150% RDF	0.37	0.16	5.75	6.60	19.96	26.01	33.55
SEm±	0.01	0.004	0.06	0.11	0.11	0.21	0.24
CD (P=0.05)	0.04	0.018	0.28	0.50	0.50	0.99	1.10
Genotypes							
CSH 40F*	0.32	0.14	5.02	6.41	17.22	23.97	30.83
SPH 2057	0.34	0.15	5.10	6.61	17.45	24.22	31.03
SPV 3089	0.38	0.16	4.73	5.78	15.61	22.24	28.91
CSV 43 BMR*	0.34	0.15	4.19	5.17	14.64	21.04	27.63
PDKV Ashwini	0.35	0.15	4.35	5.43	14.86	21.52	28.16
PDKV Kartiki	0.33	0.14	4.74	5.75	16.33	22.90	29.58
SEm±	0.01	0.01	0.06	0.07	0.23	0.31	0.38
CD (P=0.05)	0.03	NS	0.17	0.20	0.69	0.91	1.14
B at same level of A							
SEm±	0.02	0.01	0.15	0.26	0.26	0.52	0.58
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS
A at same level of B							
SEm±	0.02	0.01	0.12	0.16	0.43	0.60	0.74
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS
CV%	9.30	-	3.37	3.28	4.07	3.81	3.69

2057' continued for crude protein (CP) content and CP yield also over all other genotypes. Among all, BMR genotypes fared well for IVDMD, maximum value (52.65%) estimated in 'SPV 3089' being on a par 'CSV 43BMR'. But maximum DDMY (5159.0 kg/ha) was recorded in the test hybrid 'SPH 2057', primarily due to its high dry matter yield, despite its lower IVDMD compared with the BMR genotypes. Maximum ADF (34.31%) content was estimated in 'PKV Ashwini' being at par with 'PKV Kartiki' and 'SPH 2057'. Significantly highest NDF (59.56%) content was estimated in 'PKV Ashwini'. For quality traits, hybrid check 'CSH 40F' also fared well among all genotypes.

Recommended Dose of Fertilizers (RDF)

Perusal of the data of fertilizer levels (Table 1) shows that except chlorophyll content (SPAD units at 25 and 40 DAS), no other growth parameter was improved significantly due to 150% RDF over 100% RDF. On the contrary, a reduction in RDF by 50% and complete exclusion of fertilizers (0% RDF, un-fertilized control) proved detrimental to crop growth and yields as well. Unfertilized crop has significantly delayed 50% flowering and has low leaf production as evident from markedly lower LS ratio than 50% RDF and RDF. For plant height, both 0 and 50% RDF could bring marked reductions in their values over their respective succeeding level of RDF *i.e*. 100% RDF and 150% RDF. For LAI, highest values were observed with the application of 150% RDF which were significantly higher over lower levels of RDF except that with 100% RDF at 40 DAS and at harvest.

There was no significant reduction in the leaf to stem ratio (fresh and dry) from 150% RDF to 50% RDF. However, reduction was significant when fertilizer dose was reduced from 50% RDF to control (no fertilizer). The leaf to stem ratio (fresh and dry) improved slightly from 100% RDF to 150% RDF (2.8 and 6.7 per cent, respectively).

Green fodder and dry matter yields realized with RDF use (35.3 and 8.4 t/ha) were reduced by 15.9 and 15.5% with 50% RDF that got further reduced by 27.3 and 25.4% with 0% RDF as compared to 50% RDF. Further the data indicated that fertilizers (RDF) have contributed to 38.8 and 36.9% of green and dry fodder yields realized at the test site. Yield reduction reported in this study due to reduced RDF are close to those reported by Satpal *et al*. (2020) and Satpal *et al*. (2025).

TABLE 3
Quality parameters of single cut sorghum genotypes at different fertilizer levels

Treatments	HCN at 30 DAS (µg/g)	Crude protein (%)	CPY (kg/ha)	IVDMD (%)	DDMY (kg/ha)	ADF (%)	NDF (%)
Fertilizer Levels							
0% RDF	36.04	8.08	426.7	48.25	2528.0	34.65	60.16
50% RDF	43.49	9.32	667.0	51.70	3677.5	33.35	58.76
100% RDF	54.37	10.41	877.8	53.46	4490.5	32.63	57.90
150% RDF	67.40	10.53	929.3	53.82	4723.5	32.22	57.48
SEm±	0.82	0.08	21.7	0.38	64.3	0.15	0.05
C.D. (P=0.05)	3.82	0.37	101.0	1.75	299.5	0.72	0.25
Genotypes							
CSH 40F*	52.40	9.78	929.7	51.86	4873.2	33.77	58.76
SPH 2057	35.82	9.83	998.2	51.42	5159.0	34.01	58.33
SPV 3089	40.90	9.63	674.9	52.65	3659.5	31.29	58.16
CSV 43 BMR*	59.94	9.53	482.4	52.28	2613.1	31.77	57.91
PDKV Ashwini	65.36	9.10	495.3	51.51	2770.7	34.31	59.56
PDKV Kartiki	47.56	9.63	770.7	51.11	4053.8	34.15	58.74
SEm±	0.73	0.11	25.0	0.24	137.5	0.17	0.23
C.D. (P=0.05)	2.17	0.31	74.4	0.71	408.6	0.51	0.68
B at same level of A							
SEm±	2.01	0.19	53.1	0.92	157.4	0.38	0.13
C.D. (P=0.05)	5.02	NS	164.3	NS	NS	NS	NS
A at same level of B							
SEm±	1.57	0.11	50.6	0.58	259.2	0.35	0.42
C.D. (P=0.05)	5.38	NS	166.0	NS	NS	NS	NS
C.V. (%)	4.11	3.11	9.77	1.32	10.10	1.45	1.10

Fodder quality was markedly impacted by fertilizers (Table 3). Enhanced RDF (150%) has brought significant increases in HCN contents (67.4 µg/g). Highest crude protein content (10.53%) estimated with 150% RDF was on a par with 100 % RDF due to which same trend was reflected in crude protein yield. However, a reduction from RDF has proved quality inhibitive. Crude protein content and crude protein yield got significantly reduced with 0 and 50% RDF over 50% RDF and RDF, respectively. The decrease in CP content with increase in fertilizers levels were ascribed to decreases in L/S ratio. Similar impacts of N fertilization on crude protein were reported by Joshi *et al.* (2009). Although HCN content was below critical limit (200 µg/g) in all fertilizer levels but it got decreased markedly with reduced RDF from 100%RDF to 0% RDF. Enhanced HCN contents of forage sorghum due to higher levels of fertilizers of the present study were corroborated by findings of Khatri *et al.* (1997) and Aziz-Abdel and Abdel-Gwad (2008). Maximum IVDMD (*In-vitro* dry matter digestibility) and DDMY (Digestible dry matter yield) was estimated with 150% RDF which was on a par with 100% RDF. ADF and NDF estimated with unfertilized plots were significantly higher over fertilized soil (50, 100 and 150% RDF).

Nutrient content, uptake and apparent soil depletion

Perusal of the nutrient content data (Table 4) shows that highest and similar N content (1.57%) estimated in 'SPH 2057' and 'CSH 40F' being at par with all the genotypes except 'PKV Ashwini'; highest P content (0.186%) was estimated in 'SPH 2057' being at par with 'CSH 40F' and 'SPV 3089' and highest K content (1.22%) was estimated in 'SPH 2057' being at par with all the genotypes except 'CSV 43BMR' and 'PKV Ashwini'.

Higher dry matter content in 'SPH 2057' along with higher N, P and K content (1.57, 0.186 and 1.22 per cent NPK, respectively) in its biomass has resulted in significantly higher NPK uptake than all other genotypes except 'CSH 40F' in case of P and K. Nutrient concentration (NPK) in fodder and their uptakes were highest with 150% RDF but was at par with RDF. Reduced fertilizer level impacts were more discernible than that of enhanced RDFs on NPK nutrient content and their uptake. Inherent soil fertility has contributed u to 68.27-5.52-57.61 kg N-P-K /ha uptake and the application of RDF resulted into 2.06-3.27-1.82 times more N-P-K uptake over control. Application of 150% and 50% RDF have enhanced

TABLE 3A
Interaction effect of fertilizer levels and genotypes on HCN content (µg/g on fresh weight basis) of forage sorghum

Fertilizer Level (A)	Genotype (B)					
	CSH 40F*	SPH 2057	SPV 3089	CSV 43 BMR*	PKV Ashwini	PKV Kartiki
0% RDF	32.54	22.64	28.67	45.79	51.74	34.88
50% RDF	43.53	28.92	36.12	52.79	59.20	40.41
100% RDF	58.55	39.03	44.73	64.63	68.82	50.50
150% RDF	74.98	52.69	54.07	76.55	81.67	64.45
	B at same level of A		A at same level of B		-	-
C.D. (p=0.05)	5.02		5.38		-	-

TABLE 3B
Table 3b: Interaction effect of fertilizer levels and genotypes on CPY (kg/ha) of forage sorghum

Fertilizer Level (A)	Genotype (B)					
	CSH 40F*	SPH 2057	SPV 3089	CSV 43 BMR*	PKV Ashwini	PKV Kartiki
0% RDF	545.9	570.7	393.4	288.4	301.1	460.6
50% RDF	858.3	899.9	597.1	451.5	461.7	733.3
100% RDF	1126.7	1220.3	813.7	586.2	598.7	921.4
150% RDF	1187.8	1301.9	895.4	603.5	619.6	967.6
	B at same level of A		A at same level of B		-	-
C.D. (p=0.05)	164.3		166.0		-	-

the NPK uptake by 5.9-9.0-6.0% and reduced by 24.0-32.2-18.6% over RDF.

At RDF, 60.1-472.4-80.5 kg dry fodder was produced /kg N-P-K uptake. More fodder was produced per kg N-P-K uptake at 50% RDF (67.1-587.8-83.8) while less with 150% RDF (59.4-453.0-79.3). Lower fodder production per kg nutrient uptake at 150% RDF indicates their luxury consumption as the fodder yield increases were insignificant. On native soil fertility highest dry fodder was produced / unit NPK uptake (77.6-963.8-91.8 kg fodder / kg N-P-K). Mean data of genotypes (Fig. 2) shows that 66.1-619.2-83.8 kg dry fodder was produced per kg N-P-K uptake. Hurda sorghum 'PKV Ashwini' proves to be most efficient while single cut hybrid SPH 2057 the inefficient from their highest and lowest dry fodder yields/ kg N-P-K uptake. Apparent nutrient balance (Uptake-application through fertilizers) indicates that 150% RDF has reduced the N and P depletion of soil over RDF while 'CSV 43BMR', 'PKV Ashwini' and 'SPV 3089' were less depletive of soil nutrients than other genotypes.

Interaction

The interaction between factor A (Fertilizer level) and B (Variety) was found to be significant as 'B at same level of A' and 'A at same level of B' for HCN at 30 DAS (µg/g) and CPY (kg/ha) (Table 3a and Table 3b). For higher CPY at lower fertilizer levels (0 and 50% RDF), hybrids are promising to both BMR and hurda sorghums.

ECONOMICS

Perusal of the data (Table 5) reveal that test hybrid 'SPH 2057' has recorded higher gross, net income and B: C ratio (Rs. 83103, Rs. 41135 and 1.98) closely followed by the hybrid check (Rs. 77493, Rs. 35525 and 1.85). Hurda sorghum genotype 'PDKV Kartiki' was promising to other hurda sorghum and BMR sorghum genotypes from income and B:C ratio point of view. BMR check genotype 'CSV 43 BMR' cultivation proves loss making proposition based on negative net returns and <1 B:C ratio. Among fertilizer

TABLE 4
Nutrient content in dry fodder and nutrient uptake of single-cut sorghum genotypes as influenced by different fertilizer levels

Treatments	Nutrient content at harvest (%)			Nutrient uptake at harvest (kg/ha)			Nutrient balance (Application - Uptake)#		
	N	P	K	N	P	K	N	P	K
Fertilizer Levels									
0% RDF	1.29	0.104	1.09	68.27	5.52	57.61	-68.27	-5.52	-57.61
50% RDF	1.49	0.171	1.19	106.71	12.24	85.34	-66.71	-3.52	-68.74
100% RDF	1.67	0.213	1.24	140.45	18.05	104.90	-60.45	-0.61	-71.70
150% RDF	1.68	0.222	1.26	148.68	19.67	111.20	-28.68	6.49	-61.40
SEm±	0.01	0.004	0.01	3.47	0.36	1.84	-	-	-
CD (P=0.05)	0.06	0.019	0.03	16.16	1.68	8.56	-	-	-
Genotypes									
CSH 40F*	1.57	0.184	1.21	148.74	17.94	113.73	-88.74	-4.84	-88.83
SPH 2057	1.57	0.186	1.22	159.71	19.49	122.30	-99.71	-6.39	-97.40
SPV 3089	1.54	0.184	1.21	107.98	13.40	84.29	-47.98	-0.30	-59.39
CSV 43 BMR*	1.52	0.171	1.16	77.18	8.89	58.27	-17.18	4.22	-33.37
PDKV Ashwini	1.45	0.165	1.17	79.24	9.20	63.23	-19.24	3.90	-38.33
PDKV Kartiki	1.54	0.174	1.22	123.32	14.29	96.76	-63.32	-1.19	-71.86
SEm±	0.02	0.003	0.01	4.01	0.62	3.49	-	-	-
CD (P=0.05)	0.05	0.010	0.02	11.90	1.85	10.37	-	-	-
B at same level of A									
SEm±	0.03	0.01	0.017	8.49	0.88	4.49	-	-	-
CD (P=0.05)	NS	NS	NS	26.29	3.9	NS	-	-	-
A at same level of B									
SEm±	0.03	0.008	0.015	8.09	1.19	6.63	-	-	-
CD (P=0.05)	NS	NS	NS	26.56	3.73	NS	-	-	-
CV%	2.92	-	-	9.76	12.71	11.01	-	-	-

#Mean N-P-K applied for genotypes: 60.0-13.1-24.9 kg/ha.

TABLE 5
Economics of single cut sorghum genotypes as influenced by different fertilizer levels

Treatments	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
A. Fertilizer Levels				
0% RDF	38569	43225	4656	1.12
50% RDF	40980	59476	18496	1.45
100% RDF	43033	70560	27527	1.64
150% RDF	45290	74119	28829	1.64
SEm+	-	1470	-	0.03
C.D. (p=0.05)	-	6854	-	0.16
B. Genotype				
CSH 40F*	41968	77493	35525	1.85
SPH 2057	41968	83103	41135	1.98
SPV 3089	41968	58333	16365	1.39
CSV 43 BMR*	41968	41653	-315	0.99
PKV Ashwini	41968	44851	2883	1.07
PDKV Kartiki	41968	65637	23669	1.56
SEm+	-	2175	-	0.05
C.D. (p=0.05)	-	6461	-	0.15

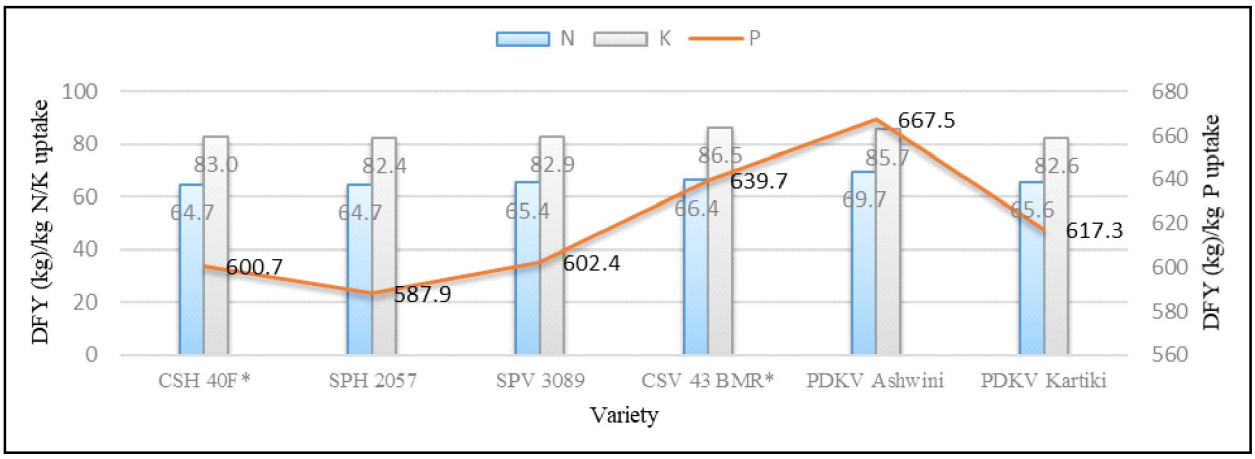

Fig. 2. Dry fodder yield/kg nutrient uptake.

levels, 150% RDF secured maximum net returns (Rs. 44886/ha), however, B:C ratio remained unaltered over 100% RDF (1.64).

CONCLUSION

It is concluded from the study that single cut forage sorghum hybrids excelled BMR and hurda sorghum genotypes in fodder yield, crude protein yield and economics. Single cut forage sorghum new test hybrids 'SPH 2057' and check 'CSH 40F' are promising from fodder, crude protein and economics point of view. For dry fodder yields, and N-P-K uptake, 'SPH 2057' was the most efficient while 'CSV 43BMR' was inefficient. Hurda sorghum PDKV Kartiki also seems promising alternatives to BMR sorghums based on yield. Among fertilizer levels, no significant gains in fodder yields and profits were seen due to 150% RDF application though it reduced soil nutrient depletion and thus 100% RDF (80-17.5-33.2 kg/ha N-P-K) is the best.

ACKNOWLEDGEMENTS

The authors are thankful to All India Coordinated Research Project on Sorghum, Hyderabad and Department of Genetics & Plant Breeding (Forage Section), CCS HAU, Hisar for providing the seed of single-cut forage sorghum genotypes used in the experiment and necessary guidelines to conduct the agronomy trial under AICRP on Sorghum. Acknowledgements are also extended to the Laboratories of Department of G&PB, CCS HAU, Hisar for providing the facility of FOSS NIRS DS3 feed analyzer instrument for estimating IVDMD (MAP Section Lab) and other quality parameters (Forage Section Quality Lab).

REFERENCES

Anonymous, 2023: Package of Practices for *kharif* crops of Haryana, Directorate of Extension Education, CCS HAU, Hisar, pp. 159-164.

AOAC. 2016. Official Methods of Analysis, 20th edn. AOAC International, Washington DC.

Aziz-Abdel, T. K. and M. A. S. Abdel-Gwad, 2008 : Yield and quality of tunis grass as affected by plant height at cutting and N fertilizer. *Animal Agric. Sci*., (Cairo), **53**: 157-169.

Devi, S., Satpal, S.S. Rao and B. Gangaiah, 2021 : Screening and selection of elite forage lines for salinity tolerance. pp. 36. In: Souvenir and Proceedings: Physiological Interventions for Climate Smart Agriculture, International Plant Physiology Virtual Symposium, 11-12 March, 2021, ICAR-SBI, Coimbatore.

Gangaiah, B. and M.S. Kundu, 2020 : Introduction and evaluation of single and multicut fodder crops for augmenting fodder supplies in Andaman & Nicobar Islands for supporting dairy farming. *Forage Res*., **45**(4): 289-294.

Gangaiah, B., Satpal, V.A. Tonapi, B.B. Kushawaha, P.O. Bhutala, A. Verma, G.V. Thakare, N. Vadivelu, D.K. Shukla, M. Kaur and R. Madhusudhana, 2025 : Hurda sorghum (*Sorghum bicolor* L.) for augmentation of quality fodder supplies for livestock in India. In proceedings of the International Conference on "Resource Management for Sustainable Agriculture, Food, Environment and Health" held at CCSHAU, Hisar during November 3-4, 2025. Pp 14-15.

Hogg, P. G. and H. L. Ahlgren, 1942 : A rapid method of determining hydrocyanic acid content of single plant of sudan grass. *J. Am. Soc. Agron*., **43**: 199-200.

Joshi, U.N., R.N. Arora, D.S. Phogat, B.S. Jhorar, R. Avtar and R.S. Sheoran, 2009 : Current status of crude protein and in vitro dry matter digestibility in forage crops. In: Emerging Trends in Forage Res.

& Livestock production (eds. S.K. Pahuja, U.N. Joshi, B.S. Jhorar and R.S. Sheoran) published by Indian Society of Forage Research, Hisar, India pp. 146-153.

Khatri, A., I. A. Khan, S. H. Siddiqui, M. Ahmed and K. A. Saddiqui, 1997 : *In vitro* culture of indigenous and exerted banana clones for maximizing multiplication. *Pakistan J. Bot.*, **29**: 143-150.

Koenig, R. A. and C. R. Johnson. 1942 : Colorimetric determination of phosphorus in biological materials. Industrial & Engineering Chemistry Analytical Edition, **14**: 155-156.

Kumar, 2022 : How nutrient deficient are Indian soils? Down to Earth. Published on May 6, 2022.

Meena, A. K., P. Singh and P. Kanwar, 2012 : Effect of nitrogen levels on yield and quality of sorghum (*Sorghum bicolor* L.) genotypes. *Forage Res.*, 37: 238-240.

Nathan, M. V., Y. Sun and D. Dunn, 2020 : Nutrient removal values for major agronomic crops in Missouri report for 2006-2007. Agronomy Department College of Agriculture, Food and Natural Resources University of Missouri, p. 128.

Richards, L. A., 1954 : Diagnosis and Improvement of Saline and Alkali Soils. United States Department of Agriculture **60**. pp.132.

Satpal, B. Gangaiah, K.K. Bhardwaj, N. Kharor, J. Tokas, and S. Devi, 2025 : Response of sweet sudan grass to graded levels of phosphorus and potassium fertilization. *Indian Journal of Agricultural Research*, **59**(2): 244-248.

Satpal, B. Gangaiah, N. Kumar, S. Devi, N. Kharor, K. K. Bhardwaj, P. Kumari, D. S. Phogat and Neelam, 2020. Performance of single cut forage sorghum cultivars at different fertilizer levels. *Forage Res*., **46**(2): 202-207.

Satpal, B. Gangaiah, N. Kumar, S. Devi, N. Kharor, K.K. Bhardwaj, P. Kumari, B.L. Sharma, Neelam and S. Kumar, 2021 : Performance of single cut forage sorghum [*Sorghum bicolor* (L.) Moench] genotypes under graded levels of NPK fertilizers. *Forage Res.*, **47**(2): 180-186.

Satpal, B. Gangaiah, S. Devi, N. Kharor, P. Kumari and B. L. Sharma, 2025 : Performance of brown mid rib (BMR) and Non-BMR single cut forage sorghum [*Sorghum bicolor* (L.) Moench] genotypes under varying levels of NPK fertilizer. *Forage Res*., **50**(4): 474-482.

Sheoran, O. P., D. S. Tonk, L. S. Kaushik, R. C. Hasija and R. S. Pannu, 1998 : Statistical Software Package for Agricultural Research Workers. Recent Advances in information theory, Statistics & Computer Applications by D.S. Hooda & R.C. Hasija, Department of Mathematics Statistics, CCS HAU, Hisar (139-143).

Singh, S., S.V. Prasad, and D.S. Katiyar, 2003 : Genetic variability in the fodder yield, chemical composition and disappearance of nutrients in brown midrib and white midrib sorghum genotypes. *Asian-Australas. J. Anim. Sci.*, **16**(9): 1303-1308.