



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(7): 1207-1211
Received: 19-05-2026
Accepted: 23-06-2026

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Evaluation of different *kharif* and *rabi* grain sorghum cultivars in summer season

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i7o.6085>

Abstract

Field experiment entitled “Evaluation of different *Kharif* and *rabi* grain sorghum cultivars in summer season” was conducted at the farm of Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra during summer 2025-26 on clay loam soil. The experiment was laid out in randomized block design with eighteen treatment and replicated thrice. The treatment consisted eighteen *Kharif* and *rabi* grain sorghum cultivars viz, CSH-9, CSH-30, CSH-35, SPH-1635, SPV-1595, BG-296, CSV-20, CSV-34, CSV-45, PDKV-Kalyani, PDKV-Kranti, Phule Suchitra, Phule Vasudha, Phule Revati, Parbhani Moti, Parbhani super Moti, M-35-1 and Vittal. The summer sorghum experiment was conducted to study the effect of different grain sorghum cultivars on growth character, yield attributes, quality and economics. The result revealed that among different grain sorghum cultivars PDKV Kalyani recorded significantly highest plant height and cultivar CSH-9 recorded significantly highest number of functional leaves. The dry matter accumulation (g) Plant⁻¹ was significantly highest in cultivar PDKV Kalyani. The grain yield (3489 Kg ha⁻¹) was recorded significantly highest with cultivar BG-29. The fodder yield (7255 Kg ha⁻¹) and biological yield (10454 Kg ha⁻¹) were found significantly highest with sorghum cultivar PDKV Kalyani and Phule Suchitra, respectively. Among of the all-other treatments cultivar BG-296 recorded significantly highest gross returns (114154 Rs ha⁻¹), net returns (75654 Rs ha⁻¹) and B: C (2.97).

Keywords: Sorghum cultivars, growth attributes, yield attributes, grain yield, fodder yield economics

1. Introduction

Sorghum is India's third-most significant cereal crop, next to rice and wheat. The main sorghum growing states in India are Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Uttar Pradesh, Rajasthan and Gujarat. In that, Maharashtra ranks first in sorghum production and area, but in case of productivity Andhra Pradesh ranks first while Maharashtra ranks third in productivity. India has a largest share in (32.30%) world's sorghum area and ranks fifth in production. Globally, sorghum is the fifth most important crop after rice, wheat, maize and barley, whereas in India it is the fourth largest crop. About 19.5% of the world's population and 27% of India's population takes sorghum as their primary food (Lamessa *et al.* 2016) [9]. In Vidarbha, sorghum area under *Kharif* and *rabi* sorghum has reducing trend. It has tremendous down fall in area during the year 1990, 1995, thereafter area was constant till 2005. It has area has reduced down during the year 2010. The Poor acceptance of *Kharif* sorghum grain as a food because of Grain mold in *Kharif* sorghum has largely nullified its importance under erratic rainfall condition in Vidarbha region. Shifting of more and more favorable production area from *Kharif* and *Rabi* sorghum to high valued crops, where sustainable productivity increase would be more difficult. In recent years in Maharashtra and specially Vidarbha cultivation of sorghum under summer season significantly increases. During 2018-2019 summer cultivated area around 2500-3000 ha only, but last three-to-five-year area under sorghum cultivation is more than 1.95 lakh ha. Sorghum cultivated in *Rabi* and *Summer* Season is distinguished by outstanding grain quality, utilized for human and animal for food, feed and fodder consumption and as a result fetches high price.

Sowing time is the most important non-monetary input. Sowing at proper time improves the yield by offering suitable environment to crop at all growth stages. Until now effect of sowing date

summer season on performance of these improved varieties and hybrids in Vidarbha region work has not evaluated. Sowing time directly affects the duration of crops during growing season; cultivars of different maturity groups will correspondingly be affected. The purpose of current study is identifying the suitable rabi / kharif cultivars available for summer sorghum cultivation. Summer cultivated sorghum has better food, feed, fodder quality and quantity. Therefore, felt to identify the effect of different Kharif / Rabi cultivars of sorghum for summer cultivation. Considering different views in mind, the thought is given for the determine summer cultivation of sorghum in the Vidarbha region.

2. Materials and Methods

The present field trial was conducted at the Central research station, Sorghum research unit, Dr. PDKV, Akola during summer season 2025, which is located at 23°43' N latitude and 77°64' E longitude with an altitude of 281m above the mean sea level. The soil was clay loam in texture, medium in organic carbon and low in available nitrogen, phosphorous, zinc, iron and marginally high in available potassium. The soil was slightly alkaline (pH 7.9). The Experiment was laid out in Randomized Block Design, with Eighteen treatments which are replicated thrice. The experiment consisted different eighteen *Kharif* and *Rabi* grain sorghum cultivars viz. CSH-9, CSH-30, CSH-35, SPH-1635, SPV-1595, BG-296, CSV-20, CSV-34, CSV-45, PDKV-Kalyani, PDKV-Kranti, Phule Suchitra, Phule Vasudha, Phule Revati, Parbhani Moti, Parbhani super Moti, M-35-1 and Vittal. The nutrients sources were Urea, SSP, MOP to fulfill the requirement of nitrogen, phosphorous and potassium. The nitrogen applied as split dose half as basal dose remaining as top dressing. The date of sowing of sorghum was on 09th January, 2024 with the seed rate of 8-10 kg ha⁻¹. The treatment having spacing 45 cm × 15 cm. and plot size was 4.50 m x 5.10 m. For recording the crop observations, five plants were selected and tagged from every net plot of all the treatments of each replication. On every alternate day, phenology was observed. Data collected viz. plant height, no. of leaves per plant, dry matter, stem diameter, Leaf area, leaf area index (LAI), SPAD value, days to 50% flowering and physiological maturity were visually recorded and five randomly selected plants from each treatment were used for recording various yield attributes viz, 1000 seed weight (g), grain number per panicle, grain weight per panicle (g), grain yield (kg ha⁻¹), fodder yield (kg ha⁻¹), biological yield (kg ha⁻¹). The crop was harvested manually with the help of sickle when seed almost matured and stover had turned yellow. The sun-dried bundles were threshed and winnowed and seed so obtained were weighed and data on seed and stover yields were recorded Saini *et al.* (2018) [16]. statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design Gomez and Gomez (1984) [4].

3. Results and Discussion

3.1 Plant height (cm)

Plant height was significantly influenced by different grain sorghum cultivars shown in table.1. Among the cultivars PDKV-Kalyani (217cm) recorded the highest plant height, followed by PKV-Kranti (212 cm) and Phule Vasudha (204 cm). The cultivar PDKV-Kalyani found superior to the all-other remaining cultivars. The lowest plant height of sorghum grain cultivar was recorded by CSV-34 (140 cm). The increase plant height in this cultivar may also associated prolonged vegetative growth duration and efficient translocation of assimilates to growing tissues. Sorghum cultivar possessing greater stem elongation and higher leaf area generally exhibit superior biomass production.

These finding in conformity with those of Mishra *et al.* (2017) [11], Singh and Chavhan (2017) [17] and Godre *et al.* (2024) [3].

3.2 Number of functional leaves

The number of functional leaves differed significantly among the different eighteen kharif and rabi grain sorghum cultivars. The highest number of functional leaves was recorded with Phule Revati (7.60), which was statistically at par with CSH-9 (7.54), Vittal (7.38), PKV Kranti (7.34) and BG-296 (7.33). The lowest number of functional leaves was observed in Parbhani Moti (6.17). Functional leaves serve as primary source of assimilates production and therefore directly influence grain filling and biomass accumulation, the high number of functional leaves observed in superior cultivar may be due to better genetic expression, higher chlorophyll content and enhanced nutrient uptake efficiency. Similar observation was to be reported by Kumar *et al.* (2017) [8], Nalini Naidu *et al.* (2018) [12] and Mishra *et al.* (2017) [11].

3.3 Leaf area (dm²) and Leaf area index

Significantly higher leaf area and leaf area index was recorded by cultivars PKV-Kranti (57.39 and 8.50) followed by Parbhani Moti (56.58 and 8.34). The minimum leaf area value was recorded by cultivar CSH-9 (47.13 and 6.98). This increase in leaf area from panicle initiation to flowering indicates active vegetative growth and canopy development. Among all cultivars, PKV-Kranti and Parbhani Moti consistently recorded higher leaf area and LAI at flowering stage, indicating vigorous growth and superior canopy development. The observed variation among cultivars reflects differences in genetic makeup and adaptability to environmental conditions. Similar findings were reported by Nalini Naidu *et al.* (2018) [12] and Mahalle *et al.* (2022) [10].

3.4 Dry matter accumulation (g)

The significantly higher dry matter accumulation value was recorded with sorghum cultivar PDKV Kalyani (181.34 g). The sorghum cultivar PKV-Kranti (179.48 g), M-35-1(178.68 g) and Phule Revati (174.85 g) were found to be at par with PDKV Kalyani. The lowest dry matter accumulation per plant was recorded by sorghum cultivar Vittal (151.43 g) (table.1). The higher dry matter production indicates greater photosynthetic efficiency and superior conversion of intercepted radiation into biomass. The result corroborates finding reported by Ramachandra *et al.* (2011) [14], Chongtham *et al.* (2018) [1], Godre *et al.* (2024) [3] and Venkatesh *et al.* (2024) [18].

3.5 Stem diameter (cm)

The significant variation observed in stem diameter among grain sorghum cultivars. The maximum stem diameter was recorded in BG-296 (6.36 cm), which was found statistically at par with sorghum cultivar PKV Kranti (6.28 cm). The minimum stem diameter was recorded in CSH-35 (4.67 cm). A slight stabilization or marginal decline at harvest may be due to moisture loss and physiological maturity. The superior performance of BG-296 and PKV Kranti indicates their better vegetative growth potential and dry matter accumulation capacity. The cultivars possessing thicker stems generally exhibit greater structural strength, improved nutrient translocation, accumulates more carbohydrate, enhanced lodging resistance and fodder yield. and similar finding has been reported by Chongtham *et al.* (2018) [1].

3.6 SPAD (Chlorophyll content)

The SPAD value was recorded at flowering significantly differed in chlorophyll content among different grain sorghum cultivars.

The highest SPAD value was recorded with Cultivar CSV-20 (57.97), which was significantly superior over all other genotypes. The next higher values were observed in cultivars CSH-9 (54.40), CSH-30 (54.40) and CSH-35 (55.14), which were also comparatively higher but differed significantly from the maximum. Lower SPAD values were observed with cultivars SPH-1635 (47.00), SPV-1595 (47.58) and CSV-34 (47.68). The differences among treatments were found to be statistically significant indicating real variation in chlorophyll content among sorghum grain cultivars. The higher values of SPAD may be attributed to enhances light interception, photosynthetic activity and better root growth, resulting in higher water and nutrient uptake which resulted in increased chlorophyll content in leaves. The finding in agreement with Hari Kumar *et al.* (2024).

3.7 Days to 50% flowering

Days to 50% flowering varied significantly among cultivars. The comparatively minimum days to 50% flowering were recorded with cultivar CSH-35 (66 days) followed by cultivar CSH-30 (67 days), CSH-9 (68 days), SPH-1635 (68 days) and BG-296 (67

days), indicating early flowering behaviors of these cultivars. The maximum days to 50% flowering were observed by cultivars CSV-45 (75 days), PDKV-Kalyani (73 days) and Phule Vasudha (73 days). The observed variation in flowering behavior among sorghum cultivars indicates genetic diversity for maturity duration. Early flowering cultivars may be advantageous under drought-prone conditions due to their shorter growth cycle.

3.8 Days to physiological maturity

Significant differences were observed in physiological maturity among grain sorghum cultivars. The cultivar CSH-30 matured earliest (113 days) and closely followed by cultivars CSV-34 (117 days), CSV-45(117 days) Phule Suchitra (117 days), Parbhani Moti (117 days) and Vittal (117 days). whereas PKV Kranti required the longest duration (121 days) to attain physiological maturity. Differences in maturity duration are mainly attributed to genotypic characteristics regulating growth and reproductive development. Longer maturity duration often permits greater photosynthate accumulation and biomass production, whereas early maturity enables crop escape from terminal drought stress.

Table 1: Effect of different grain sorghum cultivars on growth and yield attributes of summer sorghum

Treatment's	No. of functional leaves	Plant height (cm)	Leaf area per plant (dm ²)	Leaf area index	Dry matter (g)	Stem diameter (cm)	SPAD Value	Days to 50% flowering	Days to physiological maturity	1000 seed weight (g)	No. of grains per panicle	Grain weight per panicle (cm)
CSH-9	7.54	147	47.13	6.98	159.33	5.70	54.40	68	118	29.60	889	26.76
CSH-30	6.45	148	48.63	7.20	158.59	5.02	54.40	67	113	30.70	607	18.88
CSH-35	6.59	147	48.92	7.25	154.33	4.67	55.14	66	118	31.50	501	16.24
CSH1635	6.53	156	49.53	7.34	157.76	5.19	47.00	68	118	30.50	499	15.53
SPV-1595	6.55	164	48.56	7.19	164.90	4.72	47.58	72	119	28.00	680	19.03
BG-296	7.33	174	49.04	7.27	161.09	6.36	50.13	67	118	28.30	932	26.84
CSV-20	6.33	169	48.68	7.21	168.31	5.02	57.97	73	119	28.70	694	19.29
CSV-34	6.89	140	49.71	7.36	167.36	5.22	47.68	70	116	30.70	528	15.83
CSV-45	6.51	175	49.10	7.27	168.71	4.87	51.04	75	117	29.50	617	18.19
PDKV Kalyani	6.96	217	55.67	8.25	181.34	5.23	49.10	73	119	28.50	587	16.97
PKV Kranti	7.34	212	57.39	8.50	179.48	6.28	50.38	70	121	28.90	875	25.80
Phule Suchitra	7.11	200	56.34	8.35	172.88	5.06	47.21	69	117	28.70	729	20.25
Phule Vasudha	6.77	204	55.77	8.26	171.61	5.14	48.41	73	118	29.20	672	20.42
Phule Revati	7.60	193	56.29	8.32	174.85	5.67	48.29	71	120	30.40	848	25.78
Parbhani Moti	6.17	201	56.58	8.34	169.00	4.78	48.61	68	117	27.00	684	18.55
Par. Super Moti	6.54	163	55.76	8.33	172.86	5.19	49.10	69	119	28.30	525	15.63
M-35-1	7.09	168	55.98	8.26	178.68	5.20	48.09	69	119	26.30	510	13.58
Vittal	7.38	148	48.57	8.29	151.43	5.64	49.91	71	117	27.60	810	22.75
S.E(m)±	0.11	1.80	2.19	0.32	2.45	0.08	0.65	1.18	0.83	0.43	39.2	1.06
CD at 5%	0.33	5.17	8.73	1.28	7.05	0.23	1.86	3.39	2.39	1.37	119	3.22
GM	7.87	175	51.96	7.70	167.36	5.28	49.80	69.78	118.02	29.00	677	20.00

3.9 1000 - grain weight (g)

The 1000-seed weight differed significantly among grain sorghum cultivars. The highest test weight was recorded with cultivar CSH-35 (31.5 g), followed by sorghum cultivar CSH-30 and CSV-34 (30.7 g). The lowest test weight was observed in cultivar M-35-1 (26.3 g). The variation in test weight among cultivars reflects differences in grain filling efficiency and assimilate partitioning. Higher seed weight indicates its superior grain development potential and similar observation was reported by Mishra *et al.* (2017) ^[11] and Venkatesh *et al.* (2024) ^[18].

3.10 Number of Grain panicle⁻¹

The number of grains per panicle differed significantly among grain sorghum cultivars. Significantly the greater number of grains per panicle was recorded in grain sorghum cultivar BG-296 (932), which was statistically found at par with CSH-9 (889) PKV Kranti (875) and Phule Revati (848). The lowest number of grains per panicle was observed in cultivar SPH-1635 (499). The greater

no of grains per panicle is an important yield contributing character directly influence final yield. These finding give support to statement by Rakshit *et al.* (2021) ^[13] and Hari Kumar *et al.* (2024).

3.11 Grains weight (g) panicle⁻¹

Grain weight per panicle varied significantly among different grain sorghum cultivars. The significantly highest grain weight par panicle was recorded by cultivar BG-296 (26.84 g).The cultivar CSH-9 (26.76 g), PKV-Kranti (25.80 g) and Phule Revati (25.78 g), were found to be at par with cultivar BG-296.The comparatively minimum number of grain weight par panicle was recorded with cultivar M-35-1 (13.58 g).The increased in grain weight may be attributed to efficient grain filling and greater assimilates supply during reproductive growth. The result is in conformity with Kumar *et al.* (2017) ^[8] and Nalini Naidu *et al.* (2024) ^[12].

Post harvest Studies

3.12 Grain yield (Kg ha⁻¹)

Grain yield among the different eighteen evaluated grain sorghum cultivars differed significantly showed in table-1. Sorghum cultivar BG - 296 (3489 kg ha⁻¹) recorded significantly superior grain yield and followed by cultivar CSH-9 (3422 kg ha⁻¹), PKV Kranti (3354 kg ha⁻¹) and Phule Revati (3322 kg ha⁻¹). The

significantly lowest grain yield was recorded by cultivar M-35-1 (1765 kg ha⁻¹). The increased yield might be due to increased number of grains per panicle, grain weight per panicle which resulted in higher panicle weight. These results are in conformity with findings of Mishra *et al.* (2017) [11], Rao *et al.* (2017) [15], Ghuraiya *et al.* (2021) [2], Hariprasanna *et al.* (2023) [6] and Kumar *et al.* (2022) [7].

Table 2: Effect of different grain sorghum cultivars on Grain, Fodder, biological yield and economics

Treatment's	Grain yield (Kg ha ⁻¹)	Fodder yield (Kg ha ⁻¹)	Biological yield (Kg ha ⁻¹)	GMR (Rs ha ⁻¹)	NMR (Rs ha ⁻¹)	B:C Ratio
CSH-9	3422	4750	8172	110791	72291	2.88
CSH-30	2455	5400	7855	83468	44968	2.17
CSH-35	2111	5720	7831	73926	35426	1.92
SPH1635	2019	5800	7819	71362	32862	1.85
SPV-1595	2474	7245	9719	87720	49220	2.28
BG-296	3489	5440	8929	114154	75654	2.97
CSV-20	2411	6210	8621	83786	45286	2.18
CSV-34	1899	4530	6429	65270	26770	1.70
CSV-45	2365	7050	9415	84104	45604	2.18
PDKV Kalyani	2036	7255	9291	74776	36276	1.94
PKV Kranti	3354	7100	10454	113478	74978	2.95
Phule Suchitra	2633	4570	7203	87077	48577	2.26
Phule Vasudha	2654	5520	8174	89598	51098	2.33
Phule Revati	3222	6255	9477	107881	69381	2.80
Parbhani Moti	2411	4822	7233	81010	42510	2.10
Par. Super Moti	1954	5066	7020	67970	29470	1.77
M-35-1	1765	6230	7995	64704	26204	1.68
Vittal	2958	5033	7991	97623	59123	2.54
SE(M) ₊	1.073	26.61	3.54	3520	3520	-
CD at 5%	3.25	80.90	10.77	10150	10150	-
GM	2535	5778	8313	86594	48094	-

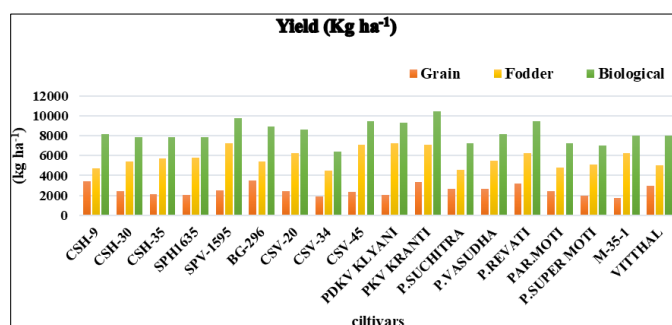


Fig 1: Grain yield, fodder yield and biological yield (kg ha⁻¹) of different grain sorghum cultivars

3.13 Fodder yield (Kg ha⁻¹)

Significant differences were recorded in fodder yield among different grain sorghum cultivars. The highest dry fodder yield was recorded by cultivar PDKV Kalyani (7255 kg ha⁻¹), and found at par with cultivar SPV-1595 (7245 kg ha⁻¹). The cultivars PKV Kranti (7100 kg ha⁻¹) and CSV-45 (7050 kg ha⁻¹) closely followed to the high performing cultivars PDKV-Kalyani and SPV-1595. The significantly the lowest dry fodder yield was recorded with cultivar CSV-34 (4530 kg ha⁻¹). Similar observations were reported by Mahalle *et al.* (2022) [10], who found significant differences in fodder production among sorghum genotypes owing to genetic variability in biomass accumulation.

3.14 Biological yield (Kg ha⁻¹)

Biological yield varied significantly among grain sorghum cultivars. The significantly highest biological yield was recorded with cultivar PKV-Kranti (10,454 kg ha⁻¹). PKV Kranti reported significantly superior biological yield over all other cultivars. The

cultivars SPV-1595 (9719 kg ha⁻¹) and Phule Revati (9477 kg ha⁻¹) closely followed to the high performing cultivars PKV-Kranti. The lowest biological yield was recorded by cultivar CSV-34 (6429 kg ha⁻¹).

3.15 GMR, NMR and B:C Ratio

The table-2 illustrates the economic analysis of different treatments of grain sorghum cultivars. Among the all eighteen grain sorghum cultivars, BG 296 exhibited highest economic efficiency with the highest GMR, NMR and B:C ratio, (114,154 Rs ha⁻¹, 75654 Rs ha⁻¹ and 2.97) respectively. Indicating profitability of treatment among cultivars. The sorghum cultivars like PKV-Kranti (113,478 Rs ha⁻¹, 74978 Rs ha⁻¹ and 2.95) and CSH-9 (110,791 Rs ha⁻¹, 72291 Rs ha⁻¹ and 2.88) were found at par with sorghum cultivars BG 296, also exhibited high economic efficiency and achieved favorable returns ratio highlighting the potential of other cultivars. The lowest GMR, NMR and B:C ratio was observed with cultivar M-35-1 (64704 Rs ha, 26204 Rs ha⁻¹ and 1.68) respectively.

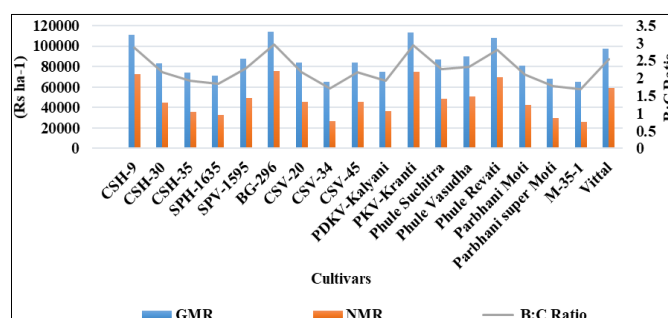


Fig 2: Gross monetary return, net monetary return, cost of cultivation of different grain sorghum cultivars.

4. Conclusion

The results of the study clearly indicate that among the different eighteen grain sorghum cultivar, significantly highest plant height (cm) was obtained with the cultivar PDKV- Kalyani followed by PKV Kranti and Phule Vasudha. The cultivar CSH-35 recorded significantly highest 1000 seed weight followed by sorghum cultivar CSH-30 and CSH -34, The grain weight and grain number per panicle were found significantly highest with cultivar BG - 296 and found at par with cultivar CSH -9, PKV – Kranti and Phule Revati. The stem girth of summer sorghum found significantly superior with BG - 296 and found at par with cultivar PKV – Kranti. The sorghum cultivar, CSH -9 recorded significantly highest number of leaves per plant and found at par with cultivar BG - 296 and Vittal. The sorghum cultivar BG - 296 recorded significantly maximum grain yield followed by cultivar PKV – Kranti and CSH-9. The significantly highest fodder yield of summer sorghum was recorded with cultivar PDKV- Kalyani closely followed by cultivar SPV-1595 and PKV- Kranti, however significantly higher biological yield was obtained with cultivar PKV - Kranti. The significantly highest monetary advantage in terms of gross monetary returns was recorded with BG -296 and found at par with cultivars PKV- Kranti, and CSH-9. The Similar trend was noticed with respect to the net monetary returns and B:C Ratio. Considering above mentioned component character and the result obtained the study revealed that for higher grain, fodder yield and monetary returns of sorghum cultivars BG- 296 and PKV Kranti are the promising and ideal in summer season cultivation.

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