Performance of open-pollinated and hybrid fodder varieties of sweet sorghum [*Sorghum bicolor* (L.)] in Grid region

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Abstract

The present study was an effort to compare the performance of fodder open-pollinated and hybrids sweet sorghum [Sorghum bicolor (L.)] in the Grid region. Two advanced sweet sorghum genotypes of open-pollinated (SPSSV15; SPSSV20), and two hybrids (PAC52093; SPSSH19) were planted at four locations of Grid region viz. two each at Sithouli (26.140° N, 78.196° E; 27.205° N, 77.498° E) and Turari (26.122° N, 78.177° E; 26.138° N, 78.207° E) of Gwalior District during rainy season of 2021. The seeds were sown using the manual dibbling method at a uniform depth of 5 cm during the second week of June in 3 replications. The recommended dose of fertilizers was applied in the form of urea, single super phosphate, and muriate of potash. Data on plant height, biomass accumulation, days to flowering and physiological maturity were recorded using standard procedures. At the 50 per cent flowering stage, ten representative plants from the four central rows of each plot were sampled. The plant biomass was oven-dried, ground and used for chemical estimation. Suitable statistical methods were used to analyze the data. The hybrid SPSSH19 proved superior to the rest of the genotypes under study in terms overall fodder performance and can be recommended as a fodder crop in the Grid region.

Keywords:

Grid Region, Hybrid sorghum, Nutrient Yield, Open-pollinated sorghum, Sorghum Fodder, Sweet Sorghum.

Introduction

The nutritive value of crop residues is very much inferior and cannot maintain the livestock. One of the alternatives of the crop residues is sweet sorghum (*Sorghum bicolor* L.) stalk. Sweet sorghum, provides grain for human consumption and fodder from stalk to livestock. Sweet sorghum is similar to grain sorghum but the stalks are juicy (Zhang *et al.,* 2018) and rich in fermentable sugars. Sweet sorghum fodder may be adapted to the Grid region as a high-yielding quality green fodder. The crop needs 12-15 inches of rain only during the season. Therefore, it is suitable for dryland production or limited irrigation. It is one of the most efferent dryland perennial crops in areas that do not have a winter freeze. It is, therefore, the fifth most important cereal crop in the world. Earlier much work has not been done regarding the usage of sweet sorghum stalk as the source of roughage in the feeding of livestock in the Grid region.

In India, there is a deficit of 23.4 percent in the availability of dry fodder, 11.24 percent in that of green fodder (Anonymous, 2018). The status of green fodder and dry fodder in

India indicated the availability of 390 and 443 m tons respectively as against the requirement of 1025, and 570 m tons. It creates a deficit of 62 and 22%, respectively. Thus, the country has an urgent need to bridge this gap and provide a balanced diet especially crude protein content and *in-vitro* dry matter digestibility to cattle through fodder crops. In the present scenario, the country is already facing a scarcity of resources, especially water. In such a grim situation, the country is limited options for fodder crops for the livestock. Hence, berseem and maize are not good options in the Grid region because of the high-water requirements. Thus, sweet sorghum is an important fodder crop that can be grown in drought and waterlogged in both conditions due to its wide adaptability. Similarly, it contributes to the food security of human beings as well as of livestock.

Sweet sorghum is one of the 5 major cultivated cereal species in the world. It is consumed as food and feed (Almodares *et al.*, 2007) and used for sugar, ethanol, and paper pulp production (Almodares and Mostafafi, 2006). The biomass and sugar content of sweet sorghum are important factors for food and industrial production. Although the effect of K fertilizer on other plants is reported (Adeli and Varco, 2002) but there are few reports regarding the effect of K fertilizer on the biomass of sweet sorghum. Therefore, it is of considerable value to carry out an experiment on biomass and carbohydrate content of sweet sorghum concerning different rates of N and K fertilizers.

The present study was an effort to compare the performance of fodder hybrids and open-pollinated sweet sorghum [*Sorghum bicolor* (L.)] in the Grid region

Materials and Methods

Two advanced sweet sorghum genotypes open-pollinated (SPSSV15; SPSSV20), and two hybrids (PAC52093; SPSSH19) were planted at four locations in the Grid region viz. Sithouli (26.140° N, 78.196° E; 27.205° N, 77.498° E) and Turari (26.122° N, 78.177° E; 26.138° N, 78.207° E) of Gwalior District during rainy season of 2021. The soil texture at the locations where the crops were cultivated varied between sandy and loam with a profile depth of 1.0 m. The crop was grown under rainfed conditions during the rainy season (June to October, Rains 710 mm; temperature range 20.3-38.6˚C, average temperature 29.0 ˚C, humidity 64%, Sun hours 9.4, rainy days 43) at all the locations.

The seeds were sown using the manual dibbling method at a uniform depth of 5 cm during the second week of June 2021 in 3 replications. Atrazine (@1 kg ha-1) was applied on the next day of sowing (pre-emergence) and 20-days after emergence (DAE) to control the initial weed flora. The seedlings were thinned to one plant and an optimum plant population of about 12 plants m^{-2} was maintained. Hand-weeding was done twice between 15 and 35 DAE. The recommended dose of fertilizers was applied (@80:40:40 kg N: P_2O_5: K_2O ha^{-1} in the form of urea, single super phosphate, muriate of potash, respectively). The half dose of N and complete P and K were administered as basal, and balance N was side-dressed at 35 DAE. Furadan 3G (@20 kg ha^{-1}) was applied in furrows at the time of sowing to control the shoot fly (*Atherigona soccata* R). Need-based minimal plant protection measures were followed to control the major insect pests of sorghum.

Data on plant height, biomass accumulation, days to flowering and physiological maturity were recorded using standard procedures. At the 50 per cent flowering stage, ten representative plants from the four central rows of each plot were sampled in all three replications and four locations for measuring biomass. After cutting the plants at ground level, fresh biomass of ten whole plants was weighed immediately and fresh biomass was calculated. The leaves along with sheath were stripped and panicle with last internode (peduncle) was separated and the fresh weight of stripped stalk was estimated.

The plant biomass was oven-dried and ground and used for chemical estimation (Goering and Van Soest, 1970; AOAC, 2019). Suitable statistical methods were used to analyze the data (Snedecor and Cochran, 1994). The data were statistically analyzed using a data analysis pack of MS Office excel 2016 (U.Q. Library, 2016).

Results and Discussion

The agronomical performance of fodder hybrids and open-pollinated sweet sorghum has been presented in Table-1. It has been demonstrated that the number of tillers, ranging between 3.06 and 3.31 per plant in various varieties of sweet sorghum, was non-significant (P>0.01). The stage of 50 percent flowering was attained in open-pollinated genome SPSSV20 at an early age and could provide forage earlier for the livestock (P<0.01) compared to other genomes. The green fodder and dry matter yield in the same genome were comparatively lower compared to others and confirmed the results the study of Sami *et al.*, (2013). The hybrid genome SPSSH19 is revealed to show better fodder performance like plant height, leave length, number of leaves per plant, and green and dry matter yield (P<0.01) compared to rest of the genomes. The trend could not be confirmed due to the lack of information in the literature. The open-pollinated variety SPSSV20 had inferior agronomical performances as green fodder. The fodder performance of open-pollinated and hybrid sweet sorghum was not different at four locations, studied in the present work (P>0.01).

Table-1: The agronomical performance of fodder hybrids and open-pollinated sweet sorghum varieties at 50 percent flowering stage.

Parameter	SPSSV15	SPSSV20	PAC52093	SPSSH19	P-Value
Age at 50% flowering	81.9 ± 0.4^{B}	77.1 ± 0.4^{B}	87.1 ± 0.4^{A}	80.2 ± 0.4^{B}	0.00
Plant height (CM)	326 ± 1^{B}	316 ± 2^{C}	335 ± 1^{B}	357 ± 1^{A}	0.00
No. of tillers/plant	3.19±0.13	3.31±0.13	3.13±0.00	3.06±0.13	0.43
Leaf length (CM)	$92.1\pm0.2^{B,C}$	89.8 ± 0.1^{C}	94.6 ± 0.3^{B}	98.5 ± 0.2^{A}	0.00
Leaf width (CM)	8.41 ± 0.02^{A}	7.77 ± 0.0^{B}	8.16 ± 0.03^{A}	8.28 ± 0.02^{A}	0.00
No. of leaves/plant	53.9 ± 0.3^{B}	51.1 ± 0.2^{B}	56.1 ± 0.2^{A}	57.3 ± 0.3^{A}	0.00
Green fodder yield (q/h)	872 ± 5^{B}	857 ± 4^{C}	888 ± 4^{B}	911 ± 4^{A}	0.00
Dry matter yield (q/h)	228 ± 1^{B}	227 ± 1^{B}	229 ± 1^{B}	250 ± 1^{A}	0.00

^{A,B,C} *- Values bearing different superscripts within the row differed significantly (P<0.05)*

Table-2 includes the chemical composition of open-pollinated and hybrids of sweet sorghum fodder genomes at the 50 per cent flowering stage. The nutrients under study except for crude protein and neutral detergent fiber were more or less similar and remained non-significant in open-pollinated and hybrid genomes of sweet sorghum (P>0.01). It could be because of similar agronomical operations and environmental conditions during the cultivation of these genomes. The content of crude protein and neutral detergent fiber were lowest in hybrid genome PAC52093 of sweet sorghum in comparison to others. The content of neutral detergent fiber increased with the advancement of the age of the crop (Zemene *et al.,* 2020). The variation in crude protein could be due to the varietal variation of the fodder crops. The chemical composition of open-pollinated and hybrid sweet sorghum was non-significant at four locations, studied in the present work (P>0.01).

Table-2: The chemical composition of fodder hybrids and open-pollinated sweet sorghum varieties at 50 percent flowering stage.

Nutrient (%)	SPSSV15	SPSSV20	PAC52093	SPSSH19	P-value
Dry Matter	20.0±2.4	19.9±2.4	20.0±2.4	19.7±2.1	1.00
Crude Protein	$13.6±1.4^{B}$	$13.2±1^{B}$	$11.3±0.6^{C}$	$14.2±1.2^{A}$	0.00
Ash	10.0±1.2	12.0±1.4	11.0±1.3	13.0±1.6	0.10
Neutral Detergent Fiber	$59.3±2.3^{A,B}$	$61.5±1.5^{A}$	$57.2±2.4^{B}$	$61.5±2.2^{A}$	0.00
Cell content	40.7±2.8	38.5±2.7	42.8±3.2	38.5±3.0	0.30
Acid Detergent Fiber	41.7±3.0	40.5±2.2	38.7±2.5	41.3±1.9	0.50
Cellulose	27.1±2.1	23.3±1.9	24.1±1.9	24.8±2	0.10
Hemicellulose	17.6±1.9	21±2.1	18.5±1.5	20.2±1.8	0.10
Acid Detergent Lignin	11.6±2.1	14±1.6	11.5±1.2	13.2±1.7	0.10
Acid Insoluble Ash	3±0.40	3.2±0.40	3.1±0.40	3.3±0.40	0.80

^{A,B,C} - Values bearing different superscripts within the row differed significantly (P<0.05)

The nutrient yields of open-pollinated and hybrids of sweet sorghum fodder genomes at the 50 per cent flowering stage have been presented in Table-3. The observations revealed that there was no significant difference in nutrient yield including dry matter, crude protein, ash, neutral detergent fiber, acid detergent fiber, cellulose, hemicellulose, acid detergent lignin, and acid insoluble ash, in open-pollinated and hybrid sweet sorghum genomes under study (P>0.01). The dry matter yield could not confirm the findings of Qu *et al*., (2014), perhaps because of different stages of harvest and variations in environmental factors. The reason could be the agronomical practices and environmental factors during the cultivation of experimental crops were similar. The yield of other nutrients could not be compared because limited information is available in the literature in this regard. The results for various locations under study were also remained non-significant (P>0.01).

Table-3: The nutrient yield of fodder hybrids and open-pollinated sweet sorghum varieties at 50 percent flowering stage.

Nutrient (q/h)	SPSSV15	SPSSV20	PAC52093	SPSSH19	P-value
Dry matter yield	228±1^{B}	227±1^{B}	229±1^{B}	250±1^{A}	0.00
Dry Matter	174±21	171±21	177±22	179±19	1.00
Crude Protein	24.7±5.4	23.1±4.3	20.5±3.5	25.9±4.1	0.40
Ash	18.3±4.2	21.5±4.9	20.5±4.7	24.4±5.3	0.50
Neutral Detergent Fiber	105±16	106±14	103±16	111±15	0.90
Acid Detergent Fiber	84.3±5.9	82.2±6.9	82.3±6.1	87.5±4.7	0.90
Cellulose	64.8±9.8	62.5±8.2	62.0±8.9	66.8±7.7	0.90
Hemicellulose	20.1±4.3	23.5±3.4	20.4±3.7	23.7±4.0	0.50
Acid Detergent Lignin	14.0±2.9	13.9±2.8	14.5±3.1	14.5±2.8	1.00
Acid Insoluble Ash	5.47±1.26	5.79±1.32	5.84±1.35	6.14±1.33	0.90

^{A,B} *- Values bearing different superscripts within the row differed significantly (P<0.05)*

The nutritional profile of fodder hybrids and open-pollinated sweet sorghum genotypes at the 50 percent flowering stage (Fig 1) showed a similar pattern (P>0.05). The Cell content ranged between 39 and 43, hemicellulose 23 and 27, cellulose 18 and 21, lignin 12 and 14, and acid insoluble ash 3 percent and confirmed the observations of Sriagtula *et al.*, (2021).

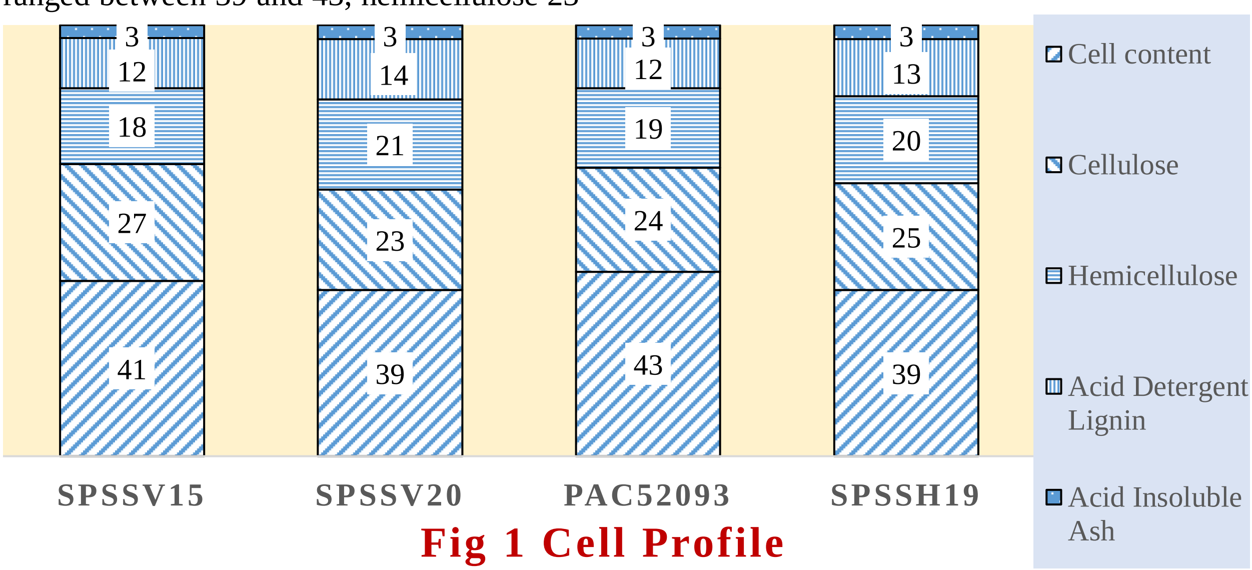

Fig 1 Cell Profile

Conclusion

The hybrid genome SPSSH19 proved superior to the rest of the genotypes under study in terms overall fodder performance. There was no significant difference in fodder performance of four genomes at the four locations under the present study. The conclusion based on the study is that hybrid variety SPSSH19 can be recommended as a fodder crop in the Grid region.

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