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EVALUATION OF FORAGE SORGHUM [*SORGHUM BICOLOR* (L.) MOENCH] GENOTYPES FOR QUALITY AND YIELD

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SUMMARY

The present study was conducted to evaluate the promising forage sorghum [*Sorghum bicolor* (L.) Moench] genotypes superior in quality and yield. The experiment was carried out in a randomized block design with three replications. The observations recorded were HCN, IVDMD, crude protein, structural carbohydrates and green fodder yield. Minimum HCN content was estimated in SPV 2455 (23µg/g) followed by SPV 2449 (64µg/g). Crude protein content was highest in SPV 2446 (10.94 %) followed by SPV 2447 (10.72 %) and IVDMD was maximum in SPV 2448 (50.80 %) followed by SPV 2450 (50.40 %). Among structural carbohydrates, highest NDF content was observed in CSH 13 (63.87), ADF content in SPV 2455 (39.55), cellulose in SPV 2449 (38.90) and hemicellulose in SPV 2455 (29.87) on percent dry weight basis. In terms of green fodder yield, the genotypes SPV 2444 (395.5 q/ ha) and SPV 2454 (374.0 q/ha) were found superior.

Keywords : Crude protein, HCN, IVDMD, Sorghum, Structural carbohydrates, Fodder yield

Today, population is increasing at a faster rate which limits the availability of natural resources. So, there is urgent need to increase the crop production with improved quality and quantity in all environmental conditions so as to meet the needs of growing population. Sorghum (*Sorghum bicolor* (L.) Moench) is one of the most widely cultivated cereal crop in tropical and sub-tropical regions of the world and ranks fifth after maize according to US grains council (Mutegi *et al*., 2010). In contrast to wheat and rice, grain sorghum constitutes the staple food in many parts of Asia and Africa and is used as a source of fodder, feed and industrial raw material (Maunder, 2002). It is a drought tolerant crop, but fairly salt tolerant which makes its wide applications in feed and fodder. Sorghum is of two types: forage sorghum (For forage and animal feed) and grain sorghum (for human consumption) (Lawali and Bubuche, 2013). Quality is an important attribute towards production of new cultivars. The primary criterion of plant breeders for selecting sorghum genotypes is the use of agronomically important traits with superior grain and fodder quality. Yield is a complex character that depends on many contributing characters. Association between yield and its components helps in evaluating the contribution of different components towards yield (Kumar *et al*., 2012). In sorghum, grain and fodder yield production are the complex characters controlled by many genes, which help in the enhancement of crop production (Mahajan *et al*., 2011). So, there is a need to study and evaluate the quality characters of sorghum to facilitate the selection for the plant breeders to develop the varieties with agronomically important traits. The main objective of present study was to evaluate the sorghum genotypes for better quality and higher fodder yield.

MATERIALS AND METHODS

The experiment consisted of twenty varieties of sorghum (*Sorghum bicolor* (L.) Moench). The present study was conducted during the *kharif* 2016 at Forage Research, Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar (Haryana). The experiment was laid out in Randomized Block Design (RBD) with three replications. The varieties were sown with a plot size of 12.5 m^2. The recommended agronomic practices were carried out to raise good crop. Qualitative traits include HCN content, crude protein and IVDMD. HCN content was estimated at the 30^{th} days after sowing (DAS). All the genotypes were harvested at 50% flowering stage. A random sample of 500 g was taken from each plot at the time of green fodder harvest, chopped well and put into paper bag. These bags were aerated by making small holes all over. The samples were first dried in the sun for 15 days and then transferred in an electric hot air oven for drying at a temperature of 60±5°C till constant weight was achieved. On the basis of dry weight of these samples, the green fodder yield was converted into dry matter yield (q/ha). Crude protein content and in vitro dry matter digestibility (IVDMD) were estimated in dried and grinded samples (2 mm sieve size), collected at 50 per cent flowering stage. The crude protein content was calculated by multiplying the nitrogen percentage with 6.25 by conventional micro-Kjeldhal method (AOAC, 1995). IVDMD was determined by method of Barnes *et al*. (1971). Structural carbohydrates *viz*. NDF, ADF, hemicellulose, cellulose, lignin and silica content were determined by the method of Goering and Van Soest (1956). All the data recorded was analyzed statistically.

RESULTS AND DISCUSSION

Data given in Table 1 reveal that the genotypes SPV 2444, SPH 1858 and SPV 2454 out yielded other genotypes in terms of green fodder yield (GFY 395.0, 395.0 and 374.0 q/ha, respectively). The data of green fodder yield (GFY) is also represented graphically in Fig. 1. In terms of crude protein yield (CPY) the genotypes SPH 1858, SPV 2445 and SPV 2454 performed better over other genotypes (CPY 13.0, 12.1 and 11.3 q/ha, respectively). Promising genotypes with higher digestible dry matter (DDM) were SPH 1858, SPV 2445 and SPV2455 (67.0, 61.0 and 56.6 q/ha, respectively). Satpal *et al*. 2016 & 2017 studied the quality and yield of forage sorghum genotypes, observed that total green fodder yield ranged from 186.2-444.8 q/ha and also reported variation for yield and quality among various genotypes studied. HCN content ranged from 23 to 177 (µg/g), estimated minimum in SPV 2455 and maximum in SPH 1856, However, it was below critical limit in all the genotypes (200 µg/g). Promising genotypes for crude protein content were SPV 2446, CSV 21F and SPV 2447 (10.94, 10.94 and 10.72 %, respectively). The genotypes promising for *in vitro* dry matter digestibility (IVDMD) were SPV 2448 and SPV 2450 (50.80 and 50.40 %, respectively).

Sorghum contains nonstructural and structural carbohydrates. It is mainly composed of hemicellulose and cellulose as structural carbohydrates. The data for structural carbohydrates is given in Table 2. The cell

TABLE 1
Evaluation of Sorghum genotypes for fodder yield and quality

Sorghum genotypes	GFY (q/ha)	CPY (q/ha)	DDM (q/ha)	HCN (µg/g)	Crude protein (%)	IVDMD (%)
SPH 1856	183.5	5.0	24.2	177	10.06	48.40
SPH 1857	27.5	2.4	11.5	157	10.29	48.40
SPH 1858	395.0	13.0	67.0	158	9.41	48.60
SPV 2443	359.0	10.4	46.8	113	10.07	45.20
SPV 2444	395.0	8.6	36.4	109	10.06	42.80
SPV 2445	338.0	12.1	61.0	142	8.97	45.20
SPV 2446	46.5	2.1	8.6	132	10.94	45.00
SPV 2447	66.0	1.4	6.1	120	10.72	46.80
SPV 2448	234.0	4.3	20.6	108	10.50	50.80
SPV 2449	339.0	9.6	49.1	64	8.75	44.60
SPV 2450	188.5	6.0	33.1	122	9.19	50.40
SPV 2451	47.5	0.8	3.8	69	9.19	41.40
SPV 2452	32.5	0.7	3.6	117	8.53	42.60
SPV 2453	257.5	7.1	34.1	73	8.97	43.20
SPV 2454	374.0	11.3	53.2	101	9.30	43.60
SPV 2455	366.5	10.7	56.6	23	8.75	46.20
CSH 13	140.0	3.1	16.2	145	9.19	47.60
CSV 30F	283.0	9.0	38.0	61	9.85	41.80
CSV 21F	260.0	6.2	23.7	135	10.94	41.60
HJ 541	188.0	5.1	25.2	101	9.41	46.60
Mean	226.05	6.5	30.9	111	9.65	45.54

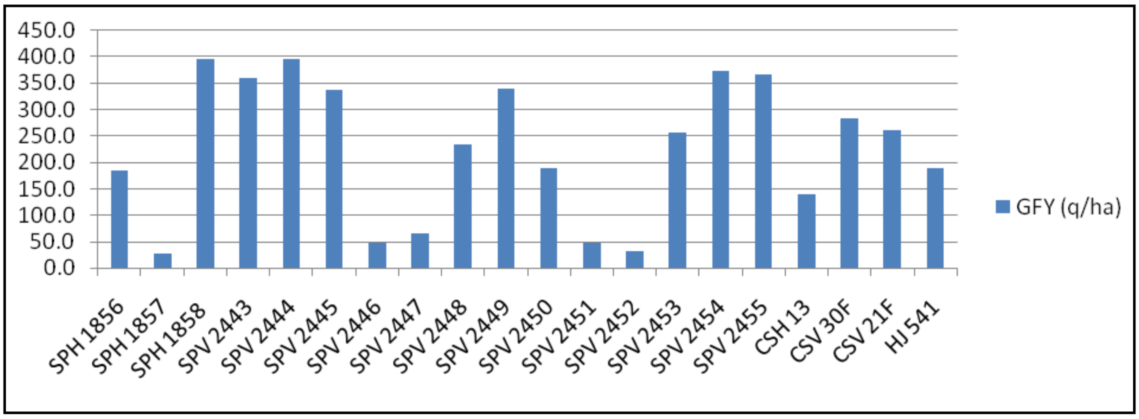

Fig. 1. GFY of different sorghum genotypes (q/ha).

TABLE 2
Evaluation of sorghum genotypes for structural carbohydrates on dry weight basis

Sorghum genotypes	NDF (%)	ADF (%)	Cellulose (%)	Hemicellulose (%)
SPH 1856	57.30	36.20	30.35	22.10
SPH 1857	57.40	34.45	36.90	21.95
SPH 1858	55.25	35.55	22.10	25.50
SPV 2443	55.65	33.25	28.40	24.40
SPV 2444	56.95	32.50	34.55	29.45
SPV 2445	51.45	37.80	29.70	19.70
SPV 2446	58.35	35.45	35.15	14.90
SPV 2447	49.75	39.45	34.10	18.30
SPV 2448	58.25	34.55	27.60	29.70
SPV 2449	47.40	36.35	38.90	27.05
SPV 2450	56.35	37.50	29.15	25.85
SPV 2451	51.50	35.35	35.65	24.15
SPV 2452	54.45	36.30	36.90	26.15
SPV 2453	56.50	32.55	24.25	27.95
SPV 2454	42.50	32.15	25.45	25.55
SPV 2455	58.10	39.55	25.90	29.87
CSH 13	63.87	31.00	24.01	25.24
CSV 30F	52.55	36.31	29.86	14.95
CSV 21F	56.60	34.65	26.05	15.80
HJ 541	53.80	35.00	24.00	22.70
Mean	54.70	35.30	29.95	23.56

wall constituents (NDF, ADF and Cellulose) exhibited upward trend with the plant maturity. Among structural carbohydrates, NDF content ranged from 42.50-63.87% and was maximum found in CSH 13 (63.87). ADF content ranged from 31.00-39.55% and maximum was observed in SPV 2455 (39.55), cellulose content ranged from 22.10-38.90 % and was maximum in SPV 2449 (38.90) and hemicellulose content ranged from 14.90-29.87% with highest in SPV 2455 (29.87) on percent dry weight basis. Nandra *et al.* 1983 studied the cellulose content in sorghum and the results showed that sorghum fodder exceeded hemicellulose content and digestibility of the hemicellulose content decreased with increasing maturity. McBee and Miller (1983) reported an increase in hemicellulose content and decrease in cellulose content during maturation stages. No significant difference was observed in hemicellulose content during different harvest stages (Gerhardt *et al.*, 1994).

Association between agronomic and morphological traits suggests complex interactions between them for developing superior hybrids. Knowledge of genetic arrangement between morphological, grain yield and agronomic traits will help in formulating breeding strategies for improving the existing genotypes/hybrids. One of the important key steps is the use of QTL mapping in understanding the genetic behavior tightly linked for marker-assisted crop improvement (Ashok *et al.*, 2011; Sinivas *et al.*, 2009; Nagarjan *et al.*, 2013, 2014).

Minimum HCN content was observed in SPV 2455 (23 µg/g) followed by SPV 2449 (64 µg/g) (Fig. 2). Crude protein ranged from 8.53 to 10.94 %. SPV 2446 had maximum crude protein (10.94 %) followed by SPV 2447 (10.72%), SPV 2448 (10.50%) (Fig. 3). Pedersen *et al.* 1982 studied the variability for quality

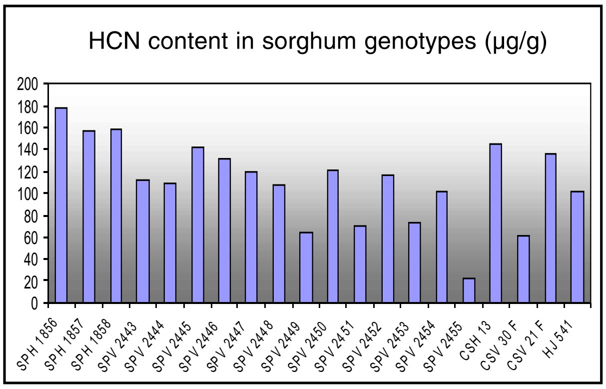

Fig. 2. HCN content (µg/g) in sorghum genotypes on fresh weight basis.

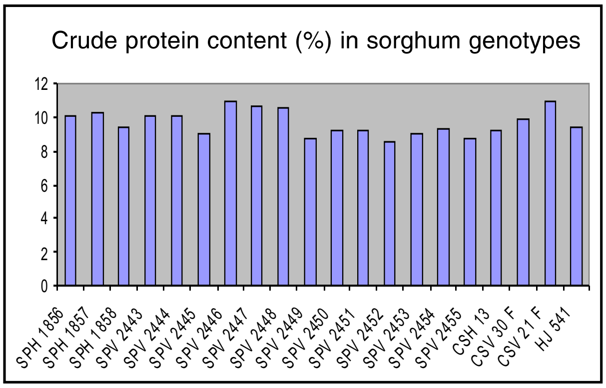

Fig. 3. IVDMD (%) in forage sorghum genotypes.

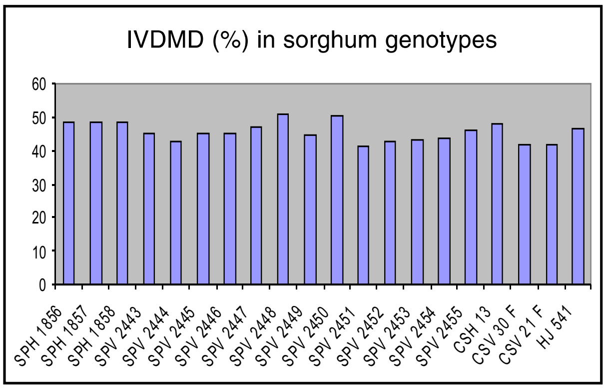

Fig. 4. *In vitro* dry matter digestibility (IVDMD) in sorghum genotypes.

and agronomic traits in forage sorghum hybrids and results showed that IVDMD ranged from 49.1-60% and crude protein ranged from 6.1- 7.3%. IVDMD ranged from 41.40 to 50.80 %, it was found highest in SPV 2448 (50.80%) followed by SPV 2450 (50.40%) and SPH 1858 (48.60%). SPV 2450 and SPV 2450 had IVDMD higher than all the other genotypes (Fig. 4). On the basis of above observations, it is concluded that SPV 2455 and SPV 2449 and SPH 1858 were found promising having maximum plant height green and dry fodder yield, crude protein, minimum HCN content and IVDMD. Generally, there is decrease in IVDMD and crude protein as plant advances in maturity (Pedersen *et al*., 1983). Satpal *et al*. 2017 studied the forage quality of multi-cut sorghum genotypes under different fertilizer rates and the results showed that HCN content ranged from 76.13-170.38 (µg/g), Crude protein ranged from 8.86-9.52 (%) and IVDMD ranged from 47.14-54.19 (%).

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