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Short Communication

FORAGE SORGHUM GERMPLASM : EVALUATION IN THE PAST TWO DECADES

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About 14,000 lines of sorghum germplasm have been collected and evaluated at Haryana Agricultural University during 1971-1994. A number of promising lines for various traits including forage types have been identified. These germplesm collections are being maintained and utilized in improvement programme.

Range of variation

The range of variability for forage yield and quality characters is given in Table 1. Maximum variability was recorded for plant height, leaf characters, fodder yield and quality traits. Similar variability was also reported by Paroda and Lodhi (1981) based on the compiled information of earlier work.

Promising genetic stocks

Identification of lines for desired trait during the evaluation of the germplasm is most essential to utilize in breeding programmes. The work done in this direction is reported in brief.

a) Fodder characters

Out of the forage sorghum germplasm evaluated at CCSHAU Hisar, the promising genetic stocks for different morphological traits and high fodder yield have been identified (Table 2). There are large number of promising genetic stocks for each of the morphological traits. However, lines like IS 1044, IS 18580, AS 18578, PS 14413, PJ 7R, HC 136, S 285, S 171, S 308 and HFS 566 have been identified promising for the quality fodder yield and these are

advised to be utilized extensively in the breeding of ideal forage sorghum varieties. Multicut sorghum lines-SSG 59-3, HFS 566, J 69, MP Chari, G 46, G 76 and HFS 197 possess characteristics of regeneration and faster growth incomparision to other agronomically superior forage types.

Table 1. Range of variation for different traits in sorghum germplasm lines

Sr. No.	Traits	Range
1.	Days to flowering	38-150
2.	Plant height (cm)	39-473
3.	Number of leaves	3-22
4.	Leaf length (cm)	35.00-110.12
5.	Leaf breadth (cm)	2.00-10.03
6.	Number of tillers	1.0-15.0
7.	Stem girth (cm)	2.6-9.3
8.	Leaf weight/plant (g)	6.3-90.0
9.	Stem weight/plant (g)	60.00-1133.33
10.	Leaf/stem ratio	0.1-0.7
11.	Green fodder yield/plant (g)	62-1510
12.	Dry matter yield/plant (g)	5.7-4167
13.	Protein (%)	3.01-8.75
14.	*In vitro* dry matter digestibility IVDMD (%)	40.4-66.2
15.	Neutral detergent fibre NDF (%)	57.48-73.30
16.	ADF (%)	30.85-42.00
17.	Cellulose (%)	21.35-32.73
18.	Lignin (%)	3.80-7.00
19.	Protein yield (q/ha)	2.27-102.80
20.	DDM (q/ha)	25.6-102.8
21.	Hydrocyanic acid HCN (ppm)	18-600
22.	Tannin (mg/g)	12.5-160.0

b) Biotic resistance

Resistant/tolerant lines to biotic stresses were also identified. A list of promising accessions resistant to foliar diseases, stem borer, shoot-fly and birds damage.

Table 2. Promising genetic stocks for different morphological and yield traits

A.	*Morphological Characters*	Promising genotypes
	Early Vigour	IS 2309, 4776, 12308, 18577, 2123, 5585, S 260, 259, 241, 266, 244, 171, JS 20, SPV 459, SPV 462, SSG 59-3, M.P. Chari
	Early in flowering (less than 60 days)	IS 4068, 4878, 1059, 455, 362, 2305, 677, 601, 12308, 13100 HFS 496, 732, 566, 621, 639, 910, 574, 575, S 259, 260, 109, 250, 244, 241, 272, 294, P 37, JS 20, MP Chari
	Plant height	IS 18580, IS 1873, S 285, S 308, S 351, S 286, S 349, HC 136, PC 6, PC 56
	Number of leaves per plant (more than 18)	IS 3192, 2123, 2205, 18551, 18573, 3240, 3238, 71694, 18577, 18575, 18580, 71687, 71664, 1044, S 325, 385, 505, 507, 604, 285, PC 6, PC56, P 57, G 46, J 470, PS 14413, SPV 8, V 60-1, HC 136
	Leaf length (more than 65 cm)	IS 1044, 5538, 13674, 18573, 18577, 18578, SU 52, HC 136, S 325, S 351, S 375
	Leaf breadth (more than 7 cm)	IS 18577, 18578, 1044, 2205, 13674, S 287, S 308, 171, S 194, S 285, HC 136, UPFS 24, UF Chari 2, PS 14413
	Stem girth (more than 4 cm)	IS 3072, 3231, 3238, 3236, 6018, 3353, 3240, 71635, 3214, 71687, 3214, 71687, 31130, 71694, 3192, 71664
	Midrib colour of leaf	White : IS 102, 2115, 2844, 18833, 19522, 6152, 24397, 18908, 24485, R 1962, 1590, 3850, 3026, 2991, 2992, 2996, A 2384, A 2385, G 57, PS 1062.
		Green : IS 4776, 3551, 1361, 4552, 6323, 24349, 21661, S 411, S 287, S 301, S 301, S 250, S 462, SPV 809, A 1868, A 2485, R 472, G 69
		Brown : IS 11861, 21887, 21888, 21889, 21890, 21891, 23253, 651, S 440-11
B.	*Yield Traits*	
	Leaf Weight/ plant (more than 65 g)	IS 1044, IS 18578, PS 14413, SU 52, HC 136, S 171, PJ7R
	Stem weight/ plant (more than 300 g)	IS 1044, IS 18578, IS 18580, PS 14413, S 194, S 285, S 308, HC 136
	Green fodder yield/ Plant	IS 1044, 18580, 5613, 4516, 11758, 12073, 12040, 12126, 12074, 3868, 3261, 613, 3185, 3037, 5664, 12308, PS 194, HC 136, SI 18, PJ 7R, J 9, V 60-1, PC 6, Roma, Sel. 512, S 308, SI 56, SPV 84, SPV 70, SL 54, CSV 6, SPV 8, S 152, A 6, G 9917, PC 16
	Dry fodder yield/ plant (more than 130 g)	IS 1044, 18578, 18580, 2384, 3268, HFS 566, 621, 639, 559, 546, 200, S 194, 285, 308, 505, HC 136, PS 14413, P 57, R 472, R a52, G 46, G 76
	Regeneration	HFS 566, HFS 565, HFS 732, HFS 8116, HFS 96, HFS 197, SSG 59-3, S 199, AS 11, S 260, S 259, HC 136, MP Chari, IS 3238, IS 3240, IS 3237, IS 3374, G 73, G 76, IS 3353

are given in Table 3. Lines G 40, IS 8087, IS 3380, SPV 98, S 171, S 260, S 435 and *S. roxburghii* showed resistance to most of the foliar diseases. IS 2205, IS 5470, IS 2123, IS 12308, IS 5469 and IS 2205 lines had resistance to stem borer while IS 1054, IS 5469, IS 18551, IS 2123 and S 171 had resistance to shoot-fly. Lines IS 5469 and IS 2123 had resistance to both stem borer and shoot fly as well as possess good fodder characters. Therefore, utilization of such genotypes in breeding programme will lead to useful results.

Table 3. Promising genetic sotcks resistance to biotic stress

Biotic stress	Promising genotype
Foliar disease resistant	IS 8087, 3037, 3383, 3380, 4068, 3374, 4878, 6143, 1141, 1061, 1499, 2194, 1458, 1255, 2269, 2944, 4492, 21119, 8347, 18829, 12178, 21415
	S 253, 411, 254, 381, 260, 171, 308, 194, 241, 440, 151, 162, 96, 435, 375
	G 40, 41, 50, 51, 57, 73, 76
	SPV 98, SPV 80, 61-1-1, P 37, 1062 B, *S.roxburghii*
Stem borer tolerant	IS 470, 2123, 12308, 21209, 8104, 5566, 5469, 3374, 5470, 1224, 8513, 19522, 5604, 2205, 1151, 18548, 18584, 2464, 18583, 18678, 637, 1002, 5268, 8315, 18577, 1059, 4777, 4692
	S 285, 171, 436, 184, 505, 501, 241, G 73, G 76, PS 28157-1, PS 14413, ICSV 700, ICSV 70-5, ICSV 708, SSG 59-3, *S. roxburghii*
Shoot fly resistant	IS 488, 1054, 18551, 660, 1003, 5469, 2123, 2146, 2212, 5410, 34664, 18577, 8585, 18811, 18584, 5604, 5470, 4663, 5566, 14385
	S 171, 260, 491, 308, 498, 440, 241, PS 14454, P 37, E 302, ICSV 700
Bird resistant	IS 14346, 1807, 1020, 827, 18433, 22121, 18584, 18677, FS 1, G 39, G 65

Eleven lines were found to be resistant to bird damage. This may be due to high tannin contents in their seers. The seed colour of most of these lines was brown, and have no adverse effect on quality of forage. Therefore, there is good scope of combining bird damage resistance with cultivar having desirable fodder traits.

c) Forage quality traits

Lines having low HCN and tannin contents and high IVDMD and protein levels were identified. Some of the promising lines for these traits (Table 4) have been utilized to develop the present day varieties.

Table 4. Promising genetic stocks for quality traits

Quality trait	Promising genotypes
Low in HCN	IS 4776, 2844, 6128, 3313, 6090, 1059, 3247, 2944
	SRS 5, S 109, T 26, C 10-2, T 30, S 178, *S.roxburghii*, PC 6, L 309, V 60-1
Low in Tannin	*S. roxburghii*, S 171, HC 136, C 433, S 109, S 120, S 152, S 375, S 308, SPV 98, SPV 94, PJ 7R, IS 3247, S 498, HC 260, IS 4776, V 60-1, IS 3214, M 35-1
High protein	M.P. Chari, S 301, S 209, Impi. Jowar, HC 136, HC 171, PC 154, S 499, S 411, S 120, 54-1, HFS 566, S 520, IS 651, S 184, S 308, PC 1, IS 4770
High IVDMD	IS 4770, IS 8312, IS 6380, EC 127664, IS 8314, IS 4776, HC 136, HFS 566, S 208, S 260, S 281, S 259, S 171, S 428, S 472, S 199, SU 520

Sorghum genotypes, Imp. Jowar, PC 1 and S 520 had high protein (more than 7%) whereas IS 4770, IS 8312, IS 6880 and EC127664 had high digestibility (more than 55%). However HC 136 and HFS 566 appeared to be most promising genotypes in quality as they had high contents of both protein and *in vitro* dry matter digestibility. The lines IS 1059, IS 3247, JS 29/1, IS 4776 and NS 256 have been observed to be stable in low HCN content (Lodhi *et al.*, 1979). Low content of both HCN and tannin is dominant to high HCN and tannin, hence it is possible for the breeders to develop low HCN and tannin lines using the above desirable genetic stocks.

d) Good combining and stable forage sorghum lines

The germplasm lines found promising based on their evaluation for yield and quality were utilized to study their combining ability and stability for various forage yield and quality characters. Forage sorghum lines identified as good combiners and stable are given in Table 5. Lines IS 1049, IS 6090, PJ 7R, C 406-8, T 30 and PC 6 were found to be good combiners for height and leaf characters while G 10, HC 136, SPV 102, SPV 98 and JS 263 were best combiners for fodder yield. HC 136 was good combiner for both fodder and seed yield. *S. roxburghii* was good combiner for IVDMD and tannin. IS 4776 was good combiner for protein and HCN while IS 1049 was good combiner for protein and IVDMD. PJ 7R and S 241 were stable for both morphological and fodder yield characters. Likewise, IS 4776 was stable for protein, low HCN, S171, *S. roxburghii* for IVDMD and low tannin, IS 1049 for protein and IVDMD. Utilization of germplasm lines having good combining ability and stability for more number of forage yield and quality characters is likely to be more useful for genetic improvement in forage sorghum (Lodhi and Grewal, 1988).

Table 5. Good combining and stable forage sorghum genetic stocks

A.	*Good general combining lines for*	
1.	Morphological traits (Height, leaf length, leaf breadth, number of leaves & flowering etc.)	IS 1049, IS 6090, SSG 59-3, PJ 7R, C 406-8, T 30, PC 6
2.	Fodder Yield traits	T 48, T 30, G 10, HC 136, SPV 102, KS 29/1 C 406-8, IS 1488, CK 60A, SPV 98, JS 2643, SPV 99, *S. roxburghii*, IS 1049, C 433, PC 9
3.	Seed yield traits	SPV 80, G 10, HC 136, IS 6090, S 171
4.	Proetin %	IS 1049, *S. roxburhii*, IS 6090, C 433, IS 4776, CK 60A, SPV 98
5.	IVDMD %	JS 263, IS 1049, IS 6090, *S. roxburhii*, CK 60A, SPV 98
6.	Low HCN (ppm)	JS 263, IS 4776, IS 6090, S 202
7.	Low tannin (mg/g)	HC 136, S. roxburhii, SPV 4, S 171
B.	*Stable lines for*	
1.	Morphological traits	IS 84, S 241, PJ 7R, IS 3214, S 308,S 171
2.	Fodder yield	HC 260, PC 14413, S 194, PJ 7R, C 433, C 406-2 PC 6, C 19
3.	Seed Yield	S 171, SPV 346, IS 7090, S 308, IS 14346, HC 136, HD 3, S 109
4.	Stem borer tolerance	HC 19522-1, IS 5538, PS 28157, PS 19349-1, IS 1044, PS 14413, 285, S308, IS 12308
5.	Multicut traits	IS 14485, 18849, 14564, 18812, 3312, 3234, 3513, 3237, 3238, 3236, 3267, 472, 3192, 3240, 3366, 3310, 3318, 3329, 3191, SSg 59-3
6.	Protein %	IS 6090, S 171, IS 2123, IS 18573, IS 5538, HC 136, IS 5604, IS 1049, JS 263, IS 4776
7.	IVDMD %	IS 5470, IS 6090, IS 1049, *S. roxburghii*, IS 18573, SPV 98, S 171, S 259, IS 18583, HC 136
8.	Low HCN (ppm)	IS 1059, IS 4776, NS 256, IS 3247, JS 29/1
9.	Low tannin (mg/g)	HC 136, S 109, *S. roxburghii*, S 171

Although large number of above promising genetic stocks have been utilized in breeding superior forage sorghum cultivars, yet emphasis is further needed to collect, evaluate and utilize the forage sorghum germplasm to develop superior genotypes. There is necessity to give more emphasis on these aspects in forage sorghum improvement programme and available forage sorghum germplasm is required to be studied not only for forage traits but also for nutritive traits and resistance to disease, insect and pests.

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