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STABILITY ANALYSIS FOR GRAIN YIELD AND ITS COMPONENT IN GRAIN SORGHUM

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ABSTRACT

Seventy seven sorghum entries comprising 60 hybrids and 17 parents of sorghum (*Sorghum bicolor* L.) were evaluated for stability for panicle length,number of rachis per panicle, 100 grain weight and grain yield per plant. The hybrids *viz.*, 56 A X TNS 81,205 A X TNS 81 and 205 A X MR 750 were identified as stable hybrids with high yield and *per se* performance. For adaptable breeding programme for target environment, the hybrids would be of appropriate source materials.

KEY WORDS: Stability Environment, yield components

Sorghum (*Sorghum bicolor* (L.) Moench) is an important food and feed crop cultivated in *Kharif, Rabi* and summer seasons in Tamil Nadu. It is grown under widely different edaphic and environmental conditions and it is known to exhibit a high degree of genotype-environment interactions. The stability of yield in different environments is considered important in crop breeding programmes. There is, therefore, a need to develop varieties with stability in performance over a wide range of environmental conditions. Various procedures have been employed to characterize the behaviour of individual genotypes for varying environmental conditions (Eberhart and Russell 1966; Finlay and Wilkinson, 1963; Perkins and Jinks 1968; Tai, 1971; Lin and Binns, 1988).

Earlier studies on stability in sorghum were mostly based on phenotypic stability and non-additive in nature (Singh and Nayeem 1980). Students on additive nature of stability are very limited in grain sorghum . Hence, the present investigation was undertaken with a view to work out the additive nature of stability for panicle characters in grain sorghum.

Table 1. Pooled analysis of variance for different characters of grain sorghum

Source		Mean Square			
		Panicle length	Number of rachis per panicle	100 grain weight	Grain yield per plant
Environments	3	94.15**	870.18**	0.606**	2455.99**
Genotypes	77	35.76**	224.7**	0.206**	746.26**
Genotypes X Environment	237	1.76**	45.11**	0.007**	25.95**
Linear response	79	2.33**	35.48*	0.006	37.57**
Deviation from response (Non-linear)	158	1.46*	43.44*	0.007	19.9*
Pooled error	640	0.58	9.28	0.003	6.53

* Significant at 5 per cent level

** Significant at 1 per cent level

MATERIALS AND METHODS

Seventy seven sorghum entries comprising of 60 hybrids and 17 parents were evaluated for stability for panicle characters in four different environments at Regional Research Station, Aruppukottai (Summer and Rabi) and Agricultural Research Station, Kovilpatti (Summer and Rabi). Four environments were created for conducting the trial in two locations and two seasons. The four environments E1,E2,E3 and E4 are as under.

E1 - RRS, TNAU, Aruppukottai - Summer 1994

E2 - ARS, TNAU, Kovilpatti - Summer 1994

E3 - RRS, TNAU, Aruppukottai - Rabi 1994

E4 - ARS, TNAU, Kovilpatti - Rabi 1994.

The experiment was conducted in a randomised block design with three replications in all the four environments. Each genotype was accommodated in two rows with 20 plants in each row spaced 45 cm between rows and 15 cm between plants within the row. The recommended package of practices was followed in all the four environments. Measurements on panicle length,number of rachis per panicle, 100 grain weight and grain yield per plant were made on ten plants selected at random in each replication and in each cross combination under each environment. The combined analysis of variance (along with random replicated and environmental effects) was carried out for each series of trial. Stability statistic was estimated for each entry separately following the method suggested by Lin and Binns (1988).

RESULTS AND DISCUSSION

Pooled analysis of variance for stability for four characters including grain yield in grain sorghum is presented in Table 1. The mean squares due to genotypes was significant for all the characters. The genotype X environment interaction was also significant for all the four characters studied. The components such as linear response and deviation from linear response were significant for all the characters except 100 grain weight, indicating enough variability among genotypes as well as environments.

The results of additive analysis are furnished in Table 2. The method suggested by Lin and Binns

Table 2. Additive analysis of T1 & T4 types of stability parameters for data of 77 grain sorghum genotypes

Stability parameters	Ms	Panicle length	No. of rachis per panicle	100 grain weight	Grain yield
T1	Msg	158.91	7053.88	0.0016	28085.96
	Mse	35.96	1027.46	0.00022	9892.72
	Msg/ Mse	4.42**	6.86**	7.27**	2.83**
T2	Msg	12.88	0.68	1.57	1.43
	Mse	9.10	9.19	6.97	24.60
	Msg/ Mse	< 1	< 1	< 1	< 1
T3	Msg	312.29	5937.36	0.0020	14433.90
	Mse	245.32	256641.56	0.0046	35571.39
	Msg/ Mse	< 1	< 1	< 1	< 1
T4	Msg	41.39	1199.33	0.0026	616.25
	Mse	5.39	131.41	0.00022	141.67
	Msg/ Mse	7.68**	9.13**	11.81**	4.35**

** Significant at 1 per cent level

Table 3. Stability parameters (T1 and T4) for four characters in grain sorghum

Crosses	Panicle length			Number of rachis per Panicle			100 grain weight			Grain yield per plant		
	Mean	T1	T4	Mean	T1	T4	Mean	T1	T4	Mean	T1	T4
111 A X TNS 79	27.64	1.30	0.91	70.33	33.10	8.10	2.43	0.014	0.014	68.70	40.00	11.06
111 A X TNS 80	23.09	3.49	1.07	62.25	11.74	1.18	2.25	0.003	0.003	36.73	48.33	21.02
111 A X TNS 81	24.15	0.35	0.14	62.92	55.50	54.34	2.08	0.007	0.002	43.18	10.78	10.65
111 A X TNS 82	30.38	3.75	0.05	78.17	127.60	10.26	2.57	0.054	0.004	68.13	62.37	17.24
111 A X TNS 83	28.10	-0.21	0.11	62.33	17.71	9.70	2.50	0.008	0.002	62.38	29.34	26.45
111 A X TNS 88	24.28	0.38	0.36	56.33	4.61	0.28	2.31	0.004	0.004	53.83	28.08	26.17
111 A X CS 3541	24.05	0.90	0.89	71.58	95.81	3.40	2.45	0.029	0.002	61.23	87.37	10.94
111 A X SPV 881	26.19	0.60	0.39	70.92	12.22	10.03	2.41	0.002	0.002	58.92	28.49	3.49
111 A X SB 1085	26.24	2.13	0.10	68.67	185.00	48.93	2.40	0.008	0.008	48.21	54.57	17.64
111 A X MR 750	26.02	0.46	0.15	78.40	30.26	2.78	2.71	0.003	0.003	62.95	43.52	21.74
111 A X AKR 150	28.23	1.20	0.57	68.10	77.42	49.83	2.49	0.003	0.002	70.19	11.39	9.34
111 A X TNS 001-1-3-1-1	25.23	0.43	0.12	69.00	46.58	41.73	2.43	0.007	0.003	63.68	13.20	9.78
56 A X TNS 79	23.79	2.64	0.96	72.60	19.47	1.51	2.43	0.004	0.003	69.76	41.24	20.47
56 A X TNS 80	21.68	5.11	0.74	57.40	90.16	7.62	2.11	0.007	0.006	59.18	36.24	18.81
56 A X TNS 81	22.10	0.11	0.04	67.30	107.04	64.82	2.50	0.004	0.002	91.03	10.43	6.85
56 A X TNS 82	21.65	0.95	0.93	66.90	4.02	1.51	2.26	0.005	0.004	57.00	24.49	13.56
56 A X TNS 83	21.01	1.46	0.86	59.70	2.44	1.27	2.08	0.003	0.002	70.70	14.89	13.79
56 A X TNS 88	24.18	3.27	0.81	60.00	35.50	3.38	2.16	0.003	0.002	53.24	24.55	2.72
56 A X CS 3541	23.50	2.54	0.64	66.90	67.07	19.25	2.14	0.003	0.002	58.82	21.86	17.85
56 A X SPV 881	21.28	4.10	2.08	65.30	140.10	114.18	2.48	0.009	0.004	53.37	31.47	9.82
56 A X SB 1085	30.43	0.25	0.04	64.40	31.74	31.68	2.93	0.020	0.003	52.64	16.52	12.01
56 A X MR 750	22.69	2.97	2.97	62.80	6.48	0.22	2.48	0.010	0.002	64.94	79.76	15.61
56 A X AKR 150	21.77	2.06	1.62	54.40	9.91	6.96	2.20	0.013	0.003	48.48	22.42	10.14
56 A X TNS 001-1-3-1-1	22.69	2.09	1.65	68.10	176.55	87.86	2.37	0.004	0.004	50.95	25.36	16.47
26 A X TNS 79	21.58	3.71	2.81	55.30	174.17	127.45	2.36	0.006	0.006	41.38	109.45	16.52
26 A X TNS 80	20.56	2.77	2.73	76.30	58.52	4.72	2.38	0.003	0.003	39.95	107.48	13.39
26 A X TNS 81	23.22	1.41	0.79	57.70	29.98	11.22	2.30	0.025	0.015	46.76	15.31	5.73
26 A X TNS 82	24.73	0.37	0.15	74.40	6.24	1.18	2.48	0.007	0.002	34.81	66.60	20.15
26 A X TNS 83	23.47	1.83	0.43	61.80	78.50	75.72	2.28	0.011	0.005	51.20	112.20	10.54
26 A X TNS 88	21.75	4.23	0.29	62.40	24.68	11.85	2.28	0.004	0.002	37.41	64.32	11.14
26 A X CS 3541	21.83	5.28	2.64	44.50	19.46	12.36	2.48	0.003	0.003	41.39	48.48	12.98
26 A X SPV 881	27.99	3.05	0.30	42.00	14.88	3.77	2.37	0.003	0.001	53.49	36.79	19.06
26 A X SB 1085	20.60	1.30	0.88	73.20	82.39	7.14	2.32	0.003	0.002	42.50	31.08	26.87
26 A X MR 750	26.69	0.83	0.37	55.25	13.11	10.04	2.51	0.001	0.001	62.85	41.58	14.18
26 A X AKR 150	21.59	4.29	1.02	57.83	32.14	26.69	2.13	0.003	0.003	35.93	61.41	12.86
26 A X TNS 001-1-3-1-1	23.88	0.64	0.33	60.25	11.73	15.33	2.46	0.003	0.002	43.11	96.40	6.62
73 A X TNS 79	22.06	0.48	0.28	58.17	11.73	12.48	2.04	0.004	0.002	53.66	7.33	4.21
73 A X TNS 80	23.98	0.59	0.36	61.75	12.59	19.56	2.45	0.007	0.003	62.71	64.19	18.52

Table 3. Contd.

Crosses	Panicle length			Number of rachis per Panicle			100 grain weight			Grain yield per plant		
	Mean	T1	T4	Mean	T1	T4	Mean	T1	T4	Mean	T1	T4
73 A X TNS 81	23.79	3.82	0.40	64.33	21.75	7.36	2.83	0.004	0.002	52.18	45.67	7.54
73 A X TNS 82	25.08	3.69	0.83	71.92	7.40	3.13	2.02	0.002	0.001	53.58	19.17	4.48
73 A X TNS 83	25.97	6.25	0.11	71.83	120.13	113.88	2.32	0.008	0.001	54.18	35.44	16.96
73 A X TNS 88	26.27	1.33	0.26	72.08	9.35	3.89	2.57	0.005	0.002	67.69	24.07	12.22
73 A X CS 3541	19.62	3.75	0.97	53.00	19.80	5.14	2.38	0.014	0.001	55.63	79.48	11.99
73 A X SPR 881	27.62	5.93	0.25	73.08	56.55	44.87	2.38	0.002	0.001	79.18	43.90	3.39
73 A X SB 1085	26.42	1.72	0.74	54.25	14.98	3.07	2.06	0.015	0.007	42.60	116.96	38.65
73 A X MR 750	28.33	0.39	0.19	86.70	14.93	8.68	2.52	0.004	0.002	73.03	19.53	14.12
73 A X AKR 150	24.90	1.32	1.19	70.70	30.14	11.37	2.62	0.008	0.001	52.39	10.43	10.08
73 A X TNS 001-1-3-1-1	26.54	1.58	1.58	60.80	10.52	2.02	2.09	0.004	0.001	42.93	75.76	61.62
205 A X TNS 79	31.98	1.41	0.29	63.20	33.58	14.81	2.46	0.003	0.002	63.94	80.69	31.37
205 A X TNS 80	30.54	1.38	0.28	62.80	24.01	21.76	2.32	0.013	0.003	79.15	83.83	10.73
205 A X TNS 81	24.08	0.53	0.36	75.90	90.11	37.52	2.55	0.002	0.001	98.93	4.32	2.50
205 A X TNS 82	21.67	1.15	0.84	62.50	11.41	8.05	2.35	0.002	0.002	54.69	14.82	10.78
205 A X TNS 83	29.74	1.93	0.88	62.20	28.50	23.14	2.55	0.002	0.001	73.23	28.50	27.93
205 A X TNS 88	27.05	1.92	1.03	60.20	19.49	7.23	2.58	0.003	0.001	39.54	62.74	12 19
205 A X CS 3541	23.53	4.44	1.52	55.80	31.82	15.91	2.84	0.021	0.002	78.25	138.58	21.24
205 A X SPV 881	27.85	0.72	0.40	74.00	1.72	1.03	2.72	0.028	0.003	61.16	41.14	25.36
205 A X SB 1085	28.93	4.28	4.13	69.70	2.06	1.40	2.11	0.023	0.003	62.76	22.15	4.84
205 A X MR 750	24.08	3.36	0.47	73.20	31.03	8.03	2.65	0.005	0.002	74.03	14.20	9.51
205 A X AKR 150	26.31	5.32	1.25	70.90	10.92	8.90	3.02	0.010	0.002	63.90	15.38	3.71
205 A X TNS 001-3-1-1	26.64	0.87	0.66	63.60	16.72	14.20	2.38	0.002	0.002	52.42	17.86	14.32
111 A	21.32	3,33	1.98	64.80	6.73	3.06	2.23	0.002	0.001	41.02	72.36	8.88
56 A	21.21	2.30	2.00	54.10	31.91	2.56	1.91	0.004	0.003	34.65	24.70	10.64
26 A	22.49	0.43	0.41	50.80	13.78	5.76	1.89	0.006	0.004	27.83	8.12	8.06
73 A	20.69	0.75	0.41	58.80	10.68	3.13	2.02	0.000	0 001	45.54	11.21	10.95
205 A	20.10	4.31	0.57	60.30	39.23	11.66	2.03	0.004	0.004	46.96	50 51	11 65
TNS 79	25.00	1.01	0.68	65.40	65.50	4.35	2.13	0.031	0.001	50.43	5.45	5.18
TNS 80	22.02	0.45	0.20	56.10	26.90	23.85	2.27	0.014	0.002	50.45	4.36	4.21
TNS 81	23.53	0.32	0.24	61.70	78.80	9.46	2.32	0.010	0.000	44.93	5.64	4.80
TNS 82	22.56	0.93	0.86	61.70	40.68	3.68	2.38	0.008	0.002	54.26	111.14	2.78
TNS 83	26.28	0.87	0.13	66.00	20.20	17.43	2.12	0 002	0 001	55.46	68 60	7 73
CS 3541	19.07	3.67	0.83	57.90	6.41	4.40	2.18	0.017	0.002	35.00	15.17	6.86
SPV 881	23.40	2.18	1.45	56.30	20 90	2.84	2.28	0 004	0.003	44.58	25.95	11 88
SB 1085	21.78	3.20	0.44	51.50	6.70	0.45	2.04	0 006	0 003	44.60	16 92	11 16
MR 750	24.03	1.79	0.31	54.90	9.03	2.34	2.07	0.002	0.002	33 90	13.72	10 78
AKR 150	20.47	4 39	1.15	65.70	43.74	24.21	2.31	0.025	0.024	35 10	56.33	29 42
TNS 001-1-3-1-1	21.27	4 27	1.09	59 40	24.79	21.12	2.24	0.001	0.001	44.68	3 42	0 89
Grand mean	24.15	-	-	63.70	-	-	2.35	-	-	54.7	-	-

(1988) has been used for working out the additive nature. Significant additive effect was observed with the panicle characters under the stability parameter T1 and T4. Type 1 [T1] is the variance of the genotype across environments and Type 4 [T4] is the genotype X location X year experiment, the year within location mean sum of square for a genotype averaged over all locations.

For panicle length, the stability parameters *viz*., type 1 and type 4 showed additivity which is highly significant. The type 1 and type 4 stability parameters have helped to identify crosses *viz*., 111A X TNS 81, 111 A X TNS 83, 111 A X MR 750, 111 A X TNS 011-1-1-3-1-1, 56 A X SB 1085, 26 A X TNS 82 and 73 A X MR 750 as stable hybrids for panicle length (Table 3). They have low mean square deviation. These hybrids have shown stability for panicle length. These hybrids may serve as the best source for selection and improvement for panicle length. The number of rachis per panicle also showed the additivity nature of stability parameters type 1 and type 4. The hybrids *viz*., 111 A X SPV 881, 56 A X TNS 79, 26 A X TNS 82, 73 A X TNS 82, 73 A X TNS 88, 73 A X MR 750, 205 A SPV 881 and 205 A X AKR 150 recorded low mean square deviation and high *per se* performance for this character. They showed least fluctuations in their performance for this trait over the change of environments.

Considering the additivity of type 1 and type 4 stability parameters, 100 grain weight is heritable for its stability. The two parameters showed that the hybrids *viz*., 111 A X-TNS 83, 111 X MR 750, 56 A X TNS 81, 26 A X MR 750, 73 A X TNS 81, 73 A X TNS 88, 73 A X MR 750, 73 A X-AKR 150, 205 A X TNS 81, 205 A X TNS 81, 205 A X TNS 88 AND 205 A X MR 750 were stable for 100 grain weight across the environments (Table 3). They exhibited low mean square deviation for the stability parameters T1 and T4. For adaptable breeding programme for target environment, these hybrids would be of appropriate source material.

Yield stability is an important characteristic for commercial hybrids with a wide range of adaptation. The grain yield stability is additive in nature. Hence, the stability is heritable. Therefore, the improvement could be made through suitable breeding programme. The parameters type 1 and type 4 showed that the hybrids *viz*., 111 A X AKR 150, 111 A X TNS 001-1-3—1-1, 56 A X TNS 81, 205 A X TNS 81, 205 A X MR 750 AND 205 A X AKR 150 were stable for any fluctuations in the environments. The highest yielding hybrids *viz*., 56 A X TNS 81 AND 205 A X TNS 81 were in the category of stable genotypes (Table 3). Hence, selection from these sources may provide stable genotypes for grain yield.

For overall performance, the hybrids *viz*., 56 A X TNS 81, 205 A X TNS 81 and 205 A X MR 750 were identified as stable hybrids by type 1 and type 4 stability parameters possessing high grain yield and high *per se* performance besides stability. Therefore, the improvement could be made through suitable crossing programme.

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