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STABILITY PARAMETERS IN MACARONI WHEAT

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ABSTRACT

The stability parameters for six traits related to quality and productivity performed in a 11-parent diallel mating techniques of macaroni wheat (*Triticum durum* Desf.) are reported. The genotypes interacted significantly with environment for all the characters. Nonlinear components revealed highly significant difference for reproductive phase, seed hardness, protein content, and gluten content. The parent varieties Jori 'C' 69 and Raj 911 appeared to be more adapted as they exhibited nonsignificant deviation from regression, regression coefficient less than unity, and high grain yield. Jori 'C' 69 also showed adaptation for gluten content. Twenty cross combinations in F_1 generation exhibited better stability for higher grain yield in comparison to their parental performances. The hybrids Meghdoot x WL 1002 and NP 404 x DWL 5023 were stable for seed hardness, protein and gluten content.

Key words: *Triticum durum*, macaroni wheat, stability parameters, diallel cross.

The stability parameters provide information about adaptability of genotypes and their stability over a wide range of agroclimatic conditions. If adaptability in real sense is a genetic characteristic, then preliminary evaluation can be made to identify the stable genotypes and their cross combinations left for the final stages of testing. Such a study will provide a sound basis to breeder in the intensive selection programmes. The importance of stability study in macaroni wheat has recently been recognised by several Indian workers [1, 2].

MATERIALS AND METHODS

Eleven genetically diverse cultivars of macaroni wheat (*Triticum durum*) included in the study were NP 404, MPO 215, DWL 5023, Jori 'C' 69, JNK-4W-184, NP 401, Meghdoot, Karnataka Local, Raj 911, WL 1002, and Kathia 25. These cultivars were crossed in all possible combinations (excluding reciprocals). The resulting 66 genotypes (11 parents and 55 F_1s) were raised in randomized complete block design with three replications at three different locations at the Crop Research Stations of C. S. Azad University of Agriculture and Technology, Kanpur, Fatehabad (Agra), and Mauranipur (Jhansi), representing diverse agroclimatic conditions of Uttar Pradesh. The interplant and interplot distances were 15 and 30 cm, respectively. The data were recorded on five random plants on reproductive phase, harvest index, grain yield per plant, seed hardness, protein content, and gluten content. The means of the individual plants were utilized for statistical analysis. The stability analysis was carried out using the Eberhart & Russell model [3].

RESULTS AND DISCUSSION

The experimental results indicated that the pattern of genotype-environment interaction among the genotypes was not similar but varied from trait to trait under study. Stability analysis showed that the differences between the genotypes and genotype-environment interaction component for all the traits related to quality and productivity were significant (Table 1). It also revealed that the average performance of genotypes with respect to grain yield and other traits varied significantly.

Table 1. ANOVA (MSS) for stability of 11 characters in a 11-parent-diallel cross and parent varieties of macaroni wheat

Source	Genotypes (G)	Environment (E)	G x E	E = (G x E)	Environment (linear)	G x E (linear)	Pooled deviation	Pooled error
Degree of freedom	65	2	130	132	1	65	66	360
Reproductive phase	21.2**	2831.9**	5.4**	28.8	5661.1**	5.7	5.2**	1.75
Harvest index	17.3**	185.5**	2.7**	4.2	368.7**	3.1	2.3	1.69
Grain yield per plant	80.5**	5098.5**	35.3**	77.1	10197.8**	39.3	31.0	9.36
Seed hardness	4.6**	42.9**	1.1**	1.4	85.6**	1.4**	0.8**	0.07
Protein content	2.3**	31.2**	0.8**	1.3	62.4**	1.2**	0.5**	0.03
Gluten content	3.1**	37.5**	0.9**	1.5	1.2	1.3**	0.5**	0.02

**Significant at P = 0.01.

The environment (linear) interaction component was highly significant for all the traits except gluten content, while the linear component of environment interaction was significant for seed hardness, protein and gluten content. The variance due to deviations (nonlinear) were significant for reproductive phase, seed hardness, protein content and gluten content reflecting considerable genetic diversity in the material, as also reported earlier [4]. Such nonlinear deviation might also be of practical value to construct and test the utility of the multiple regression models to know more critically the complex mechanism of adaptation.

Table 2. Mean performance and stability parameters

Parent/hybrid	Grain yield per plant			Harvest index		
	$\bar{X}$	b_i	S^2_{di}	$\bar{X}$	b_i	S^2_{di}
NP 404	22.8	1.21*	–22.9	35.1	0.45	–3.38
MPO 215	23.0	1.84**	–25.3	34.5	0.62	–3.38
DWL 5023	28.6	1.03	–24.8	40.0	1.31	0.42
Jori'C' 69	28.4	0.87	–26.4	39.7	1.73	–3.38
JNK-4W-184	26.0	1.69**	–25.2	38.0	2.01*	–3.39
NP 401	21.5	1.98**	–13.2	37.4	1.33	10.72
Meghdoot	17.4	–0.25	–23.6	32.9	0.21	–3.37
Karnataka Local	17.0	0.90	–6.0	39.6	0.04	–3.20
Raj 911	28.1	0.07	320.3	35.5	0.52	–2.73
WL 1002	23.8	1.70**	–27.2	37.5	0.15	–3.25
Kathia 25	22.4	0.65	–18.4	38.1	1.78*	35.43
Hybrids with high stability for grain yield						
NP 404 x DWL 5023	31.5	0.48	22.2	38.4	1.04	–2.37
NP 404 x JNK-4W-184	36.4	0.67	–20.1	35.8	–0.26	0.76
NP 404 x Karnataka Local	21.5	0.12	23.0	35.0	–0.09	2.02
NP 404 x WL 1002	27.6	0.47	–13.1	37.0	1.47	–2.81
NP 404 x Kathia 25	27.4	0.27	–26.9	34.5	0.84	–1.19
MPO 215 x JNK-4W-184	23.6	0.77	26.8	41.2	1.77**	–3.45
MPO 215 x Meghdoot	27.1	0.35	–2.9	45.2	1.43	–3.46
MPO 215 x Raj 911	30.5	0.71	–27.0	42.8	1.21	–3.33
MPO 215 x WL 1002	25.4	0.93	–17.8	35.7	–1.17	–3.01
MPO 215 x Kathia 25	29.9	0.96	–23.3	41.2	2.11**	–3.12
DWL 5023 x JNK-4W-184	25.4	0.66	2.5	39.4	0.86	–0.33
DWL 5023 x NP 401	36.6	0.39	110.4	39.4	3.14**	–2.46
DWL 5023 x Karnataka Local	29.1	0.21	–23.7	40.0	1.16	–3.39
DWL 5023 x Kathia 25	29.0	0.96	–23.3	40.1	–0.56	4.99
Jori'C' 69 xRaj 911	25.7	0.93	–20.0	37.8	0.26	–2.62
JNK-4W-184 x Meghdoot	26.5	0.69	55.2	35.2	–0.47	–2.02
JNK-4W-184 x Karnataka Local	25.4	0.96	32.0	37.1	–0.67	–2.53
JNK-4W-184 x Raj 911	26.0	0.72	26.0	37.1	0.14	–3.06
JNK-4W-184 x Kathia 25	28.8	0.76	3.1	40.8	1.57	7.40
Meghdoot x Karnataka Local	23.8	0.16	–20.5	36.5	1.23	–2.73
Meghdoot x WL 1002	23.8	0.41	45.4	34.0	–1.27	4.15
Karnataka Local x Kathia 25	18.9	0.58	–1.0	36.3	0.86	–2.28
Raj 911 x WL 1002	29.6	–0.08	–26.3	41.2	–0.28	6.62
SE ±	1.8	0.33		1.4	0.51	

*, **Significant at 5% and 1% levels, respectively.

for different characters in macaroni wheat

Reproductive phase			Seed hardness			Protein content			Gluten content		
$\bar{X}$	b_i	S^2_{di}	$\bar{X}$	b_i	S^2_{di}	$\bar{X}$	b_i	S^2_{di}	$\bar{X}$	b_i	S^2_{di}
40.2	1.25**	10.21	11.5	–0.25	0.21	11.7	0.41	–0.01	8.5	0.35	0.03
37.8	1.36**	18.69	15.7	0.78	1.18**	12.7	0.16	–0.02	11.1	0.20	–0.02
40.0	1.28**	–1.63	16.9	1.32	1.88**	10.7	0.72	–0.02	8.7	0.66	–0.01
38.9	0.87**	7.47	16.8	0.92	0.36**	14.0	0.24	0.08*	12.1	0.11	–0.04
44.7	1.44**	–1.78	14.8	0.80	0.36	13.8	–0.54	0.29**	11.6	–0.63	0.22**
36.0	1.36**	12.36	12.3	–0.59	0.32**	11.5	0.62	0.08*	9.7	0.45	0.85**
36.8	1.34**	–1.56	12.8	0.48	0.30*	12.1	0.03	0.07	10.1	0.28	0.41**
43.27	1.11**	17.27	12.0	–0.54	–0.04**	11.9	2.99**	1.24**	9.5	0.27	0.79**
40.2	1.14**	–1.72	16.4	0.70	6.76**	12.7	0.39	0.01	10.5	–0.08	0.07*
37.9	1.04**	2.60	15.8	–0.60	2.54**	13.2	–0.46	–0.02	10.6	–0.11	0.46**
37.9	1.20**	11.18	12.1	0.07	0.92**	10.1	0.32	–0.01	7.5	0.34	0.03
41.7	1.59**	–1.21	13.3	0.86	0.62**	11.8	2.03**	0.53	10.7	1.96**	0.49**
42.7	1.24**	–1.14	14.5	2.90**	0.40**	12.5	0.33	0.06**	11.0	0.67	0.04
41.9	1.89**	–1.66	14.0	–0.11	0.11**	12.4	2.69	0.01	11.0	2.79**	0.08*
43.2	1.32**	11.87	13.7	0.45	1.44**	12.2	0.62	0.62**	10.9	0.65	0.85**
39.9	1.45**	1.14	13.1	0.05	–0.06**	12.6	–0.02	3.98**	11.0	0.13	4.08**
43.3	1.40**	5.00	15.0	1.33	0.47**	12.2	1.02	0.01*	10.8	1.01	0.33**
39.1	1.20**	–1.23	12.7	1.88	0.38**	12.1	–0.39	–0.03	10.6	–0.75	–0.01
37.4	0.37	–1.69	15.7	1.65	4.24	12.9	0.45	0.34**	10.9	0.39	0.22**
38.1	0.81*	2.83	14.7	0.53	0.25**	12.4	1.10	0.53**	10.1	1.30	0.95**
44.3	1.14**	0.51	13.2	0.90	0.72	11.0	0.29	0.68**	9.1	0.56	0.33**
44.4	1.21**	–1.75	14.0	2.63*	0.01*	12.5	–0.34	0.51**	10.6	–0.30	0.46**
40.9	1.49**	–1.32	15.2	3.43**	1.22**	11.5	0.24	0.01	9.8	0.14	0.01
44.5	1.41**	7.66	14.4	1.65	1.82**	12.8	1.89**	0.57**	11.1	1.89**	0.55**
42.4	0.92**	–1.15	13.2	3.10**	0.98**	12.7	2.36**	0.11*	11.2	2.23**	0.21**
36.4	0.95**	12.52	15.2	–0.49	0.86**	12.2	–0.15	0.12*	9.9	–0.02	0.02
41.3	1.50**	2.28	13.7	1.44	0.47	12.3	2.93**	0.02	10.7	2.92**	0.13**
45.7	1.30**	–0.76	12.4	–0.42	–0.02*	12.6	1.73*	0.33	10.6	2.11**	0.13**
41.5	0.75*	16.41	13.5	3.07**	–0.07**	11.9	1.67*	0.06	10.4	1.77*	0.25**
43.8	1.45**	3.04	13.5	0.24	4.48**	11.6	0.83	0.20**	10.1	1.03	0.50**
38.4	0.88**	–1.67	12.5	0.54	–0.05	11.4	3.55**	–0.03	9.9	3.47**	0.02
38.4	1.21**	7.97	12.8	0.08	0.17	12.7	0.46	–0.03	11.3	0.48	–0.01
45.7	1.15**	4.48	11.6	0.01	1.40**	12.8	0.57	0.96**	11.1	0.28	0.45**
42.3	1.17**	–0.91	16.9	–0.08	–0.02**	12.9	0.13	–0.03	10.8	0.25	0.16**
3.1	0.53		0.6	1.07		0.5	0.71		0.52	0.68	

The characters, being under the control of many loci, reflected considerable interaction and little stability [5]. In the present study, grain yield and gluten content exhibited substantial amount of interaction components ($\hat{\sigma}^2_{gl}$ + $\hat{\sigma}^2_{sl}$) as compared to genetic variance ($\hat{\sigma}^2_g$ + $\hat{\sigma}^2_s$), indicating the poor stability for these traits [6].

The large variation in regression coefficients indicated that genotypes had different degree of environmental response. The variability among environments determines the usefulness of this regression response parameter, as reported by [7]. In the present set of materials, the parents, Jori'C' 69 and Raj 911 were more adapted cultivars in view of performance under a wide range of conditions and also showed nonsignificant deviation from regression, regression coefficient less than unity, and high mean for grain yield. Phenotypically, these cultivars were diverse in their morphological characteristics and genetic background. Other parents, namely, Meghdoot, Karnataka Local and Kathia 25, were also important, having nonsignificant deviation from regression, less than unit regression coefficient, and considerable mean yield. On the other hand, genotypes DWL 5023, JNK-4W-184, WL 1002, MPO 215, MP 404 and NP 401 were found to be especially adapted for the favourable environments (Table 2).

The cultivar Jori'C' 69 showed stability for reproductive phase and gluten content, and Raj 911 for harvest index and protein content. The cultivars NP 404, MPO 215, DWL 5023, Meghdoot, Raj 911, WL 1002, and Kathia 25 were stable for protein content, and NP 404, MPO 215, DWL 5023, Jori'C' 69 and Kathia 25 for gluten content (Table 2).

Twenty three F_1s were stable for their yielding ability ranging from 18.9 to 36.6 g per plant. Twenty hybrids, namely NP 404 x DWL 5023, NP 404 x JNK-4W-184, NP 404 x Karnataka Local, NP 404 x WL 1002, NP 404 x Kathia 25, MPO 215 x JNK-4W-184, MPO 215 x Meghdoot, MPO 215 x Raj 911, MPO 215 x WL 1002, MPO 215 x Kathia 25, DWL 5023 x JNK-4W-184, DWL 5023 x NP 401, DWL 5023 x Karnataka Local, DLW 5023 x Kathia 25, Jori'C' 69 x Raj 911, JNK-4W-184 x Meghdoot, JNK-4W-184 x Raj 911, JNK-4W-184 x Kathia 25, JNK-4W-184 x Karnataka Local, Meghdoot x Karnataka Local, Meghdoot x WL 1002, Karnataka Local x Kathia 25, and Raj 911 x WL 1002 involved high x high, high x low or low x low adaptive cultivars.

Considerable stability for quality attributes was observed in six F_1s, viz. NP 404 x Meghdoot, NP 404 x Raj 911, MPO 215 x Kathia 25, Jori'C' 69 x Meghdoot, NP 401 x Karnataka Local, and Meghdoot x WL 1002. Ten F_1s, namely, NP 404 x MPO 215, MPO 215 x DWL 5023, MPO 215 x Jori'C' 69, MPO 215 x Meghdoot, DWL 5023 x NP 401, DWL 5023 x WL 1002, Jori'C' 69x Meghdoot, JNK-4W-184 x NP 401, Meghdoot x WL 1002, and Raj 911 x WL 1002, were better for protein content. Gluten content also showed high stability in ten F_1s, viz. NP 404 x JNK-4W-184, MPO 215 x DWL 5023, MPO 215 x Meghdoot, DWL 5023 x

NP 401, DWL 5023 x WL 1002, Jori'C' 69 x NP 401, Jori'C' 69 x Meghdoot, Jori'C' 69 x Raj 911, Jori'C' 69 x WL 1002, and Meghdoot x WL 1002.

Three hybrids (MPO 215 x Meghdoot, DWL 5023 x NP 401, and Meghdoot x WL 1002) had high stability for grain yield and at least for two quality attributes. The hybrid Meghdoot x WL 1002 was stable for two yield traits and all the three quality attributes.

Eight F1s, namely, NP 404 x DWL 5023, NP 404 x JNK-4W-184, MPO 215 x Raj 911, DWL 5023 x NP 401, DWL 5023 x Karnataka Local, DWL 5023 x Kathia 25, JNK-4W-184 x Kathia 25, and Raj 911 x WL 1002, exhibited better stability and performance for grain yield in comparison to all the standard cultivars included in the study. Therefore, the introduction of dwarfing genes has ensured the availability of good combiners for several traits influencing both quality and productivity in durum wheat.

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