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SHORT COMMUNICATION

Stability for Yield and its Component Traits in Durum Wheat (*Triticum durum* Desf.)

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Fifty genotypes of durum wheat were evaluated over four diverse environments for grain yield and its component traits (tiller number, grains/spike and 100 grain weight). Genotype × environment interaction was found significant for all the traits except 100 grain weight. Further, linear component of G×E interaction was significant for 100 grain weight suggesting that the variation in performance of different genotypes could be predicted. The genotypes IDYT-CA-05-47, NI 146, PDW 215, IDYN 46 and IDYN 49 were found to desirable and stable across the environments for grain yield. Thus, these genotypes could be included in the hybridization programme to converge the stability characteristics of grain yield for the development of a stable variety adapted to wider range of environments.

Key Words: Durum wheat, G×E interaction, Grain yield, Linear component, Stability

Wheat is the second most important food crop in India after rice, both in terms of area and production. In any breeding programme it is necessary to screen and identify phenotypically stable genotype for yield which could perform more or less uniformly under different environmental conditions. It is an established fact that yield is a complex character (Whitehouse *et al.*, 1958) and largely depends upon its components characters, with an interaction with the environments resulting in to the ultimate product i.e. yield. So for breeding a stable variety, it is necessary to get the information on the extent of genotype×environment (GE) interaction for yield and its component characters. To meet the objective of developing varieties with high yield potential a wide collection of germplasm must be available so that the evaluation for desirable traits for yield can be exercised and a breeding programme for an ideal plant type concept can be made accordingly. A phenotype is the product of interplay of genotype and its environment. A specific genotype does not exhibit the same phenotype under the changing environments and different genotypes respond differently to a specific environment. This variation arising from the lack of correspondence between the genetic and non-genetic effects is known as genotype × environment interaction. G × E interactions are generally considered impediment in plant breeding as it baffles the breeder in judging the real potential of a genotype when grown in different environments. The existence of interaction between genotype and environment has been recognized by Fisher and Mackenzie (1923). Several workers considered G×E interactions as linear functions of environment and proposed regression of yield of a genotype on the mean yield of all genotypes in each environment to evaluate stability of performance of genotype (Eberhart and Russell, 1966; Finlay and Wilkinson, 1963; Perkinis and Jinks, 1968).

The main objective of a breeding programme is to develop varieties that perform well over a broad spectrum of environments. According to Frey (1964), a variety having wide or good adaptability is one which gives consistently superior performance over several environments. Thus, the assessment of the nature and extent of genotype×environment interaction and identification of phenotypically stable genotypes, showing low genotypic×environment interaction, becomes important. This requires the screening of promising and stable genotypes over a set of environmental conditions. It is observed that the phenotypic response to change in environment is not the same for all the genotypes. The consequences of variation in phenotype depend upon the environment. Genotype-environment interaction are of major consequence to the breeders in the process of evolution of improved genotypes when the varieties/ genotypes are grown at several locations for testing their

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performance, their relative ranking do not remain the same, this cause difficulties in demonstrating significant superiority of any genotype. The information about phenotypic stability is useful for the selection of crop varieties as well as for breeding programmes. In durum wheat few studies are available on these aspects Kaya *et al.*, 2002; Benmahammed, 2010. The objective of the present study is to explore the effect of genotype (G) and genotype × environment (GE) on grain yield.

Materials and Methods

The experimental material for the present study comprised of 50 durum wheat genotypes made available from Directorate of Wheat Research (DWR), Karnal. These 50 durum wheat genotypes were grown in simple randomized block design experiment (RBD) in three replication as timely (22 Nov.) and late sowing (18 Dec.) for two years (2010-11 and 2011-2012) at Research and Demonstration Farm of Kisan (P.G.) College, Simbhaoli, Ghaziabad (UP) in each year, thus giving four environments. Each genotype was grown in a single row plot of 3m length with a distance of 25 cm and 10 cm between rows and plants, respectively.

All the recommended cultural and agronomic practices including pest control measures were adopted to raise good crop. To identify the comparative behavior of different genotypes under different environment, observations were recorded on five randomly selected plants for tiller number, grains/spike, 100-grain weight (g) and grain yield (g). In all the experiments, plot means (mean of five plants) were used for environment-wise analysis of variance and pooled analysis of variance for the estimation of G x E interaction effects and stability analysis as suggested by Eberhart and Russell (1966). In this model, regression coefficient (b) is considered as parameter of response and S^2d as parameter of stability. Assuming S^2d equal to zero, the high value of 'b' means more change in Y for unit change in I, in other words variety is more responsive. Such variety may, therefore, be recommended only for highly favourable environment. A relatively lower value of 'b' say around one, means less responsive to the environmental changes and, therefore, more adaptive. However, if 'b' is significantly less than one, the variety may be grown only in poor environment.

The unit value of 'b' considered as most desirable, indicating that the mean performance of a genotype increases with an average amount as conditions improve. The smaller values simply failure to take advantage of better environments, while larger values imply serious yield decline when environments are unfavorable. S^2d, if, significant from zero will invalidate the linear prediction. If S^2d is non-significant, the performance of a genotype for a given environment may be predicted. Accordingly, a variety whose performance can be predicted (i.e. S^2d =0) is said to be stable. Here stability means predictability, or in other words phenotypic stability of individual variety is the function of two parameters, namely linear (b) and non-linear (S^2d) sensitivity coefficient.

Results and Discussion

The environment-wise analysis of variance (Table 1) was significant for all the traits in all the environments suggesting sufficient genetic variability in the material. One regression approach (Eberhart and Russell, 1966) has been applied to understand the genotype × environment interaction effects and stability of 50 genotypes grown under four environments. In the pooled analysis of variance for different traits also exhibited highly significant differences among the genotypes for all the traits further suggesting enough genetic variability among the genotypes (Table 2). The variances associated with genetic effects were smaller than the variances associated with environmental effects for all the characters i.e. the number of grains/spike, tiller number, 100 grain weight and grain yield which contradicted the observations of Rharrabti *et al*. (2003). This shows that under the present environmental conditions for determination of such characters, the genotypes need to be evaluated in multi environmental trials. Furthermore, the larger variances associated with genetic effects than the variances associated with genotype × environment for number of grains/spike, tiller number, 100 grain weight and grain yield indicates a greater influence and stability of genetic factors relative to the variability associated with the interaction of genotype × environment for these characters in durum wheat. Mean squares due to environments were also significant for all the traits indicating that the environments under study were diverse enough. Further, genotype × environment (G × E) interaction were also significant for all the traits except 100 grain weight suggesting that the traits responded to the environments differently. The G × E linear component was significant for 100 grain weight suggesting that the variation in performance of different genotypes is due to the regression of genotypes on environments and hence the performance is predictable in nature. The

List of genotypes used in the present study and their pedigree

S.No.	Name of Genotype	Pedigree
1	Macs-2856	CPAN 6079/MACS 2340
2	IDYT-CA-05-59	STJ3//Bcr/Lks4
3	IDYT-CA-05-40	Plc/Ruff//Gta/Rtte
4	IDYT-CA-05-48	Jori c69/Hau
5	IDYT-CA-05-47	FG. S. TAKCO, G11'S' (BAXI/E2198)
6	NI-146	Old released variety pedigree not available
7	PDW-215	RAJ 911//AA'SD#2E/3/DWL 5002
8	Behar Wheat	A land race of bread wheat type
9	Bejaga Yellow	M. LOCAL/GAZA
10	DWL-5023	CR'S'-LD'S'-GR'S'
11	NI-59	Released variety
12	Kiran	BIJAGA-YELLOW/A-206
13	MPO-215	Released variety
14	MASA-35	Exotic line of durum
15	Malwa Raj	Released variety
16	PKD-5	Released variety
17	JAI	Released variety
18	HD 4502(Malvika)	PI'S72*BY//TC60/3/ZENATI/BTL//WLS
19	Meghdoot	HI-6-23/HY-23//NP-404
20	Jai Raj	Released variety
21	Motia	(S) LV-BOMBAY;(S) LV; BANSI
22	PDW 254	Advance durum line
23	Vijay	NATURAL CROSS MOTIA/KHP (dm)
24	HI -8381(MALVASHIRI)	Released variety
25	EC34	Jori c69/Hau
26	EC38	20048 Traikia (Mor)/Mrb5//Stj3
27	EC39	Bicrederaa1/Azeghar2//Icajihan25
28	IDSN-72	BELLAROI/4/BCRIS/BICUM//LLA RETA INIA/3
29	IDSN-148	SOOTY-9/RASON-37//LLARETA INIA/10/ALTAR 84
30	IDSN-49195	PLATA-7/ILBOR-1//SOMAT-3/3/SORA/2*PLATA-12
31	IDYN-46	PLATA-6/GREEN-17//SNITAN/4/YAZI-1/AKAKI-4//SOMAT-3/3
32	IDYN-49	SOMAT-3/GREEN-22/4/GODRIN/GUTROS//DUKEM/3/THKNEE-11/6
33	IDYN-76	SOMAT-3/GREEN-22/4/GODRIN/GUTROS//DUKEM/3/THKNEE-11/7
34	EDUYT-54	MAALI/6/MUSK-1//AC089/FNFOOT-2/4/MUSK-4/3/PLATA-3
35	DDW-01	PDW 233/DCB 25
36	DDW-05	GULAB/DCB 53
37	DDW-06	RASCON 30/3/CELTA//WH 896
38	IDSN-76	LABUD/NIGRIS-3//GAN/3/AJAIA-13/YAZI/10
39	IDYN-100	PH 896-21/5/BRAK-2/AJAIA-2//SOLGA-8/5
40	IDSN-236	PH 896-21/5/BRAK-2/AJAIA-2//SOLGA-8/3
41	EDUYT-64	TARRO-1/2*YUAN-1//AJAIA-13/YAZI/3/3/SOMAT-3/PHAX-1
42	RAJ-1555	COCORIT 'S'/RAJ 911
43	PDW 233	YAV'S'/TEZ ''S''
44	WH 896	STIL''S''/YAV'IS7/PEN''S
45	NI-5749	G-4-48*N59
46	IDYT-CA-0561	ICAMORTA0472/Ammar7
47	IDYT-CA-0562	Stj3Lks4
48	IDYT-CA-0563	Plc/Ruff//Gta/Rtte
49	IAIISWIP-D/1 DON06-IRR-41	OROBEL//BUSHEN-4/2*GREEN-18/8/GEDIZ/FGO
50	IAIISWIP-D/1 DON06-IRR-42	HUBEI//SOOTY-9/RASCON-37/3/2*SOOTY_9

Table 1. Environment-wise analysis of variance for yield and yield traits in durum wheat

Source of variation	d.f.	Mean squares			
		Tiller number	Grains/spike	100-grain weight	Grain yield
Environment I					
Replication	2	286. 75	131. 76	1. 07	243. 45
Genotypes	49	3. 24**	224. 89**	0. 99**	10. 41**
Error	98	0. 88	8. 04	0. 54	0. 75
Environment II					
Replication	2	292. 43	1. 92	00. 31	208. 42
Genotypes	49	3. 91**	9. 05**	0. 24**	3. 12**
Error	98	0. 92	0. 56	0. 03	0. 72
Environment III					
Replication	2	257. 77	9. 53	3. 15	110. 92
Genotypes	49	5. 54**	37. 52**	5. 45**	23. 48**
Error	98	0. 97	3. 13	0. 68	1. 83
Environment IV					
Replication	2	289. 99	1. 71	3. 26	124. 03
Genotypes	49	7. 02**	22. 03**	1. 54*	42. 70**
Error	98	0. 34	7. 4	0. 80	2. 30

*,**= Significant at P = 0. 05 level and P = 0. 01 level.

Table 2. Joint regression analysis for yield and yield related characters in durum wheat

Source of variation	d.f.	Mean squares			
		Tiller number	Grains/spike	100-grain weight (g)	Grain yield (g)
Genotype (G)	49	2. 10**	129. 64**	2. 49**	5. 14**
Environment (E)	3	51. 20**	10644. 36**	55. 23**	374. 97**
GXE	147	1. 16**	24. 41**	0. 39	3. 78**
E+GXE	150	2. 16	236. 81	1. 48	11. 20
E (linear)	1	358. 39**	74510. 46**	386. 62**	2624. 87**
GXE (linear)	49	0. 85	27. 68	0. 87**	3. 19
Pooled deviation	100	1. 19**	23. 39**	0. 30**	3. 80**
Pooled error	392	0. 60	9. 73	0. 48	0. 82

**= Significant at P = 0. 01 level.

mean square due for pooled deviation is significant for all the traits but mean square for G × E (linear) is non-significant for grains/spike, tiller number and grain yield suggesting that variation in performance of genotypes is entirely unpredictable. Similar to the present results the importance of G×E interaction in durum wheat have been recognised by several workers (Akcura *et al.*, 2009; Gohil and Jadeja, 2009; Mohammedi *et al.*, 2010, 2014; Sakin *et al.*, 2011; Hassan *et al*., 2013). Eberhart and Russell (1966) model has been extensively used in different crop plants.

The mean number of grains/spike (Table 3) ranged from 30.09 grains to 43.40 grains. The highest number of grains/spike was observed for genotype DWL-5023 and minimum number was recorded by the genotype Kiran. Among the 50 genotypes, seven genotypes namely IDYT-CA 0548, NI-146, PDW-215, DWL-5023, MASA-35, Motia and DDW-06 recorded the higher mean number of grains/spike than the population mean (33.95±1.82). Considering high mean performance and stability parameters together, five genotypes namely NI–146, PDW–215, Motia, MASA-35 and DDW06were found to desirable and stable performance across the environments for number of grains/spike. The mean tiller number ranged from 5.88 to 8.89 over the four environments. The genotype WH-896 recorded the highest number of tillers and MACS-2856 recorded the lowest number of tillers/plant. Among the fifty genotypes, seven genotypes namely MASA-35, Meghdoot, EC-34, IDYN-46, IDYN-49, IDSN-236 and WH-896 recorded the higher number of tillers/plant than the population mean (7.20±1.00). Considering high mean performance and stability parameters together, seven genotypes i. e. MASA35, EC34, IDYN46, IDYN49, IDSN236, WH896 and Meghdoot were found desirable and have stable performance across the environment's fortiller number.

Table 3. Estimates of stability parameters in 50 genotypes of durum wheat

S.No.	Genotypes	Grains/spike			Tiller number		
		$\overline{X}$	b	S^2d	$\overline{X}$	b	S^2d
1	MACS-2856	31.12	0.79	-6.66	5.88	0.79	0.31
2	IDYT-CA-05-59	30.77	0.88	-10.26+	6.87	0.48**	0.32
3	IDYT-CA-05-40	32.10	0.84	-8.38	7.63	0.94	1.92+
4	IDYT-CA-05-48	37.67	1.40**	78.75++	7.49	1.32*	1.75
5	IDYT-CA-05-47	33.69	1.03	-11.23	7.73	1.66**	0.31
6	NI-146	36.01	1.14	-0.83	7.34	1.61**	1.13
7	PDW-215	36.25	1.15	2.29	7.06	0.61*	0.14
8	Behar Wheat	34.01	1.00	-2.76	7.50	1.27	1.89
9	Bejaga Yellow	33.97	1.06	-0.83	7.39	1.08	1.23
10	DWL-5023	43.40	0.54**	602.24++	7.58	1.02	2.36
11	NI-59	33.13	0.99	-4.73	7.00	0.88	1.83
12	Kiran	30.09	0.96	-8.74	6.07	1.23	0.48
13	MPO-215	31.55	0.80	15.42	6.90	1.22	0.17
14	MASA-35	36.67	1.03	-11.35	8.84	1.35	0.24
15	Malwa Raj	31.45	0.77	43.68+	6.01	1.46*	0.26
16	PKD-5	32.81	0.96	-0.92	7.09	1.08	1.81
17	JAI	30.98	0.72*	36.04	7.63	1.01	2.15+
18	HD-4502	32.26	0.97	-12.18	6.46	1.18	1.28
19	Meghdoot	31.55	0.85	1.80	8.30	1.05	0.19
20	JAI RAJ	33.43	1.01	-10.75	7.37	0.93	1.18
21	MOTIA	35.83	1.00	-7.75	7.81	1.80**	1.44+
22	PDW-254	31.99	0.86	-5.72	7.46	1.61**	1.14
23	VIJAY	32.55	0.89	1.07	6.24	0.95	0.16
24	HI 8381	33.79	0.96	-9.02	7.08	0.67*	0.39
25	EC-34	35.14	1.14	-10.86+	8.39	1.14	-0.10
26	EC-38	33.02	0.94	-0.17	7.51	1.41**	1.07
27	EC-39	34.48	1.06	-7.65	7.39	0.71	1.81
28	IDSN-72	34.53	1.09	-5.29	7.20	0.78	0.65
29	IDSN-148	33.73	1.08	-9.99	7.17	0.62**	1.36
30	IDSN-195	35.06	1.08	-7.23	6.88	1.24	-0.02
31	IDYN-46	33.83	1.06	-7.47	8.81	1.13	-0.01
32	IDYN-49	32.82	0.91	-1.81	8.65	1.04	1.28
33	IDYN-76	34.86	1.06	-4.85	6.86	0.76	1.17
34	EDUYT-54	33.36	1.02	0.36	6.40	1.17	0.19
35	DDW-01	32.11	0.97	-11.81	6.92	0.35**	0.07
36	DDW-06	36.07	1.11	-11.57	7.42	0.72	0.52
37	IDSN-76	34.83	1.06	-7.52	7.36	1.50**	0.61
38	IDYN-100	32.86	0.99	-9.90	7.10	1.01	0.69
39	IDSN-236	35.21	1.12	-2.52	8.86	0.96	2.15
40	EDUYT-64	33.81	1.04	9.63+	7.48	0.70*	2.22+
41	RAJ-1555	34.07	1.00	-9.04	6.72	0.71	0.69
42	PDW-233	34.35	1.04	-4.65	7.49	0.64*	0.45
43	WH-896	34.68	1.04	-2.92	8.89	0.74	0.72
44	NI-5749	34.90	1.02	0.01	7.29	0.98	1.97
45	NI-5749	33.92	1.05	-0.49	5.95	0.32**	0.25
46	IDYT-CA-0561	33.57	1.00	12.02+	7.16	1.06	1.04
47	IDYT-CA-0562	35.09	1.15	11.22+	7.40	0.36**	1.23
48	IDYT-CA-0563	34.77	1.11	-5.60	7.08	1.21	1.61
49	IA11SWID-D/ IDON 06-IRR-41	33.95	1.12	0.88	6.91	0.72*	2.04+
50	IA11SWID-D/ IDON 06-IRR-42	35.38	1.16	-5.88	7.20	0.84	1.99
	Population mean	33.95			7.20		
	S.E. of Mean	1.82			1.00		

*,**= Significantly deviating from unity at P=0.05 at P=0.01 level, respectively.
+,++= Significantly deviating from zero at P=0.05 at P=0.01 level, respectively.

Table 4. Estimates of stability parameters in 50 genotypes of durum wheat

S.No.	Genotypes	100-grain weight (g)			Grain yield (g)		
		$\overline{X}$	b	S^2d	$\overline{X}$	b	S^2d
1	MACS-2856	3. 56	0. 90	0. 21	29. 79	1. 18	4. 62
2	IDYT-CA-05-59	3. 46	0. 76*	0. 15	31. 13	1. 06	10. 95
3	IDYT-CA-05-40	3. 60	0. 93	0. 26	32. 11	1. 29*	15. 16
4	IDYT-CA-05-48	3. 57	0. 91	0. 01	34. 71	1. 01	23. 38
5	IDYT-CA-05-47	3. 61	0. 86	0. 13	37. 66	1. 19	15. 58
6	NI-146	3. 22	0. 63**	-0. 04	35. 82	0. 97	18. 72
7	PDW-215	3. 82	1. 00	0. 55	36. 54	1. 18	15. 73
8	Behar Wheat	3. 89	0. 91	0. 35	33. 03	0. 65*	27. 61^{+}
9	Bejaga Yellow	3. 47	0. 90	0. 15	33. 59	0. 67*	14. 42
10	DWL-5023	3. 83	0. 93	0. 36	34. 34	0. 48**	29. 41^{+}
11	NI-59	3. 79	1. 00	0. 66	33. 20	0. 60**	17. 51
12	Kiran	3. 24	0. 85	-0. 02	26. 86	1. 01	6. 44
13	MPO-215	3. 31	0. 70	0. 03	31. 04	1. 26	2. 27
14	MASA-35	3. 17	0. 55**	-0. 03	34. 61	1. 41*	11. 67
15	Malwa Raj	3. 30	0. 85	0. 18	35. 85	0. 38**	53. 50^{++}
16	PKD-5	3. 44	0. 86	-0. 13	31. 36	1. 10	5. 45
17	JAI	3. 52	1. 01	-0. 03	28. 89	1. 48**	18. 54
18	HD-4502	3. 44	0. 63**	-0. 12	34. 90	1. 22	10. 74
19	Meghdoot	3. 32	0. 59**	0. 01	35. 63	0. 99	43. 41^{+}
20	JAI RAJ	3. 45	0. 78	-0. 07	34. 98	1. 30*	20. 78
21	MOTIA	3. 59	0. 88	-0. 09	34. 13	0. 78	59. 09^{++}
22	PDW-254	3. 54	0. 88	-0. 07	33. 13	1. 04	34. 86^{+}
23	VIJAY	3. 58	1. 04	-0. 02	30. 96	0. 95	17. 68
24	HI8381	3. 36	0. 73*	0. 20	30. 88	1. 06	11. 59
25	EC34	3. 05	0. 50**	-0. 09	32. 83	1. 33*	5. 19
26	EC38	3. 47	0. 87	-0. 04	35. 84	1. 37*	6. 59
27	EC39	3. 28	0. 49**	-0. 02	33. 55	1. 28	5. 79
28	IDSN-72	3. 53	0. 99	8. 12^{+}	35. 54	1. 26	30. 39^{+}
29	IDSN-148	3. 30	0. 66*	0. 06	34. 53	0. 85	30. 76^{+}
30	IDSN-195	3. 38	0. 82	-0. 06	32. 41	1. 19	26. 74
31	IDYN-46	3. 53	0. 78	-0. 06	36. 84	1. 12	11. 71
32	IDYN-49	3. 68	0. 97	0. 09	36. 87	0. 98	39. 36
33	IDYN-76	3. 33	0. 56**	-0. 05	32. 92	0. 28**	19. 56
34	EDUYT-54	3. 53	1. 05	0. 07	30. 90	0. 90	5. 24
35	DDW-01	3. 53	0. 84	0. 10	27. 89	0. 80	15. 09
36	DDW-06	3. 65	1. 34*	0. 05	32. 43	1. 32*	12. 86
37	IDSN-76	3. 99	1. 60**	0. 09	32. 20	0. 89	8. 70
38	IDYN-100	3. 73	1. 39*	-0. 07	35. 13	1. 06	32. 74^{++}
39	IDSN-236	4. 21	1. 75**	0. 51^{+}	34. 43	1. 17	28. 22
40	EDUYT-64	4. 15	1. 62**	1. 26^{+}	33. 86	0. 84	13. 00
41	RAJ-1555	3. 89	1. 45*	0. 29	34. 35	0. 90	11. 83
42	PDW-233	3. 84	1. 13	0. 09	30. 79	0. 79	34. 32^{++}
43	WH-896	3. 83	1. 13	0. 11	33. 49	0. 98	55. 12^{++}
44	NI-5749	3. 96	1. 59**	0. 46	35. 13	1. 55**	24. 59
45	NI-5749	3. 52	1. 08	0. 13	30. 04	1. 16	1. 93
46	IDYT-CA-0561	3. 50	1. 01	0. 14	29. 59	1. 27	6. 61
47	IDYT-CA-0562	3. 73	1. 47**	0. 25	34. 98	0. 41**	13. 17
48	IDYT-CA-0563	3. 94	1. 51**	0. 02	32. 97	0. 78	36. 60^{+}
49	IA11SWID-D/ IDON 06-IRR-41	3. 91	1. 68**	0. 79^{+}	33. 33	1. 32*	22. 45
50	IA11SWID-D/ IDON 06-IRR-42	4. 01	1. 63**	0. 67^{+}	36. 51	1. 09	35. 03
	Population mean	3. 58			33. 20		
	S.E. of Mean	0. 20			1. 73		

*,**= Significantly deviating from unity at P=0. 05 at P=0. 01 level, respectively.
+,++= Significantly deviating from zero at P=0. 05 at P=0. 01 level, respectively.

Similarly for 100-grain weight, the mean ranged from 3.05 g to 4.21 g (Table 4) over the environments. Among the fifty genotypes, IDSN236 possessed the heaviest grain (4.21 g/100 grains) and genotype EC34 possessed the lightest grain (3.05 g/100 grains) and thirteen genotypes were having higher grain weight than the population mean (3.58±0. 20). Considering high mean performance and stability parameters together, five genotypes namely NI59, PDW233, Behar Wheat, PDW215 and DWL5023 were found desirable and have stable performance across the environments for 100 grain weight.

The mean grain yield ranged from 26.86 g/plot (Kiran) to 37.66 g/plot (IDYT-CA-05-47). Among the fifty genotypes, IDYT-CA-05-47, NI 146, PDW 215, Malwa Raj, Meghdoot, Jairaj, EC 38, IDSN 72, IDYN-46, IDYN-49, IDYN-100, NI 5749, IDYT-CA-0562 and IASWID-D/IDON 06-IRR-42 showed higher grain yield than the population mean (33. 20±1. 73). Considering high mean performance and stability parameters together, the genotypes IDYT-CA-05-47, NI 146, PDW 215, IDYN 46 and IDYN 49 were found to desirable and stable performance across the environments for grain yield (Table 4). Since performance *per se* and stability are two independent attributes and were considered by different set of gene systems (Finlay and Wilkinson, 1963; Bucio-Alanis *et al*., 1969; Verma *et al*., 1978 and Singh and Gupta, 1984). The genotypes Meghdoot, IDSN 72 and IDYN 100 had high mean grain yield with average response (b=1), but these genotypes were unstable as these had significant deviation from regression. Further, the genotypes Jairaj, EC38 and NI 5749 were having high mean grain yield than the population mean and regression coefficient significantly greater than unity (b>1) hence these genotypes are specifically adapted for favourable environments. Furthermore, the genotypes Malwa Raj and IDYT-CA-0562 having higher mean grain yield than the population mean and regression coefficient significantly lesser than unity (b<1) hence these genotypes are specifically adapted to poor environments. The genotypes MACS 2856, IDYT-CA-05-59, Kiran, MPO 215, PKD5, Vijay, HI 8381, EDUYT-54, DDW-01 and NI5749 having lower mean grain yield than the population mean and unit regression (b=1), hence these genotypes are poorly adapted to all the environments (Table 3 and 4). Further, considering high mean performance and stability parameters together, the genotypes NI146, PDW215, Motia, MASA35 and DDW 06 for grains/ spike; MASA 35, EC34, IDYN-46, IDYN-49, IDSN-236, WH896 and Meghdoot for tiller number; NI59, PDW233, Behar Wheat, PDW-215 and DWL 5023 for 100 grain weight were screened as desirable and stable (Table 3 and 4). It is also evident from Table 5 that the linear component of G× E was pre-dominant for grains/spike and 100 grain weight while the non-linear component was pre-dominant for tiller number and grain yield. The result of the present study indicated that none of the genotypes studied were consistently superior for all the traits and the genotypes NI-146 and PDW-215 for grains/spike and grain yield; IDYN-46 and IDYN-49 for tiller number and grain yield; PDW 215 for 100 grain weight and grain yield showed stability together (Table 6). The stable genotypes identified for different traits may be used as parents in future breeding programmes for the development of new strains with combination of stable traits.

Table 5. Magnitude of linear and non linear portion of G × E interaction for different characters

S.No.	Characters	Linear component (%)	Non-linear component (%)
1.	Grains/spike	54. 20	45. 80
2.	Tiller number	41. 66	58. 34
3.	100-grain weight (g)	74. 35	25. 65
4.	Grain yield (g)	45. 63	54. 37

Table 6. Genotypes showing stable performance for different characters (high mean, b=1 and S^2 d=0)

Characters	Stable genotypes
Grains/spike	NI 146, PDW 215, Motia, MASA 35 and DDW 06
Tiller Number	MASA 35, EC 34, IDYN 46, IDYN 49, IDSN 236, WH 896 and Meghdoot
100-grain weight (g)	NI 59, PDW 233, Behar Wheat, PDW 215 and DWL 5023
Grain yield (g)	IDYT- CA- 05- 47, NI 146, PDW 215, IDYN 46 and IDYN 49

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