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SCREENING GENETIC VARIABILITY IN ADVANCE LINES FOR DROUGHT TOLERANCE OF BREAD WHEAT (*TRITICUM AESTIVUM*)

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ABSTRACT

Screening of 54 advanced lines of wheat including three checks *viz*., MP-3173 (C), MP-3020 (C) and HI-8427 (C) was carried out under rainfed sown condition with objectives to estimate genetic variability for various traits to identify potential genotypes for drought tolerance. All the advance lines of wheat studied in investigation revealed considerable amount of genetic variability for majority of the traits. Grain yield per plant showed significant positive correlation with number of tillers per plant (r_p = 0.752), biological yield per plant (r_p = 0.703), root biomass (r_p = 0.651), root length per plant (r_p = 0.521), days to maturity (r_p = 0.369) spike length (r_p = 0.290), harvest index (r_p = 0.200), spike density (r_p = 0.192), thickness of stem (r_p = 0.187) and 1000- grain weight (r_p = 0.165). Path analysis indicated that biological yield per plant (1.017) followed by harvest index (0.740) and number of spikelet per spike (0.206) were the main yield contributing traits suggesting the possibility of improving grain yield through direct selection of these traits. It is suggested that, these characters can be considered as selection criteria in improving the grain yield of durum wheat genotypes. On account of this genetic variability it has been found that genotypes JWJ-4, JWJ-7, JWJ-52, JWJ-34, JWJ-37, JWJ-26, JWJ-19, JWJ-38 and JWJ-18 were potential genotypes.

INTRODUCTION

India is second largest wheat producer in the world with a production level of 80.7 million ton that is approx 12% of the global wheat production (Singh *et al*., 2012). Since 2000, India has struggled to match that record production figure and thus faces a critical challenge in maintaining food security in the face of its growing population. The current major challenges facing future wheat production in India are increasing heat stress, dwindling water supplies for irrigation etc. (Joshi *et al*., 2007). Damage caused by temperature extremes and drought could be minimized or eliminated by framing strategy to develop thermo tolerance genotypes during early growth period. There is continuous increase in demand of wheat grain to feed the increasing population of about 109 million tons of wheat is to be needed to feed its projected population of 1.4 billion by 2020 AD. However to fulfill the task of meeting the increasing demand of wheat there is an urgent need to breed the high yielding wheat genotypes tolerant to high temperature and low moisture stress coupled with rust resistance and quality and suitable under semi irrigation.

Genetic improvement in wheat though started since its domestication but the progress has not been made up to the satisfaction. Hence, the desired improvement in productivity could not be achieved during the early phase of development. Most of the varieties were developed either through selection from local germplasm or through introduction from specific areas. Thereafter, breeder started generating breeding material through hybridization. The important aspects of breeding varieties of wheat is to develop high yielding, drought and diseases resistant, early maturing, lodging and shattering resistant varieties which had led to the emergence of new cropping systems.

As we know, yield of Wheat is complex quantitative traits and under pleiotropic gene control at the same time it is highly influenced by environment and contributed by many other traits. Furthermore, selection based on only yield is misleading. For effective selection, information on nature and magnitude of variation in population, association of character with yield and among themselves and the extent of environmental influence on the expression of these characters are necessary (Yagdi 2009; Tsegaye *et al*., 2012). High magnitude of variability in a population provides the opportunity for selection to evolve a variety having desirable characters. Correlation and path coefficient analysis could be used as an important tool to bring information about appropriate cause and effects relationship between yield and some yield components in wheat (Khan *et al*., 2003). Path analysis was used for different crops to determine the direct and indirect effects of yield components (Khaliq *et al*., 2004; Chaudhary and Joshi 2005; Yagdi, 2009; Yasin and Singh, 2010; Tsegaye *et al*., 2012).

Keeping in view the aforesaid problems, the present investigation has been planned to screen the advance generation lines of bread wheat with the objectives (i) to estimate genetic variability for yield and its components and root characters. (ii) to find out association of yield with its components and root traits and (iii) to identify potential genotypes for drought tolerance.

MATERIALS AND METHODS

The experimental material comprised 54 advance lines of wheat including three checks *viz*, MP-3173 (C), MP-3020 (C) and HI-8427 (C) under rainfed sown condition. These genotypes were grown in a Randomized Block Design with three replications each genotype was accommodated in a four row of 2.5 m length, spaced at 23 cm with plant to plant spacing of 5 cm. The experiment was conducted with all recommended agronomic requirements to raise the good crop.

The average of ten plants was subjected to variance analysis and test of significance as per the method of Fisher (1935). Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated by the method suggested by Burton (1952). The estimates of PCV and GCV were classified as low, moderate and high according to Sivasubramanian and Madhavamenon (1973). Correlation coefficients were calculated for all the character combinations at genotypic and phenotypic levels as per the formula given by Miller *et al*. (1958). Path coefficient analysis was under taken in parents for designing new plant type with the knowledge of direct and indirect influence of yield contributing characters on yield. Wright (1921) proposed the original technique; analysis was carried out by modified method devised by Dewey and Lu. (1959). Path coefficients were rated based on the scales given by (Lenka and Mishra, 1973).

RESULTS AND DISCUSSION

The analysis of variance revealed that the mean sum of squares for genotypes was highly significant for all the traits investigated (Table 1). This significance suggested the presence of substantial amount of genetic variability among the wheat genotypes.

In the present investigation, high heritability coupled with high genetic advance was exhibited for characters viz., plant height, number of tillers per plant, root biomass, biological yield per plant, number of grains per spike and spike length (Table 2). Such values indicated, predominantly the presence of additive gene action in the expression of these traits and consequently, greater chance of improving these traits through simple selection. These results were in accordance with the results of Shukla *et al*. (2000) for grain yield and biological yield, Kumar *et al*. (2002) for harvest index and Shoran *et al*. (2005) for 1000-grain weight.

Grain yield per plant was positively and significantly associated with number of tillers per plant (0.752), biological yield per plant (0.703), root biomass (0.651), root length per plant (0.521), days to maturity (0.369) spike length (0.290), harvest index (0.200), spike density (0.192), thickness of stem (0.187) and 1000- grain weight (0.165). However number of spikelets per spike (0.116) had shown positive non-significant (Table 4). These results are in agreement with the findings of Shrimali (2001) for root development, Mondal *et al*. (2004) for root length and root biomass, Lad *et al*. (2003) number of grains

Table 1: Analysis of variance for yield attributes of 54 genotypes of wheat

Source of variation	Degree of freedom	Mean sum of square DTF	DM	PH	NTPP	SL	NSPS	SD	NGPS	TW	BYPP	HI	RL	RB	ST	GYPP
Replication	(r-1 = 2)	0.05	3.87**	2.67**	1.28**	14.89**	1.77**	0.28**	0.81	0.19**	28.24	4.04	7.03**	0.32**	0.03**	3.71**
Genotypes	(V-1) = 53	12.88**	30.37**	573.95**	1.97**	3.87**	16.50**	0.17**	45.49**	23.65**	48.24**	121.96**	3.99**	1.75**	0.34**	5.37**
Error	(r-1) (v-1) = 106	0.71	0.41	0.63	0.13	0.29	0.47	0.02	2.04	0.09	3.15	14.71	0.66	0.06	0.01	0.59
SE Diff.		0.48	0.68	0.46	0.20	0.30	0.39	0.07	0.81	0.17	1.02	2.19	0.46	0.15	0.05	0.44
CD at 5%		1.36	1.92	1.28	0.57	0.87	1.11	0.21	2.31	0.49	2.87	6.20	1.31	0.42	0.13	1.25
CD at 1%		1.79	2.54	1.70	0.76	1.15	1.47	0.27	3.05	0.65	3.80	8.21	1.74	0.56	0.18	1.65
ECV%		1.37	0.89	0.74	9.08	5.82	4.49	7.63	3.73	0.73	10.57	9.18	7.15	9.16	1.94	11.28

** Significant at 1% level, * Significant at 5% level

GYPP Grain yield/plant
DTF Days to 50% flowering
DM Days to maturity
PH Plant height
NTPP Number of tillers/plant
SL Spike length
NSPS Number of spikelets/spike
SD Spike density
NGPS Number of grains/spike
TW 1000-grain weight
BYPP Biological yield/plant
HI Harvest index
RL Root length
RB Root biomass
ST Stem thickness

Table 2: Parameters of genetic variability for yield attributes in advance lines of wheat

Characters	Mean	Range Minimum	Maximum	PCV %	GCV %	ECV %	H^2(bs) (%)	GA	GA as a % of mean
Days to 50% flowering	61.41	54.58	65.21	3.55	3.28	0.71	85.2	3.83	6.24
Days of maturity	133.96	126.67	139.83	2.48	2.32	1.41	87.3	5.98	4.46
Plant height	106.99	81.57	139.12	12.94	12.92	0.63	99.7	28.43	26.7
Number of tillers/plant	3.91	2.67	5.90	22.03	20.07	0.13	83.0	1.47	37.66
Spike length	9.30	7.21	11.70	13.10	11.74	0.29	80.3	2.01	21.66
No. of spikelets/spike	15.33	11.07	20.77	15.74	15.08	0.47	91.8	4.56	29.77
Spike density	1.66	1.18	2.24	15.73	13.77	0.02	76.4	0.41	24.75
No. of grains/spike	38.21	29.63	49.63	10.64	9.96	2.04	87.7	7.34	19.21
1000-grain weight	41.71	32.62	46.37	6.76	6.72	0.09	98.8	5.74	13.76
Biological yield/plant	16.79	9.13	28.13	25.40	23.09	3.15	82.7	7.26	43.25
Harvest index	41.81	22.29	58.33	16.90	14.23	14.55	70.8	10.37	24.81
Root length / plant	11.38	9.07	14.59	11.71	9.27	0.66	62.6	1.72	15.11
Root biomass	2.89	1.58	4.45	27.52	25.95	0.07	88.9	1.45	50.40
Thickness of stem	4.36	3.63	5.22	7.88	7.64	0.01	93.9	0.66	15.25
Grain yield/plant	6.86	4.37	9.66	21.51	18.33	0.60	72.7	2.22	32.32

Table 3: Genotypic correlation between yield attributes in advance lines of wheat

	DTF	DM	PH	NTPP	SL	NSPS	SD	NGPS	TW	BYPP	HI	RL	RB	ST	GYPP
DTF	1.000	-0.061	0.231	0.083	0.192	0.245	0.096	0.232	0.311	0.134	-0.200	0.144	0.098	0.015	-0.006
DM		1.000	0.247	0.252	0.059	-0.017	-0.082	-0.101	0.291	0.435	-0.129	0.459	0.376	0.165	0.455
PH			1.000	-0.045	0.058	0.371	0.349	0.113	0.336	0.421	-0.531	0.312	0.014	0.257	0.054
NTPP				1.000	0.332	0.151	-0.117	0.289	-0.029	0.744	-0.153	0.457	0.819	0.039	0.804
SL					1.000	0.482	-0.323	0.577	0.234	0.356	-0.050	0.311	0.342	0.391	0.371
NSPS						1.000	0.668	0.673	0.302	0.293	-0.246	0.46	0.267	0.512	0.144
SD							1.000	0.254	0.129	0.004	-0.203	0.242	-0.023	0.224	-0.158
NGPS								1.000	0.04	0.274	-0.129	0.353	0.282	0.394	0.227
TW									1.000	0.121	0.055	0.503	0.069	0.411	0.199
BYPP										1.000	-0.637	0.572	0.754	0.248	0.719
HI											1.000	-0.222	-0.244	-0.081	0.055
RL												1.000	0.644	0.444	0.558
RB													1.000	0.362	0.761
ST														1.000	0.241

Table 4: Phenotypic correlation between yield attributes in advance lines of wheat

	DTF	DM	PH	NTPP	SL	NSPS	SD	NGPS	TW	BYPP	HI	RL	RB	ST	GYPP
DTF	1.000	-0.065	0.213**	0.115	0.160*	0.221**	0.079	0.207**	0.289**	0.143	-0.151	0.153	0.072	0.016	0.025
DM		1.000	0.227**	0.204**	0.016	-0.015	-0.041	-0.111	0.275**	0.393**	-0.122	0.337**	0.334**	0.160*	0.369**
PH			1.000	-0.041	0.056	0.356**	0.301**	0.106	0.334**	0.382**	-0.446**	0.251**	0.011	0.247**	0.045
NTPP				1.000	0.300**	0.140	-0.117	0.263**	-0.030	0.709**	-0.091	0.491**	0.751**	0.028	0.752**
SL					1.000	0.404**	-0.427**	0.522**	0.212**	0.298**	-0.048	0.251**	0.308**	0.330**	0.290**
NSPS						1.000	0.645**	0.623**	0.292**	0.267**	-0.222**	0.359**	0.227**	0.479**	0.116
SD							1.000	0.195*	0.112	0.001	-0.161*	0.143	-0.051	0.202**	-0.132
NGPS								1.000	0.036	0.238**	-0.094	0.270**	0.241**	0.360**	0.192*
TW									1.000	0.106	0.047	0.401**	0.064	0.391**	0.165*
BYPP										1.000	-0.527**	0.516**	0.664**	0.214**	0.703**
HI											1.000	-0.112	-0.168*	-0.074	0.200*
RL												1.000	0.499**	0.326**	0.521**
RB													1.000	0.328**	0.651**
ST														1.000	0.187*

Table 5: Path coefficient showing direct and indirect effect of characters contributing to grain yield per plant in wheat

	DTF	DM	PH	NTPP	SL	NSPS	SD	NGPS	TW	BYPP	HI	RL	RB	ST
DTF	**-0.0214**	-0.0015	-0.0043	0.0061	-0.0334	0.0455	-0.0184	0.0045	0.0082	0.146	-0.1118	0.0036	0.0028	0.0001
DM	0.0014	**0.0227**	-0.0046	0.0108	0.0032	-0.0033	0.0095	-0.0024	0.0078	0.3997	-0.0905	0.0080	0.0130	0.0008
PH	-0.0046	0.0052	**-0.0202**	-0.0022	-0.0117	0.0734	-0.0699	0.0023	0.0094	0.389	-0.3304	0.0060	0.0004	0.0013
NTPP	-0.0025	0.0046	0.0008	**0.0531**	-0.0627	0.029	0.0271	0.0057	-0.0008	0.722	-0.0671	0.0117	0.0292	0.0001
SL	-0.0034	0.0004	-0.0011	0.016	**-0.2085**	0.0834	0.099	0.0113	0.006	0.3028	-0.0357	0.0060	0.012	0.0017
NSPS	-0.0047	-0.0004	-0.0072	0.0075	-0.0844	**0.2063**	-0.1495	0.0134	0.0082	0.2716	-0.1647	0.0086	0.0088	0.0025
SD	-0.0017	-0.0009	-0.0061	-0.0062	0.089	0.133	**-0.2319**	0.0042	0.0032	0.0023	-0.1194	0.0034	-0.002	0.0011
NGPS	-0.0044	-0.0025	-0.0021	0.014	-0.109	0.1285	-0.0456	**0.0216**	0.001	0.2418	-0.0699	0.0064	0.0094	0.0019
TW	-0.0062	0.0063	-0.0067	-0.0016	-0.0443	0.0603	-0.026	0.0008	**0.0282**	0.1075	0.0346	0.0096	0.0025	0.0020
BYPP	-0.0031	0.0089	-0.0077	0.0377	-0.062	0.055	-0.0005	0.0051	0.003	**1.0177**	-0.3900	0.0123	0.0258	0.0011
HI	0.0032	-0.0028	0.009	-0.0048	0.0101	-0.0459	-0.0374	-0.002	0.0013	-0.5364	**0.7400**	-0.0027	-0.0065	-0.0004
RL	-0.0033	0.0077	-0.0051	0.0261	-0.0523	0.0741	-0.0332	0.0058	0.0113	0.5252	-0.0833	**0.0238**	0.0194	0.0017
RB	-0.0015	0.0076	-0.0002	0.0399	-0.0643	0.0469	0.0119	0.0052	0.0018	0.6761	-0.124	0.0119	**0.0389**	0.0017
ST	-0.0003	0.0036	-0.005	0.0015	-0.0688	0.0988	-0.047	0.0078	0.011	0.2182	-0.055	0.0078	0.0128	**0.0052**

Residual effect = 0.187

per spike, number of tillers per plant, spikelets per spike. The path coefficient analysis of different traits contributing towards grain yield per plant revealed that biological yield per plant (1.017) had very high positive direct effect followed by high positive direct effect of harvest index (0.740) and number of spikelet per spike (0.206). However spike density (-0.2319) had highest negative direct effect on grain yield per plant (Table 5). Therefore, these traits should be given due importance while practicing selection, aimed at improvement of grain yield in wheat. These results agree with the finding of Singh and Dwivedi (2002) for number of spikelet per spike and biological yield per plant and Shah and Deora (2002) for harvest index.

On the basis of above findings advance generation line JWJ 13, JWJ 4, JWJ 27, JWJ 34 and JWJ 52 were found superior than the best check MP 3173 and among the other advance generation line under studies in respect of grain yield per plant, root length, root biomass and stem thickness. These lines have high grain yield, moderate root length, moderate root biomass and moderate to high stem thickness. Apart from above the advance generation lines JWJ 18, JWJ 19, JWJ 26, JWJ 37 and JWJ 38 were at par in yield with best check MP 3173 and other related yield contributing traits. These lines may given due importance at the time of formulation of breeding programme for drought resistance in wheat.

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