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Research Article

Character association and component analysis in wheat (*Triticum aestivum* L.)

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Abstract :
Character association and component analysis studies in bread wheat germplasm were conducted under *Rabi* seasons of 2006-2007 and 2007-2008, in field experimentation centre of Department of Genetics and Plant Breeding Allahabad Agriculture Institute-Deemed University, Allahabad. All the characters revealed high differences, high value of GCV and PCV in both years of *Rabi* seasons for seed yield per plant, effective tillers per plant and 1000 grain weight. Seed yield showed positive and significant correlation with effective tillers per plant, grains per spike, spike length and 1000 grain weight both at genotypic and phenotypic level in 2006-2007 and 2007-2008 crop seasons. Seed yield per plant showed positive direct effect on effective tillers per plant, plant height, 1000 grain weight and days to maturity. Thus, these characters may be effective as selection indices during breeding programme for improving yield.

Key words:
Genetic variability, Heritability, Genetic advance, PCV and GCV, Correlation, Path-coefficient

Introduction

Wheat (*Triticum aestivum L.)* is the world's leading cereal grain and most important food crop, occupying commanding position in Indian Agriculture, which occupies 28% area under cereals and contributing 33% of the total food grain production in the country. Wheat offers a great wealth of material for genetical studies due to its wide ecological distribution and enormous variation encountered for various morphological and physiological characters. Along with the knowledge of variability, a thorough understanding the character association with yield is also essential for successful crop improvement programme. Therefore, the study which reveals the association between characters related to productivity should be given importance. The ultimate goal of plant breeder is to increase yield which is highly influenced by the changing environment. Therefore, a breeder has to select the best genotype adapted to a particular environment. Keeping this in view, the present investigation was undertaken under two years in timely sown conditions, to identify best genotypes and draw relationships between yield and related traits and the path co-efficient analysis for yield and related traits in wheat.

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Material and methods

The experiment was conducted at the field experimentation centre of the Department of Genetics and Plant Breeding, Allahabad Agriculture Institute-Deemed University, Allahabad during the *Rabi* seasons of 2006-2007 and 2007-2008 using 30 advanced lines of bread wheat. The lines were sown in a double row of two meter length spaced at 25cm with an approximate plant to plant spacing of 4cm with 3 replications under timely sown conditions. The genotypes were procured form International Maize and wheat Improvement centre (CIMMYT), Mexico. The recommended agronomic practices were followed. Five plants were selected randomly from each genotype per replication for agronomic data and observations on days to heading and days to maturity were recorded on plot basis. The data obtained were subjected to the biometrical analysis that included analysis of variance, heritability, genetic advance, correlation coefficient and path analysis.

Results and discussion

Data were collected for morphological characters *viz,* days to 50% heading, days to maturity, plant height and seed yield per plant and other related attributes on the basis of five randomly selected competitive plants and averaged in each replication. The mean data were subjected to analysis of variance, correlation and path analysis as per the methods of

Panse and Sukahatme (1967), *Al-* Ji-Bouri *et al* (1958) and Deway and Lu (1959) respectively.

Highly significant mean squares due to genotypes for all the characters at both the years revealed the presence of enough genetic variability in the material under study (Table 1). In general mean values for days to 50% heading, days to maturity, effective tillers per plant, spike length, grains per spike and seed yield per plant were higher in 1st year (2006-2007) in comparison to 2nd year (2007-2008). Whereas, plant height and grains per spike were higher in 2nd year. Among the International Bread Wheat Screening Nursery (IBWSN) genotypes, IBWSN 1121 was the highest yielding genotype across the year. Genotype IBWSN 1101 was early in heading for both the years. This confirms the fact that yield and yield attributes are more affected by environmental fluctuations in comparison to morphological characters. The lower yield in 2nd year (2007-2008) can be attributed to environmental effects due to sowing under late sown conditions and environmental temperature or heat stress.

High phenotypic and genotypic co-efficient of variation (PCV and GCV) recorded for yield per plant at both the years, followed by days to maturity, effective tillers per plant, grains per spike and 1000-grain weight. Heritability (broad sense) was higher in 1st year (2006-2007) for all the characters as compared to 2nd year (2007-2008) and this finding was supported by Kadar *et al* (2002), Kadar and Moldovan (2003). High genetic advance and heritability reflects that the chances of obtaining high grain yield per plant are better in 1st year(timely sown) than 2nd year(late sown) and similar to other related characters (Table 2). Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability estimates alone**.**

Estimates of correlation coefficient measures the degree of relationship between pairs of characters. The results of phenotypic and genotypic correlations among different attributes are presented in Table 3. It was observed that the genotypic correlations were greater than the phenotypic correlations in almost all the cases in both the year, indicating strong influence of Genotype X Environment interaction for these traits. Genotypic and phenotypic correlation studies exhibited that plant height had negative and significant correlation with seed yield per plant for both the years and these results were in agreement with that of Sinha and Sharma (1980) and Singh and Diwivedi (2002) indicating that the dwarf genotypes had higher yield as compared to tall genotypes, this is again strong evidence from green revolution dwarfing genes contributed yield enhancement. The results further revealed significant and positive correlations of effective tillers per plant and grains per spike with seed yield per plant for both years (2006-2007) and (2007-2008). The results are in accordance with the findings of Narwal *et al* (1999), Yadav and Mishra (1993).

Path coefficient analysis was based on correlation coefficient using grain yield per plant as the dependent factor and remaining seven other quantitative characters *viz,* days to 50% flowering, days to maturity, plant height, effective tillers per plant, spike length, grains per spike and test weight as independent factors. Correlation coefficients of each independent quantitative and qualitative character were partitioned into direct and indirect effects towards grain yield. Direct effect of any characters on grain yield gives an idea about effective selection that can be made to being improvement in the latter. The indirect effect indicates the interrelationship of component characters towards contribution to yield. In the present investigation, effective tillers per plant had the positive direct effect on seed yield per plant on both the years (0.967 & 1.550) for 2006-2007 and 2007-2008, respectively (Table 5). This was followed by grains per spike (0.3449), plant height (0.2660), 1000 grain weight (0.1317) and spike length (0.1330) for 1st year and plant height (0.6855), grains per spike (0.4049), spike length (0.2775) and 1000 grain weight (0.1590) for 2nd year.

On contrary, days to 50% heading, spike length and 1000-grain weight had direct but negative effects on seed yield per plant for 1st year where as, plant height and 1000-grain weight for 2nd year. Effective tillers per plant had high positive indirect effects for 1st and 2nd years. Grains per spike and plant height also had positive indirect effect for 1st and 2nd year. Grains per spike had positive indirect effect via, spike length. The results thus revealed that effective tillers per plant and grains per spike should be criteria of selection for increasing grain yield in wheat. Sarkar *et al* (2002) and Chawdhary and Mandal (1991) were also of the same view for better yield in wheat.

Path co-efficient based on phenotypic correlations showed that effective tillers per plant had the highest positive direct effect on seed yield per plant at both the years (0.9580 and 0.4355). This was followed by grains per spike (0.3361) and spike length (0.1286) for 1st year and plant height (0.2192), grains per spike (0.2117), spike length (0.0978) and 1000 grain weight (0.0121) for 2nd year (Table 4).

Days to 50% heading and days to maturity has direct but negative effects on seed yield for both the years. Effective tillers per plant had high positive indirect

effects for both the years. Days to maturity and plant height had positive indirect effect for 1st and 2nd years indicating their importance in determining these complex characters and therefore should be kept in mind while practicing selection aimed at the improvement of grain yield. Similar results were reported by Mondal *et al* (1997), Narwal *et al* (1999), Dokuyucu *et al* (2002), Bergale *et al.* (2002).

Therefore, in conclusion effective tillers per plant and grains per spike should be the ultimate target traits of the plant breeder for yield improvement.

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Table 1: Analysis of variance for eight important Yield Components in thirty Wheat Genotypes for 1st and 2nd Year.

Characters	Replication (df=2)		Genotype (df=29)		Error		S.Em		C.D	
	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year
Days to 50% heading	2.209**	0.553	24.98**	21.194**	0.156	3.704	0.224	1.092	0.449	2.187
Days to maturity	0.725**	0.102	10.803**	3.853	0.083	3.260	0.163	1.025	0.328	2.051
Plant height	1.124**	46.069**	35.010**	27.994**	0.069	11.143	0.149	1.895	0.299	3.793
Effective tillers per plant	0.018	1.286	4.539**	2.733**	0.013	0.590	0.067	0.436	0.134	0.873
Spike length	0.001	0.270	0.581**	0.404**	0.002	0.105	0.026	0.184	0.052	0.369
Grains per spike	0.058*	0.001	1.248**	0.806**	0.015	0.188	0.071	0.246	0.143	0.494
1000 grain weight	0.263*	16.496*	26.840**	14.956**	0.076	5.141	0.157	0.287	0.314	2.576
Seed yield per plant	0.028	1.105	6.676	3.439**	0.022	1.300	0.084	0.647	0.168	1.296

*and** significant at 5% and 1%, respectively

Table 2 Mean, Range, Phenotypic and Genotypic Co-efficient of Variation, Heritability and Genetic Advance for eight important Yield Component Traits in Wheat Genotypes

Character	Year	Mean	Range	GCV	PCV	Heritability (Broad sense)	Genetic advance
Days to 50% Heading	1st	88.56	83.00-92.50	03.24	03.27	0.981	5.86
	2nd	88.41	82.94-92.22	02.73	03.49	0.611	3.88
Days to maturity	1st	119.63	116.90-123.56	01.58	01.59	0.977	3.84
	2nd	119.59	117.46-121.72	00.37	01.55	0.057	0.21
Plant height (cm)	1st	91.37	85.03-98.23	03.73	03.74	0.994	7.01
	2nd	93.73	88.65-101.54	02.52	04.36	0.335	2.82
Effective tillers per plant	1st	09.11	06.02-10.73	13.47	13.53	0.991	2.51
	2nd	08.99	06.58-10.57	09.39	12.69	0.547	1.28
Spike length (cm)	1st	08.10	07.26-09.36	05.42	05.45	0.989	0.90
	2nd	08.04	07.39-08.85	03.92	05.62	0.485	0.45
Grains per spike	1st	11.24	09.67-13.06	05.70	05.80	0.963	1.29
	2nd	11.20	10.14-12.60	04.05	05.60	0.521	0.67
1000 grains weight (g)	1st	36.78	31.63-44.05	08.12	08.15	0.991	6.12
	2nd	37.15	32.10-39.91	04.86	07.80	0.389	2.32
Seed yield per plant (g)	1st	11.01	08.23-12.96	13.52	13.58	0.990	3.05
	2nd	10.92	08.93-12.70	07.73	12.99	0.354	1.03

Table 3 Genotypic and Phenotypic Correlation Co-efficient for eight important Yield Component traits in Wheat Genotype for 1st year.

Character	Correlation	Year	Days to maturity	Plant height	Effective tillers per plant	Spike length	Grains per spike	1000 grain weight	Seed yield per plant
Days to 50% Heading	r_g	1st	0.311**	0.002	-0.003	-0.083	-0.256*	0.024	-0.119
		2nd	0.364	0.261*	-0.164	-0.309*	0.013	0.028**	-0.245*
Days to Maturity	r_g	1st		-0.021	-0.163	0.326**	0.075	0.133	-0.128
		2nd		0.378**	-0.236	0.762**	-0.194	0.488**	-0.697**
Plant height	r_g	1st			0.233	-0.169	-0.288**	0.041	-0.266*
		2nd			0.501**	0.019	-0.168	0.498**	-0.685**
Effective Tillers per Plant	r_g	1st				-0.113	-0.414**	-0.131	0.968**
		2nd				-0.259*	-0.455**	-0.016	0.551**
Spike Length	r_g	1st					0.188	-0.119	0.133
		2nd					0.165	-0.212	0.277**
Grains per Spike	r_g	1st						0.038	0.345**
		2nd						0.133	0.405**
1000 grains Per spike	r_g	1st							0.132
		2nd							0.509

*and** significant at 5% and 1%, respectively.

Table 4 Phenotypic Path Analysis, showing Direct and Indirect Effect of Different Yield Component Characters on Seed Yield per Plant in 1st and 2nd year.

Character	Year	days to 50% Heading	Days to Maturity	Plant height	Effective tillers per plant	Spike length	Grains per spike	1000 grain weight	Seed yield per plant
Days to 50% heading	**1st**	**-0.138**	-0.042	-0.001	0.001	0.011	0.034	-0.002	-0.116
	2nd	**-0.156**	-0.009	-0.007	0.003	0.017	0.012	-0.007	-0.143
Days to Maturity	**1st**	0.010	**0.097**	-0.002	-0.016	0.031	0.006	0.012	-0.128
	2nd	0.0003	**0.006**	0.002	-0.0008	0.0005	0.0004	0.000	-0.034
Plant height	**1st**	0.0000	-0.001	**0.039**	0.009	-0.007	-0.011	0.002	0.262
	2nd	0.005	0.033	**0.111**	0.027	-0.0048	-0.017	0.009	0.219
Effective tillers per plant	**1st**	-0.004	-0.160	0.226	**0.967**	-0.109	-0.390	-0.124	0.958
	2nd	-0.008	-0.052	0.090	**0.375**	-0.059	-0.091	-0.040	0.435
Spike length	**1st**	0.005	-0.021	0.110	0.007	**-0.066**	-0.012	0.008	0.129
	2nd	0.005	-0.004	0.002	0.007	**-0.042**	-0.002	0.002	0.098
Grains per spike	**1st**	-0.019	0.002	-0.010	-0.015	0.007	**0.037**	0.001	0.336
	2nd	0.009	-0.008	0.018	0.029	-0.007	**-0.119**	-0.016	0.212
1000 grain weight	**1st**	-0.001	-0.003	-0.001	0.003	0.003	-0.001	**-0.026**	0.131
	2nd	0.002	-0.0001	0.003	-0.004	-0.002	0.005	**0.040**	0.012

R Square =0.9411 Residual Effect =0.2426

Table 5 Genotypic Path Analysis, showing Direct and Indirect Effect of Different Yield Component Characters on Seed Yield per Plant in 1st and 2nd years
Square =0.9620 Residual Effect =0.1950

Character	Year	days to 50% Heading	Days to Maturity	Plant height	Effective tillers per plant	Spike length	Grains per spike	1000 grain weight	Seed yield per plant
Days to 50% heading	**1st**	**-0.141**	-0.042	-0.0002	0.001	0.012	0.036	-0.003	-0.120
	2nd	**0.145**	0.198	0.0378	-0.024	-0.045	-0.045	0.042	-0.245
Days to Maturity	**1st**	0.031	**0.099**	-0.002	-0.016	0.032	0.007	0.013	-0.128
	2nd	0.094	**0.069**	0.095	-0.016	0.053	0.053	0.034	-0.697
Plant height	**1st**	0.001	-0.001	**0.041**	0.009	-0.007	-0.012	0.002	0.266
	2nd	-0.095	-0.503	**-0.365**	-0183	-0.007	-0.007	-0.182	0.685
Effective tillers per plant	**1st**	-0.003	-0.160	0.229	**0.981**	-0.111	-0.407	-0.129	0.968
	2nd	-0.331	-0.476	1.012	**2.017**	-0.532	-0.523	-0.032	1.551
Spike length	**1st**	0.006	-0.023	0.012	0.008	**-0.071**	-0.013	0.008	0.133
	2nd	-0.050	0.124	0.003	-0.042	**0.162**	-0.002	-0.034	0.277
Grains per spike	**1st**	-0.011	0.003	-0.013	-0.018	0.008	**0.044**	0.002	0.345
	2nd	0.006	-0.086	-0.074	-0.202	0.073	**0.443**	0.059	0.405
1000 grain weight	**1st**	-0.001	-0.003	-0.001	0.003	0.001	-0.001	**-0.024**	0.132
	2nd	-0.013	-0.022	-0.023	0.0007	0.009	-0.006	**-0.045**	0.159