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Genetic parameters of variation and correlation analysis in wheat under terminal heat stress

Anita Kanwar, AP Agrawal, DJ Sharma and HP Agrawal

Abstract
Present investigation was conducted at All India Co-ordinated Wheat & Barley Improvement Project, B.T.C. College of Agriculture and Research Station, Bilaspur, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during Rabi season 2018-19. The experiment aimed to study the genetic variability, heritability, genetic advance, correlation coefficient and path coefficient. The study material comprised of 25 germplasm lines. Genetic variability was observed for most of the characters as evidenced by significant mean squares to genotypes suggesting that, it could be helpful in isolation of better germplasm. The magnitude of GCV and PCV was observed high to moderate for the characters number of seeds per spike, number of seeds per plant, effective tillers per m^2, 1000 seed weight (g), biological yield (g) and seed yield per plot (kg). The high heritability estimate was recorded for the character number of seeds per spike and effective tillers per m^2. The high genetic advance was observed for effective tillers per m^2 and number of seeds per plant. Among 12 characters studied the high genetic advance as percentage of mean was observed for number of seeds per spike and number of seeds per plant and high heritability coupled with high genetic advance as percentage of mean was found for number of seeds per spike, number of seeds per plant and 1000 seed weight (g). Results of association analysis revealed that length of spike, number of spiklets per spike, number of seeds per spike and number of seeds per plant exhibited the positive correlation with seed yield per plot. Hence, direct selection for these traits may lead to the development of high yielding wheat genotypes.

Keywords: Wheat, correlation, variation, yield and crops

Introduction
Wheat (*Triticum aestivum* L.) is a self-pollinated crop belonging to Poaceae family. Species *Triticum aestivum* grouped in the 3 ploidy level diploid (2n= 14, tetraploid (2n= 24) and hexaploid (2n= 42).There are 17 diverse species out of 17 species only three species are cultivar all through the world *viz. Triticum aestivum, Triticum durum* and *Triticum dicoccum* .The *Triticum aestivum* (common wheat) is the main significant species occupy more than 90% of the total wheat area in India. *Triticum durum* (macaroni wheat) is the second main significant species cover about 10% of the total area in India and *Triticum dicoccum* is grown on a limited scale in Gujarat, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu.
It is the most important grain food crop of India. In India, wheat is the second very most important food crop behind rice both in terms of area and production. It have been describe as the 'King of cereals' because of the acreage it occupy, high productivity and the prominent situation it holds in the world wide food grain trade.
Wheat is world's leading cereal crop, occupied an area of 222.01 mha, with a total production of 753.31 mt and productivity 3.39 t per ha (USDA) in world. In India, wheat has covered an area of 30.785 mha, with total production of 98.510 mt per ha and productivity 3.2 mt per ha. In Chhattisgarh, wheat occupies an area about 114.70 (000 ha), with a production of159.50 (000 tonnes) and average productivity of 13.91 q per ha (Anonymous, 2017-18) [3].
In Chhattisgarh paddy is taken as main crop in kharif and after harvesting of paddy wheat is cultivated as second crop in rabi season. Due to late harvesting of kharif paddy, leads to late sowing of wheat in the state. As in Chhattisgarh winter is for very short period (80-90days), generally temperature is more at day time as compared to night. Temperature rises gradually after second to third week of January. Wheat crop requires low temperature for 100-110days, favourable for yield potential. Therefore heat tolerance in wheat variety is still prime concern of agricultural research because of above the optimum temperature (22-24 ºC) wheat yield is drastically affected. The reason behind is the high temperature (short winter) reduce the crop cycle of the wheat cultivation (Pandey and Parihar, 1997). About 50 % of the wheat in Chhattisgarh is sown after first to second week of the December and suffer from terminal heatstress and which causes the significantly yield loss. Overdue sown wheat suffers drastic yield losses which may exceed to 40-50%.

The productivity of wheat in the state is far lower than the national productivity. The late sowing and early rise in the temperature during winter season are the main causes of the lower productivity. Further un-availability of wheat varieties with better late heat tolerance index and high yield added significantly to the lower productivity.

The information of pattern for genetic variation in a crop species in any known region or country is very significant for plan prospect germplasm examination missions and after that it's efficient utilization in crop enhancement programme. Evaluation of genetic variability for grain yield and its components is of utilize to predict the extent of progress feasible on behalf of seed yield and other significant characters.

The heritability measurement and genetic advance proved to be the vital parameter for separating the desirable genotypes. Heritability provide information on involvement of genotypic variation to the corresponding phenotypic variation whereas, genetic advance reflect genetic architecture of any population. High genetic advance coupled with high heritability give an idea of true heritable traits for in good selection during breeding programme.

The measure phenotypic, genotypic and environmental correlations between yield and its components have basic and foremost endeavors to find out plan for plant selection. The magnitude and direction of correlation offer a plan for future improvement in concerned character. In situation anywhere more variables are included in correlation study, the indirect relationship become complex .The correlation among seed yield and its component are helpful tools to find out important genotypes.

Materials and Methods

The experimental materials comprised of genetically diverse 25 wheat genotypes which were raised under late sown condition during rabi season, 2017-18 in a Latin square design with two replications at research farm of Wheat Section, Department of Genetics and Plant Breeding, was conducted at the All India Co-ordinated Wheat & Barley Improvement Project, B.T.C. College of Agriculture and Research Station, Bilaspur, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during rabi season 2018-19. Each genotype was grown in a plot size 1.2 X 6.0 meter for each entry in each replication. The crop was provided with protective irrigation and recommended doses of fertilizers. The Research Farm is located at 22˚09 N' latitude and 82˚15 E' longitude and at an altitude of 298 m above mean sea level. The region falls under the Eastern plateau and hill region (Agro-climatic zone-7) of India. Chhattisgarh state is classified into three agro-climatic zones, of which Bilaspur falls under the Chhattisgarh plains zone of the state. Five competitive plants were randomly tagged for recording observations for each entry in each replication for observing all the quantitative characters and mean of each character was used for statistical analysis. Observations for all the traits were recorded by taking five plants per plot. The data were recorded for days to 50% heading, days to maturity, plant height, effective tillers per meter square, seed yield per plot, 1000 seed weight, length of spike, number of spiklets per spike, number of seeds per spike, number of seeds per plant, biological yield and harvest index. Analysis of variance for the observations recorded on different characters was carried out as per the standard procedure of Fisher (1930). Genotypic and phenotypic coefficients of variation were estimated according to Burton and Devane (1953). Heritability in broad sense and Genetic advance were worked out as per the procedures of Falconer (1981), Johnson *et al*., (1955) [9], respectively. Phenotypic and genotypic correlation and path coefficients of variation were computed as per the method given by Dewey and Lu (1959) [4].

Result and Discussion

Analysis of variance

The Analysis of variance worked out for seed yield and its 11 component in wheat indicated that the mean sum of squares due to genotypes were highly significant for all the characters. This is an indication of existence of sufficient variability for the traits.

Parameters of Genetic variability

Genotypic and phenotypic coefficients of variation are simple measures of variability; these measures are commonly used for the assessment of variability. The relative values of these types of coefficient gives an idea about the magnitude of variability present in a genetic population. Thus, the components of variation such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were computed. The phenotypic coefficients of variation were marginally higher than the corresponding genotypic coefficients of variation indicated the influence of environment in the expression of the characters under study.

Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are categorized as low (less than 10%), Moderate (10-20%) and high (more than 20%) as suggested by Siva Subramanium and Madhava Menon (1973). Heritability governs the resemblance between parents and their progeny whereas; the genetic advance provides the knowledge about expected gain for a particular character after selection. Heritability suggests the relative role of genetic factors in expression of phenotypes and also acts as an index of transmissibility of a particular trait to its offspring's. However, the knowledge of heritability alone does not help in formulating concrete breeding programme, genetic advance along with heritability helps to ascertain the possible genetic control for any particular trait. The nature and extent of the inherent ability of a genotype for a character is an important parameter determining the extent of improvement of any crop species. Heritability and genetic advance are the important genetic parameters for selecting a genotype that permit greater effectiveness of selection by separating out environmental influence from total variability.

Heritability

Heritability estimates along with genetic advance are normally more useful in predicting the gain under selection than that of heritability alone. However, it is not necessary that a character showing high heritability will also exhibit high genetic advance (Johnson *et al*. 1955) [9]. An attempt has been made in the present investigation to estimate heritability in broad sense and categorized as low (<50%), moderate (50-70%) and high (>70%) as suggested by Robinson (1966). The magnitude of genetic advance was categorized as high (> 20%), moderate (10% - 20%) and low (< 10%).

Correlation coefficient analysis

Correlation analysis clearly revealed that the phenotypic and genotypic correlations in general are similar in direction but the magnitude of genotypic correlation was higher than the phenotypic correlations. The low phenotypic correlation could result due to masking influence and modifying effect of the environment on the association of characters. Pandey and Gritton (1975) pointed out that no suitable test of significance of genetic correlation is available. Therefore, their primary utility is in strengthening interpretations based on phenotypic correlation and in better predicting correlated responses to selection. Hence, important findings based on phenotypic correlation are discussed here. In the present investigation correlation coefficients at genotypic, phenotypic and environmental level have been worked out among seed yield and its components are presented in table 1.

From the results of present experiment its evident that the character days to 50% heading have positive correlation with number of spiklets per spike (0.512), number of seed per spike (0.308) and negatively correlated with number of seed per plant (-0.376) and 1000 seed weight (-0.328).Wahidy *et al.*,(2016) [13] also reported correlation between days to 50% heading and number of seeds per spike.

Days to maturity have positive correlation with plant height (0.379), length of spike (0.281) and negatively correlated with number of spiklets per spike (-0.384). Similarly reported by Singh *et al.*, (2006) that plant height, days to maturity and length of ear have positive significant correlation.

Table 1: Analysis of variance for grain yield and its components in Wheat (*Triticum aestivum* L.) under terminal heat stress

Source of Variation	DF	Mean Sum Of Square											
		Days to 50% Heading	Days to maturity	Plant Height (cm)	Effective tillers /m²	Length of Spike (cm)	No. of Spiklets/ Spike	No. of Seeds/ Spike	No. of Seeds/ Plant	1000 Seed Weight (g)	Biological Yield (g)	Harvest index	Seed yield/ Plot (kg)
Replication	1	2.42	1.62	3.54	16.82	0.01	1.39	3.50	178.39	3.71	0.05	67.09	0.01
Treatment	24	9.31**	22.77**	63.74**	4602.26**	1.38**	2.82**	119.42**	148.60**	67.46**	0.95	47.59**	0.17
Error	24	1.21	1.66	3.55	328.03	0.13	1.28	6.86	133.24	5.01	0.17	13.70	0.05

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

Table 2: Genetic parameters of variation for grain yield and its components in wheat under terminal heat stress

S. No.	Characters	Mean	Range		GCV (%)	PCV (%)	H^2 (bs)	Genetic advance	GA as% of mean
			Min.	Max.					
1	Days to 50% Heading	63.98	61.00	68.00	2.57	4.42	33.86	1.11	3.08
2	Days to maturity	117.14	109.00	121.50	2.81	3.30	72.31	5.75	5.16
3	Plant Height (cm)	83.88	71.90	95.20	6.10	7.50	66.30	8.58	10.23
4	Effective tillers /m²	265.74	175.00	363.00	17.40	18.68	86.69	88.67	33.37
5	Length of Spike (cm)	8.86	7.31	10.26	8.94	9.82	83.01	1.49	16.78
6	No. of Spiklets/ Spike	16.27	13.83	18.15	5.39	8.80	37.46	1.11	6.79
7	No. of Seeds/ Spike	36.88	21.53	51.30	20.34	21.55	89.14	14.60	39.57
8	No. of Seeds/ Plant	182.46	114.23	251.40	18.37	20.20	82.81	62.85	34.44
9	1000 Seed Weight (g)	45.49	26.75	56.28	12.28	13.23	86.17	10.69	23.49
10	Biological Yield (g)	5.12	3.75	6.50	12.21	14.60	69.94	1.17	21.03
11	Harvest index	45.82	38.57	58.29	8.98	12.10	55.30	6.31	13.76
12	Seed yield/ Plot (kg)	2.33	1.74	2.95	10.64	14.22	56.22	0.38	16.44

Table 3: Genotypic (G) and Phenotypic (P) correlation coefficients for grain yield and its components in wheat under terminal heat stress

		Days to 50% Heading	Days to maturity	Plant Height (cm)	Effective tillers /m²	Length of Spike (cm)	No. of Spiklets/ Spike	No. of Seeds/ Spike	No. of Seeds/ Plant	1000 Seed Weight (g)	Biological Yield (g)	Harvest index	Seed yield/ Plot (kg)
Days to 50% Heading	P	1.000											
	G	1.000											
Days to maturity	P	-0.083NS	1.000										
	G	0.164 NS	1.000										
Plant Height (cm)	P	-0.070NS	0.271 NS	1.000									
	G	0.032 NS	0.379**	1.000									
Effective tillers /m²	P	-0.037NS	0.106 NS	-0.051 NS	1.000								
	G	-0.020NS	0.116NS	-0.083NS	1.000								
Length of Spike (cm)	P	0.004 NS	0.246 NS	0.085 NS	-0.242 NS	1.000							
	G	0.084 NS	0.281*	0.049NS	-0.261NS	1.000							
No. of Spiklets/ Spike	P	0.012 NS	-0.147NS	0.143 NS	0.040 NS	0.300 *	1.000						
	G	0.512**	-0.384**	0.333*	0.310*	0.388**	1.000						
No. of Seeds/ Spike	P	0.182 NS	0.210 NS	0.099 NS	-0.534 **	0.614 **	0.068 NS	1.000					
	G	0.308*	0.256NS	0.228NS	-0.567**	0.705**	-0.035NS	1.000					
No. of Seeds/ Plant	P	-0.132NS	0.077 NS	0.143 NS	0.095 NS	0.007 NS	0.247 NS	0.014 NS	1.000				
	G	-0.376**	0.152NS	0.095NS	0.085NS	0.075NS	0.479**	0.004NS	1.000				
1000 Seed Weight (g)	P	-0.104NS	-0.012NS	0.264 NS	0.149 NS	0.274 NS	0.381 **	-0.200 NS	-0.045 NS	1.000			
	G	-0.328*	0.032NS	0.333*	0.157NS	0.309*	0.839**	-0.166NS	-0.032NS	1.000			
Biological Yield (g)	P	-0.065NS	0.004 NS	0.137 NS	0.220 NS	-0.029 NS	0.173 NS	-0.129 NS	-0.067 NS	0.114 NS	1.000		
	G	-0.121NS	0.060NS	0.371**	0.355*	0.058NS	0.284*	-0.190NS	-0.139NS	0.198NS	1.000		

Harvest index	P	0.081 ^{NS}	-0.164 ^{NS}	-0.035 ^{NS}	-0.215 ^{NS}	0.125 ^{NS}	0.044 ^{NS}	0.076 ^{NS}	-0.028 ^{NS}	0.138 ^{NS}	-0.410 **	1.000	
	G	0.110 ^{NS}	-0.266 ^{NS}	-0.201 ^{NS}	-0.244 ^{NS}	0.079 ^{NS}	0.115 ^{NS}	0.134 ^{NS}	-0.025 ^{NS}	0.219 ^{NS}	-0.550 **	1.000	
Seed yield/ Plot (kg)	P	0.061 ^{NS}	-0.117 ^{NS}	0.125 ^{NS}	0.038 ^{NS}	-0.025 ^{NS}	0.164 ^{NS}	-0.126 ^{NS}	-0.042 ^{NS}	0.220 ^{NS}	0.653 **	0.321 *	1.000
	G	-0.118 ^{NS}	-0.096 ^{NS}	0.191 ^{NS}	0.152 ^{NS}	-0.013 ^{NS}	0.490 **	-0.199 ^{NS}	-0.199 ^{NS}	0.398 **	0.717 **	0.171 ^{NS}	1.000

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

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