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Analysis of variability, heritability and genetic advance of yield, its components and quality traits in wheat

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Abstract
One hundred five advanced lines of wheat were grown in a randomized complete block design (RCBD) with three replications. Analysis of genetic variability, heritability and genetic advance for twelve traits were done. The phenotypic coefficient of variation (PCV) was higher in magnitude than that of genotypic coefficient of variation (GCV) for all the traits under studied. The high estimates of phenotypic coefficient of variation (>10%) were recorded in E_1 and E_2 for spike length (10.22), and tillers per plant (12.19) respectively. High estimate of heritability in broad sense (>75%) was recorded for test weight (88.72 %), plant height (86.70%), harvest index (76.7 %), spike length and in E_1. While all the characters in the E_1 and E_2 had the moderate to low estimates of heritability. Test weight, spike length, peduncle length, harvest index, in E_1 and harvest index in E_2 showed moderate estimate of genetic advance in percent of mean (10-20%). Rest of the traits showed low estimate of genetic advance in percent of mean in both environments This indicates that these high traits may be controlled by additive genetic variation that can be utilized for further breeding programs and crossing nurseries of wheat improvement.

Keywords: Coefficient of variation, heritability, genetic advance

Introduction
Wheat, (*Triticum aestivum* L. *em.* Thell) the world's largest cereal crop which belongs to Graminae (Poaceae) family of the genus *Triticum*. It has been described as the 'King of cereals' because of the acreage it occupies, high productivity and the prominent position in the international food grain trade. Wheat is consumed in a variety of ways such as bread chapatti, porridge, flour, suji etc.

The term "Wheat" is derived from many different locations, specifically from English, German and Welsh language. Wheat is most commonly defined by all cultures as "that which is white" due to its physical characteristics of light colored crops.

In India, during 2019-20 Rabi season, wheat has been cultivated in 30.55 million hectares constituting 24.34 per cent of the total crop acreage. Indian wheat production in 2019-20 has made another landmark achievement by producing 107.18 mt with an average national productivity of 3508 kg/ha. During the past year production was also more than 100 million tonnes (103.60 million tonnes) and the current year production has witnessed a change of 3.58 million tonnes (+3.46%). The positive growth in production is attributed to the increased area by 4.21 per cent despite a fall in the crop yield marginally by - 0.72 percent. Increase in the support price by `85 per quintal in comparison to the recent past year and announced as `1925 per quintal of wheat, might have had a positive impact on the crop acreage (+1.24 million hectares). The crop area and productivity have increased in a majority of the states is a main reason behind the landmark production. States like Madhya Pradesh, Maharashtra, Gujarat and Rajasthan have shown a significant increase in the crop area over the past year have resulted in a major quantum jump in overall wheat production. However, there existed regional variation in all the three variables in compasion to the previous year final estimates (2018-19).

Among the wheat producing states, Uttar Pradesh registered a significant level of crop output estimated at 32.09 million tonnes (30%), followed by Madhya Pradesh (18.58 million tonnes: 17%), Punjab (18.21 million tonnes: 17%), Haryana (12.07 million tonnes: 11%), Rajasthan (10.57 million tonnes: 10%) and Bihar (6.55 million tonnes: 6%). The aforementioned six states hold a share of about 92 per cent in total wheat production. With the exception of Chhatisgarh, Haryana, Odisha, Punjab, Telangana and Uttar Pradesh, the rest of the states registered an increase in production during 2019-20 relative to 2018-19.

Overall production from all these states has declined by 1.23 million tonnes owing to the fall in yield levels and/or acreage. The highest fall was noticed in Uttar Pradesh (-0.65 million tonnes: -1.99%). The increase in wheat production was maximum in the case of Madhya Pradesh (+2.06 million tonnes: +12.48%), followed by Gujarat (+0.85 million tonnes: +35.46%) and Maharashtra (+0.83 million tonnes: 66.20%). In percentage terms, it was highest for West Bengal (72.53%: 0.25 million tonnes)(Project Director's Report 2019-20).Wheat may be compared well with other cereals in nutritive value. It has good nutrition profile with 12.6 per cent protein, 1.7 per cent reducing sugars, 66.8 per cent starch, 68.5 per cent total carbohydrates and provides 314K cal/100g of food. It is also a good source of minerals and vitamins *viz*., thiamin (0.30 mg/100g), riboflavin (0.07 mg/100g) and niacin (1.7 mg/100mg) (Kumar *et al*., 2011). For maintaining the sustainability and self sufficiency, the country need to target of 100 million tonnes by year 2030. Overall, there was 1.546% decrease in production while area sown to wheat increased by only 1.37% relative to previous crop season. In.

Haryana, there was increase in production by 5.2% with marginal increase in area *i.e*. 0.9%. However, Punjab recorded 3.0% increase in production with little decrease in area *i.e*. 0.7%. Although, the increase in production would be largely attributed to extended cool winter and cool weather and relatively high amount of rains during the crop season.

Yield being a complex character is a function of several component characters and their interaction with environment. Probing of structure of yield involves assessment of mutual relationship among various characters contributing to the yield. In this regard, genotypic and phenotypic correlation reveals the degree of association between different characters and thus aid in selection to improve the yield and yield attributing characters simultaneously. Further, path coefficient analysis helps in partitioning of correlation coefficients into direct and indirect effects in the assessment of relative contribution of each component character to the yield.

In the present study, 104 geographically diverse indigenous genotypes were used for the tudy of character association of path coefficient analysis in wheat.

Material and Methods

A field experiment was carried out during *Rabi* 2015-16 at Main Experimental Station Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). The experiment was conducted to evaluate the 109 wheat germplasm lines along with 4 checks (namely LOK-1, HD-2009, WH-147 and DBW-17) in Augmented Block Design. These genotypes exhibited wide spectrum of variation for various agronomical and morphological characters. The experimental field was divided into 7 blocks and 19 plots in each block (15 test genotypes along with 4 checks). Each plot was consisted two rows of 2.5 m length with spacing of 5 cm within the rows and 25 cm between the rows.

The data was recorded on 5 randomly selected plants from each plot for eleven characters *viz.* days to 50% flowering, days to maturity, plant height (cm), tillers per plant, spike length (cm), flag leaf area (cm^2), peduncle length (cm), 1000-grain weight (g), biological yield per plant (g), grain yield per plant (g) and harvest index (%).Heritability in broad sense refers to the ratio of genotypic variance to the phenotypic variance. It is useful for the plant breeders in the selection of elite genotypes from homozygous lines and also a good index of the transmission of characters from parents to their offspring. Genetic advance refers to the improvement in the genetic value of the selected plant over the base population and is the measure of genetic gain under selection. Heritability estimates along with genetic advance is normally more powerful than heritability estimates alone in predicting the genetic gain under selection (Burton and Devane 1953) [16]. There is immense need to increase production, productivity and quality of wheat to meet increasing food demand of fastly growing population.

Result and Discussion

Analysis of variance (ANOVA) The analysis of variance revealed highly significant differences for all the fifteen traits indicated the existence of sufficient genetic variability among all the genotypes. The mean sums of squares from ANOVA for various traits under study depicted in (Table 2). The wide ranges of variability yields better scope for selection and utilization of important morphological, physiological, yield and quality contributing traits in wheat breeding. The genetic information obtained through analysis of genetic variability, heritability and genetic advance existing among characters at genotypic and phenotypic levels presented in (Table 3)

Coefficient of variation

The character possessing high genotypic coefficient of variation value has better scope of improvement through selection. The influence of environment on each trait could be determined on the basis of difference between phenotypic coefficient of variation and genotypic coefficient of variation. A perusal of coefficient of variation (Table 4.3) magnitude of phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits in both conditions i.e. E_1 and E_2. The high estimates of phenotypic coefficient of variation (>10%) were recorded for spike length, and moderate estimates (5-10%) of PCV were recorded for spikelets per spike, harvest index, flag leaf area, plant height in E_1. In E_2 estimates of phenotypic coefficient of variation (>10%) were recorded for tillers per plant, and moderate estimates (5-10%) of PCV were recorded for test weight, harvest index, spikeletes per spike, biological yield, spike length, peduncle length and for grain yield. Similar findings for these traits were also earlier reported by Meena *et al*., (2014) [10], Govind *et. al*., (2015) [15] and Mecha *et al*. (2016) [11].

Whereas all the characters in the E_1 and E_2 showed the low (<5%) estimates of phenotypic coefficient in both E_1 and E_2 environments. The magnitude of phenotypic coefficient of variation was higher than genotypic coefficient of variation for the characters reveald higher degree of interaction of genotypes with the environment. These findings are in close agreement with the findings of earlier workers Prasad *et al.* (2006), Rangare *et al.* (2010) [12], Maan and Yadav (2010), Zine *et al*. (2013) and Verma *et al.* (2013) [13] Yadav *et al*., (2014) [14], Govind *et al*., (2015) [15] and Mecha *et al*. (2016) [11].

Heritability and genetic advance

Heritability in broad sense gives an idea of the magnitude of environmental influence on the phenotypic expression of a character. Heritability in narrow sense, which gives the precise idea of response to selection, broad sense heritability can also be considered as the upper limit of the transmissibility of the character. In this context, the high estimates of heritability (Table 4.3) was recorded for grain yield per plant followed by biological yield per plant both E_1 and E_2. Observations on higher estimates of heritability for these traits are in close agreement with the results of Prasad *et* *al*., (2006), Verma *et al*., (2013) [13], Yadav *et al*., (2014) [14], Maurya *et al*., (2014), Meena *et al*., (2014) [10], Mecha *et al*. (2016) [11].

Conclusion

From the present study it is concluded that characters *viz*., for spike length, and tillers per plant respectively. High estimate of heritability in broad sense (>75%) was recorded for test weight, plant height, harvest index, spike length and in E_1. This indicates contribution of additive genetic variation and attention should be required at the time of selection for these traits.

Table 4.3: Estimate of range, coefficient of variation (PCV and GCV), heritability, genetic advance and genetic advance in percent of mean for 12 characters in wheat

S. No.	Characters		Range		General mean	Coefficient of variation (%)		h² (Broad sense)	Genetic advance 5%	Gen. adv as % of Mean 5%
			Parents	Crosses		GCV (%)	PCV (%)			
1	Days to 50% flowering	E_1	77.00-87.00	79.00-83.67	81.84±0.64	1.36	1.93	0.49	1.62	1.98
		E_2	75.67-83.33	75.33-78.67	77.09±0.84	1.07	2.17	0.24	0.84	1.09
2	Flag leaf area (cm²)	E_1	17.21-23.52	19.04-22.56	21.45±0.46	3.61	5.19	0.48	1.11	5.19
		E_2	17.56-19.10	15.37-19.93	18.20±0.33	2.93	4.35	0.45	0.74	4.07
3	Days to maturity	E_1	121.00-128.33	118.33-125.00	122.76±0.67	1.01	1.39	0.53	1.89	1.53
		E_2	115.67-118.33	115.67-118.67	117.15±0.53	0.41	0.90	0.21	0.46	0.39
4	Plant height (cm)	E_1	66.68-95.34	78.85-98.06	85.34±0.92	4.78	5.14	0.86	7.84	9.18
		E_2	68.56-84.26	72.44-79.86	76.81±1.04	1.79	2.97	0.37	1.72	2.23
5	Tillers/plant	E_1	5.63-7.37	4.97-7.33	6.27±0.40	4.07	4.07	0.12	0.18	2.87
		E_2	5.43-6.60	4.83-7.33	5.93±0.39	4.33	12.19	0.13	0.19	3.17
6	Spike length (cm)	E_1	14.61-17.43	13.18-22.37	16.54±0.45	9.03	10.22	0.78	2.71	16.43
		E_2	14.53-16.81	13.12-17.32	15.83±0.41	5.09	6.83	0.04	0.09	0.70
7	Peduncle length (cm)	E_1	24.57-30.51	19.58-29.78	25.45±0.64	7.70	8.86	0.75	3.50	13.78
		E_2	24.74-29.01	22.72-27.77	25.52±0.83	1.52	5.84	0.07	0.21	0.81
8	Biological yield/ plant (g)	E_1	61.43-69.93	61.00-71.39	65.18±0.69	3.14	3.64	0.74	3.65	5.60
		E_2	63.47-74.02	65.12-81.02	72.04±1.90	5.08	6.84	0.55	5.60	7.77
9	Grain Yield/ Plant (g)	E_1	30.90-37.67	26.07-41.73	26.60±0.41	4.18	4.99	0.70	1.92	7.22
		E_2	36.37-39.00	35.70-39.40	22.32±0.42	4.34	5.45	0.63	1.59	7.11
10	Test weight (g)	E_1	35.81-45.16	33.89-45.47	35.96±0.64	8.67	9.21	0.88	6.05	16.83
		E_2	30.27-36.19	24.55-34.83	37.65±0.59	0.94	2.91	0.10	0.23	0.62
11	Harvest index (%)	E_1	17.37-24.59	15.96-22.11	40.87±0.76	5.86	6.70	0.76	4.32	10.59
		E_2	12.20-15.32	11.41-14.63	31.17±0.96	7.10	8.90	0.64	3.64	11.68
12	Spikelets/Spike	E_1	23.59-28.42	23.01-28.45	19.18±0.70	5.70	8.52	0.44	1.50	7.86
		E_2	21.24-25.02	18.08-24.95	13.11±0.60	1.67	8.20	0.04	0.09	0.70

Note: E_1= Timely sown, E_2= Late sown

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