



ISSN (E): 2277- 7695  
ISSN (P): 2349-8242  
NAAS Rating: 5.23  
TPI 2021; 10(7): 1233-1237  
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[www.thepharmajournal.com](http://www.thepharmajournal.com)

Received: 08-04-2021

Accepted: 20-06-2021

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## Genetic variability, heritability and genetic gain for yield and its contributing traits in wheat (*Triticum aestivum* L. em. *Thell.*) Under sodic soil

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### Abstract

Ninety six wheat genotypes were evaluated for genetic variability, heritability and genetic advance under timely and late sown conditions at Main Experimental Station of Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, U.P. (India). The genotypes were grown in randomized complete block design and data were collected on twelve characters. Analysis of the observed data showed that the mean squares due to treatments for all the traits in both the environment were highly significant. In general, the 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<sub>1</sub> and E<sub>2</sub>. The high estimates of phenotypic coefficient of variation (>15%) were recorded for flag leaf area, tillers/plant, biological yield / plant, grain yield/ plant exhibited moderate estimates (5-15%) of PCV in both environment except days to 50% flowering and days to maturity in E<sub>1</sub> and E<sub>2</sub>. The high estimates of genotypic coefficient of variation (>15%) were recorded for flag leaf area, tillers/ plant, biological yield/ plant, grain yield/ plant in both environment and test weight and chlorophyll content in E<sub>1</sub>. The high estimate of genetic advance in per cent of mean was observed for flag leaf area, plant height, tillers/plant, peduncle length, biological yield/plant, grain yield per plant and chlorophyll content in both environments and harvest index and test weight in E<sub>2</sub>. This study suggests that the presence of adequate genetic variability, heritability and genetic advance for these traits under timely and late sown condition is suitable for breeding programs and crop improvement.

**Keywords:** Analysis of variance, genetic advance, GCV, Heat stress, Heritability, PCV

### Introduction

Wheat (*Triticum aestivum* L. em. *Thell.*, 2n=42) is a self-pollinated crop of the member of *Poaceae* family and one of the most leading cereal of many countries of the world including India. It has been described as the 'King of cereals' because of the acreage it occupies, high productivity and the prominent position it holds in the International food grain trade. It is the most important food crop of India and is a main source of protein and energy. In India, wheat is the second most important food crop after rice both in terms of area and production. Wheat is consumed in a variety of ways such as *bread*, *chapatti*, *porridge*, *flour*, *suji* etc. Wheat has relatively high content of niacin and thiamin which are principally concerned in providing the special protein called '*Glutin*'. Wheat proteins are of special significance because *Glutin* provides the framework of spongy cellular texture of bread and baked products. In India, wheat covered about 29.72 mha during the recent past 2017-18 *Rabi* season and accounts for about 37 percent of the country's total food grains production as per the recent 3<sup>rd</sup> Advance Estimates from Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers Welfare (MoA&FW), India.

In India, during 2017-18 *Rabi* season the production of wheat 98.61million tonnes and average productivity was 33.18 q/ha, with the area of 29.72 million ha. During the year 2017-18 in Uttar Pradesh, the total wheat production was 31.98 million tonnes and average productivity was 32.69 q/ha., with the area of 9.786 million ha.

Wheat production in 2017-18 has made another record and hallmark level output of 98.61 mt with an average national all time highest productivity of 3318 kg/ha. The perusal of state wise production indicated that Uttar Pradesh tops the list with 17.61mt, followed by Punjab (17.61mt), Madhya Pradesh (15.91 mt), Haryana (11.31 mt), Rajasthan (9.53 mt) and Bihar (4.58 mt). These top six states together contributed about 92 per cent of the total production (Anonymous 2018).

## Materials and Methods

The was carried out during *Rabi* 2015-16 and 2016-17 at Main Experiment Station Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). This place is located between 24° 47' and 26° 56' N latitude, 82° 12' and 83° 98' E longitude and at an altitude of 113 m above mean sea level. This area falls in sub-tropical climatic zone. The soil type is sandy loam. The annual rainfall is about 1270 mm. The climate of district Ayodhya is semi-arid with hot summer and cold winter.

The experimental materials of the study comprised of 96 treatments of wheat. These materials included 72 F<sub>1</sub>'s, 22 parental lines (18 females + 4 males) and two standard variety. Eighteen lines were crossed with 4 testers following Line x Tester mating design during 2015-16 at Main Experiment Station (MES), Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). Half of seed of 72 F<sub>1</sub>'s crosses made among 18 lines and 4 testers during year, 2016-17 were sowed in timely town and half of seed sowed in late sown. The experimental materials consisting of 96 genotypes (72 F<sub>1</sub>'s + 22 parents and 2 checks) were sown at Main Experiment Station of Department of Genetics & Plant Breeding in Randomized Block Design with three replications in a single row (F<sub>1</sub>'s), and 2 rows (parents) in plot of 3 m length with inter and intra-row spacing of 23 cm and 10 cm, respectively.

The data were recorded on 5 randomly selected plants from each plot for twelve characters *viz.* Days to 50% flowering, Days to maturity, Plant height (cm), Number of tillers per plant, Spike length (cm), Peduncle length (cm), flag leaf area, 1000-grain weight (g), Biological yield (g), Grain yield per plant (g), Harvest index, Chlorophyll content (mg / 100g). Data recorded on the above characters were subjected to estimate the correlation coefficient (Searle, 1961) and path coefficient analysis (Dewey and Lu, 1959).

## Result and Discussion

The mean squares due to treatments were highly significant for all the twelve characters studied while, mean squares due to replications were found non-significant for all the characters in both parents and F<sub>1</sub>. The differences among treatments were highly significant for all the characters in E<sub>1</sub> and E<sub>2</sub>. Further partitioning of treatment variances was done in parents as well as crosses for all the twelve characters in E<sub>1</sub> and E<sub>2</sub>. Variance due to parents vs crosses were also highly significant for all characters while non-significant for days to maturity, spike length and chlorophyll content in E<sub>2</sub> and harvest index in E<sub>1</sub>. Variance due to lines vs testers were highly significant for all characters. Partitioning of variances in to lines revealed highly significant differences for all characters in both environments, except flag leaf area and harvest index in E<sub>2</sub> whereas in testers the variances were non-significant for all the characters except plant height. The analysis of variance for combining ability for all the twelve characters. The variances due to lines x testers exhibited highly significant differences for all twelve characters in E<sub>1</sub> and E<sub>2</sub> whereas, variance due to testers were significant for plant height in E<sub>1</sub>. The variances due to lines were significant for flag leaf area in E<sub>2</sub> whereas rest of all the characters is highly significant in E<sub>2</sub> except harvest index, harvest index is non-significant in E<sub>2</sub>. The presence of large amount of variability might be due to diverse source of materials taken as well as environmental influence affecting the genotypes.

Similar findings were also reported by Panwar and Singh (2000), Kumar *et al.*, (2003), Asif *et al.*, (2004)<sup>[2]</sup>, Cheema *et al.*, (2006)<sup>[5]</sup>, Chaitali and Bini (2007), Yousaf *et al.* (2008), Nagireddy and Jyothula (2009)<sup>[15]</sup>, Rangare *et al.* (2010), Maan and Yadav (2010)<sup>[9]</sup>, Zine *et al.*, (2013), Verma *et al.*, (2013), Yadav *et al.*, (2014), Maurya *et al.*, (2014), Meena *et al.*, (2014), Mecha *et al.* (2016)<sup>[10]</sup>.

The coefficient of variation, heritability and genetic advance and genetic advance in per cent of mean in E<sub>1</sub> and E<sub>2</sub> for all the twelve characters have been given in Table 4.3. In general, the 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<sub>1</sub> and E<sub>2</sub>. The high estimates of phenotypic coefficient of variation (>15%) were recorded for flag leaf area, tillers/ plant, biological yield / plant, grain yield/ plant exhibited moderate estimates (5-15%) of PCV in both environment except days to 50% flowering and days to maturity in E<sub>1</sub> and E<sub>2</sub>. The high estimates of genotypic coefficient of variation (>15%) were recorded for flag leaf area, tillers/ plant, biological yield/ plant, grain yield/ plant in both environment and test weight and chlorophyll content in E<sub>1</sub>. Moderate estimates (5-15%) of GCV in both environment except days to 50% flowering and days to maturity in both environment. Similar findings for these traits were also earlier reported by Kisana *et al.* (1982), Rahman *et al.* (2008) and similar results for grain yield per plant and effective tillers per plant was also earlier reported by Chaitali and Bini (2007), Yousaf *et al.* (2008) Rangare *et al.* (2010), Meena *et al.*, (2014), Govind *et al.*, (2015)<sup>[7]</sup> and Mecha *et al.* (2016)<sup>[10]</sup>.

In the present investigation, the high estimate of heritability in broad sense (>75%) was recorded for all the characters except for days to maturity in both environments while days to 50% flowering in E<sub>1</sub>, spike length and chlorophyll content in E<sub>2</sub>. Observations on higher estimates of heritability for these traits are in close agreement with the results of Prasad *et al.*, (2006)<sup>[16]</sup>, Verma *et al.*, (2013), Yadav *et al.*, (2014), Maurya *et al.*, (2014), Meena *et al.*, (2014), Mecha *et al.* (2016)<sup>[10]</sup>.

The high estimate of genetic advance in per cent of mean (>20%) was observed for flag leaf area, plant height, tillers/plant, peduncle length, biological yield/ plant, grain yield per plant and chlorophyll content in both environments and harvest index and test weight in E<sub>2</sub>.

Spike length in both environments and test weight and harvest index in E<sub>1</sub> 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.

In the present investigation, the high estimate of heritability in narrow sense (>30%) was recorded for all the characters except for biological yield /plant, grain yield / plant and harvest index in both environments while tillers/ plant in E<sub>1</sub>, spike length and chlorophyll content in E<sub>2</sub>. These observations on higher estimates of heritability and genetic advance for these traits are in close agreement with the results of Abid and Muhammad (1993), Prasad *et al.*, (2006)<sup>[16]</sup>, Payal *et al.*, (2007), Yousaf *et al.*, (2008), Nagireddy and Jyothula (2009)<sup>[15]</sup> and Laghari *et al.* (2010)<sup>[8]</sup>, Yadav *et al.*, (2014), Maurya *et al.*, (2014), Meena *et al.*, (2014), Mecha *et al.* (2016)<sup>[10]</sup>. Biological yield /plant, grain yield / plant and harvest index in both environments while tillers/ plant in E<sub>1</sub>, spike length and chlorophyll content in E<sub>2</sub>. These observations on higher estimates of heritability and genetic advance for these traits

are in close agreement with the results of Abid and Muhammad (1993), Prasad *et al.*, (2006) [16], Payal *et al.*, (2007), Yousaf *et al.*, (2008), Nagireddy and Jyothula (2009)

[15] and Laghari *et al.* (2010) [8], Yadav *et al.*, (2014), Maurya *et al.*, (2014), Meena *et al.*, (2014), Mecha *et al.* (2016) [10].

**Table 1:** Analysis of variance for 12 characters in wheat

S. No.	Characters Df	Replication		Treatments		Error	
		2.00		93.00		186.00	
		E <sub>1</sub>	E <sub>2</sub>	E <sub>1</sub>	E <sub>2</sub>	E <sub>1</sub>	E <sub>2</sub>
1	Days to 50% Flowering	0.77	1.20	9.54**	11.23**	1.36	1.19
2	Flag Leaf Area (cm <sup>2</sup> )	0.38	5.97	109.91**	74.95**	1.36	3.70
3	Days to Maturity	2.39	1.49	8.50**	8.68**	1.27	1.04
4	Plant Height (cm)	0.35	5.07	246.90**	206.46**	2.46	4.33
5	Tillers/Plant	4.03	1.83	85.93**	70.56**	2.09	4.38
6	Spike Length (cm)	1.57	0.51	5.80**	6.49**	0.49	1.52
7	Peduncle Length (cm)	1.19	0.05	32.79**	37.46**	1.15	2.53
8	Biological Yield/ Plant (gm)	595.31	211.25	39464.21**	44221.21**	374.66	371.94
9	Grain Yield/ Plant (gm)	31.21	14.11	5946.86**	6777.17**	45.97	27.67
10	Test Weight (gm)	0.13	1.33	31.24**	73.17**	1.41	1.93
11	Harvest Index (%)	0.38	3.05	41.05**	41.60**	3.06	2.11
12	Chlorophyll Content	0.19	1.66	11.85**	5.63**	0.18	0.69

\*, \*\* significant at 5 and 1 per cent probability levels, respectively

**Table 2:** Analysis of variance for 12 characters in line x tester mating design in wheat including parents

Characters Df		Source of variation							Error
		Replication	Parents	Parents vs Crosses	Crosses	Line Effect	Tester Effect	Line * Tester Eff.	
		2.00	21.00	1.00	71.00	17.00	3.00	51.00	
Days to 50% Flowering	E <sub>1</sub>	0.77	10.92**	116.18**	7.63**	15.45**	13.07	4.70**	1.62
	E <sub>2</sub>	1.20	11.36**	48.45**	10.67**	33.99**	7.83	3.06**	1.19
Flag Leaf Area (cm <sup>2</sup> )	E <sub>1</sub>	0.38	50.57**	126.55**	127.23**	275.44**	196.67	73.74**	1.46
	E <sub>2</sub>	5.97	30.09**	70.97**	88.28**	141.50	70.39	71.59**	3.70
Days to Maturity	E <sub>1</sub>	2.39	8.75**	86.00**	7.34**	13.94**	9.91	4.98**	1.45
	E <sub>2</sub>	1.49	7.58**	1.87	9.10**	28.86**	5.45	2.73**	1.04
Plant Height (cm)	E <sub>1</sub>	0.35	235.10**	1907.46**	227.00**	785.78**	129.91**	46.45**	2.74
	E <sub>2</sub>	5.07	189.10**	79.65**	213.38**	558.16**	81.69	106.20**	4.33
Tillers/Plant	E <sub>1</sub>	4.03	5.82**	274.54**	106.97**	259.07**	21.05	61.32**	2.19
	E <sub>2</sub>	1.83	2.42**	2043.68**	62.92**	194.05**	22.94	21.56**	4.38
Spike Length (cm)	E <sub>1</sub>	1.57	4.74**	60.59**	5.35**	15.59**	2.76	2.09**	0.55
	E <sub>2</sub>	0.51	7.61**	3.22	6.21**	14.64**	1.78	3.66**	1.52
Peduncle Length (cm)	E <sub>1</sub>	1.19	30.94**	34.55**	33.31**	96.56**	25.85	12.66**	1.25
	E <sub>2</sub>	0.05	40.95**	139.73**	34.99**	81.50**	35.27	19.47**	2.53
Biological Yield/ Plant (gm)	E <sub>1</sub>	595.31	24415.58**	1459630.50**	23912.87**	49310.69**	9843.25	16274.56**	250.97
	E <sub>2</sub>	211.25	35650.74**	1797371.63**	22063.88**	52766.41**	3934.11	12896.16**	371.94
Grain Yield/ Plant (gm)	E <sub>1</sub>	31.21	4725.89**	185460.94**	3779.63**	8108.27**	1321.71	2481.33**	38.98
	E <sub>2</sub>	14.11	6074.49**	276082.06**	3191.98**	7183.61**	350.92	2028.56**	27.67
Test Weight (gm)	E <sub>1</sub>	0.13	5.28**	141.93**	37.36**	74.90**	10.38	26.43**	1.54
	E <sub>2</sub>	1.33	8.61**	633.55**	84.37**	249.69**	51.19	31.21**	1.93
Harvest Index (%)	E <sub>1</sub>	0.38	44.96**	3.70	40.42**	80.17**	9.04	29.02**	3.39
	E <sub>2</sub>	3.05	45.82**	347.64**	36.04**	35.77	58.95	34.78**	2.11
Chlorophyll Content	E <sub>1</sub>	0.19	5.61**	3.13**	13.82**	48.46**	2.98	2.91**	0.16
	E <sub>2</sub>	1.66	4.44**	0.99	6.04**	14.50**	0.99	3.52**	0.69

\*, \*\* significant at 5 and 1 per cent probability levels, respectively

NOTE: E<sub>1</sub>= Timely sown, E<sub>2</sub>= Late sown.

**Table 2:** 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 (%)		h <sup>2</sup> (Broad sense)	Genetic advance 5%	Gen. Adv as % of Mean 5%
			Parents	Crosses		GCV (%)	PCV (%)			
			E <sub>1</sub>	E <sub>2</sub>		E <sub>1</sub>	E <sub>2</sub>			
1	Days to 50% flowering	E <sub>1</sub>	81.00-88.00	79.00-87.00	82.51±0.67	2.02	2.47	67	2.82	3.42
		E <sub>2</sub>	71.00-78.00	70.00-80.00	72.89±0.62	1.49	2.50	91	0.74	4.13
2	Flag leaf area (cm <sup>2</sup> )	E <sub>1</sub>	17.22-35.96	16.01-43.50	27.60±0.66	21.83	22.23	96	12.19	44.15
		E <sub>2</sub>	18.13-30.60	13.35-38.91	24.70±1.10	19.66	21.12	87	9.31	37.69
3	Days to maturity	E <sub>1</sub>	119.00-128.33	117.33-125.00	122.35±0.64	1.29	1.58	66	2.64	2.16
		E <sub>2</sub>	109-117.66	109.00-119.00	113.07±0.58	1.42	1.68	71	2.79	2.47
4	Plant height (cm)	E <sub>1</sub>	72.95-112.06	62.16-115.98	80.22±0.90	11.87	12.03	97	19.36	24.13
		E <sub>2</sub>	63.06-101.10	64.08-106.23	77.60±1.19	10.92	11.24	94	16.96	21.86
5	Tillers/plant	E <sub>1</sub>	9.00-13.00	7.33-42.00	12.49±0.83	41.97	43.52	93	10.42	83.37
		E <sub>2</sub>	6.33-9.66	6.00-27.66	12.54±1.19	37.29	40.78	84	8.81	70.24
6	Spike length (cm)	E <sub>1</sub>	13.78-19.35	15.53-22.36	17.23±0.40	7.95	8.93	79	2.52	14.59
		E <sub>2</sub>	12.13-19.35	12.23-19.84	16.20±0.70	8.13	11.10	54	1.99	12.27
7	Peduncle length (cm)	E <sub>1</sub>	19.41-34.09	19.58-40.60	25.23±0.62	13.47	14.13	91	6.68	26.46
		E <sub>2</sub>	18.00-34.09	15.16-32.63	23.72±0.91	14.31	15.81	82	6.33	26.69
8	Biological yield/ plant (g)	E <sub>1</sub>	245.00-575.00	103.33-571.66	286.13±11.28	39.86	40.44	97	231.57	80.93
		E <sub>2</sub>	180.00-575.00	91.77-415.00	253.95±11.05	47.21	47.81	98	243.87	96.03
9	Grain Yield/ Plant (g)	E <sub>1</sub>	72.43-205.74	34.32-208.33	103.75±3.89	42.50	42.99	98	89.79	86.54
		E <sub>2</sub>	54.21-205.74	31.61-152.79	88.18±3.04	53.32	53.66	99	96.27	89.16
10	Test weight (g)	E <sub>1</sub>	30.90-36.06	28.76-47.73	34.57±0.68	9.03	9.65	88	6.02	17.40
		E <sub>2</sub>	28.69-36.06	19.10-42.16	30.07±0.80	16.03	16.69	92	9.54	31.72
11	Harvest index (%)	E <sub>1</sub>	29.64-41.93	29.95-43.18	35.95±1.00	9.98	11.09	81	6.65	18.50
		E <sub>2</sub>	30.13-41.10	28.86-41.16	33.99±0.84	10.58	11.43	86	6.86	20.18
12	Chlorophyll content	E <sub>1</sub>	9.42-14.63	7.53-16.13	10.72±0.24	18.24	18.67	96	3.94	36.73
		E <sub>2</sub>	9.06-14.57	8.07-15.20	11.06±0.47	11.63	13.81	71	2.23	20.17

## Conclusion

Following major conclusion has been drawn from the present study in which 96 wheat genotypes were evaluated in randomized complete block design in two conditions (timely and late sown) to assess the genetic diversity based on qualitative characters and yield components.

- Analysis of variance showed significant differences among the wheat genotypes for all the twelve quantitative and qualitative traits.
- In general, the 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<sub>1</sub> and E<sub>2</sub>.
- The high estimate of heritability in narrow sense was recorded for all the characters except for biological yield /plant, grain yield / plant and harvest index in both environments while tillers/ plant in E<sub>1</sub>; spike length and chlorophyll content in E<sub>2</sub>.

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