Journal of AgriSearch, 12 (2): 87-92
An Open Access International Peer Reviewed Quarterly

ISSN : 2348-8808 (Print), 2348-8867 (Online)
https://doi.org/10.21921/jas.v12i02.15237

Genetic Variability, Correlation and Path Analysis in Wheat (Triticum aestivum L.) under Late Sown Condition

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ABSTRACT

The crop improvement programme in wheat mainly depends on presence of higher genetic variability in the population or diverse parents for hybridization and for effective selection of desirable traits. Therefore it is eventually measure the genetic variability, heritability, genetic advance, correlation and other essential estimate of various parameters related to yield and yield attributing traits. The present investigation entitled "Genetic variability, correlation and path analysis in wheat (Triticum aestivum L.) under late sown condition" was conducted at Nidharia Agriculture Farm of Shri Murli Manohar Town Post Graduate College Ballia, Uttar Pradesh during rabi season 2023-24. The present experiment consists of twenty two (22) genotypes and carried out in Randomized Block Design with three replications. Results revealed that all the characters are highly significant except days to 50% flowering and rest of eleven characters are i.e. plant height (cm), number of tillers per plant, flag leaf area (cm²), spike length (cm), biological yield (g), days to maturity, peduncle length (cm), number of grains per spike, test weight (g), harvest index (%) and grain yield per plant (g) showed that treatments are differ significantly. HTWYT-34 produced higher grain yield followed by SAWYT-346, HTWYT-45, SAWYT-302 and SAWYT-326 genotypes are significantly out yielded over remaining genotypes. The highest phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) was observed in grain yield per plant followed by biological yield, number of tillers per plant, harvest index, flag leaf area, test weight, number of grain per spike, spike length, peduncle length, plant height and days to maturity, respectively .High heritability and high genetic advance was observed for biological yield per plant. Rest of the characters has high heritability and low genetic advance except peduncle length and spike length showed moderate heritability and low genetic advance. Grain yield per plant showed positive and highly significant correlation with numbers of tillers per plant, biological yield per plant and harvest index at both phenotypic and genotypic level. Flag leaf area, and spike length showed positive and significant correlation at genotypic level and positive and non-significant at phenotypic level.

Keywords: Wheat, Variability, Heritability, Genetic advance, GCV, PCV, Correlation

ARTICLE INFO

Received on	:	24/04/2025
Accepted on	:	27/06/2025
Published online	:	30/06/2025

INTRODUCTION

Wheat is a cereal crop. The word cereal is derived from a roman word 'CERES' which means the "Goddess of grain". Wheat (Triticum aestivum L.) is an important rabi season crop in world, belongs to family poaceae (Gramineae), genus Triticum and species aestivum with chromosome number 2n=6x=42 and basic chromosome number x=7. Wheat ranks 1st in world among the cereals both in respect of area and production so, wheat is called as 'King of cereal' and also knowing for staple food of the world. Wheat plays a vital role in food and nutritional security of the country. Nearly 55% of the world population depends on wheat for about 20% of calories intake and 19% of protein. It is one of the major food grains of the country and a staple food of the people of North India, where people have preference for chapatti. Wheat is well distributed all over the world. Wheat is one of the most cultivated crops in the world. Leading producing countries are mostly confined in the European and Asian countries including India. Today, wheat is grown on more land area than any other commercial crop and continues to be the most important food grain source for humans. Countries in North America, South America, North Africa, East and Southern Africa, Oceania etc., also cultivated wheat for different purposes. The countries viz, China, USA, India, Russia, Canada, European Union and Australia account for 61% of global wheat production. In the marketing year 2023-24 the global production of wheat is 784.91 million metric ton (https://www.statista.com). China is the largest wheat producer country in the world with 136.6 million metric tons followed by European Union with production volume 134 million metric tons. (https://www.statista.com). In India wheat is the second most important crop in respect of area and production after rice. The area harvested for wheat in India

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was about 34.15 million hectares in 2023-24 with the production 110.55 million tons (Ministry of Agriculture and Farmer Welfare). The major wheat producing states are UP, Punjab, Haryana, Madhya Pradesh, Rajasthan Bihar, Maharashtra , Himachal Pradesh and Jammu and Kashmir. Uttar Pradesh is the largest wheat producing state in India, Uttar Pradesh contributing 30% to India's total wheat production is expected to see 4.7% increase in output to 35.43 million tons this year (2023-24), (Department of Agriculture and Farmer Welfare). Azamgarh is the highest wheat producing districts in Uttar Pradesh. In Ballia districts total production of wheat was 514.64 metric tonnes, productivity was 34.84 quintal per hectare and area was 147717 hectare (District Agriculture Office Ballia) in 2022-23. After the Green Revolution in the 1970's, the production of wheat in India has sown a huge increase. As per reports of the Food and Agriculture Organization (2003), wheat ranks first in area and production in the world among cereals. South and East Asia contributed immensely towards increase in global wheat production. Since the introduction of high yielding varieties in 1965, there has been a quantum jump in the wheat production and productivity. In India, wheat is a common rabi cereal grown mainly in the plains of the north, south and western India except in most of the north eastern part of India, Punjab, Haryana, Uttar Pradesh, West Bengal, Bihar, Madhya Pradesh, Assam, coastal regions of south India etc. The major states that are involved in the cultivation of wheat are those located in the plains like Uttar Pradesh, Punjab and Haryana. They account for nearly 70% of the total wheat produced in the country. Punjab and Haryana yield the highest amount of wheat because of the availability of better irrigation facilities.

Wheat evolved from wild grasses, probably somewhere in the Near East. A very likely place of origin (South West Asia) was the area known in early historical times as the fertile crescent-a rich soil region in the upper reaches of the Tigris-Euphrates drainage basin. Even today substantial genetic variability among the wild relatives of wheat is found in Iran, Israel and bordering countries. The acquaintance of early man with wheat goes back as early as 15000-10000 BC (Briggle, 1980). Wheat is found in three polyploidy groups viz., diploid (2n = 2x = 14), tetraploid (2n = 4x = 28) and hexaploid (2n = 6x = 42). The present evidences indicate that the tetraploid wheats (AABB genome) evolved from an alloploid combining Triticum monococcum (AA) and an unknown and possibly extinct species which was supposed to be the progenitor of BB genome (Poehlman, 1987). For several years it was believed that the B genome of wheat was contributed by Aegilops speltoides. However, comparison of seed protein of this wild species with that of tetraploid wheats revealed that the prominent albumin bands of Aegilops speltoides are missing in the profile of the tetraploid wheat (Johnson, 1972). Thus, Aegilops speltoides could not be considered as one of the diploid progenitors of hexaploid wheat. A similar conclusion was drawn by cytogenetic investigations of Kimber and Athwal (1972). Further, natural hybridization of a tetraploid with a seven chromosome wild grass (Aegilops squarrosa L., DD genome, renamed as Triticum tauschii Coss. Schmal) gave rise to hexaploid wheats like Triticum aestivum, T. compactum etc. (Schmidt, 1974). Wheat as food is considered more nutritive as compared to other cereals. It has nutrition profile as 12.1% protein, 1.8% lipids, 1.8% ash, 2.0 reducing sugar, 6.7% pentose, 59.2% starch, 70% total carbohydrates and protein 341 k cal/100g of food. It is also a good source of minerals and vitamins viz. (37mg 1100g), iron (4.1mg 1100g), thiamine (0.45mg 1100g), riboflavin (0.13 mg 1100g) and nicotinic acid (5.4mg 1100g).

MATERIALS AND METHODS

The present investigation was conducted at Nidhariya Agriculture Farm of Shri Murli Manohar Town (Post Graduate) College Ballia, Uttar Pradesh during rabi season 2023-24. The present experiment consists of twenty two (22) genotypes and carried out in Randomized Block Design (RBD) with three replications. All the genotypes/cultivars/germplasm collected from BHU (Banaras Hindu University) Varanasi of bread wheat was shown 06 December 2022. Data was recorded from five competitive plants from each replication/plot were randomly selected and recording observation for all the quantitative traits/characters except days to 50% flowering and days to maturity. Both days to 50% flowering and days to maturity were recorded on plot basis.

RESULTS AND DISCUSSION

Analysis of variance for Randomized Block Design for twelve characters is calculated to test the significance of differences among various genotypes. Mean sum of squares are mentioned in Table 1. After study we found that all the characters are highly significant except days to 50% flowering so, it will not be studied further, and rest of eleven characters are i.e. plant height (cm), number of tillers per plant, flag leaf area (cm^2), spike length (cm), biological yield (g), days to maturity, peduncle length (cm), number of grains per spike, test weight (g), harvest index (%) and grain yield per plant (g) showed that treatments are differ significantly. In the present investigation the performance of 12 quantitative characters are mentioned in Table 2. HTWYT-34 produced higher grain yield followed by SAWYT-346, HTWYT-45, SAWYT-302, and SAWYT-326, genotypes are significantly out yielded over remaining genotypes. In addition to seed yield some other character can be used in breeding programme as donor parent despite having medium or low seed yield. In this term the genotypes which can be used for several other characters on the basis of their mean performance are superior. SAWYT-326, HTWYT-28, SAWYT-312 for plant height; SAWYT-346, HTWYT-28, HTWYT-45 for number of tillers per plant; SAWYT-346, SAWYT-319, SAWYT-321 for flag leaf area, SAWYT-312, SAWYT-319, SAWYT-321 for peduncle length; SAWYT-348 SAWYT 347, and SAWYT-320 for spike length; HTWYT-37, SAWYT-346, HTWYT-45 for days to maturity; SAWYT-346, SAWYT-326, HTWYT-34 for biological yield per plant, SAWYT-321, HTWYT-37, HTWYT-28 for number of grain per spike, HTWYT-34, SAWYT-320 and SAWYT-302 for test weight; SAWYT-312, HTWYT-37 and HTWYT-45 for harvest index . on the basis of overall Evaluation , SAWYT-346, HTWYT-45 and HTWYT-34 are best lines observed for most of the characters.

Table 1: Analysis of variance (ANOVA) for 12 characters in wheat (*Triticum aestivum* L.)

Characters / Sources of ariation	d.f	Days to 50% flowering	Number of tillers per plant	Plant height (cm)	Flag leaf area (cm2)	Peduncle length (cm)	Spike length (cm)	Days to maturity	Biological yield (g)	Grain per spike	Test weight (g)	Harvest index (%)	Grain yield per plant (g)
Replication	2	3.742	6.692*	0.44	0.064	0.908	0.049	1.879	6.76	5.989	0.112	5.493*	5.807
Treatments	21	3.155	12.914**	61.174**	16.375**	7.312**	0.532**	24.62**	583.922**	43.344**	24.648**	73.773**	78.477**
Error	42	2.441	1.692	2.612	0.879	1.44	0.209	1.387	4.128	1.952	0.065	1.498	2.11

Significant@–* 5%, **1% Level of significance

Table 2: Mean value for 12 quantitative traits in wheat (Triticum aestivum L.)

Treatment	Days to 50% flowering	Plant height (cm)	Number of tillers/ plant	Flag leaf area (cm2)	Peduncle length (cm)	Spike length (cm)	Days to maturity	Biological yield(g)	Number of grain /spike	Test weight (g)	Harvest index (%)	Grain yield /plant (g)
SAWYT–312	74.67	84.45	16.47	20.62	31.77	10.55	120.00	59.89	52.86	36.00	46.27	27.71
SAWYT–327	75.67	87.41	16.13	23.71	34.20	10.82	120.33	62.91	52.30	34.53	38.03	23.93
SAWYT–344	75.00	88.46	16.00	21.38	35.68	9.84	119.33	35.85	50.00	36.50	40.38	14.50
HTWYT–28	75.00	83.16	18.73	23.42	33.17	10.31	123.00	68.22	58.73	34.50	40.64	27.74
HTWYT–26	76.33	88.66	14.80	21.43	33.47	10.50	124.00	78.32	58.06	35.17	33.07	25.93
HTWYT–34	75.67	94.03	17.67	27.02	34.00	10.50	121.00	92.93	50.57	43.53	36.12	33.57
SAWYT–320	76.00	91.41	12.13	25.37	34.53	10.89	122.00	68.27	54.59	40.87	30.18	20.63
HTWYT–37	75.33	90.39	12.53	25.53	34.91	9.98	114.33	57.13	59.86	34.10	40.82	23.33
HTWYT–33	75.00	94.16	12.80	25.47	36.08	10.68	121.33	70.87	54.84	34.00	27.08	19.20
SAWYT–326	75.00	80.42	14.13	24.73	34.19	10.21	123.33	93.35	54.33	36.53	30.05	28.07
SAWYT–302	74.67	94.74	16.73	23.17	36.46	9.90	120.33	72.21	47.68	39.60	41.35	29.88
HTWYT–45	75.67	91.43	18.67	24.79	35.45	10.09	118.67	78.21	57.55	29.60	39.61	30.99
BLACKWHEAT	78.33	100.7	13.87	20.22	39.00	9.79	127.67	66.27	49.59	36.10	35.33	23.44
SAWYT–348	74.33	89.71	14.73	24.51	36.02	10.97	121.33	75.53	53.61	39.00	32.77	24.77
SAWYT–346	74.00	95.07	18.80	28.42	35.41	10.10	117.00	100.05	58.12	33.70	33.47	33.49
SAWYT–321	73.00	93.67	13.60	28.12	33.14	10.76	120.00	60.96	63.07	35.80	35.00	21.35
SAWYT–347	74.33	95.33	13.87	25.61	33.53	10.90	119.00	70.61	55.76	38.40	33.28	23.50
SAWYT–319	75.33	90.51	14.47	28.30	32.76	9.64	124.67	70.41	51.99	36.00	31.13	21.93
SAWYT–340	74.67	90.22	14.53	24.16	35.04	10.15	122.67	61.17	49.77	34.50	30.56	18.71
SAWYT–334	74.33	94.19	1S3.13	23.01	35.82	10.58	121.67	55.65	52.57	37.43	33.79	18.83
SAWYT–345	74.67	89.23	13.67	24.58	35.4	9.78	125.00	70.47	54.57	37.63	28.96	20.42
SAWYT–331	75.33	89.54	13.07	22.71	34.43	10.62	120.00	61.43	54.88	35.60	29.92	18.39
MAXIMUM	78.33	100.7	18.80	28.42	39.00	10.97	127.67	100.05	63.07	43.53	46.27	33.57
MINIMUM	73.00	80.42	12.13	20.22	31.77	9.64	114.33	35.85	47.68	29.60	27.08	14.50
GRANDMEAN	75.11	90.77	15.02	24.38	34.77	10.35	121.21	69.58	54.33	36.32	34.90	24.11

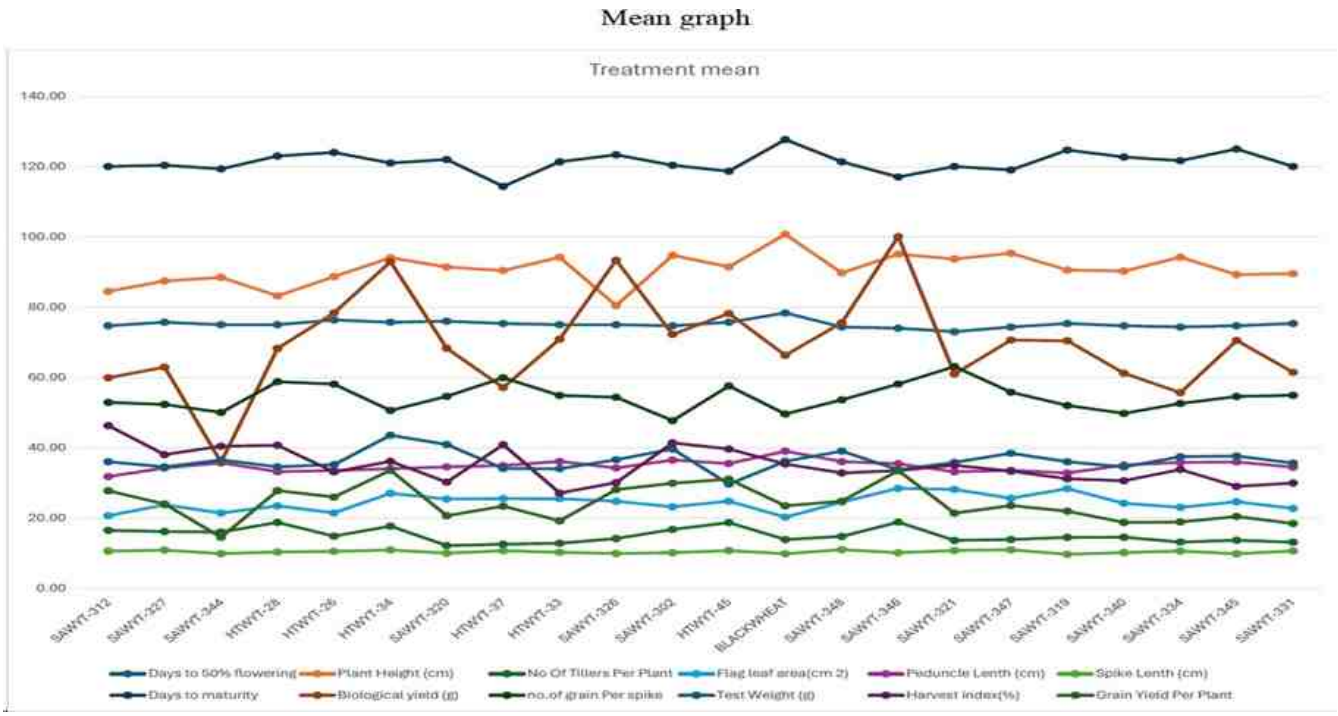

Fig. 1: Mean graph for 12 quantitative traits in wheat

The magnitude and nature of variation estimated using genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV). Phenotypic coefficient of Variation (PCV) was found higher than genotypic coefficient of variation (GCV) for all the traits due to the influence environmental factors. Estimates of coefficient of variation mentioned in Table 3. The highest phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) was observed in grain yield per plant followed by biological yield, number of tillers per plant, harvest index, flag leaf area, test weight, number of grain per spike, spike length, peduncle length, plant height and days to maturity, respectively . Similar findings were reported by Chauhan et al. (2023).

Heritability is the quality of a characteristic being transmissible from parent to offspring. The maximum broad sense heritability was observed for test weight (99.210 %) and minimum heritability value of spike length (34.062 %). Test weight (99.210%), biological yield (97.909%), harvest index (94.146 %), grain yield per plant (92.347 %), plant height (88.197 %), number of grain per spike (87.604%), flag leaf area (85.460 %), days to maturity (84.814 %), and number of tillers per plant (68.852%) show high heritability, while peduncle length (57.605%) and spike length (34.062 %) show moderate heritability . Similar findings were reported by Prasad et al. (2021) and Chauhan et al. (2023) .

The highest genetic advance was observed for biological yield per plant (28.337) and the lowest genetic advance was observed for spike length (0.395, while rest all the characters have low genetic advance mentioned in Table-3. The highest genetic advance as % of mean was observed for grain yield per plant (41.434) followed by biological yield per plant (40.727), while the lowest genetic advance as % of mean was observed for spike length (3.814). Similar findings were reported by Prasad et al. (2021) and Chauhan et al. (2023).

Table 3: Variability parameters of various characters in wheat (Triticum aestivum L.)

Variability parameters / Characters	GCV	PCV	CV	Heritability %	Genetic advance	Genetic advance as % of mean
Plant height(cm)	4.868	5.183	1.784	88.197	8.547	9.417
Number of tillers /plant	12.873	15.514	8.658	68.852	3.306	22.004
Flag leaf area (cm2)	9.323	10.085	3.846	85.460	4.328	17.755
Pedunclelength(cm)	4.023	5.301	3.451	57.605	2.187	6.291
Spikelength (cm)	3.172	5.436	4.416	34.062	0.395	3.814

Variability parameters / Characters	GCV	PCV	CV	Heritability %	Genetic advance	Genetic advance as % of mean
Daystomaturity	2.296	2.493	0.972	84.814	5.280	4.356
Biologicalyield(g)	19.981	20.193	2.920	97.909	28.337	40.727
Numberofgrain /spike	6.837	7.304	2.571	87.604	7.162	13.182
Testweight(g)	7.881	7.912	0.702	99.210	5.874	16.170
Harvestindex(%)	14.064	14.494	3.507	94.146	9.811	28.110
Grainyield/plant(g)	20.931	21.781	6.026	92.347	9.988	41.434

Grain yield per plant showed positive and highly significant correlation with numbers of tillers per plant (0.722** and 0.702**), biological yield per plant (0.784** and 0.783**) and harvest index at both phenotypic and genotypic level. Grain yield per plant showed negative and non-significant correlation with plant height (-0.03 and - 0.017), peduncle length (-0.19 and -0.081) and days to maturity (- 0.171and - 0.172), number of grain per spike (0.13 and 0.096)and test weight (0.03 and 0.029) showed positive and non-significant at both genotypic and phenotypic level. Flag leaf area (0.245*and0.2),and spike length (0.306*and 0.166) showed positive and significant at genotypic level and positive and non-significant at phenotypic level . Number of tillers per plant, biological yield and harvest index showed positive and highly significant association with grain yield per plant so, these traits are important from breeding point of view.Similar result were reported by Kumar and Chaudhary (1986) and Avinashe et al. (2014).

Table 4: Genotypic and phenotypic correlation coefficient for 12 characters in wheat (Triticum aestivum L.)

Characters	Plant height (cm)	No. of tillers/ plant	Flag leaf area (cm²)	Peduncle length (cm)	Spike length (cm)	Days to maturity	Biological yield (g)	No. of grain/spike	Test weight (g)	Harvest index (%)	Grain yield/plant (g)
Plant height (cm)	-	-0.173 (g) -0.124 (p)	0.184 (g) 0.165 (p)	0.655** (g) 0.455** (p)	0.019 (g) 0.083 (p)	0.001 (g) 0.01 (p)	0.033 (g) 0.036 (p)	-0.153 (g) -0.144 (p)	0.161 (g) 0.161 (p)	0.168 (g) -0.147 (p)	0.03 (g) -0.017 (p)
Number of tillers/plant		-	0.044 (g) 0.001 (p)	-0.204 (g) -0.057 (p)	0.167 (g) -0.01 (p)	-0.192 (g) -0.165 (p)	0.363** (g) 0.364** (p)	-0.033 (g) -0.056 (p)	-0.216 (g) -0.17 (p)	0.557** (g) 0.551** (p)	0.722** (g) 0.702** (p)
Flag leaf area (cm²)			-	-0.300* (g) -0.19 (p)	0.101 (g) 0.059 (p)	-0.305* (g) -0.280* (p)	0.483** (g) 0.433** (p)	0.419** (g) 0.358** (p)	0.065 (g) 0.067 (p)	-0.365** (g) -0.342** (p)	0.245* (g) 0.2 (p)
Peduncle length (cm)				-	-0.454** (g) -0.167 (p)	0.236 (g) 0.154 (p)	0.056 (g) 0.011 (p)	0.429** (g) 0.324** (p)	0.013 (g) 0.006 (p)	-0.223 (g) -0.124 (p)	0.2 (g) -0.081 (p)
Spike length (cm)					-	-0.662** (g) -0.380** (p)	0.046 (g) 0.024 (p)	0.460** (g) 0.340** (p)	0.044 (g) 0.019 (p)	0.345** (g) 0.186 (p)	0.306** (g) 0.166 (p)
Days to maturity						-	0.04 (g) 0.084 (p)	0.398** (g) 0.327** (p)	0.211 (g) 0.195 (p)	0.411** (g) 0.38 (p)	0.171 (g) 0.178 (p)
Biological yield (g)							-	0.432** (g) 0.342** (p)	0.112 (g) 0.113 (p)	-0.305* (g) -0.264* (p)	0.784** (g) 0.783** (p)
Number of grain/spike								-	0.433** (g) 0.306** (p)	-0.127 (g) 0.046 (p)	0.603** (g) 0.096 (p)
Test weight (g)									-	0.174 (g) 0.134 (p)	0.029 (g) 0.009 (p)
Harvest index (%)										-	0.344** (g) 0.385** (p)
Grain yield/plant (g)											-

g = Genotypic correlation coefficient, p = Phenotypic correlation coefficient)
* Significant at 5% level of significance
** Significant at 1% level of significance

CONCLUSION

Analysis of variance revealed highly significant differences among the treatments for all traits except days to 50% flowering. The genotypes HTWYT – 34 showed highest grain yield over remaining genotypes. The highest phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) was observed in grain yield per plant followed by biological yield per plant, number of tillers per plant, harvest index, flag leaf area, test weight, number of grain per spike, spike length, peduncle length, plant height, and days to maturity respectively. Test weight, biological yield per plant, harvest index, grain yield per plant, plant height, number of grain per spike, flag leaf area, days to maturity and number of tillers per plant show high heritability while peduncle length and spike length show moderate heritability. High heritability coupled with high genetic advance was observed for only in biological yield per plant. Positive and highly significant correlation of grain yield per plant with number of tillers per plant, biological yield and harvest index at both genotypic and phenotypic level, these traits showed strong association with grain yield per plant.

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Citation:

Singh B, Gupta D K, Singh Yogesh and Pathak V N.2025. Genetic variability, correlation and path analysis in wheat (Triticum aestivum L.) under late sown condition. Journal of AgriSearch 12(2): 87-92.