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Character association studies in F4 segregation population of bread wheat (*Triticum aestivum* L.)

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Abstract
In this study, an experiment was conducted at the Research Farm of the Department of Genetics and Plant Breeding at Lovely Professional University in Phagwara, Punjab. The experiment evaluated 52 different wheat genotypes along with 5 control samples using an Augmented Block Design. The main objective was to gain a deeper understanding of the factors that have a significant impact on wheat production, by investigating genetic diversity, correlation, and path coefficient analysis. Through this experimental trial, we came to know that selection for grain yield per is done by visualizing the characteristics such as chlorophyll content, biological yield per plant, and harvest index are required for wheat crop improvement.

Keywords: Segregating lines, variability, correlation, path analysis, research, genetic improvement, and genetic diversity

Introduction

Wheat is an incredibly important crop on a global level, both in terms of its extensive land coverage and high yield. It is scientifically classified as (*Triticum aestivum* L). and belongs to the Poaceae family, also known as Gramineae. Wheat plants have spikelets that contain multiple flowers, with some remaining stationary while others form an actual spike on the opposite sides of the rachis. This crop is capable of self-pollination and is considered to be hermaphroditic. Due to its vital role as a staple food, wheat plays a critical part in ensuring global food security. It is recognized as the most significant cereal crop worldwide and is often known as the "King of Cereals" (Elahi *et al*., 2021; Briggle and Reitz, 1963) [12, 5]. The straw of the plant is utilized as a food source for cattle worldwide. It contains a protein known as gluten, which ranges from 9% to 16%. The most commonly grown type of wheat today is called Hexaploid wheat, also known as common bread wheat, and it is favored for making bread. Bread production primarily relies on wheat flour.

Wheat that comes from dry regions tends to be dense and has a protein content of 11.5% to 16%, along with strong gluten, making it highly desirable. Wheat contains a range of important nutrients, including carbohydrates (mostly starch, making up 60-80% of its composition), proteins (8-15%) that provide all essential amino acids except for methionine, tryptophan, and lysine, fats (1.5-2.5%), minerals (1-2%), B complex vitamins, vitamin E, and crude fibers (Around 2.3%). India has approximately 32% of the world's land used for cereal cultivation and is the second-largest producer of wheat globally, contributing about one-ninth of the total global production. Notably, the states of Haryana, Punjab, and Uttar Pradesh have seen significant increases in wheat production. Additionally, Madhya Pradesh has recently expanded its cultivation. Punjab, in particular, grows wheat on 3.5 million hectares, resulting in a total yield of 17.5 million tonnes.

To improve crop productivity, it is essential to identify specific characteristics that have a significant impact on the overall yield. This necessitates an understanding of genetic factors such as genetic advance, heritability, and correlation. The genetic characteristics such as variability, estimation of heritability, and genetic advance were calculated using the methodology introduced by Johnson *et al*., 1955) [20]. The relationship between different traits was evaluated by analyzing variance and covariance components, as described by Fisher (1954) [14] and (Al-Jibouri *et al*., 1958) [1]. Path analysis, as outlined by Dewey and Lu (1959) [10], was used to determine the direct and indirect effects of individual traits on grain yield.

Material and Methods

The present study has been carried out in a research farm of the Department of Genetics and Plant Breeding, School of Agriculture, Lovely Professional University, Phagwara, Punjab. Here we use Augmented Block Design to estimate 52 Wheat genotypes and 5 checks are utilized. The 52 genotypes selected and are planted in the field in 5 blocks which contain (10 Test genotypes and 5 check varieties) in each block. Except for the last block which contains 2 genotypes more in number. Each genotype is sown in 2 lines with a row-to-row spacing of 22.5 cm and plant-to-plant spacing of 5cm.

Data from the following trial is taken from 5 random plants that are tagged in each genotype (F4 segregating Population) to obtain accurate results regarding their performance along with the check varieties. Data such as Days to 50% flowering, Days to maturity, Plant height (cm), Number of tillers per plant, Number of productive tillers per plant, Number of Spike lets per ear, Ear length(cm), Ear weight (gm), Number of grains per spike, 1000 seed weight (gm), Grain yield per plant (gm), Biological yield per plant (gm), Harvest index (%), Chlorophyll content were collected from the randomly selected plants in each genotype. The average mean performance of each genotype is analyzed separately for each character. Panse and Sukhatme (1967) [34] created the analysis of variance to evaluate the importance of various qualities. Burton (1952) [6] created a technique for calculating GCV and PCV. Burton and Vane (1953) [7] created the concept of heritability in a wide sense (h2), whereas Johnson *et al*. (1955) [20] provided the genetic breakthrough. Using the approach described by Al- Jibouri *et al*., (1958) [1] and Dewey and Lu (1959) [10], the GCV, PCV, and path coefficient analyses were computed.

Result and Discussion

Analysis of variance for augmented design was carried out for fourteen characters to test the significance of differences among various treatments (checks) and is presented in Table 1. Genetic variability was estimated for fourteen characters in 52 test genotypes and 5 checks in F4 segregating generation. The variation due to blocks was significant for Number of productive tillers per plant, days to 50% heading however the differences among the block were not significant for the remaining characters. The differences among the five check varieties were significant for chlorophyll content and days to 50% heading. Findings based on recent research are reported by Kachi *et al*., (2020) [21], Barman *et al*., (2020) [3]

In the F4 population, Higher PCV values were observed in Grain yield per plant (33.37), which was followed by number of tillers per plant (29.15), ear length (28.66), number of productive tillers per plant (26.05), chlorophyll content (22.33), Harvest index (22.05), biological yield per plant (21.60) and ear weight (20.16). Medium values of PCV were observed in test seed weight (19.32), number of grains per ear (18.05), plant height (13.86), and number of spikelets per ear (11.84). Low PCV values were observed in days to 50% heading (5.35) and days to Maturity (5.03). GCV values were highest in ear length (26.63), and number of tillers per plant (22.34). Medium GCV values were observed in Grain yield per plant (19.28) followed by number of productive tillers per plant (19.25), number of grains per ear (15.47), chlorophyll content (14.12), test seed weight (12.87), biological yield per plant (12.62), and harvest index (11.39). Low values of GCV were observed in plant height (8.72), number of spikelets per ear (6.96), ear weight (5.87), days to maturity (4.28), and days to 50% heading (3.71). Findings common in both PCV and GCV are found in Nimbal and Naik (2021) [27], and Jaiswal *et al*., (2022) [18] for the Number of productive tillers.

Higher heritability values were recorded in ear length (86.34) followed by number of grains per ear (73.52), days to maturity (72.25), and test seed weight (70.67). Moderate heritability values were recorded in number of tillers per plant (58.71), number of productive tillers per plant (54.59), days to 50% heading (48.08), chlorophyll content (39.99), plant height (39.62), number of spikelets per ear (34.50), biological yield per plant (34.14), grain yield per plant (33.39), ear weight (32.189), and harvest index (21.38 High genetic advance per percent mean were recorded in ear length (51.06) followed by number of tillers per plant (35.31), number of productive tillers per plant (29.34), number of grains per ear (27.37), test seed weight (24.95) and grain yield per plant (22.98). whereas medium values of genetic advance as a percent of the mean were observed in chlorophyll content (18.42), biological yield (15.21), harvest index (12.49), and plant height (11.32). Low values of genetic advance as a percent of the mean were observed in number of spikelets per ear (8.43), ear weight (7.69), days to maturity (7.50), and days to 50% heading (5.30) Similar findings were observed by Bhuwal *et al*., (2021) [4], Dabi *et al*., (2019) [9], Kumar *et al*., (2022) [24], Mishra *et al*., (2019) [26]

Table.3 shows an analysis of genotypic correlation where the days to 50% heading exhibited a positive and highly significant association with Days to maturity (0.5319**). Whereas a negative significant association was recorded in ear length (-0.2782*), Days to maturity show a positive highly significant association with Days to 50% heading (0.5319**), Plant height does not show any positive or negative association with all the respective traits. number of tillers per plant shows a positive and highly significant association with number of productive tillers per plant (0.9446**) and a negative significant association with (-0.2841*), number of productive tillers per plant shows a positive and highly significant association with number of tillers per plant (0.9446**), Ear length shows a positive and highly significant association with biological yield per plant (0.4664**), and a positive significant association was recorded in ear weight (0.3351*). whereas negative and highly significant association was noticed in chlorophyll content (-0.4561**), and negative significant association with Number of tillers per plant (-0.2841*) and days to 50% heading (-0.2782), number of spikelets per ear shows a positive and highly significant association with Number of grains per ear (0.4738**), whereas a positive significant association was observed in ear weight (0.3428*), ear weight shows a positive and significant association with Number of spikelets per ear (0.3428*), and harvest index (0.3028*), test seed weight does not show highly significant and significant correlation values with any of the genetic parameters. chlorophyll content shows a negative and highly significant association with ear length (-0.4561**), and biological yield per plant (-0.4201**), biological yield shows a positive and highly significant association with ear length (0.4664**), whereas a negative highly significant association was noticed in chlorophyll content (-0.4201**). Harvest index shows a positive and significant association with ear weight (0.3028*), Grain yield per plant shows a positive and highly significant association with harvest index (0.7674**), biological yield per plant

(0.7689**), and ear length (0.4525**). Whereas a negative and highly significant association was noticed in chlorophyll content (-0.4080**) at genotypic levels. Similar findings were observed in work done by Ozukum *et al*., (2019) [28], Ashish *et al*., (2020) [2], Tarakeshwar *et al*., (2020) [31], Kumar *et al*., (2020) [23], Jan *et al.*, (2020) [19]

Analysis for genotypic path coefficient correlation shows direct and indirect effects of various characters on grain yield per plant in Table.4 and Figure 3. Here Days to 50% heading (-0.0005) exhibited a negative direct effect on grain yield per plant. It also revealed negligible positive indirect effect through characters like plant height (0.0002), ear length (0.0001), number of grains per ear (0.0007), test seed weight (0.0002), chlorophyll content (0.0004), biological yield per plant (0.0001), harvest index (0.0025) and the negligible negative indirect effect was recorded in days to maturity (-0.0003), number of tillers per plant (-0.0001), number of productive tillers per plant (-0.0001), number of spikelets per ear (-0.0001), whereas Days to maturity (0.0256) exhibited a positive direct effect on grain yield per plant. It also revealed a negligible positive indirect effect through characters like days to 50% heading (0.0136), number of productive tillers per plant (0.0009), number of spikelets per ear (0.0019), number of grains per ear (0.0067), test seed weight (0.0035), chlorophyll content (0.0041). Whereas the negligible negative indirect effect was recorded in plant height (-0.0029), number of tillers per plant (-0.0004), ear length (-0.0055), ear weight (-0.0004), biological yield per plant (-0.0017), and harvest index (-0.0002), whereas Plant height (0.0141) exhibited a positive direct effect on grain yield per plant. It also revealed a negligible positive indirect effect through characters like number of tillers per plant (0.0037), number of productive tillers per plant (0.0029), ear length (0.0011), number of spikelets per ear (0.0015), ear weight (0.0031), number of grains per ear (0.0007), test seed weight (0.0029), chlorophyll content (0.0020), biological yield per plant (0.0025), harvest index (0.0027). Whereas negligible negative indirect effect was recorded in days to 50% heading (-0.0007), days to maturity (-0.0016). Whereas Number of tillers per plant (0.1415) exhibited a positive direct effect on grain yield per plant. It also revealed a negligible positive indirect effect through characters like days to 50% heading (0.0262), plant height (0.0370), number of productive tillers per plant (0.1337), number of spikelets per ear (0.0210), ear weight (0.0201), chlorophyll content (0.0269), harvest index (0.0143). Whereas the negligible negative indirect effect was recorded in days to maturity (-0.0022), ear length (-0.0402), number of grains per ear (-0.0038), test seed weight (-0.0209), and biological yield per plant (-0.0094). Whereas Number of productive tillers per plant (-0.1364) exhibited a negative direct effect on grain yield per plant. It also revealed negligible positive indirect effect through characters like ear length (0.0310), number of grains per ear (0.0063), test seed weight (0.0232), and biological yield (0.0132). Whereas the negligible negative indirect effect was recorded in days to 50% heading (-0.0230), days to maturity (-0.0050), plant height (-0.0278), number of tillers per plant (-0.1289), number of spikelets per ear (-0.0228), ear weight (-0.0355), chlorophyll content (-0.0245), and harvest index (-0.0210). Whereas Ear length (0.0414) exhibited a positive direct effect on grain yield per plant. It also revealed a negligible positive indirect effect through characters like plant height (0.0034), number of spikelets per ear (0.0041), ear weight (0.0139), number of grains per ear (0.0029), test seed weight (0.0025), biological yield per plant (0.0193), harvest index (0.0093). Whereas the negligible negative indirect effect was recorded in days to 50% heading (-0.0115), days to maturity (-0.0089), number of tillers per plant (-0.0118), number of productive tillers per plant (-0.0094), number of spikelets per plant (0.0041), ear weight (0.0139), number of grains per ear (0.0029), test seed weight (0.0025), biological yield per plant (0.0193), harvest index (0.0093).

Whereas the Number of spikelets per ear (0.0073) exhibited a positive direct effect on grain yield per plant. It also revealed a negligible positive indirect effect through characters like ear weight (0.0025), number of grains per ear (0.0035), test seed weight (0.0002), harvest index (0.0014), ear length (0.0007), number of productive tillers per plant (0.0015), number of tillers per plant (0.0011), plant height (0.0008), days to maturity (0.0005), days to 50% heading (0.0011). Whereas the negligible negative indirect effect was recorded in chlorophyll content (-0.0002) and biological yield per plant (-0.0008). Whereas Ear weight (-0.0273) exhibited a negative direct effect on grain yield per plant. It also revealed negligible positive indirect effect through characters like days to 50% heading (0.0023), days to maturity (0.0004), number of productive tillers per plant (0.0067), and test seed weight (0.0006). Whereas the negligible negative effect was recorded in plant height (-0.0061), number of tillers per plant (-0.0039), ear length (-0.0091), number of spikelets per ear (-0.0094), number of grains per ear (-0.0027), chlorophyll content (-0.0024), biological yield per plant (-0.0040), harvest index (-0.0083). Whereas Number of grains per ear (-0.0077) exhibited a negative direct effect on grain yield per plant. It also revealed negligible positive indirect effect through characters like number of spikelets per ear (0.0037), number of productive tillers per plant (0.0004), number of tillers per plant (0.0002), and days to 50% heading (0.0002). Whereas the negligible negative indirect effect was recorded in days to maturity (-0.0020), plant height (-0.0004), ear length (-0.0005), ear weight (0.0008), test seed weight (-0.0017), chlorophyll content (-0.0008), biological yield per plant (-0.0007), harvest index (-0.0003). Whereas Test seed weight (-0.0317) exhibited a negative direct effect on grain yield per plant. It also revealed negligible positive indirect effect through characters like ear weight (0.0007), number of productive tillers per plant (0.0054), number of tillers per plant (0.0047), and days to 50% heading (0.0014). Whereas the negligible negative indirect effect was recorded in days to maturity (-0.0044), plant height (-0.0066), ear length (-0.0019), number of spikelets per ear (-0.0010), number of grains per ear (-0.0069), chlorophyll content (-0.0038), biological yield per plant (-0.0057), harvest index (-0.0051). Whereas Chlorophyll content (0.0140) exhibited a positive direct effect on grain yield per plant. It also revealed a negligible positive indirect effect through characters like biological yield (0.0059), test seed weight (0.0017), number of grains per ear (0.0014), ear weight (0.0013), number of productive tillers per plant (0.0025), number of tillers per plant (0.0027), plant height (0.0020), days to maturity (0.0022). Whereas negligible negative indirect effect was recorded in days to 50% heading (-0.0005), ear length (-0.0064), number of spikelets per ear (-0.0005), and harvest index (-0.0030). Whereas biological yield (0.6325) exhibited a positive direct effect on grain yield per plant. It also revealed a negligible positive indirect effect through characters like harvest index (0.1256), test seed weight (0.1128), number of grains per ear (0.0573), ear weight (0.0935), ear length (0.2950), plant height (0.1127). whereas the negligible negative indirect effect was recorded in days to 50% heading (-0.1256), days to maturity (-0.0419), number of tillers per plant (-0.0420), number of productive tillers per plant (-0.0610), number of spikelets per ear (-0.0693), chlorophyll content (-0.2657). Whereas the Harvest index (0.6518) exhibited a positive direct effect on grain yield per plant. It also revealed a negligible positive indirect effect through characters like harvest index (0.1294), test seed weight (0.1044), number of grains per ear (0.0231), ear weight (0.1974), number of spikelets per ear (0.1217), ear length (0.1468), number of productive tillers per plant (0.1001), number of tillers per plant (0.0657), plant height (0.1261). whereas the negligible negative indirect effect was recorded in days to 50% heading (-0.0490), days to maturity (-0.0044), and chlorophyll content (-0.1387).The above results show close similarity with the findings of Dipika *et al*., (2020) [11] Fikre *et al*., (2015) [13], Rajput *et al*., (2018) [30], Devesh *et al*., (2021) [35], Khanal *et al*., (2020) [22], Chaudhary *et al*., (2020) [8].

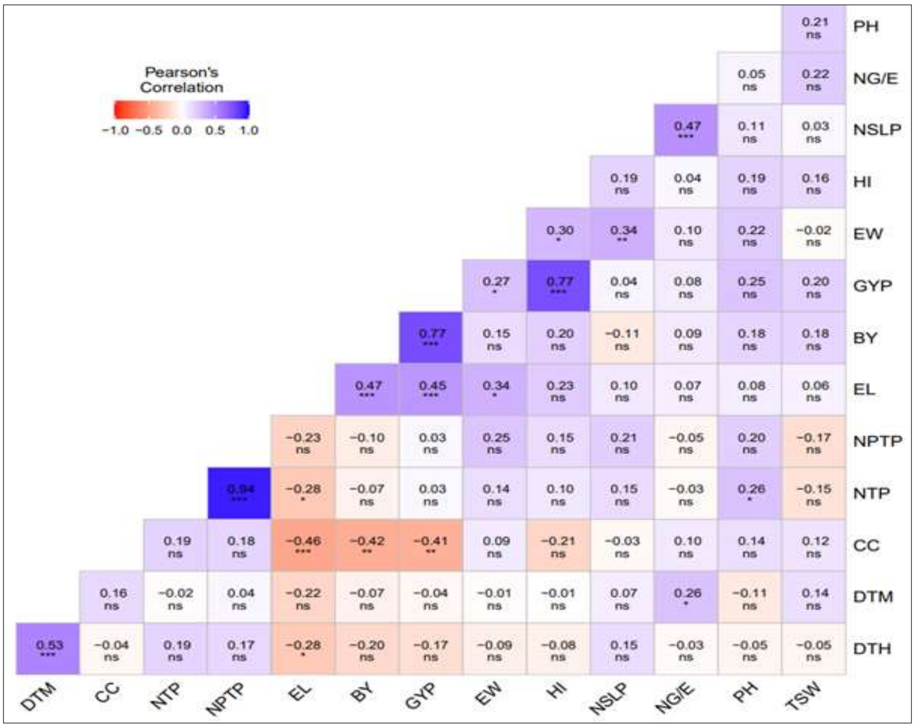

Fig 1: Phenotypic Correlation Coefficient heat map

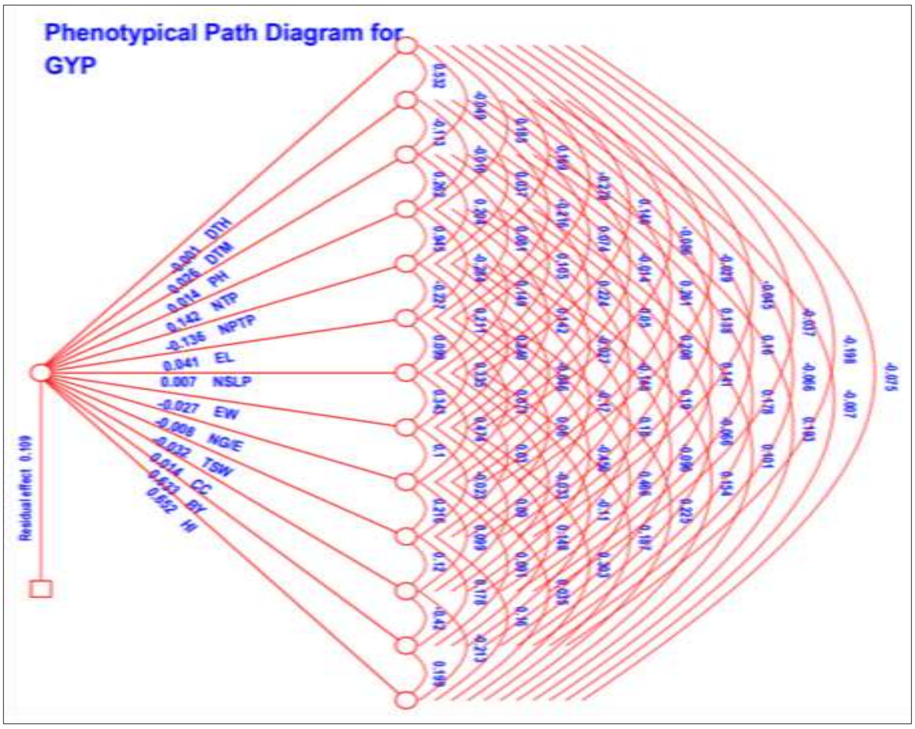

Fig 2: Phenotypic path diagram for Grain yield per plant

Table 1: Analysis of Variance for Various Yield contributing characters in Wheat

Source	Df	Mean squares													
		DTH	DTM	PH	NTP	NPTP	EL	NSLE	EW	NGE	TSW	CC	BY	HI	GYP
Treatment (Ignoring Blocks)	56	33.23*	41.09**	138.77ns	3.14*	1.99*	8.41**	3.23ns	0.23ns	66.08**	56.94ns	76.11ns	40.20ns	69.87ns	14.03ns
Treatment: Check	4	42.50*	21.86ns	155.91ns	1.30ns	0.59ns	0.92ns	0.56ns	0.40ns	5.56ns	11.94ns	157.28*	18.14ns	101.79ns	13.26ns
Treatment: Test	51	24.70ns	42.20**	133.86ns	3.17*	1.92*	7.80**	3.50ns	0.21ns	52.10**	56.30ns	70.12ns	41.50ns	64.26ns	13.24ns
Treatment: Test vs. Check	1	431.22**	61.74*	320.47ns	8.90*	11.46**	69.31**	0.26ns	0.55ns	1021.47**	269.81ns	57.00ns	62.26ns	228.20ns	57.09*
Block (eliminating Treatments)	4	44.70*	21.06ns	187.43ns	3.01ns	3.63*	2.07ns	5.36ns	0.04ns	33.50ns	88.37ns	70.03ns	13.13ns	75.75ns	9.55ns
Residuals	16	12.82	11.71	80.83	1.31	0.87	1.07	2.29	0.34	13.80	66.75	42.08	27.33	89.83	8.82
CV values		3.81	2.64	10.64	18.20	16.92	11.17	9.57	15.39	9.74	11.67	17.12	17.81	16.76	18.41

Ns P>0.05; **p*<=0.05; ***p*<=0.01

DTH -Days to 50% heading, DTM- Days to maturity, PH- Plant height, NTP- Number of tillers per plant, NPTP- Number of productive tillers per plant, EL- Ear length, NSLE- Number of spikelets per ear, EW- Ear weight, NGE- Number of grains per ear, TSW- Test seed weight, CC- Chlorophyll content, BYP- Biological yield per plant, HI- Harvest index, GYP- Grain yield per plant

Table 2: Genetic Variability Parameters for grain yield and Its Components in Wheat

Characters	Range		Mean	Co-Variance		Hbs (%)	GA	GA% Mean
	Minimum	Maximum		GCV (%)	PCV (%)			
Days to heading	83.0	110	92.97	3.71	5.35	48.08	4.93	5.30
Days to maturity	99	145	129.08	4.28	5.03	72.25	9.68	7.50
Plant height (cm)	47	110.2	83.50	8.72	13.86	39.62	9.46	11.32
Number of tillers per plant	3	10.2	6.11	22.34	29.15	58.71	2.16	35.31
Number of productive tillers per plant	2.8	7.8	5.31	19.25	26.05	54.59	1.56	29.34
Ear length (cm)	7.12	16	9.75	26.63	28.66	86.34	4.98	51.06
Number of Spike lets per spike	12.4	21.4	15.79	6.96	11.84	34.50	1.33	8.43
Ear weight (gm)	1.34	3.36	2.27	5.87	20.16	32.19	1.20	7.69
Number of grains per ear	28.4	56.4	40.00	15.47	18.05	73.52	10.95	27.37
Test seed weight (gm)	20.2	53.0	38.84	12.87	19.32	70.67	10.29	24.95
Chlorophyll content	10.40	59.975	37.51	14.12	22.33	39.99	6.91	18.42
Biological yield per plant	19.425	42.336	29.83	12.62	21.60	34.14	4.54	15.21
Harvest index (%)	21.75	58.543	36.35	11.39	22.05	26.07	4.12	12.49
Grain yield per plant	4.72	20.2	10.90	19.28	33.37	33.39	2.51	22.98

Table 3: Genotypic correlation of quantitative traits in Bread wheat

Trait	DTH	DTM	PH	NTP	NPTP	EL	NSLE	EW	NGE	TSW	CC	BY	HI
DTH	1.0000	0.5319**	-0.0492	0.1854	0.1685	-0.2782*	0.1458	-0.0859	-0.0286	-0.0453	-0.0374	-0.1985	-0.0752
DTM	0.5319**	1.0000	-0.1130	-0.0158	0.0367	-0.2160	0.0744	-0.0140	0.2613	0.1377	0.1600	-0.0662	-0.0068
PH	-0.0492	-0.1130	1.0000	0.2616	0.2035	0.0812	0.1054	0.2237	0.0498	0.2075	0.1412	0.1782	0.1934
NTP	0.1854	-0.0158	0.2616	1.0000	0.9446**	-0.2841	0.1485	0.1421	-0.0268	-0.1477	0.1900	-0.0664	0.1007
NPTP	0.1685	0.0367	0.2035	0.9446**	1.0000	-0.2269	0.2108	0.2458	-0.0465	-0.1699	0.1796	-0.0964	0.1537
EL	-0.2782*	-0.2160	0.0812	-0.2841*	-0.2269	1.0000	0.0987	0.3351*	0.0707	0.0603	-0.4561**	0.4664**	0.2252
NSLE	0.1458	0.0744	0.1054	0.1485	0.2108	0.0987	1.0000	0.3428*	0.4738**	0.0304	0.0326	-0.1095	0.1867
EW	-0.0859	-0.0140	0.2237	0.1421	0.2458	0.3351	0.3428*	1.0000	0.1000	-0.0231	0.0898	0.1479	0.3028*
NGE	-0.0286	0.2613	0.0498	-0.0268	-0.0465	0.0707	0.4738**	0.1000	1.0000	0.2164	0.0987	0.0906	0.0354
TSW	-0.0453	0.1377	0.2075	-0.1477	-0.1699	0.0603	0.0304	-0.0231	0.2164	1.0000	0.1198	0.1784	0.1602
CC	-0.0374	0.1600	0.1412	0.1900	0.1796	-0.4561**	-0.0326	0.0898	0.0987	0.1198	1.0000	-0.4201**	-0.2128
BY	-0.1985	-0.0662	0.1782	-0.0664	-0.0964	0.4664**	-0.1095	0.1479	0.0906	0.1784	-0.4201**	1.0000	0.1986
HI	-0.0752	-0.0068	0.1934	0.1007	0.1537	0.2252	0.1867	0.3028*	0.0354	0.1602	-0.2128	0.1986	1.0000
GYP	-0.1659	-0.0420	0.2523	0.0325	0.0338	0.4525**	0.0450	0.2706	0.0808	0.1976	-0.4080**	0.7689**	0.7674**

Ns *p*>= 0.05; * *p*<0.05; ** *p*<0.01; and *** *p*<0.001

DTH -Days to 50% heading, DTM- Days to maturity, PH- Plant height, NTP- Number of tillers per plant, NPTP- Number of productive tillers per plant, EL- Ear length, NSLE- Number of spikelets per ear, EW- Ear weight, NGE- Number of grains per ear, TSW- Test seed weight, CC- Chlorophyll content, BYP- Biological yield per plant, HI- Harvest index, GYP- Grain yield per pla

Table 4: Path coefficient showing direct (diagonal) & indirect effect (off-diagonal) of different characters on grain yield per plant in wheat (F4 segregating population)

Trait	DTH	DTM	PH	NTP	NPTP	EL	NSLE	EW	NGE	TSW	CC	BY	HI
DTH	-0.0005	-0.0003	0.0002	-0.0001	-0.0001	0.0001	-0.0001	0.0003	0.0007	0.0002	0.0004	0.0001	0.0025
DTM	0.0136	0.0256	-0.0029	-0.0004	0.0009	-0.0055	0.0019	-0.0004	0.0067	0.0035	0.0041	-0.0017	-0.0002
PH	-0.0007	-0.0016	0.0141	0.0037	0.0029	0.0011	0.0015	0.0031	0.0007	0.0029	0.0020	0.0025	0.0027
NTP	0.0262	-0.0022	0.0370	0.1415	0.1337	-0.0402	0.0210	0.0201	-0.0038	-0.0209	0.0269	-0.0094	0.0143
NPTP	-0.0230	-0.0050	-0.0278	-0.1289	-0.1364	0.0310	-0.0288	-0.0335	0.0063	0.0232	-0.0245	0.0132	-0.0210
EL	-0.0115	-0.0089	0.0034	-0.0118	-0.0094	0.0414	0.0041	0.0139	0.0029	0.0025	-0.0189	0.0193	0.0093
NSLE	0.0011	0.0005	0.0008	0.0011	0.0015	0.0007	0.0073	0.0025	0.0035	0.0002	-0.0002	-0.0008	0.0014
EW	0.0023	0.0004	-0.0061	-0.0039	0.0067	-0.0091	-0.0094	-0.0273	-0.0027	0.0006	-0.0024	-0.0040	-0.0083
NGE	0.0002	-0.0020	-0.0004	0.0002	0.0004	-0.0005	0.0037	-0.0008	-0.0077	-0.0017	-0.0008	-0.0007	-0.0003
TSW	0.0014	-0.0044	-0.0066	0.0047	0.0054	-0.0019	-0.0010	0.0007	-0.0069	-0.0317	-0.0038	-0.0057	-0.0051
CC	-0.0005	0.0022	0.0020	0.0027	0.0025	-0.0064	-0.0005	0.0013	0.0014	0.0017	0.0140	0.0059	-0.0030
BY	-0.1256	-0.0419	0.1127	-0.0420	-0.0610	0.2950	-0.0693	0.0935	0.0573	0.1128	-0.2657	0.6325	0.1256
HI	-0.0490	-0.0044	0.1261	0.0657	0.1001	0.1468	0.1217	0.1974	0.0231	0.1044	-0.1387	0.1294	0.6518
GYP	-0.1659	-0.0420	0.2523	0.0325	0.0338	0.4525	0.0450	0.2706	0.0808	0.1976	-0.080	0.7689	0.7674
Partial R^2	0.0001	-0.0011	0.0036	0.0046	-0.0046	0.0187	0.0003	-0.0074	-0.0006	-0.0063	-0.0057	0.4863	0.5001

Residual effect = 0.1092

DTH -Days to 50% heading, DTM- Days to maturity, PH- Plant height, NTP- Number of tillers per plant, NPTP- Number of productive tillers per plant, EL- Ear length, NSLE- Number of spikelets per ear, EW- Ear weight, NGE- Number of grains per ear, TSW- Test seed weight, CC- Chlorophyll content, BYP- Biological yield per plant, HI- Harvest index, GYP- Grain yield per plant

Conclusion

Based on the observation of genetic parameters from the experimental trial we can thereby conclude that high PCV and GCV were observed in number of tillers per plant, and ear length. High heritability was recorded for days to maturity, ear length, number of grains per ear, and test seed weight. Association studies indicated that the advantages of upgrading wheat genotypes through simultaneous selection for Grain yield per plant are done by number of productive tillers per plant, chlorophyll content, biological yield per plant, and harvest index. Path coefficient analysis revealed that the highest consideration should be given to harvest index, biological yield per plant, chlorophyll content, number of spikelets per ear, ear length, number of tillers per plant, plant height, and days to maturity in F4 generation.

References

1. Al-Jibouri H, Miller PA, Robinson HF. Genotypic and environmental variances and covariances in an upland Cotton cross of interspecific origin 1. Agronomy Journal. 1958;50(10):633- 636.
2. Ashish, Sethi SK, Vikram, Phougat D, Antim. Genetic variability, correlation, and path analysis in bread wheat (*Triticum aestivum*) genotypes for yield and its contributing traits. Journal of Pharmacognosy and Phytochemistry. 2020;9(6):388-391.
3. Barman M, Choudhary VK, Singh SK, Singh MK, Parveen R. Genetic variability analysis in bread wheat (*Triticum aestivum* L.) genotypes for morpho-physiological characters and grain micronutrient content. International Research Journal of Pure & Applied Chemistry. 2020;21(22):1-8.
4. Bhuwal S, Kumar P. Assessment of genetic variability parameters in bread wheat (*Triticum aestivum* L.). Genotypes under southern Chhattisgarh conditions. The Pharma Innovation Journal. 2021;10(10):375-378.
5. Briggle LW, Reitz LP. Classification of Triticum species and wheat varieties grown in the United States (No. 1278). US Department of Agriculture; c1963.
6. Burton GW. Quantitative inheritance of grasses. In: Proceedings 6th International Grassland Congress. 1952;1:273-283.
7. Burton GW, Devane DE. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material 1. Agronomy Journal. 1953;45(10):478-481.
8. Chaudhary R, Kumar S, Singh S, Prasad J, Jeena AS, Upreti MC. Study of genetic parameters and character association in wheat (*Triticum aestivum* L.). Int. J Chem. Stud. 2020;8(3):2312-2315.
9. Dabi A, Mekbib F, Desalegn T. Genetic variability studies on bread wheat (*Triticum aestivum* L.) genotypes. Journal of Plant Breeding and Crop Science. 2019;11(2):41-54.
10. Dewey DR, Lu K. A correlation and path-coefficient analysis of components of crested wheatgrass seed production 1. Agronomy Journal. 1959;51(9):515-518.
11. Dipika P, Kulkarni GU, Ghadage NC, Sharma LK. Correlation and Path Analysis for Seed Yield in Bread Wheat (*Triticum aestivum* L.). Ind. J Pure App. Biosci. 2020;8(5):524-530.
12. Elahi T, Pandey S, Shukla RS. Agro-morphological diversity in promising wheat genotypes grown under restricted irrigated conditions. Electronic Journal of Plant Breeding. 2021;12(3):643-651.
13. Fikre G, Alamerew S, Tadesse Z. Path Coefficient and Correlation Studies of Yield and Yield Associated Traits in Bread Wheat (*Triticum aestivum* L.) Genotypes at Kulumsa Agricultural Research Center, Southeast Ethiopia. 2015;38:2225-0557.
14. Fisher RA. Statistical methods for research workers, Oliver and Boyd. Ltd. London; c1954.
15. Gaur SC, Sahu RK. Genetic Variability, Heritability and Genetic Advance Studies for Grain Yield and Yield Attributing Traits in Bread Wheat (*Triticum aestivum* L. em. Thell).
16. Gerema G, Lule D, Lemessa F, Mekonnen T. Morphological characterization and genetic analysis in bread wheat germplasm: A combined study of heritability, genetic variance, genetic divergence, and association of characters. Agricultural Science & Technology (1313-8820), 2020, 12(4).
17. Ibrahim AU. Genetic variability, Correlation and Path

Analysis for Yield and yield components in F6 generation of Wheat (*Triticum aestivum*. L)., e-ISSN: 2319-2380, p- ISSN: 2319-2372. 2019 Jan;12(1):17-23.
18. Jaiswal A, Tiwari S, Shukla RS, Kumar V, Pandey S, Biswal M, *et al*. Genetic analysis of hybrid wheat under timely and late sown conditions. The Pharma Innovation Journal. 2022;11(3):1721-1725.
19. Jan N, Shakil R, Kashyap SC. Studies on Interrelationship and Path Analysis in Wheat (*Triticum aestivum* l.) for Yield and Component Traits. 2020;20(2):1483-1486.
20. Johnson HW, Robinson HF, Comstock RE. Estimates of genetic and environmental variability in soybeans 1. Agronomy Journal. 1955;47(7):314-318.
21. Kachi M, Abro TF, Sootaher JK, Baloch TA, Mastoi MA, Soomro TA, *et al*. Estimation of heritability and genetic advance in F2 populations of bread wheat (*Triticum aestivum* L.) genotypes. International Journal of Biosciences. 2020;16(2):286-295.
22. Khanal D, Thapab DB, Dhakala KH, Pandeya MP, Kandel BP. Correlation and path coefficient analysis of elite spring wheat lines developed for high-temperature tolerance. Environment & Ecosystem Science. 2020;4(2):73-76.
23. Kumar A, Tarkeshwar Singh M, Gupta A, Singh S, Gaur SC. Character Association and Path Coefficient Studies in Bread Wheat (*Triticum aestivum* L. em. Thell). International Journal of Current Microbiology and Applied Sciences. 2020;11:1323-1330.
24. Kumar V, Mishra PC, Babbar A, Khande D. Genetic variability analysis of yield and its attributes in F1 and their parent of bread wheat (*Triticum aestivum* L.) over the environment. The Pharma Innovation Journal. 2022;11(2):817-820.
25. Maurya AK, Yadav RK, Singh AK, Deep A, Yadav V. Studies on correlation and path coefficients analysis in bread wheat (*Triticum aestivum* L.) Journal of Pharmacognosy and Phytochemistry. E-ISSN: 2278-4136 P-ISSN: 2349-8234, JPP. 2020;9(4):524-527.
26. Mishra U, Sharma AK, Chauhan S. Genetic variability, heritability, and genetic advance in bread wheat (*Triticum aestivum* L.). Int. J Curr. Microbiol. App. Sci. 2019;8(7):2311-2315.
27. Nimbal AM, Naik VR. Genetic variability for yield parameters in F2 population of wheat (*Triticum aestivum* L.) under rainfed conditions. The Pharma Innovation Journal. 2021;10(12):482-486.
28. Ozukum W, Avinashe H, Dubey N, Kalubarme S, Kumar M. Correlation and path coefficient analyses in bread wheat (*Triticum aestivum* L.). Plant Archives. 2019;19(2):3033-3038.
29. Pooja Dhanda SS, Yadav NR, Beniwal RS, Anu. Correlation and path coefficient analysis of some quantitative traits in recombinant inbred lines of bread wheat. International Journal of Chemical Studies. 2018;6(3):350- 354.
30. Rajput RS. Correlation, path analysis, heritability, and genetic advance for the morpho-physiological character of bread wheat (*Triticum aestivum* L.). Journal of Pharmacognosy and phytoch Phyto chemistryemistry. 2018;7(2):107-112.
31. Tarkeshwar Kumar A, Yadav M, Gaur SC, Chaudhary RP, Mishra G. Studies on Correlation and Path Coefficient for Yield and its Component Traits in Bread Wheat (*Triticum aestivum* L. em. Thell). International Journal of Current Microbiology and Applied Sciences. 2020;11:688-696.
32. Upadhyay P. Correlation and path coefficient analysis among yield and yield attributing traits of wheat (*Triticum aestivum* L.) genotypes. Archives of Agriculture and Environmental Science. 2020;5(2):196-199 (2020).
33. Varsha Verma P, Saini P, Singh V, Yashveer S. Genetic variability of wheat (*Triticum aestivum* L.) genotypes for agro-morphological traits and their correlation and path analysis. Journal of Pharmacognosy and Phytochemistry. 2019;8(4):2290-2294.
34. Panse VG, Sukhatme PV. Statistical methods of agricultural workers. 2nd Endorsement. ICAR Publication, New Delhi, India. 1967, 381.
35. Devesh P, Moitra PK, Shukla RS. Correlation and path coefficient analysis for yield, yield components and quality traits in wheat. Electronic Journal of Plant Breeding. 2021;12(2):388-395.