International Journal of Academic and Applied Research (IJAAR)
ISSN: 2643-9603
Vol. 8 Issue 3 March - 2024, Pages: 12-32

Genetic Variability Analysis of Some Quantitative Traits in F3 Populations of Inter Specific Crosses in Bread Wheat

Muhammad Azam[1], Abdul Mateen, Syed Abdul Malik, Syed Shamsullah, Ikhlaq Ahmed, Muhammad Zahid, Khalid Iqbal, Muhammad Naeem, Bismillah khan kakar, Sakhawat ali, Muhammad Ishaq shah, Rafiq Ahmed and Khalil ahmed.

Agriculture Research Department of Agriculture and Cooperatives Balochistan.pakistan.
Corresponding azammengal12@gmail.com

Abstract: *Wheat, botanically known as Triticum aestivum L. is most important staple diet belonging to family Poaceae. The present research was aimed to study the genetic variability of wheat (Triticum aestivum L.) in F3 populations, conducted at theexperimental field of Agriculture Research Institute, Quetta in cropping season of 2017by following Randomized Complete Block Design (RCBD) with three replications. The objective of the experiment was to evaluate the performance of bread wheat parental lines and F3 populations to identify heredity and selection response for yield and its contributing parameters. According to mean performance of comparative study between parent lines and their F3 population, minimum days to heading was noted in parent Zarghoon 79, minimum days to maturity was noted in parent Faisalabad-85, maximum grain yield plant^{-1} was observed in parent PR-102, maximum number of grain spike^{-1} were counted in parent PR-102, maximum height was scaled in Pir-sabaq 2010 and maximum 1000 grain weight was weighed in PR- 102 × Zarghoon 79,maximum tillers plant^{-1} was counted in Raskoh 2005 × Zarghoon 79. Moreover, according to heterosis and heterobeltiosis, highest heterobeltiosis for days to heading exhibited by Zarghoon 79 × Raskoh and the greatest heterobeltiosis for days to heading was showed by Zarghoon 79 × Raskoh, best heterosis and heterobeltiosis fornumber of grain spike^{-1} revealed by Faisalabad 85 × Zardana 89, greater heterosis and heterobeltiosis for grain yield plant^{-1} was exhibited by Faisalabad 85 × Zardana 89. Highest negative heterosis for tiller plant^{-1} was depicted by PR-102 × Zarghoon 79, as well as highest negative heterobeltiosis for number of tiller plant^{-1}, highest heterosis as well as the highest heterobeltiosis estimate for days to maturity revealed by PR-102 × Raskoh 2005. Therefore, the study suggested that the parent PR-102 and cross Faisalabad 85 × Zardana 89 identified as novel germplasm can be used in further breeding programs for better wheat crop stand.*

Keywords: genetic, variability, quantitative traits, inter specific crosses wheat bread. .

INTRODUCTION:

Wheat (*Triticum aestivum L.*) is the main food crop for people worldwide and it belongs to the *Poaceae* family known as *Graminae* as well. It is supposed to be the earliest crop that man has ever adopted. Wheat is consumed on daily basis (staple food) by the people who live in Pakistan and ranked fourth position in production (i.e., rice, cotton, and sugarcane), with 80 percent of farmers growing it on an area of around 9.0 million hectares (close to 40 percent of the country's total cultivated land) during the winter or "Rabi" season (Raza A, 2019). Wheat is one of the foremost important cereal crops sown and used up across the world and it provides more calories and protein in meals than any other crop. Wheat ranked second worldwide when it comes to the total production volume, global amount of wheat producedcame to about 765.41 million metric tons in crop year 2019-20 (Shahbandeh, 2020).

Being self-pollinated wheat has become more appealing to many of breeders that haveevaluated a lot of cultivars only by selection. Effective selection is the essence of any successful breeding program. If there is wide range of heritable differences theselection will be more effective. So, knowledge about the inheritance of essential plant characteristics is important to move in the right way (Khan, 2003). The heritability values could help to measure the amount of combination between parents and their progenies (Memon, 2007).

Comprehensive research activities are in progress to focus on desirable traits present in germplasm, to obtain the objective of high yield. Unluckily, additive genes are comparatively less percentage than non-additive, to use both, the breeding procedure justlike bi- parental hybridization is commonly advised to make better the grain yield andyield associated characteristics (Shekhawat, 2006). Gene flow and heritability in certain wheat crosses were examined as a part of the current research. This informationcan be used to create a successful breeding strategy to choose hybrids or possible sergeants with desired qualities in future generations. It is the first most consumed cereal crop in our country. Wheat flour is the major ingredient in backing items as well

(Habib & Khan, 2003). World wheat production is based on modern species: hexaploid (bread wheat) and tetraploid (durum wheat), which is the second in terms ofusage whereas diploid species: (*Triticum monococcum*) is in use as well.

MATERIALS AND METHODS

The research work was carried out at Agriculture Research Institute (ARI) Quetta during rabi season of 2017-18 by following Randomized Complete Block Design (RCBD) with three replications to evaluate the genetic variability of morphological and yield contributing traits in F3 populations of bread wheat.

Plant Material

The seeds of parents and F3 population were obtained from Balochistan Agriculture Research and Development Centre, (BARDC) Quetta.

3.1.1 Parents: 06

1. Zarghoon 79
2. Zardana 89
3. Raskoh 2005
4. Faisalabad 855
5. PR102
6. Pirsabaq2010

3.1.2 F3 population

1. Pir-sabaq 2010 × Zarghoon 79
2. PR102 × Raskoh 2005
3. Faisalabad 85 × Zardana 89
4. Pirsabaq 2010 × Zardana 89
5. Zarghoon 79 × Raskoh 2005
6. PR102 × Zarghoon

Cultural practices

Single hand drill was used for line sowing method. Wheat seeds were sown during 1stweek of November 2017. Seeds of each entry were sown seeds in two rows of three- meter-longwith 25 cm apart row to row at parallel distance. Urea and DAP Fertilizer was used at the time of field preparation, the remaining Urea was applied in two dozes, one with first irrigation while the second doze was applied at pre booting stage.

Observations Recorded

The following observations were recorded during the experiment.

Days to heading

Days to heading were determined when about 50 % of heads were appeared.

Days to maturity

Days to maturity were counted when the more than 50 % of studied lines wereturned yellowish and near to ready for harvesting.

Plant height (cm)

The stature of each chose plant was estimated in centimeters from soil surface to the tip of main tiller excluding awns and the mean plant tallness per genotype was determined.

Tillers plant^{-1}

When crop was matured, the number of fertile tillers plant^{-1} were counted and recordedfrom each selected plot.

Grains spike^{-1}

The total number of seeds spike^{-1} of randomly selected spike was counted, and the average number of seeds spike^{-1} was calculated.

Grain yield plant^{-1} (g)

After harvesting, every plant was threshed separately by hand and grains were weighted on electronic digital balance and yield plant^{-1} was assessed in grams.

1000-grain weight (g)

1000 seeds were counted at random and weighted in grams in the laboratorieswith the help of electronic digital balance.

Statistical Analysis

The data was subjected to analysis of variance (ANOVA) according to Steel (1997), so as to work out the statistical difference among the genotypes, while means for different traits were separated using Tukey's Honesty Significant Differences (HSD) test at 5% probability level as described by Stewart (1998). The genetic parameters including heterosis and heterotopies were calculated according to methods developed by Falconer (1989)

RESULTS

It was the goal of the current investigation to discover the hereditary boundaries of F3 populations for distinct wheat characteristics. An extensive investigation into hereditary factors, including heritability rate, hereditary variability, and hereditary addition at 20% determination force, was carried out using six cultivars and six F3 descendants. Plant height (cm), days to heading, days to maturity, number of tillers plant^{-1}, and number of grains spike^{-1}, 1000 grain weight (g) and grain yield plant^{-1} wereall recorded in the field. Table 4.1 shows the results of the mean squares of genotypes,parents, and crosses, but the mean execution of genotypes (parents and F3 crossovers) and information about hereditary boundaries, viz. environmental variations (σ^2e), hereditary difference (σ^2g), phenotypic change (σ^2p), heritability rate in wide-sense (h^2) and hereditary development (GA) at 20% choice weight of F3 inhabitants for all the traits under study, are presented from Table 2 and Table 9.

Analysis of Variance

The analysis of variance was carried out for seven parameters recorded for yield and its related traits (Table 4.1). Mean squares displayed that majority of the characters, including days to heading, days to maturity, plant height (cm), tillers plant^{-1}, grain spike^{-1}, grain yield plant^{-1} (g) and 1000 grain weight (g), were highly significant differences ($P \leq 0.01$) among the tested parents and F3 population.

Mean performance of parents and F3 population

Days to heading

The average performance of parents and F3 population were determined, and the results(table-4.2) suggested that regarding parental lines; minimum days toheading were taken by Zarghoon-79 (114 days) and the maximum days to heading were recorded for Zardana-89 (128 days). Among the F3 populations,minimum days to heading were taken by PR102 × Raskoh 2005 (120 days) and the maximum days to heading were noted for Zarghoon 79 × Raskoh 2005 (132 days).

International Journal of Academic and Applied Research (IJAAR)
ISSN: 2643-9603
Vol. 8 Issue 3 March - 2024, Pages: 12-32

Table 4.1: Mean squares of different traits of parents and crosses of bread wheat

Source of variances	D.F.	Days to heading	Days to maturity	Plant height	Tillers plant^{-1}	Grains spike^{-1}	Grain yield / plant (g)	1000-grain weight (g)
Parents								
Replication	2	6.067	0.4667	3.659	0.16800	2.563	1.9332	0.1542
Parents	5	160.833**	41.4000**	545.051**	2.116**	491.076**	27.1664**	41.0181**
Error	8	0.733	0.3000	4.429	0.33800	13.276	1.9993	3.2683
Crosses								
Replication	2	1.292	1.5417	6.427	0.0467	390.822	0.4613	1.9741
F3 population	5	380.762**	83.0238**	176.887**	29.9160**	524.437**	66.4277**	96.3249**
Error	8	1.815	1.3988	16.924	0.1210	460.458	1.1442	4.7545

** indicates significant level at 1% of probability level.

Days to maturity

The parent Faisalabad-85 received (table-4.2) minimum days to maturity (180 days) andthe maximum days to maturity were recorded for PR-102 (190 days). Among the F3 population, maximum days to maturity were taken by Faisalabad × Zardana 89 (188 days) and the minimum days to maturity were noted for Pirsabaq × Zardana 89 (180 days).

Plant height (cm)

Pir-Sabaq-2010 attained (table-4.2) the maximum plant height (97.71 cm), and the least plant height (64.73 cm) was obtained in parent Faisalabad 85. The cross of PR 102 × Raskoh 2005 produced the tallest F3 hybrids, reaching a height of 90.07 centimeters; while in cross combinations Pir-sabaq 2010 × Zardana 89, Zarghoon 79

× Raskoh 2005, PR102 × Zarghoon 79, Pir-sabaq 2010 × Zarghoon 79, Faisalabad

85 × Zardana 89 produced plants of 90.07 cm, 88.33 cm, 82.79 cm and 81.79 cm, correspondingly. However, the lowest plant height of 75.58 cm was detected in the cross combination of Faisalabad 85 × Zardana 89.

Tillers plant^{-1}

In case tillers plant^{-1} the highest values (table-4.2) for this trait (11.86 plant^{-1}) were obtained in parent PR-102; while the lowest number of tillers plant^{-1} (7.42) were obtained in parents Faisalabad-85 and Raskoh-2005. Among the F3 populations, the highest tillers plant^{-1} (16.06) was obtained in cross combination of Zarghoon 79 × Raskoh 2005; while the lowest number of tillers plant^{-1} (12.36) was obtained in cross combination of Pir-sabaq 2010 × Zarghoon 79.

Number of grains spike^{-1}

The highest numbers of grain spike^{-1} (66.06) were (table-4.2) obtained in parent PR- 102; however, the lowest grains spike^{-1} (46.67) in numbers were found in the parentalline Zarghoon-79. Among the F3 population, maximum number of grain spike^{-1} (59.00)was obtained in cross combination of Pirsabaq 2010 × Zardana 89; while the minimumnumber of grain spike^{-1} (54.66) was obtained in the cross combination of Zarghoon 79

× Raskoh 2005.

Grain yield plant^{-1}

For grain yield plant^{-1} ttable-4.2 is displayed to show the obtained results of tis study.The maximum value (14.79 g) was recorded in the bread wheat parental line PR-102 and the lowest possible grain yield plant^{-1} (8.47 g) was seen for parental line Zardana-89. Results showed that the cross between promising wheat parental lines Faisalabad 85 and Zardana 89 produced the highest plant^{-1} grain yield (14.00 g), whereas the cross between PR102 × Raskoh2005 produced the lowest plant^{-1} grain yield (8.72 g).

1000-grain weight (g)

The 1000-grain weight was presented in table-4.2, where maximum (53.00 g) for parent Zarghoon-79; while the lowest 1000-grain weight (43.07 g) was obtained in case of the parent PR102. Among the F3 population, 1000 seeds weight was highest (53.54 g) in case of cross combination PR102 × Zarghoon79; while the lowest 1000- grain weight (34.20 g) was recorded for cross combination of Faisalabad 85 × Zardana 89.

Heterosis and heterobeltiosis

Days to heading

Heterosis and heterobeltiosis studies on days to heading (table-4.3) revealed that the cross Zarghoon 79 × Raskoh had the highest relative heterosis (14.78 %) for days toheading, while the cross Zarghoon 79 × Raskoh had the highest heterobeltiosis estimation (13.79 %) for days to heading among all studied wheat F3 hybrids.

International Journal of Academic and Applied Research (IJAAR)
ISSN: 2643-9603
Vol. 8 Issue 3 March - 2024, Pages: 12-32

Days to maturity

In the days to maturity studies (table-4.4), the heterosis and heterobeltiosis studies revealed that the cross PR102 × Raskoh 2005 resulted in the highest negative relative heterosis (-3.70 %) for days to maturity, and the highest negative heterobeltiosis estimate (-4.21 %) for days to maturity among F3 hybrids was also documented in thecross, i.e., PR102 × Raskoh 2005 for daysto maturity.

Table 4.2: Mean performance of genotypes for plant height, tillers plant^{-1}, spikelets spike^{-1}, spike length and grain spike^{-1}.

Genotype	Days to heading	Days to maturity	Plant height (cm)	Tillers plant^{-1}	Grains spike^{-1}	Grain yield plant^{-1} (g)	1000-grain weight (g)
			Parents				
Zarghoon-79	114e	184c	89.38e	7.68bc	46.67e	10.00d	53.00a
Zardana-89	128a	186b	90.08d	7.74b	47.12d	8.47f	48.92c
Faisalabad-85	120c	180d	94.73f	7.42d	46.07f	9.40e	43.07e
Raskoh-2005	116d	188b	93.47c	7.42d	61.56b	12.07b	49.77b
PR-102	120c	190a	94.68b	11.86a	66.06a	14.79a	30.50f
Pir-Sabaq-2010	124b	182c	97.71a	7.48cd	61.01c	10.82c	47.08d
			Crosses				
Pir-sabaq 2010 × Zarghoon 79	124c	185bcd	81.05b	12.36f	55.00def	11.54 abc	45.51 ab
PR102 × Raskoh2005	120cd	182d	90.07a	13.90bc	57.66bc	8.72 c	44.08 b
Faisalabad 85 × Zardana 89	126ab	188b	75.58c	12.80ef	58.66b	14.00 a	34.20 c
Pirsabaq 2010×Zardana 89	128b	180a	88.33a	14.13bc	59.00ab	10.61 bc	44.02 b
Zarghoon 79 × Raskoh 2005	132a	186bc	82.79b	16.06a	54.66ef	13.08 ab	34.64 c
PR102 × Zarghoon 79	121cd	183cd	81.79b	13.80bcd	56.66cd	13.52 a	53.54 a

Plant height (cm)

A study on plant height (table-4.5) found that the cross Faisalabad × Zardana 89 resulted in the highest negative relative heterosis (-18.21 %) for plant height, while thecross combinations of Faisalabad × Zardana 89 displayed the maximum negative heterobeltiosis (-20.22 %) for plant height.

Tillers plant^{-1}

Heterosis and heterobeltiosis studies on tillers plant^{-1} (table-4.6) indicated that the cross Zarghoon 79 × Raskoh 2005 resulted in maximum relative heterosis (112.72%) for tillers plant^{-1}; while the maximum heterobeltiosis (109.11%) was displayed by thecross combinations of Zarghoon 79 × Raskoh 2005.

Number of grains spike^{-1}

There were five F3 hybrids with positive heterosis for number of grain spike^{-1} based on the heterotic effects of (table-4.7) Cross-combinations of Faisalabad 85 × Zardana 89 showed the highest relative heterosis (25.89%). In terms of heterobeltiosis, Faisalabad 85 × Zardana 89 was the best-performing F3 hybrid, with 24.49 percent heterobeltiosis for the quantity of grain spikes plant^{-1}.

Grain yield plant^{-1} (g)

For grain yield plant-1, (table-4.8) the cross combinations of Faisalabad 85 × Zardana 89 exhibited the higher relative heterosis (56.69%), whereas the cross combinations of PR102 × Zarghoon 79 (9.08 %) exhibited the lower relative heterosis. Faisalabad 85 ×Zardana 89 were the high scored F3 hybrids for heterobeltiosis, with 48.94% heterobeltiosis for grain yield plant^{-1}.

Seed index (1000 grain weight g)

Heterosis and heterobeltiosis studies on seed index (table-4.9) indicated that the crossZarghoon 79 × Raskoh 2005 resulted in maximum negative relative heterosis (- 32.59%) for seed index, while the maximum negative heterobeltiosis (-34.64%) waspresented by the cross combinations of Zarghoon 79 × Raskoh 2005.

Table 4.3: Heterotic effects of six F3 hybrids over mid parents (relative heterosis) and better parents (heterobeltiosis) for the character **days to heading**

Variety	Seed Parent	Pollen Parent	Mid parent	Better parent	F3	Heterosis	Heterobeltiosis
Pir-sabaq 2010 × Zarghoon 79	124	114	119.00	114.00	124	4.20	8.77
PR102 × Raskoh 2005	120	116	118.00	116.00	120	1.69	3.45
Faisalabad 85 × Zardana 89	120	128	124.00	128.00	126	1.61	-1.56
Pirsabaq 2010 × Zardana 89	124	128	126.00	128.00	128	1.59	0.00
Zarghoon 79 × Raskoh 2005	114	116	115.00	116.00	132	14.78	13.79
PR102 × Zarghoon 79	120	114	117.00	120.00	121	3.42	0.83

Table 4.4: Heterotic effects of six F3 hybrids over mid parents (relative heterosis) and better parents (heterobeltiosis) for the character **days to maturity**

Variety	Seed parent	Pollen parent	Mid parent	Better parent	F3	Heterosis	Heterobeltiosis
Pir-sabaq 2010 × Zarghoon 79	182	184	183.00	184.00	185	1.09	0.54
PR102 × Raskoh2005	190	188	189.00	190.00	182	-3.70	-4.21
Faisalabad 85 × Zardana 89	180	186	183.00	186.00	188	2.73	1.08
Pirsabaq 2010 × Zardana 89	182	186	184.00	186.00	180	-2.17	-3.23
Zarghoon 79 × Raskoh 2005	184	188	186.00	188.00	186	0.00	-1.06
PR102 × Zarghoon 79	190	184	187.00	190.00	183	-2.14	-3.68

International Journal of Academic and Applied Research (IJAAR)
ISSN: 2643-9603
Vol. 8 Issue 3 March - 2024, Pages: 12-32

Table 4.5: Heterotic effects of six F3 hybrids over mid parents (relative heterosis) and better parents (heterobeltiosis) for the character **plant height (cm).**

Variety	Seed parent	Pollen parent	Mid parent	Better parent	F3	Heterosis	Heterobeltiosis
Pir-sabaq 2010 × Zarghoon 79	97.71	89.38	93.55	97.71	81.05	-13.36	-17.05
PR102 × Raskoh2005	94.68	93.47	94.08	94.68	90.07	-4.26	-4.87
Faisalabad 85 × Zardana 89	94.73	90.08	92.41	94.73	75.58	-18.21	-20.22
Pirsabaq 2010 × Zardana 89	97.71	90.08	93.90	97.71	88.33	-5.93	-9.60
Zarghoon 79 × Raskoh 2005	89.38	93.47	91.43	93.47	82.79	-9.44	-11.43
PR102 × Zarghoon 79	94.68	89.38	92.03	94.68	81.79	-11.13	-13.61

Table 4.6: Heterotic effects of six F3 hybrids over mid parents (relative heterosis) and better parents (heterobeltiosis) for the character tillerplant^{-1}

Variety	Seed parent	Pollen parent	Mid parent	Better parent	F3	Heterosis	Heterobeltiosis
Pir-sabaq 2010 × Zarghoon 79	7.48	7.68	7.58	7.68	12.36	63.06	60.94
PR102 × Raskoh2005	11.86	7.42	9.64	11.86	13.9	44.19	17.20
Faisalabad 85 × Zardana 89	7.42	7.74	7.58	7.74	12.8	68.87	65.37
Pirsabaq 2010 × Zardana 89	7.48	7.74	7.61	7.74	14.13	85.68	82.56
Zarghoon 79 × Raskoh 2005	7.68	7.42	7.55	7.68	16.06	112.72	109.11
PR102 × Zarghoon 79	11.86	7.68	9.77	11.86	13.8	41.25	16.36

Table 4.7: Heterotic effects of six F3 hybrids over mid parents (relative heterosis better parents (heterobeltiosis) for the number of grainspike^{-1}

Variety	Seed parent	Pollen parent	Mid parent	Better parent	F3	Heterosis	Heterobeltiosis
Pir-sabaq 2010 × Zarghoon 79	61.01	46.67	53.84	61.01	55	2.15	-9.85
PR102 × Raskoh2005	66.06	61.56	63.81	66.06	57.66	-9.64	-12.72
Faisalabad 85 × Zardana 89	46.07	47.12	46.60	47.12	58.66	25.89	24.49
Pirsabaq 2010 × Zardana 89	61.01	47.12	54.07	61.01	59	9.13	-3.29
Zarghoon 79 × Raskoh 2005	46.67	61.56	54.12	61.56	54.66	1.01	-11.21
PR102 × Zarghoon 79	66.06	46.67	56.37	66.06	56.66	0.52	-14.23

Table 4.8: Heterotic effects of six F3 hybrids over mid parents (relative heterosis) and better parents (heterobeltiosis) for the charactergrainyield plant^{-1}

Variety	Seed parent	Pollen parent	Mid parent	Better parent	F3	Heterosis	Heterobeltiosis
Pir-sabaq 2010 × Zarghoon 79	10.82	10	10.41	10.82	11.54	10.85	6.65
PR102 × Raskoh2005	14.79	12.07	13.43	14.79	8.72	-35.07	-41.04
Faisalabad 85 × Zardana 89	9.4	8.47	8.94	9.40	14	56.69	48.94
Pirsabaq 2010 × Zardana 89	10.82	8.47	9.65	10.82	10.61	10.01	-1.94
Zarghoon 79 × Raskoh 2005	10	12.07	11.04	12.07	13.08	18.53	8.37
PR102 × Zarghoon 79	14.79	10	12.40	14.79	13.52	9.08	-8.59

International Journal of Academic and Applied Research (IJAAR)
ISSN: 2643-9603
Vol. 8 Issue 3 March - 2024, Pages: 12-32

Table 4.9: Heterotic effects of six F3 hybrids over mid parents (relative heterosis) and better parents (heterobeltiosis) for the seed index (1000 grain weight)

Variety	Seed parent	Pollen parent	Mid parent	Better parent	F3	Heterosis	Heterobeltiosis
Pir-sabaq 2010 × Zarghoon 79	47.08	53	50.04	53.00	45.51	-9.05	-14.13
PR102 × Raskoh2005	30.5	49.77	40.14	49.77	44.08	9.83	-11.43
Faisalabad 85 × Zardana 89	43.07	48.92	46.00	48.92	34.2	-25.64	-30.09
Pirsabaq 2010 × Zardana 89	47.08	48.92	48.00	48.92	44.02	-8.29	-10.02
Zarghoon 79 × Raskoh 2005	53	49.77	51.39	53.00	34.64	-32.59	-34.64
PR102 × Zarghoon 79	30.5	53	41.75	53.00	53.54	28.24	1.02

Discussion

Bread wheat cultivars of diverse origin are cultivated commercially by farmers, therefore environmental change influences grain output. Yield changes significantly as a result of their collaboration with many environmental situations, as grain yield isa complex quantitative measure that represents the sum of a variety of contributing elements that have an impact on crop production, either directly or indirectly (Mehmetand Yildirim, 2016; Alamerew et al., 2019). Wheat output can be boosted by developing productive cultivars that are more tolerant to biotic and abiotic stresses andmore adaptable to a variety of agro-climatic environments. Selection for grain production improvement is only effective if the breeding material contains a substantial amount of genetic variety (Todorov et al., 2015; Meyari et al., 2018).

The minimum days to heading were taken by Zarghoon-79 (114 days) and themaximum days to heading were recorded for Zardana-89 (128 days). Among the F3 populations, minimum days to heading were taken by PR102 × Raskoh 2005 (120 days)and the maximum days to heading were noted for Zarghoon 79 × Raskoh 2005 (132 days). The parent Faisalabad-85 received minimum days to maturity (180 days) and themaximum days to maturity were recorded for PR-102 (190 days). Among the F3 population, maximum days to maturity were taken by Faisalabad × Zardana 89 (188 days) and the minimum days to maturity were noted for Pirsabaq × Zardana 89 (180 days). Pir-Sabaq-2010 achieved the maximum plant height (97.71 cm), and the lowest plant height (64.73 cm) was found in parent Faisalabad-85. Among the F3 population, the tallest plant height (90.07 cm) was observed in cross combination of PR102 × Raskoh 2005; while in cross combinations Pirsabaq 2010 × Zardana 89, Zarghoon 79 × Raskoh 2005, Pir-sabaq 2010 × Zarghoon 79 and Faisalabad-85 × Zardana 89 produced plants height 88.33 cm, 82.79 cm, 81.79 cm, and 81.05 cm, respectively. However, the lowest plant height of 75.58 cm was noted in the cross of Faisalabad-85 × Zardana 89.

In case tillers plant^{-1} the highest values for this trait (11.86) were obtained in parent PIR-102; while the lowest number of tillers plant^{-1} (7.42) were obtained in parents Faisalabad-85 and Raskoh-2005. Among the F3 population, the highest tillers plant^{-1} (16.06) was obtained in cross combination of Zarghoon 79 × Raskoh 2005; while the lowest number of tillers plant^{-1} (12.36) was obtained in cross combination of Pir-sabaq2010 × Zarghoon 79. The maximum number of grain spike^{-1} (66.06) was obtained in parent PIR-102; while the minimum number of grain spike^{-1} (46.67) was obtained in the parent Zarghoon-79. Among the F3 population, maximum number of grain spike^{-1}(59.00) was obtained in cross combination of Pirsabaq 2010 × Zardana 89; while the minimum number of grain spike^{-1} (54.66) was obtained in the cross combination of Zarghoon 79 × Raskoh 2005.

The 1000-grain weight was highest (53.00 g) in case of parent Zarghoon-79; while thelowest 1000-grain weight (30.50 g) was obtained in case of the parent Pir-Sabaq-2010.In the case of the F3 population, the 1000-grain weight was highest (53.54 g). The lowest 1000-grain weight was (34.20 g) in the case of the cross combinations PR102 × Zarghoon 79 and Faisalabad 85 × Zardana 89. Most of the time, the parent PIR-102had a grain yield plant^{-1} value of 14.79 g. The lowest grain yield plant^{-1} value was found in Zardana-89. For F3, we found that the best combination of Faisalabad 85 andZardana 89 was able to get 14.00 g plant^{-1}, while the worst combination of PR102 andRaskoh 2005 got 8.72 g.

Furthermore, Salim et al. (2015) and Shah et al. (2016) noticed that the wheatgenotypes fluctuated greatly in favor of studied attributes, including plant height, spikelets spike^{-1}, spike length, grain weight spike^{-1}, grains plant^{-1}, 1000-grain weight, grain yield, and grain yield. According to Turk and Celik (2015), the number of tillersand grain yield are the two most important yield contributing criteria for selecting highyielding wheat cultivars for commercial production. Spike weight plant^{-1}, accordingto Shahryari et al. (2018) and Zahid et al. (2018), was the highly significant differencesin wheat grain yield, whereas grain weight spike^{-1} and the wheat Germplasm includedin this experiment contrasted considerably for their genotypic performance (Akhtar and Chowdhary, 2016). Additionally, they discovered thatthe length of the main ear plant^{-1}, the number of tillers plant^{-1}, and the number of spikesplant^{-1} were all positivelyconnected with grain yield.

In 2016, Aycecik and Yildirim found that plant height, spike length, spikelets spike^{-1},grains spike^{-1}, and 1000 grain weight were all linked to grain yield. But productive tillers plant^{-1}, spikelets spike^{-1}, and 1000 grain weight had a negative influence on grain yield (Bhangar et al., 2017). Baye et al. (2020) described positively significant relationship between yield and plant tallness, the number of grains spike^{-1}, the weightof each grain, and the weight of 1000 kernels. Genetically, plant height, spike length, spikelets spike^{-1}, grains spike^{-1}, and 1000-grain weight were all linked to grain yield, Deswal et al. (2016) found. Phenotypically, these traits were also linked to grain yield(Dokuyucu et al., 2017). Flag leaf area was found positive but not significant link to grain yield, while the number of fertile tillers plant^{-1} was negatively but not significantly linked to grain yield. Fellahi et al. (2015) found that the number of spikeletsspike^{-1}, the number of grains spike^{-1}, and the weight of 1000 grains spike^{-1} were all linked to grain yield at both genotypic and phenotypic levels. Gupta et al. (2017) foundthat grain yield plant^{-1} was linked to the number of tillers plant^{-1} and the days to maturity at the genotypic stage, but not at the phenotypic stage (Hannachi et al., 2018).

It is possible to learn a lot about the parents' ability to combine their genes in new offspring through research on heterosis. Heterosis estimation of heterosis over the superior parent may be effective in detecting actual heterotic cross combinations. Hybrid wheat breeders found that the standard heterosis for grain yield on a large plotbasis was between 6% and 8%. (Singh et al. 2004; Singh et al. 2016). Heterosis is a faster, cheaper, and easier way to increase crop yields. Hybrid varieties can be commercially viable and heterotic studies can be used to identify valuable hybrid combinations in breeding program if the amount of heterosis is high enough. The use of hybrid wheat technologies can have a significant impact on grain yields (Mollasadeghi et al., 2015; Rizkalla et al., 2017). Although Freeman first documentedthe presence of heterosis inwheat in 1919, it has not been widely used until recently. Studies on heterosis could aid in the development of hybrid wheat breeding tactics. Plant breeders working withautonomous crops frequently use diallel cross progenies as a source of geneticinformation (Dokuyucu et al. 2017).

Hassan et al. (2022) and Coopera et al. (2017) studied heterosis in most of the crops including wheat is an important tool in evaluating genetic characteristics. The kind andextent of heterosis could play a key function for the plant breeder in creating the rightbreeding strategies. Therefore, present work is carried out to characterize the extent of heterosis in bread wheat and to discover superior parents and crosses (Jaiswalet al. 2018). A heterozygote's increased vigor, size, resilience to disease, and climatic extremes are all examples of heterosis, which is a manifestation of heterozygosity. Sufficient hybrid vigor should be attainable only with specified parental combinations(Rasul et al. 2002).

Pure lines of greater extent of general combining capacity that demonstrate the additivegene impact must be selected throughout breeding operations. Progeny prediction andcross combination and genotype selection can be done based on this. using breeder- conducted abilities research in conjunction with genetic transfer of desirable traits to progeny (Madic et al. 2015). To build a successful breeding program, Sheikh et al. (2017) found that combining ability is critical in both general and specific aspects. Breeding for improved varieties of crops like wheat is made possible in large part by maintaining a diverse genetic pool (El-Maghraby et al. 2015; Bao et al. 2017; Belderok, 2017).

F3 progeny with moderate to high heritability and significant genetic gain were also found. According to Khokhar et al. 2019 and Nizamani et al. 2019, our findings arein line with their findings, which found more genotypic variability; medium to high heritability values; and greater plant height inheritance with the combination ofadvancement. In addition, they found huge variations between the genetic makeup of the parents and the offspring. Plant height appears to be predominantly controlled by additive genes; hence direct selection may be beneficial in isolated generations based on existing data.

TJ83 × TD-1, Sunhari × TD-1, TJ83 × Sarsabz and TJ-83 × Sarsabz offspring with optimal genetic parameters may be produced, as may TJ-83 × PBGST-1 offspring withideal genetic parameters, as well as TD-1 offspring with ideal genetic parameters. Selection of breeding materials is done to improve the height of following generationsof plants. length of peduncle. The top node of the wheat plant is measured to the baseof the spike to determine the peduncle length. Sarsabz produced the greatest pedunclelength (39.5 cm) among the parents, whereas TD-1 produced the shortest peduncle length (24.9 cm). TJ83 × Sarsabz generated the greatest peduncle length (40.0 cm) and TD-1 × Sarsabz produced the smallest (33.8). Genomic progress and modest heritability were found in the descendants. The progeny of TJ-83 × Sarsabz showed the highest heritability percentage (h2=89.5%) and the greatest genetic progress (GA=9.8). Inflorescence length heritability has been documented by other researchers,and the current findings are consistent with those findings (Nizamani et al. 2019). As described by Nizamani et al. (2020) a polygenic trait affecting wheat grain productionis the seed index. When comparing seed index values between parents and F3 offspring, we found a wide range from 24.2 to 37.1 g on average. It was found that practically all of the F3 progenies had moderate to high heritability estimates, althoughthe highest percentage of heritability (h2=92.4 percent) and the highest genetic advance (GA=7.4) were found in the progenies Moomal-TD-1 and Sunhari-Moomal, respectively. To increase wheat seed index, the researchers found that F3 offspring of the crosses Moomal × Td-1, Sunhari × Moomal, and TJ83 × Moomal may be the bestbreeding material to use.

Rasul et al. (2002) showed that the yield of a crop variety is still the most important quality. A plant's grain yield is mostly determined by the length of the spike, the number of spikelets, the number of grains, and the seed index. Table 2 shows the mean performance, and it shows that the highest grain production plant^{-1} was producedby parent PBGST-1 (7.7g), followed by Sarsabz (7.5g). Moomal × TD-1 had the greatest mean value of the F3 offspring (9.5g). The progeny's heritability estimations and genetic advancements, as shown in graph 8, ranged from low to high, as expected.Progeny from the cross between TJ-83 and Moomal showed the highest heritability percentage (h2=73.7 percent) and the greatest genetic progress (GA=4.4). Therefore, TJ-83 × Moomal, Moomal × TD-1 and TJ-83 × Sarsabz may be useful breeding populaces for assortment and selection in future generations for the development of grain yield plant^{-1} based on these findings. A similar pattern of outcomes emerged byHussain It was the goal of the current investigation to discover the hereditary boundaries of F3 populations for distinct wheat characteristics. An extensive investigation into hereditary factors, including heritability rate, hereditary variability, and hereditary addition at 20% determination force, was carried out using six cultivarsand six F3 descendants. Plant height (cm), days to heading, days to maturity, number of tillers plant^{-1}, number of grains spike^{-1}, 1000 grain weight (g) and grain yield plant^{-1}were all recorded in the field

REFERENCES

Afridi, K., Ahmad, G., Ishaq, M., Khalil, I. A., Shah, I. A., Saeed, M. & Ahamd, N. (2014). Genetic potential and variability for morpho-yield traits in durum wheat (*Triticum turgidum L. Var. Durum*). *International Journal Farm & Allied Science*, 3(*12*), 1206-1212.

Akhtar, N. & Chowdhary, M. A. (2016). Estimation of genetic and phenotypiccorrelation coefficients among grain yield and its components in bread wheat.*International Journal of Agriculture and Biology*, 8(*4*): 516–522.

Akhtar, N., Mehmood, T., Ahsan, M., Aziz, A., Ashraf, M. Ahmad, S., Asif, M. & Safdar, E. (2015). Estimation of correlation coefficients among seed yield andsome quantitative traits in wheat (*Triticum aestivum L.*). *African Journal of Agricultural Research*, 6(*1*): 152-157.

Alamerew, B., Mecha, S., Aseefa, A., Assefa, E. & Dutamo, D. (2019). Correlation and path coefficient studies of yield and yield associated traits in bread wheat (*Triticum aestivum* L.) genotypes. *Advance Journal of* Plant *and Agriculture Research*, 6(*5*): 226-235.

Anilkumar, C. V., & Ramalingam, J. (2011). Parent progeny regression analysis inF2 and F3 generations of rice. Electronic Journal of Plant Breeding, 2(4), 520-522.

Aycecik, M. & Yildirim, T. (2016). Path coefficient analysis of yield and yield components in bread wheat (*Triticum aestivum L.*) genotypes. *Pakistan Journal Botany*, 38(*2*): 417-424.

Bajaniya, N. A., Pansuriya, A. G., Vekaria, D. M., Singh, C. & Patel, J. M. (2019). Estimation of heterosis in different crosses of durum wheat (*Triticum durum* L.). *International Journal of Chemical Studies*, 7(*3*): 3833-3839.

Baloch, M. Z., Ansari, B. A., & Memon, N. (2003). Performance and selection of intraspecific hybrids of spring wheat (*Triticum aestivum* L.). *Pakistan JournalAgriculture. Veterinary Science*, 19(*1*), 28-31.

Bao, Y. G., Sen, W., Wang, X., Wang, Y. Li, X., Wang,L., & Wang, H. (2017). Heterosis and combining ability for major yield traits of a new wheat germplasm shannong 0095 derived from Thinopyrum intermedium. *Journal of Agricultural Sciences,* 8(*6*):753-760.

Barker, T. C. & Varughese, G. (2017). Combining ability and heterosis among eight complete spring hexaploid triticate lines. *Journal of Crop Science*, 32(*2*):340- 344.

Baye, A. B., Muluken, B., Derebe, B. & Moral, M. T. (2020). Genotypic and phenotypic correlation and path coefficient analysis for yield and yield- relatedtraits in advanced bread wheat (*Triticum aestivum* L.) lines. *Journal of* Plant *Breeding and Science*, 27(*2*): 597-610.

Belderok, B. (2017). Bread-making Quality of Wheat: A Century of Breeding in Europe (Book). Kluwer Academic Publishers, *Netherlands*, Pp. 34.

Bhangar, D. B., Lad, N. D., Bhor, T. J., Mukhekar, G. D. & Biradar, A. B. (2017). Correlation and path coefficient analysis in wheat. *Journal of Maharashtra Agriculture University*, 28(*1*): 23-25.

Coopera, J. K., Amir, M., Ibrahim, H., Rudda, J., Haysa, D., Mallaa, S. & Bakera, J. (2017). increasing hard winter wheat yield potential via synthetic hexaploid wheat: II. heritability and combining ability of yield and its components. *Journal of Crop Science*, 53(*1*): 67-73.

Dedaniya, A. P., Pansuriya, A. G., Vekaria, D. M., Memon, J. T. & Vekariya, T. A. (2018). Estimation of heterosis in different crosses of bread wheat (*Triticum aestivum L.*). *International Journal of Chemical Studies*, 6(*3*): 3622-3628.

Deswal, R. K., Grakh, S. S. & Berwal, K. K. (2016). Genetic variability and characters association between grain yield and its components in wheat. *Annals Journal of Biology*, 12(*2*): 221-224.

Dokuyucu, T., Akkaya, A. & Akcura, M. (2017). Path analysis of yield and some yield related traits of Durum wheat genotypes grown in rainfed conditions of Mediterranean Region. *Turkish Journal of Field Crops*, 7(*1*): 31-3

El-Gammaal, A. A. & Yahya, A. I. (2018). Genetic variability and heterosis in F1 and F2 generations of diallel crosses among seven wheat genotypes. *Journal of Plant Production*, 9(*12*): 1075-1086.

El-Maghraby, M. A., El-Shehawi, A. M. & Harby, M. H. (2015). Genetic diversity inbread wheat as revealed by RAPD markers and its relationship to leaf rust and hybrid performance. *Alex Journal of Agriculture Research*, 55(*1*): 31-38.

Falconer, K. J. (1989). Dimensions and measures of quasi self-similar sets.*Proceedings of the American mathematical society*, *106*(2), 543-554.

Fellahi, Z. E. A., Hannachi, A., Bouzerzour, H. & Boutekrabt, A. (2015). Line × testermating design analysis for grain yield and yield related traits in bread wheat (*Triticuma estivum* L.). *International Journal of Agronomy*, 20(*2*): 1-9.

Fetahu, S., Sali, A., Imer, R., Dukagjin, Z., Qëndrim, S., Hans, K. & Fetah, E. (2015).Determinatoin of heterosis and heterobeltiosis for plant height and spikegrain weight of F_1 generation in bread wheat. *Journal of Ecosystems and Ecology Science*, 5(*3*): 431- 436.

Gaur, S. C., & Sahu, R. K. (2020). Genetic Variability, Heritability and Genetic Advance Studies for Grain Yield and Yield Attributing Traits in Bread Wheat(Triticum aestivum L. em. Thell).

Gomez, K. A. & Gomez, A. A. (1980). Statistical procedures for agricultural research(2 ed.). John Wiley and Sons, *New York*, pp680.

Gupta, R. S., Tiwari, D. K. & Singh, R. J. (2017). Genotypic and phenotypic correlations in bread wheat (*Triticum aestivum* L). *New Botanist*, 29 (1/4) - 49-54.

Habib, I., & Khan, A. S. (2003). Genetic model of some economic traits in bread wheat(*Triticum aestivum* L.). *Asian Journal of Plant Sciences*, 2(*17-24*), 1153- 1155.

Hammad, S. M., El-Seidy, E. H. & Darwesh, M. A. H. (2017). Inheritances of leaf rust resistance in six wheat crosses. *Journal of Agronomy*. 9 (*3*): 222-242.

Hannachi, R., Chaturvedi, B. & Gupta, R. R. (2018). Selection parameters for some grain and quality attributes in spring wheat (*Triticum aestivum* L.). *Journal of Agriculture Science*, 15(*4*): 186-190.

Hassan, A., Hussain, M. A., Bashir, M. A., Mostafa, Y. S., Alamri, S. A., & Hashem, M. (2022). Screening of different wheat genotypes against leaf rust and role ofenvironmental factors affecting disease development. *Journal of King SaudUniversity-Science*, 101991.

Hassan, G., F. Muhammad, F. H. Khalil & Raziuddin. (2017). Heterosis and heterobeltiosis studies for morphological traits in bread wheat. *Sarhad Journal of Agriculture Science*, 22 (*1*): 51-54.