ANNUAL REPORT

2022-23

WHEAT RESEARCH INSTITUTE,

AARI, Faisalabad

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INTRODUCTION

Wheat Research Institute, AARI, Faisalabad, Pakistan has a very splendid past and present since its foundation (1906) as Cereal Section. Wheat is the most vital crop of Pakistan and considered as a security pillar. Wheat production and yield is less as compared to the potential due to number of abiotic stresses (heat, salt, drought etc.) and biotic stresses (rusts, smuts, bunts, blight, aphid etc.). The scientists of this institute have been employed to develop and release bread wheat, durum and barley varieties having better yield, quality and resistant to biotic and abiotic stresses.

WRI paid more than sixty-nine varieties of bread wheat, three varieties durum wheat and seven varieties of barley so far. Out of these varieties, Chenab-70, Pak-81, Inqilab-91, Seher-06, Faisalabad-08, Galaxy-13, Akbar-19 of wheat, Haider-93, of barley and durum-97 of durum endured as the super wheat varieties of Pakistan. This institute has released six wheat varieties (Anaj-17, Akbar-19, Dilkash-20, Subhani-21, MH-21 and Arooj-22) and five barley varieties (Sultan-17, Jau-17, Jau-21 and Talbina-21) and one durum variety (durum-21) during the last five years. The varieties released up till now are contributing a significant share for increasing wheat, barley and durum yield and production of the country in general and Punjab in explicit.

WRI is focusing five disciplines (breeding, pathology, entomology, agronomy and cereal technology) are working in the institute. Breeding however, is an essential part of its research work as it focusses on various aspects of wheat crop.

The Institute has strong collaboration with key national and international institutes; like CIMMYT, Mexico, PBI, Australia, FAO, Rome, ICARDA, Lebanon, UC, Davis, USA, CIAT, Colombia, IFPRI, Washington, USA, KARI, Kenya, UMN, USA. These international institutes provide novel germplasm and training and financial assistance to the researchers. These struggles are being made to progress from green revolution to the gene revolution. Seventy-two experiments in different research areas like breeding, pathology, entomology, crop management and quality have been planned by Wheat Research Institute, Faisalabad during the year of 2022-23. Different PARB projects were also conducted by this institute. WRI, Faisalabad contributed six advanced lines of bread wheat, three of durum and two of barley in National Uniform Yield Trials (2023-24). Currently two advanced lines of wheat are in the final process of variety approval.

CLIMATE/WEATHER

In the field of crop science, weather data play a pivot role. Unpredicted weather nastily affronts the wheat crop and vice versa. Therefore, by keeping in mind the weather conditions researchers make frequent routine decisions related to agronomic practices.

Rainfall in the month of January 2023 and February 2023 displayed positive effects on wheat crop. The suitable temperature in the month of March and April showed significant effect on heading and flowering stage also. At nearly every stage of growth, wheat is generally sensitive high temperatures especially at reproductive stages (pre and post anthesis). If the period of high temperature will withstand shorter at this stage, there will be the more wheat yield and production. Four frosty nights and two frosty days in months of January 2023 were observed which promoted tillering capacity. The meteorological data is shown in the table 1.

Table 1: Meteorological data during the wheat crop season 2022-23

Months	Air Temp. (C^0)		Relative Humidity (%)		Rainfall (mm)	Av Sunshine Hours H:M	Frosty nights	Frosty days
	Ave Max	Ave Min	8 am	5pm				
Oct. 2022	33.5	17.7	72.7	47.2	0	8:38	0	0
Nov. 2022	28.2	12.4	81.5	51.3	4	6:56	2	2
Dec. 2022	21.8	7.4	87.2	58.9	2.3	5:33	2	1
Jan. 2023	18.4	4.8	84.7	55.9	30.7	4:49	4	2
Feb. 2023	26.1	10.7	77.3	44.5	6.4	6:57	2	1
March 2023	25.8	15.3	82.7	56.7	55.2	6:45	8	1
April 2023	33.5	18.4	65.3	43.8	42.8	8:39	6	0

BREAD WHEAT *(Triticum aestivum L.)*
GERMPLASM IMPROVEMENT AND ITS MAINTENANCE
(a)-Crossing Block

The key aims of crossing block was to preserve germplasm with their distinctive traits and to combine high yield, adaptability and tolerance to biotic and abiotic stresses characteristic. Germplasm improvement and maintenance offers a chance to integrate the wanted genes in the current varieties with the help of hybridization. In order to ease crossing process and to synchronize male and female parents, crossing blocks were planted twice (1st and 3rd week of November 2022) in which each entry was planted in paired row plots of 2.5 m length. The crossing Block composed of different groups viz; current varieties (45), exotic lines (18), disease resistant (34), drought tolerant (94), salt tolerant (7), heat tolerant (59), grain quality (17), high yielding (2), Misc (128). Data were recorded for 12 different traits. About 1000 target crosses were made keeping in view different objectives like higher yield, heat, drought, disease resistance and acceptable quality (table 2).

Table 2: Genetic diversity of different traits in crossing block during 2022-23.

Traits	Range	Traits	Range
Days to heading	91-110	Tillers plant^{-1}	8.7-22.3
Days to maturity	113-151	1000 grain weight (g)	17.0-50.2
Plant height (cm)	50-127	Leaf and yellow rusts	0-100S
Canopy temperature (^{0}c) (booting)	14.0-17.2	NDVI range (booting)	0.70-0.82
Leaf color (light green, medium. dark), size (Broad, medium, narrow) & orientation (droopy, semi droopy, erect, semi erect)			Wide range

(b)-Local land races

Local land races with enhanced levels of resistance/tolerance to multiple stresses provide important source of genetic diversity for crop improvement. However, their exploitation for cultivar improvement is limited by crossing incompatibility barrier and linkage drags. Wild crosses are capable of enhancing diversity in wheat but still requiring further breeding selection to generate varieties with elite performance for sustainable national food security. A total number of 45 land races were plated and tested for agronomic and pathological traits**.** The genetic diversity of these traits is table 3.

Table 3: Genetic diversity in local land races during 2022-23.

Sr. No.	Traits	LLR Range
1	Plant height (cm)	80-145
2	Days to heading	95-113
3	Days to maturity	117-148
4	Tiller plant^{-1}	11-18.8
5	1000 grain wt	24-44
6	Leaf & yellow rust reactions	0- 100 S
7	Leaf color, size & orientation	Wide range

(c)-Pre-breeding nursery

Pre breeding include all the activities related to the identification of desirable traits from the other unadopted materials and transfer these traits to an intermediate set of materials that breeders can use further in producing new varieties for farmers. During 22-23 pre breeding nursery was consisted of 136 top performing lines incorporated from different sources in which each entry was planted in paired row plots of 2.5 m length. These top performing lines were characterized for different traits (table 4) and will be further used in hybridization program.

Table 4: Recorded traits in PBN during 2022-23.

Traits	Days to maturity	Tillers plant^{-1}	Plant height (cm)	Yield (g)
Range	147-138	160-90	100-70	998-400

Crossing block, pre breeding nursery and local land races entries showed a wide range of variability for each trait viz, leaf color (light green, medium. dark), leaf size (broad, medium, narrow) & leaf orientation (droopy, semi droopy, erect, semi erect) with disease reaction for leaf and yellow rust were in 0-100 S range.

FILIAL GENERATIONS

(a)-Filial generations for high yielding irrigated material

About 214 fresh crosses of high yielding and rust resistance were attempted. In F_1, 244 crosses were studied, and 199 crosses were selected. F_2 generation was planted with 1.8 x 6m plot size. F_2 contained 233 entries and 146 entries were selected. F_3 contained 184 entries and 121 entries were selected. From F4, 88 entries were selected out of 178 entries. While F5 contained 49 crosses out of which 34 crosses and 627 head rows were selected. F6 generation was sown with plot size of 1 row x 2.5 m. F6 contained 1605 entries from which 111 entries were selected. F_7 generation was advanced by adopting selected bulk method. In F_7, 111 lines were tested, out of which 61 lines were selected and promoted for preliminary yield trials. Genotypes studied and selected in filial generations for high yield material under irrigated conditions are shown in the following table.

Table 5: Study of filial generations for high yielding irrigated material

Filial Generations	Genotypes studied	Genotypes selected
F1	244	199
F_2	233	146
F_3	184	121
F_4	178	88
F_5	49 crosses	34 crosses, 627 heads
F_6	1605	111
F_7	111	61

(b)-Filial generations for drought tolerance material

Filial generations (F_0-F_7)

Two hundred single (F_0 generation) and sixty top crosses were attempted, out of which 157 single and 56 top crosses were harvested. F_1 generation was planted in irrigated condition so that sufficient seed may be produced. F_2 to F_7 were planted in rainfed conditions and these generations were exposed to artificial rusts inoculated conditions. Entries/plants exhibiting drought tolerance, desirable plant height and diseases resistance were selected using selected bulk. The breeding material was planted during last week of October, 2022 and fertilized @120:90:60 N: P: K kg ha^{-1}at sowing time. Plot size of F_2-F_7 was 1.8x6m while single row of F_6 was sown in 2.5m length. 213, 287, 245, 183, 157, 3500, 353 and 51 entries from F_0 to F_7 entries were selected, respectively (table 6).

Table 6: Detail of filial generations for drought tolerance during 2022-23

Generations	Entries studied	Entries selected
F_0	260	213
F_1	315	287
F_2	295 SHB	245 SHB
F_3	204 SHB	183 SHB
F_4	204 SHB	157 SHB
F_5	190 SHB	132/3500 SH
F_6	83/5505SHR	34/353 SHRP
F_7	143	51

SHB= Single head bulk, and SHRP=Single head row progeny, SHR=Single head rows

(c)-Filial generations for heat tolerance material

Two hundred and fourteen fresh crosses for heat tolerance were harvested. F_1 generation was sown during 2nd week of November 2022 with the plot size of 1x2.5m. F_2-F_6 generations were sown during first week of December 2022. Plot size of F_2-F_5 was 1.8x6m while single row of F_6 was sown of 2.5 m length. Data regarding disease incidence and plant type was recorded. At maturity, single heads from desirable plants of F_2, F_3 and F_4 were bulked to raise successive generations. The selected material was finally evaluated on visual grain basis. For generation advancement, the following table depicts the number of entries selected out of studied entries in each filial generation.

Table 7: Study of filial generations for heat tolerance material

Filial Generations	Entries studied	Entries selected
F_2	230	179
F_3	127	92
F_4	81	47
F_5	152	101, 1618
F_6	2006	84
F_7	130	49

(d)-Filial Generation of durable rust resistance

About 100 fresh crosses of high yielding durable rust resistance were attempted. F_1 generation was sown during 2nd week of November 2022 with plot size of 1 row x 2.5 m. In F_1, 226 crosses including top crosses were studied and 160 crosses were selected. F_2 to F_7 were planted with 1.8*6m plot size in irrigated conditions and these generations were exposed to artificial rusts inoculated conditions. Single head row of F_6 was sown in 2.5m length on the same date and fertilized @120:90:60 N: P: K kg ha^{-1} at sowing time. Data regarding diseases incidence and plant type were recorded. At maturity, single heads from desirable plants of F_2, F_3 and F_4 were bulked to raise successive generations. The selected material was finally evaluated on grain yield and visual grain basis. Entries selected from F_7 generation were promoted to preliminary yield trial. Results of different generations are given in table 8.

Table 8: Selected entries of filial generations of durable rust resistance.

Generations	Entry	
	Tested	Selected
F_1	226	160
F_2	213	135
F_3	98	66SHB
F_4	149	75SHB
F_5	91	76/1385
F_6	42/1547	32/60SHR
F_7	24/63	19/26SHRP

(e)-Filial generations of salt tolerance

Thirty fresh crosses of high yielding salt tolerance were harvested. 118 F_1 crosses were studied which were sown on 11th of Nov with plot size of 1 row x 2.5 m. Among them 109 crosses were selected. F_2 generation was sown with 6rows x 5m plot size. F_2 contained 40 entries and 29 entries were selected. F_3 was planted following 5rows x 5m plot size and 59 entries were studied from which 49 entries were selected for further evaluation while in F_4 40 entries were studied and 25 were selected.

SCREENING TRIALS

(a)-Drought tolerance

Screening Bread Wheat Germplasm for Drought Tolerance

Forty-eight wheat genotypes were sown in plot size of 1 row of 2.5-meter length. The experiment was sown in RCBD design under normal irrigation and water stress conditions. Akbar-19 and Arooj-22 were used as check varieties. Range of various traits under drought and normal conditions are given in table 9.

Table 9: Range of Various Traits under drought and normal conditions.

S. No.	Traits	Normal	Rainfed
1	Days to heading	100-123	96-113
2	Germination (%)	80-90	70-85
3	Days to maturity	136-146	130.5-143
4	Plant height (cm)	88-120	80-110
5	Flag leaf area (cm^2)	39-140	29-94
6	Canopy temperature (°C)	13.5-18.6	14.9-19.7
7	NDVI	0.70-0.85	0.65-0.80
8	Spike length (cm)	10.5-17.1	9.8-15.6
9	Thousand grain weight (g)	30-56	23-47
10	Grain yield (Kg ha^{-1})	3865.7-7291.5	1586.3-3732.4

The high yielding genotypes than the best check variety under normal and rainfed conditions in each block are given as under;

Table 10: Top five best performing genotypes under normal & rainfed conditions.

RAINFED			
S. No.	**Code**	**Parentage/Pedigree**	**Yield (Kg ha^{-1})**
1	V-21291	BECARD/FRNCLN//KACHU/KIRITATI/3/BOKOTA CMSS14B01372T-099TOPY-099M-0SY-38M-0WGY	3732.4
2	V-21522	WBLL1*2/BRAMBLING*2//BAVIS*2/3/CHYAK1/VILLA JUAREZ F2009//WBLL1*2/BRAMBLING CMSS13B01606T-099TOPY-099M-099NJ-099NJ-3Y-0WGY	3719.1
3	V-21533	KACHU/DANPHE*2//BORL14 CMSS14Y01482T-099TOPM-099Y-099M-0SY-34M-0WGY	3612.4
4	V-21665	MUCUY*2//SUP152/BAJ #1 CMSS13B01217T-099TOPY-099M-099NJ-099NJ-27Y-0WGY	3265.6
5	V-21542	BOKOTA/MUCUY CMSS14B00062S-099M-0SY-6M-0WGY	3132.6
Check		**Akbar-19**	**1639.6**
		Arooj-22	**1586.3**
CV (%) = 12.26, LSD (0.05) = 362.99			
NORMAL			
S. No.	**Code**	**Parentage/Pedigree**	**Yield (Kg ha^{-1})**
1	V-21542	BOKOTA/MUCUY CMSS14B00062S-099M-0SY-6M-0WGY	7091.56
2	V-21261	NADI#2//TRCH/HUIRIVIS #1/3/NADI#1 CMSS12Y00880T-099TOPM-099Y-099M-0SY-17M-0WGY	6904.94
3	V-20097	WEEBILL-1/8/BABAX/LR43//BABAX/6/MOR/VEE#5// DUCULA/3/DUCULA/4/MILAN/5/BAU/MILAN /7/SKAUZ/BAV92 PB13Ht000250-0A-0A-0A-17A-0A	6704.99
4	V-20580	MUTUS*2/MUU//2*MUCUY CMSS13Y01148T-099TOPM-099Y-099M-0SY-16M-0WGY	6625.01
5	V-21533	KACHU/DANPHE*2//BORL14 CMSS14Y01482T-099TOPM-099Y-099M-0SY-34M-0WGY	6291.76
Check		**Akbar-19**	**5491.9**
		Arooj-22	**7291.5**
CV (%) = 10.32, LSD (0.05) = 242.59			

(b)-Heat tolerance study

Twenty-one bread wheat genotypes were sown in 2 rows of 2.5-meter length inside and outside tunnel on 3rd week of November 2022. The same set was sown late on 2nd December 2022. Post anthesis heat shock was imposed by covering the tunnel with polypropylene sheet for about three weeks after anthesis. Out of 21 entries, 9 entries performed well in all three (normal, stress and late) sets than the check variety (Dilkash-20). Relative yield in normal and tunnel sets is given in table 11.

Table 11: Relative yield in normal and tunnel sets

Genotypes	Relative Yield in tunnel set vs normal	Relative Yield in late set vs normal
V-20337	0.89	0.73
V-20611	0.89	0.73
V-21443	0.95	0.62
HYT-100-76	0.83	0.59
V-19317	0.81	0.62
HYT-100-47	0.80	0.58
V-19308	0.80	0.53
V-21433	0.73	0.49
V-20613	0.70	0.60
Dilkash-20	0.71	0.57

YIELD TRIALS

Station Yield Trials

The most promising lines selected from different sources i.e. F_7 generation, International nurseries/ trials, drought, heat stress and plant pathology program were evaluated in station yield trials.

(a)-Preliminary wheat yield trials (irrigated)

In irrigated preliminary yield trials (A-trials), 216 advance lines were evaluated, using Alpha Lattice Design with two replications, in four trials (54 test entries and 2 check varieties Akbar-19 and Arooj-22, in each trial) and 11 advance lines were evaluated using randomized complete block design with two replications, compared with check varieties viz. Akbar-19 and Arooj-22. Trials were planted on November 08, 2022 with plot size of 6m x 1.62m and harvested plot size was 5m x 1.62m. Fifty-two advance lines performed better than the one or both the check varieties on the basis of better grain yield and desirable diseases tolerance. The selected advance lines will be studied further in Regular Wheat Yield Trials. The respective data of days to 50 % heading, days to maturity, Reproductive phase (days), plant height, diseases reaction and grain yield of selected entries is given in the table 12.

Table 12: Yield performance and related traits of promising lines in preliminary wheat yield trials (irrigated)

A-1 (Normal)									
Sr. No.	V-Code	Entry	Days to 50% Heading	Days To Maturity	Reproductive Phase (Days)	Plant Height (cm)	Disease Reaction		Grain Yield (kg ha^{-1})
							Leaf Rust	Yellow Rust	
1	V-22034	35	109	150	41	97	10M	20M	5834
2	V-22005	5	107	151	44	110	20MS	10M	5544
3	V-22014	15	108	149	41	89	10M	0	5536
4	V-22028	29	107	152	45	97	10RMR	20M	5440
5	V-22009	10	109	149	40	105	20M	30M	5412
6	V-22013	14	109	150	41	107	20MS	0	5329
7	V-22033	34	103	151	48	111	30M	0	5277
8	V-22015	16	106	149	43	99	30MS	0	5267
9	V-22006	6	107	150	43	107	10M	5M	5223
Arooj-22 (Check)		40	107	151	44	97	20M	0	5220
10	V-22011	12	109	152	43	111	0	20M	5201
11	V-22044	46	110	150	40	95	30M	TR	5199
12	V-22017	18	105	151	46	102	10M	10MR	5160
13	V-22020	21	109	151	42	99	10MS	0	5152
14	V-22035	36	103	151	48	87	0	0	5144
15	V-22042	44	107	150	43	105	30M	TR	5138
16	V-22004	4	107	151	44	104	20MSS	20M	5093
17	V-22010	11	109	151	42	107	20MS	20M	5037
Akbar-19 (Check)		8	103	150	47	90	5M	20RMR	5035
LSD (kg ha^{-1})= 419.33, CV (%)= 4.33									

A-2 (Normal)									
Sr. No.	V-Code	Entry	Days to 50% Heading	Days to Maturity	Reproductive Phase (Days)	Plant Height (cm)	Disease Reaction		Grain Yield (kg ha^{-1})
							Leaf Rust	Yellow Rust	
1	V-22099	47	109	150	41	98	10M	60M	5691
2	V-22059	5	109	151	42	100	0	20MR	5565
3	V-22065	12	109	151	42	96	0	0	5552
4	V-22084	31	110	151	41	93	0	30M	5471
5	V-22103	51	109	151	42	92	0	20M	5461
6	V-22097	45	109	150	41	99	0	20M	5454
7	V-22057	3	109	151	42	94	0	10M	5260
8	V-22079	26	101	151	50	98	0	10M	5259
9	V-22095	43	109	150	41	89	0	0	5203
10	V-22066	13	109	151	42	105	0	0	5186
Arooj-22 (Check)		40	106	150	44	97	20M	0	5172
11	V-22085	32	110	151	41	96	30MS	5M	5127
12	V-22068	15	109	150	41	91	0	0	5101

13	V-22069	16	107	149	42	98	10MR	0	5058
14	V-22067	14	109	151	42	93	0	0	5036
Akbar-19 (Check)		8	101	149	48	91	5M	20RMR	5015
LSD (kg ha^{-1}) = 415.22, CV (%) = 4.06									

A-4 (Normal)

Sr. No.	V-Code	Entry	Days to 50% Heading	Days to Maturity	Reproductive Phase (Days)	Plant Height (cm)	Disease Reaction		Grain Yield ($kgha^{-1}$)
							Leaf Rust	Yellow Rust	
1	V-22197	36	110	151	41	92	10M	0	5962
2	V-22189	28	107	151	44	100	20M	10M	5891
3	V-22194	33	107	150	43	103	20M	0	5806
4	V-22184	23	101	150	49	95	10M	0	5725
5	V-22196	35	103	150	47	86	10M	0	5669
6	V-22204	44	108	150	42	83	20M	40M	5636
7	V-22183	22	107	150	43	96	10M	0	5635
8	V-22174	13	103	150	47	78	0	0	5580
9	V-22206	46	106	150	44	89	20M	10M	5542
10	V-22192	31	110	151	41	96	20M	0	5423
11	V-22169	7	103	150	47	92	0	0	5381
12	V-22186	25	109	150	41	95	0	0	5364
13	V-22214	54	101	149	48	88	0	0	5343
14	V-22198	37	108	150	42	102	20M	0	5276
15	V-22202	42	109	151	42	86	30MSS	0	5234
Akbar-19 (Check)		8	101	150	49	90	5M	20RMR	5190
16	V-22215	55	101	150	49	81	30M	0	5153
17	V-22193	32	110	150	40	101	0	0	5127
Arooj-22 (Check)		40	106	150	44	95	20M	0	5104
LSD (kg ha^{-1}) = 399.36, CV (%) =3.73									

A-5 (Normal)

Sr. No.	V-Code	Entry	Days to 50% Heading	Days to Maturity	Reproductive Phase (Days)	Plant Height (cm)	Disease Reaction		Grain Yield ($kgha^{-1}$)
							Leaf Rust	Yellow Rust	
1	V-22224	10	110	151	41	103	10MR	0	5672
2	V-22223	9	107	150	43	103	10MR	10M	5635
Arooj-22 (Check)		8	107	150	43	97	20M	0	5496
3	V-22222	7	109	151	42	112	0	10M	5411
4	V-22220	5	108	151	43	93	20M	0	5388
Akbar-19 (Check)		4	102	150	48	95	5M	20RMR	5354
LSD (kg ha^{-1})= 377.87, CV (%)= 344									

(b)-Regular wheat yield trial (B-Trial)

Two hundred and sixty nine promising advance lines were selected from different breeding programs and were evaluated in regular yield trials (B-trials) under normal planting time (on November 08, 2022) and irrigated conditions, to assess their grain yield potential and diseases tolerance. The trials were conducted using Alpha Lattice Design with two replications, and performance was compared with check varieties viz. Akbar-19, Arooj-22. Forty-nine advance lines have been selected, keeping in view better grain yield than the higher yielding check and desirable diseases tolerance, for further study and out of these forty-nine lines, the selected ones with be evaluation in multi-location Punjab Uniform Wheat Yield Trials. The respective data of days to 50 % heading, days to maturity, reproductive phase (days), plant height, diseases reaction and grain yield of selected entries is given in the table 13.

Table 13: Yield performance and related traits of promising lines in regular wheat yield trials (irrigated)

B-1 (Normal)

Sr. No.	V-Code	Entry	Days to 50% Heading	Days to Maturity	Reproductive Phase (Days)	Plant Height (cm)	Disease Reaction		Grain Yield (kg ha^{-1})
							Leaf Rust	Yellow Rust	
1	V-21170	25	107	150	43	115	0	10M	5793
2	V-21086	20	110	151	41	97	10M	20M	5737
3	V-21049	16	105	151	46	106	10M	30M	5460
4	V-21205	43	107	152	45	103	20M	10M	5441
5	V-21187	33	103	151	48	102	0	10M	5282
6	V-21207	45	107	152	45	98	10M	10M	5270
7	V-21194	36	104	151	47	83	20M	20M	5210
Arooj-22 (Check)		40	108	152	44	105	20M	0	5210
Akbar-19(Check)		8	101	150	49	102	5M	20RMR	4908
LSD (kg ha^{-1}) = 365.46, CV (%) = 3.59									

B-2 (Normal)

Sr. No.	V-Code	Entry	Days to 50% Heading	Days to Maturity	Reproductive Phase (Days)	Plant Height (cm)	Disease Reaction		Grain Yield (kgha^{-1})
							Leaf Rust	Yellow Rust	
1	V-22246	23	106	151	45	77	10M	20M	5828
Arooj-22 (Check)		40	104	151	47	90	20M	0	5299
Akbar-19(Check)		8	100	149	49	88	5M	20RMR	5062
LSD (kg ha^{-1})= 408.09, CV (%)= 4.33									

B-3 (Normal)

Sr. No.	V-Code	Entry	Days to 50% Heading	Days to Maturity	Reproductive Phase (Days)	Plant Height (cm)	Disease Reaction		Grain Yield (kgha^{-1})
							Leaf Rust	Yellow Rust	
1	V-22287	10	107	152	45	84	30M	0	5631
2	V-22328	52	111	151	40	90	20M	40M	5581
3	V-22301	24	100	150	50	87	0	0	5338

4	V-22289	12	107	153	46	100	0	0	5322
5	V-22288	11	101	150	49	82	30M	20M	5314
6	V-22302	25	100	150	50	75	0	0	5305
7	V-22303	26	99	150	51	100	0	TMR	5262
8	V-22292	15	104	151	47	80	20M	10M	5157
9	V-22311	34	101	151	50	100	20M	0/40MS	5132
10	V-22297	20	107	151	44	95	10M	10M	5121
11	V-22295	18	107	152	45	95	0	0	5035
12	V-22305	28	104	149	45	90	0	0	4988
Akbar-19(Check)		8	103	151	48	81	5M	20RMR	4983
Arooj-22 (Check)		40	106	150	44	97	20M	0	4965
LSD (kg ha^{-1}) =350.93, CV (%) = 3.65									

B-4 (Normal)

Sr. No.	V-Code	Entry	Days to 50% Heading	Days to Maturity	Reproductive Phase (Days)	Plant Height (cm)	Disease Reaction		Grain Yield ($kgha^{-1}$)
							Leaf Rust	Yellow Rust	
1	V-21541	21	103	151	48	82	0	5M	6235
2	V-21551	26	101	150	49	98	0	0	6227
3	V-21542	22	101	150	49	100	0	0	6207
4	V-21547	24	104	149	45	100	10M	5M	6199
5	V-21532	15	102	150	48	90	20M	40M	6108
6	V-21573	32	106	152	46	97	10MS	0	6091
7	V-21579	37	100	150	50	86	10M	10M	6073
8	V-21576	35	101	151	50	104	10MS	5M	6048
9	V-21574	33	106	151	45	97	10M	0	6046
10	V-21545	23	102	149	47	98	10M	0	6043
11	V-21517	7	101	151	50	82	0	0	5995
kbar-19 (Check)		8	103	149	46	92	5M	20RMR	5922
Arooj-22 (Check)		40	107	150	43	86	20M	0	5332
LSD (kg ha^{-1}) = 408.00, CV (%) = 3.51									

B-5 (Normal)

Sr. No.	V-Code	Entry	Days to 50% Heading	Days to Maturity	Reproductive Phase (Days)	Plant Height (cm)	Disease Reaction		Grain Yield ($kgha^{-1}$)
							Leaf Rust	Yellow Rust	
1	V-20580	48	106	150	44	93	10M	5M	6150
2	V-22664	32	105	152	47	80	10M	10M	6040
3	V-21237	36	107	151	44	88	20MSS	20M	5944
4	V-20170	49	105	151	46	90	10M	0	5941
5	V-21665	52	107	151	44	100	10M	10M	5893
6	V-21256	44	106	151	45	95	0	10MR	5829
7	V-22652	20	104	150	46	101	0	0	5792
8	V-22661	29	107	152	45	96	10M	0	5756
9	V-22659	27	107	151	44	90	10M	20M	5698
10	V-21669	45	107	151	44	88	0	0	5650
11	V-22644	12	105	151	46	116	10M	20M	5638
12	V-20572	47	110	152	42	97	0	0	5567

13	V-22646	14	102	149	47	91	0	20M	5562
14	V-22663	31	108	151	43	87	20MS	0	5560
15	V-20550	46	107	151	44	102	0	10M	5536
16	V-22667	35	106	150	44	90	10M	10M	5531
17	V-22645	13	102	150	48	90	10M	10M	5523
18	V-22647	15	107	149	42	92	10M	0	5501
Arooj-22 (Check)		40	107	150	43	93	20M	0	5500
Akbar-19 (Check)		8	102	150	48	93	5M	20RMR	5409
LSD (kg ha^{-1})=388.55, CV (%)=3.32									

(c)- Preliminary yield trial (Rainfed)

A-Trial (Rainfed)

In A-I trial 22 advanced lines (out of 71) were found high yielding than the check varieties (Dilkash-20 & MA-21) under rainfed conditions (table 14).

Table 14: Top fifteen high-yielding candidate lines in A-I Trial (rainfed) 2022-23

A-I (Rainfed)			**Dilkash-20**	**MA-21**	**YR**	**LR**
			3169	1706		
S. No.	**Variety Code**	**Yield (kg ha^{-1})**	**Percentage increase over check varieties**			
1	V-22528	4101.2	29.41	139.51	40M	0
2	V-22526	3954.3	24.78	130.93	30M	10M
3	V-22521	3845.7	21.35	124.59	0	20M
4	V-22516	3785.2	19.44	121.05	0	10MR
5	V-22543	3722.2	17.45	117.38	30M	10M
6	V-22546	3722.2	17.45	117.38	30M	0
7	V-22523	3718.5	17.34	117.16	30M	10M
8	V-22525	3635.8	14.73	112.33	30M	5MR
9	V-22550	3583.9	13.09	109.30	TM	10M
10	V-22508	3477.8	9.74	103.10	40M	40M
11	V-22532	3448.1	8.80	101.37	30M	0
12	V-22522	3334.6	5.22	94.74	0	10M
13	V-22571	3330.9	5.10	94.52	0	20M
14	V-22534	3285.2	3.66	91.85	0	10MS
15	V-22503	3266.7	3.08	90.77	0	0
CV = 14.5 , LSD = 403.22						

In A-II trial 28 advanced lines (out of 71) were found high yielding than all the check varieties (Akbar-19, Dilkash-20 & MA-21) under rainfed conditions as given below,

Table 15: Top fifteen high-yielding candidate lines in A-II Trial (Rainfed) 2022-23

A-II (Rainfed)			Akbar-19	Dilkash-20	MA-21	YR	LR
			3106.2	3127.2	2902.5		
S. No.	Variety Code	Yield (kg ha^{-1})	Percentage increase over check varieties				
1	52	4482.7	44.3	43.3	54.4	0	0
2	49	4049.2	30.4	29.5	39.5	10M	0
3	17	4035.8	29.9	29.1	39.0	20M	0
4	37	3893.8	25.4	24.5	34.2	0	0
5	23	3872.8	24.7	23.8	33.4	10M	10M
6	5	3872.2	24.7	23.8	33.4	40M	30M
7	9	3797.5	22.3	21.4	30.8	10M	0
8	34	3770.4	21.4	20.6	29.9	0	30M
9	25	3754.3	20.9	20.1	29.3	0	10M
10	13	3709.9	19.4	18.6	27.8	0	20MS
11	35	3701.2	19.2	18.4	27.5	10M	20MSS
12	11	3551.9	14.3	13.6	22.4	10M	0
13	41	3494.4	12.5	11.7	20.4	0	20M
14	24	3435.8	10.6	9.9	18.4	10M	0
15	29	3354.3	8.0	7.3	15.6	0	0
CV =7.42 , LSD = 231.40							

Regular Yield Trial (B-Trials), Rainfed

In regular yield trials under drought conditions, two hundred and sixty- nine entries were tested following alpha lattice design with two replications and with two check varieties i.e. Akbar-19 and Arooj-22 in five regular (B-I to B-V) trials. The best performing entries in all the regular trials under drought conditions on the basis of yield potential and rust resistance are given as under;

Table 16: Top high-yielding candidate lines in -B Trial (Rainfed) 2022-23

Sr. No.	Variety Code	Parentage/Pedigree	Yield (kgha^{-1})	Disease Reaction 2022-23	
			Rainfed	Lr	Yr
B-I					
1	V-21187	TACUPETO F2001*2/KIRITATI//BLOUK #1/3/WBLL1*2/BRAMBLING*2//BAVIS CMSS14Y00189S-099Y-099M-0SY-5M-0WGY	4869.1	0	10M
2	V-21034	NSM*4/14-2//FRTL/2*PIFED/3/VORB /4/ NR 384(Lr37/Yr17/Sr38) PB14177-OA-OA-0A -26A-0A	4501.4	30M	0
Check		Arooj-22	**5159.3**		
		Akbar-19	**4351.2**		
LSD (0.05) = 442.70, CV (%) = 11.79					
B-II					
1	V-22250	KACHU*2/3/ND643//2*PRL/2*PASTOR*2/4/ KFA/2*KACHU CMSS14B01580T-099TOPY-099M-099NJ-099NJ-26Y-0WGY	4523.5	0	10M

2	V-22246	SHORTENED SR26 TRANSLOCATION //2*WBLL1*2/KKTS/3/BECARD/4/2*BORL14 CMSS14B01498T-099TOPY-099M-099NJ-099NJ-36Y-0WGY	4498.8	10M	20M
3	V-22276	WBLL1//PUB94.15.1.12/WBLL1/3/BORL14 PTSS17Y00032S-0B-099Y-099M-3Y-0B-0Y	4404.3	0	0
4	V-21225	MUNAL #1/FRANCOLIN #1*2/3/ATTILA*2 /PBW65//MURGA CMSS12Y00701T-099TOPM-099Y-099M-099NJ-099NJ-20Y-0WGY	4382.7	10M	0
5	V-22232	PAURAQ/NELOKI/3/WBLL1*2/BRAMBLING *2//BAVIS CMSS14Y00584S-099Y-099M-099NJ-099NJ-14Y-0WGY	4300.0	20M	0
6	V-22254	NUWEST/4/D887.74/PEW/3/LNCR//CARSTEN/ GGT/5/MRS/CItr 14482//OWW68007 /3/RONDEZVOUS/6/BECARD*2/DANPHE #1 /7/BOKOTA CMWS14B00042T-099TOPY-099M-099NJ-099NJ-16Y-0WGY	4266.7	0	0
7	V-22230	BORL14//BECARD/QUAIU #1 CMSS12Y00070S-099Y-099M-099NJ-099NJ-21Y-0WGY	4151.9	0	30M
Check		Arooj-22	**3991.4**		
		Akbar-19	**3307.4**		
LSD (0.05) = 496.43, CV (%) = 14.12					
B-III					
1	V-21503	NADI/COPIO//NADI#2 CMSS11B00910T-099TOPY-099M-099NJ-099NJ-37WGY-0B	4438.3	30MS	30M
2	V-22311	MEX94.27.1.20/3/SOKOLL//ATTILA/3*BCN/4/ PUB94.15.1.12/WBLL1/5/MUCUY	4133.3	20M	0/40MS
3	V-22287	MILAN/KAUZ//PRINIA/3/BAV92/4/WBLL1*2/ KUKUNA/5/KACHU*2/FRNCLN PTSS17Y00209S-0B-099Y-0M-34Y-0Y	4034.6	30M	0
4	V-22310	MUNAL*2/CHONTE*2/3/SWSR22T.B./2* BLOUK #1//WBLL1*2/KURUKU CMSS14B01547T-099TOPY-099M-099NJ-099NJ-43Y-0WGY	3861.7	10M	60M
5	V-22301	BORL14*2//BECARD/QUAIU #1 CMSS12B00634T-099TOPY-099M-099NJ-099NJ-17Y-0WGY	3702.5	0	0
6	V-21504	KFA/2*KACHU//BECARD/MUNAL #1 CMSS13Y00084S-099Y-099M-099NJ-099NJ-11Y-0WGY	3577.778	30MS	0
7	V-22295	SOKOLL/3/PASTOR//HXL7573/2*BAU/4/ WBLL4//OAX93.24.35/WBLL1/5/MUTUS*2/ CHONTE PTSS16Y00213S-0B-099Y-099M-13Y-020Y-0B-0Y	3550.0	0	0

Checks		Arooj-22	**3433.5**		
		Akbar-19	**3357.9**		
LSD (0.05) = 390.68, CV (%) = 12.46					
B-IV					
1	V-21589	CHAKWAL-50/3/ATTILA*2/PBW65*2//TNMU PB14DR0010824-0A-0A-0A-7A-0A	4718.5	10M	0
2	V-21577	MUTUS*2/HARIL #1*2/3/SWSR22T. B/2* BLOUK #1//WBLL1*2/KURUKU CMSS14B01582T-099TOPY-099M-0SY-55M-0WGY	4691.4	30MS	10M
3	V-21517	KENYA SUNBIRD/2*KACHU//KFA/2*KACHU CMSS13B00499S-099M-099NJ-099NJ-25Y-0WGY	4648.2	0	0
4	V-21580	CASCBL/BAVIS//2*BORL14 CMSS14B01613T-099TOPY-099M-0SY-12M-0WGY	4611.1	10M	10MR
Checks		Arooj-22	**4112.4**		
		Akbar-19	**3254.3**		
LSD (0.05) = 398.05, CV (%) = 12.04					
B-V					
1	V-21635	QG4.37A/4/MILAN/KAUZ//PRINIA/3/BAV92 /5/MILAN/KAUZ//PRINIA/3/BAV92/6/SKAUZ *2/PRL/CM6553//INQ-91 PB14DR001152-0A-0A-0A-1A-0A	4563.6	10M	60M
2	V-22644	KACHU#1//WBLL1*2/KUKUNA/3/BRBT1*2/ KIRITATI/6/ROLF07*2/5/REH/HARE//2*BCN /3/CROC_1/AE.SQUARROSA (213) //PGO/4/ HUITES/7/BORL14 CMSS12B01029T-099TOPY-099M-099NJ-099NJ-20Y-0WGY	4235.8	10M	20M
3	V-22647	MUTUS*2//TAM200/TURACO/3/KFA/2* KACHU/4/MUNAL*2/WESTONIA CMSS14Y01703T-099TOPM-099Y-099M-099NJ-099NJ-11Y-0WGY	4200.0	10M	0
Checks		Arooj-22	4188.9		
		Akbar-19	3409.9		
LSD (0.05) = 354.28, CV (%) = 10.73					

(e)-Short Regular Wheat Yield Trial

During this year, five late regular wheat yield trials were conducted in which 280 advanced lines were verified by means of alpha lattice design with two replications by using two checks (Akbar-19 and Arooj-22) of bread wheat. The tardily sowing was done on 6th December 2022. Data regarding days to plant height, disease reactions, yield, days to heading and maturity were documented. Selections of fortunate lines on the basis of yield, disease score and visual grain basis

were made (table 17). Among 280, 40 advanced lines were selected for further evaluation in provincial uniform wheat yield trials. Among these selected advance lines, following lines surpass the best checks in late sown condition depicted that these lines perform better in heat stress scenario.

Table 17: Yield performance advanced lines in short regular yield trial (2022-23)

B-1 (Short)			
V. Code	**Yield ($kgha^{-1}$)**	**% Increase Over Checks**	
		Akbar-19	**Arooj-22**
		3120	**3778**
V-21209	4764	52.7	26.1
V-21207	4449	42.6	17.8
V-21039	4441	42.3	17.5
V-21183	4406	41.2	16.6
V-21050	4386	40.6	16.1
V-21034	4264	36.7	12.9
V-21214	4144	32.8	9.7
V-21205	3972	27.3	5.1
V-21203	3962	27.0	4.9
21049	3870	24.0	2.4
B-II (Short)			
		2994	**3512**
V-22232	4840	61.6	37.8
V-22265	4394	46.8	25.1
V-22240	4144	38.4	18.0
V-22254	4001	33.6	13.9
V-21225	3960	32.3	12.7
V-22230	3874	29.4	10.3
V-22236	3818	27.5	8.7
V-22248	3789	26.6	7.9
V-22262	3521	17.6	0.2
B-III (Short)			
		3173	**3694**
V-22301	4691	47.9	27.0
V-22294	4519	42.4	22.3
V-22303	3973	25.2	7.6
V-21504	3946	24.4	6.8
V-22302	3889	22.6	5.3
V-22320	3864	21.8	4.6
V-21503	3785	19.3	2.5
V-22287	3769	18.8	2.0
V-22296	3704	16.7	0.3

B-IV (Short)			
		3623	**4263**
V-21526	4342	19.8	1.9
B-V (Short)			
		2718	**3117**
V-22647	4015	48	28.8
V-22665	3912	44	25.5
V-22643	3751	38	20.3
V-22663	3573	31	14.6
V-20671	3325	22	6.7
V-21665	3285	21	5.4
V-20550	3125	15	0.3
CV (%) = 11.45, LSD (0.05) = 295.64			

(d)-Regular Yield Trial (SABWGPYT)

Fifty advanced lines of bread wheat, selected from South Asia Bread Wheat Genomic Prediction Yield Trials 2021-22 were tested in regular yield trials (B-Trial) under normal planting irrigated conditions. Data for emergence (%), days to 50% heading, Normalized Difference Vegetation Index (NDVI), canopy temperature, plant height (cm), lodging (%), diseases incidence and grain yield (kgha^{-1}) were recorded. Five advanced lines have been selected which performed better than check varieties (Akbar-19) for grain yield (594 kgha^{-1}) and exhibited good disease tolerance. Among selected advance lines, V-22429 gave highest grain yield of 6308 kgh^{-1}a followed by V-22424 (6292 kgha^{-1}), V-22444 (6248 kgha^{-1}), 22408 (6235 kgha^{-1}) and V-22421 (6185 kgha^{-1}), respectively.

(e)-Punjab Uniform Wheat Yield Trials (PUWYT)

This trial is coordinated by Chief Scientist, Wheat Research Institute, AARI, Faisalabad. Advance lines are contributed by public sector and private sector stakeholders conducting research on wheat improvement (table 17). This year, fifty-eight advance lines were evaluated against check varieties Akbar-19 and Arooj-22, using alpha lattice experimental design with two replications. The trials were planted on normal planting in November 2022, at 30 locations throughout Punjab province under irrigated and rainfed conditions. The highest average grain yield was produced by NR-587 (4511 kg ha^{-1}) followed by V-21239 (4447 kg ha^{-1}) and NIBGE 10HP-435 (4393 kg ha^{-1}), while check varieties Arooj-22 and Akbar-19 produced 4387 kg ha^{-1} and 4311 kg ha^{-1}, respectively (table 18).

Table 18: PUWYT 2022-23 (grain yield:kg/hac)

Ranking	Entry Name	KHANEWAL	VEHARI	ARIF WALA	PAK PATTAN	MMRI, SAHIWAL	ARMY FARM, DEPALPUR	Renalakhurd	Farooqabad	Gujranwala	M.B. DIN	Kot Naina	ICI	Sargodha	WRI, FSD, (IR)	WRI, FSD, (RF)	FAZILPUR	JAHANIAN	R.Y.KHAN	RARI, BWP	ALIPUR	B.NAGAR	KHANPUR	AZRI, BHAKKAR	KAROR	Kalurkot	BARI, CHAKWAL	Attock	NARC Isd	FATEH JANG	UAF	Grand Average (kg/ha)
1	NR-587	4500	5298	5013	3271	5138	4892	3788	3350	3463	4288	3321	2725	4742	5348	3500	4483	6409	6567	4833	5125	5758	5067	4550	4883	4517	4364	2140	4897	3500	5733	4511
2	V-21239	5300	5297	4988	2625	4517	5465	3979	2523	3938	3438	3742	3271	4171	5371	3670	3942	6015	5950	4417	5292	5358	5300	4800	4334	4334	5363	1957	5077	3364	5520	4447
3	NIBGE 10HP-435	4813	5343	4863	2817	5171	4950	3454	2304	4008	5175	3775	2813	3533	5916	3550	5333	5917	5950	2625	5125	5267	5717	5292	4867	4767	3689	1987	4831	3035	5013	4393
4	AROOJ-22 (Check)	4908	4865	4908	3350	5000	5209	3333	2800	3529	4200	3588	3067	3679	5180	3418	4300	5714	5425	3000	6125	5092	6333	5025	4500	4617	5038	3444	5169	2889	5120	4387
5	IS-20242	5104	4812	4829	3483	4800	5550	4321	3863	3738	4483	4092	3258	3204	4547	3931	5375	6675	4550	3250	4500	5942	5717	4884	4784	4583	3858	3124	3909	3049	4213	4381
6	AS-8108	5100	5225	4688	4200	4904	5075	4192	2800	3908	3804	3096	3521	3904	4316	4446	5200	6033	3242	4750	4792	5642	5183	4584	4250	4375	4684	2434	4524	3069	4787	4358
7	V-21240	5225	5423	4933	3758	4688	4725	3888	3054	3633	3971	3696	3308	3308	5246	3458	3383	6126	5475	4417	5025	5450	6008	4984	4725	4442	3920	1804	4540	2875	4520	4354
8	TRW-20	5075	5070	4196	3054	4813	5300	3342	3250	4171	3092	3538	3871	3813	4870	3700	3767	4517	6825	4250	4708	4025	6633	5084	4667	4400	5500	1817	4907	2965	4773	4330
9	NR-583	4725	4477	4908	3288	4829	4833	4400	3342	3188	3321	3383	2696	4188	5244	2821	3492	5375	5250	3583	6375	4783	6067	4667	4825	4475	4894	3014	4809	3083	4800	4311
10	AKBAR-19 (Check)	5300	5240	4283	2938	4892	5813	3675	4050	2921	3480	3621	2375	2983	5086	2926	3942	5317	6458	4917	6667	4733	6008	4834	4717	4484	3604	3790	3861	3382	3733	4311
11	ICS-3351	4167	4920	4646	2404	4721	5133	3988	2996	3542	3467	3529	3121	4000	5378	3440	5708	5917	3500	4833	4208	5258	5358	4584	4400	4533	5991	2260	4819	3250	4827	4297
12	NW-150	4779	3600	4058	4004	4771	5508	3421	2746	3892	4292	3888	3758	3700	5381	3771	3942	6542	5425	4667	6375	5825	4508	4575	4567	4517	3518	1897	3311	3132	4507	4296
13	204164	4458	5075	4296	3533	5363	5658	4171	3108	3996	3683	4158	2525	4963	5325	3387	4483	6126	5600	4500	5175	5450	4942	4417	4450	4025	3278	1844	4258	2944	3347	4295
14	V-21648	4721	5093	4563	3317	4688	5279	3729	3446	3450	4383	3533	3579	2483	4540	2553	5858	6126	5950	3250	5417	5450	4758	4417	4400	4258	4782	2107	5147	3250	3898	4283
15	TW1992	4904	4073	5033	2158	4429	5125	3800	2758	3283	4113	3696	3526	4471	3981	3889	5375	5920	5092	2583	3958	5267	5125	5117	4667	4433	4778	2807	4843	3069	5450	4277
16	V-20612	5125	5483	4404	3325	4979	4979	4171	3621	3500	3154	4113	3271	3525	5688	2041	4392	5675	5458	2750	5500	5050	4642	5084	4650	4367	3411	2807	3916	3828	4387	4236
17	NR-582	5525	5500	4292	2917	4592	4967	3375	2163	4042	4863	4042	2806	6413	4946	2910	4483	6401	3675	4000	6292	5700	5117	4834	4517	4425	2589	1980	4448	3451	3733	4233
18	TARA-2001	4863	5502	4492	2083	4571	5804	3875	2713	3208	4538	3113	3863	4308	5044	2164	3942	5851	5608	4417	4624	5208	5058	5250	4984	4642	3611	2567	3534	3014	4533	4233
19	BF-21151	5054	5555	4433	2471	4750	5025	4163	3038	3850	3229	3333	4013	4171	4565	3316	3583	6467	4292	5583	3408	5750	5858	4500	4434	4317	3373	2573	3542	3465	4658	4229
20	TW19101	4883	4370	5200	3038	4483	4975	3838	3371	3921	3746	3721	2533	3183	5140	2859	3208	4550	5092	5167	5206	4042	5417	5250	4684	4542	3573	3130	4296	3090	6013	4209
21	AS-1409	4738	3917	4529	3017	4608	5175	3017	2204	2846	4458	3333	2658	3854	5178	3328	5375	5375	7000	3583	5625	4783	5650	4517	4400	4108	4149	3150	4707	3222	4947	4209
22	WV-1340	5600	4565	4400	2300	4704	4992	3029	2138	3846	3654	3842	3404	3242	4796	3303	3583	5508	5775	4250	6375	4900	5892	4792	4450	4433	3864	1817	4979	3028	4640	4203
23	V-20611	4646	4792	4433	2971	4004	5083	3238	3771	2713	3225	3500	2779	3375	5376	3787	5017	5989	5775	3583	4542	5333	5233	5000	4800	4467	4480	3124	4140	2708	5080	4196
24	TWS19125	4513	5345	4888	2138	4088	5196	3800	2621	3954	3250	3663	3379	3546	4881	3719	5375	5371	5075	3500	4167	4775	5892	4217	4317	4442	4580	2743	4082	3785	4493	4189
25	INDUS-22	5171	4933	4813	2679	4525	4471	3442	2018	3096	3821	3704	3842	2908	4564	3113	3942	5851	5600	3917	6125	5208	6008	4833	4350	4300	2914	1920	4643	3438	5520	4176
26	21C244	4858	4482	4647	3183	4963	4617	3700	3288	2904	3433	4013	2908	3650	4806	3174	4300	5783	3325	5833	4914	5142	5025	4917	4717	4167	4296	2347	4858	3083	4160	4172
27	SW-215006	4625	4707	4746	2625	4625	5300	3363	3383	3304	3683	3443	3258	3904	4888	2706	4483	5850	5075	4000	6375	5208	5175	4750	4834	4425	4242	1860	3459	3139	4187	4168
28	21C252	4450	4990	4771	3513	4096	4693	4829	3583	3271	3846	3446	3646	4121	4640	3821	3025	5300	4208	3833	5083	4717	5175	5417	4867	4584	3422	1590	4443	2979	4053	4167
29	PGMB-20-7	5038	4407	4863	2554	3892	4317	3842	2721	3825	3775	2996	3117	3063	3957	3211	3942	5655	5600	3042	5625	5025	7033	5417	4867	4617	3784	2133	5077	3104	4533	4160
30	IS-20121	4092	4183	5129	2583	4367	4621	3979	3108	3271	3829	3529	2863	3079	3924	3116	4658	5508	5950	4333	5767	4900	5417	4800	4725	4334	3742	2377	4881	2881	4573	4147
31	V-21668	4975	4228	4667	2633	3783	5317	4096	3025	3371	3713	3404	1979	3217	4972	3510	4300	5642	5425	5333	3417	5017	5358	4783	4267	4250	3961	2214	4958	2896	5653	4145
32	V-21433	4729	5423	4288	3117	3708	4400	3738	2579	4254	3729	3738	3046	3942	4716	3613	3942	5100	5250	3667	5200	4533	5717	4642	4567	4292	4758	2237	4451	2896	4027	4143
33	AZP-22	3829	4840	4946	2733	3829	5025	4329	2592	4508	3683	3988	3646	4096	4827	3051	3942	4275	5425	3500	5667	3800	5592	4917	4767	4459	3411	1747	4729	3389	4520	4135
34	NIBGE 11HP-407	5021	4898	4538	2829	4271	4958	3742	2617	3611	3825	3242	3063	3783	4533	3770	4725	5508	5600	3758	4792	4900	5358	4158	4517	4317	2533	2140	4147	3238	3080	4122
35	NR-584	4038	5158	4433	3350	4404	4754	3508	2800	3221	3325	4175	3117	4229	5081	2883	5375	5642	5458	4333	3583	5017	4825	4500	4533	4275	2751	2540	4585	3215	4560	4121
36	IPL-21	4654	5428	4454	2683	4333	4844	4363	3429	4113	3804	3638	3204	3583	4039	2758	3942	5100	4375	4167	6625	4533	5858	4667	4434	4559	3390	2144	3291	2904	4427	4113
37	EV-20105	5396	4460	5025	2133	4179	5300	3238	2525	3567	3025	3508	2946	3754	4891	4124	3100	5783	4550	4250	5502	5142	5117	4550	4417	4100	3963	2117	4863	3238	5240	4110
38	V-20096	4908	4813	4996	2833	4175	4896	4025	3308	3779	2646	3208	3408	3038	5055	3264	3458	5783	5250	5425	3708	5142	5425	4833	4644	4542	3144	2364	2796	2833	5507	4107
39	V-21265	5121	4843	4513	3029	4746	4858	3654	3379	3088	3746	3363	3483	4729	4974	3039	2858	5508	5075	2892	3667	4900	5558	4646	4350	4784	4567	2500	2817	2894	4587	4098
40	V-21648	4754	3867	5821	2625	4517	4922	4046	3621	3788	3354	2829	3704	4483	4083	3783	3342	4817	6475	2750	5167	4108	4583	4750	4808	4500	2009	3450	4103	3139	3667	4012
41	PGMB-20-47	5033	4833	4750	3050	3625	5425	3633	3133	3150	3525	3304	3892	3571	4231	3316	3133	5025	5450	3875	5667	4475	4875	4917	4334	4484	4053	1734	4881	2507	3920	4008
42	V-21254	4646	4790	4638	2950	3908	4904	3886	3950	2954	3221	3800	2333	3579	5596	3604	3067	5375	3500	4500	5792	4783	6250	4417	4400	4600	3540	2134	2801	2944	3520	4006
43	10171	4988	4600	4842	2150	4767	4367	3300	2583	3075	2421	3258	3104	4200	4343	2947	3942	5783	5950	3083	5625	5142	6683	4417	4684	4200	3142	1997	2451	3285	4293	3985
44	NW-154	5500	4945	3963	2838	4883	4738	3908	2467	2671	2700	3042	3663	3408	4437	1809	3583	5508	5608	3250	5583	4900	5067	4567	4450	4317	3832	2097	3778	3340	4400	3975
45	204080	4483	4480	4600	2988	4217	4933	3811	3471	3025	3354	3338	2954	2738	4691	3340	3175	4958	3333	4350	5332	4417	5600	4475	4867	4167	3680	2347	4827	2951	4693	3953
46	1FAG-21	3688	4697	4246	1821	3925	3875	3417	2500	3542	4142	3138	3292	4617	4760	2659	3583	5375	5250	4083	5125	4783	5517	4500	4583	4459	3318	2004	3769	3028	4720	3947
47	20BT005	4184	4018	4433	2958	3363	4228	3825	2467	3308	3154	3183	2746	3183	3904	3183	5200	4567	4900	2958	6542	4050	6725	4584	4817	4500	3222	2430	3291	3076	4773	3902
48	204006	3958	4467	4113	1996	4046	4479	3354	1938	3338	3054	3421	3208	2875	4944	3985	4125	5508	5083	3583	5708	4900	5008	4550	4450	4275	3206	2070	2855	3188	5027	3890
49	3FAG-21	5038	5188	4496	3388	4367	4108	4296	2329	3054	2150	3475	3588	2696	4740	2595	3425	6125	4200	4000	4792	5450	6592	4584	4584	4283	1544	2110	1747	2729	4893	3885
50	IC21H6F	3758	4752	4383	2717	3988	5259	3813	3292	3342	3004	3567	3396	3083	4544	2821	3350	5096	3908	4167	4483	4533	5700	4500	4817	4342	2493	2480	2385	3444	5027	3881
51	5FAG-21	4483	4777	4525	2688	3617	4929	3250	3288	2333	2263	2729	4088	3225	4882	2567	4125	6195	3508	2792	6008	5517	6717	4750	4417	4359	1833	3267	1489	3313	5360	3857
52	4FAG-21	5479	4715	4258	2850	4750	5150	3400	2892	3138	1933	3421	3804	3182	4609	2839	2975	5100	5958	4167	5583	4533	4458	4834	4584	4617	1582	2247	1140	2796	4147	3815
53	2FAG-21	5192	4825	4917	3038	4200	4788	3538	3108	3088	2979	3221	3771	2217	3887	2629	3583	5100	5458	3583	6375	4533	4850	4625	4550	4117	1658	1970	1899	3764	3507	3782
54	PGMB-20-39	3800	3968	4004	2733	3483	3829	3325	2429	2483	2542	2729	2796	3121	3748	2950	3942	5096	5275	4750	5042	4533	4725	4708	4550	4609	3322	2440	4573	2813	3267	3780
55	IC21H1A	4308	4043	5246	2892	3813	4658	4004	2813	2179	2400	3008	3738	2475	4077	2839	3275	4958	5975	3083	5683	4408	5542	5000	4650	4317	1658	2027	1231	3021	5307	3764
56	18FI21	3479	3882	2942	2971	3171	3200	3125	2298	4050	2429	2488	3179	2900	3022	2840	5200	4475	5283	3417	4417	3983	6067	4500	4417	4417	3998	2390	4976	2818	5173	3676
57	IC21H3C	4538	4478	4242	2621	3883	5183	4046	2167	2192	1700	2471	3367	3000	3101	3132	3583	4753	3525	3083	5917	4233	5000	4500	4525	4225	1050	2247	1326	3403	4413	3589
58	RCA KHAZANA	3729	3433	3439	2217	4150	4638	3388	3392	2954	3038	2817	2675	2271	3830	1654	3767	4275	5067	3417	5250	3800	5775	4534	4500	4084	2000	2217	1913	2889	4307	3514
59	IC21H2B	3775	3960	4383	2946	4088	4185	3763	3125	2689	1933	3038	3108	2075	3833	2965	3942	4275	3517	2750	5375	3800	6067	4450	4267	4309	1367	1863	869	2951	5200	3505
60	IC21H5E	2983	3148	3413	2171	3658	3783	3558	2496	2079	1979	2725	3367	2600	3769	3696	3317	3990	5250	2625	5875	3550	4975	4500	4092	4817	1544	2550	904	2910	4080	3340

National Uniform Wheat Yield Trials (NUWYT 2022-23)

This trial comprised eighty entries (77 advance lines, 03 Check varieties; Akbar-19, Arooj-22 and one local check) and was coordinated by National Wheat Coordinator, Islamabad. Wheat Research Institute, Faisalabad contributed eight advance lines in this trial. Trials were conducted on 23 locations under irrigated and six locations under rainfed conditions in Punjab. The performance of the candidate lines (contributed by WRI) better than check varieties under irrigated and rainfed conditions is given in table 19 and table 20, respectively.

Table 19: The performance of the promising candidate lines (contributed by WRI) under irrigated conditions (23 locations) in Punjab.

Sr. No.	V-Code	NUWYT Year Testing	Average Grain Yield (kg ha^{-1})	Rust Resistance Index (RRI)		% Increase over Check Variety		
				Leaf Rust	Yellow Rust	Arooj-22	Akbar-19	Local Check
1	V-19347	2nd	4649	8.17	7.27	4.68	5.44	4.45
2	V-19559	1st	4635	8.04	3.42	4.37	5.13	4.13
3	HYT-100-74	2nd	4616	7.73	6.01	3.94	4.69	3.71
4	V-19308	2nd	4586	5.60	6.74	3.27	4.01	3.03
5	V-20337	1st	4542	7.58	9.00	2.27	3.02	2.04
6	HYT-100-76	2nd	4472	7.69	4.69	0.70	1.43	0.47
Arooj-22(Check)			**4441**					
Akbar-19(Check)			**4409**					
Local Check			**4451**					

Table 20: The performance of the promising candidate lines (contributed by WRI) under rainfed conditions (6 locations) in Punjab.

Sr. No.	V-Code	NUWYT Year Testing	Average Grain Yield (kg ha^{-1})	Rust Resistance Index (RRI)		% Increase over Check Variety		
				Leaf Rust	Yellow Rust	Arooj-22	Akbar-19	Local Check
1	V-19347	2nd	4164	8.17	7.27	12.06	13.96	15.19
2	V-19308	2nd	3999	5.60	6.74	7.62	9.44	10.62
3	V-20337	1st	3973	7.58	9.00	6.92	8.73	9.90
4	V-19532	1st	3932	4.72	5.48	5.81	7.61	8.77
5	HYT-100-74	2nd	3847	7.73	6.01	3.53	5.28	6.42
6	HYT-100-76	2nd	3762	7.69	4.69	1.24	2.96	4.07
Arooj-22(Check)			**3716**					
Akbar-19(Check)			**3654**					
Local Check			**3615**					

WHEAT AGRONOMY

(a)-Effect of climate change on sowing time of wheat crop

The trial was conducted to find out the best sowing time for newly developed wheat lines under changing climate scenario. Ten newly developed wheat lines viz. V-19347, HYT-100-74, V-19308, HYT-100-76, HYT-100-47, V-20337, V-19532, V-20330, V-19559 and V-19317 along with four check varieties i.e. Akbar-19, Subhani-21, Dilkash-21 and Arooj-22 were planted seven times starting from 20th October 20th December with ten days interval. Maximum grain yield of 6677 kg ha^{-1} was recorded when crop was sown on 20th October on overall mean basis, followed by 1st November sown grain yield (6342 kg ha^{-1}) and 10th November sown grain yield (6115 kg ha^{-1}). Among the varieties/lines It was found that V-19308, produced maximum grain yield (6217 kg ha^{-1}) amongst all varieties, which was followed by HYT-100-47 (6050 kg ha^{-1}) and HYT-100-76 (5953 kg ha^{-1}), respectively (table 21).

Table 21: Effect of climate change on sowing time of wheat crop

Advanced lines/ varieties	20th Oct.	1st Nov.	10th Nov.	20th Nov.	30th Nov.	10th Dec.	20th Dec.	Means
Akbar-19	5608	5484	5485	5787	5332	4281	4216	5171f
Subhani	6279	5918	5212	3991	3440	3360	3061	4466h
Dilkash	6367	5844	6177	5153	4286	3912	3889	5090f
Arooj-22	7263	6608	5856	5530	4760	4632	4149	5543d
V-19347	7738	7253	6170	5883	5356	4100	4438	5850bc
HYT100-74	6489	6277	5864	5218	4478	4212	4309	5264ef
V-19308	7410	6928	6667	6559	5383	5403	5169	6217a
HYT100-76	7011	6924	6422	5882	5781	5130	4519	5953bc
HYT100-47	7658	6909	6931	5858	5797	5001	4196	6050ab
V-20337	6123	6846	6395	6249	4885	4971	4620	5663cd
V-19532	5864	5787	5682	4877	4539	4405	4140	5027f
V-20330	5658	5562	5695	4891	4188	3304	3911	4763g
V-19559	6133	5948	6561	5389	4856	4607	4385	5499de
V-19317	7881	6500	6486	5735	4600	4072	3869	5590d
Means	6677a	6342b	6115c	5500d	4835e	4385f	4206f	
Cd1 for sowing dates 188, for varieties 244 and for interaction 522								

SEED PRODUCTION

a)-Single head progenies

For maintaining the purity of the variety/seed, breeder's nucleus seed, single head progenies of each variety were planted every year. For this purpose single head rows of ten commercial wheat varieties, one Durum wheat, twenty advanced lines of NUWYT and PUWYT were planted in the 3rd week of November. The number of head rows varied from 20 to 200 per variety/line, head rows of each variety were observed at different stages of plant development and rows deviating from the original variety were discarded. Uniform, vigorous and disease resistant rows of each variety were harvested and threshed separately. The seed of head row was also observed for grain characteristics. Selected entries were planted as breeder's seed to produce the pre-basic seed of commercial wheat varieties whereas the seed of head rows of candidate lines was kept separately for further study. The detail of selected heads is given in table 22 and 23

Table 22: Detail of single heads selected (2022-23)

Sr. No.	Name of Variety	Single head selected	Sr. No.	Name of Variety	Single head selected
1	Faisalabad.08	50	11	HYT-70-16	200
2	Punjab.11	50	12	V-17086	100
3	Galaxy.2013	50	13	HYT-100-47	100
4	Ujalla.16	50	14	HYT-100-74	100
5	Anaj.2017	100	15	HYT-100-76	100
6	Akbar-19	250	16	V-19347	100
7	Dilkash-20	250	17	V-19317	50
8	Subhani-21	100	18	V-19308	50
9	MH-21	50	19	V-18352	50
10	Arooj-22	250			

Table 23: Detail of selected single heads progenies

Sr. No.	Name of Variety	Accepted Progenies	Rejected Progenies
1	Faisalabad.08	5	0
2	Galaxy.2013	5	0
3	Ujalla.16	5	0
4	Anaj.2017	5	0
5	Akber-19	47	3
6	Dilkash-20	48	2
7	Subhani-21	45	5
8	MH-21	10	0
9	Arooj-22	48	2
10	HYT-70-16	4	20
11	V-19308	4	6
12	V-19347	8	2
13	HYT-100-47	10	0
14	HYT-100-74	7	3
15	HYT-100-76	9	1
16	V-19317	9	1

(b)-Pre-basic and basic seed production

Pure and true to type seed of a variety plays an important role in crop productivity. For maintaining the seed purity of commercial varieties and candidate lines, breeder's seed is produced from heads. From breeder's seed, pre-basic seed is produced every year, most of seed is being supplied to the Punjab Seed Corporation and other registered private seed companies. Four commercial varieties of bread wheat and one durum wheat was planted at low seed rate with self-propelled seed drill to produce the Pre-Basic seed. The crop was kept under observation from tillering to maturity stages and deviating entries were discarded. As per instructions, the crop was inspected twice by the Deputy Director, FSC & RD to check the quality standards of pre-basic seed and crop purity. Besides producing the pre basic seed, some quantity of basic seed of commercial varieties was also produced. The detail of pre-basic and basic seed production during 2022-23 is given in table 24.

Table 24: Pre basic and basic seed produced (2022-23)

Sr. No.	Varieties	Pre-Basic seed (Kg)	Basic (Kg)
1.	Arooj-22	11600	4900
2.	Subhani-21	1600	1600
3.	Dilkash-20	4500	1600
4.	Akbar-19	5150	1750
5.	Durum-21	600	0

c)-Seed production of barley varieties.

Following quantity of seed of different barley varieties was produced given in the table 25.

Table 25: Quantity of barley seed produced (2022-23)

Sr. No.	Varieties/lines	Quantity seed kg
1	Talbina-21	200
2	Jau-21	200
3	Pearl-21	200
4	Jau-17	200
5	Sultan-17	200

(d)-Hybrid seed program

Cytoplasmic Male Sterile (A) lines, maintainer line (B) and fertility restorer lines are the main components of hybrid seed production. Thirty-three A-lines (CMS lines) along with the same number of B-lines (maintainers) were planted in the field. Thirty-three CMS lines were maintained by crossing with their respective maintainer (B-lines). Sixteen fertility restorers were also maintained by selling.

WHEAT ENTOMOLOGY

(a)-Effect of different climatic factors on wheat aphid population

The experimental trial was conducted at the research area of wheat Research Institute, Faisalabad during 2022-23. Three Moericke Yellow water tray traps were installed at 60m apart from each other in three different fields of wheat crop at the height of 75cm from the ground level. Daily alate aphid population was recorded from these yellow water tray traps and later on data was transformed into weekly basis. The weekly counts of trapped alate aphids were correlated with a-biotic factors. The results are given in the tabulated form (table 26).

Table 26: Average wheat aphid population/ trap/week

Months / Year	Temperature (C^0)		Humidity (%)		Rain fall/ week	Av. Aphid population. /Trap/week
	Max C^0	Min C^0	8 am	5 pm	(mm)	
January, 2023						
1st week	15.89	4.2	91.0	68.28	0	5.6
2nd week	17.5	5.2	85.5	51.87	0	7.96
3rd Month week	19.63	5.07	78.5	44.5	0	10.93
4th week	20.31	4.71	84.37	52.5	30.6	15.27
February,2023						
1st week	21.86	8.36	79.43	41.0	0	45.31
2nd week	23.25	8.96	66.43	36.86	0	133.28
3rd week	27.86	11.9	82.0	48.43	0	444.86
4th week	28.67	13.58	81.28	44.0	6.4	391.77
March,2023						
1st week	22.48	14.5	83.14	53.57	0	717.25
2nd week	28.02	14.0	80.83	49.62	0	1382.39
3rd week	24.34	15.94	81.62	63.5	15.8	414.29
4th week	26.12	14.94	84.37	59.25	39.4	65.4
April,2023						
1st week	58	15.78	73.0	53.86	37.4	11.98

(b)-Correlation of wheat aphid with climatic factors

Data showed that aphid population was started trapping on yellow water tray traps during 1st week of January, 2023 (5.6/trap/week) and then gradually increased during subsequent weeks and peek of aphid population was observed during 2nd week of March (1382.39/trap/week). Aphid population was started to decrease during 1st week of April-2023 (11.98/trap/week) due to rise of temperature and maturity of crop. Aphid population was maximum when maximum and minimum temperature was 28.02C^0 & 14.0C^0, respectively with relative humidity 80.83% &49.62% at 8am & 5pm, respectively. Aphid population showed +ve and non-significant correlation with maximum and minimum temperature. While aphid population had +ve and –ve effect & non significantly correlated with relative humidity at 8am and 5pm, respectively. Rainfall had –ve effect and non-significantly correlated with aphid population (table 27).

Table 27: Correlation of wheat aphid with climatic factors

Aphid Population	Max C^0	Min C^0	R.H (%) 8.0 am	R.H (%) 5.0 pm	Rainfall (mm)
	0.0396	0.5133	0.0264	-0.0473	-0.3173
P Value	0.8977	0.0728	0.9318	0.8781	0.2908

(c)-Varietal screening of wheat varieties/ advance lines against aphid

The trial was conducted at the research area of Wheat Research Institute, Faisalabad during 2022-23. Fourteen (14) wheat varieties/Advanced Lines i.e, V1(Akbar-19), V2(Subhani-21), V3(Dilkash-21), V4(Arooj-22), V5(19347), V6(HYT-74), V7(19308), V8(HYT-76), V9(HYT-100-47), V10(20337), V11(19532), V12(20330), V13(19559), V14(19317) were screened out against aphid attack. The data of aphid population was recorded at 10 days interval during the month of February-March, 2023 from 10 randomly selected tillers of each line/ variety. The aphids were dislodged on white paper sheet with the help of camel hair brush and then counted. The results are as mentioned in table 28 in three different dates

Table 28: Average aphid population per tiller on different wheat varieties / lines

Sr.	Varieties	15-02-23	24-02-23	08-03-23	Av. Aphid pop./tiller
1	Akbar-19	7.8	8.3	6.867	7.656 d
2	Subhani-21	5.367	7.467	5.3	6.044 e
3	Dilkash-21	4.867	4.233	4.2	4.433f
4	Arooj-22	4.8	4.533	3.6	4.311f
5	V5-19347	8.833	13.0	8.9	10.244 c
6	HYT-74	4.333	4.567	4.233	4.378 f
7	V7-19308	4.5	5.0	4.833	4.778 f
8	HYT-76	5.233	5.3	3.833	4.789 f
9	HYT-100-47	8.133	9.3	4.8	7.411 d
10	V10-20337	13.533	14.133	6.867	11.511b
11	V11-19532	15.933	13.3	8.9	12.711a
12	V12-20330	10.167	13.2	8.633	10.667 bc
13	V13-19559	9.9	13.167	9.067	10.711bc
14	V14-19317	11.4	13.4	9.5	11.433b
Lsd value at 0.05%=1.991					

The lowest aphid population was recorded on wheat varieties/lines viz, Arooj-22(4.311), HYT-74(4.378), Dilkash-21(4.433), V-19308(4.778) and HYT-76 (4.789), and these were statistically at par with each other while maximum aphid population was observed on V-19532 (12.711) followed by V-19317(11.433), V-19559 (10.711), V-19317 (11.433), V-19347 (10.244), Akbar-19 (7.656), and Subhani-21 (6.044).The above mentioned wheat varieties/lines were statistically different with each other regarding aphids population/tiller**.** However, all the above-mentioned varieties/lines behaved statistically different among one another (table 29, 30 and 31).

Table 29: A**verage aphid population per tiller on different wheat varieties/line (15-02-2023)**

Sr.	Varieties	R1	R2	R3	Av. Aphid pop./tiller
1	Akbar-19	7.8	8.3	7.3	7.8 de
2	Subhani-21	4.3	5.6	6.2	5.367ef
3	Dilkash-21	5.2	3.1	6.3	4.867f
4	Arooj-22	4.1	5.1	5.2	4.8f
5	V5-19347	9.2	9.1	8.2	8.833cd
6	HYT-74	3.4	4.3	5.3	4.333f
7	V7-19308	4.1	3.2	6.2	4.5f
8	HYT-76	6.4	5.2	4.1	5.233ef
9	HYT-100-47	10.3	7.4	6.7	8.133d
10	V10-20337	15.1	16.2	9.3	13.533ab
11	V11-19532	14.3	16.2	17.3	15.933a
12	V12-20330	10.2	11.2	9.1	10.167cd
13	V13-19559	11.4	9.6	8.7	9.9cd
14	V14-19317	12.3	10.4	11.5	11.4bc
LSD value at 0.05%=2.056					

Table 30: Average aphid population per tiller on different wheat varieties/lines (24-02-2023)

Sr.	Varieties	R1	R2	R3	Av. Aphid pop. /tiller
1	Akbar-19	7.2	9.3	8.4	8.3bc
2	Subhani-21	7.1	8.2	7.1	7.467c
3	Dilkash-21	3.2	4.3	5.2	4.233d
4	Arooj-22	4.3	5.2	4.1	4.533d
5	V5-19347	12.3	12.4	14.3	13.0a
6	HYT-74	5.3	4.2	4.2	4.567d
7	V7-19308	5.4	4.3	5.3	5.0d
8	HYT-76	4.2	5.4	6.3	5.3d
9	HYT-100-47	10.4	7.9	9.6	9.3b
10	V10-20337	12.4	15.7	14.3	14.133a
11	V11-19532	12.3	13.4	14.2	13.3a
12	V12-20330	12.1	13.2	14.3	13.2a
13	V13-19559	12.2	14.2	13.1	13.167a
14	V14-19317	12.6	14.7	12.9	13.4a
Lsd value at 0.05%=2.056					

Table 31: A**verage aphid population per tiller on different wheat varieties/lines (08-03-2023)**

Sr.	Varieties	R1	R2	R3	Av. Aphid pop./tiller
1	Akbar-19	8.2	6.0	6.4	6.867b
2	Subhani-21	4.6	6.6	4.7	5.3c
3	Dilkash-21	3.6	4.8	4.2	4.2cd
4	Arooj-22	4.3	3.1	3.4	3.6d
5	V5-19347	7.7	9.9	9.1	8.9a
6	HYT-74	4.1	4.7	3.9	4.233cd
7	V7-19308	5.9	4.7	3.9	4.833cd
8	HYT-76	4.5	3.8	3.2	3.833cd
9	HYT-100-47	3.9	5.8	4.7	4.8cd
10	V10-20337	7.0	6.3	7.3	6.867b
11	V11-19532	8.4	9.6	8.7	8.9a
12	V12-20330	10.1	7.2	8.6	8.633a
13	V13-19559	9.3	8.4	9.5	9.067a
14	V14-19317	10.1	9.8	8.6	9.5a
Lsd value at 0.05%=2.056					

(d)-Screening of wheat germplasm against aphids

Trial was conducted in the research area of Wheat Research Institute, Faisalabad. Three hundred and seventy-five wheat varieties/ lines of crossing block 2022-23 were screened out against aphid attack. The data of aphid population was recorded at 10 days interval during the month of February-March, 2023 from 10 randomly selected tillers of each variety/ line. The aphids were dislodged on white paper sheet with the help of camel hair brush and then counted. The results are presented in the table 32.

Table 32: Average aphid population / tiller on wheat germplasm

Material	Total Entries	Average Aphid population (range) / Tiller on each variety/line (Mean values)			
CB	375	0-05	6-10	11-15	Above 16
		154	207	13	01

The result showed that the aphid population ranged from 3.5 to 17 aphid / tiller. Out of three hundred and seventy-five wheat varieties/ advanced lines, only 154 varieties/ lines had up to 5 aphids per tiller and they showed tolerance / resistance against aphid attack. These lines/ varieties from crossing block 2022-2023 were had the lowest aphid population per tiller than others. The above-mentioned varieties / lines were proposed for breeding program of variety development process. While the rest of the varieties / lines in crossing block 2022-2023 had more aphids per tiller and they were not recommended for using in crossing program.

(e)-Survey of Aphid Population on wheat Crop in Different Ecological Zones of the Punjab

The survey was conducted in different climatic zones of the Punjab (Nankana, Sheikhupura, Lahore, Kasur and Faisalabad) to record aphid infestation on seven different wheat varieties i.e., Faisalabad-08, Ujala-16, Anaj-17, Akbar-19, Dilkash-21, Subhani-21 and MH-21). Aphid infestation was recorded on an average from 10 spots in each district on 28-02-2023, 02-03-2023, 20-03-2023, 22-03-2023 and 30-03-2023 Aphid population was recorded per tiller basis by selecting 10 tillers randomly from each variety/ line on each spot. The aphids were dislodged on white paper sheet with the help of camel hair brush and then counted (table 33).

Table 33: Average aphid population on different wheat varieties in different ecological zones (districts) of the Punjab

District	Date	Fsd -08	Ujala -16	Anaj -17	Akbar-19	Dilkash -21	Subhani -21	MH -21	Av.pop/ Tiller
Nankana	28/2/23	8.7	7.2	9.8	9.2	7.3	9.4	9.6	8.74
Sheikhupura	02/3/23	9.6	11.3	12.1	7.9	10.1	8.9	8.9	9.83
Lahore	20/3/23	10.7	9.4	12.2	9.0	9.1	9.9	8.8	9.87
Kasur	22/3/23	8.7	10.1	7.9	8.9	11.4	7.9	8.9	9.11
Faisalabad	30/3/23	9.9	7.8	8.8	7.7	10.3	11.5	10.6	9.51
Average pop./tiller		9.41	8.88	9.88	8.67	9.64	9.52	9.36	-

Survey revealed that aphid population on different wheat varieties ranged from 8.7-10.7, 7.2-11.3, 7.9-12.2, 7.7-9.2, 7.3-11.4, 7.9-11.5 and 8.8-10.6 aphids/tiller on Faisalabad-08, Ujala-16, Anaj-17, Akbar-19, Dilkash-21, Subhani-21 and MH-21, respectively. Aphid population was recorded more on Anaj-17 in Lahore and Sheikhupura districts and low on Ujala-16 and Dilkash-21 in Nankana, respectively. However, on the whole wheat aphid population remained below economic threshold level (25-30 aphids tiller^{-1}) throughout the crop season in the Punjab.

WHEAT PATHOLOGY

(a)-Diseases/rusts surveillance (monitoring of newly emerging diseases)

Comprehensive survey was conducted to monitor the rust attack on wheat varieties as well as to monitor the newly emerging diseases of wheat in different district of Punjab, Pakistan. During the cropping season, 2022-23, one hundred and fifty locations were surveyed, out of which leaf rust was observed on 36 locations in Central and Southern Punjab with low intensity specifically on old varieties like Galaxy-13, while yellow rust was observed on 13 locations with low intensity (up to 30%). However, during crop season 2022- 23, the stripe rust attack was less as compare to the leaf rust attack at all the surveyed locations. The survey results indicate that all the surveyed fields were free from newly emerging diseases like wheat blast and stem rust diseases; however, spot blotch was observed at few locations on almost all the prevailing varieties.

(b)-Disease trap nurseries (monitoring of rust virulence pattern)

To monitor the virulence pattern of rust resistant genes as well as for the observation of leaf, stripe and stem rusts symptoms on foliar part of plant, the trap nurseries were planted at eight different locations i.e. Faisalabad, Bahawalpur, Khanewal, Kala Shah Kaku, Kot Naina, Islamabad, Pirsabak and Peshawar. The data indicated that the leaf rust was trapped on 03-12-2022 on Morocco, while stripe rust was trapped during the 1st week of February, 2023 in 1st disease trap nursery rust planted at research area of WRI, Faisalabad. The isogenic lines which were resistant to leaf, yellow and stem rusts are given in table 34.

Table 34: Isogenic lines showed resistant response to leaf and stripe rusts.

Isogenic lines for LR	The isogenic lines having leaf rust resistance genes i.e. Lr9, Lr10, Lr 11, Lr17, Lr25, Lr 28 and Lr31 showed resistant response.
Isogenic lines for YR	The isogenic lines having stripe rust resistance genes i.e. Yr-5, Yr-10, Yr-15, Yr18, Yr27, Yr31, Yr32 and Yr-SP were showed resistant response.
Isogenic lines for SR	None of the tested entries showed the symptoms of stem rust

(c)- Disease screening nursery

During the 2022-23 cropping season, eight hundred ninety one (870) genotypes including entries under NUWYT, PUWYT, A Trails, B Trails and commercial varieties, were screened against both leaf and stripe rust diseases. The nursery was planted at Bahawalpur, Khanewal, Faisalabad, Kala Shah Kaku, Kot Nina, Islamabad, Pirsabak and Peshawar for evaluation against both leaf and stripe rusts. At each location, the tested entries including susceptible check variety (Morocco) were sown in single row of two meters length. At Faisalabad and Bahawalpur material was tested under rust inoculation conditions whereas at other locations screening was conducted under natural conditions. The result regarding rust response at adult plant stage indicates that among tested 870 entries, 238 entries showed susceptible response to leaf rust and 212 entries showed susceptible response to stripe rust (Annexure-I). However, remaining all entries including PUWYT & NUWYT entries i.e. V-19532, V-20330, V-19313, V-21239, V-21668, V-21265, HYT-90-21433, HYT-90-21443, HYT-90-21448, V-19347, HYT-100-74, V-19308, HYT-100-76 and HYT-100-47, showed very good tolerance against leaf and yellow rust and were recommended for further studied (table 35).

(d)-Seedling and adult plant resistance to leaf rust.

For seedling study, the leaf rust 1st trapped inoculum (collected during 1st week of December, 2022), was purified by single pustule method and further multiplied on Morocco under controlled glass house conditions. The whole set of crossing block (CB-2022-23) comprises of 403 lines/varieties as well as 184 entries of disease trap nurseries having PUWYT, 2022-23 & NUWYT, 2022-23 lines were sown in pots. After 7-9 days of germination, the plants were inoculated with leaf rust and the inoculated plants were kept in dew chamber at 15-20 ^{o}C and 100 % relative humidity for 12 hours and then shifted into glass house (Annexure II). After 14-16 days of inoculation, leaf rust scoring was done for leaf rust. While for adult plant study, the above-mentioned same entries were planted in the field for the selection of lines/varieties having adult plant resistance against both leaf rusts. The rust data was recorded twice at adult plant stage. The results indicates that 0ut of 184 entries, seventy six including PUWYT & NUWYT entries i.e., V-19532, V-20330, V-19313, V-21239, V-21668, V-21265, HYT-90-21433, HYT-90-21443, V-21448, V-19347, HYT-100-74, V-19308, HYT-100-76 and HYT-100-47 showed low infection type i.e. 0,1,2 against local leaf rust races while the remaining entries showed high infection type (3 & 4) against local leaf rust races. Similarly, out of 403 CB entries, 189 lines/varieties showed low (0,1 & 2) infection type while the remaining showed high (3 & 4) infection type (Annexure. II).

Table 35: Advanced wheat lines showing acceptable rust reaction under stressed/rust inoculated condition.

V. code	Leaf rust 21/3/23	Stripe rust 28/3/23	V. code	Leaf rust 21/3/23	Leaf rust 28/3/23
V-19532	20M	10M	V-21668	10M	10M
V-20330	20M	10M	V-21265	20M	10M
V-19317	10M	10M	V-19347	0	5M
V-21239	20M	0	HYT-100-74	0	0
V-21433	20M	10M	V-19308	TM	TM
V-21443	20M	0	HYT-100-76	TM	TM
V-21448	10M	20M	HYT-100-47	0	0
Morocco	100S	100S	Morocco	100S	100S
R = Resistant, MR = Moderately Resistant, M = MRMS = Moderately Resistant, Moderately Susceptible, S = Susceptible, T = traces					

(e)-Rust management through chemical

For chemical control of rust diseases in wheat, the four proposed fungicides including Nativo (Trifloxystrobin + Tebuconazole 25%WG) @1gm/litre of H_2O, Tilt (Propiconazole) @2mL/litre of H_2O, Score (Difenconazole 250EC) @1mL/ litre of H_2O, and Amistar Top@2mL/litre of H_2O, were applied on rust susceptible wheat varieties i.e. Morocco and Galaxy-13, planted at research area of WRI, Faisalabad. The first spray was applied after tillering to jointing stage while the 2nd spray was applied on flag leaf initiation to before flowering stage. The result indicates that Difenconazole and Trifloxystrobin + Tebuconazole perform best as compare to Propiconazole and Amistar Top (Table 36).

Table 36: Efficacy of different fungicides against both leaf rust and stripe rust during cropping year 2022-23

Treatments	1st spray		2nd spray	
	Leaf Rust Severity		Final Leaf Rust Severity	
	23-02-23	28-02-23	09-03-23	14-03-23
	Before	After	Before	After
Morocco	**LR**	**LR**	**LR**	**LR**
T_1-Trifloxystrobin + Tebuconazole	20S	5MS	10MSS	5MS
T_2- Propiconazole	20S	10MS	20MSS	10MS
T_3-Difenconazole	20S	5MS	20MSS	5MS
T_4 – Control	20S	70S	80S	100S
T_5 – AmistarTop	20S	5MS	20MSS	10MS
Galaxy-13				
T_1-Trifloxystrobin + Tebuconazole	20MSS	5MS	10MSS	5MS
T_2- Propiconazole	20 MSS	10MS	20MSS	10MS
T_3-Difenconazole	20 MSS	5MS	20MSS	10MS
T_4 – Control	20 MSS	70S	80S	100S
T_5 – AmistarTop	20 MSS	5MS	20MSS	10MS

Difenconazole and Trifloxystrobin + Tebuconazole perform best as compare to Propiconazole and Amistar Top against leaf rust. However, stripe rust infection was very low that is why the results are not reliable against stripe rust and needs confirmation with the addition of some new chemistry fungicides. Fungicides do not increase the yield potential of wheat varieties, but have the capacity to overcome the risk of losses resulting from rust and other fungal diseases.

BARLEY *(Hordeum vulgare L.)*

(a)-Maintenance and improvement barley crossing Block

One hundred and twenty genotypes (including 66 of 2-rowed + 54 of 6-rowed head types) were planted at the research area of Wheat Research Institute, Faisalabad. One entry of 2-rowed head and 10 entries of 6-rowed head types were rejected on the basis of mixed head rows, lodging intensity and disease infestation. True to type heads from remaining entries were selected and threshed to maintain the genetic purity. Some important traits are recorded as mentioned in table 37.

Table 37: Traits recorded in barley crossing block during 2022-23

(i)-Entries

S. No.	Traits	Head type	Entry		
			Total	Rejected	Selected
1	Spike type	2-rowed head	66	1	65
2		6-rowed head	54	10	44
	Total		120	11	109

(ii)-Traits

S. No.	Traits	Ranges
1	Plant height (cm)	80-108
2	Days to heading	82-137
3	Days to maturity	114-150

(b)-Filial generations

Out of 28 crosses attempted, sixteen (16) were threshed out successfully as F_0 seed while 15 from 21 entries in F_1 were promoted to next phase of generation. Similarly, heads of 16 from 19 entries in F_2, 6 from 10 entries in F_3 and 12 from 22 entries in F_4 were threshed in bulk to advance the generation.

(c)-Preliminary yield trials

Twenty-eight advanced barley lines were sown under 2 and 6-rowed head types separately in two yield trials (A-I and A-II) against check varieties Sultan-17 (2-rowed) and Pearl-21 (6-rowed) in a lay-out of RCBD with a plot size of 5 m x 4 rows. Out of which, 8 lines of 2-rowed types viz. B-22004, B-22005, B-22011, B-22010, B-22003, B-22008, B-22007 and B-22002 produced maximum grain yield in A-I trial against 2-rowed check Sultan-17 (4094 Kg ha^{-1}). Similarly, 5 lines of 6-rowed types viz. B-22016, B-22018, B-22027, B-22015, B-22026 and B-22023 produced maximum grain yield in A-II trial against 6-rowed check Pearl-21 (3237 kg/ha). However, advanced lines of B-22004 (4979 kg/ha), B-22005 (4737 Kg ha^{-1}), B-22016 (4227 Kg ha^{-1}) and B-220018 (4217 Kg ha^{-1}) remained top yielder lines in Preliminary Yield Trial (table 38).

Table 38: Results (kg ha^{-1}) of barley preliminary yield trials during 2022-23.

S. No	A-I				A-II			
	V. code	Rowed type	Yield Kg ha^{-1}	Ranking	V-code	Rowed type	Yield Kg ha^{-1}	Ranking
1	B-22001	2	3424	XVI	B-22015	6	4072	IV
2	B-22002	2	4120	IX	B-22016	6	4227	I
3	B-22003	2	4360	V	B-22017	6	2518	XII
4	B-20004	2	4979	I	B-20018	6	4217	II
5	B-22005	2	4737	II	B-22019	6	2383	XV
6	B-22006	2	4077	XI	B-22020	6	2483	XIV
7	B-22007	2	4152	VIII	B-22021	6	2492	XIII
8	B-22008	2	4197	VII	B-22022	6	3230	IX
9	B-22009	2	3702	XIII	B-22023	6	3252	VII
10	B-22010	6	4364	IV	B-22024	6	2307	XVI
11	B-22011	2	4479	III	B-22025	6	3218	X
12	B-22012	2	3502	XV	B-22026	6	3682	VI
13	B-22013	2	4004	XII	B-22027	6	4114	III
14	B-22014	2	3634	XIV	B-22028	6	2797	XI
15	Sultan-17	2	4094	X	Sultan-17	2	3934	V
16	Pear-21	6	4232	VI	Pear-21	6	3237	VIII

(d)-Regular yield trial

Nineteen (19) barley lines were sown under 2-rowed and 6-rowed head types in two yield trials (B-I and B-II) separately against check varieties Sultan-17 (2-rowed) and Pearl-21(6-rowed) under RCBD with a plot size of 5m x 4 rows. Among them, 4 lines of 2-rowed types viz. B-21015, B-21034, B-21025 and B-21022 produced maximum grain yield in B-I trial against 2-rowed check Sultan-17 (3644 Kg ha^{-1}). Similarly, nine lines of 6-rowed types viz. B-21045,B-21046, B-21008, B-21001, B-21043, B-21013, B-21007, B-21044 and B-21048 produced maximum grain yield in B-II trial against high yielding check of 6-rowed head type Talbinah-21 (3905 Kg ha^{-1}). However, B-21015 (4570 Kg ha^{-1}), B-21034 (4362 Kg ha^{-1}), B-21045 (4767 Kg ha^{-1}) and B-21046 (4710 Kg ha^{-1}) considered to be top yielder lines in Regular Yield Trial of 2022-23 (table 39).

Table 39: Results (kg ha^{-1}) of barley regular yield trials (2022-23).

S.No	B-I				B-II			
	V. code	Rowed type	Yield Kg ha^{-1}	Ranking	V-code	Rowed type	Yield Kg ha^{-1}	Ranking
1	B-21015	2	4570	I	B-21001	6	4555	IV
2	B-21016	6	3075	XI	B-21007	6	4327	VII
3	B-21021	2	3564	VII	B-21008	6	4684	III
4	B-21022	2	4154	IV	B-21013	6 + 2	4339	VI
5	B-21025	2	4317	III	B-21043	6	4438	V
6	B-21032	2	3470	VIII	B-21044	6	4291	VIII
7	B-21033	2	3077	X	B-21045	6	4767	I
8	B-21034	2	4362	II	B-21046	2	4710	II
9	B-21035	2	3414	IX	B-21048	6	4055	IX
10	B-21037	6	2812	XII	Sultan-17	6	4035	X
11	Sultan-17	2	3644	VI	Pearl-21	2	3734	XII
12	Pear-21	6	4102	V	Talbinah-21	6	3905	XI

(e)-Barley rainfed trial

Seven advanced lines of barley were sown under RCBD with a plot size of 5 m x 4 rows to evaluate their yield potential against three check varieties viz. Sultan-17, Jau-17 and Pearl-21 under normal irrigated and rainfed conditions. On overall mean basis, the check Sultan-17 produced maximum grain yield of 3352 Kg ha^{-1} followed by B-19026 with the yield of 3284 Kg ha^{-1}. However, in normal condition, B-18021 gave maximum yield of 4279 Kg ha^{-1}. Whereas in rainfed conditions check variety Sultan-17 remained high yielder with 2825 Kg ha^{-1} followed by Jau-17 check variety (2585 Kg ha^{-1}). Moreover, under rainfed condition yield remained 2230 Kg ha^{-1} whereas the yield of 3849 Kg ha^{-1} was obtained in normal condition (table 40).

Table 40: Yield data (kgha^{-1}) of barley advanced lines in rainfed condition (2022-23)

S. No.	V. Code	Rowed Type	Average Kg ha^{-1}	Rank
1	B-18009	2	2508	IV
2	B-19011	2	1631	X
3	B-19022	2	1763	IX
4	B-19026	2	2122	VI
5	B-18021	6	2547	III
6	B-18016	6	1887	VIII
7	B-19017	6	2108	VII
8	Sultan-17	2	2825	I
9	Jau-17	2	2585	II
10	Pearl-21	6	2230	V
	Average	---	---	

(f)-Punjab Uniform Barley Yield trial (PUBYT)

Ten advanced lines of barley including two check varieties (Sultan-17 and Pearl-21) were sown to evaluate yield potential at five different locations in the Punjab Province with a plot size of 5 m x 4 rows under RCBD. On overall mean basis, three promising lines viz. produced higher grain yield than both of the check varieties. However, B-20007 produced maximum grain yield over 5 locations with yield of 4624 kg/ha followed by B-21057(4437 Kg ha^{-1}) and B-21053 (4238 Kg ha^{-1}) against the yield of check Pearl-21(4123 Kg ha^{-1}) and Sultan-17(3969 Kg ha^{-1}) varieties (table 41).

Table 41: Yield data (Kg ha^{-1}) of barley advanced lines in PUBYT during 2022-23

S.No.	V, Code	WRI, Fsd	Sgd.	Khanewal	KSK, GA	P. Pattan	Average
1	B-20009	2897	3195	4356	2660	4734	3564 IX
2	B-21053	4354	4145	4612	3677	4406	4238 III
3	B-21056	3474	3734	3761	3022	3939	3586 VIII
4	B-21057	4797	4534	4259	4028	4567	4437 II
5	B-20007	5044	4734	4395	4245	4706	4624 I
6	B-20014	2918	3114	3322	2411	3761	3109 X
7	B-21060	4384	4178	4145	3761	4250	4143 IV
8	B-21061	3624	3845	3928	3075	4106	3715 VII
9	Sultan-17	4162	4331	4134	3186	4034	3969 VI
10	Pearl-21	4614	4434	3995	3772	3800	4123 V
Average		4025	4024	4090	3383	4234	---

(g)-National Uniform Barley Yield Trial (NUBYT)

Eleven decoded entries of barley crop were received from National Wheat Coordinator NARC, Islamabad and planted in three replications under RCBD layout across the country. Among eleven entries, four lines excelled higher grain yield over all entries through the country. However, Barley line of B-19026 produced maximum grain yields of 3520 Kg ha^{-1} followed by an Entry of B-19022 (3268 Kg ha^{-1}). Detailed results are mentioned in the table 42.

Table 42: Yield (Kg ha$^{-1)}$ data of National Uniform Barley Yield Trial (NUBYT)

Sr #	Code	Entry Name	Institutes	Baluchistan	Sindh	Punjab	KPK	Pakistan
1	5	B-19026 (2R)	**WRI FSD**	5157	3124	3075	1928	3520 I
2	4	B-19022 (2R)	**WRI FSD**	4352	3281	2861	1891	3268 II
3	1	B-18016 (2R)	**WRI FSD**	4486	2509	2866	1753	3068 III
4	3	B-19017 (6R)	**WRI FSD**	4208	2559	2866	2087	3050 IV
5	6	BARD-46 (2R)	BARDC Quetta	5234	2038	2705	1301	3036 V
6	2	B-19011 (2R)	**WRI FSD**	3846	2289	2877	1693	2817 VI
7	10	Sultan-17 (check) 2R	WRI **FSD**	3894	2405	3001	1664	2895 VII
8	11	Pearl-21 (Check) 6R	WRI FSD	4031	2070	2553	2556	2838V III
9	9	PRB-05 (2R)	CCRI Pirsabak	3590	2382	2772	2183	2810 IX
10	8	PRB-04 (2R)	CCRI Pirsabak	3749	2323	2529	2120	2760 X
11	7	BARD-2 (2R)	BARDC Quetta	3841	2027	2474	1715	2628 XI
G. Mean				**4217**	**2455**	**2780**	**1899**	**2972**

DURUM WHEAT (*Triticum durum* Desf.)

(a)-Maintenance of Germplasm and Hybridization

The main objective of research work on durum is to develop high yielding, good quality and disease resistant wheat varieties through interspecific crosses. Two forty (240) cultivars/ advanced lines of durum and triticale were sown to make the desirable cross combinations. Seventy (70) crosses were attempted and 60 fresh crosses were harvested for next year's planting.

(b)-Filial Generations (F_1-F_7)

F_1-Generation

Sixty crosses were planted in a single row of 2.5m length along with their parents to compare their morphology and vigor. Fifty-four crosses having desirable traits were harvested to advance the further generation.

F_2-F_7 Generations

The filial generations (F_2-F_7) were sown and selected for desirable traits. Segregating materials were surrounded by the spreader rows of highly susceptible variety (Morocco). Modified bulk method was used for selection in F_2, F_3 and F_4 generations. From F_5, uniform, disease resistant and desirable heads were selected to raise single head rows of F_6 generation. Outstanding and stable lines from F_6 were selected and harvested for inclusion in F_7 generation. Entries studied and selected in different generations are given in the table 43.

Table 43: Details of filial generations of durum wheat

Sr. No.	Generations	Entries studied	Entries selected
1	DF_1	60	54
2	DF_2	37	22
3	DF_3	39	15
4	DF_4	35	10
5	DF_5	40	440 S.H (22 Crosses)
6	DF_6	520 SHR	80 SHRP
7	DF_7	60	44

(c)-Station Yield Trials

The most promising lines selected from different sources i.e. F_7 generation, international nurseries/ trials, drought, heat stress and plant pathology program were evaluated in station yield trials (A & B trials).

(i)-Preliminary Durum Yield Trial (A-Trial)

During the reported year, preliminary drum yield trial of durum wheat was conducted under normal conditions. Trial consisted of 57 test entries/lines with 3 check varieties (Durum-97, Durum-21 & Akbar-19). The planting was done following RCBD design with two replications. The lines that performed better than the three checks are given in table 43 with their data regarding disease reaction and grain yield (table 44).

Table 44: Yield performance of promising durum lines in preliminary yield trials

Sr. No	Lines/ Genotypes	Disease reaction		Yield ($Kgha^{-1}$)
		Leaf rust	Yellow rust	
1	D-22031	0	0	5250
2	D-22006	0	0	5111
3	D-22002	10 MS/MR	0	4965
4	D-22056	0	0	5047

(ii)-Regular Durum Yield Trial (B-Trial)

Regular durum wheat yield trial was conducted under normal conditions. Trial was planted with plot size of 6 m x 0.27 m using RCB design with three replications and harvested plot size was 5 m x 0.27 m. Trial consisted of 15 test entries/lines including 2 check varieties (Durum-21 & Akbar-19). Promising lines that surpassed three check varieties are given in table 44 with their respective data of disease reaction and grain yield.

Table 45: Yield performance of promising durum lines in regular yield trials

Sr. No.	Lines/ Varieties	Disease reaction		Yield ($Kgha^{-1}$)
		Leaf rust	Yellow rust	
1	D-21022	0	0	4595
2	D-21044	0	10MS/MR	3825
3	D-21020	20MS/MR	0	3790

(d)-Provincial Uniform Durum Yield Trial (PUDYT)

During 2022-23, provincial uniform durum yield trial (PUDYT) was conducted across seven locations in Punjab. Trial consisted of eight entries with two check varieties (D-21 and Akbar-19). Two lines out of eight lines were selected on the basis of their yield against check (table 46).

Table 46: Yield performance of promising durum lines in PUDYT

Sr. No	Entry No	Yield ($Kgha^{-1}$)
1	D-19939	4419
2	D-19943	4409

WHEAT RESEARCH SUB-STATION, MURREE

(a)-Development of crosses

A set of 100 lines of crossing bock were sown in the field in June 2022. Out of 100, thirty lines were selected for development of crosses. The selections were based upon previous year's rust disease data. Emasculation was done on 10 lines from each line and 10 direct crosses were attempted by using pollen from resistant wheat varieties. After harvesting the seed was stored for next sowing.

(b)-Screening of germplasm at seedling stage

Inoculum of two races of leaf rust was increased on a set of morocco during February-2022. That inoculum was then inoculated on germplasm consisting of 50 wheat lines including synthetic wheat obtained from The Chief Scientist, Wheat Research Institute, Faisalabad. The results showed that most of the local varieties and synthetics were tolerant against two races of leaf rust (MKTTS and MHTTS) showing a reaction 0-2. Only eight lines were susceptible against race MKTTS while five lines were susceptible against race MHTTS.

(c)-Performance of wheat lines during winter season

To check the performance of spring wheat varieties during the snowy period at WRSS, Murree, a set of 20 lines of wheat varieties (10559, 10567, 10568, 10569, 10570, 10571, 10572, 10587, 10589, 10599, 10617, 10618, 10619, 10620, 10622, 10637, 10639, 10640, 10678 and 10697) including two winter varieties were sown in the field on November 2022. The plants germinated normally and covered by the snow in the mid of December. The plants remained in the field during snow period and showed stunted growth after the snow melts. Plant growth remained poor after the snowy period, the spikes were small having only 1-2 seeds each and matured very late in early June 2022.

CEREAL TECHNOLOGY

(a)- Effect of fermented barley flour addition in whole wheat flour on the quality of chapatti

Chapatti quality was improved from fermented barley four addition in whole wheat flour and remained acceptable up to addition of 20% fermented barley flour in wheat flour. Protein and beta glucan content of chapatti increased with addition of fermented barley flour while fat, carbohydrates and energy content of chapatti decreased as content of fermented barley flour increased.

(b)-Qualitative analysis of wheat breeding material for iron and zinc

Flour of wheat breeding material was made through UDY Cyclone sample mill. Flour was used for the qualitative estimation of zinc (table 47) and iron (Table 48) concentration in wheat through Dithizone staining and Prussian Blue Procedure. In these analyses it was releveled that high Zinc (50 ppm or above) lines / varieties were 24, Medium Zinc (38-49 ppm) lines/varieties were 19 and Low Zinc (< 38ppm) lines/varieties were 10. High iron (50 ppm or above) lines / varieties were 22, Medium iron (37-49 ppm) lines/varieties were 19 and Low iron (< 37 ppm) lines/varieties were twelve.

Table 47: Dithizone staining for zinc estimation in wheat

High Zinc (50-65ppm)	**Medium Zinc (38-49ppm)**	**Low Zinc (< 38ppm)**
24 lines / varieties i.e. D1-2, D1-04, D1-5, D1-8, D1-9, D1-15, D1-16, D1-19, D1-23, D1-24, D3-1, D3-2, D3-3, D3-38, D5-4, D5-08, D5-16, D5-19, D5-24, D5-28, D8-01, D8-05, D8-28 and D8-38.	**19 lines / varieties** i.**e.** D1-1, D1-3, D1-28, D3-4, D3-5, D3-9, D3-15, D3-16, D3-23, D3-24, D3-28, D5-1, D5-9, D5-15, D5-39, D8-2, D8-3, D8-8 and D8-19.	**10 lines / varieties i.e.** D1-25, D3-19, D3-25, D5-3, D5-25, D5-32, D5-40, D8-9, D8-15 and D8-16.

Table 48: Prussian blue procedure for iron estimation in wheat

High Fe (50-65ppm)	**Medium Fe (38-49ppm)**	**Low Fe (< 37ppm)**
22 lines / varieties i.e. D1-1, D1-2, D1-3, D1-04, D1-8, D1-16, , D1-25, D3-1, D3-2, D3-3, D3-4, D3-16, D3-25, D3-28, D5-1, D5-3, D5-08, D5-19, D5-24, D5-39, D8-01, and D8-05.	**19 lines / varieties** i.**e.** D1-9, D1-15, D1-19, D1-28, D3-9, D3-24, D3-38, D5-9, D5-15, D5-25, D5-28, D5-32, D5-40, D8-2, D8-3, D8-4, D8-8, D8-19 and D8-23.	**12 lines / varieties i.e.** D1-5, D1-23, D1-24, D3-05, D3-15, D3-19, D3-23, D5-4, D5-16, D8-9, D8-15 and D8-16.

(d)-Quality evaluation of bread wheat advanced lines/varieties

Five hundred and sixty entries in National Uniform Wheat Yield Trials and Punjab Wheat Yield Trials collectively were analyzed for their qualitative and quantitative potential. This study was conducted to screen advanced lines for different quality traits such as 1000 grain weight, test weight, protein, starch and gluten content. Five hundred and sixty entries / advanced lines included in National Uniform Wheat Yield Trials and Provincial Wheat Yield Trials for the year 2022-23 were tested for comprehensive quality parameters especially grain weight, test weight, protein, starch and gluten contents. In NUWT samples, minimum value of

1000 grain weight, test weight, protein, starch content and gluten was 31.20g, 70.0 Kg/hl, 10.6%, 50.9% and 18.0%, recorded in plot no. P16, P149, P144, P92 and P24, respectively while maximum value of 1000 grain weight, test weight, protein, starch content and gluten was 50.0g, 78.5 Kg/hl, 16.2%, 56.7% and 35%, noted in plot no. P69, P96, P70, P110 and P23 in respective mode.

In the same manner, PUWT samples showed minimum value of 1000 grain weight (30.08g), test weight (70.0 Kg/hl), protein (12.9%), starch content (49.7%) and gluten (22.0%) in entry No.3, 3, 26, 9 and 20 while maximum value of 1000 grain weight (48.73g), test weight (79.4 Kg/hl), protein (16.3%), starch content (55.8%) and gluten (35.0%) was found in entry No.15, 51, 58, 40 and 49, respectively (table 49 and 50).

Table 49. National Uniform wheat yield trials (Normal 2022-23)

Plot No.	1000 grain weight (g)	Test weight (Kg/hl)	Protein (%)	Moisture (%)	Starch (%)	Gluten (%)
P1	36.30	74.20	15.30	9.60	54.20	29.00
P2	38.60	73.70	14.20	9.40	53.90	29.00
P3	34.40	72.80	14.40	9.50	52.90	28.00
P4	37.15	73.60	15.10	9.60	53.40	28.00
P5	42.20	74.20	13.70	9.50	53.30	24.00
P6	33.10	70.80	14.10	9.60	53.60	27.00
P7	40.00	74.20	13.80	9.30	54.60	23.00
P8	39.30	74.60	13.70	9.60	54.50	26.00
P9	35.60	71.50	13.20	9.70	54.10	24.00
P10	48.80	74.80	13.70	10.10	53.50	24.00
P11	41.70	73.60	13.80	9.80	53.80	24.00
P12	36.60	74.30	15.10	9.70	53.20	30.00
P13	39.60	73.70	14.30	9.70	52.90	23.00
P14	40.00	74.60	15.40	9.60	53.70	24.00
P15	34.50	73.20	12.70	10.20	54.90	25.00
P16	31.20	70.40	13.60	10.00	51.90	29.00
P17	42.65	73.50	14.60	10.30	51.80	26.00
P18	46.80	76.80	15.70	9.80	51.50	32.00
P19	33.80	71.80	14.90	9.80	54.20	30.00
P20	33.00	70.40	15.30	9.90	51.90	30.00
P21	36.80	74.30	14.50	9.20	52.50	25.00
P22	41.60	74.60	14.80	9.60	53.90	28.00
P23	34.70	74.20	16.00	9.40	53.70	35.00
P24	37.10	73.30	13.20	9.70	54.50	18.00
P25	36.00	75.30	14.00	9.60	54.20	24.00
P26	36.90	71.20	12.70	9.80	54.80	23.00
P27	39.40	74.70	13.20	9.70	54.70	22.00
P28	37.50	72.30	13.50	9.60	53.80	24.00
P29	38.70	73.40	13.60	9.20	52.60	26.00
P30	41.10	76.20	13.50	9.60	54.60	24.00
P31	34.95	74.30	12.80	9.80	55.10	20.00

P32	34.90	73.60	13.40	10.10	54.10	26.00
P33	40.00	73.20	13.50	9.80	53.20	24.00
P34	37.70	73.80	13.50	9.60	53.50	28.00
P35	37.45	73.60	13.80	9.30	54.60	23.00
P36	37.30	75.60	13.50	9.60	55.60	26.00
P37	36.40	72.40	13.10	9.60	54.30	25.00
P38	36.50	74.20	15.00	9.90	53.90	29.00
P39	40.00	73.70	13.40	9.80	52.90	19.00
P40	38.60	74.50	14.20	9.70	53.80	26.00
P41	37.35	71.20	14.70	9.70	53.10	28.00
P42	41.00	73.40	14.20	10.00	54.00	26.00
P43	49.90	75.00	14.90	10.20	52.40	28.00
P44	48.25	73.50	15.30	9.40	52.80	32.00
P45	35.00	72.60	14.00	9.70	54.20	26.00
P46	34.00	71.80	13.30	9.90	52.20	24.00
P47	33.90	72.00	14.10	9.50	53.60	27.00
P48	36.20	71.80	15.20	9.90	51.40	29.00
P49	39.90	71.00	12.40	9.90	54.30	21.00
P50	34.20	71.80	14.40	9.40	54.90	27.00
P51	41.60	75.60	12.70	9.90	55.80	21.00
P52	35.00	73.60	14.60	9.90	53.40	27.00
P53	38.00	74.30	14.60	9.50	53.60	27.00
P54	40.00	71.20	13.00	9.40	54.50	25.00
P55	38.35	75.40	13.80	9.60	53.90	25.00
P56	48.00	74.80	13.60	9.90	54.30	24.00
P57	36.45	74.50	13.40	9.30	55.00	24.00
P58	38.50	73.50	14.50	9.40	53.10	28.00
P59	35.75	72.70	15.10	9.50	52.90	30.00
P60	35.00	73.50	14.20	9.80	53.60	26.00
P61	38.30	74.80	13.60	9.50	55.50	28.00
P62	40.70	74.50	13.40	9.70	53.30	25.00
P63	34.60	72.40	13.20	10.00	53.40	23.00
P64	40.65	73.20	12.80	9.60	55.30	22.00
P65	40.90	74.90	13.00	9.40	54.20	23.00
P66	33.10	74.20	13.80	9.80	52.70	27.00
P67	39.00	72.70	13.40	9.60	54.00	25.00
P68	36.50	70.50	14.50	10.30	52.30	26.00
P69	50.00	72.00	14.30	9.60	53.50	27.00
P70	42.00	75.30	16.20	9.20	53.00	32.00
P71	37.75	72.50	15.20	9.90	52.60	29.00
P72	39.35	76.80	15.10	9.50	53.60	29.00
P73	38.20	74.70	14.80	9.40	52.20	28.00
P74	36.40	73.00	14.20	9.40	53.80	27.00

P75	39.25	75.60	15.70	9.60	52.80	30.00
P76	46.00	73.20	13.40	9.80	54.40	29.00
P77	34.90	73.80	13.80	9.90	53.80	26.00
P78	40.40	72.20	14.20	9.70	53.10	27.00
P79	36.60	73.60	14.30	9.90	53.10	26.00
P80	37.10	73.50	14.70	9.30	53.30	31.00
P81	38.90	72.80	15.30	9.60	52.50	31.00
P82	32.25	71.80	15.70	9.60	52.40	33.00
P83	37.40	74.20	14.20	9.60	53.90	27.00
P84	34.60	74.60	15.20	9.60	52.50	31.00
P85	34.25	73.80	13.70	9.90	53.10	24.00
P86	35.00	72.80	14.10	9.80	53.70	27.00
P87	47.60	74.60	15.50	9.90	51.70	33.00
P88	32.60	72.70	15.80	9.50	52.40	32.00
P89	42.70	75.60	15.70	9.60	53.60	31.00
P90	38.00	71.20	14.00	10.00	52.70	27.00
P91	36.10	73.70	13.20	9.70	54.50	25.00
P92	35.40	72.80	15.50	9.50	50.90	26.00
P93	38.20	73.60	14.80	9.80	52.00	25.00
P94	35.80	73.20	14.40	9.50	53.70	26.00
P95	34.80	73.80	14.50	9.30	54.10	29.00
P96	40.00	74.70	15.20	9.30	53.20	26.00
P97	34.90	72.40	13.60	9.90	54.30	26.00
P98	32.60	73.20	13.20	9.60	54.00	24.00
P99	36.00	76.20	13.70	9.80	54.40	26.00
P100	37.95	71.80	12.90	9.60	53.40	23.00
P101	39.95	72.00	15.40	9.80	51.70	31.00
P102	36.80	75.60	15.00	9.60	53.40	31.00
P103	36.25	73.70	14.50	9.70	54.40	28.00
P104	34.00	75.00	13.80	9.80	52.30	25.00
P105	38.00	73.80	14.10	9.70	52.50	24.00
P106	32.80	73.60	14.90	9.50	52.90	30.00
P107	39.65	73.20	15.10	9.40	53.80	29.00
P108	43.00	74.20	13.90	9.60	54.60	26.00
P109	31.60	75.30	15.80	9.80	52.20	32.00
P110	39.20	74.60	16.10	9.60	52.10	32.00
P111	32.60	72.00	14.20	9.70	53.10	28.00
P112	37.00	73.50	15.20	9.60	52.50	29.00
P113	36.00	72.80	15.30	9.40	53.30	31.00
P114	35.00	71.60	15.40	9.60	51.50	31.00
P115	35.00	71.00	15.20	9.60	52.20	30.00
P116	35.00	72.80	15.00	9.80	53.00	27.00
P117	38.70	72.30	15.10	9.60	51.40	30.00
P118	45.00	74.20	15.90	9.40	52.20	33.00

P119	37.40	72.60	15.00	9.60	52.60	28.00
P120	36.00	75.40	15.20	9.80	54.20	26.00
P121	35.20	70.80	15.70	9.40	52.20	33.00
P122	36.00	71.50	15.20	9.70	52.80	30.00
P123	35.50	74.30	14.70	9.80	52.40	28.00
P124	34.85	73.80	13.90	9.50	54.30	26.00
P125	39.90	76.00	14.20	9.20	54.30	26.00
P126	37.50	74.30	14.80	10.00	53.80	26.00
P127	38.50	72.80	14.30	9.40	54.50	28.00
P128	37.05	74.20	15.70	10.10	51.80	32.00
P129	37.40	74.80	14.10	9.80	53.00	27.00
P130	34.75	72.10	14.60	9.90	52.90	28.00
P131	39.20	71.70	13.10	9.30	55.00	23.00
P132	44.10	75.30	13.20	9.20	53.20	25.00
P133	39.40	73.60	15.90	9.30	52.40	32.00
P134	49.00	75.60	15.00	9.90	52.20	29.00
P135	37.55	74.20	13.90	9.60	52.80	24.00
P136	32.70	70.70	14.40	9.80	53.40	27.00
P137	37.35	74.80	13.80	9.70	53.60	26.00
P138	40.00	74.60	15.20	9.30	53.50	32.00
P139	40.00	74.20	14.40	9.50	54.70	28.00
P140	39.35	71.70	14.40	9.70	54.10	27.00
P141	35.85	70.60	14.80	9.70	53.70	26.00
P142	41.45	76.70	12.80	9.50	55.50	23.00
P143	39.95	72.30	12.40	9.60	54.90	23.00
P144	41.10	75.30	12.60	9.60	53.80	22.00
P145	35.40	70.80	13.90	10.50	52.50	25.00
P146	35.00	74.80	13.70	9.50	53.90	26.00
P147	41.50	76.20	14.40	9.60	54.60	28.00
P148	47.20	74.30	14.40	9.90	53.20	27.00
P149	37.80	70.00	12.90	9.90	53.90	21.00
P150	39.85	76.80	13.80	9.50	54.00	25.00
P151	39.60	73.20	12.80	9.30	54.90	23.00
P152	40.90	76.30	13.20	9.50	55.20	23.00
P153	37.75	74.60	11.80	9.70	55.50	20.00
P154	41.00	75.00	13.80	9.60	53.30	26.00
P155	34.30	70.20	14.50	9.40	52.90	29.00
P156	36.95	76.40	14.00	9.60	53.20	28.00
P157	36.20	73.60	14.60	9.60	53.30	29.00
P158	31.50	72.30	14.90	9.90	52.40	29.00
P159	33.70	70.80	14.70	9.30	53.70	28.00
P160	35.80	75.70	16.00	9.60	53.10	34.00
Range	**31.2-50.0**	**70.0-76.8**	**11.8-16.2**	**9.2-10.5**	**50.9-55.8**	**18.0-35.0**

Table 50: National Uniform wheat yield trials (rainfed 2022-23)

Plot No.	1000 grain weight (g)	Test weight (Kg/hl)	Protein (%)	Moisture (%)	Starch (%)	Gluten (%)
P1	36.5	70.5	14.8	9.8	53.5	25.0
P2	40.5	75.3	14.3	9.8	54.7	26.0
P3	40.0	74.3	13.4	10.0	54.5	23.0
P4	40.6	75.2	13.9	9.9	54.9	25.0
P5	40.2	73.2	13.0	10.3	54.9	21.0
P6	40.0	75.6	12.0	10.3	55.9	19.0
P7	41.7	74.0	11.6	10.4	56.7	17.0
P8	50.0	77.3	13.1	10.2	55.2	23.0
P9	35.8	73.4	13.2	10.4	55.2	22.0
P10	48.7	74.3	13.6	10.0	55.0	20.0
P11	40.0	73.7	12.7	10.1	55.9	22.0
P12	42.8	71.4	12.6	10.3	55.4	20.0
P13	42.2	73.4	12.5	10.4	55.2	19.0
P14	38.1	75.7	12.0	10.1	56.5	22.0
P15	35.6	77.2	13.0	10.0	55.2	21.0
P16	38.5	76.4	13.0	10.3	55.6	21.0
P17	42.6	70.2	13.2	10.5	52.9	23.0
P18	47.7	74.0	11.8	10.6	54.6	21.0
P19	43.5	74.5	11.6	10.3	55.8	18.0
P20	39.0	72.3	12.8	9.9	54.9	22.0
P21	37.2	74.8	12.6	10.2	55.3	22.0
P22	40.0	73.6	12.2	10.0	56.2	20.0
P23	38.9	75.4	12.4	10.1	56.0	20.0
P24	49.5	72.6	11.3	10.1	55.7	17.0
P25	40.3	71.6	11.1	10.6	55.8	14.0
P26	37.8	73.2	12.2	10.4	52.6	16.0
P27	41.9	74.8	12.1	10.2	55.9	18.0
P28	38.3	75.6	11.9	10.3	55.2	17.0
P29	35.3	73.4	13.9	10.2	55.0	24.0
P30	36.6	76.3	14.1	10.2	54.8	25.0
P31	38.3	71.4	13.7	9.9	55.8	25.0
P32	37.6	76.4	13.0	9.9	54.2	23.0
P33	38.2	74.2	13.1	10.3	54.2	22.0
P34	48.2	75.2	11.3	10.3	56.5	18.0
P35	45.8	73.2	12.1	10.2	55.2	18.0
P36	41.5	76.5	11.6	10.7	56.0	18.0
P37	40.0	73.2	11.1	10.5	56.5	17.0
P38	38.9	74.2	12.0	10.2	54.2	18.0
P39	39.3	73.6	12.8	10.2	55.6	19.0
P40	42.0	78.0	11.4	10.5	56.2	17.0

P41	49.6	72.3	13.0	10.0	55.1	21.0
P42	41.5	75.0	12.3	10.6	55.0	19.0
P43	48.2	75.8	13.0	10.4	54.0	21.0
P44	39.3	76.2	11.7	10.4	55.5	18.0
P45	37.1	73.2	12.3	10.8	54.6	17.0
P46	37.9	75.2	11.8	10.5	55.1	18.0
P47	37.0	74.0	11.8	10.2	56.0	18.0
P48	37.5	74.2	11.8	10.6	55.4	15.0
P49	39.4	75.6	11.3	10.4	56.7	19.0
P50	36.2	74.2	12.2	10.6	55.1	17.0
P51	47.6	72.0	11.9	10.6	56.2	19.0
P52	41.8	75.3	12.2	10.2	55.1	19.0
P53	39.4	74.6	12.7	10.4	54.3	20.0
P54	39.9	70.5	11.9	10.1	56.0	20.0
P55	46.2	77.5	12.8	10.1	54.8	20.0
P56	42.1	73.7	12.8	10.3	55.5	20.0
P57	37.8	74.7	12.9	10.2	55.7	21.0
P58	37.6	73.2	13.8	10.0	53.1	23.0
P59	40.0	74.2	15.2	9.8	53.1	29.0
P60	36.3	75.2	14.3	10.1	53.5	24.0
P61	37.4	73.8	14.3	10.2	54.9	27.0
P62	38.0	74.0	13.4	10.1	54.4	22.0
P63	35.8	72.1	13.1	10.1	55.0	23.0
P64	33.7	72.7	12.6	10.9	54.4	21.0
P65	36.5	75.3	13.0	10.5	54.0	21.0
P66	38.2	76.2	12.7	10.4	55.9	20.0
P67	39.2	75.3	13.0	10.2	54.6	19.0
P68	36.2	72.4	11.9	10.2	54.6	17.0
P69	41.3	73.2	11.0	10.6	55.6	15.0
P70	41.0	75.8	11.5	10.2	56.1	14.0
P71	37.3	78.0	10.8	10.4	56.6	14.0
P72	40.5	73.6	11.5	10.2	56.6	18.0
P73	41.2	76.4	12.3	10.1	56.2	21.0
P74	40.8	74.2	12.0	10.1	55.2	18.0
P75	39.7	74.6	12.4	10.2	53.6	20.0
P76	43.0	73.0	12.1	10.2	56.6	19.0
P77	32.9	73.6	14.0	10.0	54.1	26.0
P78	39.3	75.2	13.1	10.3	53.8	21.0
P79	42.5	78.2	12.1	10.3	54.7	15.0
P80	42.2	71.6	12.5	10.2	56.2	21.0
P81	44.1	75.6	11.8	10.3	55.6	18.0
P82	41.7	75.7	12.2	10.7	55.5	16.0
P83	37.3	70.2	11.4	10.4	56.1	16.0
P84	37.0	76.0	12.2	10.2	56.1	21.0

P85	40.7	74.3	11.0	11.5	56.3	15.0
P86	42.9	74.7	12.4	10.6	54.7	19.0
P87	41.3	74.2	12.2	10.3	55.4	17.0
P88	37.2	74.6	12.2	10.2	56.5	20.0
P89	49.5	78.0	13.5	9.8	55.6	23.0
P90	39.2	73.4	11.3	10.6	56.4	16.0
P91	34.3	74.6	12.8	10.3	53.9	20.0
P92	41.7	76.3	12 .3	10.4	54.8	17.0
P93	42.2	74.0	11.5	10.2	56.2	16.0
P94	41.7	77.7	12.3	10.4	55.8	20.0
P95	45.0	75.8	12.1	10.7	54.7	20.0
P96	38.9	78.5	11.7	10.7	55.7	17.0
P97	38.5	72.0	13.4	10.4	54.3	23.0
P98	38.2	75.7	11.0	10.6	56.0	16.0
P99	45.7	73.7	13.2	10.4	54.8	21.0
P100	43.2	75.2	11.1	10.3	56.2	16.0
P101	41.2	77.6	11.9	10.4	56.3	20.0
P102	40.0	77.8	12.5	10.1	56.0	21.0
P103	41.6	74.7	11.7	10.4	55.4	16.0
P104	38.3	74.8	11.8	10.5	54.1	16.0
P105	42.6	76.0	12.0	10.0	55.1	17.0
P106	48.7	77.2	11.8	10.3	54.2	18.0
P107	41.5	74.2	12.0	10.4	56.2	19.0
P108	41.6	76.3	11.4	10.4	56.5	17.0
P109	41.6	73.6	11.0	10.5	56.4	14.0
P110	42.3	75.3	11.1	10.2	56.7	15.0
P111	37.9	74.6	11.3	10.5	56.6	16.0
P112	49.6	74.5	11.7	10.2	56.1	15.0
P113	39.5	74.2	12.3	10.2	55.9	20.0
P114	49.9	74.5	12.2	10.2	55.3	19.0
P115	38.4	73.6	12.6	10.5	55.4	21.0
P116	39.4	73.8	12.6	10.1	55.0	18.0
P117	38.2	70.6	14.0	10.5	53.3	24.0
P118	42.4	74.7	13.0	10.2	54.0	21.0
P119	35.8	72.3	13.7	9.9	54.6	24.0
P120	39.7	75.6	13.3	10.4	54.7	22.0
P121	39.0	72.4	13.9	10.1	54.1	24.0
P122	40.7	76.6	14.1	10.0	55.0	26.0
P123	37.3	72.8	13.9	10.0	53.6	23.0
P124	39.6	74.7	12.5	10.3	55.6	19.0
P125	41.5	78.0	12.8	10.2	55.5	19.0
P126	41.8	77.6	12.5	10.0	56.3	20.0
P127	38.9	75.4	11.7	10.7	56.0	17.0
P128	41.2	74.2	12.6	10.0	54.9	20.0

P129	40.1	77.4	12.0	10.2	54.2	18.0
P130	41.3	75.3	12.4	10.0	55.0	18.0
P131	45.0	75.0	11.3	10.5	55.7	14.0
P132	43.1	76.4	12.2	10.0	54.2	18.0
P133	42.8	71.7	11.3	10.2	56.3	16.0
P134	48.9	77.2	12.3	10.3	55.1	19.0
P135	38.2	74.3	11.3	10.2	55.5	16.0
P136	37.4	78.0	12.4	10.0	53.6	17.0
P137	40.0	75.2	12.8	10.0	55.5	22.0
P138	38.3	76.2	12.5	10.0	55.9	21.0
P139	42.2	70.4	12.6	10.1	55.0	20.0
P140	40.8	74.2	13.2	10.2	55.1	21.0
P141	42.1	72.2	12.6	10.1	55.8	18.0
P142	39.2	75.7	11.9	10.3	55.8	18.0
P143	40.3	73.2	11.3	10.3	55.8	16.0
P144	42.1	77.0	10.6	10.4	56.2	14.0
P145	42.7	75.2	11.1	10.0	56.2	15.0
P146	36.8	78.3	11.2	10.4	56.2	16.0
P147	41.6	75.3	11.8	10.6	55.8	17.0
P148	45.0	75.6	12.5	10.6	54.5	20.0
P149	42.2	74.7	12.8	10.0	53.8	19.0
P150	41.0	73.8	13.1	10.3	54.9	23.0
P151	36.8	75.4	13.2	10.4	54.8	22.0
P152	40.7	76.2	12.6	10.0	54.2	20.0
P153	42.2	75.2	13.0	9.8	54.6	18.0
P154	40.0	70.4	13.0	10.2	55.0	20.0
P155	37.9	73.6	11.5	10.3	55.8	17.0
P156	43.3	76.2	11.1	10.4	56.4	15.0
P157	40.8	76.4	11.8	10.2	55.2	18.0
P158	36.4	75.6	11.9	10.0	55.4	17.0
P159	41.3	76.3	11.3	10.3	56.3	15.0
P160	40.0	77.7	12.8	10.2	55.5	20.0
Range	**32.9-50.0**	**70.2-78.5**	**10.6-12.3**	**9.8-11.5**	**52.6-56.7**	**14.0-29.0**

Table 51: Punjab Uniform wheat yield trials (Normal 2022-23)

Entry	1000 grain weight (g)	Test weight (Kg/hl)	Starch (%)	Protein (%)	Gluten (%)	Moisture (%)
1	39.98	73.55	53.85	13.50	23.00	9.85
2	34.58	72.10	54.10	14.60	28.00	9.40
3	30.08	70.70	52.35	15.50	30.00	9.55
4	36.80	74.55	53.35	15.60	30.00	9.60
5	38.38	75.70	54.20	13.60	24.50	9.75

6	37.03	72.80	52.90	15.40	30.50	9.60
7	36.70	71.70	54.30	13.75	26.50	9.75
8	37.40	72.25	53.40	13.55	24.50	9.80
9	36.68	74.40	53.95	13.95	26.00	9.90
10	42.48	72.10	53.15	13.95	24.00	10.25
11	40.23	74.90	53.40	14.70	28.00	9.65
12	38.23	73.30	55.65	13.70	26.00	9.50
13	36.58	73.60	54.95	13.15	23.50	9.80
14	38.33	75.55	53.75	14.65	26.00	9.75
15	34.63	71.30	53.95	14.55	28.50	9.65
16	37.35	73.10	53.20	15.15	29.50	9.45
17	38.10	74.30	54.25	14.75	27.50	9.75
18	38.48	74.70	54.15	14.15	25.50	9.70
19	40.90	72.85	54.45	13.35	25.00	10.00
20	38.15	73.30	54.50	13.00	22.00	9.70
21	40.40	71.30	54.00	13.70	24.00	9.95
22	37.20	71.75	53.35	14.60	26.50	9.60
23	40.15	73.30	53.55	14.30	27.50	9.90
24	35.18	72.40	52.45	14.90	31.00	9.55
25	35.73	73.10	52.90	14.35	27.00	9.90
26	38.35	72.40	54.25	12.90	23.50	9.70
27	38.33	73.30	54.30	14.45	27.00	9.55
28	34.40	73.30	53.65	14.40	27.50	9.85
29	41.10	73.55	53.10	15.55	29.50	9.55
30	40.35	73.45	54.05	13.65	23.50	9.80
31	34.95	74.40	54.25	13.25	24.50	9.85
32	38.40	72.90	53.75	14.25	26.00	9.65
33	40.58	73.75	52.85	14.80	28.50	9.70
34	32.35	72.60	53.60	13.85	26.50	9.65
35	39.53	70.95	52.65	14.75	25.50	9.95
36	33.38	72.05	53.50	13.80	25.50	9.95
37	41.48	75.20	54.10	15.60	31.50	9.55
38	39.80	72.00	53.15	14.80	28.00	9.60
39	40.70	73.65	53.20	15.15	29.00	9.65
40	37.40	74.40	55.75	13.45	25.50	9.60
41	37.88	72.60	53.65	13.45	25.00	9.80
42	39.15	73.90	53.40	14.05	27.00	9.75
43	35.00	74.05	53.65	14.90	30.00	9.60
44	36.80	73.95	53.95	14.40	25.50	9.60
45	33.70	72.55	54.30	13.50	24.00	9.80
46	39.85	75.50	53.60	15.05	28.50	9.80
47	35.73	70.85	52.95	15.50	30.50	9.55
48	36.88	73.20	54.55	13.75	27.50	9.55
49	42.05	74.15	53.45	15.25	29.50	9.60

50	40.25	71.70	53.25	14.55	28.50	9.65
51	40.40	73.95	53.55	15.55	30.50	9.45
52	36.05	72.00	53.35	14.90	28.50	9.55
53	37.90	71.30	54.05	13.75	25.00	9.70
54	39.48	73.70	53.50	14.25	26.50	9.70
55	43.18	72.45	54.05	14.50	26.50	9.50
56	32.73	73.45	53.50	14.05	26.50	9.50
57	38.58	72.45	54.50	14.05	26.50	9.65
58	33.43	70.90	54.00	14.00	26.00	9.45
59	38.88	70.85	53.05	15.05	29.00	9.65
60	36.30	72.30	53.35	14.15	26.50	9.80
Range	**30.08-43.18**	**70.7-75.7**	**52.35-55.75**	**12.90-15.60**	**22.0-31.50**	**9.40-10.25**

Table 52: Punjab Uniform wheat yield trials (rainfed 2022-23)

Entry	1000 grain weight (g)	Test weight (Kg/hl)	Starch (%)	Protein (%)	Gluten (%)	Moisture (%)
1	38.78	72.05	53.80	13.80	24.50	10.05
2	35.60	73.10	53.25	14.95	29.50	9.75
3	35.89	69.95	50.65	15.85	33.00	9.90
4	44.35	74.85	53.05	14.85	26.50	9.85
5	43.98	76.90	52.40	15.30	30.00	10.00
6	32.19	72.10	52.20	15.20	30.00	9.65
7	38.35	74.40	53.20	14.85	29.00	10.00
8	42.10	73.50	53.05	14.60	27.50	10.10
9	39.39	73.90	49.65	15.10	28.50	9.65
10	42.51	75.25	51.70	16.10	32.50	9.70
11	38.78	77.70	51.45	15.95	30.50	9.95
12	37.72	74.90	53.90	14.65	27.50	9.95
13	36.41	73.30	53.15	14.65	27.50	9.80
14	48.14	78.10	52.30	15.90	29.00	9.85
15	48.73	74.60	53.40	14.10	25.00	10.20
16	34.71	76.10	53.10	15.30	30.00	9.90
17	41.26	74.70	52.55	15.80	30.50	9.75
18	37.20	77.85	53.45	14.95	29.00	9.70
19	35.44	74.30	53.80	14.20	26.50	9.70
20	37.88	77.70	52.70	15.55	29.50	9.50
21	38.28	75.35	53.00	14.95	26.50	9.85
22	41.68	73.95	53.25	14.70	27.50	10.05
23	35.78	77.05	52.90	15.05	29.50	9.90
24	36.83	73.60	51.60	15.80	30.50	10.10
25	43.23	74.95	51.50	15.90	31.50	10.20
26	37.73	75.50	53.00	14.75	27.00	10.00
27	45.26	76.85	53.10	13.85	25.00	10.05
28	37.20	72.80	52.00	15.55	30.50	9.70
29	45.59	73.45	52.50	15.30	33.50	9.85

30	31.10	75.30	54.25	13.40	23.00	9.90
31	40.56	74.50	51.30	15.40	28.00	9.70
32	36.77	76.40	52.70	14.80	26.50	9.90
33	41.78	75.65	51.65	15.55	33.50	9.80
34	47.03	74.65	52.00	15.65	30.50	10.10
35	38.29	76.10	51.15	16.20	32.50	9.95
36	33.23	73.90	51.05	16.10	31.00	10.00
37	41.74	74.15	52.95	15.25	30.50	9.85
38	39.95	75.50	52.95	15.35	26.50	9.70
39	38.70	73.00	54.35	13.95	26.00	9.65
40	43.60	75.75	53.80	14.60	28.00	10.10
41	37.03	72.95	52.40	14.75	27.50	9.90
42	39.73	77.20	51.50	15.90	31.50	9.90
43	39.18	76.40	52.65	15.60	31.00	9.80
44	36.39	74.15	53.60	14.90	29.00	9.60
45	41.91	76.15	53.05	15.35	29.00	9.70
46	40.33	76.85	52.05	15.55	29.50	9.70
47	37.85	71.80	51.90	14.95	29.00	9.95
48	41.08	75.20	53.10	14.25	25.00	10.00
49	39.54	74.40	51.85	15.70	35.00	9.65
50	40.79	73.15	52.65	15.35	33.00	9.85
51	39.88	79.40	52.30	15.80	30.00	9.55
52	41.70	73.20	53.65	13.95	26.50	10.05
53	36.45	75.90	52.70	15.15	28.50	9.75
54	41.55	74.60	52.95	14.85	27.50	9.80
55	41.13	76.25	51.25	15.45	29.50	9.95
56	38.50	73.85	52.80	15.45	29.00	9.75
57	46.75	76.35	52.05	15.45	29.50	9.70
58	40.20	76.10	50.80	16.25	30.50	9.80
59	41.48	73.55	52.65	15.20	31.50	9.50
60	39.84	73.55	52.95	14.65	28.50	9.95
Range	**31.10-48.73**	**69.95-79.40**	**49.65-54.35**	**13.40-16.25**	**23.0-35.0**	**9.50-10.20**

(e)-Determination of quality traits in advanced lines of barley

Nineteen barley advanced lines/varieties under different Trials (2022-23) were analyzed for quality traits. (table 53)

Table 53: Q**uality traits in advanced lines of barley**

Advance lines	**Quality Traits**		
	1000 grain wt. (g)	**Test wt. (kg hL^{-1})**	**Protein (%)**
Advance lines	**31.40-45.95** B-21048-Jau-21	**46.7-61.0** B-21001-E.21022	**12.0-14.7** B-21001-Pearl-21

(f)-Effect of planting time on grain quality traits

(i)-Thousand grain weight (g)

Regarding thousand grain weight, V-20337, V-19532 and HYT-100-76 performed best in first two sowing dates i.e. 20th October and 1st November. But when we see the values in third sowing date (10th November), the toppers were HYT-100-47, HYT-100-74 & V-19308. Among checks, Dilkash-21 & Arooj-22 performed well in initial sowing dates whereas Akbar-19 gradually showed potential with delayed sowing (table 54).

Table 54: Effect of sowing dates on thousand grain weight (g)

Sr. No.	Varity/Cultivar	D1	D2	D3	D4	D5	D6	D7
1	Akbar-19	30.14	33.91	35.17	37.47	34.07	38.77	38.52
2	Subhani-21	28.65	31.35	28.37	36.23	26.46	32.11	28.52
3	Dilkash-21	36.88	38.00	37.44	36.45	36.61	33.52	35.80
4	Arooj-22	37.68	39.88	39.83	35.83	36.05	37.96	37.44
5	V-19347	33.85	38.36	39.55	35.03	33.93	38.12	38.19
6	HYT-100-74	35.94	41.09	40.41	36.32	38.07	37.52	37.17
7	V-19308	36.23	35.45	42.12	35.78	34.43	33.51	37.85
8	HYT-100-76	39.13	39.91	38.45	40.29	36.97	33.35	32.50
9	HYT-100-47	38.29	36.17	41.53	41.17	35.72	35.65	37.83
10	V-20337	40.37	40.51	39.00	38.70	37.54	35.19	37.20
11	V-19532	41.04	39.32	39.85	39.92	42.08	39.20	35.83
12	V-20330	34.05	32.99	34.56	38.49	31.96	29.89	31.63
13	V-19559	33.09	35.67	35.62	36.36	34.73	35.59	36.84
14	V-19317	36.60	35.54	35.31	33.64	30.36	34.03	33.58

(ii)-Test Weight (kg hl^{-1})

Regarding test weight, HYT-100-76 & HYT-100-47 performed best in first two planting dates. Also HYT-100-47 maintained the vigor in D3 accompanied by V-19308. But in D4 the only winner was V-20337. HYT-100-74 along with V-19308 performed best when planted at 5th planting date i.e. 1st December. V-19308 maintained the strength till last planting date as well (table 55).

Table 55: Effect of sowing dates on test weight (g)

Sr. No.	Varity/Cultivar	D1	D2	D3	D4	D5	D6	D7
1	Akbar-19	70.83	71.43	72.83	72.27	76.33	72.77	75.17
2	Subhani-21	72.00	73.07	72.53	69.50	72.20	71.67	71.87
3	Dilkash-21	70.87	73.00	75.17	73.57	73.30	71.10	71.73
4	Arooj-22	72.50	72.50	76.27	75.27	75.23	74.00	73.93
5	V-19347	74.07	75.67	74.63	74.07	75.53	73.97	73.73
6	HYT-100-74	72.77	73.83	75.53	73.10	78.60	77.83	77.33
7	V-19308	75.20	75.80	78.87	75.80	78.27	76.13	78.17
8	HYT-100-76	75.13	77.77	77.93	73.20	75.83	73.33	72.33
9	HYT-100-47	75.77	77.50	78.17	74.20	75.73	75.70	76.60
10	V-20337	73.93	76.17	77.57	76.27	76.27	77.57	75.17
11	V-19532	73.87	73.17	76.00	72.47	70.40	74.70	75.07

12	V-20330	71.93	72.27	72.97	70.97	71.67	69.87	71.27
13	V-19559	70.33	72.67	75.17	72.83	72.30	74.60	73.23
14	V-19317	71.27	73.67	74.43	72.37	70.00	75.17	73.67
Average		**72.89**	**74.18**	**75.58**	**73.28**	**74.40**	**74.17**	**74.23**

(iii)-Starch (%)

This year, there was a regular minor decreasing trend was observed in the values of starch percentage with respect to planting date but regarding cultivars, V-19347, V-19308, V-20337, HYT-100-76 & HYT-10047 gave best values in first three planting dates whereas Akbar-19, Subhani-21 & HYT- 100-74 accompanied them in D3. Akbar just like test weight showed the strength with delayed sowing (table 56).

Table 56: Effect of sowing dates on starch percentage

Sr. No.	Varity/Cultivar	D1	D2	D3	D4	D5	D6	D7
1	Akbar-19	53.9	53.5	54.2	54.5	54.8	54.5	54.2
2	Subhani-21	53.1	53.7	55.0	52.5	53.6	54.2	54.0
3	Dilkash-21	53.3	53.3	53.9	53.4	54.2	53.6	53.5
4	Arooj-22	54.2	52.6	53.9	53.6	53.5	53.6	54.4
5	V-19347	54.2	54.1	54.8	54.1	53.4	53.8	53.2
6	HYT-100-74	53.2	52.7	54.3	54.1	53.5	53.9	53.5
7	V-19308	54.4	54.6	54.7	54.6	53.7	53.9	54.2
8	HYT-100-76	54.2	54.2	54.2	54.0	54.2	53.5	54.0
9	HYT-100-47	54.1	54.9	54.2	53.9	54.3	54.0	53.6
10	V-20337	54.6	54.2	54.8	53.6	53.7	53.8	54.2
11	V-19532	53.3	52.9	52.9	53.4	52.6	53.5	53.5
12	V-20330	53.6	52.9	53.4	53.6	53.5	53.3	53.4
13	V-19559	53.8	54.0	54.1	54.0	54.5	54.9	53.7
14	V-19317	53.5	53.7	53.9	53.9	53.2	54.1	53.4
Average		**53.8**	**53.7**	**54.2**	**53.8**	**53.8**	**53.9**	**53.8**

(iv)-Protein (%)

As far as protein percentage is concerned, a slight decrease was observed in first two planting dates but it remained in a constant range in other planting dates (table 57).

Table 57: Effect of sowing dates on protein percentage

Sr. No.	Varity/ Cultivar	D1	D2	D3	D4	D5	D6	D7
1	Akbar-19	13.17	13.83	13.43	13.23	12.73	12.70	12.90
2	Subhani-21	14.93	14.33	12.97	14.90	14.23	13.80	13.90
3	Dilkash-21	14.37	14.23	13.87	14.43	13.93	14.00	14.00
4	Arooj-22	13.13	14.20	13.23	13.90	13.43	13.27	12.83
5	V-19347	13.60	13.60	13.17	13.80	14.37	14.40	14.50
6	HYT-100-74	14.30	15.43	14.27	14.67	14.87	15.07	15.10
7	V-19308	13.20	12.83	13.07	13.60	13.83	13.80	13.73
8	HYT-100-76	13.53	13.50	13.87	13.93	14.03	14.07	14.00
9	HYT-100-47	13.53	13.00	13.73	14.27	13.90	14.50	14.97

10	V-20337	13.20	14.13	13.30	14.37	14.43	14.60	13.97
11	V-19532	14.60	15.57	15.27	14.97	15.27	14.63	14.03
12	V-20330	14.27	15.60	14.63	14.90	14.97	15.00	14.97
13	V-19559	13.67	13.43	13.53	13.50	13.03	12.97	13.77
14	V-19317	13.93	13.80	13.33	14.20	14.37	13.83	14.43
Average		13.82	14.11	13.69	14.19	14.10	14.05	14.08

(v)-Gluten (%)

The trend of gluten percentage was much similar to that of protein (table 58).

Table 58: Effect of sowing dates on gluten percentage

Sr. No.	Varity/ Cultivar	D1	D2	D3	D4	D5	D6	D7
1	Akbar-19	23.3	25.0	23.7	23.3	21.0	20.3	21.3
2	Subhani-21	30.0	26.0	21.7	27.3	25.0	24.3	26.3
3	Dilkash-21	27.3	26.3	25.0	27.0	25.3	25.3	25.3
4	Arooj-22	22.7	24.0	20.7	22.7	20.7	20.3	20.7
5	V-19347	23.3	24.3	22.0	23.3	25.7	25.3	26.0
6	HYT-100-74	26.3	29.0	25.3	26.7	26.7	27.7	28.7
7	V-19308	23.3	21.3	22.0	24.3	24.0	24.0	25.0
8	HYT-100-76	23.7	23.0	23.3	24.7	25.0	25.0	25.7
9	HYT-100-47	23.0	21.3	23.7	23.7	23.7	24.7	28.0
10	V-20337	21.7	24.7	22.7	25.7	26.0	25.3	24.7
11	V-19532	27.0	29.7	27.3	28.3	29.0	25.7	25.3
12	V-20330	27.3	30.3	28.3	29.0	28.0	29.0	29.0
13	V-19559	25.0	23.7	24.0	23.3	22.3	22.3	25.3
14	V-19317	24.7	24.0	21.3	25.3	24.7	23.0	25.3
Average		**24.9**	**25.2**	**23.6**	**25.3**	**24.8**	**24.5**	**25.5**

(g)-Impact of tempering conditions on milling yield and rheology of flour

Three cultivars were chosen for this trial. All gave maximum milling yield at 15% moisture content on two duration i.e. 8 hours and 16 hours. Also there was no remarkable difference among all three cultivars. But the results were poor when grain was tempered for 24 hour (table 59).

Table 59: Impact of tempering conditions on milling yield and rheology of flour

Tempering Conditions		Flour Yield (%)		
		Varieties/ Lines		
Time (Hours)	Moisture (%)	HYT-100-76	HYT-100-74	HYT-100-47
8	14	66	67	68
	15	71	73	72
	16	67	67	68
16	14	68	70	69
	15	71	72	72
	16	66	64	65
24	14	67	68	68
	15	65	63	65
	16	64	64	65

(h)-Preparation of chapatti & bread from aleuron flour

Three wheat cultivars were milled for separation of aleuron to make bread and chapatti to get functional benefits. Sensory evaluation revealed that score for chapatti was equal but Akbar-19 proved best for bread production (table 60).

Table 60: Sensory evaluation of chapatti & bread from aleuron flour

Wheat Variety	Sedimentation value (ml)	Chapatti Quality (Score/100)	Bread Quality (Score/100)
HYT-100-76	28	73	60
HYT-100-74	28	72	61
HYT-100-47	27	74	61

Study of growth rate of key developmental stages of bread wheat advanced lines under changing climate conditions

Selected ten advanced lines of bread wheat were planted with three replications following randomized complete block design (RCBD) under two environments (late planting & normal planting under irrigated conditions) for experiment purpose. The growth rate of selected development stages as per Zadok's scale (zadoks et al., 1974; Tottman and Broad, 1987) were measured in relation to thermal time (Cd). The thermal time (heat units) was calculated by multiplying the number of days with average temperature prevailed during the days. The data of agronomic (at critical stage) and quality parameters were parameters was recorded (table 61 and 62).

Table 61: Data of agronomic parameters

Sr.#	Variety	H (cm)	MD	Tillering (cm)	H-D (cm)	Spike length	Spikelets	No. of grain/spike
1	Akbar-19	105.00	145.00	73.00	101.00	11.17	17.83	189.00
2	Arooj-22	102.67	145.33	78.33	104.00	9.50	16.83	172.00
3	Dilkash-21	104.00	145.00	74.33	104.00	10.67	20.83	210.67
4	HYT-100-47	102.50	142.67	62.17	102.00	11.17	17.67	192.33
5	HYT-100-74	99.67	143.67	58.67	102.00	11.17	17.83	181.67
6	HYT-100-76	104.50	143.00	72.67	102.67	11.50	19.67	183.33
7	Subhani-21	99.83	147.00	76.83	108.00	9.67	18.33	202.33
8	V-19308	102.17	144.00	74.17	103.00	10.67	16.33	169.67
9	V-19317	108.33	145.00	66.67	103.67	12.83	17.83	219.33
10	V-19347	105.50	145.00	93.33	103.33	11.83	19.67	186.67

Note: H=Heigth, MD=Maturity Days, H-D=Heading days

Table 62: Data of quality parameters

Sr.#	Variety	1000 G. Wt. (g)	Test Wt. (kg/hl)	Protein (%)	Moisture (%)	Starch (%)	Gluten (%)	Zeleny
1	Akbar-19	35.17	72.83	13.43	10.23	54.23	23.67	43.00
2	Arooj-22	39.83	76.27	13.23	10.43	53.90	20.67	44.33
3	Dilkash-21	37.44	75.17	13.87	10.03	53.93	25.00	51.67
4	HYT100-47	41.53	78.17	13.73	10.70	54.23	23.67	53.33
5	HYT100-74	40.41	76.53	14.27	10.17	54.30	25.33	49.67
6	HYT100-76	38.45	77.93	13.87	10.17	54.17	23.33	56.00
7	Subhani-21	28.37	72.53	12.97	10.37	54.97	21.67	43.00
8	V-19308	42.12	78.87	13.07	10.53	54.73	22.00	55.00
9	V-19317	35.31	74.43	13.33	10.53	53.87	21.33	50.33
10	V-19347	39.55	76.30	13.17	10.20	54.83	22.00	48.67

PROJCTS

(1)- PARB Project # 904 (Nutrition enhancement of wheat crop)

(a)-Crossing block and filial generations

One hundred wheat genotypes having high Zn (18-55 mg kg^{-1}) and Fe (22-141 mg kg^{-1}) contents were planted for evaluation, screening and hybridization. Fifty fresh crosses have been harvested. The filial generations (F_1-F_6) were sown and selected for desirable traits. Segregating materials were surrounded by the spreader rows of highly susceptible variety (Morocco). Modified bulk method was used for selection in F_2 & F_5. Entries studied and selected in different generations are given in the table 63.

Table 63: **Details of filial generations**

Sr. No.	Generations	Entries Studied	Entries Selected
1	F_1	170	162
2	F_2	182	126
3	F_3	107	76
2	F_4	37	25
5	F_5	14	10
6	F_6	336 (SHR)	74 (SHR)

(b) Agronomic fortification

Trial with seven treatments of soil and foliar application of zinc and iron was sown for the biofortification. The wheat variety Anaj-2017 was used in this experiment. Different levels of zinc and iron was applied in soil and foliar application. Data on yield and yield parameters plant height (cm), spikelet per spike, spike length (cm), grain yield ($kgha^{-1}$), zinc and iron contents in grains (mg/kg) has been recorded.

Zinc and iron contents in grains were also measured accordingly. Seed samples were analyzed from Soil Bio-chemistry Section of Post-Harvest Research Center (PHRC) of AARI to estimate the Fe and Zn contents in the respected treatments.

- Maximum zinc (Zn) contents (49.24 mg kg^{-1}) were observed when 0.5% $ZnSO_4$ was applied as foliar.
- Maximum iron (Fe) contents (258.72 mg kg^{-1}) were observed when 1% $FeSO_4$ was applied as foliar.

These standardized doses of iron and zinc were disseminated to stakeholders through farmer's day and brochures.

(c)-Pasta Product Fortification

Pasta was one of the products used for the study and biscuits, which is equally a favourite snack but has a completely different cooking process, was used as the comparative product. These two products were fortified with Fe and Zn salts i.e., FeSO4, NaFeEDTA, ZnSO4 and ZnO, respectively. The doses incorporated were according to the RDA (Recommended Daily Allowance) of an individual, which is 10mg/day for zinc and 14mg/day for iron. The doses were set keeping into account the maximum limit of the two minerals for the human body, i.e., 45-50 mg/day was maximum limit for both salts. Considering the limited pattern of the study NaFeEDTA is a better iron fortificants, ZnO and ZnSO4 were almost at par with similar results, use of fortificants in biscuits were more substantial as compared to in pasta (which can be a lead to further study), combination of different mineral fortificants/salts can be considered for desirable results.

(2)- PARB Project # 770 (Development and dissemination of rice and wheat varieties suitable for irrigated rice-wheat cropping system in the climate change scenario)

(a)-Filial generations (F_0, F_1, F_5, F_7)

Fifty single (F_0 generation) crosses were attempted, out of which 50 single crosses were harvested. F_1 generation was sown in irrigated condition so that sufficient seed may be produced. F_5 and F_7 generations were sown in waterlogging conditions at RRI, KSK. Entries/plants exhibiting waterlogging tolerance, desirable plant height and diseases resistance were selected using selected bulk. Fifty-two F_{1s} were sown on 10-11-22 at WRI-FSD and F_5 and F_7 generations were sown on 29-11-22 at RRI, KSK and fertilized @120:90:60 N: P: K kg ha^{-1} at sowing time. Plot size of F_5 and F_7 was 1.8 m x 6 m. 50, 52, 17 and 102 entries from (F_0, F_1, F_5, and F_7) were selected, respectively (table 64).

Table 64: Detail of filial generations for waterlogging tolerance

Generations	Entries studied	Entries selected
F_0	50	50
F_1	52	41
F_5	17 SHB	15 SHB
F_7	102	54

SHB= Single Head Bulk,

(b)-A-Trial (Irrigated)

In A-I 14 advanced lines (out of 54) and A-II 10 advanced lines (out of 22) were found high yielding than all the check varieties (Akbar-19 & Subhani-21) under irrigated conditions (table 65).

Table 65: High yielding advanced lines in A-trials

A-Trial (Irrigated)		Akber-19	Arooj-22
		2950	3220
Variety Code	Yield (Kg ha^{-1})	Percentage increase over check varieties	
V-22032	3514	19.11	9.13
V-22036	3490	18.30	8.39
V-22049	3450	16.94	7.14
V-22058	3452	17.01	7.20
V-22059	3420	15.93	6.21
V-22060	4160	41.01	29.19
V-22062	3592	21.76	11.55
V-22063	3440	16.61	6.83
V-22067	3543	20.10	10.03
V-22068	3450	16.94	7.14
V-22069	3410	15.59	5.90
V-22073	3420	15.93	6.21
V-22074	3480	17.97	8.07
V-22081	3480	17.97	8.07
V-22087	3830	29.83	18.94
V-22088	3826	29.69	18.81
V-22089	3913	32.64	21.52
V-22090	3501	18.68	8.73
V-22095	3549	20.31	10.22
V-22099	3925	33.05	21.89
V-22100	3888	31.79	20.75
V-22104	3913	32.64	21.52
V-22105	3962	34.31	23.04
V-22106	3551	20.37	10.28
LSD (0.05) = 141.53, CV (%) = 4.16			

(c)-Regular Yield Trial (B-Trial)

In regular yield trials under waterlogging conditions, thirty-eight entries were tested following alpha lattice design with two replications and with two check varieties i.e. Akbar-19 and Arooj-22 in RRI-KSK, WRI-FSD and SSRI Pindi Bhuttian in regular yield (B-trial) trial. Nine (09) selected best entries in all the regular yield trials on the basis of yield potential and rust resistance (table 66).

Table 66: Regular yield trials (2022-23)

Sr. No	Variety Code	Parentage/Pedigree	Yield (kg ha^{-1})	Disease Reaction 2022-23	
			Irrigated	LR	YR
1	V-21002	AQUAB/GA-2002 PB14001-0A-OA-0A -26A-0A	3974	10MS	0
2	V-21008	AQUAB /6/ PFAU/SERI.1B//AMAD/3/ WAXWING/4/AKURI/5/PFAU/ SERI.1B// AMAD/3/WAXWING PB14007-OA-OA-OA-16A-OA	3614	10MS	0

3	V-21013	BABAX/3/FASAN/Y//KAUZ/4/BABAX/5/LU 26/ HD2179/6/NR 388 PB14092-OA-OA-0A -1A-0A	3768	5MS	0
4	V-21033	CROC_1/AE.SQ444/3/T.DOCOCCON T194625 AE.SQ (372)//3*PASTOR/4/ T.DICOCCON/5/NR 384(Lr37/Yr17/Sr38) PB14154-OA-OA-OA-20A-OA	3691	5MS	0
5	V-21035	FRET2/WBLLI//TACUPETO F2001*2 /3/T.DICOCCON P194624/AE.SQ.(409)// BCN /4/NR 395(Lr19/Sr2) PB14151-OA-OA-0A -34A-0A	3501	10MS	5MS
6	V-21038	WATAN/2*ERA/6/BAV92//IRENA/KAUZ/3/HUI TES/4/GONDO/TNMU/5/BAV92//IRENA/KAUZ/ 3/HUITES PB13013-1A-0A-OA-16A-0A	3975	0	0
Check		Arooj-22	3382	5MS	0
LSD (0.05) = 116.62, CV (%) = 3.06					

(3)-PARB Project No. 734 (Improving yield, drought and salinity tolerance in wheat through GA-sensitive dwarfing gene system)

(a) Yield Trials at Ten Different Locations of Punjab

Nursery of 43 selected genotypes/lines with 07 current cultivars (MH-21, Akbar-2019, Dilkash, Subhani, FSD-2008, Fakhr-e-Bhakhar, Pak-13) was established at 10 different locations of Punjab including irrigated, barani and salt affected areas during the crop year 2022-23. Total 50 entries with 2 replications were sown following alpha lattice design. Four trials were sown in irrigated areas in following research stations: (1) Wheat Research Institute, Faisalabad (2) Muhammad Nawaz Sharif University of Agriculture, Multan, C-Block (3) Rice Research Institute, Kalashakaku (4) Punjab Seed Corporation, Khanewal. Three trials were sown under drought conditions two in barani areas including (1) Barani Agriculture Research Institute, Chakwal (2) Barani Agriculture Research Station, Fateh Jhang and one under drought condition at WRI, FSD. Three trials were planted in salt affected areas at (1) MNSUAM Jalalpur Pirwala Campus Reaearch Farm, Jalalpur (2) Soil Salinity Research Institutes, Pindibhatian (3) Regional Agricultural Research Institute, Bahawalpur.

(b) Phenotyping

Phenotyping of each trial was done by measuring morphological and yield contributing traits at their appropriate time. Morphological traits related to plant architecture like plant height, peduncle length, internodal length and spike length were measured. Harvesting and threshing of each trial was completed and yield per plot was recorded in kg/ha. Variations in the measured values of various traits are as under:

- Reduced plant height was 44.38 cm and the tallest plant was 125.72 cm height.
- Minimum value of peduncle length was 22.76 cm and maximum peduncle length was recorded 55.78 cm
- Internodal lengths were ranged between 7.12 cm to 23.45.88 cm.
- Maximum length of spike was 13.65 cm and minimum length was of 8.38 cm
- Highest average yield recorded was 4911.65 kg/ha and minimum yield was 3087.69 kg ha^{-1}.

Best performing wheat lines were identified on the basis of reduced height, high yielding drought and salinity tolerance and having alternate dwarfing genes. From 43 genotypes five best genotypes (E1, E5, E13, E32, E39) were selected by comparing the mean values that have optimum reduced height and better performance over all the locations including irrigated, barani and salt affected areas. These genotypes were having greater yield (> 3348 kg/ha) than the check varieties Akbar-2019, Subhani, Pak-13, MH-21, Dilkash, FSD-2008 and Fakhr-e-Bhakhar. Among three environmental conditions, in irrigated areas average yield was higher than the barani and salt effected areas where E32 was best among all fifty genotypes having average yield 5314 kg/ha on all the four locations of irrigated areas. Genotypes E19 and E27 showed excellence performance along with all above mentioned genotypes producing 4874 and 4754 kg/ha than the check variety Akbar (4714 kg ha^{-1}). Both these genotypes have Rht 5 and Rht 13B GA responsive dwarfing genes. Minimum recorded yield in irrigated areas during 2022-23 was 3592 kg ha^{-1} of the E23. In Barani Areas due to less precipitation at the time of sowing germination was poor and average performance of all genotypes were poor than in irrigated areas. While the promising performance of E5 was observed under barani condition at all the three locations (FSD Barani, Fateh Jhangh and Chakwal producing 3062 kg ha^{-1} than best check variety Akbar 2019 (2353 kg ha^{-1}). Along with top five varieties that surpassed most of check varieties E2 and E31 also showed better performance in barani areas giving 2464 and 2421 kg ha^{-1} respectively.

During experimental years 2022-23 mostly genotypes did not confer any sign of yellow and leaf rust as the rust is an airborne disease that required specific conditions of humidity and temperature for its development except at the location of Fateh Jhang where yellow rust was observed (20M to 100 S). Morphological and yield traits of the five selected best lines is given in table 66 in which performance of all genotypes was poor than in irrigated areas. While the promising performance of E5 was observed under barani condition at all the three locations (FSD Barani, Fateh Jhang and Chakwal producing 3062 kg/ha than best check variety Akbar 2019 (2353 kg ha^{-1}). Along with top five varieties that surpassed most of check varieties E2 and E31 also showed better performance in barani areas (table 67).

Table 67: Morphological and yield contributing traits of selected genotypes

Genotype	Plant Height (cm)	Peduncle Length (cm)	Spike Length (cm)	1000 grain wt (g)	Grain Yield (kgha^{-1})	Dwarfing gene	YR
E1	92.07	42.38	12.41	40.22	3595	Rht1, Rht18	20M
E5	99.45	39.68	12.2	46.92	3348	Rht 1	20MSS
E13	96.62	35.79	11.81	37.06	3416	-	20MSS
E32	95.37	35.785	11.2	34.29	3456	Rht5	20MSS
E39	90.72	37.8275	10.95	36.31	3616	-	20M
Akbar-19	92.5	34.82	11.57	39.32	3859	-	20M

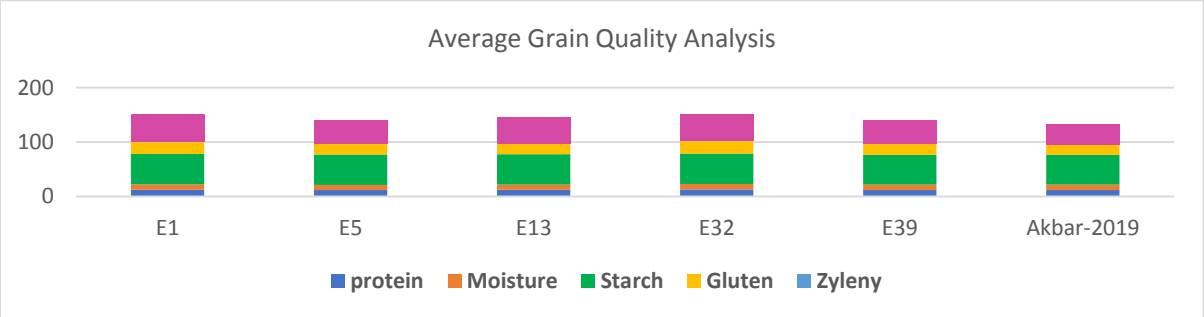
Crop Stand of five best genotypes

(c) Quality Analysis

Grain quality analysis for the protein contents, moisture%, gluten, starch, alpha amylase, ash and zeleny of best wheat genotypes were determined using grain analyzer in the cereal technology lab of the Wheat Research Institute, Faisalabad of the 05 best selected lines. Ranging values of each parameter is given as under:

- Protein contents varies between 9.7 to 16.3% of maximum and minimum value respectively.
- Values of moisture percentage ranges from 9.3 to 10.2 %.
- Maximum value of starch contents recorded was 57.4% and minimum value was 46.2%.
- Higher percent value of gluten content was recorded 43% and minimum value was 13%.
- Zeleny varies between 32 to 82
- Falling No. ranged between 300 s to 508 s

Exposure to salt and drought stress led to a significant increase in grain protein content, wet and dry gluten contents. However, these stress conditions also resulted in a significant reduction in traits such as thousand-grain weight, grain protein yield, and test weight. During 2022-23 wheat growing season crop stand was not good in barani areas and the accumulation of protein and other grains quality parameters was badly affected and average protein contents were lower than irrigated areas. Similarly, in salt effected areas protein Contents was lower as compared in irrigated areas. All the five best varieties were as similar in grain quality parameters as the current cultivated variety Akbar-2019.



Average Grain Quality Contents presence at different location of Punjab

PUBLICATIONS

1. Abdullah M, Zulkifal M, Tufail T, Akbar FH, Owais, M, Ahmed J, Javed A, Tabassum MI, Kanwal A, Asghar M, Musa M, Arif MAR, Hameed A and Haider I (2023). Added value upshot of barley amalgamation in wheat four to boost the physico-chemical quality attributes of fat bread. Cereal Research Communications.1-9.
2. Abdullah M, Tufail T, Hussain M, Nadeem M, Owais M, Zulkiffal M, Tanveer MH and Jbawi E Al (2022). Effect of sprouted barley flour on the quality wheat of bread, biscuits and cakes. Cogent Food & Agric. 8: 2122272.
3. Ahmad J, Rehman A, Ahmad N, Anwar J, Nadeem M, Owais M, Abdullah M, Gulnaz S, Ramzan Y, Shair H, Saleem M, Shahzad R. Dilkash-20: A newly approved wheat variety recommended for Punjab, Pakistan, with supreme yielding potential and disease resistance 2023. SABRAO J. Breed. Genet. 55(2): 298-308.

4. Ahmad N, Rehman A, Gulnaz S, Javed A, Sultana R, Ajmal S, Ahsan A, Shamim S, Nadeem M, Shair H, Abdullah M, Ahmad J, Sarwar M. 2023. Appraisal of bread wheat germplasm for quality attributes and their relationship with grain yield. SABRAO J. Breed. Genet. 55(2): 388-398.
5. Ahmad N, Javed A, Gohar S, Ahmed J, Sher A, Abdullah M, Asghar S, Javed K, Iqbal J, Kumar S, Qayyum A. 2022. Estimation of drought effects on different bread wheat genotypes using morpho-physiological traits. Biochemical Systematics and Ecology. 2022 Oct 1; 104:104483.
6. Ahmad J, Tabassum MI, Owais M, Riaz M, Nadeem M, Abdullah M, Shair H, Gulnaz S, Ghafoor I, Javed A and Mahmood A. 2022. Talbina-21: Pakistan's first hull-less, high yielding and lodging tolerant barley variety. Pl. Cell Biotech. Mol. Bio. 23(29-30): 1-9.
7. Ahmad R, Tabassum MI, Abdullah, Sarwar M, Tanvir MH, Abdullah M, Ghafoor I, Makhdoom, M., and J. Ahmad. 2022. JAU-17: A first high yielding malting barley variety suitable for marginal lands of Punjab. JAR. 60(1):11-16.
8. Ahmad NA, Javed S, Gohar J, Ahmed A, Sher M, Abdullah S, Asghar K, Javed J, Iqbal S, Kumar A, Qayyum. 2022. Estimation of drought effects on different bread wheat genotypes using morpho-physiological traits. Biochem. Sys. Eco.104: 104483.
9. Ahmad B, Ahmed R, Younas MT, Saeed M, Masroor S, Wahab A, Hayder B, Subhani M, Abbas M, Tariq S, Mahmood B. 2022. Effect of automated controlling system using raspberry-Pi microprocessor on growth parameters of eggplant in green house. Pak. J. Biotech. 19(2): 25-30.
10. Afzal A, Syed S, Saeed M, Sultan R, Kanwal M, Shahid M, Zahid M, Mahmood B. 2022. Breeding wheat for rust resistance: conventional and modern approaches. Pl. Protect. 6(3): 1-8.
11. Akhter MS, Noreen S, Mehmood S, Aqeel M, Zafar ZU, Rashid M, Arshad MN, Owais M, Ahmad J and KH Shah. 2023. Silicon supplement improve growth and yield under salt stress by modulating ionic homeostasis and some physiological indices in Hordeum vulgare L. J soil Sci. Pl Nutr. https://doi.org/10.1007/s42729-023-01240-4
12. Anjum N, Muhammad A, Malik FSN, Zulfiqar B, Rafique R, Shah MH, Javed A, Asif M, Ahmad S, Ayub CM, Iqbal Z, Azam M, MA, Iqbal. 2022. Yield and quality assessment of grapevine cultivar Sultnina at different geographic locations of Punjab, Pakistan. Int. J. Agr. Ext. 10 (1):125-133.
13. Ashraf A, Ahmad N, Shahid M, Zahra T, Ali Z, Hassan A, Awan A, Batool S, Raza MA, Irfan U, Maqsood M, Makhdoom M and MN Khalid (2022). Effect of different media compositions of 2,4-D, Dicamba and Picloram on callus induction in Wheat (*Triticum aestivum* L). Biol. Clin. Sci. Res. J., 2022: 259
14. Asghar S, Rahman A, Ahmad, N, Ajmal S S. Ahsan AS, Gulnaz SS, Javed M, Iqbal J, Bibi S, Fiaz S, Elesawy B, Eskary A, Ismail KA, Gharib AF, Din AM, Tabassum MI and A. Qayyum. 2022. Evaluation of Pakistani wheat germplasm for leaf rust resistance at various locations. PloS ONE 17(5):e0266695.
15. Abar MH, Sarwar G, Khan A, Hameed A, Mahmood K, Tauseef M, Anwar SA, Muhammad T, Javed MH, Akhtar B, Rauf S, Ashiq M, Jamil M, Abdullah M, Mahmood A., Shah, MT., Ullah, M., Faooq, J., Rizwan, M., Abbas, HG and M. I. Tabassum. 2022. Bio-efficacy of PB-rob (L) as mating disruptant against pink boll worm, *Pectinophora gossypiella* (Saunders) in cotton. Pl Cell Biotech and Mol Biol. 23(23&24):33-42.
16. Asma S, Fayyaz AM, Majeed K, Rehman A, Ali S, Liu J, Rasheed A, Y. Wang. 2022. Genetic variability and aggressiveness of T*illecia indica* isolates causing Kernal Bunt in wheat. J. Fungi. 8(3):219.

17. Bashir H, Jamil MW, Shah SAH, Tabassum MI, Bibi F, Akhtar S, Mahmood K, Shahzad N, Khaliq A, Sher R, Shamim S, Riaz M, Majeed T and S. Shaukat (2022). Correlation studies of yield components and grain quality of *Oryza sativa* under drought stress. Biosci. Res. 19(4):1801-1808.
18. Ghani A, Yousaf M I, Hussain K, Hussain S, Razaq A, Akhtar N, Ibrar I, Kamal N, Ali B, Khan AM, Shah SWH, Khanum S, Hassan RM.2023. Relationship between high-temperature stress and key physio-chemical, reactive oxygen species and antioxidants in spring maize hybrids under semi-arid conditions. Biological and Clinical Sci. Res. J. 4 (1): 199.
19. Hanif S, Shakoor A, Saleem MF, Saleem MF, Ali S, Ashraf MA, Nadeem M, Shair H, Haq A, Khan RAH and MA. Amin. 2022. Exogenous application of proline to enhance rice tolerance against heat and drought stresses. Pak. J. Agric. Res. 35(2): 324-333.
20. Iqbal J, Ahmad N, Tabassum MI, Rabbani G, Hassan F, Rafique M, Iqbal M, Mustafa R, Ashraf S, Javed A and Abdullah S. 2022. MA-21: A disease tolerant and long-rooted wheat variety depicting long-stay in the rainfed regime. J. Agric. Res. 60(2): 107-113.
21. Javed A, Ahmad N, Ahmed J, Hameed A, Ashraf MA, Zafar SA, Maqbool A, Al-Amrah, H, Alatawi HA, Al-Harbi MS and Ali EF. 2022. Grain yield, chlorophyll and protein contents of elite wheat genotypes under drought stress. J. King Saud Univ.Sci. 34(7): p.102279.
22. Javed A, Nawab NN, Gohar S, Akram A, Javed K, Sarwar M, Tabassum MI, Ahmad N, Mallhi AR. 2022. Genetic analysis and heterotic studies in tomato (*Solanum lycopersicum* L.) hybrids for fruit yield and its related traits. SABRAO J. Breed. Genet. 54(3): 492-501.
23. Javaid MM, Ahmad N, Javed A, Makhdoom, M, Saleem M, Owais M, Nadeem M, Rahman S, Mehboob S, Naz S, Rehman A, Ahmed J, Tanveer MH. 2022. Monitoring and detection of wheat blast disease caused by *Magnaporthe oryzae Triticum* pathotype in Punjab, Pakistan. SABRAO J. Breed. Genet. 54(5): 1004- 1015.
24. J. Iqbal, Nadeem Ahmad, M.I. Tabassum, G. Rabbani, F.Hassan, M. Rafique, M.Iqbal, R. Mustafa, S.Ashraf, A. Javed and S. Abdullah.2022. MA-21: a disease tolerant with long-rooted wheat variety depicting long-stay in the rainfed regime. J. Agric. Res., 60(2):107-113.
25. Javed A, Ahmad N, Ahmed J, Hameed A, Ashraf A, Zafar SA, Maqbool A, Al-Amrah H, Alatawi HA, Al-Harbi MS. and Ali EF. 2022. Grain yield, chlorophyll and protein contents of elite wheat genotypes under drought stress. J. King Saud Univ Sci.:102279.
26. Khalid A, Hameed A, Shamim S and Ahmad J. 2022. Divergence in single kernel characteristics and grain nutritional profiles of wheat genetic resource and association among traits. Front. Nutr. 8:805446.
27. Kanwal A, Makhdoom M, Ghafoor I, Ali Z, Zulkiffal M, Abdullah M, Ajmal S, Ahmad J, Tariq M, Bakhsh A, Sarwar M, and A. Rehman. 2022. Grain magnitude upshots by different genetic parameters and molecular strategies in wheat. J. Agric. Res, 60(2):89-100.
28. Kanwal, S., Jamil, S., Afza, N., Ghafoor, I., Shehzadi, M., Kanwal, R. and Iqbal, M.Z., 2022. Drought tolerance in rice and role of wrky genes. J. Ani. Pl. Sci. 32(3): 615-630.
29. Kamal N, Saeeda Khanum, Muhammad Siddique, Muhammad Saeed, Muhammad Farooq Ahmed, Muhammad Tanveer Ahmed Kalyar, Shafiq-Ur-Rehman, Basharat Mahmood.2023. Heterosis and Combining Ability Studies in A 5 x 5 Diallel Crosses of Maize Inbred Lines. J. App. Res. Pl. Sci. 4(1): 419-424.
30. Khan RT, Ilyas R, Kamal N, Saleem S, Bibi S, Khan MR, Younas MT, Rehman HM, Ullah S and Mahmood B. 2022. Effects of Different Hormonal Concentrations on In vitro Regeneration and Multiplication of Pearl Millet (*Pennisetum glaucum* L.). J. Appl. Res. Pl. Sci. 3(2): 311-316.
31. Riaz M, Tabassum MI, Abdullah, Sarwar M. Tanveer MH, Abdullah M, Ghafoor I, Makhdoom M and J. Ahmad (2022). Jau-17: A first high yielding malting barley variety suitable for marginal lands of Punjab. J. Agric. Res., 60: 01

32. Rahoo AM, Rahoo RK, Saeed M, Burhan M, Keerio N. 2022. Molecular identification and growth of *Xenorhabdus* and *Photorhabdus* symbionts of entomopathogenic nematodes. Pl. Protect. 6(2): 20-26.
33. Saeed M, Jamil Z, Shehzad T, Hasan SZ, Bibi R, Malik SN, Rehman HM and Ahmed R. 2023. Role of Next Generation Sequencing (NGS) in Plant Disease Management: A Review. J. App. Res. Pl. Sci. 4(1): 512-517.
34. Siddique M, Khanum S, Kamal N, Khan AH, Hayat S, Raza S, Kohli SA, Bhatti MH, Ghani A, Saleem Z and Ahmad R. 2022. Heterosis and combining ability studies in pearl millet. Pak. J. Biotech. 19(2): 84-88.
35. Saeed MS, Kaukab S, Rehman A, A. Amin. 2022. Chronological levels for selection and development of disease resistance, climate resilient and high yielding lentil cultivar for food security. Pl cell biotech and mol. Bio. 23(23 & 24): 6-21.
36. Sultan R, U. Hanif and M. Saeed. 2022. Estimation of salt tolerance potential of Synthetic Hexaploid Wheat based on Ion Discrimination. Pl. cell Biotech and Mol Bio. 23(25-26):1-8.
37. Usman M, Habib H, Satish M, Iqbal S, Altaf J, Rehman A, Khan AI, Kashif, Z, and FS Awan. 2022. Genomic characterization of *Puccinia triticinia* using molecular marker. Brazilian J of Bio. (84): e249472.
38. Zulkiffal M, Ahmed J, Riaz M, Ramzan Y, Ahsan A, Kanwal A, Ghafoor I, Nadeem M, Abdullah M. 2022. Response of heat-stress tolerant and susceptible wheat lines in diverse planting environments by using parametric stability models. SABRAO J. Breed. Genet. 54(1): 127-140.
39. Zulkiffal M, J. Ahmed, M. Owais, N. Ahmed, A. Ahsan, A. Rehman, J. Anwar, M. Riaz, Y. Ramzan, Musa, M. and M. Nadeem. 2022. Disclosure of stress driver's traits related to reliability in normal, drought and heat prone settings in bread wheat advanced lines. Bulg. J. Agric. Sci., 28 (3): 488-493.

CAPACITY BUILDING

July, 2022

- Three officers attended online training entitled 'Mendeley reference software' arranged by AARI, Faisalabad and Pakistan Scientific and technological information Centre, Faisalabad.
- One officer attended online seminar entitled "Challenges and research opportunities in oil palm tissue culture" arranged by ORI, Faisalabad.

August, 2022

- Six officers attended online training program entitled
- 'Biofortification- A gender inclusive nutrition strategy for commercialization of biofortified crops" arranged by GRAIN, Harvest plus, Islamabad.
- Two officer attended online seminar on biofortification of staple crops to combat mineral malnutrition" organized by Department of Agronomy, Faisalabad.

September 2022

- Seven officers attended conference entitled "International wheat conference at University of Agriculture, Faisalabad.
- One officer virtually attended webinar entitled "Roots of second green revolution and oil palm and palm oil arranged by bioingene.com
- Ten officer attended seminar entitled "Soybean cultivation to ensure food security" arranged by ORI, Faisalabad.

October, 2022

- Ten officers attended seminar entitled "Crop diversification through sesme cultivation and quality production" arranged by ORI, Faisalabad
- Eight officers attended on line workshop entitled "The Borlaug initiative" arranged by CIMMYT, Mexico and Cornell University, USA.
- Two officer attended online webinar entitled "climate resilient rice using biodiverse resources" arranged by bioingene.com

November 2022

- Two officers attended on line seminar on publication ethics arranged by Taylor and Francis group, Boston, USA.

December 2022

- Three officers completed four weeks mandatory training entitled "Finance, Administration and Management" at University of Agriculture, Faisalabad.
- One officer online attended webinar entitled "genetics, genomics and breeding of tree bamboos: emerging prospectus and future challenges" arranged by Bioingene.com during this month.

January 2023

- Six officers attended two days training entitled "next generation wheat workshop" at NARC, Islamabad.

February 2023

- Ten officers attended one day workshop entitled "standardization of brassica and sunflower seed production" at main library AARI, Faisalabad

March 2023

- Nil

May 2023

- Three officers attended two days seminar entitled "wheat brain storming session" at NARC, Islamabad.
- Ten officers participated in one day seminar entitled "Potash-for sustainable crop production and food security" at AARI, Faisalabad.
- One officer attended online seminar entitle 'the potential of genome editing for sustainable agriculture' arranged by bioingene.com

June 2023

- Fifteen officers attended training program entitled 'DNA fingerprinting of crops under plant breeder's rights rules' arranged by ABRI, AARI, Faisalabad.
- One officer attended online training entitled "introduction to organic agriculture" arranged by technical education and skill development authority, Philippine.

INTERNSHIP PROGRAM

About 100 students from University of Agriculture, Faisalabad, GC Women University, Madina Town, Faisalabad and GC University, Faisalabad completed their BSc (Hons) internship under the supervision of WRI scientists.

MISCELLANEOUS

i- Wheat rust surveillance

Wheat rust surveillance was conducted to observe rust existence and wheat crop condition. The activity was conducted in 145 different locations in twenty districts of Punjab.

ii- Travelling wheat seminar

Travelling wheat seminar with concluding session was conducted at Wheat Research Institute, Faisalabad.

iii- Chief Minister wheat yield competition program

Participated in Chief Minister wheat yield competition program in collaboration with Agri. (Ext) and crop reporting departments, Faisalabad for the year 2022-23.

iv- Pictorial view


TRAINING ON CAPACITY BUILDING
OF
SCIENTISTS ABOUT PRECISION PHENOTYP
FOR ZINC ENHANCEMENT IN WHEAT
22nd MARCH, 2023
Organized by
RESEARCH INSTITUTE, AARI, FAISALA


FARMER FIELD DAY
Akbar-2019
Zincol-2016


Welcome