



**Full Length Article**

## Mairaj-08: New Wheat (*Triticum aestivum*) Variety Released for General Cultivation under Normal and Late Planting in Punjab Province (Pakistan)

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### ABSTRACT

In this paper we report the release of a new wheat variety "Mairaj-08". It is a high yielding and rust resistant variety of bread wheat with erect growth habit. It was released in 2008 for irrigated areas of Punjab. Mairaj-08 is result of a local cross i.e., SPARROW/INIA/V.7394/WL711//3/BAU'S'. F<sub>1</sub> to F<sub>4</sub> progenies of this cross were advanced by pedigree method. Resistance against rusts Leaf rust=Tr. to 00MSS and Yellow rust=40 to 60MSS, RRI value of 8-8.9 for leaf and 3-6.7 for yellow rusts and high yield potential (7400 kg ha<sup>-1</sup>) are the major attributes of Mairaj-08 that make it a superior variety for its target regions. Mairaj-08 is tolerant to wheat aphid and *Helicoverpa armigera* and responsive to fertilizer compared to the check varieties. The hundred grain weight of this variety is 38-42.6 g. Seed is amber in color and contains 11.7-13.1% protein, 26-26.5% wet gluten, 8.2-9.2% dry gluten, 1.5-2.9% ash. Its flour yield is 69.9%. It has good *chapati* making quality. Plant type of Mairaj-08 is erect with plant height 90-95 cm and droopy flag leaves. Auricle color is white. Ear shape and color is tapering and red. Its straw is soft. It completes heading in 81-98 days and matures in 115-137 days. Mairaj-08 performs better in irrigated areas of Punjab when planted from 1 November to 15 December, keeping 125 kg ha<sup>-1</sup> seed rate and 125-100-75 kg NPK ha<sup>-1</sup> are applied. © 2010 Friends Science Publishers

**Key Words:** *Triticum aestivum*; Mairaj-08; Rust; Resistance; Yield; Gluten

### INTRODUCTION

Bread wheat is the most widely grown crop in the world. In Pakistan, wheat being the staple diet is the most important crop and cultivated on the largest acreages (8.303 million hectares during 2005-06) in almost every part of the country. It contributes 13.7% to the value added in agriculture and 3.0% to GDP. Pakistan falls in top ten wheat-producing countries of the world and ranks at No. 9 in terms area, at No. 5 in terms of yield per hectare and at No. 8 in terms of production.

Southern part of Punjab province, although cotton zone contributes to about 44% of the total wheat production. Due to prolong stay of cotton crop in the field, 80% wheat is being planted under late conditions. This situation necessitates the development of medium to late maturing wheat varieties like Mairaj-08 that can be successfully grown after the harvest of cotton (Ahmad *et al.*, 2005).

The existing wheat varieties such as Inqlab-91 (covers about 60-70% area under wheat in Pakistan) and Bhakkar-2002 have become susceptible to rust diseases, which needs to be replaced with new varieties (Anonymous, 2004 & 2005). Leaf rust of wheat (*Puccinia recondita* f. sp. *tritici*) is

a serious biotic hazard all over the world (McIntosh *et al.*, 1997). During favorable times, it spreads fast and can significantly reduce yields but this reduction depends upon disease intensity and time of infection (Anonymous, 1993). Leaf rust epidemic can cause upto 50% losses to grain yield (Yaqoob, 1991) and sometimes results in complete failure of the crop. Chemical control of rust diseases is not economical; therefore cultivation of rust resistant varieties is of paramount importance (Anonymous, 2005). Successive release of rust resistant varieties in Pakistan has reduced losses caused by rust (Khan, 1987). With the introduction of rust resistant varieties, new rust races also develop due to mutation. Therefore the plant breeders and plant pathologists have to be vigilant of its dynamics. Thus wheat variety having the higher yield potential, disease and insect resistance and better adaptability is a dire need of the day, because low seed yield is also attributed to non-availability of pure seed of improved varieties along with low inputs and poor management practices (Sarwar *et al.*, 1993). Sarwar and Ahmad (2003) opined that yield per unit area can be increased substantially through the evolution of high yielding genotypes, bearing a good combination of all yield components.

The new wheat variety Mairaj-08 is a result of 14 years devoted and untiring efforts of the team consisting of plant breeders, agronomists, plant pathologists, entomologists and agricultural chemists working at Regional Agricultural Research Institute, Bahawalpur. It is suitable for normal and late planting in irrigated areas of Punjab and has the potential to achieve self-sufficiency in wheat production, due to its commendable traits of early maturity and rapid grain filling capacity under adverse climatic and soil conditions. This variety possesses improved genetic potential and has performed better in yield trials.

It is hoped that this variety will be a better replacement of the existing wheat varieties especially Inqlab-91 and Bhakkar-2002 with wheat growers of Punjab in general and that of cotton and rice zone in particular.

## MATERIALS AND METHODS

Mairaj-08 was developed from a cross between two genotypes PTS/3/TOB/LFN//BB/4/BB/HD-832-5//ON, (a high yielding line received from CIMMYT, Mexico) and GV/ALD'S//HPO'S'BR-3385-3B-1B-0B (a local line resistant to rust diseases) at Regional Agricultural Research Institute (RARI), Bahawalpur. The hybridization was carried out during 1993-1994 and pedigree method of breeding was used to develop this variety. The hybrid population was evaluated for target traits and advanced to F<sub>5</sub> generation. A high yielding and rust resistant progeny was selected during 1998-1999 in F<sub>5</sub> generation and was given the number 99B2237. This line was tested in replicated wheat yield trials for grain yield evaluation and disease reaction. These trials were conducted at Regional Agricultural Research Institute (RARI), Bahawalpur and Wheat Research Institute, Faisalabad. Finally the selected line was evaluated in national uniform wheat yield trials. The yield data were subjected to ANOVA by computer using MSTATC statistical package and the means were compared using DMR test (Steel & Torrie, 1980). Various steps involved in the development of Mairaj-08 are given in Table I.

**Hybridization:** Crosses between parental lines were made at the experimental field of RARI, Bahawalpur. For this purpose the parental lines (male & female) were sown alternatively, in November in crossing block (1993-1994). The emasculation was done in the morning and emasculated spikes were covered with butter paper bags to avoid foreign pollen. The pollination was performed after four days of emasculating by removing the butter paper bags and dusting the pollen. The F<sub>0</sub> seeds harvested from female parent were collected at the time of harvest and stored for raising filial generations by space planting.

**Generation advancement (F<sub>1</sub>-F<sub>5</sub>):** A single row of 4 m length was planted with F<sub>0</sub> hybrid seed. The seeds were sown by single row drill at RARI, Bahawalpur under irrigated conditions. The F<sub>1</sub> seeds were harvested at the end

of April. Planting was done in 30 cm wide rows. This bulk planting was continued upto F<sub>5</sub> generation with negative selection of undesirable diseased plants under natural infection conditions. The seed from selected plants were bulk harvested. Progeny (99B2237) was selected in F<sub>5</sub> generation.

**Planting of yield trials:** Mairaj-08 was consecutively evaluated for three years in on-station yield trials (A, B & C). Planting of on-station trials was done in the first week of November. The testing was done in Macro Yield Trials before testing in National Uniform Yield Trials. All the yield trials were laid out in RCBD with four replications. The row to row distance was 30 cm. Planting was done with single row drill in four row plots of five m length. One to two standard checks were included in every experiment for comparison. Disease reaction was separately recorded under artificial inoculation conditions every year.

**Screening against rusts:** Test entries were planted in a single 2 m long, 30 cm apart row. Two rows of Morocco, which is universally susceptible to rusts, were planted around the test entries. In addition, a row of susceptible check (Morocco) was also planted after every entry. Artificial inoculations with a mixture of field collection/national bulk inoculums of known prevalent races/virulence of the rusts were carried out during the month of March. Initially inoculations of spreaders, 3-5 tillers in a row, were carried out by hypodermic syringe method using aqueous uredospore suspension to which 1-2 drops of Tween-20 were added to break the surface tension. Subsequently all the material was sprayed 2-3 times by turbo-air sprayer using aqueous spore suspension with fortnightly intervals to obtain heavy rust development. The data were recorded on leaf and yellow rusts as percent infection on the plants according the modified Cobb's Scale (Peterson *et al.*, 1948) during the first week of April. Relative Resistance Index (RRI) was calculated according the formula of Hussain *et al.* (1999). The desirable RRI value for leaf and yellow rusts is 7 (Mustafa *et al.*, 2007) and acceptable value is 5 or 6.

**Screening against insect pests:** Mairaj-08 was also evaluated for three years (2003-2004) in replicated yield trials at RARI, Bahawalpur and Entomological Research Institute, Faisalabad, Pakistan for its response to wheat aphid and *Helicoverpa armigera* Hubner in comparison with the check varieties Inqlab-91 and Uqab-2000.

**Production technology of Mairaj-08:** A series of replicated yield trials was conducted at for two years (2003-2005) at RARI, Bahawalpur and Agronomic Research Station, Bahawalpur (2006-2008), Pakistan for its response to different sowing dates and various NPK combinations in comparison with the check varieties Inqlab-91, Bahawalpur-2000 and Uqab-2000 to ascertain its production technology.

**Testing of Mairaj-08 in national uniform wheat yield trials (NUWYT):** Mairaj-08 was consecutively tested in 62 NUWYT trials for two years (2002-2004) throughout Pakistan. At all the locations, the experiment was planted in

RCBD with four replications. Six rows per plot with row to row distance of 30 cm were planted with each entry. The sowing time and crop husbandry practices were different at all locations. The replicated data of individual locations were averaged and converted to kg ha<sup>-1</sup> for comparison (Mustafa *et al.*, 2004 & 2005).

**Physico-chemical properties of Mairaj-08:** The Physico-chemical properties were studied by National Coordinator Wheat, National Agricultural Research Centre, Islamabad (2002-2003) and Director, Agronomic Research Institute, Faisalabad (2003-2004). The test was carried out in Food Technology and Research Laboratory according to standard procedures including 1000-seed weight, test weight, PSI (hardness), grain ash, grain protein (by NIR), gluten consistency, wet gluten, dry gluten and SDS value (Mustafa *et al.*, 2007).

## RESULTS AND DISCUSSION

**Yield performance:** The major objective of development of Mairaj-08 was to provide the farmers of irrigated areas of Punjab a high yielding and rust resistant variety of wheat. Therefore the rust resistant exotic line was hybridized with a high yielding line. The segregating population was advanced following a pedigree method of plant breeding. Following this method only rust resistant and high yielding plants were selected and their seeds were bulked till F<sub>5</sub> generation. The superior single progeny in F<sub>5</sub> generation

proved to be high yielding and blight resistant and was tested in a series of replicated trials before putting it into a National testing system that is mandatory for the release of a variety in Pakistan.

**Station yield trials:** Mairaj-08 was studied for grain yield in preliminary (A), regular (B) and advance (C) yield trials from 1999-2000 to 2001-2002 (3 trials). The data on grain yield recorded in these trials are presented in Table II. These data shows that grain yield of Mairaj-08 ranged from 4021 to 6042 kg ha<sup>-1</sup> as compared to Inqlab-91 for which yield ranged from 3646 to 5521 kg ha<sup>-1</sup>. The new variety Mairaj-08 gave 0.9 to 10.9% higher yield than Inqlab-91 (Table II). The differences were highly significant. The released varieties that were already available in the market, although possessed relatively high yield potential, they appeared to be susceptible to rusts as reported previously (Anonymous, 2004, 2005). Consequently, they are being banned by the government for general cultivation to avoid epidemic of rust. Since the major emphasis was placed on incorporation of rust resistance in the target variety aimed for release in irrigated areas of Punjab, Mairaj-08 appeared to be a promising line with respect to this major trait wanted for wheat cultivation in rust prone areas. Consequently, Mairaj-08 was forwarded to macro-wheat-yield trials.

**Macro wheat yield trials:** These trials were conducted at Agronomic Research Stations, Karore (Layyah) and Khanewal (4 trials); Agronomic Research Institute, Faisalabad (9 trials) and Regional Agricultural Research

**Table I: Various steps involved in the development of wheat variety Mairaj-08**

Year	Generations/Trials	Remarks
1993-94	Parental lines were inter-crossed at RARI, Bahawalpur	F0 hybrid seeds were harvested for plantation
1994-95	F <sub>1</sub> population was raised	F1 hybrid seeds were harvested for plantation of F <sub>2</sub>
1995-96	F <sub>2</sub> population was raised	F2 hybrid seeds were harvested for plantation of F <sub>3</sub>
1996-97	F <sub>3</sub> population was raised	F3 hybrid seeds were harvested for plantation of F <sub>4</sub>
1997-98	F <sub>4</sub> population was raised	F4 hybrid seeds were harvested for plantation of F <sub>5</sub>
1998-99	F <sub>5</sub> population was raised	Rust resistant and high yielding progeny was selected and given the number 99B2237 and was forwarded to wheat yield trials
1999-02	A, B, C Trials	These trials were conducted at RARI, Bahawalpur
2003-08	Macro Wheat Yield Trials	These trials were conducted at various locations in Punjab under coded numbers by Director, Wheat Research Institute, Faisalabad
2002-08	Potential and Wheat Varietal Yield Trials	These trials were conducted at RARI, Bahawalpur
2002-08	Rust resistance studies	These studies were conducted at RARI, NARC and WRI, Faisalabad
2003-04	Entomological Trials	These trials were conducted at RARI and Entomological Research Institute, Faisalabad
2003-05	Agronomic Trials	These trials were conducted at various locations in Punjab by Director, Agronomic Research Institute, Faisalabad
2002-04	National Uniform Wheat Yield Trials (NUWYT)	These trials were conducted by National Coordinator Wheat, NARC, Islamabad throughout Pakistan
2002-04	Physico-chemical characters and chemical composition of seed of Mairaj-08	The quality traits were studied by NARC, Islamabad and Director, Agronomic Research Institute, Faisalabad
2008	On the basis of its better performance, it was released for general cultivation in the name of Mairaj-08 by the Punjab Seed Council, Lahore	

**Table II: Grain yield performance of Mairaj-08 in on-station trials at RARI, Bahawalpur, Pakistan**

Trials	Years	Yield (kg ha <sup>-1</sup> )		%± over Inqlab-91	LSD (0.05)
		Mairaj-08	Inqlab-91		
'A' (Normal)	1999-00	6042	5521	9.4	637
'B' (Normal)	2000-01	4021	3987	0.9	472
'C' (Normal)	2001-02	4042	3646	10.9	625
Average (3 years)		4702	4385	7.2	

**Table III: Grain yield performance of Mairaj-08 in macro wheat yield trials during 2003-04 to 2007-08**

Locations	Yield (kg ha <sup>-1</sup> )		%± over Inq-91	LSD (0.05)	
	Mairaj-08	Inq-91			
<b>2003-2004</b>					
ARF, R. Y. Khan (N)	3991	3667	8.8	468	
ARF, R. Y. Khan (L)	2610	2440	7.0	127	
WRI, Faisalabad (N)	2556	2389	7.0	186	
WRI, Faisalabad (L)	2495	3074	-18.8	228	
RARI, Bahawalpur (N)	4362	3633	20.1	388	
RARI, Bahawalpur (L)	2889	2583	11.8	257	
Agronomist Karore (N)	5000	5133	-2.6	634	
Average (7 locations)	3415	3274	4.3		
<b>2004-2005</b>					
ARF, R. Y. Khan (L)	3704	3380	9.6	183	
CRS, Multan (L)	4850	4250	14.1	246	
Agronomic Research Station Karore (Layyah) (N)	5123	4751	7.8	1018	
RARI, Bahawalpur (L)	2789	2611	6.8	266	
RARI, Bahawalpur (N)	6420	5772	11.2	517	
ORS, Khanpur (N)	4638	5000	-7.2	134	
Agronomist Khanewal (N)	4184	4370	-4.3	1246	
CRSS, Haroonabad (L)	2871	2778	3.3	160	
Average (8 locations)	4322	4114	5.1		
<b>2005-2006</b>					
Locations	Yield (kg ha <sup>-1</sup> )			%± over checks	LSD (0.05)
	Mairaj-08	Inq-91	Uqab-2000		
Bahawalpur (N)	4430	4189	3794	5.8	16.8
Bahawalpur (L)	2967	2601	2377	14.1	24.8
Khanpur (N)	4379	4290	4100	2.1	6.8
Bahawal nagar (N)	5574	5182	5426	7.6	2.7
Muzaffar Garh (L)	3963	4082	3552	-2.9	11.6
Average (5 locations)	4263	4069	3850	4.8	10.7
<b>2006-2007</b>					
Locations	Mairaj-08	Inq-91	BHK-02	Fareed-06	LSD (0.05)
Bahawalpur (N)	5312	5146	5014	4882	133
Bahawalpur (L)	4576	3375	2569	4035	177
Rahim Yar Khan (N)	5694	4876	3537	4009	154
Bahawal nagar (N)	5074	4482	5426	4861	152
Muzaffar Garh (N)	4324	3963	4074	4343	126
Dera Ghazi Khan (N)	3963	4482	3352	3713	235
Hasil pur (N)	6667	5556	4722	6528	250
Karore (N)	2739	2527	1631	4043	233
Karore (L)	3367	2950	2747	2943	285
Average (9 locations)	4635	4151	3675	4373	219
%± over checks		12.0	26.0	6.0	
<b>2007-2008</b>					
Locations	Mairaj-08	Sehar-06	Fareed-06	BHK-02	LSD (0.05)
Bahawalpur (N)	7417	7472	7195	6554	165
Bahawalpur(L)	4722	4667	4611	4222	188
Rahim Yar Khan (N)	3740	3570	3740	3910	254
Muzaffar Garh (L)	2444	2472	1527	1194	252
Bahawal Nagar (L)	3056	2844	2055	1472	326
Dera Ghazi Khan (L)	3333	3288	2811	2360	205
Karore(N)	2611	3444	3000	3056	233
Karore(L)	2889	1889	2354	2278	134
Average (8 locations)	3777	3706	3412	3131	187
%± over checks		2.0	11.0	21.0	

Institute, Bahawalpur (2 trials) and at other locations in southern Punjab for five years (2003-2004 to 2007-2008) in late and normal seasons. The results revealed that the new variety gave 4.3 and 5.1% higher yield than the check variety Inq-91 during 2003-2004 and 2004-2005 on the

**Table IV: Grain yield performance of Mairaj-08 in National Uniform Wheat Yield Trials at various locations (2002-2003 Normal)**

Locations	Yield (kg ha <sup>-1</sup> )			%± over check	LSD (0.05)
	Mairaj-08	Bahawalpur-97			
ARF, R. Y. Khan	5325	4758		11.9	N.S
ORS, Khanpur	5500	5042		9.1	441
RARI, Bahawalpur	3938	4042		-2.6	667
P.S.C, Khanewal	4042	3396		19.0	737
Sharif Mumtaz farm Bhowana, Jhang	4167	3600		15.8	583
Average (5 locations)	4594	4168		10.2	

Source: Mustafa *et al.* (2004)

**Table V: Grain yield performance of Mairaj-08 in National Uniform Wheat Yield Trials at various locations (2002-2003 Late)**

Locations	Yield (kg ha <sup>-1</sup> )			%± over check	LSD (0.05)
	Mairaj-08	Bahawalpur-97			
RARI, Bahawalpur	3292	3250		1.3	470
AZRI, Bhakkar	3250	3250		-	385
Sharif Mumtaz farm Bhowana, Jhang	2658	2625		1.3	363
UA, Faisalabad	3312	3117		6.3	N.S
MMRI, Yousafwala	3146	2750		14.4	506
P.R.S, Sahoowali	1813	1750		3.6	522
Average (6 locations)	2912	2790		4.4	

Source: Mustafa *et al.* (2004)

Locations	Yield (kg ha <sup>-1</sup> )			%± over check	LSD (0.05)
	Mairaj-08	Bahawalpur-97			
Sargodha/In service training Institute	3521	2979	3000	18.2	17.4
Heer Farm Bharnala	3850	3788	3913	1.6	-1.6
NARC, Islamabad	5650	5000	5550	13.0	1.8
Average (15 locations)	4299	4031	3763	6.6	14.2

Source: Mustafa *et al.* (2005)

basis of average of 7 and 8 locations. Mairaj-08 gave 4.8 and 10.7% higher yield than the check varieties like Inq-91 and Uqab-2000, respectively on the basis of average of 5 locations during 2005-2006. During 2006-2007, Mairaj-08 had 12.0, 26.0 and 6.0% higher yield than Inq-91, Bhakkar-2002 and Fareed-06, respectively on the basis of average of 9 locations. The new variety gave 2.0, 11.0 and 21.0% higher yield than the check varieties like Saher-06, Fareed-06 and Bhakkar-2002, respectively on the basis of average of 8 locations during 2007-2008 (Table III).

**National uniform wheat yield trials:** Mairaj-08 was tested in national testing system through National Uniform Yield Trial (NUWYT) consecutively for two years (2002-2003 & 2003-2004) across the country. The location-wise comparison (Tables IV-VII) of Mairaj-08 with check varieties for grain yield revealed that Mairaj-08 gave 4.4 and 10.2% higher yield than check variety Bahawalpur-97 on the basis of five and six locations average during 2002-2003 (Table IV-V). Mairaj-08 gave 6.6 and 1.4 and 14.2 and 13.5% higher than Inq-91 and Wahaq-2002, respectively during 2003-2004 on the basis of average of 15 and 12 locations (Table VI-VII). The two years evaluation of Mairaj-08 over multiple locations confirmed the results of on-station studies, where it was concluded that Mairaj-08 having better grain yield

**Table VI: Grain yield performance of Mairaj-08 in National Uniform Wheat Yield Trials at various locations (2003-2004 Normal)**

Location	Yield (kg ha <sup>-1</sup> )			%± over checks		LSD (0.05)
	Mairaj-08	Inqlab-91	Wafaq-2002	Inqlab-91	Wafaq-2002	
ARF, R. Y. Khan	3129	2892	2731	8.2	14.6	320
RARI, Bahawalpur	4167	4104	3854	1.5	8.1	422
CRSS, Haroonabad	5083	5052	4792	0.6	6.1	240
ARF, Vehari	4083	4025	2758	1.4	48.0	470
ARF, Karore Layyah	3704	3771	3500	-1.8	5.8	477
AZRI, Bhakkar	4896	4167	2958	17.5	65.5	653
Shorkot	3518	3296	3279	6.7	7.3	N.S
WRI, Faisalabad	5158	5273	4674	-2.2	10.4	343
UA, Faisalabad	3812	3547	3274	7.5	16.4	343
Chak-126/RB-Fsd.	4339	4218	3782	2.9	14.7	N.S
Kasur/Nakai Model Farm Wahan Adhan	5354	4296	4188	24.6	27.8	202
M.K. Model Farm	4217	4063	4188	3.8	0.7	188
Farooq Abad						
Sargodha/In service training Institute	3521	2979	3000	18.2	17.4	407
Heer Farm Bharnala	3850	3788	3913	1.6	-1.6	175
NARC, Islamabad	5650	5000	5550	13.0	1.8	715
Average (15 locations)	4299	4031	3763	6.6	14.2	

 Source: Mustafa *et al.* (2005)

**Table VII: Grain yield performance of Mairaj-08 in National Uniform Wheat Yield Trials at various locations (2003-2004 Late)**

Location	Yield (kg ha <sup>-1</sup> )			%± over checks		LSD (0.05)
	Mairaj-08	Inqlab-91	Wafaq-2002	Inqlab-91	Wafaq-2002	
ARF, R. Y. Khan	2329	2160	2510	7.8	-7.2	180
ORS, Khanpur	3440	3454	2458	-0.4	40.0	260
RARI, Bahawalpur	2958	2917	2675	1.4	10.6	271
CRSS, Haroonabad	4836	4479	3369	8.0	43.5	273
Lodhran	2733	2675	2750	2.2	-0.6	358
Multan, Pak German	2583	2600	2271	-0.7	13.7	360
ARF, Karore Layyah	2083	2063	1979	1.0	5.3	256
MMRI, Yousafwala	3958	4188	3313	-5.5	19.5	166
UA, Faisalabad	2829	2809	2843	0.7	-0.5	N.S
Sayyed Wala Farm, Qasur	3208	3417	1917	-6.1	67.3	226
ARF, Gujranwala	3188	2896	3292	10.1	-3.2	144
NARC, Islamabad	3750	3700	4000	1.4	-6.3	N.S
Average (12 locations)	3158	3113	2781	1.4	13.5	

compared to already released varieties possesses high tolerance against rust diseases. It was also observed that with overall good performance, the new variety is better adapted to various climatic conditions of Punjab and Pakistan than the earlier released varieties (Mustafa *et al.*, 2004 & 2005).

**Yield potential and varietal trials:** Mairaj-08 was also tested for grain yield performance at RARI, Bahawalpur and Agronomic Research Station, Bahawalpur. It gave 9 and 20% more yield than Inqlab-91 and Uqab-2000, respectively during 2005-2006 (Table VIII). Mairaj-08 was also tested at Punjab Seed Corporation Farms, Khanewal during 2007-08 in bigger blocks. Mairaj-08 was the best performer in term of yield compared to the checks by

**Table VIII: Wheat varietal trials**

Varieties	Yield (kg ha <sup>-1</sup> )			%± over checks
	Normal	Late	Average	
<b>RARI, Bahawalpur (2005-2006)</b>				
Mairaj-08	4430	2967	3699	
Uqab-2000	3794	2377	3086	20
Inqlab-91	4189	2601	3395	9
LSD (0.05)	371	219	-	-
<b>ARS, Bahawalpur (2006-2008)</b>				
Varieties	2006-07	2007-08	Average	
Mairaj-08	5262	4134	4698	
Inqlab-91	4585	3994	4290	
LSD (0.05)	272	N.S		
<b>Punjab Seed Corporation, Khanewal (2007-2008)</b>				
Varieties	Sowing Date	Area (ha)	Yield (kg ha <sup>-1</sup> )	%± over checks
Mairaj-08	01.12.2007	1.4	4496	
Uqab-2000	01.12.2007	0.5	4469	0.6
Inqlab-91	10.11.2007	0.5	4183	7.5
Shafaq-06	09.12.2007	4.6	4056	10.8
Fareed-06	05.12.2007	2.2	3984	12.9
Bhakkar-2002	11.11.2007	1.6	3779	19.0

**Table IX: Grain yield potential of Mairaj-08 in National Uniform Wheat Yield Trials on Pakistan basis**

Varieties	Punjab	Sindh	NWFP	Pakistan
<b>2002-2003 (Normal)</b>				
Mairaj-08	3938	3574	4234	3913
L-check	4103	3033	4181	3887
<b>2003-2004 (Normal)</b>				
Mairaj-08	4244	4045	4305	4200
Inq-91	3920	4045	4281	4048
L-check	3738	4045	4144	3937

 Source: Mustafa *et al.* (2004, 2005)

producing 0.6 to 19.0% higher yield than Uqab-2000, Inqlab-91, Shafaq-06, Fareed-06 and Bhakkar-2002 (Table IX).

**Production technology:** Six trials were conducted at Regional Agricultural Research Institute, Bahawalpur and Agronomic Research Station, Bahawalpur during the years, 2003-2004 and 2004-2005 to ascertain its package of production technology. The results showed that Mairaj-08 performed better in irrigated areas of Punjab when planted from 1st November to 15 December, keeping 125 kg ha<sup>-1</sup> seed rate, fertilizer @ 125-100-75 kg NPK ha<sup>-1</sup> and 5-6 irrigations are applied (Table X-XI).

**Rust reaction studies:** The response of the variety Mairaj-08 to various foliar diseases was studied at Crop Diseases Research Programme, NARC, Islamabad, Wheat Research Institute, Faisalabad and Regional Agricultural Research Institute, Bahawalpur. The comparison of Mairaj-08 with released varieties showed that the rust score of Mairaj-08 varied from Tr to 10MSS for leaf rust and 40MSS to 60MSS for yellow rust as compared to 10S to 20S for leaf rust and 40S to 90S for yellow rust of the check varieties i.e., SKD-1 and Inqlab-91 during 2002-2003 and 2003-2004, respectively (Table XII). According to the Wheat Traveling Seminar Report (2003-2004), Mairaj-08 was found to be free of leaf rust, while it had only 5-30 MSS yellow rust score (Table XIII). The data on leaf and yellow rust recorded at RARI, Bahawalpur

**Table X: Grain yield performance of Mairaj-08 in sowing date trial at RARI, Bahawalpur (2003-2004 & 2004-2005)**

Varieties	Yield (kg ha <sup>-1</sup> )						
	1.11.03	15.11.03	30.11.03	15.12.03	30.12.03	15.01.04	Average
<b>2003-2004</b>							
Mairaj-08	5834	4111	3500	3125	2639	2097	3551
Inqlab-91	4750	3450	3705	2722	2500	1840	3161
Uqab-2000	4931	3756	3195	2750	2709	1938	3210
LSD (0.05) for sowing dates =415 for varieties =262 for interaction = 642							
<b>2004-2005</b>							
Mairaj-08	5522	5555	3933	3800	1967	1056	3639
Inqlab-91	5037	4444	3866	3333	1778	945	3223
Uqab-2000	5814	4811	4078	3066	2045	1333	3525
LSD (0.05) for sowing dates = 188 for varieties = 196 for interaction = 479							

**Table XI: Grain yield performance of Mairaj-08 in Fertilizer trial at RARI, Bahawalpur**

Nutrients NPK (kg ha <sup>-1</sup> )	2003-2004		2004-2005	
	Mairaj-08	BWP-2000	Mairaj-08	BWP-2000
0-0-0	1647	1682	2213	1893
75-50-25	3011	2670	3446	3326
125-75-50	3200	2898	4390	3503
125-100-75	3522	3446	4213	3858
225-125-100	-	-	4390	3680

**Table XII: Disease reaction of Mairaj-08 in NUWYT**

Varieties	Lr		Yr	
	TR	RRI	TR	RRI
<b>2002-2003</b>				
Mairaj-08	Tr	8.9	40MSS	6.7
SKD-1	20S	1.3	90S	3.3
<b>2003-2004</b>				
Mairaj-08	10MSS	8	60MSS	3
Inqlab-91	10MSS	8	40S	2
TR=Terminal reaction RRI=Relative resistance index Tr= Traces				
Yr=Yellow rust (5 and above) Lr=Leaf rust (6 & above)				
Source: Mustafa <i>et al.</i> (2004, 2005)				

**Table XIII: Disease reaction of Mairaj-08 as reported in Wheat Traveling Seminar Report, 2003-2004**

Variety	Trial	Lr	Yr
Mairaj-08	NUWYT (Late) NARC,	0	10MSS
“	NUWYT (Normal) NARC,	0	5MSS
“	NUWYT (Late) CCRI, PSK,	0	30MSS

revealed that score of Mairaj-08 varied from Tr to 10RMR for leaf rust and from zero to Tr for yellow rust during the years 2005-2006 to 2007-2008 (Table XIV). Mairaj-08 had Relative Resistance Index value of 8-8.9, which is above desirable limit. Mairaj-08 was also found to be resistant to loose smut disease. Leaf and yellow rusts of wheat, beside yield reduction, damages the quality of grain as well. Therefore the grains obtained from susceptible varieties grown under diseased conditions are of inferior quality, whereas the resistant varieties produced better yield quality of grains. This phenomenon was recorded in the case of Mairaj-08 as well when grown in disease condition.

**Table XIV: Disease reaction of Mairaj-08 at RARI, Bahawalpur during 2003-2004**

Year	Lr	Yr
2005-2006	Tr	0
2006-2007	10-RMR	Tr
2007-2008	Tr	0

0, R, MR, RMR, MRMS and MS denote resistant reactions while S denotes susceptible reaction (Anonymous, 2004 & 2005; Hussain *et al.*, 1999)

**Table XV: Response of Mairaj-08 to Aphid and *Helicoverpa armigera* at Regional Agricultural Research Institute, Bahawalpur during 2003-2004**

Varieties	2003-2004	
	Av. No of Aphids/Tiller	Av. No of <i>H. armigera</i> /Tiller
Mairaj-08	17	0.20
Inqlab-91	16	0.33
Uqab-2000	20	0.47

**Table XVI: Physico-chemical characters and chemical composition of seed of Mairaj-08 in National Uniform Wheat Yield Trials 2002-2003**

Characteristics	Mairaj-08	Bahawalpur-97
1000 grain wt.(gm)	39.1	41.4
PSI	31.0	36.0
Grain ash (%)	1.5	1.3
Grain protein (%)	11.7	12.9
Gluten consistency	MS	MS
Wet Gluten (%)	26.5	28.7
Dry gluten (%)	8.2	8.9
SDS Value (cc)	32.0	18.0

Source: Mustafa *et al.* (2004)

**Table XVII: Physico-chemical characters and chemical composition of seed of Mairaj-08 in National Uniform Wheat Yield Trials 2003-2004**

Quality Traits	Mairaj-08	Inqlab-91	Wafaq-2002
1000 grain wt. (g)	37.8	41.6	37.1
Test wt. (Kg/HL)	75.7	80.1	78.4
PSI	35.0	37.0	36.0
Grain Ash (%)	2.9	1.5	1.4
Grain Protein (% d.b)	13.1	15.4	10.5
Gluten Consistency	S	MS	S
Wet. Gluten (%)	26.0	35.3	17.5
Dry Gluten (%)	9.2	11.7	7.0
SDS value (cc)	25.2	30.0	20.0

Source: Mustafa *et al.* (2005)

**Screening against insect pests:** The response of the variety Mairaj-08 to various insect pests was studied at Entomological Research Institute, Faisalabad (2003-2004 & 2004-2005) and Regional Agricultural Research Institute, Bahawalpur (2003-2004). A perusal of the data shows that the Mairaj-08 had less attack of wheat aphid (17.0 per tiller) and *Helicoverpa armigera* (0.20 per tiller) as compared to the check varieties Inqlab-91 (16.0 aphid per tiller & 0.33 *H. armigera* per tiller) and Uqab-2000 (20.0 aphid per tiller & 0.47 *H. armigera* per tiller) at Bahawalpur (Table XV).

**Quality traits of Mairaj-08:** Seed of Mairaj-08 contains 11.7-13.1% protein, 26-26.5% wet gluten, 8.2-9.2% dry gluten and 1.5-2.9% ash. Its flour yield is 69.9%. It has better

**Table XVIII: Physico-chemical characters and chemical composition of seed of Mairaj-08**

Varieties	1000 grain wt. (g)	Test wt Kg/HL	Protein (%)	Flour yield (%)	Chapatti quality	Bread quality score points/ 100
Mairaj-08	42.60	78.70	12.87	69.9	Good	61.50
Fareed-06	39.00	80.10	11.89	68.4	Good	60.00
Inqlab-91	42.80	79.70	11.00	69.9	Fairly Good	68.50

Source: Director, Agronomic Research Institute, Faisalabad

chapatti making quality than the others (Mustafa *et al.*, 2004). The quality traits recorded by N.A.R. Centre, Islamabad and Agronomic Research Institute, Faisalabad (Table XVI-XVIII) revealed that the new variety is better than the existing checks. Gluten consistency, a desirable character of the variety (Mustafa *et al.*, 2004) is strong to medium strong, while gluten percentage of the variety is also good.

**Botanical description of Mairaj-08:** The plant of Mairaj-08 is erect. At boot stage the leaf color is dark green. It has 135 productive tillers per meter row at maturity. Plant height is 90-95 cm. Stem color is red and diameter is 4 cm with upper internodal length of 33 cm. Number of nodes from ground level are four. Flag leaf width and length are 1.5 and 29 cm, respectively. Auricle hairiness is sparse with weak anthocyanin. Its straw is soft. It completes heading in 81-98 days and matures in 115-137 days. It is lodging and disease (rusts) resistant. The ear emerges 75-85 days after sowing. Ear color is red at maturity with a width and length of 0.8-1.0 and 7-12 cm, respectively. Its size is medium and shape is tapering. The spikelets are dense and shattering resistant. Mairaj-08 is awned variety; awn length is 6-8 cm, with horizontal habit and color is light red. Anther color is yellow. Seeds are elongated with amber color with a width and length of 3 and 5-7 mm, respectively. Seed thickness is 1.5 mm. Seed germ size is longer with intermediate seed groove. Seed is hard with rough surface. Number of seeds per spike varies from 50 to 70 and 1000 grain weight is 38-42.6 g.

**Seed quality:** Seed quality is an important parameter that determines the acceptability of a commodity among the consumers (Bhatty, 1988). The comparison of quality parameters showed that seed of Mairaj-08 contains 11.7-13.1% protein, 26-26.5% wet gluten, 8.2-9.2% dry gluten and 1.5-2.9% ash. Its flour yield is 69.9%. It has good chapatti making quality. These traits were comparable with those of Inqlab-91 and Wafaq-2002 (Table XVI-XVIII).

## CONCLUSION

Mairaj-08 is not only a high-yielder, possesses better quality traits and tolerant/resistant to all diseases and insect pests but is also best suited in wheat-cotton-wheat rotation. Due to its better adaptability, it has the potential to be replaced with the previously approved varieties.

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