"SADIQ-21": A NEW HIGH YIELDING AND DROUGHT TOLERANT WHEAT VARIETY

Imtiaz Ali[1,*], Natasha Kanwal[1], Muhammad Tariq Mahmood[2], Mashal Rehman[1], Rana Imtiaz Ahmad[1], Abid Ali[1], Khalid Mahmood[1], Muhammad Sajjad[1], Akash Zafar[1], Nadia Manzoor[1], Madiha Mobeen Khan[1], Muhammad Imran Akhtar[1], Naeem Arshad Maan[1], Asad-ur-Rahman Ch.[1], Zubaida Rasheed[3], Ume Eimen[4]

[1]Regional Agricultural Research Institute, Bahawalpur, Pakistan.
[2]Gram Breeding Research Station, Kallurkot, Bhakkar.
[3]Department of Soil and Environmental Sciences, The Women University Multan.
[4]Institute of Botany, Bahauddin Zakariya University Multan.

*For correspondence: imtiaz.malghani@gmail.com

Abstract

Sadiq-21 is the recently approved bread wheat (Triticum aestivum L.) variety holding higher grain yield potential and resistance against foliar diseases including rusts. It has been recommended for general cultivation in Punjab in 2021. The variety has been evolved through selection from exotic germplasm at Regional Agricultural Research Institute (RARI), Bahawalpur. The variety owns higher grain yield potential (>6700 kg ha^{-1}) and resistance against rusts (yellow rust, brown rust and black rust). The variety has better adaptability to withstand low moisture stress, therefore can better yield in rainfed areas of the province as well. It has good grain size (1000-grain weight ranges 38-40g), dense grain with high test weight (75.7 kg hl^{-1}) and semi dwarf height range (110-115cm). It is less appealing to aphids and very good receptive to fertilizers. Its grain is amber in colour containing good total protein, gluten protein and starch (12.9%, 21% and 53.9% respectively). Chapati making quality is good. It has good potential yield when sown during first fortnights of November @ 100-120 kg seed ha^{-1} and NPK dose of 150-120-60 kg ha^{-1}, respectively in average fertile soils. In short Sadiq-21 can play an important role in boosting existing yield outcome and in annual seed replacement percentage.

Keywords: New variety, *Triticum aestivum*, disease resistance, grain quality, production package

Introduction

Hexaploid bread wheat (*Triticum aestivum* L. 2n=6x=42) is the main food crop of Pakistan being cultivated on 9.178 million hectares all over the country (Anonymous, 2021). The crop is being grown on 40% of the cultivable area of Pakistan. Punjab is the main wheat producing province in the country both on area (75%) and production (77%) basis. South Punjab is the main wheat producing region in Punjab which shares about 40% of all Punjab's production while 30% of national production (Ali *et al*, 2019). Farmers of South Punjab are facing many problems like shortage of water, late planting, heat stress, diseases and insect pests problem (Irshad *et al.,* 2018). Regional Agricultural Research Institute (RARI), Bahawalpur situated in South Punjab is focusing on all of these mentioned issues relating to wheat crop.

The new variety is a selection from CIMMYT germplasm (37-ESWYT). This genotype was tested in yield trials both on-station and out-station. The genotype showed better performance in South Punjab, whole Punjab and at the national level as well. The strain showed tolerance against major fungal diseases of wheat i.e. leaf rust (*Puccinia triticina*), yellow rust (*Puccinia striiformis*) and stem rust (*Puccinia graminis*).

The strain was also tested under late planting to expose it to maximum heat stress conditions and gave encouraging results indicating as heat tolerant. As concerned quality, protein percentage is high (12.9%) with desirable gluten. Inclusion of this strain can push up the existing potential of wheat yield at farmers' field in South Punjab especially and in Punjab generally. It is hoped that the new variety "Sadiq-21" will replace the existing varieties and will cover a larger area under wheat.

Materials and methods

Selection of the genotype

The strain "Sadiq-21" was selected from CIMMYT germplasm (37-ESWYT) with following parentage and pedigree:QUAIU/5/UP2338*2/SHAMA/3/MILAN/KAUZ/CHIL/… CMSS11B01129S-099M-099Y-8M-OWGY. The genotype was particularly selected due to high biomass, more number of productive tillers m^{-2}, greater ear length, increased grains ear^{-1} and resistance against yellow rust (Yr) and leaf rust (Lr). Various phases in the evolution of Sadiq-21 are summarized in table 1.

Station yield trial

Sadiq-21 was tested for yield performance from 2016-17 to 2017-18 in preliminary and regular yield trials at Regional Agricultural Research Institute (RARI), Bahawalpur. The layout for preliminary and regular yield trials was RCBD with three replications. Plot size was kept 5m x 1.2m in preliminary and 5m x 1.8m in regular yield trials, respectively, keeping row to row distance of 30cm. Single row hand drill was used for sowing. One to two commercial varieties were included in each experiment as check for comparison. Data for yield and its contributing traits were recorded alongwith resistance against rusts and other desirable features at proper stages.

Punjab Uniform Wheat Yield Trial

The advance line was also tested in multi-sites yield trials under different agro-climatic circumstances throughout the province at 28 locations during 2018-19. The trial is used to be coded and coordinated by the Director, Wheat Research Institute, Faisalabad. Layout was alpha lattice with two replications having plot size of 5m x 1.2m. Uniform agronomic practices were adopted at all the sites. Data for yield and other traits were recorded by every component and sent to the coordinator. The data were compiled and averaged and shared with all the components.

National Uniform Wheat Yield Trial

NUWYT was consisted of new lines developed by wheat breeders all over Pakistan. Purpose of this trial is to find out the yield potential and average performance of new strains on country level. Field layout of these experiments was alpha lattice under 2 replications with 5m x 1.8m plot size adjusting 30cm inter-row distance. Crop husbandry practices were nearly uniform, sowing time was varying a little but soil and climatic conditions were varying a lot at included sites.

Production Technology and Disease Studies

The advance line was tested agronomically, pathologically and entomologically. Simultaneously, disease screening studies were also carried out at various hot spots for relative rust throughout the country by Crop Diseases Research Institute, Islamabad. The disease inoculum spreader was planted in alternate rows along with the test genotypes for provision of a substrate for speedy proliferation and dispersal of rust inoculum (Ahmad *et al.,* 2020). The data on rust reaction were recorded at suitable intervals following modified Cobb's Scale. Plots were individually harvested and threshed at maturity at all targeted sites and data on grain yield per plot was recorded in kilograms which later on converted to kg ha^{-1}. The data of station yield trials was analyzed through statistix software following RCBD while PUWYT and NUWYT trials data was analyzed through R software under alpha lattice design for analysis of variance following Steel and Torrie (1984).

RESULTS AND DISCUSSION

1. Yield Assessment

The data presented in Table 2 showed that Sadiq-21 gave 5% higher yield than the check variety Aas-11 in preliminary yield trial conducted during 2016-17. In 2017-18, it produced 2-7 percent higher yield than Jauhar-16 and 5-9% than Ujala-

16 under normal and late planting conditions, respectively (Table 3) in normal and late planting, respectively.

Results of PUWYT showed that Sadiq-21 out yielded both the check varieties FSD-08 and Jauhar-16 @ 4.3% and 27% respectively when averaged 9 locations in south Punjab (Table 4). While 10-18% higher yield than FSD-08 and Jauhar-16 (Table 5) on average of all Punjab (28 locations) basis as reported by Hussain *et al.* (2019).

Lastly, the elite line was assessed in NUWYT (national uniform wheat yield trials) under diverse agro-climatic environments throughout the country. The data of NUWYT showed that Sadiq-21 produced 4.6% higher yield than Pak-13 and 6.7% than Jauhar-16 when averaged 9 locations in South Punjab during 2019-20 (Table 6) while 7.5 % higher grain yield than check variety Pak-13 and 8.5 % than Jauhar-16 on 20 sites at all Punjab basis. The new variety showed 3.0% to 9.8% high yield than checks at 33 sites all over the country (Table 7). In second year testing under NUWYT variety gave 2.8% to 6.5% more grain yield than check varieties when averaged 9 locations in south Punjab (Table 8). While it showed 1.5 and 4.4% higher yield than Ghazi-19 and Pak-13 respectively when averaged 21 locations on all Punjab basis during 2020-21(Table 9).

2. Development of Production Package

Research trials were conducted for two years for appraisal of the most suitable planting time and fertilizer (NPK) dose, in comparison with commercial varieties. Detail is given as under:

3. Agronomic Studies

3.1. Planting time trials:

To estimate most suitable planting time, different agronomic studies/trials were conducted for two years from 2019-20 through 2020-21 at RARI, Bahawalpur as well as Agronomic Research Station, Bahawalpur. The new variety was tested in different sowing dates with an interval of 10 days each starting from 20th October

to Ist January. Various commercial checks were included in the experiments for comparison. Sadiq-21 presented good grain yield in the subject trials conducted at Regional Agricultural Research Institute, Bahawalpur (Table 10). Similarly, Sadiq-21 demonstrated almost comparable performance in sowing date trials conducted at Agronomic Research Station, Bahawalpur during 2019-21. The outcomes are in accordance with the verdicts of Hussain *et al*., (2014) and Ali *et al*., (2019). The statistics also revealed that the new variety gave maximum grain yield when sowing was completed during 1st two weeks of November.

The variety presented good grain yield when planted within the month of November but yield abridged in tardy planting. These results are in accordance with the findings of earlier scientist Aslani & Mehrvar, (2012), who conveyed a decline in yield and yield components due to tardy sowing. Results pertaining to planting time during 2019-21 at RARI Bahawalpur disclosed that the new variety yielded the maximum when sown on 11th November as matched to later days. The results also revealed that Sadiq-21 showed at par performance than FSD-08. Results of trials at Agronomic Research Station, Bahawalpur showed that Sadiq-21 showed peak grain yield when cultivated on 1st November. The variety executed better output than Ghazi-19 while at par with Akbar-19. So it can be clinched that the most appropriate sowing time for the new variety in first half of November.

3.2. Fertilizer trials: Data indicated that 150-120-60 NPK kg ha^{-1} is the optimal/balanced fertilizer dose for the variety to get better yield (Table 11). Similar results were reported by Tariq *et al.*, (2013) Ali *et al*., (2019) for newly developed wheat varieties of the time.

4. Pathological Studies

Resistance of Sadiq-21 against rust types was examined at Regional Agricultural Research Institute, Bahawalpur from 2019 to 2021 (Table 12). The

two years data indicated that Sadiq-21 is resistant to both rusts i.e. leaf and yellow rusts. Rust score ranging from 10MR to 20M for brown/leaf rust (*Puccinia triticina*) and 20MSS to 40MSS for yellow/stripe rust (*Puccinia striiformis*) was recorded for the subject variety in comparison with susceptible check (Morocco) with score of 70S to 80S for brown rust and 80S for yellow rust under southern Punjab's weather conditions (Fayyaz *et al.* 2020 and 2021).

Sadiq-21 can be used as better genetically resistant source in breeding programs targeting improvement in wheat germplasm against brown and yellow rust. The two rust types not only reduce grain yield by lowering down photosynthetic activity and traslocation of photosynthates to grains, but also reduce the grain quality (Kong *et al.*, 2010; Wang *et al.*, 2020). This spectacle was seen in the instance of Sadiq-21 as well if planted under epidemic conditions . Hussain *et al*., (2011), (Lan *et al., (*2017), and Ali *et al.*, (2019) reported new varieties of wheat to be more resistant to rust diseases as compared to checks.

5. Grain quality studies

Grain quality traits are important parameters that determine the adequacy of a product for its buyers. Sadiq-21 was evaluated for its quality traits during 2019-20 and 2020-21 (Table 13). The grain of Sadiq-21 contains 12.9 percent protein and gluten up to 21.0%. It has good chapati making quality. Its test weight is comparable with check varieties. The quality characters depicted that the variety is ahead of the prevailing checks. Strong to medium gluten consistency was recorded for the variety with acceptable gluten percentage. Hussain *et al*., (2014), Subhani *et al.*, (2014) and Ali *et al.*, (2019) reported parallel outcomes for new varieties of wheat.

Conclusion

Sadiq-21 possesses higher yield potential than check varieties. This variety is resistant to Lr, Yr and local race of stem rust. It can be suited well in heat and drought prone areas like south Punjab and rainfed areas of Pakistan due to its better

tolerance against high temperature and drought. Its grain quality traits and chapati making characteristics like dough volume and dough elasticity is good. The Punjab Seed Council, under the Chairmanship of Minister for Agriculture, GOPb, Lahore, approved this variety during its 55th meeting held on 20th September for general cultivation in Punjab for general cultivation in whole Punjab especially in warm and drought prone areas of the province. Cultivation of Sadiq-21 may shrink the risk of epidemic of rusts. It will cover a significant area under wheat crop due to its better yield potential and adaptability.

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Table 1. Summary of various steps in evolution of Sadiq-21.

Year	Trials	Description
2016-17	37-ESWYT (A Trial)	QUAIU/5/UP2338*2/SHAMA/3/MILAN/KAUZ/CHIL/…
2017-18	B-TRIAL	On-station replicated yield trials at Regional Agricultural Research Institute, Bahawalpur.
2018-19	PUWYT	Multi-locations yield testing on provincial basis through the Director Wheat Research Institute, Faisalabad.
2019-20	NUWYT (I^{st} year)	Multi-locations yield testing on national basis through the National Coordinator Wheat, Islamabad.
2020-21	NUWYT (2^{nd} year)	Multi-locations yield testing on national basis through the National Coordinator Wheat, Islamabad.
2019-21	Agronomic studies	These studies were conducted at RARI-Bahawalpur and Agronomic Research Station Bahawalpur for two years.
2019-21	Pathological studies	These studies were conducted at RARI-Bahawalpur and CDRI for two years.
2019-21	Physio-chemical studies	These studies were conducted at physio-chemical Lab at Wheat Research Institute, Faisalabad for two years.

Table 2. Preliminary Yield Trial (A-Trial) 2016-17.

Year	Name of Trial	Yield (kg ha^{-1})	
		sadiq-21	**Aas-11 (Check)**
2016-17	A-Trial (37-ESWYT)	4666	4413
Percent ± over check			**5**

Table 3. Regular Yield Trial (B-Trial) 2017-18.

Year	Name of Trial	Yield (kg ha^{-1})				
		Sadiq-21	**Jauhar-16 (Check)**	**Ujala-16 (Check)**	**Percent ± Over Jauhar-16**	**Percent ± Over Ujala-16**
2017-18	B-Trial (N)	4395	4323	4170	2	5
2017-	B-Trial (L)	3770	3520	3445	7	9

18					
Mean	**4082**	**3921**	**3807**	**4.1**	**7.2**

Table 4: Punjab Uniform Wheat Yield Trials at South Punjab Level (2018-19).

Sr. No.	Location	Sadiq-21	FSD-08 (Check)	Jauhar-16 (Check)	Percent ± Over FSD-08	Percent ± Over Jauhar-16
1	RARI, Bahawalpur (Normal time planting)	4875	5417	5042	-10.0	-3.3
2	Neelum Seeds, Jahanian	4917	4084	2708	20.4	81.6
3	MNSUA, Multan	4167	4333	3167	-3.8	31.6
4	ARF, Vehari	4084	3858	3017	5.8	35.4
5	ORS, Khanpur	3167	3167	3167	0	0
6	Alipur	4653	4611	3639	0.9	27.9
7	RRS, Bahawalnagar	4575	4008	3268	14.1	40.0
8	PSC, Khanewal	3526	3848	3566	-8.4	-1.1
9	RARI Bahawalpur (Late time planting)	3917	3000	2250	30.6	74.1
Mean		**4209**	**4036**	**3314**	**4.3**	**27.0**

Table 5: Punjab Uniform Yield Trials at all Punjab Level.

Strain/Variety	Yield (kg ha^{-1})		
	Sadiq-21	FSD-08 (Check)	Jauhar-16 (Check)

Average of 28 sites of Punjab	4457	4065	3768
Percent ± over check		**10**	**18**

Table 6. National Uniform Wheat Yield Trials 2019-20.

Sr. No.	Location	Sadiq -21	Jauhar-16 (Check)	Ghazi -19 (Check)	Pak-13 (Check)	Percent ± Over Jauhar-16	Percent ± Over Ghazi -19	Percent ± Over Pak-13
1	RARI, Bahawalpur	3723	3612	3278	3833	3.1	13.6	-2.9
2	MNSUA, Multan	4289	4062	4112	4167	5.6	4.4	2.9
3	R.Y. Khan	4778	4361	5723	4334	9.6	-16.5	10.2
4	Alipur	6534	6045	5583	5685	8.0	17.0	14.9
5	Neelam Seeds, Jahanian	6445	4583	5861	4028	40.6	10	60.0
6	ORS, Khanpur	5013	5388	6147	6217	-6.9	-18.4	-19.4
7	RSS, Bahawalnagar	4634	4373	5114	5289	5.9	-9.4	-50.1
8	PSC, Khanewal	4578	4811	5057	4022	-4.8	-9.5	13.8
9	AZRI, Bhakkar	4265	4207	4142	4740	1.4	2.9	-10.02
	Mean	**4918**	**4605**	**5002**	**4702**	**6.7**	**-1.7**	**4.6**

Table 7. All Punjab and Pakistan Level 2019-20.

Strain/Variety	Yield (kg ha^{-1})			
	Punjab (20 sites)	**Percent ± Over checks**	**Pakistan (33 sites)**	**Percent ± Over Check**
Sadiq-21	4606		4501	
Jauhar-16 (Local Check)	4246	**8.5**	4208	**7.0**
Pakistan-13 (Check)	4284	**7.5**	4100	**9.8**
Ghazi-19 (Check)	4638	**-0.1**	4369	**3.0**

Table 8. National uniform wheat yield trial 2020-21.

Sr. No.	Location	Sadiq-21	Pak-13	Ghazi -19
1	RARI Bahawalpur	5278	4789	4728
2	ARS-Khanewal	5303	5833	5192
3	R.Y Khan	4667	4111	4389

4	Jahanian	5639	4722	5306
5	Alipur	6200	5834	5961
6	Mailsi	5278	5723	6000
7	AZRI, Bhakkar	5070	4525	4740
8	PSC, Khanewal	4075	3655	4803
9	MNSUA, Multan	4384	3912	3512
Mean		**5099**	**4789**	**4959**
Percent ± over check			**6.5**	**2.8**

Table 9. All Punjab and Pakistan Level 2020-21

Strain/Variety	**Yield (kg ha^{-1})**			
	Punjab (21 sites)	**Percent ± over Checks**	**Pakistan** (31 sites)	**Percent ± over Checks**
Sadiq-21	**4216**		**4081**	
Pakistan-13 (Check)	4038	**4.4**	3992	**2.2**
Ghazi-19(Check)	4155	**1.5**	4279	**-4.6**

Table 10. Average grain yield (kg ha^{-1}) performance of Sadiq-21 under various planting times (2019-21).

Genotypes/ Planting time	20th Oct.	1st Nov.	11th Nov.	21st Nov.	1st Dec.	11th Dec.	21st Dec.	1st Jan.	**Means**
Agronomy Section RARI, Bahawalpur									
Sadiq-21	4398	4351	5000	4531	2963	2685	2685	2610	**3653**
FSD-08 (Check)	3970	4310	4766	4429	2683	2610	2467	2400	**3454**
Agronomic Research Station, Bahawalpur									
Sadiq-21	6250	6343	6204	5690	4243	3565	3472	3110	**4860**

Akbar-19 (Check)	6313	6420	5880	5780	4444	3472	3333	3148	**4849**
Ghazi-19 (Check)	6157	6111	5926	5556	4167	3426	3287	3090	**4715**

Table 11. Fertilizer doses trials, (2018-19 to 2019-20).

Tr. No.	**N**	**P_2O_5**	**K_2O**	**Yield (kg ha^{-})**	
1	0	0	0	**Sadiq-21**	**Jauhar-16** (Check)
2	0	120	60	1770	1720
3	75	120	60	2180	2140
4	**150**	**120**	**60**	3540	3420
5	225	120	60	4520	4460
6	150	0	60	4575	4530
7	150	60	60	3505	3460
8	150	180	60	4110	4050
9	150	120	0	4720	4660
10	150	120	30	4150	4050
11	150	120	90	4470	4410
LSD (0.05)				135	

Table 12. Disease studies by crop disease research institute, CDRI, Islamabad.

RARI Bahawalpur				
Genotype	**2019-20**		**2020-21**	
	Lr	**Yr**	**Lr**	**Yr**
172190	20M	40 MSS	10MR	20MSS
Morrocco (Check)	70S	80S	80S	80S

Table 13. Quality evaluation.

Varieties/ strains	Test wt. (kg hl^{-1})	Protein (%)	Starch (%)	Gluten (%)
Sadiq-21	75.7	12.9	53.9	21
PAK-13 (Check)	78	13.8	53.8	23
Ghazi-19 (Check)	74.6	12.4	52.3	18
Local check	73	14	52.7	26