

NIFA BATHOOR-08: A HIGH YIELDING AND DISEASE RESISTANT WHEAT VARIETY DEVELOPED FOR IRRIGATED AREAS OF KHYBER PAKHTUNKHWA (KP) PROVINCE OF PAKISTAN

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Abstract

The high yielding and disease resistant wheat variety NIFA Bathoor 08 was developed through introduction of an exotic CIMMYT line and was evaluated under the name of CT-99022 for seed yield, disease resistance and wide adaptation in yield trials during 1998-2007. It has shown superb yield performance in various yield trials during 1998–2004 by producing grain yield of 8%, 8.7% and 6.2% higher seed yield as compared to standard varieties Bakhtawar-92, Fakhre Sarhad and Saleem 2000 respectively. In national yield trials, CT-99022 was tested at 42 locations under normal and late planting conditions during 2005-06. On an average it produced 6.8% higher grain yield than the local check and ranked 1st in KP under normal planting. During 2006-07, CT-99022 produced 3.4% higher grain yield than the local check across 36 locations in Pakistan and produced 7.36% higher grain yield than the local check at 4 locations in KP. The line CT-99022 showed a desirable level of resistance to yellow rust (YR), Leaf Rust (LR) and desirable quality parameters. CT-99022 is well adapted in the irrigated areas of both KP. It has distinctness of different genetic background, medium tall with dark green leaves, high tillering capacity and creamy white spike with reddish stem color at maturity. CT-99022 has been approved with the name of “NIFA BATHOOR-08” by KP Provincial Seed Council for general cultivation in the irrigated areas of KP.

Introduction

Wheat is the main staple food of the people of Pakistan and is being grown by 80% of the farmers and 40% of the total cultivated area and 65% of the food crops area in the country. It contributes approximately 12.5% to the value added agriculture and 3.1% to GDP (Anon., 2005-06). Wheat is also the most important single product as a source of income of the majority of farmers in the rural areas of Pakistan. As a very sensitive commodity, a small change in its price and availability has a direct positive or negative impact on consumers, especially on poor sections of the community. In Khyber Pakhtunkhwa (KP) wheat occupies 40% of the total cropped area and 60% of the area grown to cereals in the province. During 2006-07, wheat was cultivated on about 0.755 million hectares with a production of 1.39 million tons (Anon., 2006-07). The current average yield of 1.84 tons/ha is very low and is one of the important factors leading to overall low wheat productivity in the province. The low per acre yield can be attributed to a number of biophysical and socio-economic constraints, however, lack of high yielding, disease resistant, broadly adapted and good quality wheat varieties is a major factor responsible for low wheat production in the province. The record showed that there has been severe attack of stem rust and leaf rust in wheat growing areas of Pakistan (Kamal & Moahal, 1968). Rusts are the most destructive and also the most widely recognized diseases of wheat crop (Qamar & Niks, 2007). Wheat rusts cause significant reduction in wheat yield and poses a constant threat to sustainable wheat production in all wheat growing countries including Pakistan (Sing & Julio, 2006).

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To develop high yielding, disease resistant, broadly adapted and good quality wheat varieties for the irrigated and rainfed areas of KP, the wheat breeding programme at NIFA was initiated for creation of genetic variability for important plant and grain characters. Both conventional and non-conventional breeding procedures are followed to attain these objectives. Apart from generating its own breeding material through mutagenesis and hybridization, the institute has developed an active collaboration with various international and national research institutes for exchange and evaluation of wheat germplasm. The material is tested under local environments for various economic characteristics. Useful selections made from the breeding material are either directly used for development of new varieties or utilized for incorporating their valuable genetic attributes in the locally adapted wheat varieties through cross breeding programme. A series of improved lines of wheat with grain yield potential and resistance against abiotic and biotic stresses selected/developed through selection and cross breeding are in hand. Out of these, an elite line *i.e.* CT-99022 performed well regarding grain yield and resistance to the two rusts. It was selected for adaptability and further studies for agronomic, disease and yield characteristics. The same entry has shown superb yield performance in different yield trials.

Material and Methods

International Bread Wheat Screening Nursery (IBWSN) received from CIMMYT, Mexico was planted at NIFA, Peshawar during 1998-99 to evaluate grain yield potential and resistance to rust. The entry No. 22 (CT-99022) performed well and produced the high grain yield and resistance to two rusts and was selected for further evaluation. The same entry was further evaluated in the NIFA Observation Nursery (NON) during 1999-2000 and 2000-2001 for critical examination of agronomic, yield and disease characteristics. Based on desirable morph-physiological traits, yield and resistance to diseases it was evaluated in replicated trials (Ramzan & Mehmet, 2009).

To evaluate their yield potential, different sets of trials; preliminary yield trials (2001-2002), advanced selection yield trial (normal) (2002-2003), micro plot test trials (central irrigated zone, southern irrigated zone and northern irrigated zone) (2003-04), micro plot test (all the three zones) (2004-05) and National Uniform Wheat Yield trials (2005-06 and 2006-07), were laid out by following appropriate experimental design along with recommended agronomic practices. National Uniform Wheat Yield Trials (NUWYT) were organized in Pakistan by National Coordinator (Wheat) NARC, Islamabad in which different research organizations working on wheat contributed elite lines for testing their seed yield potential. During 2005-2006, NIFA contributed CT-99022, Pulses Research Institute AARI, Faisalabad; V-03158, V-1078, V-03079, V-02192, RARI, B. Pur; V022668, V-002495-A, BARI, Chakwal; 2KC050, ARI, DI. Khan; DN-38, UAF, Faisalabad, V-9316, BIOTECH-AARI-Faisalabad, V00BT034, NIA, Tandojam; V-15-10, NARC; NR-270, CCRI, Peersabak; PR-84, PR-88, QAARI, Larkana; Q-5-1, ARS, Sawat; Maria, WRI, Sakrand, Malir. An approved variety Inqlab-91 and a local variety were included as standard check. This trial was also repeated in the mentioned locations during 2006-2007.

Rust infection scoring was done according to the methods as described by Stakman *et al.*, (1962) and the protocols followed by Crop Disease Research Institute (CDRI), Islamabad (Anon., 2000). Wheat quality parameters were evaluated according to methods set by AACC (2000), Anon., (1994) and AOAC methods (Helrich, 1990).

To determine optimum sowing time to realize yield potential, sowing date trials were conducted during 2003-04, 2004 -05 and 2005-06 at different locations and zones in the KP. Data on seed yield and yield related traits were recorded and statistically analysed (Steel & Torrie 1984).

Results and Discussion

Evaluation in screening nurseries (1998- 2001): The line CT-99022 was received from CIMMYT, Mexico in the 31ST International Bread Wheat Screening Nursery (IBWSN) and planted at NIFA, Peshawar during 1998-99. The entry No. 22 (CT-99022) performed well regarding grain yield and resistance to two rusts and was selected for further evaluation for agronomic, disease and yield characteristics in the NIFA Observation Nursery (NON). Ten lines were evaluated in the NON during 1999 to 2001. The line CT-99022 (7200 kg ha⁻¹) yielded 5% higher than the check variety Bakhtawar-92 (6867 kg ha⁻¹) during 1999-2000 and ranked 3rd and also out yielded the check variety Bakhtawar-92. Whereas CT-99022 (6933 kg ha⁻¹) yielded on average 5% higher than the check variety Bakhtawar-92 (6267 kg ha⁻¹) and Fakhre Sarhad (6867 kg ha⁻¹) during 2000-2001 (Table 1).

Preliminary yield trial (2001-2002): Sixteen lines including check varieties Bakhtawar-92 and Fakhre Sarhad were included in the PYT during 2001-02. Different yield and yield contributing traits *i.e.* days to heading/maturity (no.), plant height (cm), biological yield (kg. ha⁻¹), grain yield (kg ha⁻¹), harvest index (%), and 1000 grain weight (gm) were recorded. The line CT-99022 (4967 kg ha⁻¹), ranked 1st and out yielded both the check varieties Bakhtawar-92 (4933 kg ha⁻¹), and Fakhre Sarhad (4533 kg ha⁻¹) (Table 1).

Advance selection yield trials (normal) (2002-03): Advanced selection yield trial was conducted during 2002-03 at four locations in the KP *i.e.* NIFA, Peshawar, Agriculture University, Peshawar, Farmers Field Charsadda and CCRI, Pirsabak. Based on the mean performance over 4 locations in KP the CT99022 produced grain yield of 4362 kg ha⁻¹ and out yielded both the check varieties Bakhtawar-92 (4193 kg ha⁻¹) and Fakhre Sarhad (3777 kg ha⁻¹) (Table 1).

Micro plot test trials (2003-04): Micro Plot Test Trials were conducted in the three different zones *i.e.* Central irrigated, Southern irrigated and Northern Areas in the KP during 2003-04. In the Central irrigated Areas the trials were conducted at four locations *i.e.*, NIFA, Peshawar, KP, Agricultural University, Peshawar, CCRI, Pirsabak, Nowshera and Farmer's Field Charsadda. The line CT-99022 out yielded both the check varieties Bakhtawar-92 and Saleem-2000 at all the locations. On average CT-99022 produced the grain yield of 3682 kg ha⁻¹ as compared to Bakhtawar-92 (3425 kg ha⁻¹) and Saleem-2000 (3522 kg ha⁻¹). In the southern irrigated areas the trials were planted at two locations *i.e.*, ARI, D.I. Khan and ARS Seri Naurang. The line CT-99022 ranked 2nd by out yielding both the check varieties. The line CT 99022 produced 18.3% and 11.85% more grain

yield as compared to Bakhtawar-92 and Saleem 2000. In the Northern areas trials were conducted at three locations *i.e.* ARI, Mingora, Buffa, Mansehra and Karina, Gilgit. The CT-99022 produced the highest grain yield and ranked first. On an average of all the three locations CT-99022 produced the grain yield of 4200 kg ha⁻¹ as compared to check varieties Bakhtawar-92 (3825 kg ha⁻¹) and Saleem-2000 (3973 kg ha⁻¹) accounting an increase of 9.8% and 5.78% over both check varieties respectively (Table 1).

National Uniform Wheat Yield Trials (2005 -2007): In the NUWYT CT-99022 produced the 3rd highest mean grain yield across 42 locations under normal and late planting and combined performance under both conditions during 2005-06. CT-99022 produced grain yield of 4494 kg ha⁻¹ (6.8% higher yield than the composite local check) and ranked 1st in KP under normal planting (Table 2). During 2006-07, CT-99022 produced 3.4% higher yield than the local check across 36 locations in Pakistan whereas 7.4% higher grain yield than the composite local check at 4 locations in KP.

During 2005-06, the candidate lines in the NUWYT were evaluated for yellow rust and leaf rust along with terminal reaction, average coefficient of infection (ACI), country average relative percentage attack (CARPA,) relative resistance index (RRI). The line CT-99022 showed a desirable Relative Resistance Index (RRI) of 7 for yellow rust (YR) (Table 3) and 8 for Leaf Rust (LR) according to the disease rating of Crop Disease Research Program (CDRP), Islamabad (Table 4). Similar findings were earlier reported by Afzal *et al.*, (2009).

The candidate lines in the NUWYT were also evaluated for quality parameters *i.e.* 1000 kernel wt. (gm), Test wt. (kg ha⁻¹), PSI, Grain ASH (%), Grain Protein (%), Gluten consistency, wet Gluten (%), Dry Gluten (%), SDS Value (cc) (Table 5). CT-99022 is at par with the existing commercial wheat varieties regarding both physical and chemical qualities.

The line CT-99022 is well adapted in the irrigated areas of both KP and other provinces in Pakistan and is recommended to be sown between 25th October and 25th November. CT-99022 has been approved with the name of “NIFA BATHOOR-08” by the KP Provincial Seed Council for general cultivation in the irrigated areas of KP.

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Table 1. Seed yield performance of NIFA Bathoor 08 (CT-99022) in different yield trials.

Trial	Year	Mean seed yield (Kg ha ⁻¹)				% Increase decrease over			
		CT-99022 (NIFA Bathoor 08)	Bakht- 92	Fakhre Sarhad	Saleem 2000	Bakht- 92	Fakhre Sarhad	Saleem 2000	Saleem 2000
International Bread Wheat Nursery IBWSN (Entry No. 22)	1998-99	4396	3939	-	-	11.6	-	-	-
NIFA Observation Nursery (NON) (Entry No. 9)	1999-00	7200	6867	-	-	4.8	-	-	-
NIFA Observation Nursery (NON) (Entry No. 9)	2000-01	6933	6267	6867	-	10.6	1.0%	-	-
Preliminary Yield Trial	2001-02	4967	4933	4533	-	0.7	9.6%	-	-
Ad. Selections Yield Trial (ASYT)									
NIFA, Peshawar		3960	4050	4260	-	-2.3	-7.0	-	-
Pirsabak	2002-03	4510	4110	4230	-	9.7	6.6	-	-
Charasadda		4667	4760	3517	-	-1.7	25.6	-	-
Agri. Univ. Peshawar		4300	3850	3100	-	11.7	38.7	-	-
Mean		4362	4193	3777	-	4.4	15.5	-	-
Micro Plot Test – Central Irrigated zone	2003-04								
NIFA, Peshawar		3500	3808	-	-	-8.1	-	6.7	-
NWFP Agri. Un. Pesh.		3412	2768	-	-	13.5	-	1.6	-
CCRL, Pirsabak		3517	3058	-	-	15.0	-	1.1	-
Farmers Field, Charasa.		4567	4067	-	-	12.3	-	21.2	-
Mean		3682	3426	-	-	8.2	-	4.3	-
Micro Plot Test – Southern Irrigated zone	2003-04								
ARI, D. I. Khan		3697	3697	-	-	0.00	-	1.4	-
ARS, Seri Naurang		3954	2768	-	-	42.8	-	27.9	-
Mean		3826	3233	-	-	18.3	-	11.8	-
Micro Plot Test – Northern Irrigated zone	2003-04								
ARI, Mingora		5625	5417	-	-	3.8	-	2.8	-
Buffa, Manshera		5200	5100	-	-	2.0	-	1.9	-
Karina, Gilgit		4452	3913	-	-	13.3	-	14.9	-
Mean		5092	4816	-	-	5.7	-	2.4	-
Mean (all three zones)		4200	3825	-	-	9.8	-	5.7	-
Average % increase						8.00	8.7	6.2	

Table 2. Mean Yield Performance of CT-99022 (NIFA Bathoor 08) in National Uniform Wheat Yield Trial (NUWYT) at different seedling dates in irrigated zones of Pakistan.

Sowing time	2005-06						2006-07									
	Pakistan			KP			Pakistan			KP						
	Grain yield		% incr./dec. over check	Ranking	Grain yield		% incr/dec.	Ranking	Grain yield		% incr/de.	Ranking				
	CT-99022	Local Check			CT-99022	Local Check			CT-99022	Local Check						
Normal	3988	3813	4.6	3 rd	4494	4207	6.8	1 st	4076	4016	1.5	9 th	3907	3639	7.4	1 st
Late	3430	3228	6.3	3 rd	3432	3518	-2.5	-	3204	3044	5.3	6 th	-	-	-	-
Combined	3711	3524	5.3	3 rd	4069	3931	3.5	4 th	3640	3530	3.2	6 th	-	-	-	-
Mean % increase over check			5.4				7.8				3.4					

Table 3. Response of candidate wheat lines to yellow rust along with terminal reaction, average coefficient of infection (ACI), country average relative percentage attack (CARPA,) relative resistance index (RRI) during 2005-2006.

S. No.	Line/Variety	Yr (L ₁)	Yr (L ₂)	Yr (L ₃)	Yr (L ₄)	CARPA	RRI*	Terminal reaction to Yr
1.	V-01078	0	10MSS	10MRMS	5	625	8	10MSS
2.	V-02192	0	0	10MS	2.66	3.325	9	10MS
3.	V-03079	10MSS	60S	30S	33	41.25	5	60S
4.	V-03158	10MSS	10MRMS	40MSS	17	21.25	7	40MSS
5.	V-00BT034	0	10MRMS	30MSS	11	13.75	8	30MSS
6.	V-002495-A	0	10MSS	50MRMS	13	16.25	8	10MSS
7.	V-02268	5MSS	40S	10MSS	17.83	22.287	7	40MSS
8.	V-9316	0	50S	80MSS	40.66	50.82	4	50S
9.	2KC050	5MSS	30MSS	5S	12.16	15.2	8	5S
10.	PR-84	5MSS	60MRMS	40S	26.83	33.53	6	40S
11.	PR-86	0	5S	0	1.66	2.075	9	5S
12.	DN-38	5S	30MRMS	10S	11	13.75	8	10S
13.	Q.S-1	70S	80S	50S	66.66	83.325	2	80S
14.	CT-99022	5S	30MRMS	20MSS	13.66	17.075	7	5S
15.	NR-270	0	0	20MRMS	4	5	9	20MRMS
16.	MALIR	60S	70S	40S	56.66	70.825	3	70S
17.	V-5-10	80S	80S	80S	80	100	0	80S
18.	MARIA	5S	0	60MSS	19.66	24.575	7	5S
19.	INQILAB-91	80S	80S	70S	73.33			80S
20.	Morocco	90S	90S	90S	90			90S

RRI* = Relative Resistance Index

Leaf rust =

7

Yellow rust =

6 or 5

5

Desirable RRI

Acceptable RRI

Table 4. Responses of candidate lines to leaf rust (LR) along with terminal reaction, average coefficient of infection (ACI), country relative percentage attack (CARPA), relative resistance index (RRI) during 2005-2006.

S. No.	Line/Variety	NUWYT (Seedling Date)		RARI Bhawalpur		AARI F. Abad		CDRI, KAR		NIA T. Jam		WRI SAK		ACI	CARPA	RRI	T.R
		Lr		Lr		Lr		Lr		Lr		Lr					
1.	V-01078	5MS		TMSS		10MSS		10MS		10MS		5S		5.38	9.95	8	5S
2.	V-02192	20MSS		80S		70S		50S		50S		30S		49.6	91.76	1	80S
3.	V-03079	10MRMS		5MSS		10MS		10MS		50S		10S		15.7	29.05	6	50S
4.	V-03158	5MR		0		TMS		10MS		10MS		10S		4.16	7.70	8	10S
5.	V-00BT034	5MR		0		10MSS		10MS		10MS		10S		5.8	10.73	8	10S
6.	V-002495-A	5MRMS		0		50MSS		10MS		10MS		10S		13.2	24.42	7	10S
7.	V-02268	5S		TS		10MSS		20MS		10MS		10S		8.2	15.17	8	10S
8.	V-9316	5MRMS		5MSS		10MSS		10MS		10MS		10S		6.9	12.77	8	10S
9.	2KC050	5MRMS		0		20MS		30MS		10MS		10S		10.6	19.61	7	10S
10.	PR-84	5MRMS		TMSS		10S		10MS		10MS		20S		8.38	15.50	8	20S
11.	PR-86	5S		5MSS		5MSS		5S		5S		10S		5.8	10.73	8	10S
12.	DN-38	5MRMS		10S		60S		10S		10S		10S		18.6	34.41	6	60S
13.	Q.S-1	20MSS		TMS		30S		50S		50S		0		19.8	36.56	6	50S
14.	CT-99022	10MSS		10MSS		20S		5S		5S		0		8.6	15.91	8	20S
15.	NR-270	0		0		10MSS		5MS		5MS		0		2.6	4.81	9	10MSS
16.	MALIR	20S		10S		50S		10MS		10MS		0		17.6	32.56	6	50S
17.	V-5-10	50S		60S		60S		50S		50S		50S		54	100.0	0	60S
18.	MARIA	0		0		30MSS		5MS		5MS		10MS		7.8	14.43	8	30MSS
19.	INQILAB-91	10MSS		0		60S		10S		10S		50S		25.8			60
20.	Morocco	90S		90S		90S		70S		70S		80S		84			90

RRI* = Relative Resistance Index

Leaf rust = $\frac{\text{Desirable RRI}}{\text{Acceptable RRI}}$
 Yellow rust = $\frac{7}{6 \text{ or } 5}$
 7
 5

Table 5. Quality evaluation of national uniform wheat yield trial entries, 2005-06.

S No.	Line	1000-Kernel wt. (gm)	Test wt. (kg/h)	PSI	Grain ash (%)	Grain protein (% d. b)	Gluten consistency	Wet gluten (%)	Dry gluten (%)	SDS value (cc)
1.	V-03158	33.2	75.1	39	1.596	12.30	S	29.15	9.54	30
2.	V-022668	34	71.95	61	2.112	15.43	MS	37.59	11.99	38
3.	2KC050	37.5	71.9	43	1.643	12.49	S	21.45	7.23	23
4.	DN-38	39.6	74.2	40	1.55	13.65	W	31.34	9.19	24
5.	CT-99022	36.3	73.15	58	1.374	13.55	S	21.34	7.43	22
6.	B-9316	37.4	69.3	40	1.533	13.00	S	28.63	9.62	39
7.	V-00BT034	40.6	75.4	40	1.547	12.16	S	32	10.02	30.5
8.	V-01078	44.9	78.1	40	1.457	14.79	MS	34.55	10.58	34
9.	V-15-10	26.4	71.7	39	2.07	15.81	S	40.04	12.34	32.5
10.	V-03079	36.3	75.8	40	1.493	14.84	MS	35.46	11.42	38
11.	PR-88	38.9	74.8	44	1.334	14.16	S	19.58	6.82	22
12.	V-002495-A	33.4	73	62	1.931	15.21	MS	35.35	10.89	33.5
13.	QSI	39.2	72.5	56	2.1	12.25	S	26.49	8.61	20.05
14.	V-02192	31.8	76.1	60	1.33	11.46	S	21.44	7.48	22
15.	PR-84	39.9	74.6	44	1.378	11.44	MS	27.83	8.91	22
16.	MARIA	27.3	67.15	42	1.362	11.65	MS	27.01	9.26	35
17.	INQLAB	38.5	78.6	40	1.423	13.11	S	30.94	10.36	39
18.	MALIR	33.7	77.6	44	1.742	12.45	S	29.69	9.17	30

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