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MANTHAR-03: A HIGH-YIELDING CULTIVAR OF WHEAT RELEASED FOR GENERAL CULTIVATION IN SOUTHERN PUNJAB

Manzoor Hussain[1,*], Lal Hussain Akhtar[2], Altaf Hussain Tariq[1], Muhammad Rafiq[1] and Muhammad Nasim[3]

[1]Regional Agricultural Research Institute (RARI), Bahawalpur, Pakistan;
[2]Agricultural Research Station, Bahawalpur; [3]Soil and Water Testing Laboratory, Bahawalpur, Pakistan
[*]Corresponding author's e.mail: lhakhtar@yahoo.com

We report the release of a new wheat variety Manthar-03. *"Manthar-03"* is a high yielding and rust resistant variety of bread wheat with erect growth habit. It was released in the year 2003 as a general purpose variety. *Manthar-03* is a selection from CIMMYT material (Entry No. 42 of 29th International Bread Wheat Screening Nursery) made at Regional Agricultural Research Institute (RARI), Bahawalpur during 1996-97. This strain has the famous CIMMYT line 'Kauz' in its parentage (KAUZ//ALTAR 84/AOS). Its pedigree is CM11163-6M-20Y-10M-0M-0B. It is a more adapted and a high yielder. Genetically, this strain differs from existing commercial cultivars of Punjab. Resistance against leaf rust (5MRMS to 10MR), RRI value of 6.7 and 7.6 for leaf rust and ACI values of 3.4 & 0.7 for leaf rust) and high yield potential (6300 kg ha^{-1}) are the major attributes of *Manthar-03* that make it a superior variety for its target regions. *Manthar-03* is tolerant to wheat aphid and *Helicoverpa armigera.* The thousand seed weight of this variety is 40-44 g. Seed is amber in color and contains 12.97% protein, 8.2% dry gluten and 1.55% ash. It has good *chapati* making quality. Plant type *of Manthar-03* is erect with plant height 94 cm and droopy flag leaves. It is lodging resistant. It completes heading in 98 days and matures in 142 days. *Manthar-03* performs better when planted from 15th November to Ist. December, keeping 125 kg ha^{-1} seed rate and 125-85-50 kg NPK ha^{-1} are applied.

Keywords: *Triticum aestivum*, variety, rust resistance, quality, grain yield

INTRODUCTION

Bread wheat is the most widely grown crop in the world. Being most important crop, wheat is cultivated on an area of 9.046 million hectares during 2008-09 with a prods of 24.033 million tones in the country (Anonymous, 2010). It contributes 13.1 percent to the value added in agriculture and 2.8 percent to GDP (Anonymous, 2009). Southern Punjab contributes about 44% of the total wheat production of the province. Due to long stay of cotton crop in the field about 80% wheat in this region is being planted late. This situation necessitates the development of medium to late maturing wheat varieties like *Manthar-03* that can be successfully grown after the harvest of cotton (Ahmad *et al.,* 2005).

Wheat varieties such as Inqlab-91 (covers about 60-70% area under wheat in Pakistan) and Bhakkar-2002 have become susceptible to rust diseases and need to be replaced with new varieties (Anonymous, 2004;2005). Leaf rust of wheat *(Puccinia recondita* f. sp. *tritici)* is a serious production hazard all over the world (McIntosh *et al.,* 1997). During favorable years, 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 in grain yield (Yaqoob, 1991) and sometimes result in total failure of the crop. Chemical control of rut 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. Therefore, wheat variety having the higher yield potential, disease and insect resistance and better adaptability is a dire need of the southern Punjab.

Manthar-03 is a result of 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 will help to achieve the self-sufficiency in wheat production, due to its commendable traits. This variety possesses

improved genetic potential and thus has performed better in yield trials.

MATERIALS AND METHODS

Manthar-03 was selected from CIMMYT (Mexico) material i.e. entry No. 42 of 29th International Bread Wheat Screening Nursery (parentage is KAUZ//ALTAR 84/AOS and pedigree is CM11163-6M-20Y-10M-0M-0B), given the number 97B2210 and tested at Regional Agricultural Research Institute, Bahawalpur, and outstations for 7 years (1996-2002). This line was tested in replicated wheat yield trials for grain yield at Regional Agricultural Research Institute (RARI), Bahawalpur and Wheat Research Institute. Faisalabad. Finally, the selected line was evaluated in national uniform yield trials. The yield data were subjected to ANOVA using the MSTATC statistical program and means were compared using Duncan's Multiple Range Test (Steel and Torrie, 1980). Various steps involved in the development of *Manthur-03* are given in Table 1.

Selection of promising line*:* A nursery namely 29th International Bread Wheat Screening Nursery (29th IBWSN) was received from CYMMIT (Mexico). It was planted at the experimental field of RARI, Bahawalpur in November 1996. Entry No. 42 of the nursery was selected and given the number 97B2210.

Planting of yield trials*: Manthar-03* 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 Micro and Macro Yield Trials before testing in National Uniform Yield Trials. All the yield trials were laid out in RCBD with 4 replications. The row to row distance was maintained at 30 cm. Planting was done with single row drill in 4 row plots of 5 m length. One to two standard checks were included in every experiment for comparison.

Screening against rusts: Test entries were planted in a single 2-meter 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/virulences 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. Coefficient of Infection (CI) was calculated by multiplying the response value with the intensity of infection in percent. Average coefficient of infection (ACI) was calculated from the sum of CI values of each entry divided by the number of locations. 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: *Munthar-03* was also evaluated for two years (2000-02) in replicated yield trials at RARI, Bahawalpur for its response to wheat aphid and *Helicoverpa armigera* in comparison with the check varieties Inqlab-91, MH-97, Uqab-2000 and lqbal-2000.

Production technology of Manthar-03**:** A series of replicated yield trials were conducted at RARI, Bahawalpur and Agronomic Research Station, Bahawalpur for its response to different sowing dates and various NPK combinations in comparison with the check varieties Inqlab-91, Uqab-2000, Iqbal-2000 and Chenab-2000 to ascertain its production technology.

Testing of Manthar-03 in national uniform wheat yield trials *(NUWYT): Manthar-03* was tested in NUWYT trials during 2000-02 throughout Pakistan. At all the locations, the experiment was planted in RCBD with 4 replications. Six rows per plot where Row x Row distance was 30 cm were planted with each entry. The sowing time and crop husbandry practices were different at all the locations. The replicated data of individual locations were averaged and converted to kg ha^{-1} for comparison.

Physico-chemical properties of Manthar-03: The physico-chemical properties were studied by National Coordinator Wheat, National Agricultural Research Centre, Islamabad. The test was carried out in Food Technology and Research Laboratory according to standard procedures including 1000-seed weight, test weight, PS1 (hardness), grain ash, grain protein (by NIR) and gluten content (Mustafa *et al.,* 2007).

RESULTS AND DISCUSSION

***Yield Performance*:** The major objective of development of *Manthar-03* was to give the farmers of irrigated areas of Punjab a high yielding and rust resistant variety of wheat. Therefore, the rust resistant exotic line was selected from a CYMMIT nursery. The selected line proved to be high yielding and rust 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.

Manthar-03 was studied for grain yield in preliminary (A), regular (B) and advance (C) yield trials from 1997 to 2000 (3 trials). The data on grain yield recorded in these trials are presented in table 2. These data shows that grain yield of *Manthar-03* ranged from 4750 to 6115 kg ha^{-1} as compared to lnqlab-91 for which yield ranged from 4417 to 5693 kg ha^{-1}. The new variety *Manthar-03* gave 7.1% higher yield than Inqlab-91 (Table 2). It also out yielded the check by a margin of 3.7 % in zonal trials conducted at three locations in 1999-2000 (Table-3). The released varieties that were already available in the market, although possessed relatively high yield potential but they appeared to be susceptible to rusts as revealed in the results reported by 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, *Manthar-03* appeared to be a promising line with respect to this major trait wanted for wheat cultivation in rust prone areas. Consequently, *Manthar-03* was forwarded to Micro Wheat yield trials.

Manthar-03 was tested in micro wheat yield trials which were conducted by Director. Wheat Research Institute, Faisalabad during 1999-2000 at 10 locations in whole of the Punjab province, under coded numbers. On the basis of 10 location average, *Manthar-03* gave 2.0, 13.0 and 11 % higher yield when compared to Inqlab-91, Uqab-2000 and lqbal-2000, respectively. While it gave 4.66, 18.0 and 16.0 % higher yield when compared to lnqlab-91, Uqab-2000 and lqbal-2000, respectively, on the basis of 9 locations average (Table 4). Based on its good performance, *Manthar-03* was forwarded to national uniform wheat yield trials.

Manthar-03 was tested in national testing system through National Uniform Wheat Yield Trial (NUWYT) for two consecutive years during 2000-02 across the country by Coordinator Wheat, NARC, Islamabad. The location wise comparison of *Manthar-03* with check varieties for grain yield is given in table 5 & 6 (Mustafa *et al*., 2001). The results revealed that *Manthar-03* gave 7.1 and 5.8 % higher yield than the check variety Inqlab-91 at the national level on the basis of 12 locations in 24 trials (Table 5 & 6). The evaluation of *Manthar-03* over multiple locations confirmed the results of on-station studies where it was concluded that *Manthar-03* having better grain yield compared to already released varieties possesses high tolerance against rust diseases. It was also observed that with overall good performance, the new variety is well adapted to various climatic conditions of Punjab and Pakistan.

Several earlier workers like Ahmad *et al*. (2005), Bakhsh *et al*. (2005) and Hussain *et al*. (2010) reported higher yield in new wheat and chickpea varieties than the checks.

***Agronomic Studies*:** Three trials were conducted at Regional Agricultural Research Institute, Bahawalpur and Agronomic Research Station, Bahawalpur during the years 2000-02 to ascertain its package of production technology. *Manthar-03* performed better when planted from 15th November to 1st December, keeping 125 kg ha^{-1} seed rate, fertilizer at the rate of 125-85-50 kg NPK ha^{-1} and 5-6 irrigations are applied (Table 7 & 8). Similar results were reported by Ahmad *et al*. (2005) and Hussain *et al*. (2010).

Rust Reaction Studies: The new variety Manthar-03 was tested for its response to various foliar diseases at Crop Diseases Research Programme, NARC, Islamabad. The disease score of Manthar-03 and the check varieties recorded from 2000-01 to 2001-02 is presented in tables 9-10. The comparison of Manthar-03 with check varieties showed that the rust score of Manthar-03 varied from 5MRMS to 10MR for leaf rust as compared to 90MS to 20S for leaf rust of the check variety i.e. Morocco (Table 10). Manthar-03 had RRI value of 6.7 and 7.6 which is above desirable limit. The AC1 values (3.4 & 0.7 for leaf rust) of Manthar-03 as against 45.65 and 56.6 of susceptible variety Local White also render it rust resistant variety (Table 9). Yellow rust did not appear during that year. Resistance against leaf rust makes Manthar-03 a better option for rust prone areas. Leaf rust 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 produces better yield and grains of better quality. This phenomenon was recorded in the case of Manthar-03 as well when grown in disease conditions. Ahmad et al. (2005) and Hussain *et al*. (2010) reported new varieties of wheat to be more resistant to rust diseases compared to checks.

Screening Against Insect Pests: The new variety Manthar-03 was also screened for it reaction to various insect pests at Regional Agricultural Research Institute, Bahawalpur during 2000-02. A perusal of the data presented in Table 11 shows that the Manthar-03 had less attack of *Helicoverpa armigera* (00 & 0.30) as compared to the check varieties Inqlab-91 (0.33 & 0.62) and MH-97 (0.34 & 7.11) under normal and late sown conditions. The aphid infestation was also comparatively less in Manthar-03 (24.4 aphid per tiller) as compared to Inqlab-91 (22.3 aphid per tiller) during 2000-01. During the year 2001-02, the aphid infestation was also less on Manthar-03 (0.50 aphid per tiller) as against 0.55 & 0.56 aphid per tiller in Uqab-2000 and Iqbal-2000, respectively (Table-12). Ahmad *et al*. (2005) and Hussain et al. (2010) reported similar results for new wheat varieties.

Quality Traits of MANTHAR-03: Seed of Manthar-03 contains 12.97% protein, 8.2% dry gluten and 1.55% ash. It has good chapatti making quality. The quality traits recorded by National Agricultural Research Centre, Islamabad are given in Table 13, which reveals that the new variety is better than the existing checks. Mustafa *et al*. (2005 & 2007) reported similar results for new wheat varieties.

Varietal Characteristics: The plant of Manthar-03 is erect. At boot stage the plant colour is dark green. It has 145 productive tillers at maturity. Plant height is 94 cm. Its straw is soft. It completes heading in 98 days and matures in 142 days. It is lodging and disease (rusts) resistant. It is an awned variety. Awn habit is horizontal. Anther colour is yellow. It has long seed size with amber colour. Seed is hard with rough surface. It is 1000-seed weight is 40-44 grams. Various varietal characteristics recorded by the Federal Seed Certification and Registration Department, Islamabad, in comparison with lnqlab-91 are given in Table 14 which indicates that the new variety Manthar-03 has better traits than the check.

Table 1. Various steps involved in development of wheat variety *Manthar-03*

Years	Trials	Remarks
1996-97	A nursery namely 29th International Bread Wheat Screening Nursery (29th IBWSN) was supplied by CYMMIT (Mexico)	Rust resistant and high yielding entry No. 42 of the nursery was selected, given the number 97B2210 and was forwarded to wheat yield trials
1997-00	A. B. C Trials	These trials were conducted at RARI, Bahawalpur
1999-00	Zonal and Micro Wheat Yield Trials	These trials were conducted at various locations in Punjab under coded numbers by Director, Wheat Research Institute, Faisalabad
2000-02	Rust resistance studies	These studies were conducted at RARI and NARC, Islamabad.
2000-02	Entomological Trials	These studies were conducted at RARI,.Bahawalpur
2000-02	Agronomic Trials	Agronomic Trials at RARI & ARS, Bahawalpur
2000-02	National Uniform Wheat Yield Trials (NUWYT)	These trials were conducted by National Coordinator Wheat, NARC, Islamabad throughout Pakistan
2000-01	Physico-chemical characters and chemical composition of seed of *Manthar-03*	The quality traits were studied by NARC, Islamabad
2003	On the basis of its better performance, it was released for general cultivation in the name of *Manthar-03* by the Punjab Seed Council, Lahore during 2003	

Table 2. Grain yield performance of *Manthar-03* in on-station trials at RARI, Bahawalpur

Trials	Year	Yield (kg ha^{-1})	
		Manthar-03	**Inqlab-91**
A1 (Normal)	1997-98	5671 a	5322 a
B3 (Normal)	1998-99	4750 a	4417 b
C1 (Normal)	1999-00	6115 a	5693 b
	Average	5512	5144
	%± over checks	+7.1	

Table 3. Grain yield performance of *Manthar-03* in Zonal Wheat Yield Trials at 3 locations during 1999-2000

Locations	Yield (kg ha^{-1})	
	Manthar-03	**Inqlab-91**
C'RSS, Haroonabad	5245 a	4936 a
ORS, Khanpur	4442 a	4393 a
ARS, Khanewal	4782 a	4630 a
Average	4823	4652
% increase over cheek	+3.7	

Source: Director, Wheat Research Institute, Faisalabad

Table 4. Grain yield performance of *Manthar-03* in Micro Wheat Yield Trials at 10 locations during 2000-2001

Locations	Yield (kg ha^{-1})			
	Manthar-03	**Inqlab-91**	**Uqab-2000**	**Iqbal-2000**
RARI, Bahawalpur	5405 a	4826 a	5004 a	4676 b
ARF, Rahim Yar khan	5204 a	4932 a	4721 b	4186 bc
CRSS, Haroonabad	6346 a	5990 a	3741 c	4486 bc
WRI, Faisalabad	5735 a	5920 a	5965 a	5550 a
ARF, Vehari	3290 ab	3660 a	3382 ab	3290 ab
PSC, Khanewal	3799 b	4819a	4819 a	5097 a
Thatta Jawana Jhang	4263 a	3614 b	403 1 a	4031 a
Hafizabad, Pindi Bhattian	4170 a	4263 a	2124c	2965 b
ARF, Gujranwala	4911a	4726 a	4355 b	4633 a
RRI, Kala Shah Kaku	4720 a	4165 b	4165 b	4165 b
Average with PSC	4784	4691	4231	4307
% increase over check		+2.0	+ 13.0	+11.0
Average without PSC	4894	4 677	4165	4220
% increase over check		+4.66	+18.0	+16.0

Source: Director, Wheat Research Institute, Faisalabad

Table 5. Grain yield performance of *Manthar-03* in National Uniform Wheat Yield Trials (Seeding date normal) (Mustafa *et al*., 2001) during 2001-2002

Locations	Yield (kg ha^{-1})	
	Manthar-03	**Inqlab-91**
ARF; Rahim Yar Khan	4583 a	4000 b
RARI, Bahawalpur	5621 a	4588 b
CRSS, Haroonabad	5708 a	4913 b
ARF, Vehari	3500 a	3271 a
PSC, Khanewal	3292 b	5104 a
T.T, Singh	4000 a	3526 b
ORS; Khanpur	5238 a	4075 b
WRI; Faisalabad	5611 a	5750 a
Pindi Bhattian, Hafizabad	4846 a	4313 b
PSC, Sahiwal	4625 a	4604 a
AZRI, Bhakkar	5042 a	5188 a
ARF, Karore (Layyah)	2938 a	2708 a
Average	4587	4337
% increase over check		+5.8

Table 6. Grain yield performance of *Manthar-03* in National Uniform Wheat Yield Trials (normal & late combined) (Mustafa et *al*., 2001) during 2001-2002

Locations	Yield (kg ha^{-1})	
	Manthar-03	**Local check**
ARF, Rahim Yar Khan	3773 a	3348 b
ORS, Khanpur	4081 a	3619 b
RARI, Bahawalpur	3583 a	3335 a
C'RSS. Haroonabad. BWN	3827 a	3490 b
ARF, Vehari	3,852 a	3,583 b
PSC, Khanewal	3919 a	4177 a
WRI, Faisalabad	4843 a	4853 a
ARF, Layyah Karore	2977 a	2125 b
Gill Model Farm S. Abad, Jhang	3700 a	3382 b
Hafizabad, Pindi Bhattian	4344 a	4562 a
In service Trg. Sargodha	3927 a	3281 b
ARF, Sheikhpura	3813 a	3792 a
Average	3887	3629
% increase over check	+ 7.1	

Table 7. Grain yield performance of *Manthar-03* in Sowing Date Trials during 2000-2002

Date of Sowing	2000-2001		2001-2002	
	Manthar-03	**Inqlab-91**	***Manthar-03***	**Inqlab-91**
November, Ist	4867	7291	5202	5102
November, 15th	4950	4139	5575	5495
December Ist.	4788	4527	3485	3232
December, 15th	3100	3230	2798	2525
January, Ist.	2645	3079	2465	2593
January, 15th	2473	2242	1939	1732

Table 8. Fertilizer study on Manthar-03 at Regional Agricultural Research Institute, Bahawalpur

Treatment	2000-2001				2001-2002			
	N	**P**	**K**	**Yield kg ha^{-1}**	**N**	**P**	**K**	**Yield kg ha^{-1}**
T1	0	0	0	2006	0	0	0	1961
T2	75	50	25	3150	75	50	25	3129
T3	125	85	50	4290	125	85	50	4631
T4	175	120	75	4810	175	120	75	4907
T5	200	150	75	5020	200	150	75	5108

Table 9. Disease reaction of *Manthar-03* at Crops Diseases Research Programme, NARC, Islamabad

Years	Cultivars	ACI		RRI	
		Leaf Rust	**Yellow Rust**	**Leaf Rust**	**Yellow Rust**
2000-01	*Manthar-03*	3.4	-	6.7	-
	Local White	56.6	-	-	-
2001-02	*Manthar-03*	0.7	0.0	7.6	8.9
	Local White	45.65	-	-	-

Table 10. Leaf rust reaction *of Manthar-03* in the National Wheat Disease Screening Nursery at CDRI, Islamabad, 2001-02

Cultivars	PRC, SKI	AARI, FSD	RARI, BWP	CCRLD, SBK	NIFA, PWAR	NARC, ISD	CDRI, KHI	RRI
Manthar-03	0	10MR	0	0	0	5MRMS	0	7.6
Morocco	50S	90MS	50MSS	40S	20S	80S	30S	-

Table 11. Resistance to *Helicoverpa armigera* in *Manthar-03* and some commercial check cultivars in 2000-01

Cultivars	Aphid Population per tiller		Yield (kg ha^{-1})	
	Normal	Late	Normal	Late
Manthar-03	0.00	0.30	4475	4175
Inqlab-91	0.33	0.62	4150	3880
MH-97	0.34	7.11	4262	3925

Table 12. Resistance to aphids in *Manthar-03* compared with the standard commercial check cultivars

Years	Cultivars	Aphid Population per tiller	Yield (kg ha^{-1})
2000-01	*Manthar-03*	21.4	3250
	Inqlab-91	22.3	3084
2001-02	*Manthar-03*	0.50	2512
	Auqab-2000	0.55	2392
	Iqbal-2000	0.55	2332

Table 13. Quality traits *of Manthar-03* in National Uniform Wheat yield Trial during 2000-01

Characteristics	*Manthar-03*	Inqlab-91
1000-kernel weight (g)	42.3	37.0
Test weight (g)	79.5	74.2
PSI (%)	29.0	42.2
Ash (%)	1.55	1.54
Gluten content	MS	MS
Dry gluten (%)	8.20	5.79
Crude protein (%)	12.79	10.06

Table 14. Varietal characteristics *of Manthar-03*

Characteristics	*Manthar-03*	Inqlab-91
Days to heading	98	114
Days to maturity	142	135
Plant height	94 cm	98 cm
Lodging	Resistant/ tolerant	Resistant
Tillers per meter row	145	132
1000-kernel weight	40-44 g	44.0 g
Protein	12.97%	10.51 %
Disease reaction	Resistant/tolerant	Resistant
Grain size	Medium	-
Maturity status	Medium	Medium
Growth habit	Erect	Drooping
Yield potential	6900 kg ha^{-1}	6708 kg ha^{-1}

CONCLUSION

The cultivar Manthar-03 is not only a high-yielder and tolerant/resistant to all diseases and insect pests but also best suited to a wheat-cotton-wheat rotation. Because of better adaptability, Manthar-03 has the potential of replacing previously approved wheat cultivars, especially in the southern Punjab. This cultivar was approved and released for general cultivation during 2003 by the Punjab Seed Council, Lahore.

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