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Evaluation of Candidate Lines Against Stripe and Leaf Rusts Under National Uniform Wheat and Barley Yield Trial 2000-2001

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Abstract: The national uniform wheat and barley yield trial (NUWYT) 2000-2001 comprised of 33 promising candidate lines (29bread wheat, 1 durum wheat and 3 barley). The trial was grouped into three categories viz, rain fed (12 entries), seeding date (18 entries) and barley (3 entries). These promising lines were evaluated at multilocations in different agro-ecological zones against prevalent pathotypes of leaf and stripe rusts. Out of 33 lines, 10 lines were common to NUWYT 1999-2000, of these lines seven lines (NR-149, 95C004, 91BTO10-5, V-97112, SD1200/14, B96038 and B92044) had desirable/acceptable RRI for leaf rust. As these lines have fulfilled two years testing requirement for leaf rust resistant. So these lines can be recommended in those areas where leaf rust problem. Extremely dry weather prevailed throughout the year, so stripe rust could not develop inspite of artificial inoculations.

Key words: Stripe, leaf rust, NUWYT, candidate lines, Pakistan

Introduction

Rusts, viz., Brown or leaf rust (*Puccinia recondita* Roberge ex Demaz f.sp. *tritici* (Eriks. E. Henni) D.M. Henderson) and stripe (or yellow) rust (*Puccinia striiformis* Westend) are by far the most import diseases affecting wheat production in several wheat growing areas of the world (Singh *et al.*, 1998; Mirza *et al.*, 2000; Akhtar *et al.*, 2001). Release of wheat variety is a sensitive issue. For selecting a wheat variety some important characteristics are considered as for any other crop plant such as time of maturity, tolerance to heat stress, disease and insect resistance, shattering and lodging quality and yield. Genetic resistance is the most economical and environmentally safe measure to reduce crop losses. Growing resistant cultivars has no cost to farmers and is the most environmentally safe measure to reduce crop losses. Growing resistant cultivars has no cost to farmers and is the most economical control measure (Singh, 2000 and Line and Qayoum, 1991). Wheat varieties developed through screening survive for 4-5 years under normal environmental condition.

The objectives of this investigations were to evaluate the 33 promising candidate lines (NUWYT 2000-2001) against prevalent pathotypes of stripe and leaf rusts in the country. These lines are the candidate lines developed by the country wheat breeders, tested for yield ability, adaptation and other agronomic characters and rust situation. The wheat varietal evaluation committee (VEC) places a great weightage on the disease resistance of these lines. The rust data form the basis of recommendation by VEC to the provincial and National Seed Council's (PandNSC) regarding the approval and release of promising high yield rust resistant future varieties. This paper reports the results of NUWYT 2000-2001 evaluated at multilocation throughout the country.

Materials and Methods

The NUWYT trial 2000-2001 comprised of 33 promising candidate lines (29 bread wheat, 1 durum wheat and 3 barley). It was grouped into three categories viz. rain fed (12 entries), seeding date (18 entries), and barley (3 entries). The details of the material in respect of line number, parentage/pedigree and donor institute is given in Table 1.

The trial was planted at 11 locations for leaf rust: 2 in Sindh, 5 in Punjab, 3 in NWFP and 1 in ICT (Islamabad Capital Territory) and 9 locations for stripe rust: 5 in Punjab, 3 in NWFP and 1 in ICT. These locations represent areas comprising different agro-ecological zones and "hot spots", which provide conditions for good development of rusts.

Procedure on planting, rust inoculation, rust observation and calculation of Relative Resistance Index (RRI) was according to NUWYT report 1996-97 (Hussain, 1997).

Artificial rust inoculations with a mixture of field collections supplemented with the inoculum of known virulences of leaf rust were carried out in February 2001 to early April 2001 at CDRI-Karachi, RARI-Bahawalpur, WRI-Faisalabad, NARC-Islamabad, CCRI-Pirsabak, and NIFA-Tarnab. Similarly stripe rust inoculations were arranged in February and March 2001 at NARC-Islamabad, AARI Faisalabad, CCRI-Pirsabak and NIFA-Tarnab. Leaf rust pathotypes possessed virulence for host genes Lr1, 2b, 2c, 3,10,11,14a, 16, 17, 18, 22a, 22b, 23,25,26,30,32,33 and 34. Similarly stripe rust pathotypes possessed virulence to host genes Yr1, 2,6,7,8,9,10,18 and Yr A.

Rust inoculations of the spreaders and checks were carried out by the hypodermic syringe method using aqueous urediospore suspension to which 1 to 2 drops of Tween 20 were added, to break the surface tension. The trials planted at Sahowali (Sialkot), BARI-Chakwal, and NWFP Agriculture University were not artificially inoculated for two reasons: a) that past experience indicated that most of these sites are hot spots for the natural development of wheat rusts and b) that it is desirable to keep the natural parasite population in equilibrium in relations to hosts in these areas.

At all locations, observations on response and severity of stripe and leaf rusts were recorded according to Loegering, (1959). The severity was recorded as percent of rust infection on the plants according to the modified Cobb scale (Peterson *et al.*, 1948). As severity is determined by visual observation, readings cannot be absolutely correct. Therefore, below 5% severity, the intervals used are trace (t) to 2. Usually, 5 percent intervals are used from 5 to 20 percent severity and 10 percent intervals for higher readings.

Readings of severity and reaction are recorded together with severity first.

TR	=	Trace severity of resistant type infection
10MR	=	10 percent severity of a moderately resistant type infection
50S	=	50 percent severity of a susceptible type infection

The Coefficient of Infection (CI) for both rusts has been calculated in the manner used in CIMMYT and IRN (USDA) (Table 2). Coefficient of Infection was calculated by multiplying the response value with the intensity of infection in percent. Average Coefficient of Infection (ACI) was derived from the sum of CI

Table 1: List of lines/entries included in National Uniform Wheat Yield Trials 2000-2001

A) NUWYT (Rainfed)

Line/Var	Parentage/Pedigree	Source
SN-6	WL 711/HD 2169//GHSK'S', Pb. 23013-1A-0A	ARS-S. Naurang
SN-16	SHI # 4414/CROW'S'/SERI 82 ICW 89-0462-7AP-0AP-2AP-0TS-IAP-OTS-OAP	ARS-S. Naurang
DN –14	CETTIA CM 92313-7Y-0M-3M-ORES	ARI-D, I. Khan
PR-72	CHIL/WUH 3 CM 95700-45Y-0Y-3M-ORES-0Y	CCRI, Pirsabak
NR-149	OPATA/RAYON/KAUZ CMBW 90Y3180-010PM-3Y-010M -010M-010Y-1M-015Y-0Y	NARC. Islamabad
NR-155	KAUZ/PFAU/VEE#5/3/KAUZ CMBW 90 M4056-0TOPY-27M-010Y-010M-010Y-8M-015Y-0Y	NARC. Islamabad
NR-178	PASBAN/CHAKWAL 86	NARC. Islamabad
95C004	BWL 5023/SNB/SNB CM84986-H-IM-3M-2B-0Y	BARI- Chakwal
96R37	KAUZ*2/YACO//KAUZ CRG 837-3Y-10M-0Y	BARS-Fateh Jang
BWL-9736	IRENA CM 91575-34Y-0M-0Y-5M-0Y	NIFA-Peshawar
V-97005	CH 7016/K. K.NOOR-3//CH 0/ALD/5/CH70/4/INIA//CNO/CAL/3/LR/SON 6417/INQ 91 Pb. 24395-18A-7A-0A-1A-0A	AARI-Faisalabad
97CO27	LIRA/BUC CM 88147-22Y-0H-0Y-4M-0Y	BARI- Chakwal
MOROCCO Seeding date		
V-97052	WL 711/F12.71/COC Pb. 26521-LRG-11A-1A-9A-0A	AARI-Faisalabad
91BTO 10-5	BLS/KLT'S'/6/HK/38MA/3/4777/ REI/Y14/K/5/YR/Pb.76 BIOTECH DHP-DHL-5	Biotech-AARI-Faisalabad
V-97112	INQALAB 91/3/KVZ/CIANO//CHR/ ONE-375 Pb.25562-3A-0A-0A-6A-0A	AARI-Faisalabad
V8964? Faisalabad	4943 X 5039	Agriculture University
PR-73	WH 542 CM 67458-0 IND	CCRI-Pirsabak
IBW-96405	KAUZ*2/4/CAR//KAL/IBB/3/NAC/5/KAUZ CRG 1000-54-010M-0Y	NIFA Peshawar
PR-70	CHAM-6/KITE/PGO ICW 93-0032-7F-0K-0F	CCRI-Pirsabak
DN-16	KAUZ*2/TRAP//KAUZ, CRG 742-6Y-010M-0Y	ARI-D.I.Khan
92T009	CHENAB/HD 2204/JUNCO'S'	AZRI-Bhakkar
D-97603	KRP/D-31708//CM 74A370/3/CNO 79/RL 6043/4*NAC PBD 795-23A-1A-0A	AARI-Faisalabad
B) NUWYT (Seeding date)		
97B2236	V-6550/SUTLEG 86 BR 2679-9B-3B-0B	RARI-Bahawalpur
97B2210	KAUZ//ALTAR 84/AOS CM 111633-6M-20Y-10M-0M-0M-0B	RARI-Bahawalpur
V97046	INQALAB 91/FINK'S' Pb. 25553-1A-0A-0A-1A-1A	AARI-Faisalabad
SD-1200/14	VEE/TRAP//SOGHAT 90	NIA-Tandojam
V-97024	LR 6043/4*NAC//AGENT/SKA4 Pb.24760-47A-0A-0A-9A-0A	AARI-Faisalabad
V-7004	CMH-77A-44-IM-6Y-2M-0Y	WRI-Sakarand
SI-91195	ULC/PVN//TAN/3/BUC CM 96119-43Y-0M-0Y-4M-0RES	NIA- Tandojam
V-7005	BAU'S'/SERI CM 92991-54M-0Y-0M-4Y-0B	WRI-Sakrand
MOROCCO Barley		
BKH-001	ICB 85-0629-0AP-37APH-0AP	AZRI-Bhakhar
B-96038	WUM 143 = YAGAN	AARI-Faisalabad
B92044	PYE 'S' /JAU-83 PKB 434-7A-2A-3A-2A-0A	AARI-Faisalabad
MOROCCO		

Table 2: The observation on response of stripe and leaf rusts

Reaction	Observation	Response value
No Disease	O	0.0
Resistant	R	0.2
Resistant Mod-Res.	R-MR	0.3*
Moderately Resistant	MR	0.4
Mod.Res Mod. Susc.	MR-MS	0.6
Moderately Susceptible	MS	0.8
Mod. Susc Suscep	MS-S	0.9*
Susceptible	S	1.0

*According to vast field experience of the Institute in rust research, two new categories have been added.

values of each entry divided by the number of locations.

After some modifications a rating scale for disease resistance was adopted by PARC in 1982 for use with cereal rusts (Aslam, 1982), based on scale by Doling (1965) for selecting wheat varieties to powdery mildew and later adopted by ARC of Great Britain for the farmers.

The highest ACI of a candidate line is set at 100 and all other lines are adjusted accordingly. This gives the Country Average Relative Percentage Attack (CARPA). The '0' to '9' scale previously designated as Resistance Index (R.I) has been re-designated as RRI (Relative Resistance Index). From CARPA, RRI is calculated on a 0 to 9 scale, where 0 denote most susceptible and 9 highly resistant. The RRI is calculated according to the following formula:

$$RRI = \frac{(100 - CARPA)}{100} \times 9$$

The desirable index and acceptable index number for rusts are as below (Aslam, 1982).

Disease	Desirable Index	Acceptable Index
Stripe rust	7 and above	5
Leaf rust	7 and above	6 or 5

Lines which through yield testing show a high degree of yield stability even under high infection conditions, get their Index rating increased by "1".

Results and Discussion

Extremely dry weather prevailed throughout 2000-2001 wheat growing season and in spite of artificial inoculations at most of the sites poor rust development was observed. Stripe rust could not be developed at any of the locations and leaf rust developed only on three locations namely RARI-Bahawalpur, AARI, Faisalabad and

Table 3: Response of candidate lines to leaf rust along with coefficient of infection (C.I.), average coefficient of infection (ACI), country average relative percentage attack (CARPA), relative resistance index (RRI) during 2000-2001

Rainfed	RARI Bahawalpur	AARI Faisalabad	CDRI Karachi	ACI	CARPA	RRI	Terminal reaction
SN-6	TMR	40R	20MSS				20MSS
	0.4	8	18	8.8	35.2	5.8	
SN-16	30MS	40MRMS	20S				20S
	24	24	20	22.66	90.64	0.8	
DN –14	TMR	60MRMS	0				60MRMS
	0.4	36	0	12.13	48.52	4.6	
PR-72	5MR	20MRMS	10MS				10MS
	2	12	8	7.33	29.32	6.4	
NR-149	TR	TR	0				TR
	0.2	0.2	0	0.13	0.52	8.9	
NR-155	TMR	60MSS	TMS				60MSS
	0.4	54	0.8	18.4	73.6	2.3	
NR-178	TMR	40MSS	5MRMS				40MSS
	0.4	36	3	13.13	52.52	4.3	
95C004	TR	0	0				TR
	0.2	0	0	0.06	0.24	8.9	
96R37	20MS	0	0				20MS
	16	0	0	5.33	21.32	7.1	
BWL-9736	TR	70MSS	20MRMS				70MSS
	0.2	63	12	25.0	100	0	
97005	5MS	10MRMS	0				5MS
	4	6	0	3.33	13.32	7.8	
97CO27	5MR	60MRMS	5MRMS				60MRMS
	2	36	3	13.66	54.64	4.1	
MOROCCO	60S	90S	30S				90S
	60	90	30	60	-240	-12.6	
Seeding date							
V-97052	TMR	0	0				TMR
	0.4	0	0	0.13	0.97	8.9	
V-91BTO 10-5	TR	TMR	0				TMR
	0.2	0.4	0	0.2	1.48	8.9	
97112	10MS	0	0				10MS
	8	0	0	2.66	19.6	7.3	
V8964?	10MR	20MRMS	0				20MRMS
	4	12	0	5.33	39.4	5.5	
PR-73	TR	30MRMS	20MSS				20MSS
	0.2	18	18	12.0	89.5	0.95	
IBW-96405	TR	10MRMS	0				10MRMS
	0.2	6	0	2.06	15.2	7.6	
PR-70	TR	20MRMS	TMS				20MRMS
	0.2	12	0.8	4.33	32.3	6.1	DN-16
	TMR	30MRMS	10MS				10MS
	0.4	18	8	8.8	65.12	3.2	
92T009	TR	10MRMS	TMR				10MRMS
	0.2	6	0.4	2.2	16.28	7.5	
D-97603	TR	TR	0				TR
	0.2	0.2	0	0.13	0.96	8.9	
97B2236	TR	40R	TMRMS				TMRMS
	0.2	8	0.6	2.93	21.6	7.05	
97B2210	TR	10MRMS	5MS				5MS
	0.2	6	4	3.4	25.16	6.7	
V97046	TR	TMR	0				TMR
	0.2	0.4	0	0.2	1.48	8.8	
SD-1200/14	TR	10R	TMS				TMS
	0.2	1	0.8	0.66	4.8	8.5	
97024	10MR	30MRMS	TMR				30MRMS
	4	18	0.4	8.46	55.2	4	
V-7004	TR	40MRMS	0				40MRMS
	0.2	24	0	8.06	60.14	3.8	
S-91195	TR	40MRMS	5MRMS				40MRMS
	0.2	24	3	9.09	67.2	2.9	
V-7005	TR	60MRMS	5MS				5MS
	0.2	36	4	13.4	100	0	
MOROCCO	60S	90S	20S				90S
	60	90	20	56.6	-422	-28.9	
Barley							
BKH-001	TR	TR	20MSS				20MSS
	0.2	0.2	18	6.13	100	0	
B-96038	TR	TR	0				TR
	0.2	0.2	0	0.13	2.1	8.8	
B92044	0	TR	0				TR
	0	0.2	0	0.06	0.9	8.9	
MOROCCO	80S	90S	20MSS				90S
	80	90	18	12.66	-1022	-82.9	

Table 4: Candidate lines with desireable relative resistance index (RRI) against leaf rusts during 1999-2000 and 2000-2001

Entry No.	Candidate line	RRI during 2000-2001	RRI during 1999-2000
NUWYT (Rainfed)			
5	NR-149	8.9	9
8	95C004	8.9	9
NUWYT(Seeding date)			
15	91BTO 10-5	8.9	6
16	V-97112	7.3	8
27	SD1200/14	8.5	9
NUBYT (Barley)			
34	B96038	8.8	9
35	B92044	8.9	9

Table 5: Candidate lines with desireable/acceptible relative resistance index (RRI) against leaf rusts during 2000-2001

Entry No.	Candidate line	RRI
NUWYT (Rainfed)		
1	SN-6	5.8
4	PR72	6.4
5	NR-149	8.9
8	95C004	8.9
9	96R37	7.1
11	V-97005	7.8
NUWYT (Seeding date)		
14	V-9752	8.9
15	V-91BTO 10-5	8.9
16	V-97112	7.3
17	V-8964	5.5
19	IBW-96405	7.6
20	PR70	6.1
22	92T009	7.5
23	D-97603	8.9
24	97B2236	7.05
25	97B2210	6.7
26	V-97046	8.8
27	SD1200/14	8.5
NUBYT Barley		
34	B96038	8.8
35	B92044	8.9

CDRI, Karachi. At rest of the locations even susceptible check could not develop a susceptible reaction. Keeping in view this situation leaf rust data recorded at these locations for NUWYT nursery was utilized to calculate ACI, CARPA and RRI which could only be used to assess the resistance of the candidate lines against leaf rust only.

Leaf rust observations were recorded according to Zadoks growth stage 77-85 (Zadoks *et al.*, 1974). As mentioned earlier rust development was satisfactory only at three locations mentioned above and ACIs, CARPA and RRI calculated on the basis of this data is given in Table 3.

Out of 33 lines included in NUWYT 2000-2001, 10 were common to NUWYT 1999-2000. Of these lines only seven lines had desirable/acceptable RRI for leaf rust only (Table 4). These lines include 2 lines from rain fed, 3 from seeding date and 2 from barley. As these lines have fulfilled two year testing requirement for leaf rust resistance only on the three locations, they may be included in the NUWYT 2001-2002 for evaluation against stripe rust at all the locations and against leaf rust at rest of the locations.

In addition to these lines 4 lines from rain fed, 9 from seeding date have also shown acceptable/desirable RRI for the year 2000-2001 at the three locations, which may also be included in NUWYT 2001-2002 for complete analysis (Table 5). The lines possessing Lr27+31, Lr10 and Lr17can be combined with slow rusting type of durable resistance to increase the life of these genes (Mirza *et al.*, 2000). According to unpublished data on virulence analysis, there is no virulence present on resistant gene Lr4, 9,24 when use in combination. In addition to this, the lines with Lr10, 13 and 34 with minor partial resistance genes show durable resistance (Hussain *et al.*,1999, Ezzahiri and Roelf, 1989; Mc Intosh, 1992; Singh and Gupta; 1991; Singh and Rajaram, 1991). Therefore, the lines having durable resistance genes can safely be released as commercial cultivars in rust prone areas.

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