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RESISTANCE TO *PUCCINIA TRITICINA* IN SOME PAKISTANI WHEATS

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Abstract

Seventy six bread wheat (*Triticum aestivum* L.) candidate lines and commercial cultivars from Pakistan were postulated for their leaf rust genes resistance. Since limited information available on the genes, the main objective of the study was to postulate the known Lr genes conferring low seedling reactions to 14 pathotypes of *Puccinia triticina* in 76 Pakistani wheats. Eleven leaf rust resistance genes were present either singly or in combination: Lr1 (in 12 lines), Lr3 (4), Lr9 (2), Lr10 (28), Lr13 (27), Lr14a (2), Lr16 (9), Lr17 (8), Lr23 (18), Lr26 (36), Lr27+31 (5) in the tested material among which Lr26 was the most frequent while Lr9 was the least frequent.

Introduction

Wheat plays a pivotal role in the national economy of Pakistan. It is cultivated on an area of 8.176 million hectares annually, with total production 19.767 million tones and average yield of 2418 Kg/ha in the country during 2003-2004. The prosperity and well being of over 150 million population is intimately connected with good harvest of wheat crop (Anon., 2004).

Like other wheat growing regions of the world, rusts are the main threatening diseases to the Pakistan's wheat production. Leaf rust is the most serious disease occurring all over the country. The disease appears in the month of March during the anthesis period when the development of grain is in progress. If moderate temperature and high humidity prevails for long periods it causes heavy losses. The use of resistant varieties is the most effective, economic and environmentally safe way to reduce losses from the disease. A number of resistance genes have been identified and used to control disease. Most of the genes are of race specific nature, or major genes, against which the rust pathogen mutates and overcomes them. It is therefore important to diversify the genetic basis of resistance, which mainly depend on the availability of information about genes present in the current varieties.

Studies in the past indicate the presence of *Lr3, Lr10, Lr13, Lr16, Lr17, Lr21, Lr23, Lr26,* and *Lr27+3*1 for leaf rust, among resistance genes postulated from tested material, Lr26 was the most frequent one while *Lr21* was the least frequent (Mirza *et al*., 2000). Leaf rust resistance of Pak 81, Pirsabak 85 and Mehran 88 was based on a major gene *Lr26*. Virulence against which was identified after 1987's epidemics. Analysis of *Puccinia triticina* isolates from different parts of Pakistan indicates the presence of virulence for *Lr1, Lr2a, Lr2c, Lr3, Lr9, Lr10, Lr13, Lr15, Lr17 Lr20, Lr23, Lr24, Lr26 and Lr29* (Ahmad *et al*., 2000) but there is little information about resistant genes in most of the varieties/candidate lines. Postulation of resistant gene is therefore indispensable for rust resistance.

Materials and Methods

The host materials consisting of 76 Pakistani wheats (Table 1) was postulated for leaf rust resistance genes. Thatcher isogenic lines developed at Winnipeg Research

Station by P. L. Dyck, possessing known *Lr* genes (Table 2) were used as checks. Fourteen Mexican pathotypes of *Puccinia triticina* were named using the nomenclature of Long & Kolmer (1989) with two additional supplementary sets (Singh, 1991) (Table 2). The additional sets include genes *Lr3bg, Lr13, Lr15,* and *Lr18; Lr31* are complementary and function only if present together (Singh & McIntosh, 1984).

Nine to ten days old seedlings of wheat lines were inoculated by spraying urediospores suspended in a light mineral oil (Soltrol 170. Phillips 66 Co. Bartlesville. OK). Inoculated seedlings were placed in a dew chamber overnight at 18 to 20^{o}C and then transferred to the greenhouse at temperature 18 to 22^{o}C. Six to eight seedlings, planted in clumps, were used in tests with each pathotype. After ten days the infection types were recorded at 0-4 scale following method described by Stakman *et al*., (1962). For the postulation of *Lr13,* the infection types were recorded on 14th day of inoculation with *Lr13* avirulent race. The genes were postulated by comparing infection types produced on the lines to be tested with those on near-isogenic checks.

The presence of leaf rust (*Lr*) resistance genes in Pakistani wheats was postulated by comparing the low and high infection types displayed by the wheats with the infection types of known *Lr* genes in the tester varieties (McVey, 1989; Modawi *et al*., 1985; Statler, 1984).

Results and Discussion

Seedlings of Thatcher near-isogenic testers carrying resistance genes *Lr3ka, Lr9, Lr21, Lr25, Lr29, Lr30, Lr32 and Lr33* consistently had low infection types with all pathotypes when inoculated with 14 pathotypes indicated in (Table 2) and *Lr12, Lr20* and *Lr22a* displayed high infection types with all pathotypes. Genes *Lr12* and *Lr22a* are known to be effective only in adult plants (McIntosh, 1988). These genes could not be postulated because of low and high infection types respectively.

The following leaf rust resistance genes were postulated in Pakistani wheat lines and varieties on the basis of low and high infection types of seedlings of these varieties with 14 pathotypes in controlled conditions *Lr1, Lr3, Lr9, Lr10, Lr13, Lr14a, Lr16, Lr17, Lr23, Lr26 and Lr27+31* (Table 3). The infection types (ITs) displayed by the 37 isogenic differential lines are given in (Table 2).

Consistently it had low infection types with all pathotypes. *Lr1* displayed low infection type 0; with first six Lr1 avirulent pathtoypes and high infection type with rest of the pathotypes. *Lr3* displayed low infection type; with NCJ/BN and intermediate ITs with some others. *Lr9* had low ITs 0; with all pathotypes. *Lr10* displayed low ITs with BBB/BB, CBJ/QB, TCB/TD and high with remaining races. *Lr13* displayed low ITs in X range at 18 to 22^{o}C with pathotypes NCJ/BN and BBG/BN, BBB/BB and high ITs with rest of the pathotypes. This gene was initially described in literature as a gene for adult plant resistance (Dyck *et al*., 1966; Saini *et al*., 1988), but later it was found to be effective in seedlings at higher temperatures (Hawthorn, 1981). *Lr14a* only showed X reaction with pathotypes BBB/BB and BBG/BN and with rest of the pathotypes it displayed the high ITs. *Lr16* displayed ITs 1 or 1+ with all pathotypes. *Lr17* showed ITs low as ; with pathotypes BBB/BB, BBG/BN, TCB/TD and MFB/SP and with rest of the pathotypes it showed high ITs. *Lr19* showed high ITs with CBJ/QQ and Low ITs with rest of the pathotypes. *Lr23* displayed low ITs with pathotypes MCJ/QM and showed high ITs with pathotypes MCJ/SP that's why this gene was postulated and also *Lr23* showed IT 12 with TBD/TM and, 1 or '12' with BBB/BB, CBD/QB, CBD/QL and CBJ/QQ. *Lr26* displayed always low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP and some others. *Lr27+31* displayed the IT as X with pathotypes NCJ/BN and also with TCB/TD, BBB/BB, BBG/BN and CBJ/QB.

Table 1. Pakistani varieties/candidate lines analyzed for leaf rust resistance.

S. #	Accession	Parentage/pedigree
1.	SN-6	WL 711/HD 2169//GHSK'S', PB 23013-1A-0A
2.	DN -10	RAJ 1771, 5RK-9RK-10RK
3.	PR-71	GIMBUC,CM 93754-47M-0Y-0M-5Y-0B
4.	94R30	FONGCHAN#3/TTR'S'//VEE#9/3/COCK/VEE'S'//DOVE'S'/,SERI, CM 107444-0AP-0L-1AP-0AP
5.	95C004	BWL 5023/SNB//SNB, CM 84986-H-1M-3M-2B-0Y
6.	97- AURW- 06	MYNA/NULL//JUN, CM 90483-8M-0Y-0M-06-0B
7.	97C045	MYNA/VUL//TURACO/3/TURACO, CMBW 89Y-01234-0TOMP-18Y-10M-2Y-0M
8.	NR-149	OPATA/RAYON//KAUZ, CMBW90Y3180-0TOPM-3Y-010M-010M-010Y-1M-015Y
9.	NR-153	MONASA/KAUZ, CMBW90M345-21M-010Y-010M-010Y-6M-015Y
10.	BWL-9682	URES/BUC/FLK/3/KAUZ, CM 96817-C-0Y-0M-0Y-4M-ORES
11.	V-97088	HD 2236//SA 42/HARRIER'S', PB 25137-1A-2A-0A-12A-0A
12.	Bhittai	VEE/TRAP//SOGHAT 90
13.	Marvi 2000	CMH-77A917/PKV 1600//RL 6010/6*SKA
14.	DN-16	KAUZ*2/TRAP//KAUZ, GRG 742-6Y-010M-0Y
15.	PR-67	KAUZ*2/MYNA//KAUZ, CRG 925-1Y-010M-0Y
16.	PR-70	CHAM 6//KITE/PGO, ICW 93-0032-7F-0K-0F
17.	91BT010-5	BLS/KLT'S'/6/HK/38MA/3/4777/REI//Y/4/K/5/YR/PB76,BIOTECH DHP-DHL-5
18.	92T001	P20102/PIMA/SKA/3/TTR'S'/BOW'S', AZRI-BK-92-TOOI
19.	96B2098	ALD'S'/PVN'S'/4/TI 71 (RES)/BB/PL/SX, BR 2031-6B-1B-8B-5B-0B
20.	97B2219	BOW/CROW//BUC/PVN/3/VEE#10,CRG 682-2Y-10B-15Y-2B-0Y-0Y
21.	Moomal 2002	BUC'S'/4/TZPP/IRN 46/CNO67/3/PRI=FLAKE, CM 56744
22.	V-7005	BAU'S'/SERI, CM 92991-54M-0Y-0M-4Y-0B
23.	V-8177	(WL 74xLU26S) x LU26S
24.	V-95069	WL 711/HD2169//VRE/VEE'S', PB 23023-9A-0A-0A-5A-0A
25.	V-95153	INQILAB 91/PEWEE'S', PB 25550-8A-0A
26.	V-96052	TTR'S'/BOW'S'//SH88, PB 229148-0A-6A-0A-8A-0A

Table 1. (Cont'd.).

S. #	Accession	Parentage/pedigree
27.	SN-16	WL711/HD2169//GHSK 'S', PB.23013-1A-0A
28.	DN-14	CETTIA, CM92313-7Y-OM-3M-ORES
29.	Haider 2000	CHIL/WUH3, CM 95700-45Y-0Y-3M--ORES-0Y
30.	NR-155	KAUZ/PFAU/VEE#5/3/KAUZ, CMBW90M4056-0TOPY-27M-010Y-010M-010Y-8M-015Y-0Y
31.	NR-178	PASBAN/CHAKWAL 86
32.	BWL-9736	IRENA, CM 91575-34Y-0M-0Y-5M-0Y
33.	V-97005	CH70/6/K.NOOR//CH70/ALD/5/CH70/4/INIA//CNO/CAL/3/LR/SON64/7/INQ91,PB 24395-18A-7A-0A-1A-0A
34.	97C027	LIRA/BUC,CM88147-22Y-0M-0Y-4M-0Y
35.	V-97052	WL711//F12.71/COC,PB26521-LRG-11A-1A-9A-0A
36.	PR-73	WH 542, CM 67458-0 IND
37.	IBW-96405	KAUZ *2/4/CAR//KAL/IBB/3/NAC/5/KAUZ, CRG 1000-54-010M-0Y
38.	92T009	CHENAB/HD 2204/JUNCO 'S'
39.	97B2236	V-6550/SUTLEJ 86, BR 2679-9B-3B-0B
40.	Manthar 2002	KAUZ//ALTAR 84/AOS, CM 111633-6M-20Y-10M-10M-10M-0B
41.	SH-2003	INQ91/FINK 'S',PB 25553-1A-0A-0A-1A-0A
42.	V-97024	LR6043/4*NAC//AGENT/SKA4,PB 24760-47A-0A-0A-9A-0A
43.	V-7004	CMH-77A-44-1M-6Y-2M-0Y
44.	SI-91195	ULC/PVN//TAN/3/BUC, CM 96119-43Y-0M-0Y-4M-ORES
45.	Pak 81	KVZ//BUHO//KAL/BB, CM33027-F-15M-500Y-0M-76B-0Y-0PAK
46.	Zarghoon	CC/INIA/3/TOB/CTFN//BB/4/7C, CM8237-G-1M-3Y-2M-4Y-0M-0PAK
47.	Zamindar-80	RON/CHA//BB/NOR, CM5484-F-5Y-4M-1Y-1M-1Y-0M-0PK
48.	Faisalabad 85	MAYA/MON//KVZ/TRM
49.	Punjab-85	KVZ/TRM//PTM/ANA, CM43903-H-4Y-1M-1Y-3M-3Y-0B-0PAK
50.	Parwaz 94	V.5648/PRL
51.	Sarsabz	M20/79, S89-75-76-RS
52.	Bakhtawar 93	JUP/BJY 'S'//URES

Table 1. (Cont'd.).

S. #	Accession	Parentage/pedigree
53.	Shahkar-95	WL711//F3.71/TRM
54.	Auqab-2000	CROW 'S'/NAC//BOW 'S', PB 222138-3A-0A-0A-231A-0A
55.	Kaghan-93	TTR/JUN
56.	Pirsabak-91	KVZ//BUHO//KAL/BB
57.	Mehran-89	KVZ/BUHO//KAL/BB, CM33027-F-15M-500Y-0M-87V-0Y
58.	Pavan	VCM//CNO/7C/3/KAL/BB, CM8399-D-4M-3Y-1M-1Y-1M-0Y-0PAK
59.	Punjab-96	SA42*2/4CC/INIA//BB/3/INIA/HD832
60.	MH-97	ATTILA, CM 85836-50Y-0M-0Y-3M-0Y
61.	Tatara	ATTILA, CM 85836-50Y-0M-0Y-2M-0Y
62.	Inqilab-91	WL711/CROW 'S'
63.	Rawal-87	MAYA/MON//KVZ/TRM
64.	WL-711	S308/CHRIS//KAL
65.	Kohinoor-83	OREF1158/FDL/MFN/2*TIBA63/3/COC
66.	Margala-99	OPATA/BOW 'S' , CM 83398-2M-0Y-0M-5Y-0M
67.	Soghat-90	PAVON MUTANT-3
68.	Kohsar-95	PSN/BOW, CM69560-1M-1Y-1M-2Y-0M-0PAK
69.	Faisalabad-83	FURY/KAL/BB
70.	Anmol-91	KVZ/TRM//PTM/ANA, CM43903-H-4Y-1M-1Y-3M-3Y-0B-0PAK
71.	Blue-Silver	153-388/AN/3/YT54/N10B//LR64/AN//YT54/N10B/3/LR864/4/B4946.A.4.18.2.1Y-Y53//3/Y50A.4.18.2.1Y53//3/Y50
72.	Chakwal-97	BUC 'S'/FCT 'S' , CM64663-7M-0Y-0M-4Y-0M
73.	Chinab-2000	CATBIRD, CM 92991-59-0Y-0M-5Y-0B
74.	Iqbal-2000	BURGUS/SORT 1213//KAL/BB/3/PAK 81, PB 21912-11A-0A-0A-59A-0A-0A
75.	Shalimar-88	PB81/HD2182//PB81, PB1861-3A-3A-0A
76.	Chakwal-86	F1n/ACS//ANA, SWM4578-56M-3Y-3M-0Y-0PAK

Table 2. Seedling infection types displayed by Lr isogenic lines with 14 different pathotypes of *Puccinia triticina*.

E#	Differentials	1	2	3	4	5	6	8
		BBB/BB	BBG/BN	CBJ/QB	CBJ/QL	CBJ/QQ	CCJ/SP	NCJ/BN
1	Lr 22B	3+	3+	3+	3+	3	3	4
2	Lr1	0;	0;	0;	0;	0;	;	4
3	Lr2A	;	;	;	0;	0;	0;	1
4	Lr2B	;1-	1+	1	0;	;	;	1+
5	Lr2C	;1-	3+c	1+3c	;1-	;1-	;	3+
6	Lr3	;1-	0;	3+	12	3+	23c	;
7	Lr 3KA	;12	0;	12	;	12	;12	12
8	Lr 3BG	;1	0;	3	3+	3+	;12	0;
9	Lr9	0;	0;	0;	0;	0;	;	0;
10	Lr10	;1-	3	;1-	3+	3+	3+	3+
11	Lr11	1+3c	3+4	4	3+	4	3+	3+
12	Lr12	4	3+	3+	3+	3+	3+	4
13	Lr13	x+	X	3+	3+	3+	3+	x+
14	Lr 14A	x+	xx+	3+	3+	4	3+	4
15	Lr 14B	3+	3+	3+	3+	3+	3+	4
16	Lr 15	;1-	;1-	0;	0;	0;	3+	1
17	Lr16	1+	1	1	1+	;1-	1	1+
18	Lr17	1-	0;	3+	3+	3+	3+	3+
19	Lr18	2+3	3+	3+	_	2+3c	3	3+
20	Lr19	0;	0;	;	0;	3+	0;	0;
21	Lr20	3+	3+	3+	3+	3+	4	4
22	Lr21	2	12-	1+2	12	12	12	12
23	Lr22A	3+	3+	3+	3+	3+	3	3+
24	Lr23	12	3+	;1-	;1-	11+	3+	3+
25	Lr24	;	;	;	;	;	;1-	;
26	Lr25	0;	0;	0;	0;	;	0;	0;
27	Lr26	11+	0;	1	;	0	3	4
28	Lr10,27+31	;1	;1	;	x	xx+	3c3	x
29	Lr28	0;	x-	0;	0;	0;	0;	4
30	Lr29	;1	;1-	;1	;1-	;1-	;	;12
31	Lr30	;	12	23c	_	23c	;	3c
32	Lr32	12	12	12	12	3	1+2	3+
33	Lr33	3	3	2+3	3+	3c3	23c	3+
34	Lr34	3	3	3	3	3-,3	3-,3	3
35	Lr35	3+	3c	3c3	3c	3c3	3c3	3+
36	Lr36	;1-	;1	;1	1	1+3c	12	;1-
37	Lr37	3+4	3+	3+	3	3+	4	3+

Table 2. (Cont'd.).

E#	Differentials	9	10	11	12	13	14
		MFB/SP	TBD/TM	TCB/TD	MCJ/QM	MCJ/SP	PASTOR
1	Lr 22B	3+	3+	3+	3+	3	3+
2	Lr1	3+	3+	4	3+	3+	3+
3	Lr2A	;	3	3+	0;	0;	0;
4	Lr2B	;	3+	3+	0;	;	;
5	Lr2C	;1-	3+	3+	;	;	;1-
6	Lr3	3	3+	3+	3+	12-	3+
7	Lr 3KA	;1	12	12	;12	;1-	22+
8	Lr 3BG	3	3+	3+	3+c	23c	3
9	Lr9	0;	0;	0;	0;	0;	0;
10	Lr10	3+	3+	;1-	3+	3+	3+
11	Lr11	3+	3+c	3+	3+	3+	3+
12	Lr12	3+	3+	3+	3+	3+	3+
13	Lr13	3+	3+	3+	3+	3+	3+
14	Lr 14A	3+	3+	3+	3+	3+	3+
15	Lr 14B	3+	3+	3+	3+	3+	3+
16	Lr 15	3+	3+	3+	;1-	3+	3+
17	Lr16	1-	1	1	;1-	1	1+
18	Lr17	;	3+	;	3+	3+	3+
19	Lr18	3+	3+	3+	3	3	2+3
20	Lr19	0;	0;	0;	0;	0;	0;
21	Lr20	3+	3+	3+	3+	3+	3+
22	Lr21	;1	;1	12	1	12-	12
23	Lr22A	3+	3+	3+	3	3	3
24	Lr23	3+	12	3+	;	3	3+
25	Lr24	3+	12	;12	;12	;	;1-
26	Lr25	0;	0;	0;	0;	0;	;
27	Lr26	3c	;	3+	3c	3	12
28	Lr10,27+31	3	3+	;	3	3	4
29	Lr28	3+	3+	3+	0;	0;	0;
30	Lr29	1	1	;1	;1-	;1	;1
31	Lr30	12	23c	12	;1	;	23-
32	Lr32	;1-	12	1	1	3	12
33	Lr33	12	12	12	12	12	3+
34	Lr34	3c	3	3	3c3	3	3
35	Lr35	3c3+	3+c	_	3	3+c	3+
36	Lr36	;	1	1	1	1+	12
37	Lr37	3+	3+	3+	3	3+	4

Table 3. Seedling infection types displayed by Pakistani Lines/Varieties tested with 14 pathotypes of *Puccinia triticina*.

E#	Lines	1	2	3	4	5	6	8	8a *
		BBB/BB	BBG/BN	CBJ/QB	CBJ/QL	CBJ/QQ	CCJ/SP	NCJ/BN	NCJ/BN
1	SN-6	;	;	1	;1	;1	0;	;	;1
2	DN -10	;1-	;1	;	4	3	3+	x	;1
3	PR-71	x	x	3+	3+	3+	3+	3+	3+
4	94R30	0;	0;	0;	0;	0;	0;	0;	0;
5	95C004	;	0;	3+	3+	3+	3+	0;	;
6	97- AURW- 06	;	0;	;12	;	0;	3+	0;	;
7	97C045	;	0;	;12	;	0;	2+3c	0;	;
8	NR-149	;1-	0;	;1-	0;	0;	2+3c	;1	x
9	NR-153	;1	0;	;1-	;	0;	3+	3	3+
10	BWL-9682	1	0;	1	;	;	1+2	1+	1+
11	V-97088	;	0;	;	;	0;	3	x	1+
12	Bhittai	;	0;	0;	;	0;	3c3	x	x
13	Marvi 2000	0;	0;	0;	;	0;	0;	0;	0;
14	DN-16	;	0;	;	;	0;	23	;1	x-
15	PR-67	0;	0;	;1-	;	0;	3c3	3	4
16	PR-70	;1-	3	;1-	3+	3+	3+	3	4
17	91BT010-5	;1	0;	12	;	0;	3	x-	x+
18	92T001	;1	x	;1	12	;1-	3+	x	x
19	96B2098	;	;1-	;	;1	;1	3+	x	x
20	97B2219	;	;	;1-	;	0;	23c	x-	x
21	Moomal 2002	;1	;1-	;1	;1	;1-	12	;1	;1
22	V-7005	;	0;	;	0;	0;	2+3	x	x
23	V-8177	;	0;	0;	0;	;	;	x	x
24	V-95069	0;	0;	0;	0;	0;	0;	x	1+2
25	V-95153	;1	x-	;1-	x	x	3+	x+	x+
26	V-96052	;	;	;	;	0;	3c3	x-	x
27	SN-16	;1-	3c3	;12	4	3+	4	;	;1-
28	DN-14	2+3c	1	;	12	;1-	1+3c	0;	1
29	Haider 2000	0;	0;	0;	0;	0;	0;	0;	0;
30	NR-155	0;	0;	;	;	0;	3	3	3+
31	NR-178	;1	;	3+	3+	3+	3+	3+	3+
32	BWL-9736	1+	1	1	1+	;1	1+	1	1
33	V-97005	;1-	3	;1-	4	4	4	3+	4
34	97C027	;1	x	;1-	;1-	;1-	4	x	xx+
35	V-97052	;1	x	;1	x	xx+	4	x+	xx+
36	PR-73	1-	0;	1	;	0;	4	3+	4
37	IBW-96405	12	0;	;	;	0;	3	3	3

Table 3. (Cont'd.).

E#	Lines	1	2	3	4	5	6	8	8a *
		BBB/BB	BBG/BN	CBJ/QB	CBJ/QL	CBJ/QQ	CCJ/SP	NCJ/BN	NCJ/BN
		;	;1	0;	;1-	;1-	3+	x-	1+3+
39	97B2236	;1-	0;	;	0;	0;	3+	3	xx+
40	Manthar 2002	1	0;	;1-	;	0;	3c3	3c3	3
41	SH-2003	x-	x-	;12	x	x	4	x+	xx+
42	V-97024	0;	;	0;	0;	0;	0;	x+3	x
43	V-7004	;1-	;	0;	;	0;	0;	0;	0;
44	SI-91195	0;	;	0;	0;	0;	0;	1+	;1
45	Pak 81	;	0;	;	0;	0;	3	3+	3+
46	Zarghoon	0;	;	0;	0;	0;	0;	4	3+
47	Zamindar-80	0;	0;	0;	0;	0;	0;	x	x
48	Faisalabad 85	;1-	;	;1	;	0;	;23c	x+	3+
49	Punjab-85	0;	0;	0;	;	0;	0;	3+	3+
50	Parwaz 94	x	;1	3+	3+	3+	3+	x	x
51	Sarsabz	;1-	1	;	12	;1-	1+	1+	1+
52	Bakhtawar 93	;1-	;1	;1	;	0;	33+	3+	3
53	Shahkar-95	;1-	0;	;1	;	0;	3	x+	x
54	Auqab-2000	;	3+	;	;	;1-	3+	3	4
55	Kaghan-93	;	0;	0;	;	0;	23c	x	;1
56	Pirsabak-91	;1-	0;	0;	0;	0;	3	3+	3+
57	Mehran-89	;1-	0;	;1-	0;	0;	3	3	3+
58	Pavan	0;	;	0;	0;	0;	0;	x+3	x
59	Punjab-96	0;	3+	;1-	4	3+	3	3+	4
60	MH-97	x+	x-	3+	4	3	3	x+	x+3+
61	Tatara	;1	;	;1	;	0;	3	3+	3+
62	Inqilab-91	;	x-	;1-	x	x	3+	x	x
63	Rawal-87	;1-	;	;1-	;	0;	3	3+	3+
64	WL-711	x	x	4	4	4	4	x+3	x
65	Kohinoor-83	;1	;	;1-	;	0;	;1	;1	x
66	Margala-99	0;	x	0;	3	3+	3	3+	3+
67	Soghat-90	0;	0;	0;	0;	0;	;	x	x
68	Kohsar-95	;1-	0;	;1	;	0;	3	3+	3+
69	Faisalabad-83	0;	0;	0;	0;	0;	;	3+	3
70	Anmol-91	;1-	;	;1	;	;	3	3+	3+
71	Blue-Silver	3+	x	3+	3+	3+	4	x	x
72	Chakwal-97	0;	;1-	;	;	;1	3c3	0;	;
73	Chinab-2000	;1-	0;	;1	;	0;	3+	4	3+
74	Iqbal-2000	0;	0;	;1	0;	0;	;1-	;	;
75	Shalimar-88	;1-	;1	;	3c3	;12	3c3	x	;1
76	Chakwal-86	;	;	;1-	x	x	3	x+	x+

Table 3. (Cont'd.).

E#	Lines	9	10	11	12	13	14	Postulated
		MFB/SP	TBD/TM	TCB/TD	MCJ/QM	MCJ/SP	PASTOR	Genes
1	SN-6	;12	1-	;1-	23c	;1-	12	16
2	DN -10	x	3+	;1	3+	3+	3+	10,13,+
3	PR-71	3+	3+	3+	3+	4	3+	14a
4	94R30	1	;	x	;1-	12	;12	1,3,16,26
5	95C004	;12	3+	3+	3+	3+	3+	3,+
6	97- AURW-06	x	;	3+	3c3	3	x	3,26,+
7	97C045	x	;	3c3	3c3	23c	x-	3,26,+
8	NR-149	;1-	;	;1	3+	23c	x-	13,17,26,+
9	NR-153	;1-	;	;1	3+	3+	x-	17,26
10	BWL-9682	;1-	;	;1	;1-	1	x	16,26
11	V-97088	;1-	;	;1-	3c3	3	;12	13,17,26
12	Bhittai	3	;	;	;	3	;12	10,13,23, 26
13	Marvi 2000	0;	;	0;	0;	0;	;	9
14	DN-16	12	0;	;	23c	3	;12	10,13,26,+
15	PR-67	12	;	3+	3+	3+	x-	26,+
16	PR-70	3+	3+	;1	3+	3+	4	10
17	91BT010-5	3+	;	3+	3	3	x	13,26
18	92T001	3+	2	3+	;1-	3+	3+	13,23
19	96B2098	3+	2	;1-	;1-	3+	3+	10,13,23
20	97B2219	;1-	;	;1-	;1	3	;12	13,17,23, 26
21	Moomal 2002	;1	1	;1-	;1	1+	1+	16
22	V-7005	1+2	;	;1	;1-	3	x-	13,23,26,+
23	V-8177	3+	3+	4	3+	3+	3+	1,13
24	V-95069	12	;	3	;	3+	;12	1,13,23,26,+
25	V-95153	3+	3+	;1-	3+	3+	3+	10,27+31
26	V-96052	;	;	;1-	23c	3	;12	10,13,17,26
27	SN-16	3+	3+	;1	3+	3+	4	3,10
28	DN-14	;	;1	1-	1	1+	1+	16,+
29	Haider 2000	;1	;	;1-	1	1+	x	1,3,16,26
30	NR-155	;1-	;	;	13c	3	x	17,23,26
31	NR-178	;	3+	;1-	3+	3+	4	17
32	BWL-9736	;1-	1	;1	;1	1+	1+	16
33	V-97005	3+	3+	;	3+	3+	4	10
34	97C027	3+c	1	3+4	;	3+	3+	13,23
35	V-97052	3c3	4	;1-	3+	3+	3+	10,27+31
36	PR-73	23c	;	3+	3	3	x	26,+
37	IBW-96405	12	;	3+	3c3	3	x	26,+
38	92T009	3+	2	;	;	3+	3+	10,13,23

Table 3. (Cont'd.).

E#	Lines	9	10	11	12	13	14	Postulated
		MFB/SP	TBD/TM	TCB/TD	MCJ/QM	MCJ/SP	PASTOR	Genes
39	97B2236	;1	;	3+	0;	3+	23c	23,26,+
40	Manthar 2002	12	;	3+	3	3c3	x	26,+
41	SH-2003	3+	3+	;	3+	3+	3+	10,27+31
42	V-97024	3+	3+	0;	3+	3+	4	1,10,13
43	V-7004	;	;	0;	0;	;	;	9?
44	SI-91195	1-	1+	1	;1-	1+	1+	1,16
45	Pak 81	3	;	3+	;	3	x	23,26
46	Zarghoon	3c3	3+	;	3+	3+	3+	1,10
47	Zamindar-80	3	3+	4	3+	3	4	1,13
48	Faisalabad 85	12	;	3	3c3	3c3	;12	26,+
49	Punjab-85	3c3	;	;1-	;	3	;12	1,10,23,26
50	Parwaz 94	12	3	3+	3+	3+	3+	13,+
51	Sarsabz	;1	1+	;1-	;1-	1	1+3c	16
52	Bakhtawar 93	;12	;	3+	3	3	;12	26,+
53	Shahkar-95	1+3c	;1-	4	3	3	x	13,26,+
54	Auqab-2000	3	1-	;	0;	3+	3+	10,23
55	Kaghan-93	1	;	;1	;	3c3	;12	10,13,23, 26,+
56	Pirsabak-91	3	;	3+	;	3	x	23,26
57	Mehran-89	3+	;	3+	;	3	x	23,26
58	Pavan	3+	3	;	3	3+	3+	1,10,13
59	Punjab-96	3	3+	;	3+	3	3+	10
60	MH-97	3+	3+	3+	3	3+	3+	13
61	Tatara	3c3	;	3+	3	3+	x	26
62	Inqilab-91	3+	3+	;	3+	3+	3+	10,27+31
63	Rawal-87	x	;	3+	3	3+	;12	26,+
64	WL-711	3+4	3+	4	3+	3+	3+	13
65	Kohinoor-83	1+3c	;	;1-	3c3	3	;12	10,13,26,+
66	Margala-99	3	3+	;1-	3+	3+	3+	10,14a
67	Soghat-90	3+	3+	;	3+	3	3	1,10,13
68	Kohsar-95	3	;	3+	;	3+	;12	23,26
69	Faisalabad-83	3+	3+	;1-	3	3+	3+	1,10
70	Anmol-91	3+	;	;1-	3+	3+	;12	10,26
71	Blue-Silver	3+	3+	3+	3+	3+	3+	13
72	Chakwal-97	3c3	12	;	1+	3+	3+	3,10,23
73	Chinab-2000	3c3	;	3+	3c3	3+	;12	26
74	Iqbal-2000	23	;	3+	3+	;1	;12	3,26
75	Shalimar-88	23c	3+	;1-	3	3+	3+	10,13,+
76	Chakwal-86	;1	3+	;	3+	3+	3+	10,17, 27+31

Lr12, Lr20 and *Lr22a* displayed high infection types with all pathotypes. Genes *Lr12* and *Lr22a* are known to be effective only in adult plants (McIntosh, 1988). ITs of Pakistani lines and cultivars to the pathotypes are listed in (Table 3).

We Postulate that SN-6 carries *Lr16,* since the infection types (ITs) 1 or 1+ was observed with all pathotypes. Both DN-10 and Shalimar-88 appeared to posses *Lr10,* since displayed low ITs; with *Lr10* avirulent pathotypes BBB/BB, CBJ/QB and TCB/TD, ITs in the X range with NCJ/BN, BBG/BN and BBB/BB and high ITs with remaining pathotypes virulent on the above genes. PR-71 appeared to posses *Lr14a* since IT X was observed with the only Lr14a avirulent pathotype, BBB/BB and BBG/BN. We postulated *Lr1, Lr3, Lr16, Lr26* in two lines 94R30 and Haider 2000 since observed 0; ITs with first six *Lr1* avirulent pathotypes confirmed *Lr1,* low IT; with NCJ/BN and intermediate ITs with some other pathotypes confirmed *Lr3,* displayed ITs 1 or 1+ with all pathotypes confirmed *Lr16* and low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP and some others confirmed *Lr26*. 95C004 appeared to posses *Lr3* since IT; was observed with NCJ/BN and intermediate ITs with some others. We postulate that 97-AURW-06, 97C045 and Iqbal 2000 carry *Lr3* and *Lr26,* because low IT ; with NCJ/BN and intermediate with others confirmed *Lr3* and low ITs with first 5 pathotypes and also with TBD/TM and high IT with pathotype MCJ/SP confirmed the presence of *Lr26*. NR-149 and V-97088 appeared to carry genes *Lr13, Lr17* and *Lr26,* since low ITs in X range with pathotypes NCJ/BN and BBG/BN, BBB/BB and high ITs with rest of the pathotypes confirmed *Lr13,* since observed ITs low as; with pathotypes BBB/BB, BBG/BN,TCB/TDand MFB/SP and with rest of the pathotypes it showed high ITs confirmed *Lr17* and low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP and some others confirmed *Lr26*. The ITs displayed by NR-153 low as ; with pathotypes BBB/BB, BBG/BN, TCB/TD and MFB/SP and with rest of the pathotypes it showed high ITs confirmed *Lr17* and it also carry the gene *Lr26* since observed low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP. BWL-9682 carry the two genes *Lr16* and *Lr26* it gave low ITs with all pathotypes and gave ITs low with first five pathotypes and also with TBD/TM and high ITs with pathotype MC/SP. Bhittai and Kaghan-93 appeared to posses *Lr10, Lr13, Lr23* and *Lr26,* since ITs low with BBB/BB, CBJ/QB and TCB/TD and high with remaining races, displayed low ITs in X range with pathotypes NCJ/BN and BBG/BN, BBB/BB and high ITs with rest of the pathotypes, low ITs with pathotypes MCJ/QM and showed high ITs with pathotypes MCJ/SP also showed IT 12 with TBD/TM and; 1 or '12' with BBB/BB, CBD/QB, CBD/QL and CBJ/QQ and low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP and some others respectively. The low ITs 0; of Marvi 2000 with all pathotypes followed the pattern of *Lr9* and V-7004 also showed the same pattern but not confirmed that it has *Lr9*. DN-16 and Kohinoor 83 Low ITs were attributed to *Lr10, Lr26* and *Lr13* and an additional gene.

We attribute the low ITs of PR-67, PR-73, IBW-96405, Manthar-2002, Faisalabad-85, Bakhtawar 93, Tatara, Rawal-87 and Chinab-2000 to *Lr26* and an additional gene, most effective at 14-18 ^{o}C. *Lr26* must be drived from Kauz whereas the unidentified gene could have been inherited from either of the other two parents. PR-70, V-97005 and Punjab-96 displayed IT;1 with three *Lr10* avirulent pathotypes and high with remaining pathotypes at 18-22^{o}C. This resistance is ineffective at 24-27^{o}C and is best expressed at 14-18^{o}C (Singh *et al..*, 1991).

We postulate that wheat line 91BT010-5 and cultivar Shahkar-95 carry *Lr13* and *Lr26* because low IT in X range with *Lr13* avirulent pathotype NCJ/BN ; low ITs with first five avirulent pathotypes to *Lr26*. ITin X range with pathotypes NCJ/BN and BBG/BN, BBB/BB and high ITs with rest of the pathotypes; IT ;1 with pathotypes

MCJ/QM and showed high ITs with pathotypes MCJ/SP and also low IT 12 with TBD/TM and; 1 or '12' with BBB/BB, CBD/QB, CBD/QL and CBJ/QQ indicated the presence of *Lr13* and *Lr23* in 92T001 and 97C027. Lines 96B2098, 92T009 carry *Lr10, Lr13* and *Lr23* because of low ITs with BBB/BB, CBJ/QB and TCB/TD and high with remaining races; low ITs in X range with pathotypes NCJ/BN and BBG/BN, BBB/BB and high ITs with rest of the pathotypes; IT ;1 with pathotypes MCJ/QM and showed high ITs with pathotypes MCJ/SP and also low IT 12 with TBD/TM and ;1 or '12' with BBB/BB, CBD/QB, CBD/QL and CBJ/QQ indicated the presence of *Lr10, Lr13* and *Lr23. Lr13* is very closely linked with *Lr23* (Hawthorn, 1981) which seems to HD Indian lines and a group of Indian wheats that carry *Lr13* and *Lr23* in combination have been identified (Singh & Gupta, 1991). The line 97B2219 carry the genes *Lr13, Lr17, Lr23* and *Lr26* because showed ITs X range with pathotypes NCJ/BN and BBG/BN, BBB/BB and high ITs with rest of the pathotypes; ITs low as; with pathotypes BBB/BB, BBG/BN, TCB/TD and MFB/SP and with rest of the pathotypes it showed high ITs; displayed low ITs with pathotypes MCJ/QM and showed high ITs with pathotypes MCJ/SP; low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP and some others indicated the presence of *Lr13, Lr17, Lr23* and *Lr26*. The ITs ;1 or 1 of Moomal 2002, BWL-9736 and cultivar Sarsabz followed pattern of *Lr16*. The line V-7005 carry the genes *Lr13, Lr23* and *Lr26* because showed ITs X range with pathotypes NCJ/BN and BBG/BN, BBB/BB and high ITs with rest of the pathotypes; low ITs with pathotypes MCJ/QM and showed high ITs with pathotypes MCJ/SP; low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP and some others indicated the presence of *Lr13, Lr23* and *Lr26* and also carry an additional gene.

V-8177 and cultivar Zamindar 88 displayed IT 0; with first six *Lr1* avirulent pathotypes and high IT with rest of the pathotypes; ITs in X range with *Lr13* avirulent pathotypes NCJ/BN, BBG/BN and BBB/BB and high ITs were recorded with rest of the pathotypes. V-95069 appeared to posses *Lr1, Lr13, Lr23* and *Lr26* and an additional gene since it displayed 0; with first six pathotypes; ITs X range with pathotypes NCJ/BN and BBG/BN, BBB/BB and high ITs with rest of the pathotypes; low ITs with pathotypes MCJ/QM and showed high ITs with pathotypes MCJ/SP; low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP. Wheat lines V-95153, V-97052, SH-2003 and cultivar Inqilab-91 carry the genes *Lr10* and *Lr27+31* since they displayed low ITs with BBB/BB, CBJ/QB and TCB/TD while high with remaining races; IT as X with pathotypes NCJ/BN and also with TCB/TD, BBB/BB, BBG/BN and CBJ/QB respectively. *Lr27* and *Lr31* are complementary genes. Both must be present for the expression of resistance.

V-96052 appeared to have the genes *Lr10, Lr13, Lr17* and *Lr26* since observed low ITs with BBB/BB, CBJ/QB and TCB/TD and high with remaining races; ITs X range with pathotypes NCJ/BN and BBG/BN, BBB/BB and high ITs with rest of the pathotypes; ITs low as; with pathotypes BBB/BB, BBG/BN, TCB/TD and MFB/SP and with rest of the pathotypes it showed high ITs; low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP and some others. SN-16 carry *Lr3* and *Lr10* since it displayed low infection type; with NCJ/BN and intermediate ITs with some others; low ITs with BBB/BB, CBJ/QB and TCB/TD and high with remaining races respectively. The low ITs; 1 or 1 DN-14 with the *Lr16* avirulent pathotypes and also an additional gene more effective at 14 to 18^{o}C with some pathotypes. NR-155 appeared to posses the genes *Lr17, Lr23* and *Lr26* since it displayed ITs low as; with pathotypes BBB/BB, BBG/BN, TCB/TD and MFB/SP and with rest of the pathotypes it showed high ITs; low ITs with pathotypes MCJ/QM and showed high ITs with

pathotypes MCJ/SP; low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP and some others. The ITs low as; with pathotypes BBB/BB, BBG/BN, TCB/TD and MFB/SP of NR-178 and high infection with rest of the pathotypes followed the pattern of *Lr17*. 97B2236 appeared to posses *Lr23* and *Lr26* since it displayed low ITs with pathotypes MCJ/QM and showed high ITs with pathotypes MCJ/SP; low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP and some others and also posses additional gene. V-97024 and cutivars Pavon and Soghat-90 displayed IT 0; with *Lr1* avirulent pathotypes; ITs in the X range with *Lr13* avirulent pathotypes NCJ/BN and IT ; with BBB/BB, CBJ/QB, TCB/TD and MFB/SP; high ITs were recorded with rest of the pathotypes. SI-91195 probably carries the *Lr1* and *Lr16* because it displayed low infection type 0; with first six *Lr1* avirulent pathtoypes and high infection type with rest of the pathotypes and displayed ITs 1 or 1+ with all pathotypes respectively.

Commercial cultivars Pak 81, Pirsbak-91, Mehran-89 and Kohsar-95 appeared to posses *Lr23* and *Lr26* since they displayed low ITs with pathotypes MCJ/QM and showed high ITs with pathotypes MCJ/SP; low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP and some others. Zarghoon and Faisalabad-83 carry the genes *Lr1* and *Lr10* since they displayed the ITs 0; with first six *Lr1* avirulent pathotypes; displayed low ITs with BBB/BB, CBJ/QB and TCB/TD and high with remaining races and high ITs with rest of the pathotypes. Punjab-85 appeared to posses *Lr1*, *Lr10, Lr23* and *Lr26* genes since it displayed 0; with first six pathotypes; displayed low ITs with BBB/BB, CBJ/QB and TCB/TD and high with remaining races and high ITs with rest of the pathotypes; low ITs with pathotypes MCJ/QM and showed high ITs with pathotypes MCJ/SP; low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP. Parwaz-94, MH-97, WL-711 and Blue silver carry the gene *Lr13* since they displayed ITs X range with pathotypes NCJ/BN and BBG/BN, BBB/BB and high ITs with rest of the pathotypes. Parwaz-94 also has the additional genes with *Lr13*.

Auqab-2000 appeared to posses the genes *Lr10* and *Lr23* since it displayed low ITs with BBB/BB, CBJ/QB MCJ/QM and TCB/TD and high ITs with rest of the pathotypes. Margala-99 appeared to posses the genes *Lr10* and *Lr14a* since they displayed low infection type with BBB/BB, CBJ/QB and TCB/TD and high with remaining races and showed X reaction with pathotypes BBG/BN.

Anmol-91 carry the genes *Lr10* and *Lr26* since they displayed low ITs with BBB/BB, CBJ/QB and TCB/TD and high ITs with rest of the pathotypes; low ITs with first 5 pathotypes and also with TBD/TM and high ITs with pathotype MCJ/SP. Chakwal-97 appeared to posses *Lr3, Lr10* and *Lr23* since it displayed low ITs ; with NCJ/BN and intermediate ITs with some others; displayed low ITs with BBB/BB, CBJ/QB and TCB/TD and high with remaining races; displayed low ITs with pathotypes MCJ/QM and showed high ITs with pathotypes MCJ/SP that's why this gene was postulated and also *Lr23* showed IT 12 with TBD/TM and ;1 or '12' with BBB/BB, CBD/QB, CBD/QL and CBJ/QQ. Chakwal-86 carries the genes *Lr10, Lr17* and *Lr27+31* since it displayed low ITs with BBB/BB, CBJ/QB and TCB/TD and high with remaining races; showed ITs low as ; with pathotypes BBB/BB, BBG/BN, TCB/TD and MFB/SP and with rest of the pathotypes it showed high ITs; displayed the IT as X with pathotypes NCJ/BN and also with TCB/TD, BBB/BB, BBG/BN and CBJ/QB.

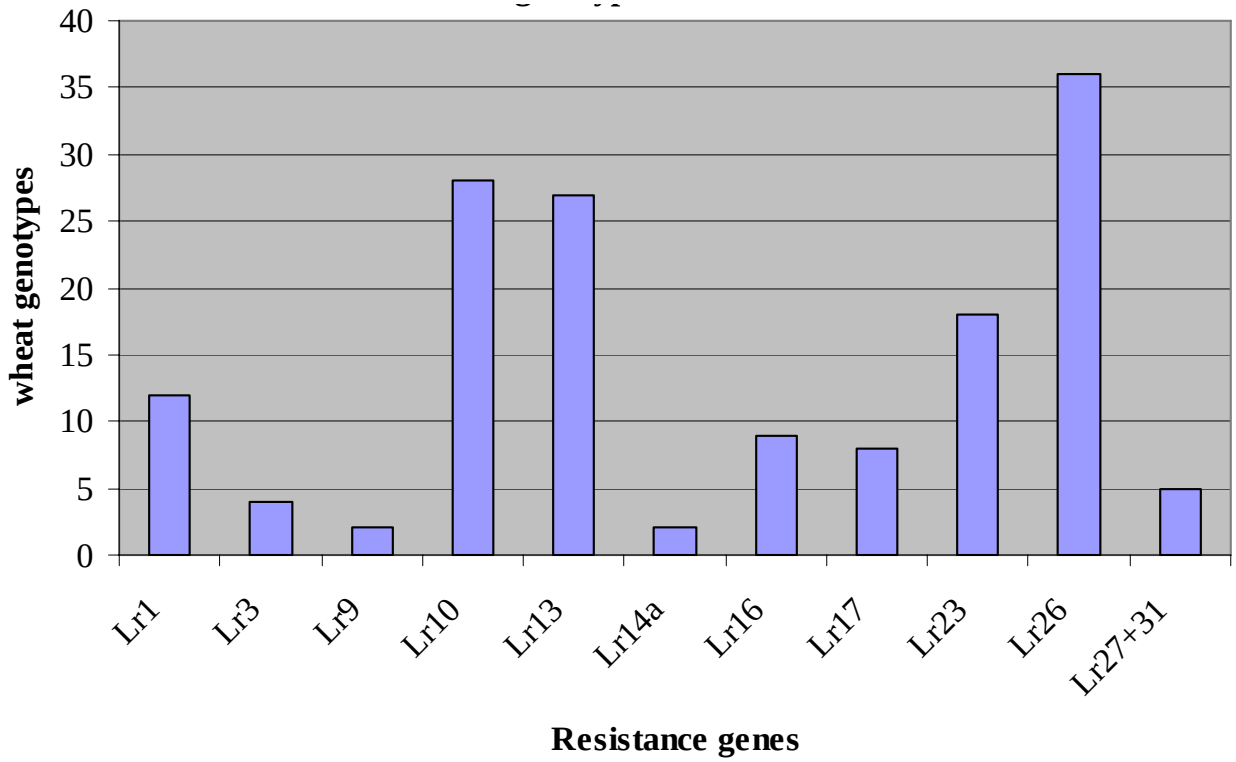

Fig. 1. Distribution of genes for leaf rust resistance in wheat genotypes.

Eleven leaf rust resistance genes *Lr1* (in 12 lines), *Lr3* (4), *Lr9* (2), *Lr10* (28), *Lr13* (27), *Lr14a* (2), *Lr16* (9), *Lr17* (8), *Lr23* (18), *Lr26* (36), *Lr27+31* (5) were present either singly or in combination. Among Pakistani wheats Lr26 was the most frequent followed by Lr9 the least frequent (Fig. 1).

Lr1 is inherited from *Triticum tauchii* in its pedigree, it was found that this gene had a high virulence frequency. *Lr3* displayed low infection type (LIT) ranging from; to; 1. Rizvi *et al*., (1984) reported this gene had high frequency in Pakistan, thus it is ineffective if deployed alone. Two Pakistani wheats have the gene *Lr9* for leaf rust resistance. This gene is lacking the virulence in Pakistan (Hussian *et al*., 1980). Our 28 commercial varieties/lines having resistance gene *Lr10* it is the second predominant gene in our wheat material. In the past Mirza *et al*., (2000) also postulated this gene in Pakistani wheats. Rizvi *et al*., (1984) and Hussain *et al*., (1980) reported the high virulence to this gene is prevailing in Pakistan; however this gene is ineffective if deployed alone. Another predominant resistance gene in our wheat material is *Lr13* which is an important adult plant resistance gene and was postulated in 27 Pakistani wheats. Low infection type exhibited by *Lr13* avirulent isolate, varying from; through X to 3 on seedling depend on pathogen culture, environmental conditions and host genetic background (McIntosh *et al*., 1995). We postulated the resistance gene *Lr14a* in 2 Pakistani wheats. Commercial variety Margala 99 has this gene and is cultivated in rainfed areas. The high virulence for *Lr14a* was detected in past by Rizvi *et al*., (1984). The variety Maxipak had this gene for leaf rust resistance and experienced a heavy epidemic in 1968 in Pakistan. *Lr16* was postulated in 9 wheats, this gene had the virulence in past reported by Hussain *et al*., (1980); Rizvi *et al*., (1984) and Khanl *et al*., (2002). In past *Lr16* had also been postulated in wheat lines/varieties in Pakistan by Hussain *et al*., (1998) and Mirza *et al*., (2000). Hassan *et al*., (1979) reported breakdown of resistance gene *Lr16* in 1978 was responsible for severe epidemic causing an average national loss of 10 percent or 830,000 tones with value of $86 million. *Lr17* is the resistance gene which was postulated in 8 varietie/lines. The major variety Chakwal 86 is cultivated in rainfed areas in Pakistan having the resistance gene *Lr17* in combination with

Lr10, *Lr13* and *Lr27+31*. Hussain *et al*., (1980) observed the virulence to *Lr17*, however, if this gene is deployed singly it will not be useful gene for resistance in field whereas in combination it will give good resistance in the field. *Lr23* was postulated in 18 Pakistani wheats. This gene, which is very close to *Lr13* (McIntosh and Hawthorn, unpublished (1981), was postulated in combination with *Lr13* only in 9 out of 31 lines having *Lr13*.The lines having *Lr23* either in combination with *Lr13* or alone, can provide good resistance in the warmer areas of Pakistan, as it is more effective at temperature above 20^{o}C (Dyck & Johnson, 1983). *Lr26* resistance is most predominant gene in Pakistani wheats, it is present singly or in combination. Zeller & Hasm, (1983) revealed that this gene is present in many winter and spring wheats carrying 1RS chromosome appears to have arisen with high yield and widespread adaptability. Nayyar *et al*., (1991) reported that virulence has emerged in most wheat growing areas in Indian subcontinent. *Lr27+31* was postulated in 5 Pakistani wheats, it is also known as "Gatcher" gene consists of *Lr27* and *Lr31* resistance genes, present together in wheat because these are complementary genes for the expression of resistance (McIntosh, *et al*., 1995). Gatcher gene may be of little use when deployed alone because Jupatico 73 carrying this gene had been highly susceptible in past (Ahmad *et al*., 2000). In Pakistani wheats the Inqilab 91 is most dominant variety cultivated in about 6 million hectares posses *Lr27+31* in addition to *Lr10*.

It is recommended that other designated genes that are not present in Pakistani wheat germplasm could be used to increase current genetic diversity. Furthermore, based on the present information additional useful genes can be incorporated in the new wheat germplasm.

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