Egypt. J. Phytopathol., Vol. **44**, No. 2, pp. 205-221 (2016)

Resistance of some Candidate Bread Wheat Promising Genotypes to Leaf Rust Disease

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Ninety wheat promising genotypes were evaluated for their resistance against leaf rust caused by *Puccinia triticina* under field conditions at Shibin El-Kom and Sadat City during 2014/15 and 2015/16 growing seasons. Evaluation was carried out through disease assessment including final leaf rust severity (FRS), coefficient of infection (CI) and relative resistance index (RRI). Thirty four candidate lines i.e. 3, 6, 14, 15, 16, 18, 20, 21, 22, 23, 24, 25, 28, 29, 30, 31, 32, 33, 36, 37, 38, 39, 43, 48, 50, 52, 55, 62, 77, 84, 86, 87, 89 and 90 out of ninety tested lines were found to be resistant to leaf rust disease and showed acceptable/desirable relative resistance index (RRI) during the two growing seasons. Therefore, these lines can be recommended in Egyptian breeding programs to produce resistant commercial cultivars to leaf rust.

Keywords: Leaf rust, promising lines, relative resistance index and wheat.

Wheat (*Triticum aestivum* L.) leaf rust caused by *Puccinia triticina* Eriks., is the most common and widespread rust disease in Egypt and worldwide. This is mainly due to the ability of the pathogen to mature, multiply rapidly and the air borne dispersal mechanism from field to another even for a long distance (Singh *et al*., 2005).

Yield losses of leaf rust disease showed fewer kernels per head as primitive result, shrunken kernels and lower kernels weight (Williams and Littlefield, 2007 & Bolton *et al*., 2008) largely due to premature senescence of infected leaves (Xu *et al*., 2005 & Williams and Littlefield, 2007). Timing and period length of plant exposure to rust affects sever losses significantly. Early disease infection in the plant growth stages is the most damaging factor (Sayre *et al*., 1998; Kolmer *et al*., 2007; Williams and Littlefield, 2007 and Huerta-Espino *et al*., 2011) and sometimes the yield losses result showed greater than 50% (Huerta-Espino *et al*., 2011). In Egypt, yield losses due to leaf rust ranged from 1.96% to 8.21% on the Egyptian wheat cultivars (Shahin and El-Orabey, 2016). For this reason, the severity of leaf rust damage can be reduced by avoiding planting too early in the growing season (Sayre *et al*., 1998) and planting early-maturing hard red winter wheat cultivars (McVey

and Long, 1993&Williams and Littlefield, 2007). However, the only effective way to eliminate crop yield losses due to leaf rust infection (other than the use of fungicides rarely a cost effective option) are through planting leaf rust resistant wheat varieties.

Release of wheat variety is a sensitive issue. For selecting a wheat variety some important characteristics are considered such as time of maturity, tolerance to heat stress, diseases and insects resistance, shattering and lodging quality and grain yield. Genetic resistance is the most economical and environmentally safe method to reduce crop yield losses. In most cases of country breeding programs wheat cultivars were replaced by new resistant cultivars due to susceptibility to rusts (Hussain *et al*., 2010a). Moreover, breeding for wheat rust resistance always requires constant novel sources of resistance genes, due to the appearance of new virulent pathogen races (Singh *et al*., 2011).

The objective of this investigation was to evaluate 90 promising candidate lines against leaf rust under Egyptian field conditions to select the resistant genotype to be included in wheat breeding programs.

Materials and Methods

Ninety wheat promising lines, their pedigree and origin sources were used in this study (Table 1). The wheat promising lines used in the present study obtained from Environmental Studies and Research Institute, Sadat University, Sadat City, Egypt. This experiment was carried out at two provinces i.e. the farm of the Faculty of Agriculture, Minufiya University, Shibin El-Kom and the farm of Environmental Studies and Research Institute, Sadat university, Sadat City, Minufiya, Egypt during 2014/15 and 2015/16 growing seasons. These experiments were planted in randomized complete block design (RCBD) with 3 replicates. The tested wheat genotypes were planted in plots of 3.5 m × 3 m (10.5 m^2), each plot contained six rows 3.5 m long, 30 cm apart. Each entry was planted in rows at 15thDecember at the two provinces. The plots were surrounded by spreader area width 2 m planted with a mixture of highly susceptible wheat genotypes to leaf rust diseases. These genotypes were *Triticum spelta sahariensis*, Morocco and Thatcher to spread rust inoculum. For field inoculation, only the spreader plants were sprayed with a mist of water and dusted with mixture of the prevalent aggressive pathotypes urediniospores mixed with a talcum powder at a ratio of 1 : 20 (v/v) (spores : talcum powder). The urediniospores of leaf rust pathotypes received kindly from Wheat Research Diseases Department, Plant Pathology Research Institute, Agricultural Research Center, Egypt.The leaf rust pathotypes used in inoculation of the tested genotypes were the same pathotypes at the two provinces. Plants were dusted in the early evening (at sunset) before dew point formation on the leaves. The inoculation of all plants at the two provinces was carried out at booting stage according to the method of Tervet and Cassell (1951). To maintain crop stand/vigor normal agronomic

practices including recommended fertilization dose and irrigation schedule were applied.

Table 1. List of the 90 tested bread wheat promising lines, pedigree and origin source

Line	Pedigree	Origin
1	HAMAM-4/ANGI-2//PASTOR-2	ICARDA
2	SEKSAKA-7/3/SHUHA-2//NS732/HER	ICARDA
3	QAFZAH-2/FERROUG-2//ZEMAMRA-8	ICARDA
4	CROC-1/AE.SQUARROSA (224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA
5	SEKSAKA-6/QAFZAH-27	ICARDA
6	SEKSAKA-7/3/SHUHA-2//NS732/HER	ICARDA
7	PRINIA-1//NESMA*2/14-2/3/DUCULA	ICARDA
8	MON'S'/ALD'S'//ALDAN'S'/IAS58/3/SAFI-1/4/ZEMAMRA-1	ICARDA
9	NESMA*2/14-2//2*SAFI-3	ICARDA
10	HUBARA-16/2*SOMAMA-3	ICARDA
11	SEKSAKA-7/3/SHUHA-2//NS732/HER	ICARDA
12	QAFZAH-25/ANGI-1//HAIEL-1	ICARDA
13	CROC-1/AE.SQUARROSA (224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA
14	TEVEE'S'/BOW#1//POTAM*2KS811261-8/3/GOUMRIA-8	ICARDA
15	MOUKA-4/RAYON	ICARDA
16	ANGI-5/ZEMAMRA-8	ICARDA
17	CROC-1/AE.SQUARROSA (224)//OPATA/4/QAFZAH-21/4/SOMAMA-3	ICARDA
18	SETTAT-45	ICARDA
19	PASTOR-2/BOCRO-2	ICARDA
20	QAFZAH-33*2/SALSAL-2	ICARDA
21	HAALA-35	ICARDA
22	HIDDAB/2*TAZA-2	ICARDA

23	HUBARA-5/3/SHA3/SERI//SHA4/LIRA	ICARDA
24	NESMA*3/14-2//2*SAFI-3	ICARDA
25	CROC-1/AE.SQUARROSA(224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA
Table 1.Cont.		
26	QAFZAH-33*6/SALSAL-2	ICARDA
27	CROC-1/AE.SQUARROSA (224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA
28	QAFZAH-33*2/SALSAL-2	ICARDA
29	BOW #1/FENGKANG 15//NESMA*2/261-9/3/DUCULA	ICARDA
30	ACHTAR*3//KANZ/KS85-8-/3/MON'S'/ALD'S'//BOW'S'	ICARDA
31	DOUKKALA-12	ICARDA
32	CROC-1/AE.SQUARROSA (224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA
33	CROC-1/AE.SQUARROSA (224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA
34	OUASSOU-20	ICARDA
35	OUASSOU-18	ICARDA
36	BOW#1/FENGKANG 15//MASSIRA	ICARDA
37	SETTAT-45	ICARDA
38	HAALA-35	ICARDA
39	Cham4/Tam200//Del 483/3/Mirtos	Turkish
40	Zarrin/Shiroodi/6/Zarrin/5/Omid/4/Bb/Kal//Ald/3/Y50E/Kal*3//Emu"s"	Turkish
41	Shi4414/Crow"s"//V82187/T.aest/5/Ti/4/La/3/Fr/Kad//Gh/6/2*Bloudan/3/Bb/2*7C//Y50E/Kal*3	Turkish
42	Vopona/Hd2402/3/Tirchmir/Ico//Sabalan	Turkish
43	Owl/Shiroodi/5/Owl/4/Bloudan/3/Bb/2*7C//Y50E/Kal*3	Turkish1
44	Alamoot/4/Gv/D630//Ald"s"/3/Azd	Turkish
45	CMSA00M00422T-01Y	Mexican
46	CMSS95Y00504S-0100Y-9B-010Y-010M-2Y-0Y-01Y	Mexican
47	CM77091-14Y-04M-06Y-3B-1Y-0B-01Y	Mexican
48	CMBW91Y03634M-030TOPM-2Y-010M-010Y-015M-5Y-0M-0SY-01Y	Mexican
49	CM15430-2S-5S-0S-0S-69S-0EGY-01Y	Mexican
50	II19975-68Y-1J-6Y-1J-4Y-1J-0B-0ARG-01Y	Mexican
51	CM77091-14Y-04M-06Y-3B-1Y-0B-01Y	Mexican
52	CMSA00M00467T-01Y	Mexican
53	CMSS95Y01036S-4Y-010M-010Y-010M-5Y-0Y-01Y	Mexican

54	II8739-4R-1M-1R-0USA-01Y	Mexican
55	MORSUD-31	ICARDA
56	MISKEET-16	ICARDA
57	BOW#1/FENGKANG 15//MASSIRA	ICARDA
58	OUASSOU-36	ICARDA
59	MISKEET-15	ICARDA
Table 1.Cont.		
60	ESWYT99#18/ARRIHANE	ICARDA
61	ACHTAR/INRA 1764	ICARDA
62	CROC-1/AE.SQUARROSA (224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA
63	MOUKA-4/RAYON	ICARDA
64	GIRWILL-13/2*PASTOR-2	ICARDA
65	BOW#1/FENGKANG 15//MASSIRA	ICARDA
66	MISKEET-17	ICARDA
67	HAAMA-16/MILAN	ICARDA
68	MISKEET-4	ICARDA
69	CROC-1/AE.SQUARROSA (224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA
70	QAFZAH-25/ANGI-1//HAIEL-1	ICARDA
71	CROC-1/AE.SQUARROSA (224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA
72	GIRWILL-13/2*PASTOR-2	ICARDA
73	ESWYT99#18/ARRIHANE	ICARDA
74	CROC-1/AE.SQUARROSA (224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA
75	MISKEET-4	ICARDA
76	MOUKA-4/RAYON	ICARDA
77	NESMA*2/14-2//2*SAFI-3	ICARDA
78	MOUKA-4/RAYON	ICARDA
79	HUBARA-2/QAFZAH-21	ICARDA
80	OUASSOU-37	ICARDA
81	HAMAM-2/DEEK-2	ICARDA
82	HUBARA-5/3/SHA3/SERI//SHA4/LIRA	ICARDA
83	DOUKKALA-30	ICARDA
84	HUBARA-16/2*SOMAMA-3	ICARDA
85	GIRWILL-13/2*PASTOR-2	ICARDA
86	CROC-1/AE.SQUARROSA (224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA
87	ESWYT99#18/ARRIHANE	ICARDA
88	OYOUN-2	ICARDA
89	MOUKA-4/RAYON	ICARDA

90	CROC-1/AE.SQUARROSA (224)//OPATA/3/QAFZAH-21/4/SOMAMA-3	ICARDA

Disease assessment:

Final leaf rust severity was recorded for each genotype according Das *et al*. (1993) as the disease severity(%) for each wheat genotype when the highly susceptible variety (Morocco) was severely rusted and the disease rate reached the highest and final level of leaf rust severity. Final rust severity includes two components i.e. disease severity based on modified Cobb's scale (Peterson *et al*., 1948), where Tr = less than 5 % and 5 = 5% up to 100 = 100 %, and host response (infection type) based on scale described by Stakman *et al*. (1962), which was expressed in five types as follows: immune (0), resistant (R), moderately resistant (MR), moderately susceptible (MS), susceptible (S) and moderately susceptible to moderately resistant (X).

Coefficient of infection (CI) was calculated by multiplying rust severity with constant values of infection type (IT). The constant values for infection types were used based on; R = 0.2, MR = 0.4, X = 0.6, MS = 0.8 and S = 1 (Stubbs *et al*., 1986). Average coefficient of infection (ACI) was derived from the sum of CI values of each line in the two provinces divided by the number of provinces.

A rating scale for disease resistance (RRI) was adopted in 1982 for use with cereals (Aslam, 1982) based on scale by Doling (1965) for selecting wheat varieties to powdery mildew. 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). Using 0 to 9 scale previously designated as resistance index (RI) has been re-designated as relative resistance index (RRI). From CARPA the value of RRI is calculated on 0 to 9 scale, where 0 denote most susceptible and 9 highly resistant (Akhtar *etal*., 2002). The relative resistance index is calculated according to the following formula:

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

The desirable index and acceptable index number for rusts areasbelow (Aslam, 1982).

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

Results

A total of 90 wheat genotypes were tested for adult plant resistance to leaf rust disease at the farm of the Faculty of Agriculture, Minufiya University, Shibin El-

Kom and the farm of Environmental Studies and Research Institute, Sadat University, Sadat City, Minufiya, Egypt (Tables 2 and 3).

1.Field evaluation of wheat genotypes against leaf rust:

1.1.Season 2014/2015:

Data in Table (2) showed that, final leaf rust severity of the tested genotypes ranged from 0-80 % at Sadat City and Shibin El-Kom. Out of 90 tested genotypes, 46 genotypes showed acceptable (RRI) to leaf rust. These genotypes were 3, 6, 14, 20, 24, 28, 29, 30, 48, 55, 62, 79, 82, 86, 89, 90 (each with 9.0), 18, 22, 23, 25, 31, 32, 36, 37, 38, 39, 43, 77, 88 (each with 8.9), 21, 33, 50, 84 (each with 8.8), 2 (8.7), 63, 71,76, 87 (each with 8.6), 15 (8.2), 83 (8.0), 35, 80, 85 (each with 6.9), 34 (6.7),72 (6.2) and 16 (5.5).

1.2.Season 2015/16:

Data in Table (3) showed that, the final leaf rust severity of the tested genotypes ranged from 0-70 % at Sadat City and 0-80 % at Shibin El-Kom. The wheat genotypes 6, 18, 20, 21, 22, 23, 24, 25, 29, 31, 32, 36, 37, 38, 39, 43, 62, 77, 84, 86, 87, 89, 90 (each with 9.0), 14, 28, 48 (each with 8.9), 3, 30 (each with 8.8), 50 (8.7), 55 (8.6),33 (8.4), 15 (7.1), 16 (6.0), 27 (5.3), 41 (5.3) and45 (5.3)showed acceptable RRI for leaf rust.

Data in Table (4) indicated that only 34 candidate lines i.e. 3, 6, 14, 15, 16, 18, 20, 21, 22, 23, 24, 25, 28, 29, 30, 31, 32, 33, 36, 37, 38, 39, 43, 48, 50, 52, 55, 62, 77, 84, 86, 87, 89 and 90 were resistant to leaf rust disease at the two provinces Sadat City and Shibin El-Kom during 2014/15 and 2015/16 growing seasons.

Table 2. Response of 90 genotypes to leaf rust along with average coefficient of infection (ACI), country average relative percentage attack (CARPA) and relative resistance index (RRI) at Sadat City and Shibin El-Kom provinces during 2014/2015 growing season

Line	Location / Final rust severity (%)*		ACI	CARPA	RRI
	Sadat City	Shibin El-Kom			
1	50 S	40 S	45	69.2	2.8
2	0	10 MR	2	3.1	8.7**
3	0	0	0	0.0	9.0**
4	70 S	30 S	50	76.9	2.1
5	40 S	60 S	50	76.9	2.1
6	0	0	0	0.0	9.0**
7	20 S	40 S	30	46.2	4.8
8	30 S	50 S	40	61.5	3.5
9	30 S	70 S	50	76.9	2.1
10	50 S	40 S	45	69.2	2.8
11	40 S	30 S	35	53.8	4.2
12	70 S	50 S	60	92.3	0.7

13	50 S	70 S	60	92.3	0.7
14	0	0	0	0.0	9.0**
15	Tr S	10 MS	5.5	8.5	8.2**
16	10 S	40 S	25	38.5	5.5**
17	30 S	50 S	40	61.5	3.5
18	0	Tr MR	0.6	0.9	8.9**
19	50 S	40 S	45	69.2	2.8
20	0	0	0	0.0	9.0**
21	Tr MR	Tr MR	1.2	1.8	8.8**
Table 2.Cont.					
22	0	Tr MR	0.6	0.9	8.9**
23	0	Tr MR	0.6	0.9	8.9**
24	0	0	0	0.0	9.0**
25	Tr MR	0	0.6	0.9	8.9**
26	40 S	50 S	45	69.2	2.8
27	30 S	50 S	40	61.5	3.5
28	0	0	0	0.0	9.0**
29	0	0	0	0.0	9.0**
30	0	0	0	0.0	9.0**
31	0	Tr MR	0.6	0.9	8.9**
32	0	5 MR	1	1.5	8.9**
33	5 MR	Tr MR	1.6	2.5	8.8**
34	Tr S	30 S	16.5	25.4	6.7**
35	10 S	20 S	15	23.1	6.9**
36	0	Tr MR	0.6	0.9	8.9**
37	0	5 MR	1	1.5	8.9**
38	0	Tr MR	0.6	0.9	8.9**
39	0	5 MR	1	1.5	8.9**
40	20 S	60 S	40	61.5	3.5
41	30 S	20 S	25	38.5	5.5
42	40 S	40 S	40	61.5	3.5
43	0	Tr MR	0.6	0.9	8.9**
44	30 S	40 S	35	53.8	4.2
45	40 S	40 S	40	61.5	3.5
46	20 S	50 S	35	53.8	4.2
47	70 S	40 S	55	84.6	1.4
48	0	0	0	0.0	9.0**
49	30 S	60 S	45	69.2	2.8
50	Tr MR	Tr MR	1.2	1.8	8.8**
51	50 S	60 S	55	84.6	1.4
52	70 S	60 S	65	100.0	0.0

53	80 S	40 S	60	92.3	0.7
54	60 S	50 S	55	84.6	1.4
55	0	0	0	0.0	9.0**
56	50 S	70 S	60	92.3	0.7
57	40 S	60 S	50	76.9	2.1
58	50 S	60 S	55	84.6	1.4
59	30 S	60 S	45	69.2	2.8
60	40 S	70 S	55	84.6	1.4
61	30 S	60 S	45	69.2	2.8
62	0	0	0	0.0	9.0**
63	10 MR	5 MR	3	4.6	8.6**
Table 2.Cont.					
74	60 MR	40 S	50	76.0	2.1
65	60 S	40 S	50	76.9	2.1
66	50 S	40 S	45	69.2	2.8
67	50 S	50 S	50	76.9	2.1
68	30 S	50 S	40	61.5	3.5
69	50 S	50 S	50	76.9	2.1
70	40 S	70 S	55	84.6	1.4
71	5 MR	10 MR	3	4.6	8.6**
72	20 S	20 S	20	30.8	6.2**
73	30 S	80 S	55	84.6	1.4
74	20 S	40 S	30	46.2	4.8
75	40 S	60 S	50	76.9	2.1
76	10 MR	5 MR	3	4.6	8.6**
77	0	Tr MR	0.6	0.9	8.9**
78	70 S	30 S	50	76.9	2.1
79	0	0	0	0.0	9.0**
80	20 S	10 S	15	23.1	6.9**
81	40 S	40 S	40	61.5	3.5
82	0	0	0	0.0	9.0**
83	5 S	10 S	7.5	11.5	8.0**
84	5 MR	Tr MR	1.6	2.5	8.8**
85	10 S	20 S	15	23.1	6.9**
86	0	0	0	0.0	9.0**
87	Tr MR	10 MR	2.6	4.0	8.6**
88	Tr MR	0	0.6	0.9	8.9**
89	0	0	0	0.0	9.0**
90	0	0	0	0.0	9.0**
Morocco (check)	80 S	90 S	85	130.8	-2.8

* Final rust severity includes two components: disease severity based on modified Cobb's scale (Peterson *et al*., 1948), where Tr = less than 5 % and 5 = 5 % up to 100 = 100 %, and host response based on scale described by Stakman *et al.* (1962), where R = resistant, MR = moderately resistant, MS = moderately susceptible and S = susceptible.
** RRI= Relative resistance index (above 5 is acceptable; means the variety is resistant to leaf rust (Aslam, 1982).

Table 3. Response of 90 genotypes to leaf rust along with average coefficient of infection (ACI), country average relative percentage attack (CARPA) and relative resistance index (RRI) at Sadat City and Shibin El-Kom provinces during 2015/2016 growing season

Line	Location / Final rust severity (%)*		ACI	CARPA	RRI
	Sadat City	Shibin El-Kom			
1	30 S	70 S	50	83.3	1.5
2	20 S	40 S	30	50.0	4.5
3	Tr MR	5 MR	1.6	2.7	8.8**
4	50 S	60 S	55	91.7	0.8
5	30 S	50 S	40	66.7	3.0
6	0	0	0	0.0	9.0**
7	50 S	50 S	50	83.3	1.5
8	40 S	60 S	50	83.3	1.5
9	30 S	50 S	40	66.7	3.0
10	60 S	60 S	60	100.0	0.0
11	50 S	30 S	40	66.7	3.0
12	30 S	50 S	40	66.7	3.0
13	60 S	60 S	60	100.0	0.0
14	0	Tr MR	0.6	1.0	8.9**
15	5 S	20 S	12.5	20.8	7.1**
16	20 S	20 S	20	33.3	6.0**
17	60 S	40 S	50	83.3	1.5
18	0	0	0	0.0	9.0**
19	30 S	60 S	45	75.0	2.3
20	0	0	0	0.0	9.0**
21	0	0	0	0.0	9.0**
22	0	0	0	0.0	9.0**
23	0	0	0	0.0	9.0**
24	0	0	0	0.0	9.0**
25	0	0	0	0.0	9.0**
26	50 S	30 S	40	66.7	3.0
27	10 S	40 S	25	41.7	5.3**

28	Tr MR	0	0.6	1.0	8.9**
29	0	0	0	0.0	9.0**
30	Tr MR	Tr MR	1.2	2.0	8.8**
31	0	0	0	0.0	9.0**
32	0	0	0	0.0	9.0**
33	10 MR	10 MR	4	6.7	8.4**
34	40 S	60 S	50	83.3	1.5
35	50 S	30 S	40	66.7	3.0
36	0	0	0	0.0	9.0**
Table 3. Cont.					
37	0	0	0	0.0	9.0**
38	0	0	0	0.0	9.0**
39	0	0	0	0.0	9.0**
40	30 S	50 S	40	66.7	3.0
41	10 S	40 S	25	41.7	5.3**
42	20 S	50 S	35	58.3	3.8
43	0	0	0	0.0	9.0**
44	10 S	50 S	30	50.0	4.5
45	20 S	30 S	25	41.7	5.3**
46	20 S	50 S	35	58.3	3.8
47	50 S	60 S	55	91.7	0.8
48	0	5 MR	1	1.7	8.9**
49	10 S	70 S	40	66.7	3.0
50	0	10 MR	2	3.3	8.7**
51	30 S	70 S	50	83.3	1.5
52	40 S	70 S	55	91.7	0.8
53	40 S	80 S	60	100.0	0.0
54	30 S	60 S	45	75.0	2.3
55	5 MR	10 MR	3	5.0	8.6**
56	40 S	40 S	40	66.7	3.0
57	70 S	30 S	50	83.3	1.5
58	40 S	80 S	60	100.0	0.0
59	20 S	80 S	50	83.3	1.5
60	30 S	70 S	50	83.3	1.5
61	30 S	70 S	50	83.3	1.5
62	0	0	0	0.0	9.0**
63	20	40	30	50.0	4.5
64	10 S	50 S	30	50.0	4.5
65	60 S	60 S	60	100.0	0.0
66	30 S	70 S	50	83.3	1.5
67	20 S	60 S	40	66.7	3.0
68	20 S	40 S	30	50.0	4.5

69	10 S	60 S	35	58.3	3.8
70	20 S	80 S	50	83.3	1.5
71	10 S	60 S	35	58.3	3.8
72	20 S	40 S	30	50.0	4.5
73	30 S	50 S	40	66.7	3.0
74	20 S	50 S	35	58.3	3.8
75	20 S	50 S	35	58.3	3.8
76	10 S	60 S	35	58.3	3.8
77	0	0	0	0.0	9.0**
Table 3. Cont.					
78	30 S	80 S	55	91.7	0.8
79	20 S	60 S	40	66.7	3.0
80	40 S	50 S	45	75.0	2.3
81	40 S	70 S	55	91.7	0.8
82	40 S	50 S	45	75.0	2.3
83	50 S	40 S	45	75.0	2.3
84	0	0	0	0.0	9.0**
85	10 S	70 S	40	66.7	3.0
86	0	0	0	0.0	9.0**
87	0	0	0	0.0	9.0**
88	30 S	40 S	35	58.3	3.8
89	0	0	0	0.0	9.0**
90	0	0	0	0.0	9.0**
Morocco (check)	80 S	80 S	80	133.3	-3.0

* Final rust severity includes two components: disease severity based on modified Cobb's scale (Peterson *et al*., 1948), where Tr = less than 5 % and 5 = 5 % up to 100 = 100 %, and host response based on scale described by Stakman *et al.* (1962), where R = resistant, MR = moderately resistant, MS = moderately susceptible and S = susceptible.

** RRI= Relative resistance index (above 5 is acceptable; means the variety is resistant to leaf rust (Aslam, 1982).

Table 4. Resistant wheat genotypes with desirable and acceptable relative resistance index (RRI) to leaf rust disease during 2014/2015 and 2015/3016 growing seasons at adult plant stag in the two provinces

C.N.	Line	2014/2015	2015/2016
1	2	8.7	-
2	3	9.0	8.8
3	6	9.0	9.0
4	14	9.0	8.9

5	15	8.2	7.1
6	16	5.5	6.0
7	18	8.9	9.0
8	20	9.0	9.0
9	21	8.8	9.0
10	22	8.9	9.0
11	23	8.9	9.0
12	24	9.0	9.0
Table 4. Cont.			
13	25	8.9	9.0
14	27	-	5.3
15	28	9.0	8.9
16	29	9.0	9.0
17	30	9.0	8.8
18	31	8.9	9.0
19	32	8.9	9.0
20	33	8.8	8.4
21	34	6.7	-
22	35	6.9	-
23	36	8.9	9.0
24	37	8.9	9.0
25	38	8.9	9.0
26	39	8.9	9.0
27	41	5.5	5.3
28	43	8.9	9.0
29	45	-	5.3
30	48	9.0	8.9
31	50	8.8	8.7
32	55	9.0	8.6
33	62	9.0	9.0
34	63	8.6	-
35	71	8.6	-
36	72	6.2	-
37	76	8.6	-
38	77	8.9	9.0
39	79	9.0	-
40	80	6.9	-
41	82	9.0	-

42	83	8.0	-
43	84	8.8	9.0
44	85	6.9	-
45	86	9.0	9.0
46	87	8.6	9.0
47	88	8.9	-
48	89	9.0	9.0
49	90	9.0	9.0

Discussion

Disease resistant wheat cultivars are considered the main factor in agriculture wheat breeding programs to protect wheat plants from disease infection and consequently from yield loss. In this study, 90 wheat genotypes were tested. The tested genotypes were grown at two provinces i.e. Shibin El-Kom and Sadat City for two successive growing seasons i.e. 2014/2015 and 2015/2016.

Data on rust incidence were recorded as percentage final rust severity, infection type, average coefficient of infection (ACI) and relative resistance index (RRI). According to the scale of 0-9 of Aslam (1982) to select resistant wheat genotypes for rust diseases, where RRI = 0 means the genotype is highly susceptible and RRI = 9 means the genotype is highly resistant. Moreover, for leaf rust, RRI = 5 or 6 means the genotype is acceptable in its resistant, while RRI = 7 and above means the genotype is desirable in its resistant. For stripe and stem rust, RRI = 6 means the genotype is acceptable in its resistant, while RRI = 7 and above means the genotype is desirable in its resistant. The RRI assessment in this study is used for the second time in Egypt after El-Orabey *et al*. (2014) who used this scale for the first time in Egypt to evaluate some promising lines form CIMMYT to select the resistant genotype for rust diseases and this point is the new issue in this study.

Data of this study revealed that, only 34 wheat lines i.e. 3, 6, 14, 15, 16, 18, 20, 21, 22, 23, 24, 25, 28, 29, 30, 31, 32, 33, 36, 37, 38, 39, 43, 48, 50, 52, 55, 62, 77, 84, 86, 87, 89 and 90 showed acceptable RRI for leaf rust during the two successive growing seasons 2014/15 and 2015/16 compared with Morocco (check).These wheat lines were found to be resistant to leaf rust disease and can be used in breeding programs to release commercial cultivars as safely production under Egyptian conditions. These results are in agreement with Akhtar *et al*. (2002); Rattu *et al*. (2009); Hussain *et al*. (2010b and c) and Hussain *et al*. (2013). Moreover, the results are in line with the work done by Mahmood *et al*. (2013) who reported that the rust score of Chakwal-50 varied from 5 MR/MS to 30 MS for leaf rust. Also, the cv. Chakwal-50 gave RRI value of 7 to 8.6 for leaf rust. The cv. Chakwal-50 has the potential to be approved and released as a new variety. Our results are in conformity

with those of El-Orabey *et al*. (2014) who found that out of sixteen CIMMYT promising lines, seven lines, *i.e.* 1, 2, 7, 8, 10, 11 and 15 were found to be resistant to rust diseases and showed acceptable/desirable relative resistance index (RRI) during the two seasons 2012/13 and 2013/14.

The tested wheat promising lines 3, 6, 14, 15, 16, 18, 20, 21, 22, 23, 24, 25, 28, 29, 30, 31, 32, 33, 36, 37, 38, 39, 43, 48, 50, 52, 55, 62, 77, 84, 86, 87, 89 and 90 should be tested for grain yield and other agronomic characters i.e. Days to heading and maturity, plant height (cm),biological yield (kg),straw yield and also flour extraction (%) and rheological properties to be registered as a new commercial cultivar, also, it must be identify the rust resistance genes present in these lines by molecular marker to know the leaf rust resistance genes and the number of genes present in these lines.

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مقاومة بعض سلالات قمح الخبز المبشرة لمرض صدأ الأوراق

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تم تقييم تسعون تركيب وراثى من القمح لمقاومتهم ضد مرض صدأ الأوراق تحت ظروف الحقل المصرية فى مزرعة كلية الزراعة - جامعة المنوفية ومزرعة معهد بحوث الدراسات البيئية - جامعة السادات - المنوفية - مصر خلال المواسم الزراعية 2015/2014 و 2016/2015 من خلال شدة الإصابة النهائية ومعامل الإصابة ومعامل المقاومة النسبى وجد أن أربعة وثلاثين سلالة وهى السلالات 3 ، 6، 14، 15، 16، 18، 20، 21، 22، 23، 24، 25، 28، 29، 30، 31، 32، 33، 36، 37، 38، 39، 43، 48، 50، 52، 55، 62، 77، 84، 86، 87، 89 و 90 من التسعون سلالة المختبرة كانت مقاومة لمرض صدأ الأوراق وأظهرت معامل المقاومة النسبى مقبول /مرغوب (RRI) خلال موسمى الدراسة لذلك هذه السلالات يمكن التوصية بإدخالها فى برامج التربية المصرية لإنتاج أصناف تجارية مقاومة لمرض صدأ الأوراق.