J. Agric. Sci. Mansoura Univ., 31 (4): 2057 - 2071, 2006

PHYSIOLOGICAL SPECIALIZATION IN *Puccinia triticina*, AND GENES CONDITIONING RESISTANCE TO WHEAT LEAF RUST DISEASE IN Egypt

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ABSTRACT

The identification of standard physiologic races and pathotypes of wheat leaf rust fungus during 2004/2005 growing season showed the presence of 10 standard physiologic races of *Puccini triticina* Eriks. These races comprised 18 pathotypes. The more frequent races was No. 209 (30%), followed by race 188 and race 210 for each (15%). The least races were i.e. race 57, 184, 108, 140, 187 and 201 each of one represented by (5%). The rest race was No. 56 represented by 10%. Pathotype PSTT was the most frequent. Furthermore, the most effective leaf rust resistance genes were i.e. Lr35 (100%), Lr37 (100%), 39 (95%), 45 (90%), 36 (85%) and 2a (80%). On the other hand, the highest virulence were recorded with Lr10, 21, 13, 22a, 22 b, 44, 46 and B each of represented by (100%). Leaf rust resistance gene(s) probably in 13 wheat cultivars matching 31 leaf rust monogenic lines against 20 pathotypes, showed probable the presence of Lr14 a in Giza164; Lr's 9 and 16 in Sids11; Lr's 9, 16, 26, 14a, 19 and 32 in Sakha 94; Lr's 3, 9, 16, 11, 26 and 32 in Giza170. The cultivar Gemmeiza9 postulated have 13 genes, Gemmeiza10 probable have 11 genes and Gemmeiza7 postulated have 9 genes. On the other hand, the rest of cultivars, postulated lack their genes. These results will remain an integral part of resistance breeding program and studies concerning the epidemiology and evolution of virulence in the leaf rust pathogen populations.

INTRODUCTION

Wheat is the most important food cereal crop in Egypt and all over the world. In Egypt, wheat rusts are the most common and dangerous diseases on wheat plants. Leaf rust in particular was the cause of eliminating and discarding many wheat cultivars in Egypt, because of their susceptibility under field conditions. Moreover, it has a wide spread on most of the susceptible commercial wheat cultivars grown under Egyptian condition. Generally, infection might be increased in the late sowing causing high losses in grain yield which reached about 23% on some cultivars (Nazime *et al.*, 1983). To increase leaf rust resistance, breeders attempt to incorporate more than one of these genes in the local cultivars to face the dynamic nature of causal organisms (Roelfs, 1988). These genes gave us the major important to facilitate the development and improvement of resistance cultivars to manage leaf rust (McVey and Long, 1993). However (Flor, 1955) was the first to use gene postulation method while, it was developed to be used in rust diseases of small grain (Statler, 1984 and Modawi *et al.*, 1985).

The main objective of the present work is to identify standard differential races and pathotypes of wheat leaf rust collected from three North Governorates were i.e. Dakhalya, Kafr El-Sheikh and Damietta during

2004/25005 growing season and to detected probable present genes for leaf rust resistant in 13 Egyptian commercial wheat germplasm under greenhouse conditions at seedling stage.

MATERIALS AND METHODS

Infected leaf rust materials were collected during 2004/2005 from both wheat commercial fields and trap nurseries grown in north Governorates i.e. Kafr El-Sheikh, Damietta and Dakahlia. The collected samples were kept at room temperature (18-24°C) overnight to be dried off then the samples were kept in glassine envelopes (8 x 15 cm) and stored in the refrigerator at 2-5°C. These samples were purified and multiplied on the susceptible check varieties i.e. Thatcher and/or Giza139.

Wheat leaf rust near-isogenic lines (NIL's) listed in Table (1) were used throughout this study. The source of the (NIL's) was the germplasm unit International Maize and Wheat Improvement Center (CIMMYT), while the Egyptian commercial wheat varieties were kindly supported by wheat breeding research section (ARC).

Either of the tested cultivars or (NIL's) were sown in 6 cm. diam. plastic pots filled with peetmoss , perlite and verniculite, in a specific greenhouse to avoid any contamination. Irrigation, fertilization etc. were performed according to the technique recommendation followed in this regard.

Rust inoculation technique: The rubbing technique was used for inoculation, in which a single pustule was multiplied on the susceptible check varieties, then rubbed on the sets of differential varieties, Near Isogenic Lines (NIL's) and Egyptian commercial wheat varieties. Then, the inoculated seedling were incubated in dew chambers at (18-20°C) in darkness for 24 hours, and transferred to the permanent benches in the greenhouse for 15 days in which the day light is available and temperature ranged between 15-25°C. After 15 days of inoculation, seedlings were prepared for score of infection type (Stakman *et al.*, 1962).

Race identification was performed according to the traditional method adapted by the infection type (Mains and Jackson, 1926), in which 0 = (No visible symptoms on the leaf) 0; hypersensitive necrosis) 1 = (minute uredinia surrounded necrotic area), 2 (medium uredinia surrounded by necrotic or chlorotic area), 3(large uredinia surrounded by chlorotic area). 4(large uredinia without any chlorosis or necrosis are) and X (resistant and susceptible reaction are present together on the leaf blade).

The data were transmitted to L (R) or H (S), since 0, 0, 1 and 2 are considered resistance or low reaction, while 3, 4 and X are considered susceptible or high reaction.

The recent race nomenclature system:

In the present system, two sets of differentials were used. The traditional one as previously mentioned by Mains and Jackson (1926). The other set adapted by Long and Kolmer (1989) included 16 differential host each with single gene of leaf rust resistance i.e. in 4 subset, 1 included (Lr1, 2a, 2c, 3), 2 (9, 16, 24, 26), 3(3Ka, 11, 17, 30), and 4 (10, 18, 21 and 2b).

Table (1): The tested near isogenic liens (NIL's).

No.	Lr gene	Genome location	Origin of seed resources	Linkage
1	1	-	Malakof	
2	2 a	5D	Webster	
3	2 c	2 DS	Brivit	
4	3 a	6 BL	Democrat	
5	9	6 BL	*Triticum umbellulatum*	
6	16	2 BS	exchange	To Sr23
7	24	3 DL	*A. elongatum*	To Sr24
8	26	1 BL	Imperial rye	To Sr31, yrg
9	3 ka	6 BL	Klien Aniversario	
10	11	2 A	Hussar	
11	17	2 AS	Klien lucko	
12	30	4 BL	Terenzio	
13	10	1 AS	Lee	
14	18	5 BL	*T. timophevi*	
15	21	1 DL	*T. tauchii*	
16	2 b	2 DS	Carina	
17	14 b	7 BL	Bowie	
18	15	2 DS	Kenya 1-12 E	
19	36	6 BS	*T. speltoides*	
20	42	1 D		
21	3 bg	6 BL	Bag	
22	12	4 BS	Exchange	
23	13	2 BS	Frontana	
24	14 a	7 BL	Hope	
25	19	7 DL	*Agropyron elongatum*	Sr 25
26	22 a	2 DS	Thatcher	
27	22 b	2 DS	*T. tauchii*	
28	23	2 BS	Gabo	
29	25	4 AB	Rosen rye	
30	27	3 BS	Gatcher	To Sr 2
31	28	4 BL	*T. speltoide*	
32	29	7 DS	*A. elongatum*	
33	32	3 D	*T. tauchii*	
34	33	1 BL	PI 584-58	To Lr44
35	34	7 D	Ternzio	
36	35	2 B	*T. speltoides*	
37	37	2 AS	*T. ventrecocsa*	To Yr 17
38	38	2 AL	A?	
39	39+	2 DS	Intermedium	
40	40+	1 D	*T. tauchii*	
41	41	1 D	*T. tauchii*	
42	43	1 D+	*T. tauchii*	
43	44	2 DS	*T. aestivum*	To Lr33
44	45	1 BL	Rye	
45	46	2 AS	Pavon 76	
46	47	1 BL	*T. speltoides*	
47	B	5 D	*T. tauchii*	

* **Lr39 = Lr41, Lr40 = Lr21, Lr43 is not a unique gene, germplasm line had Lr21 and Lr39**

The subsets are indicated in Table (2). The traditional inoculation techniques, purification and race identification were above mentioned elsewhere.

The Lr's differential hosts are placed in sets of four and a letter is assigned to each of the 16 possible combination i.e. 2^4 of the interaction. The letters B through T minus vowels are used to the identified races. The resultant reactions were matched to those in the table aiming to reach the modern nomenclature system according the similarity with the differential hosts.

Table (2):Code (Pt) for the 16 North American differential hosts for *Puccinia triticina.*

		Infection types produced on near isogenic lines Lr's			
Pt. code[a]	Host set 1: Host set 2: Host set 3: Host set 4:	1 9 3 ka B	2 a 16 11 10	2 c 24 17 14 a	3 26 30 18
B		L	L	L	L
C		L	L	L	H
D		L	L	H	L
F		L	L	H	H
G		L	H	L	L
H		L	H	L	H
J		L	H	H	L
K		L	H	H	H
L		H	L	L	L
M		H	L	L	H
N		H	L	H	L
P		H	L	H	H
Q		H	H	L	L
R		H	H	L	H
S		H	H	H	L
T		H	H	H	H

Long and Kolmer 1989 L = Low infection type H : High infection type.

[a] Pt code consists of the designation for set 1 followed by that for set 2, etc.

Gene postulation in certain Egyptian wheat varieties against leaf rust at seedling stage:

Thirteen local genotypes and 31 leaf rust near-isogenic lines were tested for leaf rust resistance using 20 pathotypes of leaf rust (*Puccinia triticina*) from collected rusted samples of 2004/2005.

All plant materials were grown in plastic posts, with 10 cm diam. Each pot contained four varieties in each corner clockwise. Inoculation and incubation procedures were carried out according to methods adapted by, (Stakman *et al.*, 1962). Rust reaction was recorded on the first leaf 22 days after sowing. Rust data were scored as previously mentioned elsewhere.

Genes were postulated according to the method of (Statler, 1984) in which, the absence of L: H or H: L reactions between the tested host (B) and the known gene host (A), indicated the presence of such gene(s) in the tested host exhibited the symbol (-0). On the other hand, when host B proved

to have H (High infection type) versus L (low infection type) in host A, this behaviour would indicated that the absence of such gene in host B = (-). The presence L (in host B): H (in host A) indicated the presence of such gene in host (B) and it may have another ones = (0). The presence of pathotypes having H: L and L: H in the comparison indicates that either of hosts did not have the same gene = (0).

		Host B (unknown)	
		Resistant	Susceptible
Host A	Resistant	LIT: LIT	LIT: HIT
(known)	Susceptible	HIT: LIT	HIT: LIT

RESULTS

Virulence formula and their frequency (%):

Data presented in Table (3) indicated the virulence formulae of 10 tested races and their frequency. These data demonstrated the presence of 20 virulence formula No. 1, 14, 2, 9, 16 and 19 which considered the more virulent ones. On the other hand, the formula of leaf rust no. 13, 17 and 20 are considered less virulent. The rest of the formula of leaf rust lied in between. Most of the less virulent formula were comprised in physiologic race 209 and 210, however, the more virulent ones were races 56, 209 and 210.

Table (3):Avirulence/virulence formula of leaf rust pathotypes identified in Egypt in 2004/2005.

Pathotypes	Avirulence/virulence formula	Frequency
EL-56-1	36, 3bg, 25, 35, 37, 38, 39, 43, 45/	10%
EL-56-2	2a, 26, 36, 3bg, 23, 25, 34, 35, 37, 43, 45/	10%
EL-57-3	1, 2a, 24, 18, 36, 3bg, 14 a, 25, 35, 37, 39, 43, 45/	5%
EL-84-4	2a, 26, 30, 15, 36, 23, 35, 37, 38, 39, 43, 45/	5%
EL-108-5	2a, 24, 26, 3ka, 17, 36, 12, 33, 35, 37, 39, 43/	5%
EL-140-6	1, 2 a, 24, 26, 36, 3bg, 23, 25, 27, 34, 35, 37, 39, 45/	5%
EL-187-7	2c, 18, 14b, 15, 3bg, 29, 35, 37, 38, 39, 45, 47/	5%
EL-188-8	1, 2a, 26, 36, 3 bg, 23, 34, 35, 37, 38, 39, 45/	15%
EL-188-9	2a, 2c, 26, 36, 3bg, 23, 34, 35, 37, 38, 39/	
EL-188-10	24, 17, 18, 3bg, 23, 25, 33, 34, 35, 37, 39, 40, 43, 45/	
EL-201-11	1, 2a, 3, 24, 26, 11, 36, 3bg, 23, 34, 35, 37, 39, 45/	5%
EL-209-12	1, 2a, 15, 36, 32, 34, 35, 37, 38, 39, 43, 45/	30%
EL-209-13	1, 24, 26, 30, 36, 42, 36g, 23, 25, 34, 35, 37, 38, 39, 43, 45, 47	
EL-209-14	2a, 24, 25, 34, 35, 37, 38, 39, 43, 45/	
EL-209-15	2a, 24, 26, 36, 3bg, 23, 34, 35, 37, 39, 43, 45/	
EL-209-16	26, 2b, 36, 23, 25, 34, 35, 37, 39, 43, 45/	
EL-209-17	2a, 3, 9, 16, 26, 3Ka, 30, 36, 36g, 12, 23, 25, 28, 29, 34, 35, 37, 38, 39, 45/	
EL-210-18	2a, 26, 36, 3bg, 23, 25, 29, 34, 35, 37, 38, 39, 43, 45, 47/	15%
EL-210-19	2a, 26, 36, 3bg, 23, 35, 37, 38, 39, 43, 45/	
EL-210-20	2a, 24, 26, 30, 15, 36, 42, 3bg, 19, 23, 45, 28, 29, 34, 35, 37, 38, 39, 41, 43, 45/	

EL = Egyptian leaf rust races

The Lr's on the left side of the slash were written however those on the right were neglected.

Leaf rust resistance gene efficacy %:

Data presented in Table (4) revealed the efficacy of leaf rust resistance genes in controlling urediospore population in North Governorates during 2004/2005. These data indicated that the highest efficacy in controlling leaf rust was recorded with Lr's i.e. 35, 37, 39, 45, 36 and 2a. On the other hand, high virulent ratio were showed with Lr's 10, 21, 13, 22a, 22 b, 44, 46, B, 9, 16, 11, 2b, 14 b, 14a, 19, 27, 32, 40 and 41. The rest of the leaf rust monogenic liens lied in between.

Table (4):**Frequency of virulence *Puccinia triticina* pathotypes against 47 near-isogenic lines from leaf rust resistance samples collected in 2004/2005.**

No.	Line	No. of avirulent pathotype	No. of virulent pathotypes	No. of total pathotypes	Frequency of avirulent %	No.	Line	No. of avirulent pathotype	No. of virulent pathotypes	No. of total pathotypes	Frequency of avirulent %
1	Lr1	6	14	20	30	25	Lr19	1	19	20	5
2	2a	16	4	20	80	26	22 a	-	20	20	-
3	2 c	2	18	20	10	27	22 b	-	20	20	-
4	3	2	18	20	10	28	23	14	6	20	70
5	9	1	19	20	5	29	25	10	10	20	50
6	16	1	19	20	5	30	27	1	18	19	5
7	24	9	11	20	45	31	28	2	17	19	10
8	26	14	6	20	70	32	29	4	16	20	20
9	3ka	2	18	20	10	33	32	1	19	20	5
10	11	1	19	20	5	34	33	2	18	20	10
11	17	2	18	20	10	35	34	14	6	20	70
12	30	4	16	20	20	36	35	20	-	20	100
13	10	-	20	20	-	37	37	20	-	20	100
14	18	3	17	20	15	38	38	12	8	20	70
15	21	-	20	20	-	39	39	19	1	20	95
16	2 b	1	19	20	5	40	40	1	18	19	5
17	14 b	1	19	20	5	41	41	1	18	19	5
18	15	4	16	20	20	42	43	14	5	19	70
19	36	17	3	20	85	43	44	-	19	19	-
20	42	2	18	20	10	44	45	18	1	19	90
21	3 bg	15	5	20	75	45	46	-	20	20	-
22	12	2	18	20	10	46	47	3	17	20	15
23	13	-	20	20	-	47	B	-	20	20	-
24	14a	1	19	20	5						

Finally, races 201, 140, 57, 187 and 84 represented by 5% for each. They included (DQPT, FQTT, FRTP, RTTP and PSST), respectively.

For the performance of gene postulation a matching between 20 commercial wheat varieties and 47 leaf rust near-isogenic lines against 20 leaf rust isolates was studied. The infection type (low = L and High = H) produced of rust reaction. The near-isogenic lines 10, 21, 13, 22a, 22 b, 27, 28, 35, 37, 40, 41, 43, 44, 45, 46 and LrB were omitted because of high infection type with Lr10, 21, 13, 22a, 22 b, 44, 46 and B, while Lr35, 37 and 45 was low infection type. On the other hand, 28, 40, 41 and 43 were absent

to rust reaction by one isolate. As well as, Egyptian commercial wheat varieties i.e. Sakha8, Sakha69, Sakha93, Sids6, Sids7 and *Triticum spelta saharensis* were omitted because the reaction was high infection except Sakha8 was omitted due to its absent of rust reaction with one pathotype.

Table (5):Infection types produced by selected pathotypes of *Puccinia triticina* Pt isolated from North Governorates of Egypt against leaf rust resistance genes and differential sets samples under greenhouse conditions at seedling stage in 2004/2005.

No.	Pt. code	Lr genes sets															*
		1	2a	2c	3	9	16	24	26	3ka	11	17	30	10	18	21	2b	
1	DQPT	L	***L	**H	L			L	L		L							201
2	FQTT	L	L					L	L									140
3	PSTT		L						L									56
4	FRTP	L	L					L							L			57
5	FSTT	L	L						L									188
6	FTTT	L	L															209
7	FQST	L	L					L	L				L					209
8	RTTP			L											L			187
9	PSST		L						L				L					84
10	PRTT		L					L										209
11	TTTT																	56
12	PQHT		L					L	L	L		L						108
13	PQTT		L					L	L;									209
14	TSTS								L								L	209
15	MSTT		L	L					L									188
16	PSTT		L						L									210
17	PSTT		L						L									210
18	NDJT		L		L	L	L		L	L			L					209
19	PQST		L					L	L				L		L			210
20	TRRP							L				L						188

* Previous designation according to Mains and Jackson, 1926

** High infection type (H) ***Low infection type (L)

Table (6):Wheat leaf rust physiological races identified from 20 pathotypes of *Puccinia triticina* and their frequency (%) in North Governorate of Egypt in 2004/2005.

No.	Physiologic races	No. of pathotypes*	Frequency (%)
1	DQPT	1	5
2	FQST	1	5
3	FQTT	1	5
4	FRTP	1	5
5	FSTT	1	5
6	FTTT	1	5
7	MSTT	1	5
8	NDJT	1	5
9	PQHT	1	5
10	PQST	1	5
11	PQTT	1	5
12	PRTT	1	5
13	PSST	1	5
14	PSTT	3	15
15	RTTP	1	5
16	TRRP	1	5
17	TSTS	1	5
18	TTTT	1	5
Total		20	100%

* The number of pathotypes within each physiologic races

Data presented in (Table 7) showed that low infection type: High infection type (LIT: HIT) of 31 near-isogenic lines of leaf rust and 13 commercial wheat varieties against 20 physiologic races of *Puccinia triticina*. Several of the comparisons had cultures with a LIT on the near-isogenic lines and a HIT on the host. This demonstrated the absence of that Lr gene in the host. Examples are those cultivars and near-isogenic lines with a comparison type + in Table (7) e.g. Giza164 compared to Lr1. From this demonstrated that Giza164 does not have genes listed in Table (7) other than Lr14a. Absence of cultures in LIT: HIT (Category 0) comparison indicate the Lr gene could be present in the cultivar listed in Table 7. Lack of cultures in the LIT: HIT category in comparisons of Lr9, LR16 and LR14a with cultivars indicated that some of the cultivars studied have Lr9, Lr16 and Lr14a (Table 7).

The cultivar that were hypothesized to have Lr9, Lr16 and Lr14a by this method can be generally grouped together as sharing a common genes (Tables 7, 7a, 7b and 8). Comparison type o: Many of the cultivars probably have Lr9, Lr16 and Lr14a as indicated by the absence of cultures in LIT: HIT category in comparisons with these three near-isogenic lines .

Data presented in Table (7a) showed comparison between 31 monogenic liens of leaf rust (Lr's) and 13 Egyptian commercial wheat varieties against 20 physiologic races of *Puccinia triticina*.

Data showed that the cultivars Gemmeiza9, Gemmeiza10 and Gemmeiza7 probably have 13, 11 and 9 Lr's genes respectively were i.e. Lr's, 3, 9, 16, 3ka, 11, 26, 14b, 42, 12, 14a, 19, 29 and 47; 9, 16, 3ka, 17, 26, 42, 12, 14a, 19, 32 and 33; and 3, 9, 16, 3Ka, 11, 17, 12, 14a and 33 respectively.

Giza170 probable has Lr genes i.e. Lr's 3, 9, 16, 11, 2b and 32; while Sakha94 has Lr9, 16, 2b, 14a, 19 and 32, respectively.

The two wheat varieties Sids11 and Giza164 probably have two and one Lr genes were i.e. Lr9, Lr16; and Lr14a, respectively.

On the other hand, Giza160, Giza168, Sakha61, Sids1, Sids9 and Sids10 lack the tested resistance genes.

Data presented in (Table 7b) showed the probable resistance genes for leaf rust near-isogenic lines in some Egyptian commercial wheat varieties at seedling stage. Data showed that Lr9, Lr16 and Lr14a were the most frequency near-isogenic lines .

Data presented in Table (8) show the common gene amongst the Egyptian commercial wheat cultivars.

Comparison LIT: HIT indicated that the two cultivars compared share a common gene. Several of the cultivars have at least one gene in common as indicted by a lack of cultivars in LIT: HIT or HIT: LIT categories in comparisons among cultivars. Cultivar Sids11 probably carried at least one gene for leaf rust resistance found in either of tested varieties i.e. Giza170, Gemmeiza7, Gemmeiza9, Gemmeiza10 or Sakha94 this common gene probably Lr9 or Lr16 (Table 7, 7a and 8).

Table (7): The LIT: HIT (low infection type: high infection type) of 31 near-isogenic lines of leaf rust (Lr's) and 13 Egyptian commercial wheat varieties against 20 physiologic races of *Puccinia triticina* at seedling stage in 2004/2005.

	Lr1	Lr2a	2 c	3	9	16	24	26	3ka	11	17	30	18	26	14b	15	36	42	3bg	12	14 a	19	23	25	29	32	33	34	38	39	47
Giza160	+	-*	+**	+	+	+	+	-	-	+	+	+	+	+	+	+	-	+	-	+	+	+	-	-	+	+	+	+	-	-	+
Giza164	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0***	+	-	+	+	+	+	+	+	-	+
Giza168	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+
Giza170	+	+	+	0	0	0	+	+	+	0	+	+	+	0	+	+	+	+	+	+	+	+	+	+	+	0	+	+	+	+	+
Gemm. 7	+	+	+	0	0	0	+	+	0	0	0	+	+	+	+	+	+	+	+	0	0	+	+	+	+	+	0	+	+	+	+
Gemm. 9	+	+	+	0	0	0	+	+	0	0	+	+	+	0	0	+	+	0	+	0	0	0	+	+	0	+	+	+	+	-	0
Gemm. 10	+	+	+	+	0	0	+	+	0	+	0	+	+	0	+	+	+	0	+	0	0	0	+	+	+	0	0	+	+	-	+
Sakha61	+	-	+	+	+	+	+	-	+	+	+	+	+	+	+	+	-	+	-	+	+	+	-	+	+	+	+	+	-	-	+
Sakha94	+	+	+	+	0	0	+	+	+	+	+	+	+	0	+	+	+	+	+	+	0	0	+	+	+	0	+	+	+	-	+
Sids1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	-	-	+	+	+	-	+	+	+
Sids9	+	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	-	+	-	+	+	+	-	-	+	+	+	-	-	-	-
Sids10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	-	+
Sids11	+	+	+	+	0	0	+	-	+	+	+	+	+	+	+	+	-	+	-	-	+	+	-	-	-	+	+	-	-	-	-

* - = Indicated that the absence of such gene in Egyptian commercial wheat variety.

** + = Indicated either of hosts did not have the same gene

***0 = Indicated that the presence of such gene in commercial wheat variety and it may have another one's.

Table (7a):Probable resistance genes for leaf rust near-isogenic lines in some Egyptian commercial wheat varieties at Seedling stage in 2004/2005.

No.	Commercial varieties	Probable Lr's* genes
1	Giza160	-
2	Giza164	14 a,
3	Giza168	-
4	Giza170	3, 9, 16, 11, 26 and 32
5	Gemmeiza7	3, 9, 16, 3 ka, 11, 17, 12, 14a and 33
6	Gemmeiza9	3, 9, 16, 3ka, 11, 26, 14b, 42, 12, 14a, 19, 29 and 47
7	Gemmeiza10	9, 16, 3ka, 17, 26, 42, 12, 14a, 19, 32 and 33,
8	Sakha61	-
9	Sakha94	9, 16, 2b, 14a, 19 and 32
10	Sids1	-
11	Sids9	-
12	Sids10	-
13	Sids11	9 and 16

* Lr's = Leaf rust resistance genes.

Table (7b):The frequency of identified Lr's genes within Egyptian commercial wheat varieties at seedling stage in 2004/2005.

No.	Lr's* genes	No. of varieties carrying Lr gene	Frequency %
1	Lr1	0	-
2	2a	0	-
3	2c	0	-
4	3	3	15%
5	9	6	30%
6	16	6	30%
7	24	0	-
8	26	0	-
9	3ka	3	15%
10	11	3	15%
11	17	2	10%
12	30	0	-
13	18	0	-
14	2b	4	20%
15	14 b	1	5%
16	15	0	-
17	36	0	-
18	42	2	10%
19	3 bg	0	-
20	12	3	15%
21	14 a	5	25%
22	19	3	15%
23	23	0	-
24	25	0	-
25	29	1	5%
26	32	3	15%
27	33	2	10%
28	34	0	-
29	38	0	-
30	39	0	-
31	47	1	5%

Varity Sakha94 probably has at least one gene for leaf rust resistance found in either of Giza160, Sakha51, Sids9, Sids10 and Sids11 this common gene is probably Lr9, Lr16, Lr2b, Lr14a, Lr19 or Lr32. Cultivar Gemmeiza10 probably has at least one gene for leaf rust resistance found in either of Sids9 and Sids11 this common gene probably Lr9, Lr16, Lr3ka, 17, 2b, 42, 12, 14a, 19, 32 or 33. Gemmeiza9 probably has at least one common gene for resistance found in either of i.e. Giza160, Sakha61, Sids9 and Sids11 this common gene probably was i.e. Lr3, 9, 16, 3ka, 11, 2b, 14b, 42, 12, 14a, 19 or 29. Gemmeiza7 probably carried at least one gene for resistance found in either of Sids9 and Sids11 this common gene probably was i.e., Lr3, 9, 16, 3ka, 11, 17, 12, 14a or 33

Giza170 probably carried at least one gene for leaf rust resistance found in either of Giza160, Sids1, Sids9, Sids10 and Sids11 this common gene probably was Lr3, 9, 16, 11, 2b or 32 (Table 7 and 8).

On the other hand, Giza164 and Giza168 probably do not have any common gene in the tested commercial wheat varieties (Table 7 and 8).

Table (8):Comparison of 13 Egyptian commercial wheat varieties inoculated with physiological races of *Puccinia triticina* on the basis low infection type: High infection type (LIT: HIT) involved in the tested wheat cultivars.

Cultivars	Giza160	Giza164	Giza168	Giza170	Gem. 7	Gem. 9	Gem. 10	Sakha61	Sakha94	Sids1	Sids9	Sids10	Sids11
Giza160		+	0***	0	+	0	+	0	0	+	+	0	+
Giza164	+		+	+	+	+	+	+	+	+	+	+	+
Giza168	-*	+		+	+	+	+	+	+	-	+	+	+
Giza170	-	+	+		+	+	+	+	+	-	-	-	-
Gem. 7	+**	+	+	+		+	+	+	+	+	-	+	-
Gem. 9	-	+	+	+	+		+	-	+	+	-	+	-
Gem. 10	+	+	+	+	+	+		+	+	+	-	+	-
Sakha61	-	+	+	+	+	0	+		0	+	+	+	+
Sakha94	-	+	+	+	+	+	+	-		+	-	-	-
Sids1	+	+	+	0	+	+	+	+	+		+	+	+
Sids9	+	+	+	0	0	0	0	+	0	+		+	0
Sids10	-	+	+	0	+	+	+	+	0	0	+		+
Sids11	+	+	+	0	0	0	0	+	0	+	-	+	

* - =Indicated that the absence of such gene in Egyptian commercial wheat variety.

** + =Indicated either of hosts did not have the same gene

***0 = Indicated that the presence of such gene in commercial wheat variety and it may have another one's.

DISCUSSION

Leaf rust disease caused by (*Puccinia triticina*) was the first factor in failure of such cultivars, which was mainly due to the dynamic nature in population of the causal organism which produces new virulences having the ability to breakdown their resistance.

This investigation revealed the existence of 10 races of *Puccinia triticina* Erik. Race 209 occupied the first rank, representing (30%) from the total, followed by race 188 (15%), race 210 (15%) and race 56 (10%). The rest of tested races i.e. 57, 84, 108, 140, 187 and 201 each one represented

by (5%). Similar results were recovered by (Sherif *et al.*, 2002 and Najeeb *et al.*, 2005).

However (Nazim *et al.*, 1976; Imbaby and Ageez 1998 as well as Sherif *et al.*, 2002) found that race 77 was the highest frequency through the studied seasons 1971-1975, 1996-1998 and 2001, respectively. Also, this race was lack in the samples which were collected from Governorates i.e. Dakhalia, Damietta and Kafr El-Sheikh are located as a front toward the winds blown from North, bearing with a considerable quantity of primary inocula, rust uredinospores (Abd El-Hak *et al.*, 1974).

The presence of single race in certain location is relevant to the available of the distribution of the simultaneous cultivations of certain cultivar(s) in such location(s). Also, this phenomenon must be noticed subsequent growing seasons.

Similar results were recorded by (Nazim *et al.*, 1976 and 1983, Sherif *et al.*, 1996 and Imbaby and Ageez, 1998).

As for the gene efficacy (%) of the tested Lr's, the obtained results revealed the presence of high efficacy which were recorded with i.e. Lr's35, 37, 39, 45, 36, 2 and 3bg which represented 100%, 100%, 95%, 90%, 85%, 80% and 75%, respectively. Similar results were recorded by (Imbaby and Ageez, 1998 and Sherif *et al.*. 2002) who showed that Lr's 9, 21 and 31a, recorded high efficacy.

The matching between the infection type of 13 tested wheat cultivars and those of the 31 near isogenic lines (NIL's) against 20 pathotypes of *Puccinia triticina* to postulate the probable resistance genes in such cultivars were also studied.

The identification of virulence combination in Pt has been and will remain an integral part of resistance breeding program and studies concerning the epidemiology and evolution of virulence in the pathogen population. The virulence combinations were designated by a four-letter code (Long and Kolmer, 1989). The obtained results showed that out of 20 leaf rust pathotypes gives 18 virulence combination. Race PSTT was the more prevalent one and comprised 15% of the pathotypes. The rest of physiologic races constituted only 5% of the pathotypes from wheat. The two physiologic races i.e. PRTT and TTTT were recorded in 2003/2004 growing seasons. Similar results were reported by Najeeb *et al.* (2005) who showed that out of 107 leaf rust pathotypes gives 99 virulence combinations.

Breeding for disease resistance is considered to be the most economic procedure for controlling leaf rust disease. It requires the identification of the prevalent physiologic races of *P. triticina* and their component of effective genes conferring resistance to be utilized in better choice within the selected parents to enhance protection.

The obtained results indicated the possibility of the identification of 16 out of 31 of leaf rust resistance genes in the tested wheat varieties against 20 leaf rust pathotypes under greenhouse condition at seedling stage.

The postulated genes of leaf rust near-isogenic lines within Egyptian wheat varieties were Lr9 and Lr16 and presented in six commercial varieties.

Lr14a was probable and found in five commercial wheat varieties frequency with about 25%. Lr2b was postulated in presence in four commercial wheat varieties, it was represented by about 20%.

The near-isogenic lines i.e. Lr3, Lr3 Ka, Lr11, Lr12, Lr19 and Lr32 each one was postulated its presence in three Egyptian commercial wheat varieties, with frequency by about 15%. Lr17, Lr42 and Lr33 each of them was probable it presence in two commercial varieties were represented by about 10% Lr14b, Lr29 and Lr47 each of them was postulate it find in one commercial variety.

On the other hand, the rest of the leaf rust near-isogenic lines (15) were i.e. Lr1, 2a, 2c, 24, 26, 30, 18, 15, 36, 3bg, 23, 25, 34, 38 and 39 were postulated did not detected in any of the tested commercial wheat varieties. similar results were previously mentioned by (McVey, 1989; Najeeb *et al.*, 2005 and Roelfs and Martens, 1988).

Concerning the situation of the tested Egyptian commercial wheat varieties in relation to the identified leaf rust resistance genes, the results obtained gave an evidence to probably to the presence of 13 resistance genes in cultivar Gemmeiza9, followed by cv. Gemmeiza10 (11); Gemmeiza7 (9). The cultivars i.e. Giza170 and Sakha94 postulated their have six genes, Sids11 (2) and Giza164 probably it have one resistance gene.

The rest of commercial wheat varieties i.e. Giza160 Giza168, Sakha61, Sids1, Sids9 and Sids10 probably lack the tested resistance genes. Similar results were in according to these above mentioned by (McVey, 1989).

These results are limited by the number of pathotypes and available tester lines with single known Lr's gene. However, this would be an effective factor in the leaf rust disease resistance breeding programe.

Regarding to the comparison between the tested commercial wheat varieties. In all possible combination, the obtained results indicated that cultivars, belonging to the category (0) indicating that cv. Giza170 carried at least one gene for leaf rust resistance found in either of Giza160, Sids1, Sids9, Sids10 and Sids11. However, category (-) indicated that Giza170 for example carrying at least one gene not present in Giza168. Category (+) indicating that both cultivars carrying genes not present in other such as Giza164 and Sids11 for instance. The presence of such resistance genes was postulated regardless of their nomenclature owing to the absence of identified pathotypes of leaf rust in Egypt. Because Lr1, 2a and Lr10 alone do not provide adequate protection against the natural rust population and cultures virulent on these three combinations, (Statler *et al.*, 1982) many of cultivars have genes in addition to the above mentioned genes. In the future more attention should be given to make an accurate identification in case of facilities existence. Similar result were in according to those above mentioned by (Mousa *et al.*, 2004 and Statler, 1982).

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التخصص الفسيولوجى لفطر بكسينيا ترتيسينا وجينات المقاومة الفعالـــه لمـــرض صدأ أوراق القمح فى مصر

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من خلال تعريف السلالات الفسيولوجية القياسية الممرضة لفطر صدأ الأوراق فى القمح موســم ٢٠٠٤/٢٠٠٥م ، تلاحـــظ وجـــود عشـــرة ســـلالات فســـيولوجية قياســـية لفطـــر صـــدأ الأوراق (*Puccinia trticina* Eriks) ، وقد اشتملت تلك السلالات القياسية على ثمانية عشر طراز مرضى ، وقد كانت السلالة رقم ٢٠٩ أكثر انتشارا (٣٠%) يليها السلالة ١٨٨ والسلالة ٢١٠ حيث أن كلا مـــن هـــاتين السلالتين يمثل (١٥%). أما باقى السلالات وهى السلالة ٥٧ ، ١٨٤ ، ١٠٨ ، ١٤٠ ، ١٨٧ ، ٢٠١ كانت تمثل ٥% ، أما السلالة المتبقيه رقم ٥٦ فكانت تمثل ١٠%. الطرز المرضية الاكثر تكرارا فى التعريـــف الحديث فكانت PSTT. فضلا عن ذلك فإن جينات المقاومة الأكثر كفاءة لمرض صدأ الأوراق فى طـــور البادرة هى ٣٥ (١٠٠%) ، ٣٧ (١٠٠%) ، ٣٩ (٩٥%) ، ٤٥ (٩٠%) ، ٣٦ (٨٥%) ، ١٢ (٨٠%).

من جانب اخر فقد سجلت أكبر عدوانيـــة للجينـــات: ١٠ ، ١٣ ، ٢٢أ ، ٢٢ب ، ٤٤ ، ٤٦ ، B حيث أن كلا منها تمثل ١٠٠%.

احتمال وجود جينات مقاومة لصدأ الورقة فى ١٣ صنف قمح تقابل ٣١ جين وقد تبين احتمـــال وجود واحد جين Lr14a فى الصنف جيزه ١٦٤ واحتمال وجود Lr's 9,16,2b,14a,19 and 32 فى الصنف سخا ٩٤ واحتمال وجود Lr's3, 9, 16, 11, 26, and 32 فى الصنف جيزه ١٧٠ وجميـــزه ٩ يفترض أن بها ١٣ جين وجميزه ١٠ يفترض أن بها ١١ جين والصنف جميزه ٧ يفترض أنه يملك ٩ جين. على الجانب الاخر ، باقى الأصناف احتمال بنقصها هذه الجينات. هذه النتائج سوف تبقـــى جـــزء مكمـــل لبرامج التربية للمقاومة والدراسة المتعلقة بالوبائية وتطور العدوانية لمسبب مرض صدأ أوراق القمح فـــى مصر.