Egypt. J. Phytopathol., Vol. 41, No. 2, pp. 99-111 (2013)

Response of Ten Egyptian Wheat Cultivars to Infection by Stem Rust and Postulation of Resistance Genes

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Stem rust has been one of the most serious diseases on wheat in Egypt, particularly on the late sowings. The locally produced wheat cultivars have been developed as field resistant to stem rust regardless their reaction in terms of infection types. Many of them served in agriculture for long time since their release showing low levels of disease severity. Out of these cultivars, ten were tested in a randomized complete block design experiment, in four replicates for three seasons at two locations, *i.e*. Nubariya and Sids Agricultural Research Stations in Egypt. The experiment was surrounded by a spreader area of highly susceptible cultivars, inoculated with a mixture of rust races as source of inoculum. Rust data were recorded as rust severity (%). The area under disease progress curve (AUDPC) was estimated as a reliable and good measure of adult plant resistance (APR), partial resistance.

According to the levels of rust severity and AUDPC values, the tested cultivars could be classified into two main groups; a) slow rusting cultivars; including cvs. Sids 1, Sids 13, Gemmeiza 7, Giza 168, Sakha 93 and Sakha 94. b), and Fast rusting cultivars; including cvs. Giza 160, Giza 164, Sakha 8 and Sohag 3 showing high level of rust severity and high estimates of AUDPC.

Under greenhouse conditions, the numbers of probable genes for stem rust resistance were postulated by testing the ten local wheat cultivars and twenty monogenic lines for stem rust against fifteen cultures of *Puccinia graminis* f.sp. *tritici* [the cv. Giza 160, characterized by high level of rust severity and high estimates of AUDPC was used as check cultivar]. Gene postulation showed that the cvs. Giza 160 and Sakha 8 do not have any of the tested genes. In addition, the fast rusting cultivars, *i.e.* cvs. Giza 160, Giza 164, Sakha 8 and Sohag 3, have low number of genes (2 genes of the tested genes or not have any genes). While, the slow rusting cultivars, *i.e.* Sids 1, Sids 13, Gemmeiza 7, Giza 168, Sakha 93 and Sakha 94 have higher number of genes (from 4 to 13 of the tested genes).

As many as the resistance genes are accumulated in any wheat cultivar, both the rust severity and AUDPC value become lower and its resistance becomes more durable.

Keywords: Fast rusting, gene postulation, *Puccinia graminis* f.sp. *tritici*, resistance genes, slow rusting, stem rust and wheat cultivars.

Stem rust of wheat caused by *Puccinia graminis* f.sp. *tritici* Eriks. and Henn. (*Pgt*) is an important disease on wheat worldwide. *Pgt* is an obligate biotroph, heteroceous in its life cycle and heterothallic in mating type (Alexopoulos *et al.*, 1996). It is known to bear many physiologic races that are mainly resulted from mutation in the asexual cycle (Roelfs, 1985). The disease has been the most biotic constraint on wheat causing yield loss ranging from 30 to 70% on a susceptible variety (Ephrem *et al.*, 2000). However, this problem has been partially solved by the production and release of new cultivars having effective field resistance *i.e.* the first resistant cultivars are Giza 135 and Giza 139. Many wheat cultivars derived from these two cultivars possessing the same resistance were developed between 1950 to 1990. All of these cultivars characterized by their seedling susceptibility to most of the common physiologic races of stem rust, but in the same time they showed high levels of adult plant resistance under field conditions (Abd El-Hak and Kamel, 1973).

Occurrence of new races can be attributed to the migration from and outside the country which is considered a great threat to the Egyptian cultivars. Detection and spread of race TTKS, in East Africa, commonly known as Ug99, is of high significance on most wheat cultivars currently grown. Developing adapted resistant cultivars in a relatively short time for replacing the susceptible cultivars before rust epidemic to mitigate potential losses (Singh *et al.*, 2006). So, the panel recommends that breeding strategy could be implemented to incorporate diverse genetic resistance to such race into the susceptible genotypes.

The objectives of this study were to postulate seedling stem rust resistance gene(s) in 10 Egyptian wheat cultivars, using 20 monogenic lines, each caring single known gene for stem rust resistance (*Sr* gene). In addition, to study the adult plant resistance of these cultivars in field terms of their levels of filed resistance by using rust severity (%) and the area under disease progress curve (AUDPC) to estimate the level of partial resistance governed by the minor genes for stem rust resistance.

Materials and Methods

Resistance to stem rust (*Puccinia graminis* f.sp. *tritici*) was studied, in both seedling and adult plant stages of the following ten Egyptian wheat cultivars:

a) Giza cultivars (*Triticum aestivum*), *i.e.* Giza 160, Giza 164 and Giza 168.
b) Sakha cultivars (*T. aestivum*), *i.e.* Sakha 8, Sakha 93 and Sakha 94.
c) Gemmeiza cultivar (*T. aestivum*), *i.e.* Gemmeiza 7.
d) Sids cultivars (*T. aestivum*), *i.e.* Sids 1 and Sids 13.
e) Sohag cultivar (*T. durum*), *i.e.* Sohag 3.

Seedling resistance tests:

Ten local wheat genotypes and 20 monogenic lines for stem rust resistance (*Sr*'s) were tested against 15 cultures of *Puccinia graminis* f.sp. *tritici* collected from Egypt in 2009 and 2010 seasons. Infection type data were used to postulate genes for stem rust resistance (Stakman *et al*., 1962). All plant materials were grown in plastic pots, each contained four cultivars in clockwise way. Plants were tested on the first leaf stage, 10 days after sowing. Inoculation and incubation procedures were carried

out according to the method adopted by (Stakman *et al.,* 1962). The glasshouse temperature was between 22-25°C during the investigations. The host-pathogen interactions were recorded after 12- 15 days of inoculation following the modified scale as suggested by (Nayar *et al.*, 1994). Rust data were scored as infection type (IT), *i.e*. R: (0, 1 and 2) and S: (3 and 4) which were designated as LIT and HIT, respectively. Genes were postulated following the methods of Browder and Eversmeyer (1980), Statler (1984) and McVey (1989). The IT data produced on the local wheat cultivars and the monogenic lines were studied. Analyses were carried out by comparing the stem rust resistant with the local cultivars (possessing unknown *Sr* genes), according to the hypothesis of gene for gene (Flor, 1956 and 1971).

Adult plant resistance test:

To determine the level of adult plant resistance (field resistance), the ten Egyptian wheat cultivars were grown under field conditions in a randomized complete block design with four replicates; the experiments were carried out in three successive grown seasons; 2009, 2010 and 2011 at two locations, Sids and Nubariya Agriculture Research Stations. The plot size was 3×3.5=10.5 m^2 (1/400 feddan), each plot comprised of 6 rows with 3 m long and 30 cm apart. All recommended agricultural practices were carried out. The technical of the experiment was surrounded by spreader area planted with mixture of highly susceptible cultivars to stem rust, *i.e.* Max, Morocco and Giza 160 which acted as spreader for the disease. Artificial inoculation with a mixture of freshly collected uredospores of the most prevalent stem rust physiologic races and a talcum powder at a ratio 20:1 talcum powder: spores on all spreader plants. Dusting was carried out in the early evening (at sunset) before dew formation and when air was not yet still. Inoculation of all plants was carried out at booting stage according to the method of Tervet and Cassell (1951).

Stem rust severity (%) was recorded in all tested cultivars according to the modified Coobb's scale (Peterson *et al*., 1948) at 7 days intervals, after firstly appeared rust symptoms were firstly appeared on each tested cultivar. Also, the area under disease progress curve (AUDPC) value was calculated for each cultivar by using the quotation of Pandy *et al*. (1989). Statistical parameters, least significant differences (L.S.D at 5%) were used to compare yield components according to Snedecor (1957).

Results

Seedling resistance:

The reactions of the tested wheat cultivars were compared to the reactions of 20 wheat monogenic lines (*Sr, s*) against 15 cultures of stem rust (*Puccinia graminis* f.sp. *tritici*). Deference and similarity of the reaction in terms of infection types (IT) between the monogenic lines and the tested cultivars were used to postulate gene(s) for resistance. Results in Tables (1 and 2) show that no avirulent isolates of the casual organism against cvs. Giza 160 and Sakha 8 were detected. This means that cvs. Giza 160 and Sakha 8 have gene(s) that were not encountered in the tested *Sr* lines set. Also, few isolates were a virulent to cv. Sohag 3, so data obtained could

Table 1. Seedling reactions of twenty wheat monogenic lines carrying single gene for stem rust resistance against 15 isolates of *Puccinia graminis* f.sp. *tritici* under greenhouse conditions during 2010/2011 growing season

No.	Monogenic line (*Sr's*)	Wheat stem rust isolate/Stem rust infection type														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	5			L	L	L		L								
2	9e				L											
3	9g	L			L	L	L							L	L	
4	9d	L		L						L		L	L	L		
5	10					L										L
6	13					L					L					
7	15		L	L		L					L	L				
8	16					L										
9	22	L	L	L	L	L	L	L		L	L	L	L	L	L	L
10	29				L							L				
11	30	L	L		L											
12	17			L	L	L										
13	7a				L	L			L							
14	26		L		L											
15	34				L		L									L
16	35		L	L										L		L
17	Tmp		L			L		L		L			L			
18	Pl			L		L									L	L
19	TT3			L	L	L	L	L					L			
20	Wld			L	L	L		L				L				

L: Low infection type. (Blank) High infection type

Table 2. Seedling reaction of ten Egyptian wheat cultivars against 15 isolates of *Puccinia graminis* f.sp. *tritici* under greenhouse conditions

No.	Wheat cultivar	Wheat stem rut isolate/Stem rust infection type														
		1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Giza160															
2	Giza 164		L			L	L		L							L
3	Giza168	L	L	L	L	L	L	L	L			L				
4	Gemmeiza 7	L	L	L	L	L	L	L		L	L	L	L	L		L
5	Sids 13	L	L	L	L	L	L	L	L							
6	Sakha 8															
7	Sakha 93	L		L	L	L	L				L			L		
8	Sakha 94		L	L	L		L							L		
9	Sids 1	L		L	L		L	L			L			L		
10	Sohag 3		L			L	L		L							L

* L: Low infection type. Blank: High infection type.

not accurately postulated all genes in this cultivar. On the other hand, virulent and avirulent isolates to the rest of the tested cultivars were available. Thus, genes for stem rust resistance in these cultivars could be postulated. Comparison between the different *Sr* monogenic lines and the local cultivars revealed the probability of genes for resistance in these cultivars, *i.e.* cv. Gemmeiza7 was resistant to 10 isolates, however, it probably carries genes; *Sr 5*, *Sr 9e*, *Sr 9g*, *Sr 10*, *Sr 13*, *Sr 15*, *Sr 16*, *Sr 22*, *Sr 29*, *Sr 30*, *Sr 17*, *Sr 34* and *Sr Tmp*. Also, from the comparison between its reaction and *Sr* genes reactions, it seemed that this cultivar probably has additional genes for stem rust resistance; cv. Giza 168**.** showed LIT to 9 cultures, thus; it probably carries ten tested *Sr* genes; *Sr 5*, *Sr 9e*, *Sr 9g*, *Sr 30*, *Sr 16*, *Sr 17*, *Sr 7a*, *Sr 26*, *Sr Tmp* and *Sr Tt3* and it has addition to other resistance gene(s); cv. Sids 13 showed LIT to 8 cultures, thus; it probably carries nine tested *Sr* genes; *Sr 5*, *Sr 9e*, *Sr 16*, *Sr 30*, *Sr 17*, *Sr 7a*, *Sr 26*, *Sr Tmp* and *Sr Tt3* and it has addition to other resistant gene(s).

Cultivar Sids 1 gave low infection type (LIT) to 7 cultures thus; it probably carries five tested *Sr* genes; *Sr 5*, *Sr 9e*, *Sr 9g*, *Sr 16* and *Sr 17* and it have addition to other resistant gene(s); cv. Sakha 93. gave low infection type (LIT) to 7 cultures thus; it probably carries five tested *Sr* genes; *Sr 5*, *Sr 9e*, *Sr 9g*, *Sr 16* and *Sr 17* and it have addition to other resistant gene(s); cv. Sakha 94. gave low infection type (LIT) to 5 cultures, thus; it probably carries four tested *Sr* genes; *Sr 5*, *Sr 9e*, *Sr 16* and *Sr 17* and it has addition to other resistance gene(s); cv. Giza 164. Was resistant to 5 isolates; however, it probably carries two genes; *Sr 16* and *SrTmp*. Also, from the comparison between its reaction and *Sr* genes reactions, it seemed that this cultivar probably has additional genes for stem rust resistance; cv. Sohag 3. This cultivar was resistant to 5 isolates; however, it probably carries genes; *Sr 16* and *SrTmp*. Also, from the comparison between its reaction and *Sr* genes reactions, it seemed that this cultivar probably has additional genes for stem rust resistance; the check wheat cultivars Giza 160 and Sakha 8 showed high infection types against all the tested rust isolates and none of the tested genes were postulated.

The postulated genes for stem rust resistance that were detected in the ten cultivars revealed the presence of 16 stem rust resistance genes (Tables 3& 4). Gene *Sr 16* proved to be the most frequent gene that was postulated in 8 out of 10 Egyptian wheat genotypes under study (80.0% frequency) followed by *Sr 5*, *Sr 9e* and *Sr* 17 (60.0 % each), *SrTmp* (50.0 % frequency), *Sr* 9g (40.0 % frequency), *Sr* 30 (30.0 % frequency), *Sr*,s 7a, 26 and Tt3 (20.0 % each) and *Sr*,s 10, 13, 15, 29 and 34 (10.0% each).

Adult plant resistance:

Data presented in Table (5) indicate that the stem rust epidemic in 2008/09 was more severe than that happened in the other two growing seasons 2009/10 and 2010/11. However, the stem rust severity in most of the tested wheat cultivars was higher in 2008/09 season than that in the other two seasons 2009/10 and 2010/11. Results showed that the tested wheat cultivars exhibited different reactions in the two locations at different levels of stem rust severity (%); In the First growing season (2008/09): the tested wheat cultivars gave different reactions in the two locations at different levels of stem rust severity (%).

Table 3. Probable resistance genes for stem rust (*Sr,s*) in ten Egyptian wheat cultivars

No.	Wheat cultivar	Probable *Sr,s* genes for stem rust infection type
1	Giza160	Not found
2	Giza 164	16, Tmp?*
3	Giza168	5, 9e, 9g, 16, 30, 17, 7a, 26, Tmp, Tt3?
4	Gemmeiza7	5, 9e, 9g, 10, 13, 15, 16, 22, 29, 30, 17, 34, Tmp?
5	Sids 1	5, 9e, 9g, 16, 17
6	Sids 13	5, 9e, 16, 30, 17, 7a, 26, Tmp, Tt3?
7	Sakha 8	Not found
8	Sakha 93	5, 9e, 9g, 16, 17?
9	Sakha 94	5, 9e, 16, 17?
10	Sohag 3	16, Tmp?

*? = additional genes may be found

Table 4. Frequency (%) of probable genes for stem rust resistance (*Sr,s* genes) detected in ten Egyptian wheat cultivars

No.	Monogenic line (*Sr,s*)	No. of cultivars caring *Sr,s* genes	Gene frequency (%)
1	5	6	60.0
2	9e	6	60.0
3	9g	4	40.0
4	9d	0	00.0
5	10	1	10.0
6	13	1	10.0
7	15	1	10.0
8	16	8	80.0
9	22	0	00.0
10	29	1	10.0
11	30	3	30.0
12	17	6	60.0
13	7a	2	20.0
14	26	2	20.0
15	34	1	10.0
16	35	0	00.0
17	Tmp	5	50.0
18	Pl	0	00.0
19	TT3	2	20.0
20	Wld	0	00.0

Table 5. Final stem rust severity on 17 wheat cultivars grown at Nubariya and Sids Agric. Stations during three successive seasons (2008/09 to 2010/11)

No.	Cultivar	Location / Season / Final stem rust severity (%)*					
		Nubariya	Sids	Nubariya	Sids	Nubariya	Sids
		2008/09		2009/10		2010/11	
1	Sids1	20S	20S	10S	10S	30MS	20MS
2	Sids13	30MS	30MS	20MS	10MS	20MS	20MS
3	Gemmeiza7	20S	20S	10S	10S	10S	5S
4	Giza160	80S	70S	70S	60S	60S	50S
5	Giza164	60S	50S	50S	40S	40S	40S
6	Giza168	30MS	20MS	10MS	10MS	20MS	20MS
7	Sakha8	70S	60S	60S	50S	50S	50S
8	Sakha93	30S	5S	10S	10S	20S	5MS
9	Sakha94	30S	20S	20S	20S	30S	20S
10	Sohoge3	60S	40S	40S	30S	30S	30S
L.S.D. at 5%		0.73	0.69	0.93	1.12	0.34	1.32

* Rust response was recorded as stem rust severity (%), followed by rust infection type.

According to the response of the tested wheat cultivars, it could be divided into two groups in each of the tested growing seasons, as follows:

In the first growing season (2008/09):

a. Low level of stem rust severity group (up to 30%) included cvs. Sids 1, Sids 13, Gemmeiza 7, Giza 168, Sakha 93 and Sakha 94 at Nubariya and Sids locations.
b. Highly susceptible cultivars group stem rust severity (more than 30%) included cvs. Giza 160, Giza 164, Sakha 8 and Sohag 3 at the two locations.

In the second growing season (2009/10):

a. Low level of stem rust severity group (up to 30%) included cvs. Sids 1, Sids 13, Gemmeiza 7, Giza 168, Sakha 93 and Sakha 94 at Nubariya and Sids locations.
b. Highly susceptible cultivars of stem rust severity (more than 30%) including cvs. Giza 160, Giza 164, Sakha 8 and Sohag 3 at Nubariya and Sids locations.

In the third growing season (2010/11):

a. Low level of stem rust severity (up to 30%) including cvs. Sids 1, Sids 13, Gemmeiza 7, Giza 168, Sakha 93 and Sakha 94 at Nubariya and Sids locations.
b. Highly susceptible cultivars of stem rust severity (more than 30%) including cvs. Giza 160 (60S, 50S), Giza 164 (40S, 40S), Sakha 8 (50S, 50S) and Sohag 3 (30S, 30S) at Nubariya and Sids locations, respectively.

Area under disease progress curve (AUDPC):

On the basis of AUDPC values, the tested wheat cultivars could be classified into two main groups. The first group included the wheat cultivars which displayed the lowest AUDPC values (less than 300) and were characterized as partially resistant cultivars "the slow-rusters" The second group included wheat cultivars which revealed higher values of AUDPC (more than 300) and were identified as "the fast-rusters".

Data in Table (6) indicate that the stem rust epidemic in 2008/09 was more severe than that happened in the other two growing seasons 2009/10 and 2010/11. However, the AUDPC in most of the tested wheat cultivars was higher in 2008/09 season than that in the other two. The AUDPC recorded in 2008 / 09 was higher on all wheat cultivars at Nubariya than at Sids stations. On the basis of AUDPC, the tested cultivars can be divided into the following two groups; the first group is slow-rusting cultivars (Sids 1, Sids 13, Gemmeiza 7, Giza 168, Sakha 93 and Sakha 94) at Nubariya and Sids locations; The second group is fast-rusting cultivars Giza 164, Giza 160, Sakha 8, and Sohag 3 at Nubariya and Sids locations.

Table 6. Area under disease progress curve (AUDPC) on 17 wheat cultivars grown at Sids and Nubariya during three successive growing seasons (2008/09-2010/11)

No.	Cultivar	Location/ Season/AUDPC*					
		Nubariya	Sids	Nubariya	Sids	Nubariya	Sids
		2008/09		2009/10		2010/11	
1	Sids1	287.0	66.5	161.0	84.0	238.0	126.0
2	Sids13	133.0	42.0	126.0	77.0	133.0	84.0
3	Gemmeiza7	145.5	77.0	101.5	73.50	42.0	133.0
4	Giza160	532.0	427.0	497.0	497.0	497.0	542.5
5	Giza164	357.0	322.0	357.0	305.0	322.0	301.0
6	Giza168	129.5	73.5	73.5	73.5	126.0	126.0
7	Sakha8	427.0	392.0	462.0	392.0	357.0	392.0
8	Sakha93	182.0	66.5	91.0	77.0	119.0	49.0
9	Sakha94	392.0	182.0	182.0	182.0	217.0	182.0
10	Sohoge3	357.0	357.0	330.0	301.0	321.0	315.0
L.S.D. at 5%		9.23	12.49	7.83	13.92	12.34	15.12

*****AUDPC was estimated according to the equation of Pandy *et al*. (1989).

Discussion

In the present study, the probability of the presence of 16 *Sr's* genes in ten Egyptian cultivars, except cvs. Sakha 8 and Giza 160, was detected. The combination of several effective resistance genes into a single cultivar should extend than single seedling genes (Roelfs *et al.*, 1992 and Li *et al.*, 2010).

Gene postulation at seedling stage and gene expression under field conditions may lead to the conclusion that if any cultivar proved to have only one single gene for stem rust resistance, it doesn't lead to durable resistance due to the rapidly development of a new physiologic race of the fungus, that may defeat and overcome this gene after its incorporation into the concerned wheat cultivars. Therefore, this cultivar will be discarded soon after it's released (Liu and Kolmer, 1997; Sawhney, 1998; Abdelkader *et al.*, 2010 and Hassan *et al.*, 2012).

Regarding the situation of the tested cultivars in relation to the postulated genes, the obtained results gave an evidence to the probability of the presence of 16 *Sr's*

genes, *i.e.* in Gemmeiza 7 (13 *Sr's* genes) followed by Giza 168 (10*Sr's* genes), Sids 13 (9*Sr's* genes), Sids 1 and Sakha 93 (5*Sr's* genes each), Sakha 94 (4*Sr's* genes), Giza 164 and Sohag 3(2*Sr's* each).Whereas, the wheat cultivars Giza 160 and Sakha 8 do not contain any resistance genes of the *Sr* set and cultures that were used in this study. These results are in accordance with these previously reported by Singh *et al.* (2008) and Imbaby (2007). Pyramiding of multiple stem rust resistance genes into one cultivar will be necessary for long-term control of stem rust. One of the major factors for successful control of stem rust in North America has been the development of cultivars carrying multiple *Sr's* genes (Zhang *et al.,* 2009). These results are in agreement with those previously reported by Nazim *et al*. (2001) and Hassan (2006). On the other hand, one of the several wheat with durable resistance to stem rust is reported to carry *Sr 2, Sr 5, Sr 6, Sr 7a, Sr 8, Sr 9b, Sr 12* and *Sr 13* (Singh and McIntosh, 1986). In contrast, *Sr 5* and *Sr Tmp* were effective and included in most of cultivars, respectively and are effective to all races of Ug 99 tell now which confirms the report of Singh *et al.* (2006).

On the basis of the AUDPC values the tested cultivars can be divided into two groups; the first group includes the slow-rusting cultivars, Sids 1, Sids 13, Gemmeiza 7, Giza 168, Sakha 93 and Sakha 94 at Nubariya and Sids locations. The second group included the fast-rusting cultivars, Giza 164, Giza 160, Sakha 8, and Sohag 3. The combination of several effective resistance genes into single cultivars should extend the period of resistance slow rusting or partial resistance has been reported to be a more durable resistance than single seedling resistance genes (Wilcoxson *et al*., 1974; 1975; Broers, 1989; Nazim *et al.,* 1990, Roelfs *et al.,* 1992, Negm, 2004 and Li *et al.,* 2010). This is due to, the accumulation of more than one stem rust resistance genes within the same cultivar, each conferring resistance against common race spectrum and to diversity of stem rust resistance, is often leads to achieve more durability for this type of resistance genes have been accumulated into any wheat germplasm, both rust severity (%) and the area under disease progress curve (AUDPC) became lower and the adult plant resistance became long lasting and more durable (Brunner *et al.,* 2010; Youssef *et al.,* 2012 and Hassan *et al.,* 2012).

As many as the resistance genes are accumulated in any wheat cultivar, both the rust severity and AUDPC value become lower and its resistance become more durable, Pyramiding of race-specific resistance genes and the use of more durable, race nonspecific resistance genes are strategies to avoid rapid adaptation of pathogens in the field (Brunner *et al.,* 2010; Lagudah, 2011; Mago *et al.,* 2011 and Sun *et al.,* 2009).

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(Received 15/09/2013;
in revised form 16/10/2013)

استجابة عشرة اصناف قمح مصرية للإصابه بصدأ الساق وتوقع جينات المقاومة بها

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يُعد مرض صدأ الساق من أكثر الأمراض خطورة علي القمح, خاصة عند تأخير الزراعة, ولذلك روعي عند تربية وانتاج اصناف قمح جديدة ان تتمتع بمقاومة حقلية لصدأ الساق, منها ما ظل لفترات طويلة وتتميز بمستوي منخفض من شدة الأصابة ومنها ما يصاب بدرجة عالية ويتم استبعاده من السياسة الصنفية المتبعة في جمهورية مصر العربية. ويهدف هذا البحث الى دراسة المقاومه طويلة الأمد فى بعض اصناف القمح المصريه ضد صدأ الساق, تم اختيار عشرة اصناف مصرية وتم تصميم تجربة بنظام عشوائي في أربع مكررات علي مدي ثلاث مواسم متتالية في جهتين مختلفتين (محطة بحوث النوبارية و محطة بحوث سدس). واحيطت التجربة بأصناف عالية القابلية للأصابة وناشرة للمرض, واجريت عدوي هذة الأصناف بخليط من سلالات الفطر *Puccinia graminis* f.sp. *tritici* وتم تسجيل شدة الأصابة (%) وحساب المساحة الواقعة تحت المنحنى المرضي, ووفقاً لشدة الإصابة والمساحة تحت المنحني المرضي أمكن تقسيم الأصناف تحت الدراسة الي قسمين رئيسيين كالأتي: أ) اصناف بطيئة الصدأ, وهي سدس ١ وسدس ١٣ وجميزة ٧ وجيزة ١٦٨ وسخا ٩٣ وسخا ٩٤. و ب) اصناف سريعة الصدأ وهي جيزة ١٦٠ وجيزة ١٦٤ وسخا ٨ وسوهاج ٣.

بالإضافة إلى ذلك تم مقابلة هذه الأصناف مع ٢٠ سلالة أحادية الجين لصدأ الساق ضد ١٥ عزلة من الفطر *P. graminis* f.sp. *tritici* (الصنف جيزة ١٦٠ والصنف سخا ٨ والتي تميزت في هذة الدراسة بمستوي عالي من المساحة تحت المنحني المرضي, لم يوجد بها اي من الجينات تحت الدراسة) من جهة اخري كانت الأصناف بطيئة الصدأ هي سدس ١ وسدس ١٣ وجميزة ٧ وجيزة ١٦٨ وسخا ٩٣ وجد بها من ٤ الي ١٣ جين من جينات مقاومة صدأ الساق تحت الدراسة. نستنتج من هذه الدراسة أنه كلما تمتع الصنف بعدد اكبر من الجينات كلما أدي ذلك الي انخفاض المساحة تحت المنحني المرضي والمقاومة للمرض تكون أطول.