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EVALUATION OF SLOW WHEAT STEM RUSTING OF SOME EGYPTIAN CULTIVARS AT SEEDLING AND ADULT STAGES

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ABSTRACT

Stem rust *(Puccinia graminis* f.sp *tritici)* is a severe widespread disease of wheat in Egypt. The present investigation is concerned with the evaluation of fifteen wheat cultivars for slow rusting at seedling and adult stages. The obtained results indicated that, Beni-Sweif-4, Beni-Sweif-6 and Misr-1 wheat cultivars proved to be highly resistant which exhibited the longest incubation period and latent period at seedling stage under greenhouse conditions. While, Sids-12 and Giza-168 cultivars proved to be resistant which showed intermediate incubation as well as latent periods as indicated by the lowest No. of pustules/cm^2 and pustule size. The cultivars Gemmeiza-10, Gemmeiz-7, Sids-13 and Gemmeiza-11 showed intermediate incubation and latent periods and exhibited moderate resistant reaction (infection type 2), intermediate No. of pustules/cm^2 and pustule size. On contrast, Sids-6 showed the shortest incubation and latent periods and the highest susceptible reaction. At adult stage, Gemmeiza-11, Sids-13 and Beni-Sweif-5 proved to be highly resistant cultivars during the two tested seasons (2009-2010 and 2011-2012). However, fluctuation in reaction was observed in case of some cultivars *i.e.,* Beni-Sweif-4, Beni-Sweif-6 and Shandwel-1 which showed highly resistant to the disease in 2009-2010 season, while they exhibited low susceptible reaction in 2011-2012 season. However, some wheat cultivars showed susceptible response along the two seasons *i.e.,* Sakha-93, Gemmeiza-7, Gemmeiza-10, Sids -6, Sids-12, Giza-168, Misr-1, and Misr-2 with low disease severities. The highest value of area under disease progress curve (AUDPC) was detected on Sids-6 wheat cultivar, while, low values were recorded with Beni-Sweif-4 and Shandwel-1 cultivars. Certain wheat varieties were susceptible to stem rust at seedling stage and became resistant as they approached maturity.

Key words: Wheat, steam rust, slow rust, incubation period, pustule size, AUDPC

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important grain crops to the humans in all over the world. Rust diseases have been a major concern and are considered the serious problems for breeders, farmers and commercial seed companies (Marsalis and Goldberg, 2006). However, wheat rusts have been reported as devastating, having the ability to destroy entire susceptible wheat crops resulting in large economical losses (Singh *et al.,* 2005 and Kuraparthy *et al.,* 2007). In recent years, the spread of new rust races across continentals has complicated the development of new resistant cultivars with durable rust resistance (Kolmer, 2005). These new virulent races, together with breeding objectives of high-yielding, pure and uniform varieties worldwide, have reduced the genetic base for disease resistance, affecting the number of potentially effective rust genes available for new cultivar development (Kolmer, 2005 and Kuraparthy *et al.,* 2007).

The objective of the present study is to evaluate some commercial wheat cultivars toward infection with stem rust disease by using different measures.

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MATERIALS AND METHODS

Evaluation of some Wheat Cultivars at Seedling Stage under Greenhouse Conditions (Slow Rusting Resistance)

Fifteen wheat cultivars were evaluated for slow rusting in the Gemmeiza glasshouse, Dept. of wheat diseases, ARE. In 2011/ 2012 seasons (Table 1). Five seedlings of each cultivar grown in 7 cm diameter plastic pots, were inoculated in the first leaf stage with urediospores of TTKTF pathotype of *P. graminis* f.sp. *tritici* which were kindly provided by wheat Dis. Res. Dept., Plant Pathol. Res., Inst., ARE mixed with talcum powder of (1:5) (w: w) according to (Tervet and Cassel, 1951). Three pots (replicates) were used for each cultivar. After 24 hr. of incubation in dew chamber fewer than 100% relative humidity, the inoculated seedlings were shifted to glasshouse benches where the temperature during the period of study remained at 22 ± 2°C with approximately 80% relative humidity. Wheat seedlings were investigated daily for pustules appearance. The number of pustules/ cm^2 was counted for each leaf and pot / cultivar. The following parameters were calculated for each cultivar which was measured on the first leaf:

Incubation period–number of days between inoculations to the appearance of the first pustule.

Latent period–was measured according to (Parlevliet, 1975) by counting the number of visible pustules on marked leaves daily until no more pustules appeared. From these data, time between inoculation and 50% of the pustule just visible was estimated.

Infection type- five infection types were used according to (Stakman *et al.* 1962), *i.e.*, 0, 0; 1 and 2 (Resistant infection type), 3 and 4 (Susceptible infection type) as shown in Table 2.

Number of pustules /cm^2 (No.p./cm^2)-number of pustules per unit leaf area cm^2 (2.0 x 0.5 cm) on the upper side of the leaves were counted as described by (Parlevliet and Kuiper, 1977).

Pustule size (PS)-Pustule size was measured using the light microscope at 10x power magnification. Leaves were sampled 20 days after inoculation and pustules were fixed in boiled mixture of lactophenol and ethanol solution (1:2, v/v) for 3 minutes. Length (L) and width (W) of 10 randomly chosen pustules per one leaf were measured following formula suggested by (Broers, 1989) as follows:

$$\text{Pustule size} = 1/4 \times \pi \, L \times W \quad (\pi = 3.14)$$

Where; (L) was the length while (W) was the width of each pustule.

Evaluation of some Wheat Cultivars under Field Conditions

The previous wheat cultivars were sown in two sets. Each cultivar was planted in two rows, 3 m. length, and 20 cm apart, 3 g seeds per row. The experiment was laid out in Randomized Complete Block Design with factorial arrangement in three replicates. The experiment was surrounded by a border of highly susceptible wheat cultivars. The border of the first set of cultivars was inoculated with a mixture of stem rust urediospores at the rate of (1:20, w: w) using baby cyclone according to (Tervet and Cassel, 1951), to ensure uniform spread of inoculum and sufficient disease development. However, the second set of varieties was completely protected using the systemic fungicide "Sumi-8 EC" at the rate of 35 ml/100L water and sprays repeated every 15 days.

Disease assessment

Wheat stem rust severity was estimated for each variety as proportion of the stem of a plant affected by the disease according to (Peterson *et al.*, 1948), every 10 days interval from the time of symptom appearance. Records of disease severity were served in calculating area under disease progress curve (AUDPC) adopted by Pandy *et al.* (1989) as follow:

$$AUDPC = D[\tfrac{1}{2}(Y_1+Y_k) + Y_2 + Y_3 + . + Y_{k-1}]$$

Where :

D = time interval.

(Y_1+Y_k)=Sum of first and last disease scores.

$(Y_2 + Y_3 + \ldots + Y_{k-1})$ = Sum of all in-between disease scores

Statistical analysis procedure: All data were subjected to statistical analysis according to the procedures "ANOVA" reported by (Snedecor and Cochran, 1980). Treatments means were compared by the Least Significant Difference test (L.S.D) at 5% probability level (Duncan, 1955).

Table 1. List of 15 Egyptian wheat cultivars and their pedigree

No.	Cultivar	Pedigree
1	**Sakha 93**	Sakha 92/TR810328 S 8871-1S-2S-1S-0S.
2	**Sakha 94**	Opata/Rayon//KauzCMBW9043180-OTOPM-3Y-010M-010M-010Y-10M-015Y-0Y
3	**Gemmeiza-7**	CMH74A .630/5X//Seri 82/3 Agent CGM.4611-2GM.-3GM.-1GM.-0CM
4	**Gemmeiza-10**	Maya 74"S"/on / 1160- 147 /3/ Bb / G11 /4/ chat "S"/5/ crow "S"CGM 5820-3GM- 1GM- 2GM- 0GM
5	**Gemmeiza-11**	BOW"S" /KVZ"S"// 7C/SERI82/3/GIZA168 /SKHA61.
6	**Sids-6**	Maya"S"/Mon"S"//CMH74A.592/3/Sakha8*2SD/10002
7	**Sids-12**	BUC//7C/ALD/5/MAYA74/ON//1160-147/3/BB/GLL/4/CHAT"S"/6/MAYA/VUL//CMH74A.630//4*SX.
8	**Sids-13**	AMAZ 19=KAUZ"S"//TSI/SNB"S".
9	**Giza 168**	MRL/BUC//Seri.CM93046-8M-0Y-0M-2Y-0B
10	**Beni Sweif-4**	DIPPERZ/BUSHEN3.
11	**Beni Sweif-5**	DIPPERZ/BUSHEN3CDSS92B1281-M-OY-OM-OY-3B-OY-OSD.
12	**Beni Sweif-6**	Jo"s"/AA"s"//Fg"s".
13	**Shandawel-1**	SITE/ MO/4/NAC//3*PVN/3/MiRLO.
14	**Misr-1**	OASIS/SKAUZ//4*BCN1312*PASTOR.
15	**Misr-2**	SKAUZ/BAV92.

Table 2. The infection types of wheat stem rust reactions adopted by Stakman *et al.* (1962) at seedling stage

Infection Type			Symptoms
0	**Low**	**R***	No uredia or other macroscopic sign of infection.
0;			No uredia, but hypersensitive necrotic or chlorotic flecks of varying size present.
1			Small uredia often surrounded by necrosis.
2			Small to medium uredia often surrounded by chlorosis or necrosis.
3	**High**	**S****	Medium-sized uredia that may be associated with chlorosis or rarely necrosis.
4			Large uredia without chlorosis or necrosis.

*R: Resistant **S: Susceptible

RESULTS AND DISCUSSION

Evaluation of some Egyptian Wheat Cultivars at Seedling Against Stem Rust Disease (under Greenhouse Conditions)

Data in Table 3 clear the mean of incubation period, latent period, infection type, No., of pustules/cm^2 and pustule size in mm^2 of fifteen Egyptian wheat cultivars. Significant differences were recorded between the tested cultivars according to the previous parameters. Among the tested cultivars, Beni-Sweif-4, Beni-Sweif-6 and Misr-1 proved to be highly resistant which exhibited the longest incubation period and latent period (8 and 11 days for each, respectively), hypersensitive reaction (0;) and (0.0) number of pustules/cm^2. Sids-12 and Giza-168 cultivars were resistant which showed intermediate incubation and latent period (6 and 9 days for each, respectively), resistant infection type (1), the lowest No., of pustules/cm^2 (3.6 and 4.6) and pustule size (0.0523 and 0.0779). Wheat cultivars, Gemmeiza-10, Gemmeiz-7, Sids-13 and Gemmeiza-11 showed intermediate incubation and latent periods (6 and 9 days for each, respectively), moderate resistant infection type (2), low No., of pustules/cm^2 (5.2, 5.3, 6.4 and 7.13) and pustule size (0.0643, 0.0903, 0.0729 and 0.0798). On contrast, Sids-6, Sakha 93 and Sakha 94 were susceptible which showed the shortest incubation and latent periods, susceptible infection type (4), high No., of pustules/cm^2 and large pustule size.

These findings were in agreement with (Lee and Shaner, 1985) who found a high positive correlation between latent period and slow rusting. Also, these data are in the line with (Torabi, 1992) who found that the latent period was connected to the reaction type in which the cultivars with susceptible reaction types had shorter latent periods compared with those possessing resistant reactions.

Evaluation of some Egyptian Wheat Cultivars at Adult Stage (under Field Conditions)

Data in Table 4 show the existence of significant differences between the tested cultivars and the growing seasons concerning with final disease severity, and area under disease progress curve. The cultivars Gemmeiza-11, Sids-13 and Beni-Sweif-5 proved to be highly resistant ones during the two tested seasons, releasing zero infection type consequently zero area under disease progress curve.

Great changes were observed, in case of Beni-Sweif-4, Beni-Sweif-6 and Shandwel-1 which showed highly disease resistant in 2009-2010 season (zero disease severity), and low susceptible disease severity in 2011-2012 season. On contrast, some wheat cultivars *i.e.* Sakha-93, Gemmeiza-7, Gemmeiza-10, Sids-6, Sids-12, Giza-168, Misr-1, and Misr-2 showed inconsistent results during the two growing seasons since they show susceptible response along to the two seasons with low disease severities. Area under disease curve (AUDPC) was run in a parallel line with disease severity. The highest values of AUDPC were detected with Sids-6 wheat cultivar (710 and 610, during the two seasons, respectively). However, the lowest values were recorded with Beni-Sweif-4, Beni-Sweif-6 and Shandwel-1 (50 for each in the second season, 2011-2012).

These results coincide with the finding of (Lowther, 1951) who found that Montana wheat variety and some of its progeny were resistant at seedling stage, whereas the adult plants were completely susceptible. Also, with the finding of (Van der Plank, 1968) who reported that the area under disease progress curve of wheat stem rust has been most successful criterion to compare between different disease severities. Also, the obtained results are confirmed with the findings of (Wilcoxson *et al.*, 1974) who stated that severity of wheat stem rust disease varied according to the varieties and the age of the plant. Also these results are in accordance with the results obtained by Nazim *et al.* (2001) where they tested thirteen Egyptian wheat cultivars to stem rust at Sakha Agric. Res. Station, North Egypt. They found that, the wheat tested cultivars could be classified into two main groups: a) slow rusting cultivars (Giza 155, Giza 157, Giza 163, Giza 164, Giza 167, Sakha 92, Sohage 1, and Sohag 2. b) Fast rusting cultivars (Giza 160 and Giza 165).

Also, similar results were obtained by (Pathan and Park, 2007) where assessed 105 wheat cultivars for seedling and adult plant resistance to stem rust.

Table 3. Mean of incubation period, latent period, infection type, No., of pustules/cm^2 and pustule size in mm^2 of fifteen Egyptian wheat cultivars under greenhouse conditions in 2011-2012 season

No.	Wheat Cultivar	Incubation period	Latent period	Infection type	No. of pustules/ cm^2	Pustule size in mm^2
1	Sakha 93	6 b	9 b	4 e	8.4 g	0.1458 h
2	Sakha 94	6 b	9 b	4 e	9.2 h	0.1288 g
3	Gemmeiza-7	6 b	9 b	2 c	5.3 d	0.0903 cde
4	Gemmeiza-10	6 b	9 b	2 c	5.2 d	0.0643 bc
5	Gemmeiza-11	6 b	9 b	2 c	7.13 f	0.0798 cd
6	Sids-6	5 a	7a	4 e	13.8 i	0.1691 h
7	Sids-12	6 b	9 b	1 b	3.8 b	0.0523 b
8	Sids-13	6 b	9 b	2 c	6.4 e	0.0729 bcd
9	Giza-168	6 b	9 b	1 b	4.6 c	0.0779 efg
10	Beni Sweif-4	8 d	11 d	0; a	0.0 a	0.0000 a
11	Beni Sweif-5	8 d	11 d	3 d	7.2 f	0.0981 def
12	Beni Sweif-6	8 d	11 d	0; a	0.0 a	0.0000 a
13	Shandwel-1	7 c	10 c	3 d	6.2 e	0.0932 def
14	Misr-1	8 d	11 d	0; a	0.0 a	0.0000 a
15	Misr-2	6 b	9 b	3 d	7.5 f	0.1190 fg

Means followed by a common letter are not significantly different at the 5% Probability level.

Table 4. Evaluation of fifteen Egyptian wheat cultivars to stem rust under field conditions expressed as final disease severity and area under disease progress curve (AUDPC) in 2009-2010 and 2011-2012seasons

No.	wheat Cultivar	2009/2010		2011/2012	
		Final disease severity	AUDPC	Final disease severity	AUDPC
1	Sakha 93	10 S*	130	5 S	75
2	Sakha 94	5 S	105	0	0
3	Gemmeiza-7	Tr Ms**	40	5 MS	52
4	Gemmeiza-10	10 S	130	10 S	130
5	Gemmeiza-11	0	0	0	0
6	Sids-6	60 S	710	40 S	610
7	Sids-12	10 S	120	5 S	105
8	Sids-13	0	0	0	0
9	Giza-168	5 S	65	10 S	160
10	Beni Sweif-4	0	0	Tr S	50
11	Beni Sweif-5	0	0	0	0
12	Beni Sweif-6	0	0	Tr S	50
13	Shandwel-1	0	0	Tr S	50
14	Misr-1	Tr S	50	10 S	130
15	Misr-2	5 S	85	20 S	260

S*: Susceptible **MS: moderately susceptible

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تقيم صفة إبطاء ظهور صدأ الساق الأسود لبعض أصناف القمح المصرية في طور البادرة والنبات البالغ

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يعتبر مرض صدأ الساق الأسود المتسبب عن فطر *Puccinia graminis* f.sp *tritici* من أهم الأمراض التي تصيب نباتات القمح في مصر، في هذا البحث تم تقييم خمسة عشر صنفا من أصناف القمح المصرية من حيث صفة إبطاء ظهور الصدأ (مقاومة جزئية) في موسمى ٢٠١٠/٢٠٠٩ ، ٢٠١٢/٢٠١١ تحت ظروف الصوبة (مرحلة البادرة) وتحت ظروف الحقل بالعدوى الصناعية (مرحلة النبات البالغ) فأظهرت الأصناف بنى سويف ٤ – بنى سويف ٦ – مصر ١ مقاومة كاملة للصدأ الأسود خلال مرحلة البادرة وأظهرت الأصناف سدس ١٢ – جيزة١٦٨ – جميزة١٠ – جميزة ٧ – سدس١٣ وجميزة ١١ أطول فترة حضانة – أقل عدد من البثرات فى وحدة المساحة – أقل حجم للبثرات فى مرحلة البادرة بينما أظهرت أقل شدة إصابة بالمرض فى مرحلة النبات البالغ، وأظهر الصنف سدس ٦ أقل فترة حضانة – أكبر عدد من البثرات فى وحدة المساحة وكذلك أكبر حجم للبثرات فى طور البادرة وكذلك أعلى شدة إصابة بالمرض في مرحلة النبات البالغ، وكانت شدة الإصابة والمساحة الواقعة تحت منحنى تقدم المرض مقاييس جيدة ومعبرة لتقدير المقاومة الجزئية للأصناف المختبرة وبالتالي يمكن تقسيم الأصناف المستخدمة بناءاً على ما سبق إلى أصناف مبطئة للصدأ (بنى سويف٤ – بنى سويف٦ – مصر ١ - سدس ١٢ – جيزة١٦٨ – جميزة١٠ – جميزة٧ – سدس١٣ وجميزة ١١ وأصناف مسرعة للصدأ (سدس ٦).

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