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IDENTIFICATION OF PREVALENT PHYSIOLOGICAL RACES OF WHEAT STRIPE RUST IN NORTH DELTA AND SOME FACTORS AFFECTING DISEASE SEVERITY

BY

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ABSTRACT

Different physiological races of *Puccinia striiformis* were identified in North Delta during two successive seasons. The races 2E22, 134E150, 174E158, 6E18, 134E158 and 238E190 were identified in 1999/2000 season whereas the races 2E0, 6E0, 6E18, 174E158, 134E158, 238E190 and 231E223 were identified in 2000/2001 season. Race 134E158 exhibited the highest frequency during the two seasons. Race 238E190 was found only on infected spikes of wheat cv. Sakha-69 during the two seasons. Wheat cultivars Sakha-8, Sakha-69, Gemmeiza-3, Gemmeiza-5, Sids-7 and Sids-9 exhibited susceptible reaction when inoculated with race 238E190 under field conditions whereas Sakha-93, Giza-168, Gemmeiza-9 and Sids-1 were resistant. Infection with race 238E190 significantly reduced the yield and yield components of the first 6 cultivars compared with control (sprayed with Sumi-8 fungicide). Disease losses in yield and yield components were significantly higher in Sids-7 and Sids-9 compared with Gemmeiza-3 and Gemmeiza-5 cvs.

The reaction of the tested wheat cultivars to infection with stripe rust was varied depending on plant growth stage and the surrounding temperature regimes. All tested wheat cultivars were generally more sensitive to infection at 8-15°C than at the higher temperature regime (14-28°C) and at seedling stage than at the adult growth stages (stem elongation, booting and heading). The recorded infection type at the higher temperature regime was varied and increased toward susceptibility when the tested plants were later transferred to the low temperature regime.

Spraying plants of wheat cv. Giza-160 at seedling and adult stages (24 h before rust inoculation) with the crude leaves extract of *Eucalyptus robusta*, *Myoporum pictum* and *Salix babylonica* was controlled the stripe rust infection through elongating the latent period (29-30 days) compared with the control (12 days). Efficiencies of these extracts were greatly decreased when used 6 days after rust inoculation. However, the Sumi-8 fungicide was the best foliar treatment for elongating the latent period (35.3-38.7 days).

Key words: stripe rust races, plant extracts, latent period and *Puccinia striiformis*

INTRODUCTION

Wheat plants (*Triticum aestivum*) are attacked with stem (*Puccinia graminis* f. sp. *tritici*), leaf (*P. recondita*) and stripe (*P. striiformis*) rust diseases. Stripe rust disease is one of the recent problems affecting wheat production in Egypt. In this respect, the first stripe rust epidemic was recorded in 1967 and then three major epidemics were recorded in 1995, 1997 and 1999 seasons where the stripe rust destroyed most of the wheat cvs in Northern and Southern Delta areas (Abdel-Hak *et al.* 1972, El-Daoudi *et al.* 1996 and Abu El-Naga *et al.* 1999).

In fact, the cultivated wheat varieties suffered from sudden epidemics of stripe rust during the five elapsed decades from the perspective of change in weather conditions in relation to the genetic make up of both host and parasite. Thus, different stripe rust races were identified in Bulgaria (Mihova 1989), in Syria and Lebanon (Hakim and El-Ahmed 1998; Hakim and Mamluk, 1998; Yahyaoui, *et al.* 2002), and in the United States (Chen *et al.* (2002). The composition of physiologic races in Syria and Lebanon was differed greatly between 1994 and 1999. Races identified in 1999, such as 230E150 and 230E134, have wider spectra of virulence on resistant genotypes than the races collected in 1994 (Yahyaoui *et al.* 2002).

The response of wheat entries to stripe rust infection might be affected by the growth temperature, stage of plant growth and wheat cultivar. Qayoum and Line, (1985) stated that all tested wheat entries showed susceptibility at both low and high diurnal temperatures in the greenhouse. The cultivars that were resistant at high temperature post inoculation became susceptible when subsequently transferred to lower temperature. Park, (1990) noticed that no infection occurred at temperature above 20.8°C compared with 15.4°C. At the high temperature, the induced resistance to stripe rust appeared only during incubation and symptoms expression, but not after spore production. During the incubation and symptoms development, the resistance of wheat cultivars to stripe rust was decreased by decreasing temperature from 21-26°C to 18-21°C (Shang *et al.* 1997).

The infection with *Puccinia striiformis* was affected also by the interaction between wheat cultivar and temperature. Zhao Wensheng *et al.* (2000) reported that Singhe 1 cv. was highly susceptible at 15°C and highly resistant at 22°C, while Minxian 169 cv was highly susceptible at both temperatures. Sandoval-Islas *et al.* (2002) concluded that the latent period (LP) was not sensitive to temperature, but percentage of severity and infection type values decreased as temperature increased.

Application of plant extracts revealed promising results in controlling wheat leaf rust disease and increased yield production (Hasabnis and Chirme, 1993). The neem extracts and Luban (Frankincense gum) effectively induced resistance in faba bean (cv. Giza-2) against rust disease caused by *Uromyces fabae*, when they were applied to plants, 24 h before inoculation (Hammouda *et al.* 1999). Spraying wheat seedlings (7 days old) of highly susceptible cultivar (Giza-160) with different plant extracts (Halfa barr, Chamomile and Persian lilac) five days before inoculation with *Puccinia recondita* f. sp. *tritici* decreased number of pustules/cm^2, disease severity and changed the infection type from susceptible to moderately susceptible. Also, these plant materials increased photosynthetic pigments, phenols content (total, free and conjugated), and activities of peroxidase and polyphenoloxidase in the sprayed ones compared with control (Sallam, *et al.* 2001).

The present work aimed to identification of the most prevalent physiological stripe rust races in North Delta and clarifying the sensitivity of certain local varieties toward resistance under the stress of high temperature. The pathogenic ability of stripe rust race 238E190 (isolated only from infected spikes) and effect of some plant extracts on latent period were also investigated.

MATERIALS & METHODS

Collection of the diseased samples:

Samples of wheat leaves and spikes infected with stripe rust were collected during 1999/2000 and 2000/01 growing seasons from different localities in the northern Egyptian Governorates [Kafr El-Sheikh (Bialla and Metobus), Gharbia (Kafr El-Zayat and Tanta), Dakhalia (El-Manzala) and Damyatta (El-Serow and El-Zarka)]. These localities were cultivated with the susceptible wheat cultivars (Sakha-69, Sakha-8, Giza-163 and Sids-9). The present work, unless otherwise mentioned, was conducted at the Experimental Farm of Sakha Agric. Res. Sta., Egypt under controlled greenhouse conditions with a daylight regime (approximately 7500 Lux light intensity) of 16 light/8 dark hours and relative humidity more than 95% as adopted by Stubbs, (1988).

Identification of the prevalent physiological races of stripe rust:

Identification of stripe rust races was achieved according to Johnson *et al.* (1972) using the world and European group of wheat differential varieties (Table 1) kindly obtained from Netherland Research Institute for Plant Protection P.O. Box 9060, 6700 GW, Wageningen. Individual pustules (*Puccinia striiformis*) were taken from the collected samples and propagated on the susceptible wheat cv. Giza-160. Seeds of differential wheat varieties were sown in 10-cm ϕ pots (10-seeds/pot). Seedlings of the different differential varieties (7-10 days old) were dusted with mixture contained urediospores of each rust sample plus talcum powder at the rate of 1: 20 (w: w) as suggested by Tervet and Cassel (1951). Pots were kept for 48 hour at 9°C followed by incubation for 18-20°C days at 15-18°C in a conditioned greenhouse as adopted by Stubbs, (1988), then the infection types of stripe rust were estimated using the scale described by McNeal *et al.* (1971) as shown in Table (2).

Capability of stripe rust race 238E190 appeared on spike to infect leaves and its effect on some parameters of wheat plant:

This study aimed to verify if stripe rust race 238E190 which appeared only on spikes of Sakha-69 cv. is specific to infect wheat spikes only. Thus, an experiment conducted in complete randomized block design with three replicates was carried out under field conditions at Sakha, Agric. Res. St. during the growing season 2000/01 to ensure or avoid this conclusion. The experimental unit consisted of 3 rows with 2-meter long and 20 cm apart, each row was cultivated with 10 g of either of 10 tested wheat cvs (Sakha-93, Sakha-8, Sakha-69, Giza-168, Gemmeiza-3, Gemmeiza-5, Gemmeiza-9, Sids-1, Sids-7 and Sids-9). The recommended agricultural practices were applied. The urediospores of the physiological race 238E190 were propagated as previously mentioned, collected and mixed with talcum powder at the rate of 1: 20 (w:w) then used for artificial inoculation according to the methods described by Tervet and Cassel (1951). At the end of tillering and beginning of booting stage, the wheat plants were uniformly dusted with the mixture of urediospore-talcum powder (inoculated plots). In the control plots, the wheat plants were un-inoculated and sprayed with a systemic fungicide Sumi-eight 5Ec (diniconazole) {(E)-1-(2,4-Dichlorophenyl)-4,4-dimethyl 1-2-(1,2,4-triazol-1-yl)-1-penten-3-01.} at rate of 0.35 ml/L water and repeated 3 times at 10 days intervals. Infection types (IT) were recorded 20 days after inoculation according to the scale of McNeal, *et al.* (1971). Number of kernels/spike, number of spikelets/spike, 1000 kernel weight (g), spikes length and yield losses [(Control – Inoculated)/Control x 100)] were also determined.

Table (1): Deaconry values and Yr genes of winter (*) and spring (**) wheat differential varieties used for identification of stripe rust races (Johnson *et al.* 1972).

Deaconry value	World differentials		European differentials	
	Varieties	Yr genes	Varieties	Yr genes
$2^0 = 1$	* Chinese 166	1	* Hybrid 46	4
$2^1 = 2$	** Lee	7	* Reichersberg 42	7
$2^2 = 4$	**Heines Kolben	6	** Heines Peko	6
$2^3 = 8$	* Vilmorin 23	3	* Nord Desprez	3
$2^4 = 16$	* Moro	10	** Compare	8
$2^5 = 32$	* Strubes Dickkopf	SD	* Carstensv	cv
$2^6 = 64$	* Sun x Omer	SU	* Spaldings prolic	SP
$2^7 = 128$	* Clement	9	* Heines VII	2
$2^8 = 256$	** Tret-spelt album	5		

Table (2): The infection type scale (Expressions) of wheat stripe rust as described by McNeal *et al.* (1971).

Infection type	Expression	Descriptions
0	0 = Immune	No visible infection
1	VR = Very resistant	Necrotic or chlorotic flecks, no sporulation
2	R = Resistant	Necrotic and/or chlorotic stripes, no sporulation
3	MR = Moderately resistant	Necrotic and/or chlorotic stripes, trace sporulation
4	LM = Low moderate	Necrotic and/or chlorotic stripes, light sporulation
5	M = Moderate	Necrotic and/or chlorotic stripes, intermediate sporulation
6	HM = High moderate	Necrotic and/or chlorotic stripes moderate sporulation
7	MS = Moderately susceptible	Necrotic and/or chlorotic stripes, abundant sporulation
8	S = Susceptible	Chlorosis behind sporulating area abundant
9	VS = Very susceptible	No chlorosis or necrosis abundant sporulation

Effect of growth temperature regime and stage of plant growth on the expression of the stripe rust infection:

This experiment was conducted during growing season 2001/02 under greenhouse conditions using the wheat cultivars Giza-168, Giza-163, Sakha-8, Sakha-69, Sakha-93, Gemmeiza-3 and Gemmeiza-5. Seeds were sown in 10-cm ϕ pots (10 seeds/pot) at seedling stage and inoculated 7-10 days after sowing or in 25 cm ϕ pots (15 seeds/pot) for inoculation at adult stages (stem elongation, booting or heading stages). The inoculation process was performed using mixture of urediospores of the prevalent stripe rust races mixed with talcum powder (prepared as mentioned above). Inoculated pots were kept in an incubation chamber for 48 hour at 9°C then exposed to 8-15°C; 10-20°C or 14-28°C for 15 days in different conditioned greenhouses. The adult plants that were previously inoculated and exposed for 15 days to the high temperature regime (14-28°C) were re-exposed for additional 7 days to lower temperature regime (8-15°C). In all experiments, the data of stripe rust infection type (IT) were recorded according to the scale of McNeal *et al.* (1971).

Effect of some natural plant extracts on stripe rust severity:

The activities of leaf extract of five plants (*Eucalyptus robusta, Myoporum pictum, Lantana camara, Shinus terebinthifolia* and *Salix babylonica*) in controlling the stripe rust infection at seedling and booting growth stages were investigated in season 2001/02. The fresh leaves of each plant were thoroughly washed with sterile water, blinded in sterile distilled water at the rate of 1g/1ml (w/v), filtered through two layers of cheesecloth then centrifuged at 3000 rpm (Gerard, *et al.* 1994) for obtaining the crude extracts.

Seeds of wheat cv. Giza-160 were sown either in small 10 cm ϕ pots (10-plants/pot) for inoculation at seedling stage (7-10 days old) or in 35 cm ϕ pots (20-plants/pot) for inoculation at booting stage. The wheat plants at a known growth stage were sprayed with a known crude leaf extracts either 24 hrs before or 6 days post inoculation. The inoculation process was carried out as described above using a mixture of spore powder of the prevalent stripe rust races of *Puccinia striiformis.* Three replicates (each one had 3 pots) were used for each particular treatment. Wheat plants sprayed with the fungicide Sumi-eight at rate of 0.35 ml/L water and sterile distilled water were served as control. Efficiency of tested treatments in controlling stripe rust infection was determined in term of latent period (the number of days between inoculation time till appearance of infection) as adopted by Tomerlin, (1983).

RESULTS

I- Identification of the prevalent physiological races of stripe rust:

Data in Table (3) revealed that 6 physiological races of *Puccinia striiformis* i.e. 2E22, 134E150, 174E158, 6E18, 134E158 and 238E190 were dominant and identified during season 1999/2000. The race 134E158 exhibited the highest frequency followed by 2E22 and 134E150 races, respectively, meanwhile race 6E18 showed the least frequency. However, 7 physiologic races namely; 2E0, 6E0, 6E18, 174E158, 134E158, 238E190 and 231E223 were identified during season 2000/01. The race 134E158 was the most frequent one followed by 174E158, while, race 231E223 was the least in this regard. In general, the race 134E158 has the highest frequency and was the most predominant during the two growing seasons. Is interest to state that the race 238E190 was reported on spikes only during both seasons.

Table (3): Identification and frequency of physiologic races of *Puccinia striiformis* f. sp. *tritici* in North Delta during the 1999/00 and 2000/01 growing seasons.

	World differentials										European differentials											
	Triticum spelta	Clemennt	Suwon 92 x Omar	Strubes Dikkopf	Moro	Vilmorin 23	Heines Kolben	Lee	Chinese 166	Total deaconry values	Heines VII	Spalding Prolific	Carstens V	Compaire	Nord Desprez	Heines Peko	Reichersberg 42	Hybrid 46	Total deaconry values	Race	Number of samples	*Frequency (%)
Yr's	5	9			10		6	7	1		2	SP		8		6	7	4				
Deaconry value	5	2	64	32	16	8	4	2	1		2	64	32	16	8	4	2	1				
1999/00	-	-	-	-	-	-	-	S	-	2	-	-	-	S	-	S	S	-	22	2E 22	24	20.51
	-	S	-	-	-	-	S	S	-	134	S	-	-	S	-	S	S	-	150	34 E15	20	17.09
	-	S	-	S	-	S	S	S	-	174	S	-	-	S	S	S	S	-	158	74 E15	17	14.52
	-	-	-	-	-	-	S	S	-	6	-	-	-	S	-	-	S	-	18	6 E18	12	10.25
	-	S	-	-	-	-	S	S	-	134	S	-	-	S	S	S	S	-	158	34 E 15	31	26.49
	-	S	S	S	-	S	S	S	-	238	S	-	S	S	S	S	S	-	190	38 E19	13	11.11
Total samples																					117	
2000/01	-	-	-	-	-	-	-	S	-	2	-	-	-	-	-	-	-	-	0	2E0	6	6.12
	-	-	-	-	-	-	S	S	-	6	-	-	-	-	-	-	-	-	0	6E0	9	9.18
	-	-	-	-	-	-	S	S	-	6	-	-	-	S	-	-	S	-	18	6E18	13	13.26
	-	S	-	S	-	S	S	S	-	174	S	-	-	S	S	S	S	-	158	174E158	18	18.36
	-	S	-	-	-	-	S	S	-	134	S	-	-	S	S	S	S	-	158	134E158	39	39.79
	-	S	S	S	-	S	S	S	-	238	S	-	S	S	S	S	S	-	190	238E190	8	8.16
	-	S	S	S	-	-	S	S	S	231	S	S	-	S	S	S	S	S	223	231E223	5	5.10
Total samples																					98	

- = No reaction occurred

S = susceptible reaction for infection

* Frequency % = Number of samples of each stripe race/ Number of total samples x 100

II- Reaction and yield parameters of different wheat cultivars as affected by stripe rust race 238E190 isolated from infected spike:

Data in Table (4) indicated that the stripe rust race 238E190 was able to infect not only spikes but also leaves of some tested wheat cultivars (Sakha-8, Sakha-69, Gemmeiza-3, Gemmeiza-5, Sids-7 and Sids-9). While, some others (Sakha-93, Giza-168, Gemmeiza-9 and Sids-1) showed resistant reaction against infection with stripe rust race 238E190 either on leaves or spikes. Thus, effect of infection with race 238E190 on some yield parameters of the most susceptible wheat cultivars was investigated.

Table (4): Reaction of 10 wheat cvs to infection by the stripe rust race 238E190.

Wheat cvs	Disease reaction on	
	Leaves	Spikes
Sakha-93	R	R
Sakh-8	S	S
Sakha-69	S	S
Giza-168	R	R
Gemmeiza-3	S	S
Gemmeiza-5	S	S
Gemmeiza-9	R	R
Sids-1	R	R
Sids-7	S	S
Sids-9	S	S

Table (5): Effect of infection with stripe rust, race 238E190, on spike length, number of spikelets/spike and induced losses.

Wheat cvs	Spike length (cm)		Loss %	Number of spiklets/spike		Loss %
	Control plots *	Inoculated plots		Control plots *	Inoculated plots	
Sakha-8	11.12	8.48	23.75	24.51	17.38	29.09
Sakha-69	13.07	9.19	29.68	26.43	19.22	27.27
Gemmeiza-3	13.78	11.08	19.59	24.82	19.65	20.82
Gemmeiza-5	13.11	10.53	16.67	23.07	18.72	18.85
Sids-7	14.09	9.86	30.03	27.54	16.55	39.90
Sids-9	14.34	10.85	24.33	26.98	17.08	36.69
L.S.D. at 0.05	1.03			2.25		

* Sprayed with fungicide Sumi-8.

Table (6): Effect of infection with stripe rust, race 238E190, on the number of kernel/spike, weight of 1000-kernels (g) and the induced losses.

Wheat cvs	Number of kernels/spike		**Loss %	1000 kernel weight		Loss %
	Control plots *	Inoculated plots		Control plots *	Inoculated plots	
Sakha-8	71.43	46.66	34.67	47.58	32.85	30.95
Sakha-69	75.96	50.71	33.24	48.89	29.99	38.65
Gemmeiza-3	72.13	53.24	26.18	48.54	35.09	27.70
Gemmeiza-5	73.52	53.69	26.97	46.13	34.12	26.03
Sids-7	84.95	49.67	41.53	55.48	25.15	54.66
Sids-9	83.11	47.97	42.28	57.09	23.41	58.99
L.S.D. at 0.05	1.25			1.68		

* Sprayed with fungicide Sumi -8.

** Losses % = (Control – Inoculated) / Control x 100

The obtained results showed that the yield attributes of tested wheat cultivars was significantly varied either in inoculated or control (sprayed with fungicide Sumi-8) plots. In plots inoculated with stripe rust race 238E190, spike length, number of spiklets/spike (Table 5), number of kernel/spike and 1000-kernels weight (Table 6) were reduced by 16.67-30.03%, 18.85-39.9%, 16.67-30.0% and 26.03-58.99%, respectively in comparison with control plots. Losses in the determined yield components due to infection with stripe rust race 238E190 seems to proportionally parallel, in general, with values of these components in control plots. Thus, losses were highest in Sids-7 and Sakha-69 (spike length) and Sids-7 and Sids-9 (number of spiklets/spike, number of kernel/spike and 1000-kernels weight) compared with Gemmeiza-3 and Gemmeiza-5 cvs.

III- Effect of growth temperature regime and stage of plant growth on the expression of the stripe rust infection in different wheat cultivars:

Data in Table (7) show that, the five wheat cultivars Giza-163, Sakha-8, Sakha-69, Gemmeiza-3 and Gemmeiza-5 were reacted as susceptible "S" or very susceptible "VS" against stripe rust infection at the seedling stage when exposed to any of the three tested growth temperature regimes i.e. 8-15, 10-20 and 14-28°C. However, Giza-168 reacted as moderate susceptible "MS" at 14-28°C and "M" at 8-15 and 10-20°C whereas Sakha-93 was high moderate "HM", moderate "M" and low moderate "LM" at temperature regimes of 8-15, 10-20 and 13-28°C, respectively. At all adult stages (stem elongation, booting and heading), Sakha-93 and Giza-168 exhibited immune reaction whereas, at stem elongation stage only, Giza-163, Sakha-8 and Sakha-69 were "VS" (ITs 9) while Gemmeiza-3 and Gemmeiza-5 were "S" at all tested growth temperature regimes. At booting stage, Giza-163, Sakha-8 and Sakha-69 reacted as "VS", "S" and MS at 8-15, 10-20 and 14-28°C, respectively. While Gemmeiza-3 and Gemmeiza-5 exhibited "MS" reaction at 8-15, 10-20 and "LM" reaction at 14-28°C. At heading stage, Giza-163, Sakha-8 and Sakha-69 showed "S" reaction at 8-15 and 10-20°C and "HM" reaction at 14-28°C. Meanwhile, Gemmeiza-3 reacts as "M" and Gemmeiza-5 reacts as "HM" at 8-15 and 10-20°C. The latter two cultivars, however, reacted as "LM" at the high temperature regime (14-28°C).

Table (7): Reaction of wheat cvs against stripe rust infection at different growth stages and growth temperature regime according to McNeal *et al.* (1971).

Wheat cvs	Infection types (Its) at different growth stages and temperature regimes											
	Seedling			Stem elongation			Booting			Heading		
	8-15 °C	10-20 °C	14-28 °C	8-15 °C	10-20 °C	14-28 °C	8-15 °C	10-20 °C	14-28 °C	8-15 °C	10-20 °C	14-28 °C
Giza-163	VS	VS	VS	VS	VS	VS	VS	S	MS	S	S	HM
Giza-168	M	M	MS	0	0	0	0	0	0	0	0	0
Sakha-8	VS	VS	VS	VS	VS	VS	VS	S	MS	S	S	HM
Sakha-69	VS	VS	VS	VS	VS	VS	VS	S	MS	S	S	HM
Sakha-93	HM	M	LM	0	0	0	0	0	0	0	0	0
Gemeiza-3	S	VS	S	S	S	S	MS	MS	LM	M	M	LM
Gemeiza-5	S	S	S	S	S	S	MS	MS	LM	HM	HM	LM

III- Effect of growth temperature change on the stripe rust disease severity:

Data in Table (8) indicated that the wheat cultivars Giza-163, Sakha-8 and Sakha-69 reacted as "MS" whereas Gemmeiza-3 and Gemmeiza-5 reacted as "LM" under the high temperature regime (14-28°C). When the same plants were subsequently transferred to lower temperature regime (8-15°C) the reaction was changed to "VS" and "MS" for the two groups of wheat cultivars, respectively.

Table (8): Effect of changing in temperature regime on stripe rust infection at booting stage according to McNeal *et al.* (1971).

Wheat cvs.	Growth temperature regime	
	14-28°C	8-15°C
Giza-163	MS	VS
Sakha-8	MS	VS
Sakha-69	MS	VS
Gemmeiza -3	LM	MS
Gemmeiza-5	LM	MS

IV- Effect of spraying wheat plants at seedling stage with some plant extracts on stripe rust severity:

Data in Table (9) indicate that applying Sumi-8 fungicide at seedling or booting stages was significantly better than any of the tested plant extracts in controlling stripe rust infection as it recorded the longest latent period (35.3-38.7 days) when used 24 h before and 6 days after rust inoculation. Among tested crude plant extracts, *Eucalyptus robusta*, *Myoporum pictum* and *Salix babylonica* were the best when used 24 h before inoculation at seedling and booting growth stages (29.0-30.3 days) compared with the control treatment (12 days). Efficiencies of these extracts were conspicuously decreased when used 6 days after rust inoculation. In this regard, *E. robusta* and *S. babylonica* were the best although the length of latent period was decreased to 14.6-15.3 days compared with 12 days in the control. On the contrary, extracts of *Lantana camara* and *Shinus terebinthifolia* leaves were not effective in extending length of the latent period particularly when used after rust inoculation (12.0-12.6 days) compared with the control treatment. At booting stage, all tested plant extracts used after rust inoculation, however, increased latent period significantly (13.0-16.5 days). The longest latent period was recorded also by the crude extracts of *E. robusta* and *S. babylonica*

Table (9): Effect of spraying wheat plants (cv Giza-160) at seedlings or booting stages with crude extracts of some plants or Sumi-eight fungicide 24 h before or 6 days after inoculation with *P. striiformis*.

Source of extract	Seedling stage		Booting stage	
	Before inoculation	After inoculation	Before inoculation	After inoculation
Eucalyptus robusta	30.3	15.3	30.3	16.5
Myoporum pictum	29.3	12.6	29.3	13.6
Lantana camara	18.7	12.0	18.6	13.0
Shinus terebinthifolia	18.7	12.0	18.6	13.0
Salix babylonica	29.1	14.6	29.0	14.8
Sumi-eight	38.7	35.3	38.7	38.0
Control	12.0	12.0	12.0	12.0
L.S.D. at 5%	4.58	0.69	0.98	0.71

DISCUSSION

No doubts that rust diseases are one of the most limiting factors of mass production of wheat (*Triticum aestivum* L.) all over the world. Stripe rust (*Puccinia striiformis tritici*), in particular, is a familiar disease in Egypt as most of the Egyptian cultivars exhibited considerable levels of susceptibility to this disease. The significance of the disease might depend upon the prevalence of the aggressive races and their affinity or compatibility with the genetic constitutions of the host in a given environment. The present results proved that 6 (2E22, 134E150, 174E158, 6E18, 134E158 and 238E190) and 7 (2E0, 6E0, 6E18, 174E158, 134E158, 238E214 and 231E223) physiologic races of *P. striiformis* could be identified during 1999/2000 and 2000/2001 seasons, respectively. The race 134E158 was the most dominant during both seasons followed by race 2E22 and 134E150 respectively in the first season and 172E158 in the second season. Some of these physiological races were reported in other Arab countries. For example, the 6E18 and 6E0 races were recorded in Syria (Hakim and El-Ahmed, 1998 and Hakim and Mamluk, 1998).

The stripe rust race 238E190 which isolated from infected spikes could not able to infect neither leaves nor spikes of the wheat cvs, Sakha-93, Giza-168, Gemmeiza-9 and Sids-1. On the contrary, this race could infect both leaves and spikes of Sakha-8, Sakha-69, Gemmeiza-3, Gemmeiza-5, Sids-7 and Sids-9 cvs. The variation in responses of these cultivars against infection with stripe rust might be genetic in nature. In the latter cultivars, the yield components (spike length, number of spiklets/spike, number of kernels/spike and weight of 1000-kernels) were significantly decreased by infection with stripe rust race 238E190 compared with the control (sprayed with Sumi-8 fungicide). The present results proved that the wheat cultivars that produced the highest yield and yield components in control healthy plots showed the highest losses in their yield and yield components when infected with stripe rust race 238E190. In general, the highest losses were observed with Sids-7 and Sids-9, while, the least losses were noticed with Gemmeiza-3 and Gemmeiza-5. Yield losses due to stripe rust infection could be attributed mainly to the reduction in wheat kernel weight (Sharma *et al.* 1985). The stripe rust infection caused great kernel yield losses in the very susceptible cultivars when the epidemic began before the booting stage (Murray *et al.* 1995 and Ma and Singh 1996).

The response of a known wheat cultivar to stripe rust infection at different growth stages might be depended on the diurnal temperature regime prevailed during plant growth. The wheat cultivars tested during the present work were greatly varied in their responses against stripe rust infection at different tested temperature regimes (8-15, 10-20 and 14-28°C). In most cases, the cultivar response was increased towards resistant reaction as the temperature regime increased and vice versa. The reaction of the tested wheat cvs inoculated at booting stage and grown at high temperature (14-28°C) was obviously changed when allow to grow for few days at low temperature (8-15°C). The Giza-163, Sakha-8 and Sakha-69 exhibited "MS" and "VS" reactions whereas Gemmeiza-3 and Gemmeiza-5 exhibited "MR" and "MS" reactions at the high and low temperature regimes, respectively. In fact, at low temperatures, the vital activities of a plant were greatly changed compared with at high temperature. These results are in harmony with Qayoum and Line (1985) who recorded that the winter wheat cultivars that were resistant at high temperature post inoculation became susceptible when subsequently transferred to lower temperature. Shang *et al.* (1997) showed that, resistance of wheat cultivars to stripe rust was decreased by decreasing temperature from 21-26°C to 18-21°C during the incubation and symptoms development. Zhao Wensheng *et al.* (2000) reported that Singhe 1 cv was highly susceptible at 15°C and highly resistant at 22°C, while Minxian 169 cv was highly susceptible at both temperatures. In fact, the high temperature induced resistance to stripe rust only at the infection stages (incubation and symptoms expression), but did not induce resistance of after spore production (Sandoval-Islas *et al.* 2002).

Regarding the effect of certain plant extracts on stripe rust severity at seedling stage under greenhouse conditions, the obtained results gave evidence to the superiority of the crude extracts of *Eucalyptus robusta*, *Myoporum pictum* and *Salix babylonica* leaves in controlling stripe rust infection by elongating the latent period particularly when used 24 h before rust inoculation either at seedling or adult growth stages. Whatever, applying the Sumi-8 fungicide as foliar spray at both growth stages either 24 h before or 6 days after rust inoculation was significantly better than any tested plant extract in this respect. On the other hand, all tested plant extracts at all tested concentrations had no significant effect when applied 6 days after rust inoculation. In fact, these plant extracts might induced resistance through increasing activities of peroxidase, polyphenoloxidase and phenols content in sprayed wheat plants. In this respect, many authors verified these findings such as Sajid *et al.* (1995) on wheat leaf rust and Hammouda *et al.* (1999) on faba bean rust. Also, Sallam, (2001) and Sallam, *et al.* (2001) mentioned that the aqueous extracts of *Cymbopogen proximus*, *Matricaria chamomila* and *Melia azadirachta* showed good activity against wheat leaf rust

(*Puccinia recondita* f. sp. *tritici*) and revealed morphological changes in the fungal structure. Spraying 7 days old wheat seedlings of highly susceptible cultivar (Giza-160) five days before inoculation with different plant extracts and plant oils controlled leaf rust through decreasing number of pustules/cm^2, disease severity and changing the infection type from susceptible to moderately susceptible. She reported also spraying these materials increased photosynthetic pigments, phenols content (total, free and conjugated), and activities of peroxidase and polyphenoloxidase in the sprayed ones compared with control.

REFERENCES

Abdel-Hak, T.M.; Stewart, D.M. and Kamel, A.H. (1972): The current stripe rust situation in the near east countries. Regional Wheat Workshop. Beirut, Lebanon, 1-29.

Abu El-Naga, S.A.; Khalifa, M.M.; Bassiouni, A.A.; Youssef, W.A.; Shehab, T.M. and Abdel-Latif, A.H. (1999): Revised evaluation for Egyptian wheat germplasm against physiologic pathotypes of stripe rust (*Puccinia striiformis* West.). Agric. Sci. Mansoura Univ., 24: 477-488.

Chen, X. M.; Moore, M.; Milus, E.A.; Long, D.L.; Line, R.F.; Marshall, D.; Jackson, L. (2002): Wheat stripe rust epidemics and races of *Puccinia striiformis* f. sp. *tritici* in the United States in 2000. Plant Disease, 86: 39-46.

El-Daoudi, Y.H.; Ikhlas Shafik, Enayat, H. Ghanem; Abu El-Naga, S.; Mitkees, R.; Sherif, S.; Khalifa, M. and Bassiouni, A. (1996): Stripe rust occurrence in Egypt and assessment of grain yield losses in 1995. Proceedings d Symposium Regional sur les Maladies des Cereales et des Leguminеuses Alimentaries. 11-14, 1996, Ra, Morroc, pp. 341-351.

Gerard, J.E.; Chandresekar, V. and Kurucheve, V. (1994): Effect of six selected plant products and oil cakes on the sclerotial production and germination of *Rhizoctonia solani*. Indian Phytopathology, 47-183-185.

Hakim, M.S. and El-Ahmed, A. (1998): The physiological races of wheat stripe rust *Puccinia striiformis* f. sp. *Tritici* in Syria during the period 1994-1996. Arab-Journal of Plant Protection, 16: 7-11.

Hakim, M.S. and Mamluk, O.F. (1998): Monitoring the pathotypes and virulences of *Puccinia striiformis* in Syria, Phytopathologia-Mediterranean. 37: 106-110.

Hammouda, A.M.; Abd El-Moneim, I.; Abd El-Ghani, S.H. and Heweidy, M.A. (1999):Induced resistance in faba bean against disease by using natural products. Egypt. J. Appl. Sci. 14: 15-26.

Hasabnis, S.N. and Chirme, B.B. (1993): Effect of some herbal extracts on germination of urediospores of *Puccinia recondita* Rob. Ex. Desm. Agric. Sci. Digest Karnal, 13: 34-36. (c.f. *CAB Abstr.*, 1995).

Johnson, R.; Stubbs R.W., Fuchs, E. and Chamberlain, N.H. (1972): Nomenclature for physiologic races of *Puccinia striiformis* infecting wheat. Trans. Br. Mycol. Soc. 58: 475-480.

Ma, H. and Singh, R.P. (1996): Contribution of adult plant resistance gene Yr18 in protecting wheat from stripe rust. Plant Disease, 80: 66-69.

McNeal, F.H.; Konzak, C.S.; Smith, E.P.; Tate, W.S. and Russel, T.S. (1971): A uniform system for recording and processing cereal data. USDA. ARS 34-121.

Mihova, S. (1989): Physiological races of *Puccinia striiformis* found in Bulgaria. Rastenievdni-Nauki, 26: 92-95.

Murray, G.M.; Ellison, P.J. and Watson, A. (1995): Effects of stripe rust on the wheat plant. Australasian Plant Pathology, 24: 261-270.

Park, R.F. (1990): The role of temperature and rainfall in the epidemiology of *Puccinia striiformis* F. sp. *tritici* in the summer rainfall area of eastern Australasian Plant Pathology, 19: 416-423.

Qayoum, A. and Line, R.F. (1985): High-temperature adult plant resistance to stripe rust of wheat. Phytopathology, 75: 1121-1125.

Sajid, M.N.; Ihsan, J.; Nasir, M.A. and Shakir, A.S. (1995): Comparative efficacy of neem product and Baytan against leaf rust of wheat. Pakistan, J Phytopathology, 7: 71-75. (c.f. *CAB Abstr.*, 1995).

Sallam, Minass, E.A. (2001): Scanning micrography in evaluation of leaf rust biological control. Egypt. J. Phytopathol., 29 (1): 11-20.

Sallam, Minass, E.A.; Abou-Taleb, Mona M.A. and El-Nashar, Fatin K. (2001): Evaluation of some plant mineral oils on the control of leaf rust disease of wheat. Egypt. J. Phytopathol., 29 (2): 1-17.

Sandoval-Islas, J.; Broers, L.H.M.; Osada-Kawasoe, S. (2002): Influence of post-infection temperature on latent period and disease severity of *Puccinia striiformis* f. sp. *hordei* in barley. Agrociencia (Montecillo), 36: 223-23.

Shang–Hong Sheng; Wang-LiGuo; Lu-HePing and Jing-JinXue (1997): Characteristics of expression of high-temperature resistance to stripe rust in wheat. Acta-Phytophylacica-Sinica, 24: 97-100.

Sharma, Y.; Kang, M. and Aujla, S. (1985): Influence of stripe rust on yield and its components in wheat. Journal of Research, Punjab. Agriculture University, 22: 425-430.

Stubbs, R.W. (1988): Pathogenicity analysis of stripe (stripe) rust of wheat it's significance in a global context breeding strategies for persistence to the rusts of wheat. N, W. Simmonds and S. Rajaram (CIMMYT) ISBN. 968-6127-23-2.

Tervet, I. and Cassell, R.C. (1951): The use of cyclone in race identification of microscopic particles. Phytopathology, 41: 282-285.

Tomerlin, J.R. (1983): Temperature and host effects on latent and infection period and urodinospore production of *Puccinia recondita*. Phytopathology, 73: 414-419.

Yahyaoui, A.H.; Hakim, M.S.; El-Naimi, M.; Rbeiz, N. (2002): Evolution of physiologic races and virulence of *Puccinia striiformis* on wheat in Syria and Lebanon. Plant Disease, 86: 499-504.

Zhao WenSheng; Xu ShiCheng; Zhang JingYuan; Wu LiRen (2000): Study on the expression of minor gene(s) resistant to *Puccinia striiformis* in interactions between wheat cultivars and temperature. Plant Protection, 26: 4-6.

تعريف السلالات الفسيولوجية السائدة للصدأ الأصفر فى القمح فى شمال الدلتا والعوامل المؤثرة على شدة المرض

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تم التعرف خلال الموسمين ١٩٩٩/٢٠٠٠ و٢٠٠٠/٢٠٠١ على عدد ١٣ سلالة فسيولوجية للفطر المسبب للصدأ الأصفر (باكسينيا سترايفورمس) فى شمال الدلتا بمصر. حيث عرفت ستة سلالات خلال الموسم الأول ,2E22, 134E150, 174E158) (6E18. 134E158 and 238E190وسبعة سلالات خلال الموسم الثانى ,2E0, 6E0, 6E18) (174E158, 134E158, 238E190 and 231E223 باستخدام أصناف القمح المفرقة العالمية والأوربية. وقد كانت السلالة 134E158 هى الأعلى تكرارا والأكثر سيادة خلال موسمى النمو. هذا وقد أوضحت الدراسة تواجد السلالة 238E190 فقط على السنابل المصابة لصنف القمح سخا- ٦٩. كما أظهرت العدوى الصناعية بالسلالة 238E190 تحت ظروف الحقل قابلية أصناف القمح سخا-٨ ، سخا-٦٩ ، جميزة-٣ ، جميزة-٥ سدس-٧ و سدس-٩ للإصابة بتلك السلالة فى حين أن الأصناف سخا-٩٣، جيزة-١٦٨، جميزة-٩ و سدس-١ كانت مقاومة. وقد سببت العدوى بتلك السلالة نقص معنوى فى المحصول ومكوناته للأصناف القابلة للإصابة بها مقارنة بالكنترول المرشوش بمبيد سومى- أيت وكان الفقد عالى المعنوية فى أصناف سدس-٧ وسدس-٩ مقارنة بأصناف جميزة-٣، جميزة -٥.

أوضحت الدراسة أيضا اختلاف رد فعل أصناف القمح المختبرة ضد العدوى بالصدأ الأصفر تبعا لمرحلة نمو النبات والنظام الحرارى السائد وبشكل عام كانت جميع أصناف القمح المختبرة أكثر حساسية للعدوى عند سيادة نظام الحرارة المنخفض (٨-١٥م) مقارنة بالنظام الحرارى الأعلى (١٤-٢٨م) كما كانت النباتات أكثر حساسية عند مرحلة البادرة عن مراحل البلوغ الأخرى. وعند نقل النباتات المحقونة بمسبب الصدأ الأصفر من نظام حرارى مرتفع الى نظام حرارى منخفض تزايدت درجة قابليتها الإصابة بالمرض.

أدى رش نباتات القمح (صنف جيزة- ١٦٠) فى مرحلتى البادرة والبلوغ بالمستخلصات الخام لأوراق الكافور والبزروميا والصفصاف الباكى قبل ٢٤ ساعة من حقنها بالجراثيم اليوريدية لمسبب الصدأ الأصفر إلى مقاومة فعالة للعدوى بالمرض من خلال إطالة فترة الكمون قبل ظهور الأعراض المرضية (٢٩-٣٠ يوما) بالنسبة للنباتات الغير مرشوشة (١٢ يوما) هذا وقد تناقصت تلك الفعالية بدرجة كبيرة عند رش النباتات بتلك المستخلصات بعد ٦ أيام من حقنها بمسبب المرض. وعموما فقد كان الرش بالمبيد الفطرى سومى- أيت الأفضل من حيث إطالة فترة الكمون (٣٥,٣-٣٨,٧ يوما).