DETECTION OF PARTIAL RESISTANCE COMPONENTS OF LEAF RUST IN NEW FOUR EGYPTIAN WHEAT CULTIVARS

El- Shamy M.M. and M.M.Mousa
Wheat Diseases Res. Dept., Plant Pathol. Res. Instit., A.R.C., Giza, Egypt

ABSTRACT
Four new Egyptian wheat cultivars, Gemmeiza-7,Gemmeiza-9, Sakha 93 and Giza.168 were tested for slow rusting against two leaf rust races , i.e. 77 (virulent) and 130 (avirulent). At seedling stage , the cultivar Gemmeiza - 9 exhibited the longest latent period , the lowest number of pustules / cm^2 and moderate resistant infection type . On contrast , the cultivars Gemmeiza- 7 and Sakha 93 had the lowest latent period , the highest number of pustules / cm^2 and susceptible infection type. The cultivar Giza 168 showed moderate values of the two parameters . A high positive correlation was found between latent period and number of pustules / cm^2 . At adult stage , the cultivar Gemmeiza 9 showed moderate resistant / moderate susceptible response (MR / MS) to a mixture of 77 and 130 leaf rust races and exhibited the lowest values of average coefficient of infection (ACI) and area under disease progress curve (AUDPC). Consequently , it gave the highest grain yield / plot (3.357 and 3.354 Kg.) and 1000 grain weight (43.640 and 43.610 gm) either under protected or rusted plots and showed small losses (0.09 and 0.07 % , respectively). Giza 168 wheat cultivar showed low susceptible response (20-S) and low values of losses (0.59 and 0.32) .The cultivars Gemmeiza 7 and Sakha 93 had high disease severity (70-S and 60-S) and the loss in grain yield / plot and 1000 kernel weight were 8.38 , 7.30 % and 7.09 and 6.93 % , respectively.

INTRODUCTION
Partial resistance was characterized by a slow epidemic build-up despite a high infection type indicating a compatible host-pathogen interaction **(Parlevliet and Van Ommeren, 1975)**. Latent period, number of pustules/ cm^2 ,disease severity and area under diseases progress curve(AUDPC), components of partial resistance, has been considered as the most important factors in determining the rate of epidemic built up **(Zadoks, 1972)**. The latent period in resistant wheat cultivars was longer than in susceptible cultivars **(Shaner, 1983)**.

Also area under disease progress curve (AUDPC) has been demonstrated to be an effective measure of rust development on cereal lines **(Singleton et. al., 1982).** Slow rust lines had low AUDPC values, while fast rusting lines have high values. The aims of·this study were to measure leaf rust development under the glasshouse condition, determination disease severity of leaf rust and loss of yield under field conditions.

MATERIALS AND METHODS

Two sets of four wheat cultivars ,Gemmeiza 7, Gemmeiza 9, Sakha 93 and Giza 168 were grown in the glasshouse of Dept. of Wheat Diseases, A.R.C. Giza at 2001/2002 growing season. Five seedlings of each cultivar grown in 7 cm plastic pots were inoculated separately in the first leaf stage with a mixture 10 mg freshly collected uredinospores of pathotype 77 and 130 individually of leaf rust and 40 gm of talcum powder **(Tarvet and Cassell, 1951).** Three pots were used for each cultivar and particular pathotype .After 24 hrs . incubation in a dew chamber under near 100% r.h., the inoculated plants were shifted to a glasshouse benchs where the mean temperature during the period of study remained $20 \pm 2\ C^0$ with approximately 80% r.h . Plants were investigated daily for pustules eruption so that flecks and pustules can be seen. In the 18th day, number of pustules /cm^2 were counted for each leaf . Differences between means of each cultivar were tested for significance by Duncan`s Multiple Range Test, and correlation between latent period and number of pustules/ cm^2 was estimated. Glasshouse infection variables measured on the first leaf were :

- **Latent period** – days from inoculation to first appearance of pustules .
- **Pustules numbers** -- number of erupted pustules /cm^2 were calculated and average of pustule number/cultivars and pathotype was estimated .
- **Infection type** – Resistance (R) , Moderate resistance (MR), Moderate susceptible (MS), Susceptible (S) according to **Stakman et. al., (1962).**

At adult stage:

The previous cultivars were planted in two sets in six rows with 3 m. length and 30 cm apart for each at the field of Gemmeiza Res.

Station in 2001/ 2002 and 2002/ 2003 .The cultivars were planted in a split plot arrangement of a randomized complete block design with three replicates. The two main plot treatments were:
1- inoculated with a mixture of leaf rust pathotypes, (77 and 130) at growth stage 37 (flag leaf just visible) according to **Zadoks,** (1972).
2- protected using fungshow fungicide (15gm / 100L).

Disease severity of leaf rust for each cultivar was assessed at five growth stages ,47, 59 , 69, 77 and 87(**Zadoks , 1972**) to detect the final response (**Peterson** *et. al.,* **1948**),which served in calculating the area under disease progress curve (AUDPC),**Pandy** *et. al.,* **(1989)** as follows :-

AUDPC = D [½ $(Y_1 + Y_k)$ + $(Y_2 + Y_3 +.....Y_{k-1})$].

Where : D $\quad\quad\quad$ = Time intervals.

$\quad\quad Y_1 + Y_k \quad\quad$ = Sum. of the first and last disease scores.

$\quad\quad Y_2 + Y_3 +..Y_{k-1}$ = Sum. of all in between disease scores.

Average coefficient of infection (ACI) was calculated for each line by multiplying the following factors by the percentage of infection according to **Saari and Willcoxson ,(1974)** .

0 = 0.0	R = 0.2	Mr = 0.4
Ms = 0.6	X = 0.8	S = 1.0

At mature stage, the middle 4 rows were harvested to determine grain yield (kg/ plot)and 1000 kernel weight (gm) . The loss of yield components were estimated using the equation adopted by **Calpouzos** *et. al.,* **(1976)**.

$$\text{Loss \%} = (1 - \frac{Yd}{Yh}) \times 100$$

Where :

$\quad\quad$ Yd = Yield of diseased plots .

$\quad\quad$ Yh = Yield of healthy (Protected) plots .

RESULTS AND DISCUSSION

Data in table (1) on latent period, number of pustules / cm^2 and infection type indicate differences in all the cultivars / pathogen isolates interaction . Among the tested cultivars , Gemmeiza 9 exhibited the the longest latent period with either race 77 or 130 of

leaf rust (13.72 and 14.61 ,respectively), the lowest mean number of pustules /cm^2 (2.44 and 1.65, respectively) and moderate resistant infection type (MR) . The wheat cultivars Gemmeiza 7 and Sakha 93 had the shortest latent period (12.01 and 12.54) and (12.81 and 13.19) , the highest number of pustules /cm^2 (7.67, 7.18) and (5.07, 5.25) and susceptible infection type (S), as inoculated by race 77 and 130 of leaf rust ,respectively . It could be noticed that mean values of latent period were lower with race 77 (more virulent) than that of race 130 (less virulent). On contrast ,mean number of pustules /cm^2 were higher with race 77 than that of with race 130 . Similar results were found by **Ahamed and Singh (2003)** who screened the wheat varieties Kundan and Agra Local (fast ruster) for seedling and adult plant response. Under the glasshouse conditions, Kundan showed long latency period (20.89 , 21.70), smaller pustule size (0.166 , 0.134) and less number of pustules (10.75 ,10.25). While the fast ruster, Agra Local had the short latency period (9.85 ,11.60), larger pustule size (0.274 ,0.396), and higher uredial number (36.40 , 34.10) in both seasons of evaluation (1998-99 and 1999-2000), respectively . Also, Agra Local showed the highly susceptible response with higher AUDPC values (1455.00 , 1300.00) whereas Kundan showed the lowest AUDPC values (218.5 , 217.00).

Table (1) : Mean of latent period (L.P), no. of pustule/cm^2 and infection type of 4 new Egyptian cultivars inocu-lated with either of pathotype 77 or 130 of leaf rust at seedling stage.

Cultivars	Pathotype 77			Pathotype 130		
	L.P	No. of pustules/cm^2	infection type	L.P	No. of pustules/cm^2	infection type
Gem. 7	12.01	7.67	S	12.81	5.07	S
Gem. 9	13.72	2.44	MR	14.61	1.65	MR
Sakha 93	12.54	7.18	S	13.19	5.25	S
Giza 168	12.61	5.91	S	13.41	3.21	S
Mean	12.72	5.80		13.25	3.79	
r	0.973			0.922		
LSD at 0.05	0.37	0.55		0.27	0.23	

A high positive correlation was found between the latent period and number of pustules /cm^2 either under race 77 (r = 0.973) or 130 (r = 0.922) of leaf rust .This correlation reveals that these components could be exploited in breeding programmes . **Andress and Wilcoxson (1984) ; Lee and Shaner (1985)** found a high positive correlation between latent period and slow rusting or partial resistance . Similar results were found by **Torabi (1992)** who found that the latent period was connected with the reaction type which the cultivars with susceptible reaction types had shorter latent periods compared with those possessing resistance reactions .

Data in Table (2) reveal that the leaf rust inoculation with a mixture of races 77 and 130 under field conditions successfully infected all the tested cultivars and cause susceptible infection type with different degrees of disease severity with the exception of Gemmeiza 9 . Wheat cultivar, Gemmeiza 9 had the lowest final disease severity (10MR/MS) and area under disease progress curve (68.00). Whereas , the wheat cultivars , Gemmeiza 7 and Sakha 93 reach 70 S and 60 S disease severity and exhibited the highest values of AUDPC (970.00 and 860.00) respectively . The wheat cultivar , Giza 168 showed moderate values of disease severity (20-s) and area under disease progress curve 170.00 units . Values of average coefficient of infection (ACI) were corresponded to the disease severity scores .**Eaton et. al.,(1984)** reported that the most efficient method of field selection for slow rusting lines might be based on both long latent period and low percent infection . Also ,**Van Der Plank (1968)** stated that area under disease progress curve of wheat stem rust has been most successful to compare between different levels of disease severity and losses in different cultivars . Consequently ,it could be say that the wheat cultivar Gemmeiza 9 could be classified as slow ruster to leaf rust ,while Gemmeiza 7 and Sakha 93 are considered as fast rusters. Whereas, Giza 168 was moderate susceptible (20 S). Similar results were obtained by **Khan et. al., (1998)** who compared between 15 promising lines /varieties of wheat for slow rusting against leaf rust and found that all slow rusting lines /varieties had less than 1000 units of AUDPC compared to more than 2000 –5000 units on susceptible varieties .

Table (2) : Mean of leaf rust disease severity (Ds.) at different growth stages , area under disease progress curve (AUDPC) and average coefficient of infection (ACI) of 4 new released Egyptian wheat Cultivars in 2001/ 2002 and 2002/2003 growing seasons .

	Growth stages										AUDPC
Cv.	47		59		69		77		87		
	Ds	ACI	Ds	ACI	Ds	ACI	Ds	ACI	Ds	ACI	
Gem. 7	0.0	0.0	Tr-s	2.0	20s	20	40s	40.0	70s	70.0	970.00
Gem. 9	0.0	0.0	0.0	0.0	Tr-MR	0.8	5 MR/MS	3.00	10 MR/MS	6.00	68.00
Sakh.93	Tr-s	2.0	5s	5	10s	10	40s	40	60s	60	860.00
Giza168	0.0	0.0	0.0	0.0	Tr-s	2	5s	5	20s	20	170.00

Growth stages according to Zadoks (1972).
47 = Flag leaf sheath opening .   59 = Emergence of ear completed
69 = Flowering complete .   77 = Late milk   87 = Hard dough

Data in Table (3) clear that differences (p 0.05) between protected and rusted wheat cultivars for grain yield/plot and 1000 kernel weight were due to differences in disease severity level of leaf rust which ranged from 10 MR/MS to 70-S . The wheat cultivar , Gemmeiza 9 in all cases (protected and rusted) gave the highest values of grain yield / plot (protected 3.357 ,rusted 3.354 kg.) and 1000 kernel weight (protected 43.64 ,rusted 43.61 gm) compared with the other cultivars . Consequently ,it suffered small losses in grain yield / plot and 1000 kernel weight (0.09 and 0.07 %, respectively) . No significant differences were found between Gemmeiza 7 and Sakha 93 in grain yield and loss % which showed 8.38 and 7.30 % losses in grain yield / plot and 7.09 , 6.93 % in 1000 kernel weight , respectively . Similar results were obtained by Khan et al ., (1997) who reported that Chenab 70 ,WL 711 , Pak.81 were fast rusting cultivars, suffering 11.22, 19.73 and 13.88 grain yield loss ,respectively . The cultivars Lu-26 ,V- 87094 and V-8829 were moderately slow rusters with 8.10 ,9.28 and 5.19 % yield loss , respectively . While ,Pavon , FSD ,85 and INQ- 91 were slow rusters .Also ,the cultivar SH-88 was fast rusting and responded as rust tolerant with respect to yield loss . Also ,Sinha and Tewari (1997) in a field experiment to assess yield losses caused by brown rust in 10 wheat cultivars ,found that RR-21 and WL-711 had about equal

amount of rust and the loss in plot yield was also equal during 1989/90 and 1990/91 crop seasons. While C-306 suffered small loss in grain weight at 45.60 rust intensity .

Table (3): **Final disease severity, mean of grain yield / plot and 1000 kernel weight of protected and rusted wheat cultivars under field artificial inoculation with a mixture of 77 and 130 leaf rust races in 2001/ 2002 and 2002/2003 growing seasons .**

Cv.	D.S.	Yield / plot (Kg)			1000 K.W. (gm)		
		Prot.	Rusted	Loss %	Prot.	Rusted	Loss %
Gem. 7	70s	2.628	2.408	8.38	40.91	38.011	7.09
Gem. 9	10 MR/MS	3.357	3.354	0.09	43.64	43.610	0.07
Sakha 93	60s	2.632	2.440	7.30	41.38	38.513	6.93
Giza 168	20s	2.724	2.708	0.59	40.73	40.600	0.32
LSD at 0.05		0.066	0.069		0.22	0.54	

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الملخص العربي

تقدير مكونات المقاومة الجزئية لصدأ الأوراق
في أربعة أصناف مصرية حديثة من القمح

مصطفى محمود الشامى – محمد مصطفى موسى

قسم بحوث أمراض القمح – معهد بحوث أمراض النباتات
مركز البحوث الزراعية – الجيزة

تـم اختبـار أربعة أصناف مصرية حديثة من القمح وهي جميزة ٧ ،
جميـزة ٩ ، سخا ٩٣ و جيزة ١٦٨ ضد سلالة رقم ٧٧ (شديدة القدرة
المرضية؛ والسلالة ١٣٠ (ضعيفة القدرة المرضية) من صدأ الأوراق .
أظهـر الصـنف جميزة ٩ رد فعل متوسط المقاومة(MR) وأطول فترة
حضانة وأقل عدد من البثرات / سم٢ في طور البادرة لكلا السلالتين . على
العكس أظهرت الأصناف جميزة ٧ وسخا ٩٣ رد فعل عالي للإصابة (S)
وأقـل فتـرة حضانة وأكثر عدد من البثرات/سم٢. بينما أظهر الصنف جيزة
١٦٨ قـيما متوسطـة لهـذه القياسات . وكان هناك ارتباط عالي بين فترة
الحضانة و عدد البثرات في وحدة المساحة . عند العدوى بخليط من السلالتين
فـي طـور النبات البالغ أظهر الصنف جميزة ٩ رد فعل متوسط المقاومة /
متوسط الإصابة (MR / MS) وأعطى أقل قيم لمعامل العدوى (ACI)
وكـذلك المسـاحة الواقعة تحت منحنى تقدم المرض (AUDPC) وبالتالي
أعطـى أعلى محصول للحوض سواء المحمية بالمبيد (٣,٣٥٧ كجم) أو
المعديـة بالصدأ(٣,٣٥٤ كجم)وكذلك وزن ١٠٠٠ حبة (٤٣,٦٤٠ و
٤٣,٦١٠ جـم) وبالتالي أعطى أقل قيما للخسارة (٠,٠٩ و ٠,٠٧ % علي
التوالـي) . أظهـر الصنف جيزة ١٦٨ رد فعل متوسط الإصابة (٢٠%)
وقيما منخفضة من الخسارة (٠,٥٩ و ٠,٣٢ % على التوالي) بينما اكتسبت
الأصـناف جميزة ٧ و جميزة ٩ درجـات عالـية مـن شـدة الإصابة
(٧٠ و ٦٠ %) وكـذلك خسـارة عالـية فـي وزن محصـول الحوض
(٨,٣٨ و ٧,٣٠ %) وكذلك وزن ١٠٠٠ حبة (٧,٠٩ و ٦,٩٣ %) .