

DURABILITY OF RESISTANCE TO LEAF RUST DISEASE (*Puccinia recondita* F. Sp. *tritici*) IN A NUMBER OF WHEAT MONOGENIC LINES

El- Shamy, M.M.

Wheat Diseases Res. Dept., Plant Pathol. Res. Instit., A.R.C., Giza, Egypt

ABSTRACT

Thirty one leaf rust monogenic lines of wheat (Lr's) were evaluated for their resistance under a artificial field condition for 4 years (2000 – 2003) at Gemmeiza Research Station. The tested Lr genes were varied greatly in disease severity but remained constant over the four years. They divided into four groups based on their reactions . Genes Lr 9, Lr18, Lr19, Lr 21, Lr 38, Lr 42 and Lr 43 were highly resistant. Lr 2a, Lr 2b, Lr 20, Lr 25, Lr 28, Lr 30, Lr 34, Lr 36 and Lr 39 showed a moderate resistance response with a verage coefficient of Infection (ACI) values less than 10 and low values of area under disease progress curve (AUDPC) . Genes Lr11, Lr12 , Lr13, Lr27, Lr32 and Lr33 showed lower susceptible responses, while the other tested Lr genes, Lr 1, Lr 2c, Lr3, Lr 3bg, Lr 3ka, Lr 10, Lr 14a and Lr14b were highly susceptible. The results showed highly positive values of Person correlation coefficient (r_s) between the four years data with an average 0.818 ranged from 0.606 to 0.987. Disease severity (DS) and area under disease progress curve (AUDPC) were highly correlated and seemed to be good estimators for resistance .

INTRODUCTION

Leaf rust of wheat caused by *Puccinia recondita* f.sp. *tritici* is widely distributed disease in temperate regions. The resistance to such disease depends on both its stability which refer to geographical and environmental conditions and durability, refer to time (Broers, 1989). Johnson,(1988) reported that disease resistance is durable if it remains effective for a long time in an environment favorable to the disease. Breeding for leaf rust resistance usually involves the use of major genes (Lr genes). Several resistance genes from cultivated and alien germplasm have been extensively used for incorporating resistance to rusts and the alien genes are likely to be more useful for better and prolonged effectiveness (Bahadur, et. al., 2002). This paper reports the durability of 31 wheat Lr genes against a mixture of the prevalent leaf rust pathotypes under artificial field conditions.

Materials and Methods

Thirty one of wheat leaf rust monogenic lines, obtained from the Dept. of Wheat Diseases, Plant Pathology institute, Giza, were selected for this study (Table1). These lines were planted in two-row plots of 2 m. length and 20 cm. apart in three replicates. The experiment was surrounded by six spreader rows of the highly susceptible cultivars. Randomization was not used in planting these lines, since it seemed to be unnecessary (Broers, 1987) , because of the high proportion of infection reaching the tested genotypes from the spreader rows, Touch test (Zadoks and Schein, 1979). Artificial inoculation was carried out just after a complete tillering by dusting with a mixture of the prevalent races and talc powder 1:5 (Tarvet and Cassell, 1951). The epidemic was started with sporulating spreader plants. Disease

severity using 0-100 scale of Peterson *et al.*, (1948) was recorded on the upper three leaves of 20 main tillers every 10 days from the appearance of leaf rust. Area under disease progress curve (AUDPC) was computed from disease severity according to Pandey *et al.*, (1989) as another parameter used to assess the resistance at any plant age as follows :-

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

Where : D = Time intervals
Y₁ + Y_k = Sum. of the first and last disease scores.
Y₂ + Y₃ + .. 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).

$$O = 0.0 \quad R = 0.2 \quad Mr = 0.4 \\ Ms = 0.6 \quad X = 0.8 \quad S = 1.0$$

The Lr genes were divided into, highly resistant (zero infection), moderate resistant (Mr / Ms), moderate susceptible (less than 30 %) and highly susceptible (more than 30 %). Person's correlation coefficient of disease severity between the four years was determined .

RESULTS AND DISCUSSION

The present study was carried out at Gemmeiza Research Station in middle of Delta, Egypt during 4 successive seasons(2000-2003). The reaction of the tested leaf rust monogenic lines against a mixture of the predominate races were recorded annually at fixed interval period (10 days) , average coefficient of infection (ACI) and area under disease progress curve (AUDPC) were determined. The analysis of variance of leaf rust reveals that the response of each tested Lr gene did not differ greatly during the four years period, whereas there was a significant difference between the Lr genes (LSD : 6.47).

According to the response of the tested Lr genes at field adult stage, data in Table (1) show that the Lr genes fill into four groups :

- 1-highly resistance genes, Lr 9, Lr 18, Lr 19, Lr 21, Lr 38, Lr 42 and Lr 43, which showed zero disease severity along the four years of evaluation.
- 2- Moderate resistance genes, Lr 2a, Lr 2b, Lr 20 Lr 25, Lr 28, Lr 30, Lr 34, Lr 35, Lr 36 and Lr 39. It showed low disease severity ranged from Tr – Mr / Ms to 10 Mr / Ms, and able to slow down leaf rust all over the tested period .
- 3-Moderate susceptible genes, Lr 11, Lr 12, Lr 13, Lr 27, Lr 32, Lr and Lr 33 which showed mean average of infection from 10s up to 30s .
- 4-Highly susceptible genes, Lr 1, Lr 2c, Lr3, Lr 3bg, Lr 3 ka, Lr 10, Lr 14a and Lr 14b mean average coefficient of infection more than 30 up to 75 % .

Similar results were obtained by El- Daoudi *et al.*,(1987) who reported that Lr 19 showed higher levels of resistance at both seedling and adult plants stages followed by Lr 15, Lr24 and Lr 9, respectively. (Sawhney and Goel, 1986) indicated that genes Lr 9, Lr 19, Lr 24, Lr 25 and Lr 28 confers effective seedling resistance to different pathotypes of leaf rust and

also exhibited adult plant resistance. Also, Tomar and Menon (1998) screened certain near isogenic lines and stocks of common wheat carrying specific Lr gene for adult plant resistance to leaf rust pathotypes under natural and artificial epiphytotic conditions , alien genes Lr 9, Lr 19 Lr 24, Lr 25, Lr 28, Lr 32 and Lr 37 conferred a high degree of adult resistance .While, Lr 18, Lr 21, Lr 22a, Lr 35 And Lr 36 exhibited moderate resistance to leaf rust .

Table(1): Severity of leaf rust disease on a 0 -100 scale, average coefficient of infection (ACI) and area under disease progress curve (AUDPC) of 31 Lr genes .

Lr genes	Disease severity				ACI	Mean of AUDPC	
	2000	2001	2002	2003			
Highly resistance							
Lr 9	0	0	0	0	0	0	
Lr 18	0	0	0	0	0	0	
Lr 19	0	0	0	0	0	0	
Lr 21	0	0	0	0	0	0	
Lr 38	0	0	0	0	0	0	
Lr 42	0	0	0	0	0	0	
Lr 43	0	0	0	0	0	0	
Moderately resistance							
Lr 2a	5-Mr/Ms	10- Mr/Ms	10- Mr/Ms	10- Mr/Ms	4.37	137.50	
Lr 2b	10- Mr/Ms	5-Mr/Ms	5-Mr/Ms	10- Mr/Ms	3.75	100.00	
Lr 20	5-Mr/Ms	5-Mr/Ms	10- Mr/Ms	10- Mr/Ms	3.75	112.50	
Lr 25	10- Mr/Ms	5-Mr/Ms	5-Mr/Ms	5-Mr/Ms	3.12	87.50	
Lr 28	10- Mr/Ms	5-Mr/Ms	5-Mr/Ms	10- Mr/Ms	3.75	100.00	
Lr 30	5-Mr/Ms	5-Mr/Ms	5-Mr/Ms	10- Mr/Ms	3.12	87.50	
Lr 34	5-Mr/Ms	5-Mr/Ms	5-Mr/Ms	10- Mr/Ms	3.12	87.50	
Lr 35	Tr- Mr/Ms	Tr- Mr/Ms	Tr- Mr/Ms	5-Mr/Ms	1.37	37.50	
Lr 38	5-Mr/Ms	5-Mr/Ms	5-Mr/Ms	5-Mr/Ms	2.50	75.00	
Lr 39	5-Mr/Ms	10- Mr/Ms	10- Mr/Ms	10- Mr/Ms	4.37	137.50	
Moderately susceptible							
Lr11	10 s	10 s	10 s	20 s	12.50	350.00	
Lr 12	20 s	30 s	30 s	40 s	30.00	900.00	
Lr 13	10 s	10 s	20 s	30 s	17.50	500.00	
Lr 27	20 s	10 s	10 s	20 s	15.00	400.00	
Lr 32	5 s	10 s	20 s	20 s	13.75	425.00	
Lr 33	20 s	20 s	20 s	30 s	22.50	650.00	
Highly susceptible							
Lr1	40 s	30 s	30 s	40 s	35.00	1000.00	
Lr 2c	50 s	60 s	80 s	80 s	67.50	2050.00	
Lr 3	50 s	60 s	80 s	80 s	67.50	2050.00	
Lr 3bg	40 s	80 s	80 s	80 s	70.00	2200.00	
Lr 3ka	60 s	80 s	80 s	80 s	75.00	2300.00	
Lr 10	20 s	40 s	30 s	40 s	32.50	1000.00	
Lr 14a	40 s	60 s	60 s	60 s	55.00	1700.00	
Lr 14b	20 s	20 s	40 s	50 s	32.50	950.00	
L.S.D.	6.47						

All lines of low moderate resistance to leaf rust had less than 5 ACI and 150 unit of area under disease progress curve (AUDPC) compared to over 75 ACI and 2300 unit in the susceptible Lr gene 3ka . Prescott and Saari, (1975) suggested that varieties and lines having ACI less than 5 were

considered as good sources of resistance, while values between 5 – 10 considered as sources of reasonable levels of resistance, while entries having A CI greater than 10 should be discarded. The performance of data show that the previous resistant and moderate genes are sources of resistance to leaf rust. The resistant / moderate resistant genes may confer adult plant resistance singly / or if linkage with other Lr / Sr genes and may be used in crossing block program with susceptible common wheat varieties to leaf rust. For example, Lr24 is known to be linked with Sr 24 (McIntosh *et. al.*, 1977) which confers a high level of resistance to both leaf and stem rusts. Also several researchs reported that Lr 34 interacts favorably with Lr 13 (Roelfs, 1988) and with Lr 33 and Lr T3 (Samborsk and Dyck, 1982) and with Lr 27 and Lr 31 (Singh and McIntosh, 1984)to confer durable resistance to leaf rust. Area under disease progress curve (AUDPC) values run in a parallel line with disease severity of the tested Lr genes.

Data in Table (2) show Person's correlation coefficient (r_s) of mean disease severity between 4 years of assessment of 0.818. The r_s values were very high ranged from 0.606 to 0.987. It means that there is a high positive correlation of disease severity between the four years and the Lr genes varied greatly in their level of resistance to leaf rust.

The high correlation coefficient (r_s) of disease severity between the four years of assessment suggests that disease severity and area under disease progress curve are a reliable epidemiological parameters and can be used to evaluate the resistance in the field.

Table (2): Person's correlation coefficient of mean disease severity between four years for 31 wheat Lr monogenic lines.

Year	Disease severity			
	2000	2001	2002	2003
2000	-	0.606	0.683	0.701
2001			0.972	0.961
2002				0.987
2003				-

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استمرارية مقاومة بعض سلالات القمح أحادية الجين لمرض صدأ الأوراق
(بكمسينيا ريكونديتا ترتيساي)

مصطفى محمود الشامي

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

تم تقييم عدد ٣١ سلالة أحادية الجين (إل- أر) لتحديد درجة مقاومتها لمرض صدأ الأوراق في طور النبات البالغ تحت ظروف العنوى للصناعية لمدة ٤ سنوات (٢٠٠٠ - ٢٠٠٣) وذلك بمحطة بحوث الجميزة. وقد أظهرت النتائج تفاوت سلالات القمح الأحادية الجين (إل- أر) في شدة الإصابة ولكنها ظلت تقريبا ثابتة لمدة أربع سنوات. تم تقسيم السلالات أحادية الجين الي أربع مجاميع طبقا لرد فعلها. وكانت الجينات إل أر ٩، إل أر ١١٨، إل أر ١١٩، إل أر ٢١، إل أر ٢٨، إل أر ٤٢، إل أر ٤٣ عالية المقاومة. بينما الجينات إل أر ١٢، إل أر ٢٢، إل أر ٢٠، إل أر ٢٥، إل أر ٢٨، إل أر ٣٠، إل أر ٣٤، إل أر ٣٦، إل أر ٣٩ متوسطة المقاومة وأعطت قيمة لمتوسط معامل العنوى (ACI) أقل من ٥ % وقيمة منخفضة للمساحة الواقعة تحت منحنى تقدم المرض (AUDPC). بينما أظهرت الجينات إل أر ١١، إل أر ١٢، إل أر ١٣، إل أر ٢٧، إل أر ٣٢، إل أر ٣٣ قيمة منخفضة من شدة الإصابة. وأظهرت باقي الجينات إل أر ١، إل أر ٢ ج، إل أر ٣، إل أر ٣ ب، إل أر ٣ ك، إل أر ١٠، إل أر ١١، إل أر ١٤ إل أر ١٤ ب حساسية عالية للإصابة. أثبت معامل ارتباط بيرسون وجود قيم عالية موجبة للارتباط بين السنوات الأربع تتراوح بين ٠,٦٠٦ إلى ٠,٩٨٧ بمتوسط ٠,٨١٨. أظهر كل من مقياس شدة الإصابة (D.S.) و المساحة الواقعة تحت منحنى تقدم المرض (AUDPC) ارتباطا عاليا يمكن الإعتماد عليهما كمقياسين دقيقة لحساب درجة المقاومة.