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## ADULT PLANT RESISTANCE EVALUATION AGAINST LEAF RUST OF WHEAT IN PAKISTAN

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### ABSTRACT

Leaf Rust (*Puccinia triticina* Roberge ex Desm f.sp. *tritici*) formerly known as brown rust, is a potential threat to wheat crop all over the world. Thirty varieties were evaluated in field under randomized complete block design (RCBD in Faisalabad (Pakistan) during 2010-11. Four cultivars (Fareed -08, FSD -08, Lasani-08, V-02192, V4178), were found immune, eight (Blue silver, Chakwal-85, Fareed-06, Sehar -06, Shafaq-06, Iqbal-2000, V-04030, V-07194) resistant, five (Chenab-2000, V-04179, V-05152, V-5153) moderately resistant, four (Chenab-2000, V-04179, V-05152, V-5153) were moderately resistant to moderately susceptible. Inqilab-91, V-03094, V-05155, V-04022 were moderately susceptible. One variety (V-032860) showed moderately susceptible to susceptible response while five cultivars, (FSD-85, Kohistan-97, Pak-81, V-06096) showed susceptible reaction. In the second experiment (Pot exp.) by using CRD thirty varieties were screened. Two cultivars (V-02192 and Lasani-08) were immune. Three varieties/lines (V-04030, Sehar-06, and FSD-08) were resistant. Two cultivars (V-04178 and Freed-06) were moderately resistant. Six varieties/lines (Punjab-76, V-07194, Sehar-06, Iqbal-2000, Shafaq-06 and V-05153) were moderately resistant to moderately susceptible. Four varieties (V-04022, V-04030, Punjab-96 and Chakwal-85) were moderately susceptible. Only one line (V-032860) was moderately susceptible to susceptible. The present study clearly emphasizes that resistant varieties should be cultivated under farmer's field conditions to avoid the yield losses from leaf rust.

**Keywords:** *Puccinia triticina* f.sp. *tritici*, *Triticum aestivum*, adult plant resistance, AUDPC.

### INTRODUCTION

Wheat is a staple food about 40% of the world (Anonymous, 2007). Main purpose of wheat cultivation is the food security (Arslan *et al.*, 2007). Its total area under cultivation in Pakistan is 9,062 thousand hectare with 23,421 thousand tons production (Anonymous, 2009). Its production should be increases 2% annually on the same area to meet the human stipulate (Van Niekerk, 2001) but its production is endangered by a number of diseases (Soliman *et al.*, 2012). Among diseases leaf rust caused by *Puccinia triticina* f.sp. *tritici* Roberge ex Desm. f sp, *tritici* (Eriks and E. Henn.) D.M. Henderson is the notable one, occurred in epidemic form several times in Pakistan (Stuthman *et al.*, 2007). 40 - 50% yield losses were recorded (Ahmad *et al.*, 2010).

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However, the extent of losses depends upon the level of susceptibility/resistance of the wheat cultivars/varieties (Beard *et al.*, 2007). Due to heavy infection of rusts growth and yield parameter of wheat plants are adversely affected (Feyissa *et al.*, 2005; Abebe *et al.*, 2013). Fayyaz *et al.* (2008) and Chun-Yan *et al.* (2011) observed leaf rust occurrence and virulence and find out that Lr1, Lr2a, Lr2b, Lr2c, Lr3, Lr3ka, Lr3bg, Lr10, Lr11, Lr12, Lr14b, Lr15, Lr16, Lr17, Lr18, Lr20, Lr21, Lr23, Lr24, Lr25, Lr26, Gatcher (10, 27+31), Lr29, Lr30, Lr32, Lr33, Lrb and Lr23+ indicated presence of virulence at five locations in Pakistan. Various types of options are available for the management of the leaf rust of wheat but the use of resistant germplasm is most reliable, durable, economical and safe way to combat the disease (Khan *et al.*, 2002; Stuthman *et al.*, 2007; Afzal *et al.*, 2009). Many scientist of the world like; Oelke and Kolmer, (2004); Anikster *et al.* (2005); Khanna *et al.*

(2005); Navabi *et al.* (2005); Stuthman *et al.* (2007) and Zhang *et al.* (2008) use the phenomena of Adult plant resistance for the management of leaf rust of wheat.

Keeping in view these above facts, the present studies were conducted to evaluate the available wheat germplasm for the source of adult plant resistance against leaf rust to combat with this malady.

#### MATERIALS AND METHODS

**Field Trial:** Thirty (30) high yielding advance lines and commercial cultivars were evaluated for resistance against leaf rust of wheat in disease screening nursery. Seeds of wheat were collected from Wheat Research Institute (WRI), AARI, Faisalabad. These varieties/lines were sown in wheat growing season in the experimental area of Department of Plant Pathology during 2009-2010. For adult plant screening following the 2 m long line sowing method for each entry maintaining Row to Row (RxR) distance of 30 cm. After every 10th entry/variety, a line of wheat cultivar “Morocco” that is highly susceptible to all the prevalent rust races of wheat and provides a substrate for rapid multiplication and distribution of rust inoculum was sown to act as rust spreader. Moreover, the nursery was also surrounded by planting two rows of “Morocco” to increase the inoculum pressure which is essential for present studies. In order to maintain crop health and vigor normal agronomic practices including recommended fertilization dose and irrigation schedule was applied. On the onset of February several plants of each spreader row were inoculated by injecting the uredospores @  $10^6$ /ml water (Rehman, 2006) into the stem with a hypodermal syringe (Zehner and Humphrey, 1929; Yakhtenfel'd, 1980). Spreader plants were also sprayed by with inoculum. Suspension was prepared by mixing fresh inoculum of (*Puccinia triticina* f.sp. *tritici*) in distilled water in the form of uredospores (Obtained from Wheat Research Institute, Faisalabad). Few drops of Tween-20 were also mixed in the uredospore suspension for better sticking on the surface of leaves and sprayed repeatedly on alternate days immediately after sun set for producing artificial epidemic conditions (Rowell, 1948). This is due to the fact that infection requires moisture.

**Pot Experiment:** For seedling stage screening nursery was raised in pots. Ten seeds of each variety/cultivar were sown per pot in under completely randomized design (CRD). As the plants attained two-leaf stage, they were thinned to four plants per pot. After every 10th

entry/variety a pot of highly susceptible wheat cultivar “Morocco” was sown as a disease spreader. The inoculum in the form of uredospores was applied on both sides of the leaves with the help of moistened camel hair brush (Kareppa and Gangawane, 1995). The seedlings were also inoculated with the help of small sprayer to ensure the wheat rust infection.

**Data collection and Analysis:** Leaf rust severity and response data for adult plant and seedling stage screening was recorded on 1<sup>st</sup>, 10<sup>th</sup> and 20<sup>th</sup> of March at an interval of 10 days by following the modified Cobb's Scale described by Peterson *et al.* (1948). Where Immune (O) = 0, Resistant (R) = 0.2, Moderately resistant (MR) = 0.4, Moderately Resistant To Moderately Susceptible (MRMS) = 0.6, Moderately Susceptible (MS) = 0.8 Moderately Susceptible to Susceptible (MSS) = 0.9, Susceptible = 1. Disease rating was done after ten days interval for determining Area Under Disease Progress Curve (AUDPC). Rust data was recorded upto the physiological maturity of the wheat. AUDPC value was determined by using trapezoidal integration of disease incidence over time, considering the whole period evaluated by using the following formula (Shanner and Finney, 1997).

$$\text{AUDPC} = \sum_{i=1}^{n-1} (y_i + y_{i+1} + \frac{1}{2}) (t_{i+1} - t_i)$$

Where n = number of assessment times  $y_i$  = disease incidence at the i<sup>st</sup> observation

$t_i$  = time at the i<sup>st</sup> observation  $(t_{i+1} - t_i)$  = time interval between two consecutive assessments. In order to allow comparison between different treatments that were assessed during periods of time, the AUDPC integral variable was divided by its respective observation (Stubbs *et al.*, 1986 and Yadav *et al.*, 1992).

#### RESULTS AND DISCUSSION

**Adult Plant Screening (Field Trial):** Data on the basis of response of different wheat cultivars showed varying degree of resistance and susceptibility. Out of thirty cultivars, FSD-08, V-02192, V-04178 and Lasani-08 were found immune. V-07194, V-04030, Iqbal-2000, Freed-06, Sehar-06, Shafaq-06, Chakwal-85 and Blue Silver showed resistant response while V-04179, V-05152, Chenab-2000 and V-05153 were moderately resistant. Punjab-76, Punjab-96, WL-711 and V-066284 were moderately resistant to moderately susceptible. V-03094, V-05155, Inqilab-91 and V-04022 were moderately susceptible. V-032860 showed moderately susceptible to susceptible response while cultivars, V-08166, V-06096, FSD-85, PAK-81 and Kohistan-97

showed susceptible reaction and expressed AUDPC = 315-450 (Table.1). Leaf rust (*Puccinia triticina* f.sp. *tritici*) causes heavy losses to wheat yield all over the world (Hussain *et al.*, 2008). The best strategy to control leaf rust of wheat is to screen out the available germplasm for resistance or susceptibility (Singh *et al.* 2001, Wamishe and Milus 2004, Martinez *et al.* 2005). Use of resistant cultivars has been preferred to limit losses from rusts for many years (McVey and Long 1993). For this purpose 30 varieties/lines were screened out. Out of thirty cultivars, FSD-08, V-02192, V-04178 and Lasani-08 were found immune with response value of 0.0 for each variety, as they gave AULRPC of 0, 0, 0 and 0 respectively. Eight varieties/lines viz V-07194, V-

04030, Iqbal-2000, Fareed-06, Sehar-06, Shafaq-06, Chakwal-85 and Blue Silver showed resistant response with response value of 0.2 for each variety, and gave AULRPC of 158, 68, 68, 15, 15, 15, 15 and 15 respectively. Four varieties/lines vize V-04179, V-05152, Chenab-2000 and V-05153 were moderately resistant with response value of 0.4 for each variety, giving AULRPC of 188, 158, 158 and 68 respectively. Four varieties/lines, vize Punjab-76, Punjab-96, WL-711 and V-066284 were moderately resistant to moderately susceptible with response value of 0.6 for each variety, giving AULRPC of 315, 188, 158 and 135 respectively.

Table1. Wheat germplasm response against leaf rust disease in adult plant screening (Field Trail).

Sr#	Varieties/ lines	AUDPC	Response
1	Fareed -08, FSD -08, Lasani-08, V-02192, V4178	0	I
2	Blue silver, Chakwal-85, Fareed-06, Sehar -06, Shafaq-06, Iqbal-2000, V- 04030, V-07194	5 - 20	R
3	Chenab-2000, V-04179, V-05152, V-5153	68 -188	MR
4	Punjab-76, Punjab-96, WL-711, V-066284	135-315	MRMS
5	Inqlab-91, V-4022, V-03094, V-05155	263 - 435	MS
6	V-32862	285	MSS
7	FSD-85, Kohistan-97, Pak-81, V-06096	315-450	S

Four varieties/lines, vize V-03094, V-05155, Inqilab-91 and V-04022 were moderately susceptible with response value of 0.8 for each variety, and gave AULRPC of 435, 420, 315 and 263 respectively. Out of thirty varieties/ lines only one line V-(032860) showed moderately susceptible to susceptible response with response value of 0.9 and gave AULRPC of 285. While

cultivars, V-08166, V-06096, FSD-85, PAK-81 and Kohistan-97 showed susceptible reaction with response value of 1.0 for each variety, giving AULRPC response values of, 450, 390, 315, 315 and 158 respectively in field condition. These results are in agreement with many research workers (Das and Roy, 1992; Long *et al.*, 1988; Arslan *et al.*, 2007).

**Seedling Screening (Pot Experiment):** Data was recorded according to Stubbs *et al.* (1986) scale from pots experiment showed some difference as compared to field trial. Those cultivars which were resistant in field did not remain resistant in pots experiment. Whereas, some cultivars gave same reaction. Two cultivars (V-02192 and Lasani-08) were immune.

Table2. Wheat germplasm response against leaf rust disease at seedling stage (Pot experiment).

Sr#	Varieties/ lines	AUDPC	Response
1	Lasani-08, V-02192	0	I
2	FSD-08, Sehar-06, V-03094	5 - 10	R
3	Fareed-06, V-04178	20 - 40	MR
4	Iqbal -2000, Punjab -76 , Shafaq-06, V- 5153, V-7194, V-04179	25 - 45	MRMS
5	Chakwal-85, Punjab-96, V-4022, V-04030	30 - 50	MS
6	V-32862	35	MSS
7	Blue silver, Chenab -2000, Kohistan-97, FSD-85, Inqlab-91, Pak-81, WL -711, V-05152, V-05155, V-8166, V-066284, V-06096	40 - 60	S

Three varieties/ lines (V-04030, Sehar-06, and FSD-08) were resistant. Two cultivars (V-04178 and Freed-06) were moderately resistant response. Six varieties/lines (Punjab-76, V-07194, Sehar-06, Iqbal-2000, Shafaq-06 and V-05153) were moderately resistant to moderately susceptible. Four varieties (V-04022, V-04030, Punjab-96 and Chakwal-85) expressed moderately susceptible response. Only one line (V-032860) exhibited moderately susceptible to susceptible reaction with AUDPC = 35 while rest of varieties/ lines (Blue silver, Chenab -2000, Kohistan-97, FSD-85, Inqilab-91, Pak-81, WL -711, V-05152, V-05155, V-8166, V-066284, V-06096) showed susceptible response (Table.2).

In pot experiment two cultivars (V-02192 and Lasani-08) were immune. Three varieties/lines (V-04030, Sehar-06, and FSD-08) were resistant. Two cultivars (V-04178 and Freed-06) were moderately resistant. Six varieties/lines (Punjab-76, V-07194, V-07194, Iqbal-2000, Shafaq-06 and V-05153) were moderately resistant to moderately susceptible. Four varieties (V-04022, V-04030, Punjab-96 and Chakwal-85) were moderately susceptible. Only one line (V-032860) was moderately susceptible to susceptible. While twelve varieties/lines (Kohistan-97, PAK-81, Inqilab-91, Chenab-2000, V-06096, FSD-85, V-066284, V-05152, Blue Silver, V-08166, WL-711 and V-05155) showed susceptible response. Similar results were reported by Barcellos, 1990; Yang *et al.*, 1990; Casuli and Ruci, 1991; Singh and Rajaram, 1992; Brammer *et al.*, 2004; Oelke and Kolmer, 2004; Arslan *et al.*, 2007; Zhang *et al.*, 2008) from conducted pot and field experiments for evaluation of wheat varieties against leaf rust disease and observe different response of wheat varieties at seedling and adult plant stage. Adult plants of different varieties conferred resistant towards leaf rust due to different genes like Lr13, Lr-34 etc. Same results were also reported by Anikster, *et al.* (2005) screened 742 accessions under greenhouse and field conditions in two subsets of 284 and 468 and concluded that Adult resistance to leaf rust was more common than seedling resistance among the accessions; 21 accessions had less than 25% leaf rust severity in field plots compared with 80 to 90% severity for highly susceptible accessions. The results of the present studies are nearly same as reported by Withanage and Dhaliwal (2004) they screened out wheat germplasm at seedling stage against two pathotype of leaf rust and one pathotype of stripe

rust with an aim to identify resistant genes. No. of varieties showed the susceptibility to both pathotype of leaf and stripe rust. However the Chinese spring variety showed resistant response because it was containing slow rusting genes.

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