Available Online at EScience Press
Plant Protection
ISSN: 2617-1287 (Online), 2617-1279 (Print)
http://esciencepress.net/journals/PP

A CASE STUDY OF OCCURRENCE AND INTENSITY OF STRIPE RUST DUE TO PLANTING DATES IN LAYYAH DISTRICT

Asghar Ali[1], Ali Raza[1], Muhammad Afnan[1], Syed Atif Hasan Naqvi[1], Ammarah Hasnain[2], Hameed-Ullah Khan Sherwani[1]

[1] *Department of Plant Pathology, Faculty of Agricultural Sciences and Technology, Bahauddin Zakariya University, Multan, Pakistan.*

[2] *Biological Science Department, Forman Christian College University, Lahore, Pakistan.*

ARTICLE INFO

Article history
Received: 5th July, 2018
Revised: 19th August, 2018
Accepted: 27th August, 2018

Keywords
Triticum aestivum
Stripe rust
cultural practices
Disease responses

ABSTRACT

The impact of cultural practices like varietal selection, sowing time and date on disease severity and incidence of wheat stripe rust was recorded from twelve different locations of three tehsils of district Layyah. Survey results showed that Galaxy, Sehar 2006, Fareed 2006, Punjab 2011 and Ujala were the commonly practiced sown varieties in Layyah district. It was found that almost all sown varieties were vulnerable to the rust pathogen showing zero resistance. Disease severity of wheat stripe or yellow rust in three tehsils of district Layyah was found maximum (73.33%) on location-1 in tehsil Layyah, while in tehsil Karor Lal Esen maximum severity was recorded on location-3 (74.44%) and in tehsil Chobara, maximum severity was noted at location III with (66.66%). Overall disease severity of wheat stripe or yellow rust in three tehsils of district Layyah was pragmatic maximum (76.49%) in tehsil Karor Lal Esen, followed by tehsil Layyah and Chobara with (72.12%) and (64.11%) respectively. Sowing of wheat at different dates in the month of mid-October first week of November, mid-November and the last week of November showed a great impact on the disease severity of stripe or yellow rust of wheat. Maximum disease incidence 67.11 % was recorded on those locations where the sowing was in practice in last week of November by the farmers. This varietal selection of wheat sown in different fields showed a big impact on the disease severity of wheat stripe rust. This information may provide a source for the better management tactics of the disease in future.

Corresponding Author: Syed Atif Hasan Naqvi
Email: atifnaqvi@bzu.edu.pk

INTRODUCTION

Wheat is the most important cereal and a vital for more than one third of the world's population. It has planted over 220 million hectares worldwide with a yield of 564.6 million tonnes, with an average of 2500 kg of grain per hectare. China grain planted about 30 million hectares, followed by the Russian Federation; India, the United States, Australia, Canada, Turkey and Pakistan (FAO, 2013). It is also a basic food culture in Pakistan, accounting for almost 36 percent of the total cultivated area, 30 percent of the added value of major crops and 76 percent of the total wheat production. Pakistan made a major step forward last year not only to achieve self-reliant in grain production but also to become a grain exporter. Among the countries of grain production, Pakistan ranked tenth in terms of surface area (8.5

million hectares) and 59 in terms of performance (21.0 million tonnes) per year (Akfirat et al., 2010). Wheat production per acre differs from one area to another and one farm to another, as some allies and support factors have to be taken into account, while the yield is calculated. Time and water availability for irrigation through the waterways support to performance. The average yield per acre of wheat is estimated to be between 20 and 25 tonnes and above it requires extra effort and additional natural factors (Afzal et al., 2009; Farrakh et al., 2011).

Wheat is an important crop of district Layyah and sown in all the three tehsils viz., Layyah, Karor Lal Esen and Chobara. Layyah contributes to the country economy not only through the noticeable wheat production but also in other cereals and fruits. Wheat is vulnerable to many pathosystems hampering the yield of this crop to a great extent Wheat is normally attacked by three types of rusts, that is leaf rust or rusty brown, (*Puccinia recondita* f.sp. *triticale*) stripe rust or yellow rust (*Puccinia striiformis* f.sp. *tritici*) and black stem (*Puccinia graminis* f.sp. *tritici*) rust, yellow rust appear repetitively on wheat and responsible for low crop yield. (Kolmer, 1993). Stripe rust can easily be identified within the field during the early morning by examining the leaves, particularly older leaves, low in number and yellow strips of pustules. Pustules developed are utterly high above the surface of the leaves and can be easily blown on a cloth or soft tissue leaving yellow color. The first evidence of stripe rust is the manifestation of yellow bands (pre-pustules), comes after small brilliant yellow elongated uredinales pustules, organized in prominent lines on the leaves, foliar sheaths, glumes and wings (Line, 2002). Pustules mature open and liberate the urediniospores masses of yellow-orange and yellow stripes in some varieties grow in long narrow leaves. Infected tissues become brown and dry as the plant grows or becomes stressful (Martinez-Espinoza, 2008). Heavy early infestations lead to dwarfed plant growth. It is currently not known of any variety that is present without stripe infestation in Pakistan.

Khan (1985) reported fifteen varieties of wheat with less rusting reaction on environmental conditions at 77-78% RH, maximum temperature 22 to 28°C and a minimum temperature 16-18°C. Keeping in view the above facts regarding the rust diseases of the wheat the current research was planned to evaluate the collection of resistant sources against the rust disease of wheat and to determine the conducive environmental variable facilitating the disease in the field. *Puccinia striiformis* f. sp. *tritici* can persist as a latent mycelium on the grain. Urediniospores can maintain the disease on host green tissue, such as voluntary grain or susceptible grain that grows in other fields. Stripe rust is most prevalent in heights and colder climates. Night temperatures are <60 ºF (15 ºC) best for pathogen activity. Stripe rust require lower temperature as compare to other rusts. Optimum germination of urediniospores occurs at 44-59ºF (7-15ºC). Infestation and disease progression are quicker between 50-60º F (10-16ºC) (Milus et al., 2009).

Khan et al. (2002) investigated 140 genotypes in MARS, Dharwad (Karnataka), collected by the pathologist of CIMMYT, Turkey and stated that out of 140 genotypes only 25 genotypes were resistant to stem rust, leaf rust and leaf blight. Khan et al. (2001) surveyed about 145 wheat varieties for brown rust resistance in a field research from the 145 lines examined, 39 were asymptomatic, 64 were resistant, 29 were moderately resistant, and 13 were moderately susceptible to brown rust. Statistical analysis has shown that cultivating with 21-40 percent of rust infection, which is characteristic of moderately sensitive resistant plants, are still tolerable for the selection of resistant cultivars. Khan et al. (2002) verified early grain sowing and late sown varieties to produce more disease. During November and December 1997, the varieties were planted at the department of plant pathology, UAF and nursery was artificially inoculated with *Puccinia recondita* f. sp *tritici* and natural inoculums were also found responsible for infection.

On the basis of disease severity scale of brown rust 89 brown rust cultivars were found to be asymptomatic, 40 cultivars were resistant, 32 moderately resistant, 10 moderately sensitive. Sixteen susceptible seven were highly susceptible planted soon. In nurseries which were planted late, 74 were symptomatic, 28 were resistant, and 31 moderately resistant. The cultivars which were sown on 1st December showed incredible higher level of disease severity of leaf rust as refer to those cultivars which were planted on November 1st. wheat varieties i.e., Inqilab 91, Bahawalpur 97, MH 97, 97, and Kohistan 99 were resistant to stripe rust. In this context farmer's practices are also too much important in the management of the disease. During the current research farmers cultural practices at farm level were explored and correlated with the disease severity of stripe rust at different locations in district Layyah.

MATERIALS AND METHODS

Study area: The investigations were conducted at different tehsils of district Layyah (31.0546° N, 71.2874° E) and department of plant pathology, Bahauddin Zakariya University, Multan. A total of twelve locations were randomly selected at three Tehsil's of District Layyah and survey was carried out to hypothesize the experiments.

Disease severity: Stripe rust reaction**,** field response and value were recorded by the modified Cobb's scale (Table 1) described by Peterson et al. (1948). Disease severity was recorded after seven days interval. Rust data were recorded up to physiological maturity of the wheat. The disease severity data was collected for stripe rusts and converted into coefficient of infection by multiplying severity with constant value for field response as described by Stubbs et al. (1986) and Roelfs et al. (1987).

$$\text{Disease severity} = \frac{\text{Sum of all the score of Individual } \frac{\text{plants}}{\text{variety}}}{\text{Total No. of Plants Observed}} \times \frac{100}{\text{Maximum Scale}}$$

Farmer's knowledge and cultural practices adopted at farm level: The information regarding the cultural practices viz., varietal selection, sowing date and time, and irrigation sources adopted at each selected farm was collected from the farm owner and it was correlated with the disease severity.

Table 1. Cobb's scale for the stripe rust response value.(Peterson et al., 1948)

Reaction	Visual symptoms	Infection %
No disease	No visible infection	0
Moderately resistant	Small uredia present surrounded by necrotic area	10-19
Moderately resistant to moderately susceptible	Small uredia present surrounded by necrotic areas as well as medium uredia with no necrosis but possible some distinct chlorosis	20-39
Moderately susceptible	Medium uredia with no necrosis but possible some distinct chlorosis.	40-59
Moderately susceptible	Medium uredia with no necrosis but possible some distinct chlorosis as well as large uredia with little or chlorosis present.	60-79
Susceptible	Large uredia and little or no chlorosis present.	80-100

Statistical analysis: Analysis of variance (ANOVA) of gathered data of disease incidence and severity was done by using SAS® 2002. Treatment means were compared using Fisher's least significant differences (LSD) at P = 0.05 and New Duncan's Multiple Range Test (DMRT) (SAS, 2002).

RESULTS

Layyah district is prominent for growing the wheat and chickpea and the environment also promotes this crop in this area, so the trouble of wheat and Chickpea are also severe in this area. Three tehsils of district Layyah comprising Layyah, Karor Lal Esen and Chobara were surveyed regularly for data collection of disease severity of wheat and farmers practices were also observed critically. Four different locations (each farm was 10 to 12 km from each other) were selected in each tehsil to calculate the infection dynamics of stripe or yellow rust of wheat. In wheat fields, farm practices were also recorded and correlated with the severity of stripe or yellow rust of wheat. We examined distinict planting dates and choice of cultivars in the same tehsil of the Layyah district for the wheat crop at various sites which were selected for the research (Table 2).

We observed five different varieties viz., Galaxy, Sehar 2006, Fareed 2006, Punjab 2011 and Ujala are being practiced in Layyah District. On what bases and parameters, a cultivar is being selected by farmer is yet non-understood able by us but this varietal selection for wheat sowing have a big impact on the rust diseases of wheat. We found that almost all the sown varieties were vulnerable to the rust pathosystems showing zero resistance to the obligate parasites (Table 3).

Disease severity of wheat stripe or yellow rust in three tehsils of district Layyah was found maximum (73.33%) on location-1 in tehsil Layyah, while in tehsil Karor Lal Esen maximum severity was recorded on location-3 (74.44%) and in tehsil Chobara maximum severity was noted at location III with (66.66%) (Figure 1).

Overall disease severity of wheat stripe or yellow rust in three tehsils of district Layyah was pragmatic maximum (76.49%) in tehsil Karor Lal Esen, followed by tehsil Layyah and Chobara with (72.12%) and (64.11%) respectively (Figure 2).

Table 2. Comparison of sowing time and varietal selection at different Locations in district Layyah.

District	Study Sites	Time of sowing	Varieties
Layyah	Location-1	Mid October	Galaxy
	Location -2	1st week of November	Sehar-2006
	Location-3	Mid October	Punjab-2011
	Location-4	Mid October	Fareed-2006
Karor Lal esen	Location-1	Last week of November	Punjab-2011
	Location -2	Last week of November	Punjab-2011
	Location-3	Last week of November	Galaxy
	Location-4	1st week of November	Galaxy
Chobara	Location-1	Mid October	Ujala
	Location -2	Mid-November	Galaxy
	Location-3	Mid-November	Galaxy
	Location-4	Mid-November	Sehar-2006

Table 3. Response of different varieties towards the stripe rust disease severity.

Sr. No.	Variety	Stripe rust severity	Tehsil Location	Response
1.	Galaxy	61.33	I (Layyah), II (Karor Lal Esen)	S
2.	Sehar 2006	47.19	II (Layyah)	MS
3.	Fareed 2006	57.91	IV (Fareed)	S
4.	Punjab 2011	71.29	I, II (Laror Lal Esen)	HS
5.	Ujala	73.33	I (Chobara)	HS

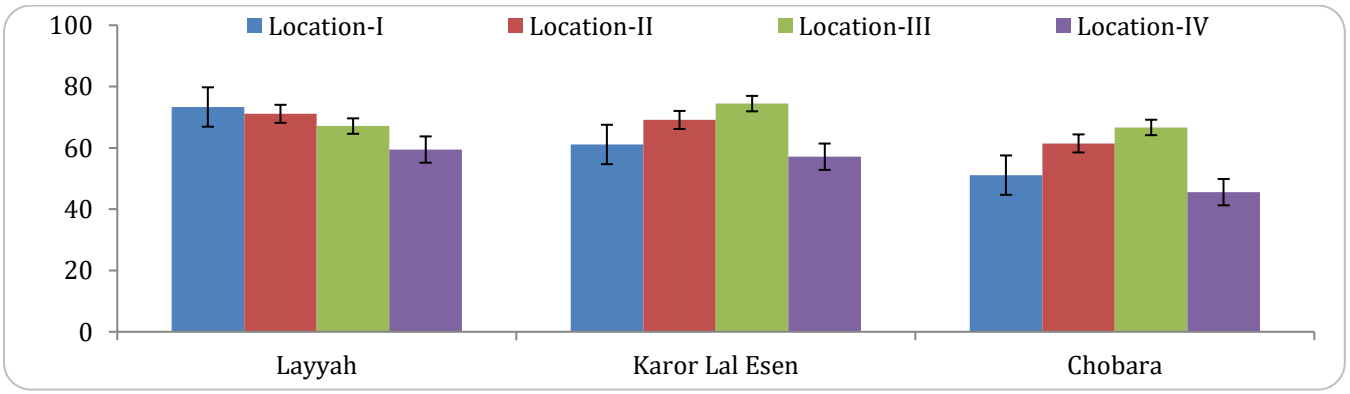

Figure 1. Disease Severity (%) of Stripe/ Yellow rust in three Tehsil's of Districts Layyah at different locations.

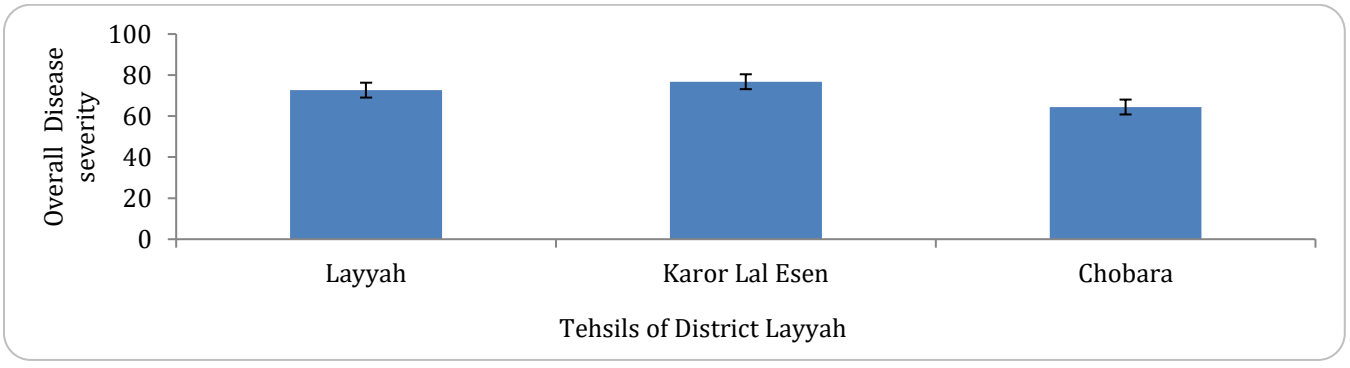

Figure 2. Overall disease Severity (%) of Stripe/ Yellow rust in three Tehsils of Districts Layyah.

Sowing of wheat at different dates in the month of mid-October first week of November, mid-November and the last week of November showed a great impact on the disease severity of stripe or yellow rust of wheat. Maximum disease incidence 67.11 % was recorded on those locations where the sowing was in practice in last week of November by the farmers (Figure 3).

DISCUSSION

Wheat (*Triticum aestivum* L.) is an important crop and elementary food for the people of Pakistan. It shares 34% to GDP (Fayyaz et al., 2008). Layyah district of Punjab is contributing in many commodities for Pakistan i.e., in cereals, fruits and lentils. During the current research various aspects were explored which were directly or indirectly related to the practices of farmers for the disease severity of the stripe rust of wheat. A comprehensive survey was carried out at different locations in district Layyah and the farmer's knowledge and practices were explored for wheat stripe rust incidence and severity. Three tehsils of district Layyah comprising Layyah, Karor Lal Esen and Chobara were surveyed regularly for data collection of disease severity of wheat and farmer's practices were also observed critically. Four different locations (each farm was 10 to 12 km from each other) were selected in each tehsil to calculate the infection dynamics of stripe or yellow rust of wheat. In wheat fields, farm practices were also recorded and correlated with the severity of stripe or yellow rust of wheat. Galaxy, Sehar 2006, Fareed 2006, Punjab 2011 and Ujala are being practiced in Layyah district. The cultivars which are planted by the grower we are unable to understand on what bases and parameters but these decisions of grower for wheat sowing have a striking effect on the rust diseases of wheat. We found that almost all the sown varieties were vulnerable to the rust pathosystems showing zero resistance to the obligate parasites. Disease severity of wheat stripe or yellow rust in three tehsils of district Layyah was found maximum (73.33%) on location-1 in tehsil Layyah, while in tehsil Karor Lal Esen maximum severity was recorded on location-3 (74.44%) and in tehsil Chobara maximum severity was noted at location III with (66.66%).

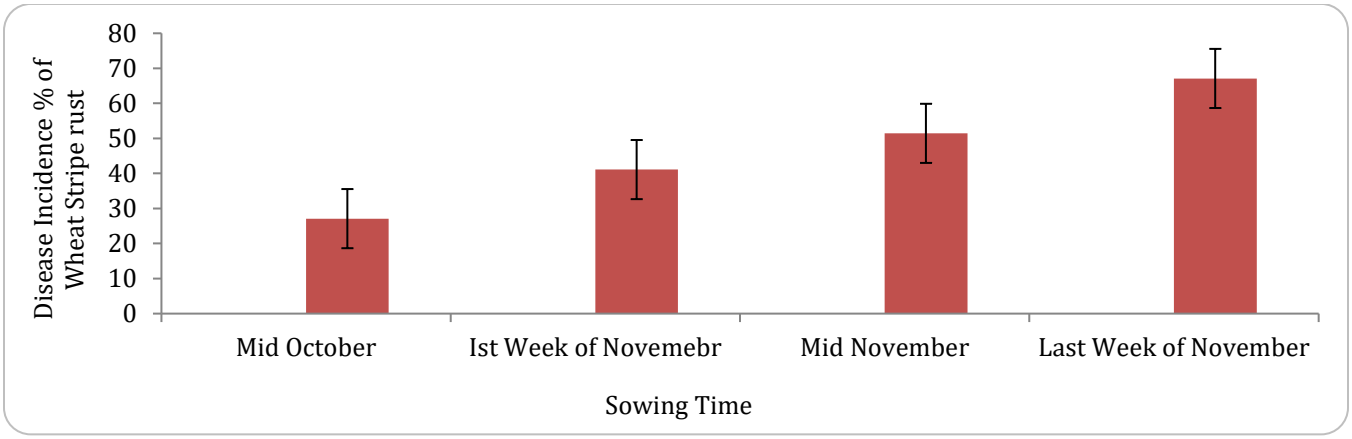

Figure 3. Impact of sowing dates on the incidence of wheat stripe/ yellow rust.

Overall disease severity of wheat stripe or yellow rust in three tehsils of district Layyah was pragmatic maximum (76.49%) in tehsil Karor Lal Esen, followed by tehsil Layyah and Chobara with (72.12%) and (64.11%) respectively. Sowing of wheat at different dates in the month of mid-October first week of November, mid-November and the last week of November showed a great impact on the disease severity of stripe or yellow rust of wheat. Maximum disease incidence 67.11 % was recorded on those locations where the sowing was in practice in last week of November by the farmers. Similar findings were obtained by Ahmad et al. (2010) who investigate 36 lines in response to yellow or stripe rust to find out their degree of susceptibility or resistance. Out of these, eighteen were susceptible, six were moderately susceptible to susceptible, seven were moderately resistant to moderately susceptible and five lines stand resistant. Maximum severity of 90% of yellow or stripe rust resulted in 54 to 55% calculated and predicted losses, respectively. While 40, 50, 60 and 70% disease severity of yellow rust caused 35-34%, 38-37%, 42-40% and 46-47% calculated and predicted losses, respectively. Likewise Ali et al. (2009) performed an research during 2005-2006 to find variability for field based partial

resistance to yellow rust among twenty wheat breeding cultivars planted at Nuclear Institute for Food and Agriculture, Peshawar, along with 'Morocco' as susceptible check. Partial resistance was assessed through the infection type, final rust severity (FRS), area under rust disease curve (AUDPC), infection rate (IR) and co-efficient of infection (CI).

Cluster analysis of the 20 wheat lines showed two main groups along Morocco as a separate cluster. Nine lines were grouped in one cluster, while remaining 11 lines were clustered in another group. The first cluster as moderately slow yellow rusting lines while later were marked as better slow rusting lines. Fahmi et al. (2005) tested five Egyptian wheat germplasm and seven isogenic lines (NILs) for wheat yellow rust, results showed that no variety was found resistant against the yellow or stripe rust of wheat. Hovmoller (1999) stated that yellow rust (*P. striiformis* f. sp. *tritici*) was likely a very injurious pathogen on wheat. In early 1990s, severe epidemics were searched out in many areas of Denmark. This coincided with favorable conditions for the pathogen in most years, and rapid multiplication of races virulent on two of the most common grown varieties, which in addition, had very poor levels of partial resistance to the pathogen. In the mid-1990s, the severity of stripe rust generally declined, and in 1996 no natural infections were observed. The observation in 1996 coincided with an increased production area of varieties with high levels of partial resistance, and a relatively cold and dry winter. In 1997 stripe rusts were observed at low incidences, and no severe epidemics were observed.

CONCLUSION

Rust diseases are the serious problem for wheat crop in Pakistan, and still there is no remedy for the management of these diseases rather farmers practices are also facilitating the dynamics of these disease.

ACKNOWLEDGMENTS

Special thanks are due to the progressive growers of the district Layyah for their help and cooperation regarding the research experiments.

REFERENCES

Afzal, S.N., Haque, I., Ahmedani, M.S., Munir, M., Firdous, S.S., Rauf, A., Ahmad, I., Rattu, A.R., Fayyaz, M., 2009. Resistance potential of wheat germplasm (*Triticum aestivum* L.) against stripe rust disease under rainfed climate of Pakistan. Pakistan Journal of Botany 41, 1463-1475.

Ahmad, S., Afzal, M., Noorka, I.R., Iqbal, Z., Akhtar, N., Iftkhar, Y., Kamran, M., 2010. Prediction of yield losses in wheat (*Triticum aestivum* L.) caused by yellow rust in relation to epidemiological factors in Faisalabad. Pakistan Journal of Botany 42, 401-407.

Akfirat, F., Aydin, Y., Ertugrul, F., Hasancebi, S., Budak, H., Akan, K., Mert, Z., Bolat, N., Uncuoglu, A., 2010. A microsatellite marker for yellow rust resistance in wheat. Cereal Research Communications 38, 203-210.

Ali, S., Shah, S.J.A., Raman, I.K.H., Maqbool, K., Ullah, W., 2009. Partial resistance to yellow rust in introduced winter wheat germplasm at the north of Pakistan. Australian Journal of Crop Science 3, 37.

Fahmi, A.I., Nazim, M., Khalifa, S.Z., El-Orabey, W.M., 2005. Genetics of adult plant resistance to leaf rust in Egyptian wheat. Egyptian Journal of Phytopathology 33, 1-10.

FAO, 2013. Food and agriculture organization of the United Nations. United Nations, pp. 1486-1487.

Farrakh, S., Ahmad, M.J., Mirza, J.I., Hameed, S., Kazi, M., Ashraf, M., 2011. RAPD analysis of stripe rust resistant synthetic hexaploid of wheat. International Journal of Applied Science and Technology 1, 80-88.

Fayyaz, M., Rattu, A.R., Ahmad, I., Akhtar, M.A., Hakro, A.A., Kazi, A.M., 2008. Current status of the occurrence and distribution of (*Puccinia triticina*) wheat leaf rust virulence in Pakistan. Pakistan Journal of Botany 40, 887-895.

Hovmoller, M.S., 1999. Epidemiology and resistance against *P. striiformis* on wheat, 16th Danish plant protection conference, pp. 119-127.

Khan, M.A., 1985. Wheat breeding rust epidemiology in Pakistan, National Seminar of Epidemiology and Forecasting of Plant Diseases, University of Agriculture, Faisalabad, Pakistan.

Khan, M.A., Khan, S.M., Hussain, M., 2002. Evaluation of wheat lines/varieties against artificial and natural inoculums of *Puccinia recondita* f. sp. *tritici* causing brown rust. Pakistan Journal of Agricultural Sciences 39, 226-231.

Khan, M.A., Mustafa, A.Y., Hussain, M., 2001. Determination of minimum leaf rust levels for breeding high yielding wheat varieties. Pakistan Journal of Phytopathology 13, 18-25.

Kolmer, J.A., 1993. Physiologic specialization of *Puccinia recondita* f. sp. *tritici* in Canada in 1991. Canadian Journal of Plant Pathology 15, 34-36.

Line, R.F., 2002. Stripe rust of wheat and barley in North America: A retrospective historical review. Annual Review of Phytopathology 40, 75-118.

Martinez-Espinoza, A., 2008. Disease Management in Wheat, 2008-2009, Wheat Production Guide.

Milus, E.A., Kristensen, K., Hovmøller, M.S., 2009. Evidence for increased aggressiveness in a recent widespread strain of *Puccinia striiformis* f. sp. *tritici* causing stripe rust of wheat. Phytopathology 99, 89-94.

Peterson, R.F., Campbell, A.B., Hannah, A.E., 1948. A diagrammatic scale for estimating rust intensity on leaves and stems of cereals. Canadian Journal of Research 26, 496-500.

Roelfs, A.P., Casper, D.H., Long, D.L., Roberts, J.J., 1987. Races of *Puccinia graminis* in the United States and Mexico during 1986. Plant Disease 71, 903-907.

SAS, 2002. Version 8.00 ed. SAS Institute Inc; Cary, North Carolina, USA.

Stubbs, R.I.W., Prescott, J.M., Saari, E.E., Dubin, H.J., 1986. Cereal Disease Methodology Manual. Centro International de Maize by trig (CIMMVT), Mexico.