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SCREENING OF WHEAT GERMPLASM AGAINST STRIPE RUST DISEASE UNDER FIELD CONDITIONS IN PAKISTAN

Waqas Raza[1], Muhammad Usman Ghazanfar[1], Atiq-ur-Rehman[2], Muhammad Fayyaz[2]
[1] *Department of Plant Pathology, College of Agriculture, University of Sargodha, Pakistan.*
[2] *Crop Diseases Research Program, National Agricultural Research Center, Islamabad, Pakistan.*

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ABSTRACT

Rust in wheat is a serious threat worldwide and causes a significant loss in yield that may be more than 90% in case of susceptible variety or under epidemic conditions. Among different rusts of wheat, Stripe rust (*Puccinia striiformis* f. sp. *tritici*) poses a serious threat to wheat production in cooler areas of Pakistan. The 70% area of wheat in Pakistan is prone to stripe rust. Enduring resistance based on partial resistance is very noteworthy and successful way to combat stripe rust dilemma in wheat crop. For this purpose, one hundred and forty nine wheat varieties/lines were screened, and severity of stripe rust was recorded. One row Morocco of which is universally susceptible to wheat rusts was planted around the nursery. Inoculum in the form of uredial suspension was sprayed uniformly with a sprayer with a fine nozzle. Data were recorded in the month of April/May when the universally susceptible wheat variety Morocco developed up to 80% severity. According to results, 60 lines/varieties were found immune against all the races of yellow rust prevailing in nature. Twenty lines showed the symptoms of resistant as chlorosis was observed without uredia. Similarly, 12 lines were moderately resistant and 35 lines were in the range of resistant to moderately resistant. Ten lines/varieties were found moderately susceptible while 5 lines/varieties showed the symptoms of susceptible. Our results indicated that a large number of varieties have high level of resistance and can be used against wheat stripe rust.

Corresponding Author: Waqas Raza
Email: waqasraza61@yahoo.com

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the second-most important food crop which provides a large supply of the dietary proteins and grown all over the world (Rajaram, 2001). The increase in the global population is expected to cross almost 9 billion in 2050 (FAO, 2013). Due to climate fluctuations, the food insecurity is increasing day by day. Therefore, food produced in developing countries has to be enhanced by 70 percent by 2050 to fulfill the demands of the people of the world (Paroda et al., 2013; Semenov et al., 2014). These changes catalyze the severity of plant diseases that are damaging the crops (Sanchez, 2000). The production of wheat in our country is low as compared to other advanced countries due to various biotic and abiotic factors. Among biotic stresses, stripe rust (yellow rust), caused by *Puccinia striiformis* f.

sp. *tritici* is a destructive foliar disease of wheat. Rust diseases are among the destructive factors of wheat and cause yield losses ranging from 10 to 70% (Chen, 2005; Milus et al., 2009) under favorable conditions in susceptible cultivars (Siwar et al., 2013). It has been reported to be prevailing at higher altitudes where wheat is grown (Boyd, 2005). The 70% area under wheat in Pakistan is prone to stripe rust (Qamar et al., 2012; Singh et al., 2004). Historically, stripe rust has been more significant in areas with cool and wet environmental conditions and, therefore, occurs more consistently in northern Europe, the Mediterranean region, Middle East, Western United States, Australia, East African highlands, China, the Indian subcontinent, New Zealand and South America (Bux et al., 2012). The pathogen has a recombinant population structure and high diversity across the world (Hovmoller, 1999). The urediniospores play the most important role in the progress of the disease. Large numbers of urediniospores are produced by the uredinia over a period of several weeks causing rapid multiplication of inoculum. These urediniospores are air borne and germinate at 5-9 °C in the presence of humidity or free water (Salvo, 2013). Stripe rust is distinguished by the presence of light yellow pustules that occur in stripes on leaves mostly. As the pustules mature, yellow-orange spores are produced (Chen et al., 2014). As the disease progresses, tissues around the pustules turn brown and dry resulting in a scorched appearance and the fields with plants displaying severe symptoms may be easily detectable from a distance (Horst, 2013). Its wider prevalence, therefore, has been a global threat to wheat production inflicting about 30 to 100% grain losses and after a long time of ambiguity, the alternate host of stripe rust was identified as *Barberis vulgaris* (Kolmer, 2005).

The safeguard measures against the destructive pathogen are therefore supreme in the framework of food security (Chakravarty, 2011). Their flexibility and adaptability to changing climatic conditions made them fit in most of the regions around the world. Such characteristics include mutation, migration, somatic and sexual hybridization of wheat rusts (Kolmer, 2005). To combat stripe rust, various strategies are being practiced worldwide. Use of chemicals and agronomic practices have proved to be successful to reduce the losses to some extent but due to health hazardous and being not eco-friendly, this remedial measure is not suitable and affordable by the farmers in developing countries like Pakistan (Afzal et al., 2010). Most approachable, cost-effective and eco-friendly method otherwise is host genetic resistance to control stripe rust (Chen, 2007; Farrokhi et al., 2011). Breeding for resistant cultivars is basically based on hypersensitive resistance and use of this resistance in breeding programs is attractive being easy to incorporate into improved germplasm and it provides complete protection to crop (Singh et al., 2000). The main objective of the present study was to screen various wheat germplasms against stripe rust and to select disease resistant lines for future wheat breeding programs.

MATERIAL AND METHODS

This present study was conducted in National Agricultural Research Center, Islamabad during the year 2011-2012 in order to screen the wheat germplasm against stripe rust of wheat. To study the rusts, the most important requirement is the multiplication and preservation of the inoculums. For spore multiplication susceptible host was selected.

Preparation of inoculum: Rust uredospores were collected from the infected plants and were dissolved in distilled water and stirred. After the adjustment, the spore concentration was set upto 50000 spores/ml and sprayed on the test plants. Symptoms developed in 7-10 days. The inoculums can be increased either on seedling or adult plants. These collected spores can be stored for a longer period in liquid nitrogen at -196 ^{o}C as described by Cunningham (1973) . The spores are dried to 20-30% relative humidity and then sealed in glass vials or aluminum packet.

Inoculation protocol: One hundred and forty nine wheat lines/commercial varieties were evaluated against stripes rust at NARC, Islamabad during the year 2011-12. One row of Morocco which is universal susceptible to wheat rusts was planted around the nursery and in addition, a row of the susceptible check (Morocco) was also planted at every 20th planted entry. Artificial rust inoculations with a mixture of field collection inoculums were carried out in Feb to March 2012.

Initially, inoculations of spreaders almost 3-5 tillers in succession, were completed by hypodermic syringe strategy utilizing watery uredospore suspension to which 1 to 2 drops of Tween-20 were added to break the surface tension. In this manner all the material was 2 to 3 times spray inoculated by turbo-air sprayer utilizing fluid spore suspension with fortnightly interims to get substantial rust advancement. At all the locations observation on response and severity of stripe were recorded according to Leogering (1959). usually, 5% intervals were used from 5-20% severity and 10% intervals for higher readings. The response of a variety refers to the type of infection recorded by the following criteria:

0 No visible infection

R **Resistant** (Visible chlorosis or necrosis, no uredia are present)

MR **Moderately Resistant (**Small uredia surrounded by either chlorotic or necrotic areas)

MS **Moderately susceptible (**Uredia medium size with no necrotic margins but possibly some distinct chlorosis)

S **Susceptible** (Large uredia with no necrosis and little or no chlorosis)

RESULTS

Data were recorded in the month of April when the universally susceptible wheat variety Morocco developed up to 80% severity. According to result 60 lines/varieties were found immune against all the races of yellow rust prevailing in nature. Twenty lines showed the symptoms of resistant as chlorosis was observed without uredia. Similarly, 35 lines were in the range of resistant to moderately resistant while 12 lines were found moderately resistant as along with the chlorosis and necrosis uredia was also observed. After immune, maximum lines/varieties showed the symptoms of moderately resistant to moderately susceptible as large uredia were observed with some chlorosis but no necrosis. Ten lines/varieties were found moderately susceptible while 5 lines/varieties showed the symptoms of susceptible as large uredia were observed without chlorosis and necrosis (Table 1, Figure 1). It is envisaged that there is still a great potential to exploit the existing sources of wheat germplasm to develop stripe rust resistant varieties. For this purpose, the process may be continued with more lines and at more locations for determination of resistance against yellow rust as well as for stability of the germplasm over years along with other desirable characteristics before final approval of the variety. It was obvious that most of the germplasm was immune and resistant to the diseases and has the potential to be selected for breeding programs in future to combat this destructive wheat disease in Pakistan.

Table 1. Response of wheat germplasm against wheat stripe rust.

S. No.	Response	Germplasm
1	Immune	NIFA2, NIFA3, NIFA5, NIFA8, NIFA9, NIFA11, NIFA12, NIFA14, NIFA21, NIFA22, NIFA23, NIFA24, NIFA25, NIFA27, NIFA29, NIFA31, NIFA32, NIFA36, NIFA42, NIFA43, NIFA44, MN1, MN2, MN4, MN5, MN7, MN12, MN14, SA17, MN16, Bakhtawar92, Kaghan93, Kohinoor83, Parwaz94, Pasban90, Shaheen94, Bahawalpur2000, Soorab96(Barley), Marvi2000, FakhreSarhad, Bahkhar2002, Tatara, Auqab2000, Zarlashata, Pirsabak2005, NR420, Lasani08, Faisalabad08, Aas2009, NARC2009, NIFABarsat09, BARS2009, Raj, Gomal08, Pirsabak2008, KT2000, Khirman, UAP4606, Ghaznavi, Sehar2006
2	Resistant	DN-110, 09FJ04, V9-99114, V22-10B-9308, V34-10B-9383, NIFA-4, NIFA 13, NIFA-16, NIFA-18, NIFA-34, NIFA-39, NIFA-40, V-08314, V-09082, V-10309, V00BT034, NR-400., TW438, Bahawalpur-97, NR-421
3	Resistant-moderate resistant	DN-101, 09FJ24, 05FJ17, RCA1, V59375, V699110, V799174, V89318, NIFA-28, V12-99160, V15-10B-93660, V30-10B-9339, V32-10B-9344, NIFA17, NIFA20, V1199129, NIFA30, NIFA37, NIFA41, V06BT005, V08BT005, V09137, V08068, NR401, NR413, NR378, TWX406, TWX411, TW76010, MN-8, MN 10, MN13, MN21, Imdad01, PVM1
4	Moderate resistant	DN-107, AZRC-3, V18-10B-9307, V20-10B-9346, NIFA-1, NIFA-19, NIFA-26, MN-11, Chakwal 86, Punjab 96, NIA-Sunehri, SH-2002,
5	Moderate susceptible	DN-105, DN-108, Ufaq, V21-10B-9351, V29-10B-9391, V-07096, MN-38, MN-39, Dera-98, AZRC-7
6	Susceptible	TWX415, MN-33, 9406, NIA-Amber, 0BT034

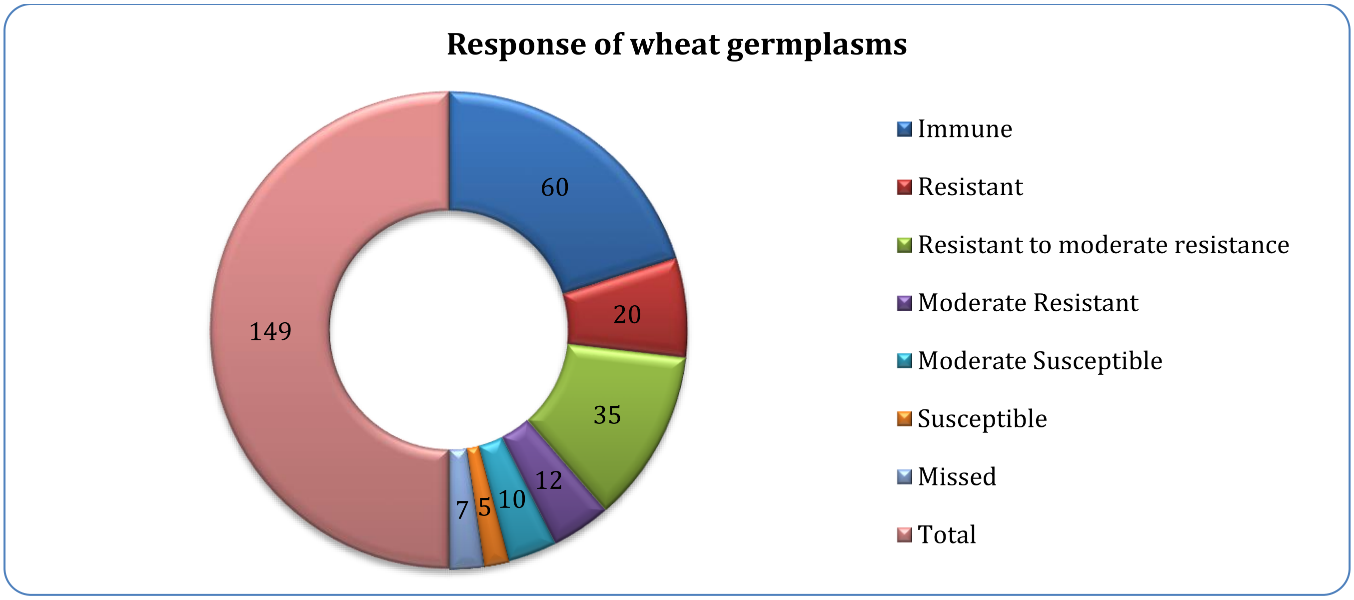

Figure 1. Graphical presentation of lines/varieties against yellow rust.

DISCUSSION

Indigenous germplasm screened against stripe rust in field condition indicated that most of the lines were moderately resistant after the resistance status which is suggested to use in the wheat breeding program because resistant varieties are the best option for successful wheat production (Admassu et al., 2012). Field data revealed that during 2011-12, at Islamabad location, almost 40.26% wheat germplasm were immune while (13.42%) were resistant and (23.48%) were resistant to moderately resistant. Only 3.35% observed to be susceptible against the rust pathogen. The results clearly indicate the broad range of resistance and resistance to moderately resistance to stripe rust in breeder's germplasm. Therefore, it is concluded that most of the wheat germplasm had a great potential to be used against stripe rust although most of the wheat varieties in Pakistan has been established few seedling resistance genes, therefore, are susceptible to its new pathotypes emerging from time to time (Bux et al., 2011). Our results are in line with those of Singh et al. (2004) who reported that most cultivated varieties in Pakistan have broken down resulting in severe economic losses (Kisana et al., 2003). We are reporting in the present study that stripe rust resistance of wheat germplasm having the varied genetic background. In order to identify resistance sources, germplasms were screened at the initial stage using the bulk of urediospores under field conditions. Almost similar results were found by Afzal et al. (2009) who investigated resistance potential of wheat germplasm against stripe rust under rainfed climate of Pakistan and observed that out of 188 cultivars/lines, most of the germplasm were resistant to disease and have the potential to be used as a resistant germplasm source against stripe rust. Our results are in conformity with those of Ali et al. (2009) who observed that most of the lines exhibit more resistance and resistant to moderately resistant under high disease pressure as compared to the susceptible check. Such lines may be exploited to explore and used for their resistance gene to minimize damages caused by stripee rust.

CONCLUSION

The present study revealed that the germplasm included in this study showed an outstanding resistant and resistant -moderately resistant against wheat stripe rust, therefore, it can directly be tested keeping in view other quality parameters, or the resistant landraces may be incorporated in the breeding programs for the development of new cultivars.

RECOMMENDATION

The wheat improvement and breeding programs could be designed involving a multidisciplinary team including plant breeders, molecular, geneticists, pathologists, and economists for sustainable cultivar development for food security and poverty elimination.

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