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

RESPONSE OF WHEAT GENOTYPES FOR RESISTANCE AGAINST LEAF RUST (*PUCCINIA TRITICINA* ERIKS.) UNDER FIELD CONDITIONS

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A R T I C L E I N F O

Article history
Received: 15th January, 2019
Revised: 13th March, 2019
Accepted: 19th March, 2019

Keywords
Wheat
Resistance
Puccinia triticina
AUDPC

A B S T R A C T

The current research was planned to evaluate the response of 37 wheat (*Triticum aestivum*) genotypes against leaf rust resistance under field conditions during 2017-18. Areas under disease progress curve (AUDPC) of all the varieties were calculated. Leaf rust severity response was variable among the tested genotypes. Out of thirty-seven genotypes, five wheat lines i.e. 17BT007, 17BT013, 16BT008, 16BT010 and 16BT011 were immune. Seven lines were found to be resistant with AUDPC values ranged from 1 to 199. Response of ten lines was moderately resistant while five lines were categorized as moderately susceptible. Ten genotypes exhibited susceptible response against leaf rust with more than 600 AUDPC value. High values above 600 of AUDPC showed greater incidence of leaf rust on wheat plants while lower AUDPC values indicated resistance to leaf rust. Present research provided the resistant wheat lines to the breeders to incorporate in their breeding program against leaf rust.

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INTRODUCTION

Wheat is mostly grown as staple food of nearly 35% of the world's population with its increasing demand in Pakistan. Wheat accounts for 9.6 percent of the value added in agriculture and 1.9 percent of GDP of Pakistan. During 2016-17, wheat crop was sown on an area of 9052 thousand hectares witnessing a decrease of 1.9 percent compared to 9224 thousand hectares during same period last year. Wheat production was estimated to 25.750 million tons during 2016-17 witnessing an increase of 0.5 percent over the last year's production of 25.633 million tons (Anonymous, 2017). The increase in production was due to better supply of inputs which contributed in enhancing per hectare yield.

Wheat is attacked by many biotic and a biotic stresses. Among them fungal diseases (rusts, smuts and bunts etc.), bacterial leaf streak, and viruses (wheat dwarf, wheat spot mosaic and wheat streak mosaic viruses etc.) are the limiting factors. Wheat rust problem has emerged due to attack of fungus not only in Asia but all over the wheat growing areas of the world. Wheat leaf rust caused by *Puccinia triticina* (formerly known as *Puccinia recondite* f. sp. *tritici*) is often a destructive foliar disease of wheat in Pakistan (Fayyaz et al., 2008; Khan et al., 2002). Leaf rust has potential to cause losses up to 50% and because of its more frequent and widespread occurrence, leaf rust probably results in greater total annual losses worldwide than stem and stripe rusts (Huerta-Espino et al., 2011). In

1978, a major leaf rust epidemic in Pakistan caused 10% yield loss that cost a national loss of US $86 million (Hussain et al., 1980). Leaf rust decreased numbers of kernels per head and kernel weights (Kolmer et al., 2005; Marasas et al., 2004; Roelfs et al., 1992). Early infection of leaf rust on wheat generally causes higher yield losses; 60–70% infection on the flag leaf at spike emergence may account for a yield loss of more than 30%. Bajwa et al. (1986) reported that losses in kernel weight of wheat varieties due to leaf rust infection ranged between 2.0% and 41% according to the level of resistance or susceptibility. Environmental parameters play a vital role in the spreading of rust and cause epidemics. At the right time, blowing wind in the opposite direction may bring spores and vectors far away from the infected plants. Leaf rust has positive association with relative humidity (RH), temperature (maximum and minimum) and rainfall, while maximum temperature have significant effect to combat the disease (Khan, 1997; Khan et al., 1998; Salman et al., 2006; Singh and Tewari, 2001).

The preferable and most economical method is the utilization of genetic resistance to manage the wheat rusts. It is the most effective, economically safe and environmentally friendly approach, as this method eliminates the need to use fungicides and reduces the cost of production. The need is to identify those cultivars with resistant sources so as to be suggested as the most fit for the cultivation in the diseased areas of the country keeping in view different ecological zones. The screening is considered as the best and the cheapest way to identify these cultivars of wheat which show resistance against leaf rust. Resistant varieties have one or more specific leaf rust resistance genes (denominated *Lr* genes). There are more than 30 different *Lr* genes available to date; however, most varieties have only a few *Lr* genes. In order to cause disease on a certain variety, the leaf rust fungus must be able to defeat all the *Lr* genes in that variety. The prevalence of different rust races is always changing in response to the different wheat varieties being grown with different *Lr* genes. Because new races of the fungus can develop, it is important to know the susceptibility of a given wheat variety (Dyck and Kerber, 1985). The objective of current research was to find out resistant sources in available advanced wheat lines against leaf rust.

MATERIALS AND METHODS

Thirty-seven high yielding wheat advanced lines were evaluated for resistance against leaf rust. Seeds of wheat were collected from Agricultural Biotechnology Research Institute (ABRI), Ayub Agricultural Research Institute (AARI) Faisalabad, Pakistan. These lines were sown during wheat growing season in the experimental area of ABRI during 2017-2018. For screening, each entry was sown in 2 m long lines maintaining row to row distance of 30 cm. After every five entries/varieties, a line of wheat cultivar “Morocco” was sown as rust spreader. It is highly susceptible to all the prevalent rust races of wheat and provides a substrate for rapid multiplication and distribution of rust inoculum. Moreover, two rows of “Morocco” were also sown around the experimental area to increase the inoculum pressure. In order to maintain crop health and vigor, normal agronomic practices including recommended fertilizer dose and irrigation were applied.

Artificial inoculation of wheat genotypes were done by spraying uredospore suspension and rubbing the leaf surface of each entry with the rusted leaves of Morocco. Different methods of artificial inoculation were followed, such as spraying with rust inoculum, rubbing, dusting with talcum powder and transplanting of rusted plants. Spreader plants were also sprayed with rust inoculum. Few drops of Tween-20 were mixed in the uredospore suspension for better sticking on the surface of leaves (Rowell, 1984). Inoculations were done in the evening four to five times during February, 2017-18.

Rust data were recorded three times at an interval of 15 days on the basis of disease severity (0-100%). Based on disease severity, area under disease progress curve (AUDPC) was calculated using CIMMYT software (Singh et al., 2000).

$$AUDPC = \sum_{i=1}^{n-1} \left(\frac{X_i + X_{i+1}}{2} \right) (t_{i+1} - t_i)$$

Where Xi= Rust intensity on date I, Ti= time in days between I and date i+1, N= No. of dates on which disease was recorded.

The minimum and maximum limits of AUDPC were 1 to 199 which categorized under resistant. The minimum and maximum limits of AUDPC were 200 to 399 which categorized under moderately resistant. However, for moderately susceptible, the minimum and maximum limits were 400 to 599 and above 600 for susceptible lines.

RESULTS

Data were recorded on the basis of severity and different wheat genotypes showed varying degrees of resistance and susceptibility. Out of thirty-seven genotypes, five wheat lines i.e. 17BT007, 17BT013, 16BT008, 16BT010 and 16BT011 were immune (no disease symptoms). Seven lines were found to be resistant viz. 17BT005, 17BT008, 7BT010, 17BT017, 17BT019, 17BT020, 17BT021and 16BT022 and their AUDPC values were 25, 25, 170, 110, 110, 110, 135, respectively. Response of ten lines viz. 17BT002, 17BT003, 17BT004, 17BT009, 17BT011, 17BT012, 16BT016, 17BT018, 16BT015 and 16BT022 were moderately resistant with AUDPC value ranged from 200 to 399. Five lines viz. 17BT001, 17BT006, 17BT014, 17BT022 and 16BT018 were categorized as moderately susceptible on the basis of AUDPC values. High values above 600 of AUDPC showed greater incidence of leaf rust on wheat plants while lower AUDPC values indicated resistance to leaf rust. Ten genotypes viz. 17BT015, 17BT023, 17BT024, 16BT002, 16BT006, 16BT005, 16BT008, 16BT017, 16BT021 and Morocco exhibited susceptible response against leaf rust with more than 600 AUDPC value (Table 1).

Table 1. Response of wheat lines/varieties to wheat leaf rust and area under disease progress curve (AUDPC).

Sr. No	Ranges of AUDPC*	Lines/ varieties	Level of resistance or susceptibility
1	0	17BT007, 17BT013, 16BT008, 16BT010, 16BT011	Immune
2	1-199	17BT005, 17BT008, 7BT010, 17BT017, 17BT019, 17BT020, 17BT021	Resistant
3	200-399	17BT002, 17BT003, 17BT004, 17BT009,17BT011,17BT012 16BT016, 17BT018,16BT015, 16BT022	Moderately Resistant
4	400-599	17BT001, 17BT006,17BT014 17BT022, 16BT018	Moderately Susceptible
5	600-More	17BT015, 17BT023, 17BT024 16BT002, 16BT006, 16BT005 16BT008, 16BT017,16BT021, Morocco	Susceptible

*The minimum and maximum limits of AUDPC were 1 to 199 which categorized under resistant while 200-399 = moderately resistant, 400-599 = moderately susceptible, and ≥ 600 = susceptible.

DISCUSSION

Genetic resistance is the most economic and effective means of reducing yield losses caused by leaf rust disease (Liu and Kolmer, 1997). In the current work, varying degree of resistance and susceptibility was observed against wheat leaf rust. This variability in virulence of advance wheat lines might be due to their genotypic behavior (Aktar-Uz-Zamana et al., 2017; Hussain et al., 2011; Rattu et al., 2009). The resistant wheat lines viz. 17BT005, 17BT008, 7BT010, 17BT017, 17BT019, 17BT020, 17BT021 may include some resistant set of *Lr* genes. These new sources of leaf rust resistance can be incorporated into wheat to escape heavy yield losses. These results were supported by the findings of other researchers (Hussain et al., 2011; Kolmer et al., 2007; Stepien et al., 2003).

During 2010-2012 growing seasons, Draz et al. (2015) evaluated 42 Egyptian wheat varieties for leaf rust resistance and only 9 varieties exhibited seedling and adult plant resistance. They also elaborated that inverse relation exists between the disease level and grain yield. Muhammad et al. (2015) screened three hundred and twenty-five wheat genotypes on the basis of leaf rust severity scale and revealed that 225 wheat genotypes showed no reaction against leaf rust, 12 genotypes showed resistant response, 20 moderately resistant, 40 moderately susceptible, 15 moderately resistant to moderately susceptible and 13 genotypes showed susceptible response against leaf rust. They also described that epidemiological factors remained highly significant for leaf rust development and had great influence on the development of leaf rust of wheat.

Breeding disease resistance genotypes is a continuous process and plant breeders need to add new effective genes to their breeding materials. Resistance expression depends on the host-parasite interaction, environmental conditions, plant growth stage and the interaction between resistance genes in wheat genome (Kolmer, 1996). New sources of resistance could be incorporated into wheat to diverse the existing gene pool for leaf rust resistance (Singh et al., 1998).

CONCLUSION

It is concluded from the current research that wheat lines, 17BT005, 17BT008, 7BT010, 17BT017, 17BT019, 17BT020 and 17BT021, resistant to leaf rust could be used for breeding wheat genotypes with higher levels of resistance to abate yield losses and to ensure food security.

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