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RESEARCH ARTICLE

SCREENING OF WHEAT FROM AVAILABLE GERMPLASM AGAINST LEAF RUST CAUSED BY *PUCCINIA TRITICINA* FOR THE SOURCE OF RESISTANCE

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ABSTRACT

The research was conducted for the source of resistance against leaf rust of wheat caused by *Puccinia triricina*. In the present study, eight varieties/advanced lines were evaluated in 2013-14 against this disease using Randomized Complete Block Design (RCBD) at the experimental research area of Department of Plant Pathology, University College of Agriculture, University of Sargodha, Pakistan. During the month of March, 2013-14 seven genotypes/successions viz. A-24, A-20, K-11, A-09, A-17, A-08 and A-29 exhibited moderately susceptible response against leaf rust of wheat as compared to an advanced line i.e. A-25 expressed moderately resistant response. Similarly, during month of April, four varieties/genotypes namely A-24, A-20, K-11 and A-25 showed moderately resistant response whereas other four genotypes/advanced lines such as A-09, A-17, A-08 and A-29 showed moderately susceptible response against leaf rust of wheat. However, conclusively it was pragmatic that eight lines/genotypes were screened out against leaf rust of wheat. Four lines namely A-09, A-17, A-08 and A-29 exhibited susceptible response to leaf rust of wheat whereas other four genotypes/successions such as A-24, A-20, K-11 and A-25 expressed moderately susceptible response to this disease. No genotype/succession/advanced line showed resistant, moderately resistant or immune response to leaf rust of wheat. It was concluded that screening of leaf rust of wheat for the source of resistance is the most economical management strategy for farmers.

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most imperative staple crop of world. It is most widely grown in Pakistan (Abdelbacki *et al.,* 2013). Its demand is increasing day by day owing to rise in population, abruptly decreasing area under cultivation and adversely changing climatic conditions (Ingala *et al*., 2012). In the world, hexaploid and tetraploid wheat (*T. aestivum* and *T. turgidumvar*. durum) is cultivated on an area of 215 million hectares, 44% (95 million hectares) is in Asia whereas on 62 million hectares it is cultivated in China, India and Pakistan (Singh *et al*., 2004). In Pakistan, it is grown on an area of 8.80 million hectares with an average production of 25.09 million tons (Mateen *et al*., 2015). Wheat production should be increased 2% annually on the same area to fulfill the human demands (Herrera-Foessel, 2011) but its production is affected by a number of diseases caused by fungi (rusts, bunts, smuts etc.) viruses (wheat spot mosaic, wheat streak mosaic, wheat dwarf etc.) and bacteria (bacterial leaf blight, black chaff, bacterial mosaic etc.) (McVey *et al*., 2004). It is considered that wheat leaf rust caused by *Puccinia triticina* is the most devastating stable threat in wheat growing areas of the world due to polycyclic nature of pathogen (Bux *et al*., 2012). This pathogen is deliberated as major factor in the low production and yield of wheat growing areas of Pakistan (Singh *et al*., 2005; Mateen *et al*., 2015). This disease reduces the production of 43-60 million hectares in Asia in case of susceptible cultivars or virulent pathogen (Aquino *et al*., 2002). Historically this disease reduced more than one million tons wheat yield in North America during 1960s similarly in Western Australia sever rust epidemic occurred during 1992 (Wiese, 1977). In the world, total 2.2 million tons of wheat production was reduced by epidemics of leaf rust with US$ 330 million similarly in Pakistan, this disease reduced 10.1% yield, 0.83 million tons of production with US $86 million (Hafiz, 1986; Hassan *et al*., 1979; Mateen *et al*., 2015). *Puccinia recondita* the casual pathogen of leaf rust of wheat is an obligate parasite which survives on grass species or on other

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voluntary wheat plants during offseason. Cool and irrigated agriculture areas encourage the spread of primary inoculum. Furthermore, favourable temperature, high humidity, excessive wind speed and dew drops during growing season of wheat leads towards development of an epidemic of wheat leaf rust (Singh *et al*., 2004b). There are five stages of spores of wheat rust through which huge quantity of uredospores are produced. These uredospores build a contact with host plant and enter into the stomata by forming germ tube. Consequently, substomatal vesicles are produced and intercellular hyphae having globose or lobed haustoria intiate physiologic contact with host cell membranes which ultimately begins the infection process (Wiese, 1987).

There are numerous conventional and non-conventional approaches such as seed treatment, spraying blindly with hazardous chemicals, computer operated precision systems, biological control methods, systemic acquired resistance and systemic induced resistance, growth regulators and well as nutritional management (Ali *et al*., 2007). Some of them are very expensive measures to manage huge area of wheat whereas some are unavailable to farmers owing to unappreciable communication barriers between farmers and research institutions. The preferable, economical and most suitable method in managing wheat rusts is the utilization of genetic resistance. The use of chemicals to control this disease is an un-advocated and unadvisable method due to numerous health hazards of pesticides in staple food. The prime focus of wheat breeders and pathologists is to screen out each variety/advance line to facilitate farmers. Many new resistant varieties from leaf rust were released after the green revolution, but new virulent races of rust pathogen spontaneously overcome the resistance (Ingala *et al*., 2012). Thus, to enhance farmers' earnings and wheat productivity, suitable control measures and approaches are needed to be adopted to overcome these losses. Chemotherapy of leaf rust is not practically applicable in Pakistan due to low market price of wheat, health vulnerability concerns and lack of a systematic disease diagnostic pattern (Shynbolat *et al*., 2010). To avoid rust outbreak it is dire need to face multifaceted confronts to identify those cultivars with resistant sources, so as to be suggested as most fit for cultivation in areas of the country prone to diseased by keeping in view the different ecological zones of Pakistan (Admassu *et al*., 2008). Therefore, screening through conventional breeding is most durable and long lasting source of resistance for farmers to minimize the disease incidence as well as it would be helpful in future studies on the identification of resistant sources in wheat against leaf rust.

Aim of study

The current research was conducted to exploit the source of resistance in wheat plants for the management of leaf rust caused by *Fusarium oxysporum* f. sp. *capsici* under natural conditions. This disease is causing huge losses in wheat growing areas of the world.

MATERIALS AND METHODS

Establishment of screening nursery

For the screening of the wheat genotypes against leaf rust, eight lines were sown in the experimental area Department of Plant Pathology, University College of Agriculture, University of Sargodha, Sargodha (Pakistan). All the entries were sown in augmented design. A line of highly susceptible variety i.e. Morocco, was sown after each entry in order to serve as the spreader for the rusts. During the growing season, the nursery was inoculated by following artificial method to provide and maintain the rust inoculum pressure.

Inoculation Techniques

To ensure the maximum disease pressure, the artificial inoculation was done by rubbing and spraying with rust inoculum which by following methods.

Spraying Method

In the distilled water the suspension of urediospores were made thoroughly. Up to a desired level, the suspension was diluted and with the help of hand sprayer it was sprayed on the nursery. Spray of simple water is important for the growth of spores.

Rubbing of leaves

Leaf rust infected leaves were collected and they were rubbed on the leaves having some moisture on leaf sheath and having no symptoms of leaf rust. Leaves were rubbed randomly in the field.

Injection Method

- Suspension of urediospores was prepared.
- The inoculums were injected into the tillers by syringes.

Recording of Rust Severity

Leaf rust disease severity and the response of varieties were recorded by the modified Cobb's scale method (Peterson *et al.,* 1948). At the initiation of disease on different varieties rating were taken after seven days interval. The rust data was recorded up to physiological maturity of the wheat. The final disease rating was taken when the spreader attained 80-100% disease severity. The disease severity on different genotypes were kept recording up to the maturity of crop. Data of environmental conditions i.e. maximum and minimum temperature, relative humidity, rainfall and wind speed were collected from Agro-metrology observatory, University college of Agriculture, University of Sargodha. The relationship between environmental conditions and disease severity were determined through correlation analysis using statistical software. During current research, Minitab 15 by Minitab Inc. U.S.A. were used.

RESULTS

During the month of March, seven genotypes i.e. A-24, A-20, K-11, A-09, A-17, A-08 and A-29 showed moderately susceptible reaction while one i.e. A-25 showed moderately resistant reaction (Table 2). Four varieties i.e. A-24, A-20, K-11 and A-25 were moderately resistant and remaining four i.e. A-09, A-17, A-08 and A-29 were moderately susceptible against leaf rust of wheat during April (Table 3). Eight lines/genotypes were screened out against leaf rust of wheat. Among all these lines, four lines (A-09, A-17, A-08, and A-29) showed susceptible reaction to leaf rust of wheat while rest of four lines/genotypes (A-24, A-20, K-11, and A-25) showed

moderately susceptible response to this disease. No line/genotype showed resistant, moderately resistant or immune response to leaf rust of wheat (Table 4).

may account for a yield loss of more than 30% (Kolmer *et al.,* 2007). In the current research the eight lines were assessed for their response to leaf rust of wheat.

Table 1. Leaf rust reaction, code for field response and response value

Reaction	Code	Field response	Response value
No disease	0	No visible infection	0.00
Resistant	R	Necrotic areas with or without minute uredia	0.02
Moderately resistant	MR	Small uredia present surrounded by necrotic area	0.4
Moderately resistant, moderately susceptible	MR/MS	Small uredia present surrounded by necrotic areas as well as medium uredia with no necrosis but possible some distinct chlorosis.	0.6
Moderately susceptible	MS	Medium uredia with no necrosis but possible some distinct cholorosis	0.8
Moderately susceptible- susceptible	MSS	Medium uredia with no necrosis but possible some distinct chlorosis as well as large uredia with little or chlorosis present	0.9
Susceptible	S	Large uredia and little or no chlorosis present	1.0

Cobb's scale (Peterson *et al.,* 1948) was used to record the rust severity data

Table 2. Response of different genotypes/lines against leaf rust of wheat on the basis of AULRPC value during month of March

S.No.	Lines	18-03-2014	25-03-2014	AULRPC value	Reaction
1	A-24	6.67	43.33	175	MS
2	A-20	6	45	178.5	MS
3	K-11	3.33	48.33	180.81	MS
4	A-09	8.33	46.6	192.26	MS
5	A-17	7.33	66.6	258.76	MS
6	A-08	5	50	192.5	MS
7	A-25	3.33	25	99.15	MR
8	A-29	18.33	53.33	250.81	MS

Table 3. Response of different genotypes/lines against leaf rust of wheat on the basis of AULRPC value during month of April

S.No.	Lines	1-04-2014	8-04-2014	AULRPC value	Reaction
1	A-24	20	13.33	116.66	MR
2	A-20	23.33	11.67	122.5	MR
3	K-11	30	8.33	134.16	MR
4	A-09	33.33	10	151.66	MS
5	A-17	28.33	15	152	MS
6	A-08	25	16.67	145.85	MS
7	A-25	21.66	13.33	122.47	MR
8	A-29	35	25	210	MS

Table 4. Overall response of different genotypes/lines against leaf rust of wheat on the basis of AULRPC value during year 2014

S.No.	Lines	18-03-2014	25-03-2014	1-04-2014	8-04-2014	AULRPC value	Reaction
1	A-24	6.65	31.65	60	55	856.28	MS
2	A-20	5	28.33	61.65	56.65	845.64	MS
3	K-11	7.5	31.65	65	55	895.3	MS
4	A-09	10	25	66.65	63.33	898.21	S
5	A-17	5	38.33	66.65	65	979.86	S
6	A-08	11.5	30	65	70	950.25	S
7	A-25	6.65	31.65	60	55	857.33	MS
8	A-29	8.5	40	70	65	1027.25	S

DISCUSSION

Wheat (*Triticum aestivum*) is staple food of Pakistan and is attacked by three rust diseases i.e. stem, strip and leaf rust caused by Puccinia graminis f. sp. tritici, Puccinia recondita f. sp. tritici *and* Puccinia triticina respectively are the most devastating diseases in the world (Huerta-Espino *et al.,* 2011). The importance of disease, in specific area, depends upon the prevalence of aggressive and/or virulent races of the pathogen as well as their compatibility with the host in a given environment (Martinez *et al.,* 2001). The pathogen infects the leaf blades, leaf sheat and glumes in highly susceptible cultivars (Marasas *et al*., 2004). It also reduced the number of kernels per head and lower kernel weights (Kolmer *et al*., 2005). Early infection of leaf rust usually cause higher yield losses 60–70% infection on the flag leaf at spike emergence

Four lines viz. A-29, A-08, A-17 and A-09 showed susceptible response to leaf rust of wheat whereas other four lines i.e. A-25, K-11, A-20 and A-24 showed moderately susceptible response to leaf rust disease. No line/genotype showed resistant, moderately resistant or immune response to leaf rust of wheat (Lal *et al.,* 2004). The present results are in stream line with Shynbolat and Aralbek, (2010) used same technique i.e. spraying of urediospores suspension on the wheat genotype to evaluate the resistant source. Including a control (Morocco) after every 9th variety or genotype, the two hundred genotypes were screened against reaction of leaf rust disease severity. Among them, 66 were immune, 48 lines showed durable resistance and 66 were susceptible against leaf rust while 79 were immune. Similarly, Bariana *et al.* (2001) and German *et al.* (2007) observed virulence and occurrence of leaf rust and consequently 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+ exhibited virulence responce at five locations in Pakistan. Leaf rust caused by *Puccinia triticina* Eriks., is one of the main diseases of wheat (Triticum aestivum L.). Genetic resistance is the most economic and effective means of reducing yield losses caused by the disease (Draz *et al.,* 2015). However, the extent of losses depends upon the level of susceptibility/resistance of the wheat cultivars/varieties (Herrera-Foessel *et al*., 2011). Due to heavy infection of rusts, growth and yield parameter of wheat plants are adversely affected (Abdelbacki *et al*., 2013; Sallam *et al*., 2016).

Conclusion

Moderately susceptible varieties of wheat i.e. A-25, K-11, A-20 and A-24 in the contemporary studies screened under Sargodha climatic conditions might be used in future breeding programs for making resistant commercial cultivars and consequently could be released directly as commercial cultivar if they possessed other desirable horticultural characters.

REFERENCES

Abdelbacki A, Soliman N, Najeeb M, Omara R. 2013. Postulation and identification of resistance genes against *Puccinia triticina* in new wheat cultivars in Egypt using molecular markers. *International Journal of Chemical Environmental and Biological Sciences*, Vol. (1), 104-109.

Admassu B, Lind V, Friedt W, Ordon F, Virulence analysis of *Puccinia graminis* f. sp. *tritici* populations in Ethiopia with special consideration of Ug99. Plant Pathology vol. (58), 362-369, (2008).

Ali S, Shah S J A, Ibrahim M. 2007. Assessment of wheat breeding lines for slow yellow rusting (*Puccinia striiformis* west. *tritici*). *Pakistan Journal of Biological Sciences*, vol. (10), 3440-3444.

Aquino P, Carrion F, Calvo R. 2002. Selected wheat statistics. In CIMMYT 2000-2001 World Wheat Overview and Outlook: Developing No-Till Packages for Small-Scale Farmers. (Ed. J. Ekboir) pp. 52-62. (CIMMYT, Mexico DF).

Bajwa M A, Aqil K A, Khan N I, 1986. Effect of leaf rust on yield and kernel weight of spring wheat. RACHIS, vol. (5), 25–28.

Bariana H S, Hayden M J, Ahmad N U, Bell J A, Sharp P J, McIntosh R A, 2001. Mapping of durable adult plant and seedling resistance to stripe and stem rust disease in wheat. *Australian Journal of Agriculture Research*, vol. (52), 1247-1255.

Bux H, Ashraf M, Hussain F, Rattu A R, Fayyaz M. 2012. Characterization of wheat germplasm for stripe rust (*Puccini striiformis* f. sp. *tritici*) resistance. *Australian Journal of Crop Sciences*, Vol. 6(1), 116-120.

Draz I S, Abou-Elseoud M S, Kamara A E M, Alaa-Eldein O A E and El-Bebany A F. 2015. Screening of wheat genotypes for leaf rust resistance along with grain yield. *Annals of Agricultural Sciences,* vol. 60(1), 29–39.

German S E, Barcellos A, Chaves M, Kohli M, Campos P, Viedma L. 2007. The situation of common wheat rusts in the Southern Cone of America and perspectives for control. *Australian Journal of Agricultural Research*, vol. (58), 620-630.

Hafiz A. 1986. Plant Diseases. Publisher PARC Islamabad, Pakistan, Page No. 552.

Hassan S F, Hussain M, Rizvi S A. 1979. Wheat diseases situation in Pakistan. National Seminar on Wheat Research and Production, August 6-9, Islamabad.

Herrera-Foessel S A, Lagudah E S, Huerta-Espino J, Hayden M J, Bariana H S, Singh D, Singh R P. 2011. New slow-rusting leaf rust and stripe rust resistance genes *Lr* 67 and *Yr* 46 in wheat are pleiotropic or closely linked. *Theoretical and Applied Genetics*, vol. (122), 239-249.

Huerta-Espino J, Singh R P, German S, McCallum B D, Park R F, Chen W Q, Bhardwaj S C, Goyeau H. 2011. Global status of wheat leaf rust caused by Puccinia triticina. *Euphytica*, vol. (179), 143–160.

Ingala L, Lopez M, Darino M, Pergolesi M F, Dieguez M J, Sacco F. 2012. Genetic analysis of leaf rust resistance genes and associated markers in the durable resistant wheat cultivar Sinvalocho MA. *Theoretical and Applied Genetics*, vol. (124), 1305-13014.

Kolmer J A, Long D L, Hughes M E. 2007. Physiological specialization of Puccinia triticina on wheat in the United States in 2005. *Plant Disease*, vol. 91(8), 979–984.

Lal A M, Singh S S, Sharma J B, Ram R B. 2004. Evaluation of inheritance to leaf rust in wheat using area under disease progress curve. *Hereditas*, vol. (141), 323-327.

Martinez F, Niks R E, Moral A, Urbano J M, Rubiales D, Hernande P. 2001. Search for partial resistance to leaf rust in a collection of ancient Spanish wheat. In: Proceeding of the 4th International Triticeae Symposium, Cordoba, Spain. September 2001 Herditas – Lund 2001, vol. 135, pp. 193–197.

Mateen A, Khan M A, Rashid A, Hussain M, Rehman S U and Ahmed M. 2015. Identification of leaf rust virulence pattern on wheat germplasm in relation to environmental conditions in Faisalabad. *Academia Journal of Agricultural Research*, vol. 3(8), 137-155.

McVey D V, Nazim M, Leonard K J, Long D L. 2004. Patterns of virulence diversity in *Puccinia triticina*on wheat in Egypt and the United States in 1998-2000. Plant Disease, vol. (88), 271-279.

Sallam M E, El-Orabey W M and Omara R I. 2016. Seedling and adult plant resistance to leaf rust in some Egyptian wheat genotypes. *African Journal of Agricultural Research*, vol. 11(4): 247-258.

Shynbolat R, Aralbek R. 2010. Evaluation of leaf rust resistance genes in durum wheat varieties in Kazakhstan. *Australian Journal of Plant Sciences and Biotechnology*, vol. (4), 77-80.

Singh R P, Huerta-Espino J, Pfeiffer W, Figueroa-Lopez P. 2004. Occurrence and impact of a new leaf rust race on durum wheat in north western Mexico from 2001 to 2003. Plant Disease, vol. (88), 703-708.

Singh R P, William H M, Espino J H, Rosewarne G. 2004b. Wheat rust in Asia: Meeting the challenges with old and new technologies. In: Proceedings of the 4th International Crop Science Congress, 26 Sep – 10ct 2004, Brisbane, Australia.

Wiese M V. 1977. Compendium of wheat diseases. (American phytopathology society: St Paul, Minnesota, USA).

Wiese M V. 1987. Compendium of wheat diseases. 2nd ed. American phytopathology society. St. Paul, Minnesota. pp.1-124.

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