Print ISSN : 0972-8813
e-ISSN : 2582-2780

[Vol. 20(1), January-April, 2022]

Pantnagar Journal of Research

(Formerly International Journal of Basic and Applied Agricultural Research ISSN : 2349-8765)

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PANTNAGAR JOURNAL OF RESEARCH

Vol. 20(1) January-April, 2022

CONTENTS

Selection of exotic germplasm of bread wheat against *Puccinia triticina* resistance with analysis of Area Under Disease Progress Curve

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ABSTRACT: Wheat (*Triticum aestivum* L.) is major cereal crop consumed by approximately 2.5 billion of global population. However, the production is affected by many diseases. Among three rusts, leaf rust (*Puccinia triticina* Eriks.) is the most crucial disease of wheat that causes yield loss. Repeated breakdown of resistance genes for leaf rust (*Lr9, Lr18* and *Lr28*) led to the study of adult plant resistance and slow rust resistance gene which are considered as more long -lasting. Host resistance is the most economical way to manage wheat leaf and stripe rust. In present study164 exotic germplasms of bread wheat were screened for disease resistance against stripe and leaf rust under epiphytotic conditions and disease severity with Area Under Disease Progress Curve (AUDPC) was analysed.All the fourteen accessions showing resistant to leaf rust in the field condition also gave lower AUDPC value. Therefore, cultivars having lower AUDPC values were acceptable for practical purposes. Present research provided the resistant wheat lines to the breeders to incorporate in their breeding programme against leaf rust.

Key words: Area Under Disease Progress Curve (AUDPC), *Puccinia triticina,* wheat

Wheat is one of the major food crops among domesticated food crops in major civilizations of Europe, West Asia and North Africa for 8000 years (Giraldo *et al.,* 2019). The total area of wheat in the world is around 220.83 mha with a production of 769.31 million tons. The normal world productivity is 3483.72 kg/ha (United States Department of Agriculture, 2019-2020). In India wheat is grown on about 30.55mha area with production and productivity of 107.18 million tons and 3508 Kg/ha, respectively in 2019-20 and ranks second in terms of total production next to rice(ICAR-IIWBR, 2020).Plant diseases affect 55% of global wheat growing areas causing an estimated loss of 20 million tons per annum. Important diseases are rusts (yellow or stripe rust, brown or leaf rust and black or stem rust), leaf blight, powdery mildew, loose smut and karnal bunt. New biotic threats like Ug99 of stem rust and virulence for resistance gene *Yr*9 in the stripe rust pathogen has emerged. Maximum yield losses are caused by leaf rust mainly due to reduction in 1000 grain weight (Rao, 1989). In India, leaf rust is well distributed being most common in NWPZ, NEPZ and CZ and occurs in higher intensities as epidemics in both North and South as the inoculum is present in the regions (Mehta, 1952 and Joshi, 1975). Epidemics of leaf rust had occurred in the years 1786, 1827, 1832, 1894, 1897, 1947, 1948, 1972 and 1975 (Nagarajan and Joshi, 1975). The infection causes grain yield losses of more than 50% in susceptible cultivars (Hussein *et al.,* 2005, Herrera-Foessel *et al.*, 2011, Terefe *et al.*, 2011).

Host resistance and foliar application of fungicides are two major approaches to manage rust disease. However, foliar application of fungicides should be in a sustainable manner as harms environmental ecology, at the same time it is not feasible for large scale application (Carmona *et al.,* 2020). Besides environmental pollution, development of resistance against some chemicals due to emergence of new pathotypes (Oliver, 2014) is also a trouble. Therefore, resistant varieties of rust may play a crucial role in environment safety and yield enhancement (Chen, 2005). The objective of current study is to find out resistant sources in 164 available exotic germplasms of bread wheat against leaf rust.

MATERIALS AND METHODS

Experiments were conducted at the Norman E. Borlaug Crop Research Centre and Wheat Grain Quality laboratory, College of Agriculture, G. B. Pant

University of Agriculture & Technology, Pantnagar, during *Rabi* 2019-2020 and 2020-2021. One hundred and sixty four exotic germplasm accessions and four checks, HD3086, HD2967, Agralocal and A-9-30-1were screened against leaf rust. Each germplasm accession was sown on 25 November 2019 in two rows of 2m using Augmented Block Design Layout. Germplasm accessions were sown in five blocks having 40 entries in each including checks, which were repeated after each 10th entry. Inoculum of five pathotypes each i.e., 104-2, 77-1, 77-5, 77-9 and 12-5 of leaf rust and 47S103, 110S84, 110S119, 238S119 and 46S119 of stripe rust were collected from Regional Station, Indian Institute of Wheat and Barley Research, Flowerdale, Shimla, H.P. The spores mixture consists of pathotypes of leaf rust was dissolved with water along with some drops of tween 20 and sprayed through hand sprayer on 05th, 13th, 20th, 27thFebruary and 06th March 2020. Fourteen germplasm accessions selected for further studies were again sown on 28 November, 2020 along with resistant checks i.e. HD3086, HD2967 and susceptible checks i.e. Ag local, A-9-30-1., Same pathotypes were inoculated as of previous on 10th, 17th, 22nd February and 4th, 12th March 2021. The observations on per cent infection from the individual accession according to Modified Cobb's scale valued as 0: immune, 0%-5%: R (resistant), 5%-10%: MR (moderately resistant), 10%-30%: MS (moderately susceptible), more than 30%: S (highly susceptible) (Table 1) were recorded at 2 week intervals (Peterson *et al.,* 1948 and Khiavi *et al.*, 2017).

Analysis

In order to catch out the effect of inoculation among the germplasm accessions under epiphytotic condition, Coefficient of Infection and Area Under Disease Progress Curve (A values), was

Table 1: Rusts infection types at Adult Plant Stage

Abbreviated Sign	Response value	Host Response	Visible symptoms
0	0.0	Immune	No visible infections
R	0.2	Resistance	Necrotic areas with or without uredia
MR	0.4	Moderately Resistance	Necrotic areas with small uredia
MS	0.8	Moderately Susceptible	Medium uredia with no necrosis but some chlorosis
S	1.0	Susceptible	Large uredia with no necrosis and no chlorosis
X	0.6	Intermediate	Variable sized uredia with necrosis or chlorosis and fully susceptible

(Peterson *et al.,* 1948)

Table 2: A value of fourteen germplasm accessions with four checks against leaf Rust

Sr.No.	AccessionsNo.	AUDPC(A Value) of Leaf Rust
1	CROC_1/AE.SQUARROSA (517)//KACHU/3/BAJ#1	63
2	CROC_1/AE.SQUARROSA (298)//KACHU/3/BAJ#1	0
3	CHEN/AE.SQ//2*OPATA/3/BAJ#1/4/SUP152	14
4	BCN//SORA/AE.SQUARROSA (323)/4/WBLL1/KUKUNA//TACHUPETO ……	14
5	ARLIN_1/AE.SQUARROSA (536)/4/WBLL1/KUKUNA//TACUPETO……	38.5
6	CHEN/AE.SQ//2*OPATA/5/SERI.1B//KAUZ/HEVO/3/AMAD*2……	3.5
7	CHEN/AE.SQ//2*OPATA/5/SERI.1B//KAUZ/HEVO/3/AMAD*2……	63
8	IG 41514/5/SERI.1B//KAUZ/HEVO/3/AMAD*2/4……	28
9	GARZA/BOY//AE.SQUARROSA (467)/3 WHEAR/KRONSTAD……	28
10	IG 41217/4/PRL/2*PASTOR//PBW343*2/KUNKUNA/3/ROLF07/5/NELOKI	14
11	ARVAND 1/3/ATTILA*2/PBW65//MURGA/4/REEDLING#1	49
12	CETA/AE.SQUARROSA (533)/3/ATTILA*2/PBW65//MURGA/4/REEDLING#1	31.5
13	68.111/RGB-U//WARD/3/FGO/4/RABI/5/AE.SQUARROSA……	49
14	68.111/RGB-U//WARD/3/FGO/4/RABI/5/AE.SQUARROSA……	31.5
15	HD3086	105
16	Ag local	784
17	HD2967	14
18	A-9-30-1	1365

determined. Coefficient of Infection (CI): It is calculated according to Saari and Wilcoxon (1974) and Pathan and Park (2006) multiplying of Disease Severity (DS) with constant values of Infection Types (IT) described on Table 1. Area Under Disease Progress Curve (A values):

It is calculated by the formula given by Wilcoxson *et al.,* 1975.

$$\text{A-values} = \sum_{i=1}^{k} \tfrac{1}{2} (S_i + S_{i-1})\, t$$

Where, S_i = Rust severity at the end of the week; K = Number of successive evaluation of rust

RESULTS AND DISCUSSION

During initial screening, out of 164 germplasm accessions, fourteen accessions were found to be immune, resistance and moderately resistance towards leaf rust. These germplasm accessions were selected and screened for the same diseases at the Adult Plant Stage in the next cropping season. During the crop season 2020-2021, the observations were recorded 4 times from 19th February to 31 1st March of 2021 at 2 week intervals. Accessions which were immune, resistant, moderately resistant taken as phenotypically resistant to leaf rust and were acceptable for selecting resistant cultivars. Therefore, all the tested fourteen germplasm accessions (except germplasm accessions serial number 1 and 7) were immune, resistant or moderately resistant and hence acceptable for selecting resistant cultivars.

Area Under Disease Progress Curve (AUDPC)

Disease progress curve is a better indicator of disease expression over time (Van der Plank, 1963). Therefore, selection of cultivars having lower AUDPC values is acceptable for practical purposes (Hei, 2017). Anwar*et al.* (2019) studied and categorised the wheat lines according to AUDPC value, i.e. AUDPC ranges 200-399 categorized under moderately resistant, AUDPC range 1-199 categorized under resistant, AUDPC value 0 categorized as immune. Out of fourteen germplasm, germplasm accessions serial number 2 i.e. CROC_1/ AE.SQUARROSA (298)//KACHU/3/BAJ#1 was immune no disease symptoms was observed. Thirteen germplasm accessions were found to be resistant i.e.,germplasm accessions serial number 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14. Therefore, all fourteen accessions were phenotypically resistant to leaf rust (Table 2).

CONCLUSION

Lower AUDPC values were calculated accessions which shownleaf rust resistance hence breeders can incorporate these resistant wheat lines in their breeding programme against leaf rust. However, disease pressure in both the seasonswas quite low therefore, further studies need to be done to confirm the resistance germplasm accessions at phenotypic level for their use in future research programme.

ACKNOWLEDGEMENTS

Authors are grateful to ICAR, IIWBR, Regional Station, Shimla for providing inoculum for creating artificial epiphytotic condition throughout the crop season

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Received: October 21, 2021
Accepted: December 30, 2021