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Evaluation of Wheat Germplasms for the Identification of Resistant Sources to Yellow Rust Caused by *Puccinia striiformis* West. *Tritici*

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ABSTRACT

*Growing cultivars with adequate level of durable resistance is the best strategy to manage yellow rust. Although, evolution of new physiological races/pathotypes resulting to overcome the effects of current resistance cultivar has force for evaluation of large number of wheat germplasms, breeding materials, cultivars for their reaction to yellow rust. In this context, field based assessment for partial resistance in thirty three promising wheat germplasm accessions against two predominant pathotypes of yellow rust revealed that eight accessions viz. EC-411587, EC-597926, EC-661236, IC-274478, IC-278958, IC-467770, IC-467771, and IC-467778 were resistance while three accessions viz. EC-661233 EC-692222 EC-692243 showed moderately resistance according to final rust severity data. Fourteen germplasm accessions showed moderately susceptible reaction while eight accessions were recorded as susceptible ranging from 50 to 60 per cent in final rust severity. AUDPC values of ten accessions were above 500 to 1015 while 13 accessions were in the range of 200-500. The remaining 13 accessions with resistance to moderately resistance reaction were observed with less than 200 in AUDPC values which clearly indicate that they were acquiring partial resistance with exhibiting good response of resistance under high disease pressure of epiphytotic condition that could be due to the presence of some effective adult plant resistance Yr genes. Correlation coefficient in between ACI with AUDPC (0.99**) and ACI with FRS (0.96**) were positively correlated by highly significance.*

Key words: *Adult plant resistance, durable resistance, pathotype/race, stripe/yellow rust*

INTRODUCTION

Yellow/stripe rust caused by *Puccinia striiformis* West. *tritici* is an important constraint to wheat production in cool environment. In most of the wheat growing areas, yield losses due to stripe rust ranges from 10-70%[4]. But it can cause 100% yield loss if infection occurs very early and the disease continues to develop during the growing season provided the cultivars are susceptible[1]. If the pathogen infects the spikes it causes extensive quality and grain yield loss. During 2010-11, severe form of stripe rust had appeared in plain areas of J & K, foot hills of Punjab and Himachal Pradesh, parts of Haryana and Tarai regions of Uttarakhand[16].

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Besides, the pathogen has ability to multiply rapidly resulting in trillions of urediospores along with long distance dispersal by its airborne urediospores and also evolution of new races/pathotypes by mutation makes management strategy a challenging task[17]. Many times wheat cultivars often appear to lose their own resistance due to the changes in virulence pattern of pathogens that ultimately can overcome the effects of current resistance genes. But, genetic resistant is the most efficient, economical and environmental friendly approach to control rusts[9]. Utilization of race-nonspecific resistance which is mainly polygenic has often been described as slow rusting or partial resistance[11] and is known to be long-lasting and more durable than race specific resistance[7]. Screening of genotypes by field based assessment is employed for partial resistance and can be assess through different measures, *viz.* final rust severity (FRS), area under rust progress curve (AUDPC) and average coefficient of infection (ACI)[12]. Slow rusting parameters can be used for grouping of different cultivars based on their resistance reaction[2,14,15]. Therefore, there is a need for the identification of new sources for durable resistance and enhancement of genetic resistance to yellow rust. So, the present study was conducted to evaluate partial resistance in promising wheat germplasm accessions at adult plant stage for exploiting as new sources of resistance to yellow rust.

MATERIALS AND METHODS

During 2013-14 crop seasons, field experiment was conducted at Crop Research Centre, Pantnagar to identify promising wheat germplasm accessions exhibiting low level of yellow rust under epiphytotic condition. The materials under study consist of 33 wheat germplasms of both exotic and indigenous accessions i.e. EC-411587, EC-577906, EC-597926, EC-597967, EC-597970, EC-598069, EC-598118, EC-598322, EC-598360, EC-635847, EC-635852, EC-661233, EC-661234, EC-661236, EC-663924, EC-664285, EC-692222, EC-692226, EC-692243, EC-693320, EC-693324, IC-274475, IC-274478, IC-274489, IC-278958, IC-278974, IC-279005, IC-311077, IC-382724, IC-382724, IC-411571, IC-467770, IC-467771 and IC-467778. Two rows of 1m line for each germplasm accession were sown surrounded by two rows of infector i.e. susceptible variety, Agra Local to maintain high inoculum pressure for epiphytotic condition. Moreover, twice inoculations in 7 days intervals of inoculum suspension at tillering stage by using hand sprayer were also been practiced to create an ideal epiphytotic condition for screening. Inoculum suspension consist of urediospores of predominant pathotypes for this region viz. 46S119 and 78S84, received from Regional Research Station, Flowerdale, Shimla, diluted in sterile water followed by adding of few drops of tween 20, an emulsifying agent. Irrigation was given for providing humidity which is a congenial condition for spore germination. After successfully development of yellow rust, disease severity for 5 times in 7 days intervals were recorded as percent of infection in each individual germplasm accessions according to modified Cobb's scale[13] (Table.1). The severity was determined by visual observations, below 5 percent severity, the intervals were Trace and usually 5 per cent interval was used from 5 to 20 per cent and 10 per cent interval between 20-100 per cent severity. The coefficient of infection (CI) was calculated by multiplying per cent disease severity and constant response values of infection/reaction type for each germplasm accession. Then, average coefficient of infection was derived by sum of CI for each germplasm accession divided by number of replication. Using following formula, area under disease progress curve (AUDPC) was calculated for each germplasm accession from the calculated ACI values of rust severity data.

$$AUDPC = \sum (X_i + X_{i+1})/2 \times t_i$$

where X_i and X_{i+1} are severity on date i and date i+1, respectively and

t_i is the number of days between date i and date i+1

Table 1: Modified Cobb's scale for scoring rusts

Reaction type	Response value	Category	Visible symptoms
0	0.0	Immune	No visible infection
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 sized uredia with no necrosis but some chlorosis
S	1.0	Susceptible	Large sized uredia with no necrosis and chlorosis
X	0.6	Intermediate	Variable sized uredia with necrosis or chlorosis and fully susceptible.

RESULTS AND DISCUSSIONS

Ten germplasm accessions were observed as immune during third week of February but remaining 23 accessions showed disease severity ranged from 5 to 10 per cent with different infection types. Then, disease severities were progress in each germplasm accessions from fourth week of February to second week of March exhibiting various form of infection type as depicted in table 2. During third week of March, which is final rust severity indicated that eight accessions viz. EC-411587, EC-597926, EC-661236, IC-274478, IC-278958, IC-467770, IC-467771, and IC-467778 were 20 to 30 per cent with resistance reaction while three accessions viz. EC-661233 EC-692222 EC-692243 showed 30 to 40 per cent with moderately resistance infection type. Fourteen germplasm accessions viz. EC-577906, EC-598069, EC-598118, EC-598322, EC-598360, EC-635847, EC-635852, EC-661234, EC-663924, EC-664285, EC-692226, EC-693324, IC-274475, and IC-382724 were observed as moderately susceptible with 0 to 50 per cent in final rust severity. Eight accessions viz. EC-597967, EC-597970, EC-693320, IC-274489, IC-278974, IC-279005, IC-311077, and IC-411571 were recorded as susceptible with 50 to 60 per cent severity while none of the tested accessions were recorded to be immune according to final rust severity as depicted in table 2.

The values of AUDPC ranged from 500 to 1015 were found in ten accessions with moderately susceptible to susceptible reaction. While 13 accessions were having AUDPC values range of 200-500 exhibiting moderately susceptible type. The remaining 13 accessions with resistance to moderately resistance reaction were observed with less than 200 in AUDPC values. Moreover, lines with acceptable levels of partial resistance restrict the evolution of new virulent races of the pathogen because multiple point mutations are extremely rare in nature[2]. Another result supports the present findings in the study where some old wheat varieties were screened against different pathotypes for yellow rust resistance both at seedling as well as adult plant stage[8]. So, among 33 tested accessions, these 25 accessions were acceptable for selecting as new source of resistance to yellow rust in wheat breeding programme. Linear relationship in between three parameters viz. AUDPC and final rust severity with ACI were explained by coefficient of determination with 99% and 92% respectively as depicted in fig. 1 and 2. There were highly significance in correlation coefficient (r) between AUDPC with ACI (r=0.99**) and ACI with FRS (r=0.96**) for the tested promising germplasm accessions (table 3).

Since, all three disease parameters i.e. final rust severity (FRS), average coefficient of infection (ACI) and area under disease progress curve (AUDPC) were strongly and positively correlated in the present study it can be concluded that these are the most appropriate parameters for field based assessment of durable resistance. Accessions exhibiting moderate resistance to resistance reaction may confer durable resistance which may be presence of some effective adult plant

resistance (APR) genes against rusts[3,5,6]. Many genes contributing to adult plant resistance to yellow rust have been identified[3,10,15]. Hence, from the study it can be concluded that the resistant germplasm accessions at adult plant stage, could be used for further study for the identification of *Yr* genes so that they could be incorporated in wheat resistance breeding programmes for developing yellow rust resistant wheat varieties. Moreover, replacing the susceptible cultivars with resistant ones immediately would require some rapid adjustments to avoid any losses to wheat production in the country.

Table 2: Screening of wheat germplasms against yellow rust under epiphytotic condition

Accession No.	Yellow rust severity score (weekly interval)					ACI	AUDPC
	17/02/14	24/02/14	03/03/14	10/03/14	17/03/14		
EC-411587	10R	20R	20R	20R	30R	4	112
EC-577906	0	0	5MS	20MS	30MS	8.8	224
EC-597926	0	0	10R	20R	30R	2.4	63
EC-597967	0	10S	20S	30S	50S	22	595
EC-597970	10S	30S	30S	50S	50S	34	980
EC-598069	0	20MS	30MS	30MS	40MS	19.2	560
EC-598118	0	0	10MS	20MS	30MS	9.6	252
EC-598322	0	10MS	20MS	30MS	40MS	16	448
EC-598360	0	5MS	10MS	30MS	30MS	12	336
EC-635847	10MS	10MS	20MS	20MS	40MS	16	420
EC-635852	0	10MRMS	20MRMS	20MRMS	30MRMS	9.6	273
EC-661233	0	10MR	10MR	30MR	40MR	7.2	196
EC-661234	5MS	10MS	20MS	20MS	30MS	13.6	378
EC-661236	5R	10R	20R	20R	30R	3.4	94.5
EC-663924	5MS	5MS	20MS	20MS	30MS	12.8	350
EC-664285	5MS	10MS	20MS	30MS	50MS	18.4	490
EC-692222	5MR	5MR	20MR	30MR	30MR	7.2	203
EC-692226	0	10MS	10MS	20MS	40MS	12.8	336
EC-692243	10MR	10MR	10MR	20MR	40MR	7.2	182
EC-693320	5S	10S	10S	40S	50S	23	612.5
EC-693324	10MRMS	20MRMS	20MRMS	30MRMS	50MRMS	15.6	420
IC-274475	10MS	10MS	20MS	20MS	40MS	16	420
IC-274478	0	5R	10R	10R	20R	1.8	49
IC-274489	0	10S	20S	40S	50S	24	665
IC-278958	0	0	5R	10R	20R	1.4	35
IC-278974	10S	20S	40S	50S	50S	34	980
IC-279005	0	20S	30S	30S	50S	26	735
IC-311077	10S	20S	40S	50S	60S	36	1015
IC-382724	10MS	20MS	20MS	30MS	30MS	17.6	504
IC-411571	0	20S	40S	50S	60S	34	980
IC-467770	0	5R	10R	10R	20R	1.8	49
IC-467771	0	5R	10R	10R	30R	2.2	56
IC-467778	0	20R	20R	30R	30R	4	119

Table 3: Correlation coefficients (r) between slow rusting parameters

Parameters	Parameters	
	AUDPC	FRS
ACI	0.99**	0.96**

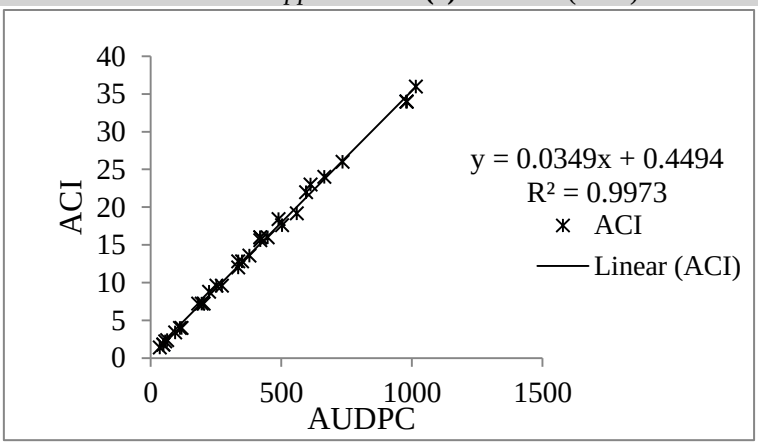

Fig.1: Association of area under disease progress curve (AUDPC) and average coefficient of infection (ACI)

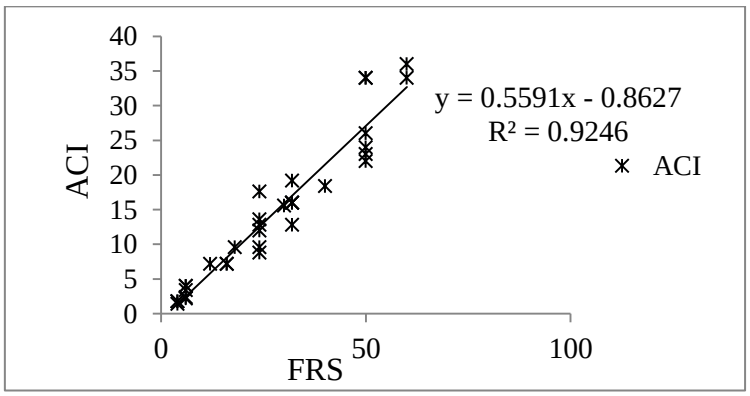

Fig. 2: Association of final rust severity and average coefficient of infection (ACI)

CONCLUSION

The results of current study showed that twenty five tested wheat germplasm accessions had diversity of resistance, ranging from resistance to moderately susceptible reaction except eight accessions with highly susceptible at adult plant stage. They acquire partial resistance by exhibiting good response of resistance and their low AUDPC values under high disease pressure of epiphytotic condition that could be due to the presence of some effective adult plant resistance *Yr* genes. Thus, it is important to assess critically the utility of such diversity of durable resistance sources against yellow rust of wheat.

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