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Stripe Rust Severity and Infection Types by using Modified Cobb's Scale in Wheat (*Triticum aestivum* L.)

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Abstract

The present investigation was carried out with the objective of enhancement for stripe rust resistance in the adapted varieties of wheat grown under timely sown irrigated conditions. The material for the experiment consisted of six stripe rust resistant lines and three adapted varieties of wheat crossed in Line into Tester design during off season 2013 at Dalang Maidan, Lahaul Spiti, Himachal Pradesh. The F_1s were grown during *rabi* 2013 at Research Farm, Division of Plant Breeding and Genetics, SKUAST Chatha, Jammu. Observations on the quantitative traits *viz.*, plant height (cm), number of effective tillers, days to 50% flowering, spike length (cm), number of grains /spike, days to maturity and grain yield per plant were recorded. Observations on the disease severity were also recorded for the parents and crosses as per the Modified Cobbs scale. Heterosis studies reveal maximum desirable positive heterosis for grain yield in the cross IBWSN 1175 x PBW 550 (15.00 percent) followed by DWR 41 x PBW 550 (10.52 percent) IBWSN 1175 x RSP561 (05.00 percent) with a disease reaction ranging between resistant to trace type of resistant reaction.The cross IBWSN 1047 x PBW 550 carry both the *Yr* genes in combination shows resistant type of rust reaction but is poor yielding with a grain yield per plant of 12.0g. This cross can be carried further by backcrossing with high yielding adapted parent and if successful depicts the role of MAS in early generation screening.

Key words : *Disease severity, resistance, rust reaction. stripe rust*

Introduction

Wheat (*Triticum aestivum* L.) is a crop of global significance, grown in diversified environments. It has been described as the 'King of cereals' because of the acreage it occupies, high productivity and the prominent position it holds in the international food grain trade (1). Wheat represents approximately 19% of global major cereal crop production. Demand for wheat in the world continues to grow rapidly with increasing population growth. It is predicted that the world population will surpass 8 billion by 2025 and the demand is expected to increase to 760 million tons by 2020 and exceed880 million metric tons by 2050 (2), thus the production needs to increase at least by 50% by the year 2025. Crop production throughout the world is reduced significantly by biotic and abiotic stresses. Diseases reduce approximately 14% of world crop production. Wheat is susceptible to many pathogens including stem rust caused by *Puccinia graminis* f.sp. *tritici*, leaf or brown rust caused by *P. triticina* and stripe or yellow rust caused by *P. striiformis* f.sp. *tritici* (Pst); they are the most important diseases of wheat which cause important losses of yield (3). Among rust diseases affecting wheat, stripe rust was considered to be the most the most destructive (4). This disease can cause significant reductions in yield and result in total losses of theproduction (5). The symptoms of stripe rust include appearance of small yellowish uredinia in linear rows on the leaf. A single infection can result in a stripe along the length of the leaf and uredinia can also occur in the spike. Stunting of plants is common with severe early infections. Numerous, highly specified pathotypes of *P. striiformis* occur and are probably evolved by mutation and somatic recombination (6).The North Western Plain Zone which is considered the bread basket of India usually experiences a favourable weather for the development and proliferation of the stripe rust pathogen during the wheat crop cycle and hence poses serious threat to the production target of wheat. In northern India, it is locally known as "*Piliya*" (yellow). It affects the productivity and quality of wheat throughout the world. Yellow rust appeared in severe form in plain areas in J & K, foot hills of Punjab and Himachal Pradesh, parts of Haryana, *Tarai* region of Uttarakhand (7).

"New" isolates (since 2000) of stripe rust were found to be more aggressivethan "old" isolates (prior to 2000) in terms of spore production, faster growth andadoptability to wider range of climatic conditions both low and high temperatures (8). There are more than 40 stripe rust resistance (Yr) genes identified so far (9). Although chemical control and wheat cultivation measures can minimize the losses caused by yellow rust at some extent, the most economic and environmental friendly way to control the yellow rust is through deployment of genetic resistance (10, 11). Stripe rust disease has remained a constant threat to sustainable wheat production in wheat

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Table-1 : Name of parents, their pedigree and source of collection.

S. No.	Name of parents	Pedigree	Source
Females			
1.	1047, 44th IBWSN	BAV92//IRENA/KAUZ/3/HUITES/4/DOLL	44th IBWSN, CIMMYT
2.	1174, 44th IBWSN	(C.80.1/B*BATAVIA//I*WBLL1/5/REH/HARE//2*BCN/…)	44th IBWSN, CIMMYT
3.	1175, 44th IBWSN	(SERI.18*2/3/KAUZ*2/BOW//KAUZ/4/CROC)	44th IBWSN, CIMMYT
4.	DWR 19	IC 296783/ IC 253000	DWR, Karnal
5.	DWR 41	IC 296436	DWR, Karnal
6.	DWR 46	IC 296446	DWR, Karnal
Males			
1.	RSP-561	HD 2687/Ae. crassa//HD 2637	SKUAST, Jammu
2.	PBW-550	WH594/RAJ3858/W485	PAU, Ludhiana
3.	DPW-621-50	KAUZ//ALTAR84/AOS/3/MILAN/KAUZ/4/ HUITES	DWR, Karnal

Table-2 : Disease severity of parents and crosses in the adult plant stage.

Parents/Hybrids	Disease severity	Infection type
Females		
IBWSN 1047	10MR	Moderately resistant
IBWSN 1174	TR	Trace resistant
IBWSN 1175	R	Resistant
DWR-19	10MR	Moderately resistant
DWR-41	R	Resistant
DWR-46	10MR	Moderately resistant
Males		
RSP-561	20S	Susceptible
PBW-550	40S	Susceptible
DPW-621-50	40S	Susceptible
Hybrids		
IBWSN 1047×RSP-561	20S	Susceptible
IBWSN 1047×PBW-550	R	Resistant
IBWSN 1047×DPW-621-50	10S	Susceptible
IBWSN 1174×RSP-561	5S	Susceptible
IBWSN 1174×PBW-550	5MR	Moderately resistant
IBWSN 1174×DPW-621-50	20S	Susceptible
IBWSN 1175×RSP-561	TR	Trace resistant
IBWSN 1175×PBW-550	R	Resistant
IBWSN 1175×DPW-621-50	TR	Trace resistant
DWR-19×RSP-561	5S	Susceptible
DWR-19×PBW-550	20S	Susceptible
DWR-19×DPW-621-50	5S	Susceptible
DWR-41×RSP-561	R	Resistant
DWR-41×PBW-550	R	Resistant
DWR-41×DPW-621-50	20S	Susceptible
DWR-46×RSP-561	10S	Susceptible
DWR-46×PBW-550	R	Resistant
DWR-46×DPW-621-50	40S	Susceptible

growing countries of the world that need to be managed properly for securing higher yields.

Long term robust resistance based upon the 'stacking' of different sources of genes with a proven level of durability offers the best solution. The effects of moderate resistances can be additive and combined to provide near immunity (12).

With this background the present study was conducted towards the isolation of pure lines from the progenies of heterotic F_1s. These heterotic F_{1s} in combination with the resistant gene(s) could lead to the enhancement of stripe rust resistance in wheat.

Materials and Methods

The material for the experiment consisted of six stripe rust resistant lines and three adapted varieties of wheat crossed in Line into Tester design during off season 2013 at DalangMaidan, LahaulSpiti. The details of the material used and methods adopted during the course of investigation are listed in Table-1.

The six female lines were crossed with three male testers to generate 18 single crosses. The F_1s were grown during *rabi* 2013 at Research Farm, Division of Plant Breeding and Genetics, SKUAST Chatha, Jammu. Progeny from all the twenty seven progenies (9 parents and 18 hybrids) were sown in randomised block design in three replications during off season 2014 at Dalang Maidan, Lahaul Spiti. Standard agronomic practices were followed and data was recorded on 3 random competitive plants of each progeny for plant height (cm), spike length (cm), numbers of effective tillers per plant, numbers of grains per spike, grain yield per plant (g), number of days to 50% flowering, number of days to maturity. The parents, F_1s were scored for stripe rust reaction in the field at the experimental field of Division of Plant breeding and Genetics located at the Main Campus, Chatha. The material was screened under natural conditions and no artificial inoculation was made. All agricultural practices recommended for the wheat crop were followed. The stripe rust severity was recorded as percent of the rust infection on the wheat plants according to the modified Cobb's scale (Fig.-1) (13) and the field response scale

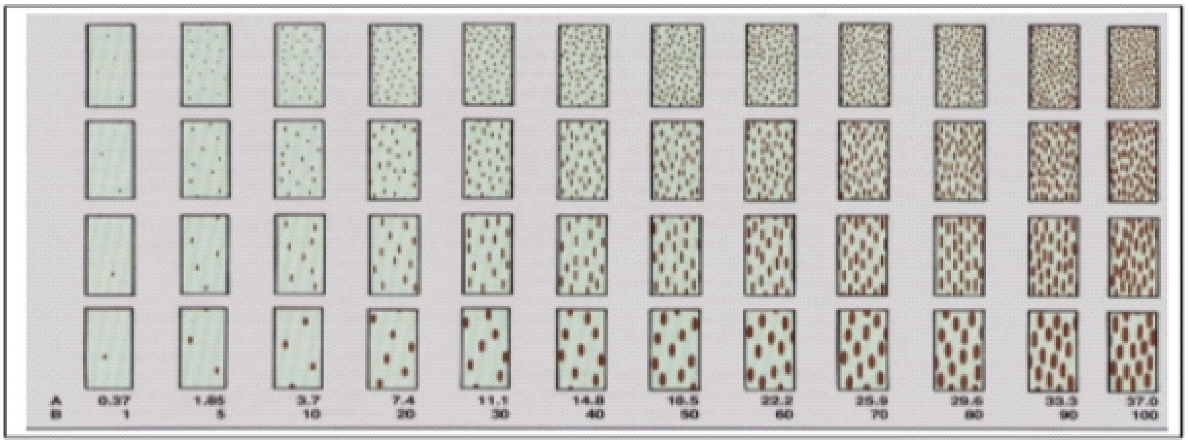

Fig.-1 : The Modified Cobb's scale A: refers to the actual percentage occupied by rust uredinia; and B: pertains to rust severities of the modified Cobb's scale after Peterson et al. 1948 (Source: Knott. 1989).

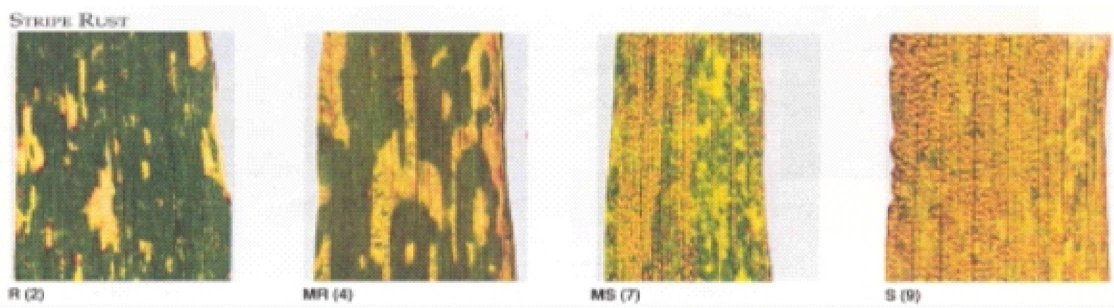

Figure-2 : The Modified Cobb's scale (Source: McIntosh *et al.* 1995, Roelfs *et al.* 1992).

referred to the infection type as described (Fig.-2) (14, 15). The data on disease severity and host reaction was combined to calculate the coefficient of infection (CI) by multiplying the severity value of 0.10, 0.4, 0.8, 1.0 for host response ratings R, MR, MS, S respectively (16).

Results and Discussion

Results pertaining to the disease reaction in terms of adult plant reaction to stripe rust under field conditions of the parents and the hybrids have been presented in Table 2.The testers which are the high yielding adapted varieties showed the disease severity ranging from 20S in RSP 561 to 40S in PBW 550 and DPW 621-50. There were five crosses that showed 'R' resistant type of reaction while two crosses had 'TR' trace value of resistant reaction while two crosses each showed 5S and 10S reaction and five showed 20S reaction. One cross (DWR 46 x DPW 621-50) showed upto 40S disease reaction. It is pertinent to note that out of the seven crosses that show resistant to trace disease reaction, four crosses show significantly high grain yield (higher than the best yielding parent DPW 621-50 and IBWSN1175). The best identified cross would be IBWSN1175 x PBW 550 and DWR 46 x PBW 550 with grain yield per plant of 23.0g and 21.0g and showing 'R' type of disease reaction. Cross IBWSN1175 x RSP 561 also has grain yield per plant of 23.0 gm and 'TR' type of disease reaction.IBWSN1175 x DPW 621-50 has grain yield of 20gm and 'TR' type of reaction.

In the present study, data on disease severity show three parents to be completely resistant or with trace disease severity. RSP 561 is the most tolerant of the adapted parents, with a disease score of 20 S.The selection of genotypes with combinations of non-racespecific resistance genes defining durable resistance over year as well as race specific genes at seedling stage is a task of prime importance for molecular marker assisted selection.

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