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ANALYSIS OF SPOT BLOTCH RESISTANCE AND ITS ASSOCIATION WITH YIELD AND ITS RELATED TRAITS IN BREAD WHEAT (*TRITICUM AESTIVUM* L.) GERMPLASM

RITUSHA TEWARI[1], J. P. JAISWAL[1]*, ANIL KUMAR[1] AND P. K. SINGH[2]
[1]Department of Genetics and Plant Breeding,
G. B. Pant University of Agriculture & Technology, Pantnagar - 263 145, INDIA
[2]Intenational Centre for Maize and Wheat Improvement (CIMMYT), Elbatan, Texcoco CP 56237, MEXICO
e-mail: jpj.gbpu@gmail.com

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***Corresponding author**

ABSTRACT
The present investigation was carried out to gather information about the germplasm accessions possessing resistance to spot blotch caused by the fungus *Bipolaris sorokinana* Sacc. In Borok. Shoem. and its association with morpho agronomic traits. Two Hundred germplasm accessions including four checks, two each resistant (Chirya 3 and Francolin) and susceptible (Sonalika and Ciano T 79) were evaluated in Augmented Block Design (ABD) at the N.E. Borlaug Crop Research Centre, G. B. Pant. University of Agriculture & Technology, Pantnagar in 2013-14.Sufficient genetic variability was present in the germplasm accessions for disease severity estimated by the disease scores was recorded at three different growth stages (GS), viz., GS 63 (beginning of anthesis to half complete), GS 69 (anthesis complete) and GS 77 (late milking). Germplasm accessions were grouped into highly resistant, moderately resistant, moderately susceptible and susceptible categories under epiphytotic conditions.Spot blotch severity exhibit negative correlation with grain yield(-0.272), thousand grain weight (-0.735), spike length (-0.289), number of spikelets per spike (-0.355) and number of grain per spike (-0.342).Resistant accessionswhich are positively associated with high yield can be used in hybridization scheme for developing improved high yielding spot blotch resistant varieties.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the staple food for a large part of the world population. In India the crop ranks second in terms of total production next to rice. Grain yield is a complex trait and highly influenced by many genetic factors and environmental fluctuations. The production of bread wheat is constrained by several biotic and abiotic stresses. The warmer parts of the world are mainly affected by many diseases and among these diseases, spot blotch or foliar blight caused by *Bipolaris sorokiniana* (Sacc. in Sorok). It is one of the most concerning disease in warm and humid regions of India and other South Asian countries due to its wide spread prevalence and increasing severity (Chowdhery *et al*., 2013). It is an important disease in that mega environment which is characterized by high humid conditions around and after heading stage.At present spot blotch of wheat is a major pathogen at national level in India and its frequency is highest in north eastern plains zone (NEPZ) amongst six agro climatic zones due to prevalence of hot and humid weather conditions..The pathogen reduces yield, germination, seedling emergence and the rooting intensity in the subsequent crop (Joshi, 1986). Several morphological characteristics of the host plant, such as, leaf surface waxes and leaf angle (Joshi and Chand, 2002) may be positively correlated with the resistance against spot blotch of wheat.

Spot blotch destroys leaf tissue and reduces photosynthetic potential, thereby reducing kernel plumpness and often resulting in loss of the grain yield (Gurung *et al*., 2012). Severe infection may also reach to the spikes, resulting in less weight due to shriveled grains. Intensive evaluation of germplasm to find out desirable donors with high nicking of genes crossing elite genotypes and further identification of highly heterotic F_1 so that subsequently desirable segregants may be obtained (Lamalaksmi *et al*., 2013). Therefore, the main objectives of the present study are to analyze association between spot blotch resistance and yield contributing traits in 200 wheat germplasm accessions and identify resistant genotypes against spot blotch By analyzing spot blotch resistance along with its correlation with yield traits would help in identification of better donors for spot blotch resistance with higher yield to be used in breeding programme.

MATERIALS AND METHODS

Field experiment was conducted in N. E. Borlaug Crop Research Centre (NEBCRC), G.B. Pant University of Agriculture and Technology, Pantnagar, Distt. U.S. Nagar, Uttarakhand during *rabi*, 2013-14. The experimental material consisted of 200 germplasm accessions including four checks, two each resistant (Chirya 3 and Francolin) and susceptible (Sonalika and Ciano T79) was evaluated in Augmented Block Design (ABD). Each genotype was grown in 2 rows of 1 m long plot with 23 cm distance between rows. The recommended cultural practices were adopted to raise good crop. The data were recorded for 9 characters viz., days to 75% heading, days to

maturity, plant height,spike length, number of spikelets per spike, number of grain per spike, thousand grain weight, grain yield and area under disease progress curve (AUDPC). To identify the entries possessing resistance to spot blotch, plants were inoculated following the method of Chaurasi a*et al*., (1999) as the aggressive isolate of *Bipolaris sorokiniana*, a causal agent of Spot blotch was obtained from Directorate of Wheat Research (DWR), Karnal, India, which was later multiplied on sorghum seeds at Pantnagar. The whole experimental material was inoculated at three different growth stages (GS): tillering (GS20), flag leaf emergence (GS37) and anthesis (GS65) with sporidial suspension (10^4spores/ml) in the evening hours.Disease severity was recorded on each plant using the double digit scale (00-99) developed as a modified Sarri and Prescott's severity scale to assess foliar blight diseases in wheat (Sarri and Prescott, 1975) by visually scoring the percent diseased area on the flag (F) and penultimate (F-1) leaves.

A double digit* scale for appraising spot blotch severity:

Severities** Top flag leaf	Second top leaf	Rating Diseases responses	Range of values
0	0-1	Immune (I)	00-01
1-2	2-4	Resistant (R)	12-24
3-4	4-6	Moderately resistant (MR)	34-46
5-6	6-8	Moderately susceptible (MS)	56-68
7-8	8-9	Susceptible (S)	78-89
9	9	Highly susceptible (HS)	99

First and second values represent percent blighted area on the top (flag) and second top leaves; ** Values 1, 2, 3, 4, 5, 6, 7, 8 and 9 correspond to 10, 20, 30, 40, 50, 60, 70, 80 and 90 percent blighted area, respectively.

The area under disease progress curve (AUDPC) based on disease severity (GS63, GS69 and GS77) over time was estimated using the following formula (Roelfs *et al*., 1992):

$$AUDPC = \sum_{i=1}^{n} [yi + yi + 1/2X (ti + 1-$$

whereYi = disease level at time ti; $t(i+1) - ti$ = time (days) between two disease scores; n = number of dates on which spot blotch was recorded. The lines that showed AUDPC (< 500) were considered resistant and the lines that showed AUDPC (> 2000) were considered susceptible.

Association between spot blotch resistance and yield traits was estimated with the help of correlation coefficient based on the variance and covariance of x and y variables. The formula for estimation of correlation coefficients given by Searle (1961) was used.

Table 1: AUDPC values of 200 germplasm accessions

Spot blotch resistant/ susceptible	Total no. of accessions	AUDPC range
Highly resistant	17	0
Moderately resistant	87	568.5-1248
Resistant	7	157.5-496
Moderately susceptible	86	1256.5-1912.5
susceptible	3	2029.5-2346

AUDPC value of checks ; 1. Chirya 3 - 454.5 (R); 2. Francolin- 914.5 (MR);3. nalika-2267 (S); Ciano T 79- 1891.5 (MS

$$r_{xy} \quad \frac{Cov.(xy)}{\sqrt{Varx.Varv}}$$

Where,

r_{xy} = Correlation coefficient between x and y
Cov. (xy) = Covariance between x and y
Var. (x) = Variance of x
Var. (y) = Variance of y
n = number of observation

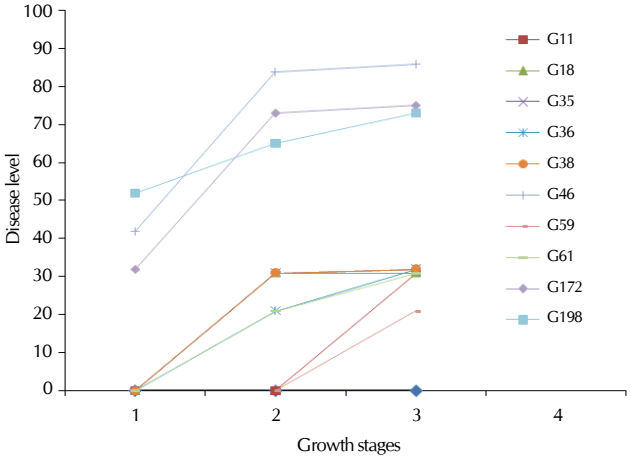
RESULTS AND DISCUSSION

Analysis of spot blotch resistance

In the present study AUDPC values were estimated by the disease scores(Roelfs *et al*., 1992). Out of 200 accessions, 17 accessions were observed highly resistant, 7 resistant, 87 moderately resistant, 3 highly susceptible and 86 accessions are moderately susceptible (Table 1).On the basis of AUDPC score area under disease progressing curve was prepared for highly resistant and highly susceptible germplasm accessions (Fig.1).

Association of spot blotch with morpho-agronomic traits

The correlation coefficients among different characters were worked out and are presented in (Table 2). Spot blotch severity exhibited negative correlation with plant height (-0.038). This finding is in complete agreement with Raemakers (1987) and Joshi *et al*. (2002). On the other hand, AUDPC has significant and negative correlation with grain yield (-0.272**) in figure2 and figure 3, thousand grain weight (-0.735**), spike length (-0.289**), number of spikelets per spike (-0.355**) and number of grain per spike (-0.342**). These findings are in complete agreement with Sharma *et al*. (1997a)and Kumar *et al*. (2013). However negative correlation was also found in days to 75% heading (-0.12) and days to maturity(-0.069). Similar report has been made by Sharma *et al*. (1997a).Values of AUDPC and yield pattern in resistant and susceptible



Growth stages: 1-GS 63, 2- GS 69, 3- GS 77; G11, G 18, G 35, G 36, G 38, G 59 and G 61 = resistant germplasm accessions, G 46, G 172 and G 198 = susceptible germplasm accessions

Figure 1: Area under disease progressing curve (AUDPC) of highly resistant and susceptible accessions

Table 2: Correlation coefficient among different characters

	Days to 75% heading	Days to maturity	Plant height	Spike length	No. of spikelets per spike	No. of grains per spike	1000 grain weight	Grain yield	AUDPC
Days to 75% heading	1.000	0.816**	-0.167 *	-0.122	0.151 *	0.055	0.006	0.086	-0.12
Days to maturity		1.000	-0.023	-0.133	0.131	0.048	-0.125	0.073	-0.069
Plant height			1.000	.0130	0.004	-0.030	-0.181 *	0.055	-0.038
Spike length				1.000	0.651**	0.596**	0.273**	0.217**	-0.289**
No. of spikelets per spike					1.000	0.902**	0.245**	0.176 *	-0.355**
Number of grains per spike						1.000	0.267**	0.186**	-0.342**
1000 grain weight							1.000	0.139 *	-0.735**
Grain yield								1.000	-0.272**
AUDPC									1.000

** Significant at 1% probability level, *Significant at 5% probability level

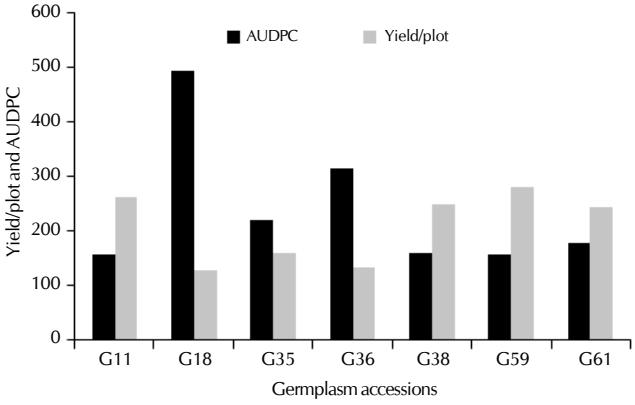


Figure 2: AUDPC and Yield pattern of resistant germplasm

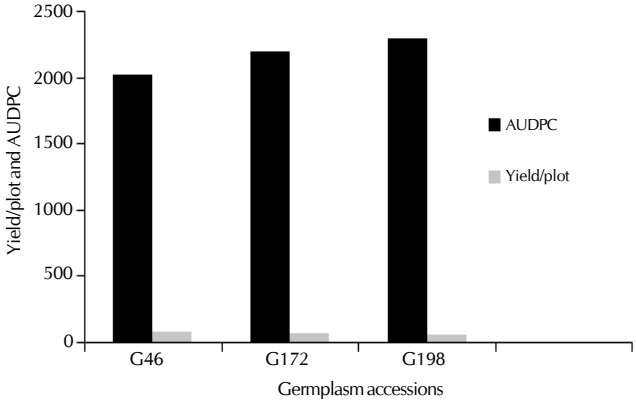


Figure 3: AUDPC and Yield pattern of susceptible germplasm

accessions have been shown in Figure 2 and 3.

Disease was negatively associated with spike length, number of spikelets per spike and number of grain per spike. Therefore, it is interesting to note that decrease in the disease severity will lead to increase in grain yield, 1000- grain weight, number of spikelets per spike and number of grain per spike.

Association analysis revealed that the spot blotch severity (AUDPC) has significant and negative correlation with all the important agronomic traits viz., grain yield (-0.272), thousand grain weight (-0.735), spike length (-0.289), number of spikelets per spike (-0.355) and number of grain per spike (-0.342). Simultaneously, AUDPC has shown negative correlation with phenological characters viz., days to 75% heading (-0.12) and days to maturity (-0.069).

Therefore, it could be concluded that the negative association of disease with important yield components as well as yield *per se* will have bearing on over all yield of the crop.The resistant accessions found in the present investigation, which are positively correlated with yield traits, can be used in hybridization programme to develop improved high yielding spot blotch resistant wheat varieties.

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