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Evaluation of wheat genotypes for resistance against spot blotch disease

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Abstract
Spot blotch caused by *Bipolaris sorokiniana* (Sacc.) Shoem is one of the most important wheat leaf disease all over world; it appears in almost all wheat growing areas and causes severe yield loss every year. A field study was conducted during *Rabi*, 2018-19 and 2019-20 crop seasons at Main Experiment Station, ANDUA and T, Kumarganj, Ayodhya to test the resistance of 200 genotypes against *Bipolaris sorokiniana* under artificial epiphytotics conditions. Each genotype was sown in last week of November in single row of one meter length. Variety Raj 4015 was used as check and was sown after every 20 genotypes. Pure culture of pathogen was inoculated on genotypes by using cleaned sprayer, at evening. Disease data was recorded using double digit scale based on per cent blighted area on flag leaf and one leaf just below. Out of 200 genotypes, thirty six namely were found resistant HS652, DBW222, PBW550, PBW821, HD2967, DPW621-50, DBW88, HD3043, HD3249, HD2733, PBW781, DBW39, HD2967, K1317, HI1612, HD3293, DBW277, HW1098, WH1254, WH1270, PBW824, UP3043, UP3042, NW7062, PBW757, PBW 797, VL1015, HPW451, VL1014, PBW800, DBW246, PBW778, TL3011, DDK1052, MACS5047 and PBW780 genotypes were found resistant, 91 were moderately resistant, 43 were moderately susceptible and 30 were found susceptible against spot blotch disease of wheat.

Keywords: Wheat, spot blotch, *B. sorokiniana*, screening

Introduction
Wheat (*Triticum aestivum* L.) is the most important cereal food crop of the world as well as the second most important cereal food crop in India, which contributes nearly one-third of the total food grains production. It is one of the oldest cereal crop. Since antiquity, wheat has been cultivated in Mohanjo-Daro and Harappa for over 5000 years (Pal, 1966). It belong to family Poaceae or Graminae. It is the most important cereal crop after rice in India and major staple food of South Asian region countries. Generally, wheat is a self-pollinated and hexaploid plant. Globally, wheat occupies around 216.95 million hectares (mha) holding the position of highest acreage among all crops with an annual production covering around 764.11 metric tonnes (mt) last year (Anonymous 2019-20) [1]. India ranked second after China, in wheat production across global. It is second most important food crop of the India, which contributes nearly one third of the total food grain production. About one tenth of the global production is contributed from India. Wheat cultivation has been traditionally dominated by the Northern region of India. In India wheat is grown during winter season. India recorded all time high 101.20 mt of wheat production from an area of 29.55 mha with an average national productivity 3424 kg/ha during 2018 (Anonymous, 2018-19) [2].
Uttar Pradesh is usually considered to be at the top of the list in terms of wheat production with a total record output of 31.99 mt (32 per cent) with respect to area 9.79 mha followed by Punjab 17.61 mt (18 per cent), Madhya Pradesh 15.19 mt (16 per cent), Haryana 11.31 mt (11 per cent), Rajasthan 9.53 mt (10 per cent) and Bihar 4.58 mt (5 per cent). The above mentioned top six states hold a share of about 92 per cent in the total wheat production in India (Anonymous, 2019, GoI) [1, 2].
It has good nutritional value than other food grains comprising 71.2g carbohydrates, 11.8g proteins, 1.5g fat, 1.2 g crude fiber, 306 mg phosphorus and 41 mg calcium per 100g grains (Rai and Mauria, 1999) [8]. Spot blotch caused by *Bipolaris sorokiniana* (Sacc.) Shoem. (syn. *Helminthosporium sativum*, teleomorph *Cochliobolous sativus*) is an important wheat disease in warmer and humid growing regions of the world such as Eastern India, South East Asia (Joshi *et al*., 2007) [5]. Yield losses were estimated to be 18-22 per cent in India (Saari, 1998) [9]. The control strategy for the diseases caused by *B. sorokiniana* is based on an integrated approach where genetic resistance is a major element, because economic returns have not always resulted in commercial grain production from fungicide inputs (Duveiller and Sharma, 2009) [3].

Hence, search of effective non-fungicidal control of spot blotch disease is of utmost importance. The best, long term, economically and environmentally safe method for sustainable disease control is the use of resistant varieties.

Material and Methods

The experiment was conducted at Main Experimental Station of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during *Rabi* 2018-19. Seeds of 200 genotypes were collected from All India Co-ordinated Wheat and Barley Improvement Project, Department of Genetics and Plant Breeding, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). Fourrows of Raj 4015 were sown as border rows around all the sides of experiment as it is susceptible to foliar blight. It was also sown after every 20 entries. All the recommended agronomical and cultural practices were followed for raising the good crop. The ten days old pure culture of *Biopolaris sorokiniana* multiplied on potato dextrose Agar and sorghum seeds were used for inoculating on entries. The spore suspension was prepared in sterilized distilled water having a spore load of 50-75 per microscopic field (10x). This suspension was sprayed at 3-4 leaf stage by using hand atomizer. The second field inoculation was made again in the same manner after the 15 days of the first inoculation.

Table 1: The double digit scale, based on per cent blighted area on the flag leaf and one leaf just below given by Kumar *et al.* (1998) [7].

A double digit* scale for appraising blight severity				
S. No.	Severity**		Rating	
	Flag leaf	Flag-1 leaf	Disease response	Range of value
1.	0	0-1	Immune (I)	00-01
2.	1-2	2-4	Resistant (R)	12-24
3.	3-4	4-6	Moderately Resistant (MR)	34-46
4.	5-6	6-8	Moderately susceptible (MS)	56-68
5.	7-8	8-9	Susceptible (S)	78-89
6.	9	9	Highly susceptible (HS)	99
* First and second value respectively, represents per cent blighted area on the flag leaf and flag-1 leaves.				
** Values 1,2,3,4,5,6,7,8, and 9, respectively correspond to 10,20,30,40,50,60,70,80 and 90 per cent blighted area.				

After inoculation, the entries were regularly watched for recording the observations of disease severity. The first observations were made after ten days of inoculation on ten plants selected randomly. The disease score of each selected plants were recorded by using Kumar *et al.* (1998) [7] double digit scale (Table 1) based on per cent blighted area on the flag and one leaf just below. The maximum disease score of each genotype was recorded finally.

Results and Discussion

Use of resistant variety is a cheapest and most economical method of disease control. Two hundred varieties (Table 2) were screened under field conditions by double digit scale based on per cent blighted area on the flag and flag-1 leaf at hard dough stages. Out of which, none genotype was found immune (score 00-01), thirty six genotypes were found resistant namely HS652, DBW222, PBW550, PBW821, HD2967, DPW621-50, DBW88, HD3043, HD3249, HD2733, PBW781, DBW39, HD2967, K1317, HI1612, HD3293, DBW277, HW1098, WH1254, WH1270, PBW824, UP3043, UP3042, NW7062, PBW757, PBW 797, VL1015, HPW451, VL1014, PBW800, DBW246, PBW778, TL3011, DDK1052, MACS5047 and PBW780 (score 12-24). Ninety one genotypes were found moderately resistant against spot blotch and thirty genotypes namely HI8713, NIDW1158, HI8811, HD3343, GW322, HI1544, MP3336, MP4010, HI8808, HI8807¸ UAS428, DDW49, UAS3001¸ MACS3949, MACS6222, GW322, DDW48, MACS6478, WHD963¸ HI8807, RAJ4083, HD2932¸ GW509, GW1346, MACS4058, NIDW1149¸ HI8802, WR544¸ LINE 1172 and HPW439 (score 78-89) were found susceptible for spot blotch disease under field conditions.

Similar observations were recorded by other workers Kenganal *et al.* (2008) [6] screened wheat cultivars against *Helminthosporium sativum* [*Cochliobolus sativus*] occurring on wheat. Out of 15 wheat cultivars screened, NIDW-295 and MACS-2496 were found immune; DDK-1013, DWR-185, DWR-225, RAJ-4037 and MACS-2846 were highly resistant; GW-344 and DWR-195 were resistant; GW-322, DDK-1001 and DWR-162 were moderately resistant, DWR-2006 and DWR-1006 were susceptible and DDK-1009 was highly susceptible. Singh *et al.* (1995) [11] in field inoculation trials only 15 of 257 genotypes were consistently resistant to *H. sativum* (*Cochliobolus sativus*). A further 47 were moderately resistant and 158 moderately susceptible, with 33 rated susceptible and 4 highly susceptible. No genotype was free from infection during the 3 test years.

Table 2: Categorization of wheat genotypes against the response of spot blotch disease under artificial disease pressure (2018-2019).

S. No.	Disease reaction	Score	No. of genotypes	Genotypes
1	Immune(I)	00-01	NIL	NIL
2	Resistant (R)	12-24	36	HS652, DBW222, PBW550, PBW821, HD2967, DPW621-50, DBW88, HD3043, HD3249, HD2733, PBW781, DBW39, HD2967, K1317, HI1612, HD3293, DBW277, HW1098, WH1254, WH1270, PBW824, UP3043, UP3042, NW7062, PBW757, PBW 797, VL1015, HPW451, VL1014, PBW800, DBW246, PBW778, TL3011, DDK1052, MACS5047 and PBW780
3	Moderately Resistant (MR)	34-46	91	HPW349, VL907, HS507, HS562, VL892, HS490, HPW468, HS673, VL3020, UP3041, HPW467, HS674, VL3019, VL3021, PBW820, DBW221, DBW88, PBW752, DBW173, HD3059, PBW771, PBW796, HI1628, WH1142, PBW644, HD3237, BRW3806, NIAW3170, WH1080, DBW257, HD3277, RAJ4529, DBW187, WH1239, K0307, HD3171, HD2888, DBW252, K8027, DBW273, PBW822, HD3345, DBW48, DBW110, DDW47, HD2932, UAS3002, HD3343, HD3090, NIAW3170, MACS6695, HI1605, MACS6696, DDK1029, MACS5052, DDK1056, MACS5053, HD3317, DBW301, HD2967,

				DBW187, DBW303, DBW304, DBW302, PBW825, WH1223, KRL19, NW 7060, WH1228, HD3298, HD3271, DBW14, DBW71, HI1621, DBW251, HS645, PBW777, TL3012, TL3013, TL3014, TL3015, UAS462, VL1013, VL1014, WH1233, MACS5049, MACS6677, VL3013, HI1612, HD3271 and WH1316
4.	Moderately Susceptible (MS)	56-68	43	WH1105, HD3226, HD3086, WH1021, WH1124, HI 1620, HI8737, HI8812, GW1348, DDW49, HI8627, UAS466, MP3288, HD2864, CG1029, HI1633, HI1634, PBW823, HI1633, UAS3002, DBW93, HI8805, AKDW299716, UAS446, MACS6222, DDK1057, HD3086, HD3347, Kharchiya65, KRL210, HI8791, HS611, B622, HG110, HI1620, DDK1053, HS644, HS446, WH1232, IWP 5019, HI1619, HS648, KRL370.
5.	Susceptible (S)	78-89	30	HI8713, NIDW1158, HI8811, HD3343, GW322, HI1544, MP3336, MP4010, HI8808, HI8807¸ UAS428, DDW49, UAS3001¸ MACS3949, MACS6222, GW322, DDW48, MACS6478, WHD963¸ HI8807, RAJ4083, HD2932¸ GW509, GW1346, MACS4058, NIDW1149¸ HI8802 , WR544 ¸ LINE 1172 and HPW439
6	Highly Susceptible (HS)	99	NIL	NIL

Iftikhar *et al*., (2012) [4] screened 56 commercial wheat varieties against spot blotch resistance under controlled and field conditions. Out of 56 commercial varieties, 12 varieties showed moderate resistance (MR) reaction under *in vitro* and *in vivo* conditions and 2 varieties showed moderate resistance at 2 scales under both conditions. Thirty two varieties showed moderate susceptible (MS) and susceptibility (S) under controlled conditions but had moderate resistance under field conditions, whereas, 9 varieties including Faisalabad-83, 85, Inqilab-91, Kaghan-93, Kirin- 95, Kohinoor- 83, MH-97, Rohtas-90 and Zarlashata showed moderate resistance under both controlled and field conditions at 1 scale level.

Singh *et al*., (2002) [11] evaluated 325 genotypes against the spot blotch. Out of these 256 genotypes 3 genotypes namely, NW-2043, MACS-2942 and HUWL -99003 gave resistant reaction, while 75 showed moderately resistant reaction.

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