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RESEARCH ARTICLE

IDENTIFICATION OF RESISTANT GENOTYPES OF BARLEY (*HORDEUM VULGARE* L.) AGAINST SPOT BLOTCH DISEASE CAUSED BIPOLARIS SOROKINIANA

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ABSTRACT

Recent studies have show that barley surpassed other cereals in the content o B-glucon, total dietary and soluble fiber, beneficial in treating hyper cholesteralemia. *Bipolaris sorokiniana* causing spot blotch and zinc deficiency are responsible for over two thirds of area coverage and much of yield losses by these diseases. A total number three hundred eighty newly developed genotypes were screened under artificial epiphytotic situation on 16 Dec 2004. Highly susceptible genotype RD-2503 was planted after every twenty test genotypes and also as border of the experimental plot. The test entries and border were inoculated with aqueous suspension of *B. sorokiniana* and broadcast inoculation with *B. sorokiniana* spore covered sorghum grains at maximum tillering boot leaf and 15 days after boot leaf stage. The field was irrigated, three days prior to inoculation and subsequent irrigations were also applied to maintain the high humidity. Out of 388 genotypes, none was found free from the disease and resistant. One hundred fifty five genotypes were moderately resistant, one hundred sixty nine were moderately susceptible, sixty two were susceptible and rests two were found highly susceptible during the crop season. Moderately resist genotypes could be used for breeding programme for management of spot blotel of barley.

Key Words **: Barley, *Bipolaris sorokiniana*, Resistant, Susceptible**

Barley (*Hordeum vulgare* Linn.) is a crop of international importance and serves mainly as staple food, animal's feed and industrial raw material in food and beverages industry. It is the first cereal to be domesticated in Middle East at least 9000 year ago. Vedas Christen mentioned it as 'Yav' and mentioned its use in different religious ceremonies. It occupies fourth position in the cereal world acreage after wheat, rice and maize. It is cultivated in almost all parts of the world, except the tropical regions. It is a major source of food

for large number of people living in the cooler semiarid areas of the world. In India, it is grown over an area of 6.58 lacs hectares with annual production of 13.10 lacs ton and productivity of 19.84 q/ha. The production of barley in Uttar Pradesh is large in comparison to Rajasthan, Madhya Pradesh, Bihar, Haryana and Punjab. In view of depletion of ground water, shortage of fertilizers and clamour for the use of lesser amounts of agrochemicals in the crop rising, it has a potential to cover wider areas and give higher net yield. It thrive better yield under limited resources of fertilizer and irrigation. Off course, it requires less water than wheat. Recent studies have shown that barley surpassed other cereal crops in the content of B-glucon, total dietary and soluble fibre, beneficial in treating hyper cholesteralemia. The most important uses of barley are as grain to live-stock and poultry, as malt for manufacture of beer, fast food and other liquors like whisky, brandy, medicine and industry. Green barley, later, plants are used as forage for the livestock. The Barley crop suffers from a number of devastating diseases caused by fungi, bacteria, viruses, nematodes and environmental factors. Of these, in Uttar Pradesh, only fungal foliar diseases such as Leaf blights, blotches and spots, caused by species of *Alternaria, Cochliobolus, Pyrenophora* and large number of other fungal pathogens have since assumed serious proportion in North Eastern Plains, North Western Plains and Peninsular zones of the country causing yield losses.

Since the use of resistant varieties is considered to be the best method for disease management, therefore, the studies were carried out for the search of sources of resistance against the spot blotch of barley caused by *Bipolaris sorokiniana*. The resistant varieties are the best and cheapest method to control the diseases and screening of genotypes/ varieties/ lines for their response under artificial condition has been considered as the best method to identify the resistant genotypes/lines. Therefore, the newly developed genotypes / varieties/ lines of barley were screened under artificial epiphytotic conditions to find out the resistant sources.

MATERIALS AND METHODS

Identification of resistant genotypes :

The experiment for genotypic resistance screening was conducted at Main Experiment Station of N.D. University of Agriculture and Technology, Kumarganj, Faizabad (U.P.). The seeds of the test genotypes were obtained from All India co-ordinated Wheat and Barley Improvement Project, Department of Genetics and Plant Breeding of N.D. University of Agriculture and Technology, Kumarganj, Faizabad (U.P.)A total number of three hundred eighty eight newly developed genotypes (Table-1) were screened under artificial epiphytotic situation . Each genotype was planted on 16 Dec. 2004 in one meter long rows having 25 and 5 cm row to row and plant to plant distance, respectively. Highly susceptible genotype RD-2503 was planted after every twenty test genotypes and also as border of the experimental plot for proper availability of the inoculum. Optimum agronomic practices were followed as per region recommendation. The test entries and borders were inoculated with the aqueous suspension of *Bipolaris sorokiniana* (10^6) and broadcast inoculation with *B. sorokiniana* spore covered sorghum grains at maximum tillering boot leaf and 15 days after boot leaf stages. The field was irrigated, three day prior to inoculation and subsequent irrigations were also applied to maintain the high humidity. Spot blotch severity were graded following double digit scale of Kumar *et al.* (1998) and per cent disease intensity and area under disease progress curve have been calculated as per standard method.

Recording and processing spot blotch data :

Ten primary tillers in each plot and genotype were randomly selected and tagged. Spot blotch severity was measured visually as percent lesion area on the flag leave and top leave on the plants. These data were straight way utilized to evaluate varietal resistance following, Kumar *et al.* (1998)'s scale to calculate area under disease progress curve (AUDPC), per cent disease intensity (PDI), and AUDPC Dubin *et al.* (1998), were calculated following formula given below:

$$\text{AUDPC} = \sum_{i=1} [(Y_{i+1} + Y_i) \times 0.5] (T_{i-1} - T_1)$$

where

Y_i = Spot blotch severity (%) at the i^{th} observations.

T_i = Time (days) of the i^{th} observations

n = Total number of observations.

Per cent disease intensity was calculated using following formula :

$$\text{PDI} = \frac{\text{Sum of total numerical rating}}{\text{Total number of leaves examined} \times \text{maximum disease score}} \times 100$$

RESULTS AND DISCUSSION

Since the use of resistant varieties is considered to be the best method for disease management, therefore, the studies were carried out for the search of sources of resistance against the spot blotch of barley caused by *Bipolaris sorokiniana*. A total number of 388 genotypes of barley, mostly newly developed ones were screened against *Bipolaris sorokiniana* under artificial epiphytotics (Table 1).

Out of three hundred eighty eight genotypes, none was found immune (score 00-01) and resistant (score 12-24). One hundred fifty five genotypes, namely, BHS-357, HBS-361, RD-2632, RD-2637, RD-2640, RD-2657, RD-2658, RD-2665, K-713, HBL-391, HBL-113, RD-2669, RD-2670, BH-648, BH-657, VLB-91, VLB-92, HUB-177, DWRUB-52, DWRUB-55, DWR-46, RD-2035, DWR-47, DWR-49, BL-751, K-551, BHS-352, HBL-276, RD-2677, RD-2681, RD-2682, RD-2683, RD-2685, RD-2691, RD-2695, RD-2698, BH-850, BH-851, BH-855, BHS-371, K-804, JB-42, JB-44, VLB-96, DWRUB-60, DWRUB-61, JB-98, JB-100, JB-105, JB-106, JB-109, JB-110, JB-111, JB-112, JB-114, JB-115, JB-116, JB-117, JB-119, JB-120, HUBL-041, HVBL-042, HUBL-044, HUBL-048, HUBL-0411, HUBL-0412, HUBL-0413, HUBL-0415, HUBL-0416, HUBL-0419, HUBL-0420, HUBL-0422, HUBL-0425, BL-1, BL-3, BL-4, BL-7, BL-9, BL-10, BL-11, BL-16, BH-887, BH-888, BH-889, BH-890, BH-891, BH-892, BH-895, BH-896, BH-897, BK-402, BK-403, BK-405, BK-407, BK-408, BK-415, BK-416, BK-417, BK-419, BK-421, BK-422, BK-423, BK-427, BK-428, BK-430, BK-431, VB-402, VB-407, VB-408, VB-415, VB-416, VB-417, VB-418, BBM-474, BBM-475, BBM-476, BBM-479, BBM-481, BBM-482, BBM-483, BBM-484, BBM-486, BBM,-487, BBM-489, BD-1213, BD-1214, BD-1218, BD-1219, BD-1221, BD-1222, K-810, K-813, K-814, K-815, K-817, K-818, K-821, K-822, K-825, K-826, K-827, K-832, K-834, K-835, K-836, K-837, K-838, NDB-943, NDB-1303, NDB-1304, NDB-1305, NDB-1307, NDB-1309, NDB-1316 and NDB-1320 were moderately resistant (score 34-46) (Table 1).

One hundred sixty nine genotypes, namely, BHS-360, BHS-362, BHS-363, RD-2552, RD-2634, RD-2655, RD-2660, RD-2661, RD-2508, DWR-51, RD-2667, RD-2674, RD-2676, BH-365, BH-365, VLB-93, HUB-173, HB-174, PL-762, HBL-393, DWRUB-54, RD-2624, JYOTI, DWR-28, BH-674, BHS-365, PL-772, RD-2668, NDB-1245, RD-2678, RD-2679, RD-2680, RD-2686, RD-2687, RD-2688, RD-2689, RD-2690, RD-2693, RD-2694, RD-2697, RD-2699, BH-854, BHS-368, BHS-369, BHS-370, K-782, K-791, K-792, JB-46, JB-48, PL-781, PL-782, PL-783. PL-796, HUB-180, HBL-404, HBL-414, HBL-415, VLB-94, NDB-1276, NDB-1280, NDB-1281, NDB-1274, NDB-1293, NDB-1295, DWRUB-57, DWRUB-58, DWRUB-59, JB-96, JB-104, JB-108, JB-113, JB-116, JB-121, HUBL-043, HUBL-045, HUBL-046, HUBL-049, HUBL-0414, HUBL-0417, HUBL-0418, HUBL-0421, BL-2, BL-5, BL-6, BL-8, BL-12, BL-13,BL-14, BL-15, BL-17, BL-18, BL-19, BH-893, BH-894, BK-401, BK-406, BK-409, BK-410, BK-411, BK-412, BK-413, BK-414, BK-418, BK-420, BK-424, BK-425, BK-426, BK-429, VB-401, VB-403, VB-404, VB-405, VB-406, VB-409, VB-410, VB-411, VB-412, VB-413, VB-414, VB-419, VB-420, BBM-470, BBM-471, BBM-472, BBM-473, BBM-477, BBM-478, BBM-480, BBM-485, BBM-488, BD-1187, BD-1190, BD-1191, BD-1193, BD-1194, BD-1195, BD-1196, BD-1207, BD-1208, BD-1211, BD-1215, BD-1216, BD-1218, BD-1223, K-809, K-811, K-812, K-819, K-823, K-824, K-828, K-829, K-831, K-833, NDB-1301, NDB-1302, NDB-1306, NDB-1308, NDB-1310, NDB-1311, NDB-1312, NDB-

Table 1 : Disease scores, percent disease intensity and area under disease progress curve (AUDPC) of Barley genotypes against *Bipolaris sorokiniana* under artificial inoculation

Categorization of genotypes	Score	Genotypes	AUDPC score
Immune	00-01	0	
Resistant	12-24	0	
Moderately resistant	34-46	135: BHS-357, HBS-361, RD-2632, RD-2637, RD-2640, RD-2657, RD-2658, RD-2665, K-713, HBL-391, HBL-113, RD-2669, RD-2670, BH-648, BH-657, VLB-91, VLB-92, HUB-177, DWRUB-52, DWRUB-55, DWR-46, RD-2035, DWR-47, DWR-49, BL-751, K-551, BHS-352, HBL-276, RD-2677, RD-2681, RD-2682, RD-2683, RD-2685, RD-2691, RD-2695, RD-2698, BH-850, BH-851, BH-855, BHS-371, K-804, JB-42, JB-44, VLB-96, DWRUB-60, DWRUB-61, JB-98, JB-100, JB-105, JB-106, JB-109, JB-110, JB-111, JB-112, JB-114, JB-115, JB-116, JB-117, JB-119, JB-120, HUBL-041, HVBL-042, HUBL-044, HUBL-048, HUBL-0411, HUBL-0412, HUBL-0413, HUBL-0415, HUBL-0416, HUBL-0419, HUBL-0420, HUBL-0422, HUBL-0425, BL-1, BL-3, BL-4, BL-7, BL-9, BL-10, BL-11, BL-16, BH-887, BH-888, BH-889, BH-890, BH-891, BH-892, BH-895, BH-896, BH-897, BK-402, BK-403, BK-405, BK-407, BK-408, BK-415, BK-416, BK-417, BK-419, BK-421, BK-422, BK-423, BK-427, BK-428, BK-430, BK-431, VB-402, VB-407, VB-408, VB-415, VB-416, VB-417, VB-418, BBM-474, BBM-475, BBM-476, BBM-479, BBM-481, BBM-482, BBM-483, BBM-484, BBM-486, BBM,-487, BBM-489, BD-1213, BD-1214, BD-1218, BD-1219, BD-1221, BD-1222, K-810, K-813, K-814, K-815, K-817, K-818, K-821, K-822, K-825, K-826, K-827, K-832, K-834, K-835, K-836, K-837, K-838, NDB-943, NDB-1303, NDB-1304, NDB-1305, NDB-1307, NDB-1309, NDB-1316 and NDB-1320	151-500
Moderately susceptible	56-68	169:BHS-360, BHS-362, BHS-363, RD-2552, RD-2634, RD-2655, RD-2660, RD-2661, RD-2508, DWR-51, RD-2667, RD-2674, RD-2676, BH-365, BH-365, VLB-93, HUB-173, HB-174, PL-762, HBL-393, DWRUB-54, RD-2624, JYOTI, DWR-28, BH-674, BHS-365, PL-772, RD-2668, NDB-1245, RD-2678, RD-2679, RD-2680, RD-2686, RD-2687, RD-2688, RD-2689, RD-2690, RD-2693, RD-2694, RD-2697, RD-2699, BH-854, BHS-368, BHS-369, BHS-370, K-782, K-791, K-792, JB-46, JB-48, PL-781, PL-782, PL-783. PL-796, HUB-180, HBL-404, HBL-414, HBL-415, VLB-94, NDB-1276, NDB-1280, NDB-1281, NDB-1274, NDB-1293, NDB-1295, DWRUB-57, DWRUB-58, DWRUB-59, JB-96, JB-104, JB-108, JB-113, JB-116, JB-121, HUBL-043, HUBL-045, HUBL-046, HUBL-049, HUBL-0414, HUBL-0417, HUBL-0418, HUBL-0421, BL-2, BL-5, BL-6, BL-8, BL-12, BL-13,BL-14, BL-15, BL-17, BL-18, BL-19, BH-893, BH-894, BK-401, BK-406, BK-409, BK-410, BK-411, BK-412, BK-413, BK-414, BK-418, BK-420, BK-424, BK-425, BK-426, BK-429, VB-401, VB-403, VB-404, VB-405, VB-406, VB-409, VB-410, VB-411, VB-412, VB-413, VB-414, VB-419, VB-420, BBM-470, BBM-471, BBM-472, BBM-473, BBM-477, BBM-478, BBM-480, BBM-485, BBM-488, BD-1187, BD-1190, BD-1191, BD-1193, BD-1194, BD-1195, BD-1196, BD-1207, BD-1208, BD-1211, BD-1215, BD-1216, BD-1218, BD-1223, K-809, K-811, K-812, K-819, K-823, K-824, K-828, K-829, K-831, K-833, NDB-1301, NDB-1302, NDB-1306, NDB-1308, NDB-1310, NDB-1311, NDB-1312, NDB-1313,NDB-1314, NDB-1315, NDB-1317, NDB-1318, NDB-1319 and RD-2675	
Susceptible	78-89	62: BHS-355, K-675, BH-646, RD-2666, RD-2673, BH-673, PL-770, BH-553, K-729, BHS-169, BH-673, RD-2684, RD-2692, RD-2696, BH-719, K-783, K-786, K-789, JB-40, JB-47, HBL-405, HBL-410, VLB-95, VLB-97, VLB-98, JB-97, JB-99, JB-101, JB-103, JB-107, HUBL-047, HUBL-0410, HUBL-0423, HUBL-0424, BL-20, BH-885, BH-886, BK-404, BD-1184, BD-1185, BD-1186, BD-1188, BD-1189, BD-1192, BD-1197, BD-1198, BD-1199, BD-1200, BD-1201, BD-1202, BD-1203, BD-1204, BD-1205, BD-1206, BD-1209, BD-1210, BD-1212, BD-1217, BD-1220, K-816, K-820 and K-830	
Highly Susceptible	99	2:JB-102 and RD-2503	

1313,NDB-1314, NDB-1315, NDB-1317, NDB-1318, NDB-1319 and RD-2675 were moderately susceptible (score 56-68).

Sixty two genotypes, namely, BHS-355, K-675, BH-646, RD-2666, RD-2673, BH-673, PL-770, BH-553, K-729, BHS-169, BH-673, RD-2684, RD-2692, RD-2696, BH-719, K-783, K-786, K-789, JB-40, JB-47, HBL-405, HBL-410, VLB-95, VLB-97, VLB-98, JB-97, JB-99, JB-101, JB-103, JB-107, HUBL-047, HUBL-0410, HUBL-0423, HUBL-0424, BL-20, BH-885, BH-886, BK-404, BD-1184, BD-1185, BD-1186, BD-1188, BD-1189, BD-1192, BD-1197, BD-1198, BD-1199, BD-1200, BD-1201, BD-1202, BD-1203, BD-1204, BD-1205, BD-1206, BD-1209, BD-1210, BD-1212, BD-1217, BD-1220, K-816, K-820 and K-830 were susceptible (score 78-89).Two genotypes, namely, JB-102 and RD-2503 were highly susceptible (score 99).

Among these genotypes, 39.94 per cent were moderately resistant, 43.55 per cent were moderately susceptible, 15.97 per cent were susceptible and 0.51 per cent was highly susceptible to *Bipolaris sorokiniana*

Out of three hundred eighty eight genotypes (Table-1), one hundred fifty five showed moderately resistant response to spot blotch. These genotypes were further classified (Table-2) on the basis of area under disease progress curve (AUDPC).

The resistant varieties are the best and cheapest method to control the diseases under control and screening of genotypes/ varieties/ lines for their response under artificial condition has been considered as the best method to identify the resistant genotypes/lines. Therefore, the newly developed genotypes / varieties/ lines of barley were screened under artificial epiphytotic conditions to findout the resistant sources. Out of three hundred eighty eight genotypes none was found free from the disease (immune) and resistant.

One hundred fifty five genotypes were moderately resistant, 169 moderately susceptible, 62 susceptible and 2 highly susceptible. Several earlier workers have also screened the barley genotypes/ lines against *B. sorokiniana* and reported variable level of resistance

Table2 : Categorization of moderately resistant barley genotypes against *Bipolaris sorokiniana* based on area under disease progress curve (AUDPC)

AUDPC range	Genotype number	Name of genotypes
151-200	(1) (0.65%)	RD 2277,
201-250	(12) (7.74%)	VLB-91, DWR-46, RD-2691, BH-855, HUBL-0411, HUBL-0419, BK-402, BK-405, BBM-479, K-822, K-827, K-834
251-300	(36) (23.23%)	RD-2637, DWRUB-52, DWRUB-55, RD-2035, DWR-47, DWR-49, RD-2681, RD-2695, K-804, JB-42, JB-44, DWRUB-61, JB-111, JB-114, JB-115, JB-117, JB-120, HUBL-0415, HUBL-0420, BH-896, BK-403, BK-422, BK-430, VB-407, BBM-475, BBM-482, BBM-486, BBM-489, BD-1213, K-814, K-815, K-817, K-835, K-836, NDB-943, NDB-1309.
301-350	(33) (21.29%)	RD-2632, K-713, RD-2669, RD-2670, BH-657, K-551, JB-106, HUBL-0413, BL-1, BL-3, BL-9, BL-11, BH-887, BH-888, BH-890, BH-891, BK-407, BK-415, BK-418, VB-402, VB-417, BBM-484, K-810, K-818, K-826, K-832, K-837, K-838, NDB-1303, NDB-1304, NDB-1305, NDB-1307, NDB-1316
351-400	(55) (35.48%)	BHS-361, RD-2658, RD-2665, HBL-113, HUB-177, PL-751, BHS-352, HBL-276, RD-2682, RD-2683, RD-2685, RD-2698, BH-850, BH-851, BHS-371, VLB-96, DWRUB-60, JB-98, JB-100, JB-105, JB-109, JB-110, JB-112, JB-116, HUBL-041, HUBL-044, HUBL-048, HUBL-0412, HUBL-0416, HUBL-0425, BL-4, BL-10, BL-16, BH-889, BH-897, BK-416, BK-419, BK-421, BK-423, BK427, BK-428, BK-431, VB-415, VB-418, BBM-474, BBM-476, BBM-481, BBM-483, BBM-487, BD-1214, BD-1219, BD-1221, BD-1222, K-825, NDB-1320.
401-450	(15) (9.68%)	HBL-391, BH-648, VLB-92, JB-119, HUBL-042, HUBL-0422, BL-7, BH-892, BH-895, BK-408, VB-408, VB-416, BD-1218, K-813, K-821.
451-500	(3) (1.94%)	BHS-357, RD-2640, RD-2657

(Hamilton *et al.*, 1960; Gayed, 1961; Lacicowa and Pieta, 1991). Misra (1973) tested 391 barley varieties; fifty of these proved very resistant, 97 very susceptible

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