

Resistance to Spot Blotch in Barley Germplasm

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Multilocation evaluation of barley germplasm accessions for resistance to spot blotch was taken up under artificial epiphytotic conditions in four crop seasons at four locations (Varanasi, Faizabad, Kanpur and Karnal). The lines identified as resistant/ moderately resistant from the field screening were again screened in poly house for three more years. Disease data was recorded following the double digit system, indicating the percent area covered on the flag leaf and on the next below to flag leaf on 1 to 9 scale. Out of 5458 accessions screened in the field during four crop seasons, only 28 accessions could be termed as resistant. Another group of 58 accessions was observed as moderately resistant and rest of accessions were in susceptible to highly susceptible group. In order to further confirm their reaction the 86 accessions (resistant and moderately resistant) were screened under controlled conditions of temperature and humidity in poly house with artificial screening at Karnal. Out of the 86 accession 68 were observed as resistant and eight as moderately resistant, while rest 10 were either moderately susceptible or susceptible. The genotypes grouped as resistant were able to keep the disease level on the plant at very low level. These accessions may carry diverse resistance genes, making them useful for breeding programme. The study will provide opportunity for increased utilization of genetic resources maintained in active collection.

Key Words: Barley, Spot blotch, Germplasm, Resistance

Introduction

Barley (*Hordeum vulgare* L.) is an important cereal grain crop in India, grown since ancient times and has been traditionally considered as poor man's crop (Chandola, 1999) because of its low input requirement and better adaptability to harsh environments like drought, salinity, alkalinity and marginal lands. Presently barley occupies nearly 0.69 m ha area producing 1.54 m tones grain, with productivity of 2.23 t/ha (Anonymous, 2011) in India. In India, area is concentrated mainly in the states of Uttar Pradesh, Punjab, Rajasthan, Haryana, Bihar, Madhya Pradesh, in plains and Himachal Pradesh, Uttarakhand, Jammu & Kashmir in the hills. In recent years use of barley as industrial raw material for malting and brewing purposes is gaining more importance. Spot blotch or leaf spot, caused by *Bipolaris sorokiniana* (earlier *Helminthosporium sativum*) is the most common form of leaf blights of barley in India.

The occurrence of the spot blotch was common in north eastern plains zone (Eastern Uttar Pradesh, Bihar, Jharkhand and eastern part of Madhya Pradesh), because of the comparatively hot and humid climate during the crop season. In recent past, spot blotch has become more

important disease on barley in north western plains zone (Punjab, Haryana, Western Uttar Pradesh, Delhi and Rajasthan except the dry belt) and also observed during the regular annual crop monitoring under All India Coordinated Wheat and Barley Improvement Project (AICW&BIP). This might be because of increased application of irrigation and fertilizers in barley (which was earlier mostly rainfed crop in the region) for better production of malt quality barley for industrial utilization as well as increased availability of these inputs resulting in the humid micro climate conducive for leaf blights development. The resistance breeding programme for spot blotch was not successful in India because there was no classified information available on the sources of effective resistance to the disease in the released cultivars and other collections. The new genotypes being evaluated for yield are also simultaneously screened in disease and pest screening nurseries under the barley network of AICW&BIP, but almost all of them are being classified as susceptible to highly susceptible under artificial inoculation at hot spot locations. Limited information (Verma *et al.*, 2002; Singh *et al.*, 2005) is available on resistance sources for spot blotch either

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based on single location screening or with a limited material. This led to the need of screening/ evaluation of the entire collection (5458 accessions) of barley genetic resources available in the DWR medium term storage module against the spot blotch disease to identify new sources of resistance, which can be utilized in barley improvement programme in country.

Material and Methods

The evaluation for resistance to spot blotch was taken up during 2003-04 to 2006-07 at Kanpur, Faizabad, Varanasi and Karnal, under artificial inoculation under the AP Cess Fund supported scheme of ICAR, New Delhi. The first three are considered to be the hot spot locations for the spot blotch where every year very heavy natural incidence of the disease is observed and Karnal gets moderate levels of natural incidence. Identical sets of germplasm accessions were supplied to all four centres for evaluation during crop seasons in each year (Table 1). The seed of a variety RD2503 was also supplied from one source every year to be used as infector. Similar layout was followed at all centres for sowing of test material and infector after every 50 rows as well as perpendicular to the test material in the field. Uniform application of irrigation and fertilizers was made at all the centres to maintain uniformity in all treatments of experimentation. The initial inoculum was supplied to all the centers from DWR, Karnal, to ensure proper disease development with sufficient inoculum load under artificial conditions as per Kumar *et al.* (1999) in addition to the natural incidence of the disease

The resistant and moderately resistant accessions identified during the field screening in first year were repeated in subsequent year for confirmation of reaction, along with a set of new accessions added every year. This provided an opportunity for at least two crop seasons screening at four centers in four crop seasons. The lines identified as resistant/ moderately resistant from the field screening over four years were then screened in poly house for three more years in 2007-08 to 2009-10 crop seasons at DWR Karnal. Disease data were recorded following the double digit system, indicating the percent area covered on the flag leaf and on the next below to flag leaf on 1 to 9 scale (Kumar *et al.*, 1998; Nagarajan and Kumar, 1998). The reaction type of the genotype was also taken into consideration apart from the percent area covered on the leaf. Observations were recorded two to three times in the season at appropriate stages and the

highest score on one genotype was reported based on final recording in the early dough stage.

The highest disease incidence score at any of the locations was considered to classify the entry in to resistant (R) up to 35, moderately resistant (MR) up to 46, moderately susceptible (MS) between 47-57 and susceptible (S) more than 57 in double digit scale. In addition to the percent area covered on the leaf, the type of lesion/ spot caused was also taken in to consideration for classification of accessions as resistant or moderately resistant. The typical eye shaped spot surrounded by a big hallow, spreading further continuously and covering major area of leaf by fusing with other spots were characteristics of susceptible genotypes. Contrary to this in the genotypes classified as resistant the size of individual spots was very small and remained almost static even at later stages in the season, while in moderately resistant genotypes the increase in spot size was there but the big hallow around the spots and necrosis of leaf tissue was not as prominent as in susceptible genotypes.

Results and Discussion

The susceptible variety RD 2503 used as check as well as infector in the study had disease score of 99 at all the four locations every year indicating the high disease development at all the locations. However at Karnal (NWPZ), where comparatively cooler climate persists longer, delayed initiation of spot blotch was observed in all years under field screening with comparatively lower disease scores than rest of the locations (NEPZ) indicating the environmental effects on the disease development. However in poly house screening at Karnal, the disease development started earlier than field screening due to controlled warmer conditions.

Table 1. Details of germplasm accessions evaluated in different years for spot blotch

Year / crop season	Number of accessions evaluated at each centre		Recorded as	
	New	Repetition from previous year	R/MR	MS/S
2003-04	1707	–	14	1693
2004-05	1921	14	135	1800
2005-06	1687	135	175	1647
2006-07	143	175	86	232
2007-10	-	86*	76	10
Total	5458		76	5382

R= resistant, S= susceptible, *Poly house screening at Karnal under artificial epiphytotics

Table 2. Germplasm lines observed as resistant and moderately resistant to leaf blight under field screening during 2003-04 to 2006-07

S. No.	BCU No.	Highest score in double digit			Overall Reaction
		Faizabad	Varanasi	Kanpur	
Resistant					
1	103	24	24	02	R
2	117	34	35	24	R
3	488	35	23	02	R
4	545	35	23	02	R
5	698	35	12	24	R
6	702	35	12	34	R
7	814	24	23	24	R
8	2156	35	24	34	R
9	4756	35	24	34	R
10	4916	35	35	24	R
11	4919	25	35	25	R
12	4920	35	35	24	R
13	4963	35	35	24	R
14	4966	35	35	24	R
15	5179	24	23	34	R
16	5180	35	23	34	R
17	5214	35	24	34	R
18	5459	35	35	34	R
19	5522	25	35	34	R
20	5527	35	25	34	R
21	5566	24	12	34	R
22	5569	35	12	34	R
23	5571	34	24	24	R
24	5593	35	35	24	R
25	5616	35	24	23	R
26	6031	24	24	34	R
27	6038	24	24	24	R
28	6079	35	24	23	R
Moderately Resistant					
1	76	46	35	46	MR
2	133	46	12	34	MR
3	572	46	12	34	MR
4	621	45	35	46	MR
5	625	46	12	24	MR
6	713	46	35	34	MR
7	716	47	24	02	MR
8	971	46	24	34	MR
9	1092	45	23	46	MR
10	1235	25	35	46	MR
11	1400	46	25	24	MR
12	1439	46	23	46	MR
13	2066	46	35	24	MR
14	3498	46	24	46	MR
15	3566	46	23	34	MR

S. No.	BCU No.	Highest score in double digit			Overall Reaction
		Faizabad	Varanasi	Kanpur	
16	3634	46	35	46	MR
17	3822	35	35	46	MR
18	3959	35	35	46	MR
19	3994	35	35	46	MR
20	4698	46	46	46	MR
21	4722	45	23	46	MR
22	4723	45	23	46	MR
23	4745	35	35	46	MR
24	4748	45	35	46	MR
25	4752	46	23	46	MR
26	4755	35	35	46	MR
27	4764	46	23	46	MR
28	4765	45	12	46	MR
29	4860	35	12	46	MR
30	4908	46	35	46	MR
31	4910	35	12	46	MR
32	4911	46	24	24	MR
33	4912	45	35	46	MR
34	4913	46	35	46	MR
35	4918	46	23	46	MR
36	4921	46	23	35	MR
37	4926	24	23	46	MR
38	4928	25	23	46	MR
39	4930	45	35	46	MR
40	4949	46	23	46	MR
41	4955	46	23	24	MR
42	4957	46	25	46	MR
43	5117	34	12	46	MR
44	5176	24	35	46	MR
45	5177	35	24	46	MR
46	5181	45	23	46	MR
47	5374	46	35	46	MR
48	5519	35	24	46	MR
49	5594	46	24	24	MR
50	5601	35	24	46	MR
51	5609	35	12	46	MR
52	5638	46	25	46	MR
53	6027	35	35	46	MR
54	6034	35	24	46	MR
55	6040	46	24	35	MR
56	6080	46	24	46	MR
57	6124	24	23	46	MR
58	6125	46	24	46	MR

* Highest score for each leaf in double digit system over the locations (R = up to 35, MR = 36-46, MS = 47-57, S = >57 score on double digit system i.e. % area covered on flag leaf and next below flag leaf)
BCU No. Barley Coordination Unit accession number

Table 3. Evaluation of selected germplasm accessions against spot blotch during 2007-10 under controlled conditions at DWR Karnal

S. No.	BCU No.	Name	Origin	Disease Reaction	S. No.	BCU No.	Name	Origin	Disease Reaction
					40	4910	29th IBON 9	E	R
					41	4911	29th IBON 11	E	R
					42	4912	29th IBON 13	E	R
					43	4913	29th IBON 20	E	R
					44	4916	29th IBON 27	E	R
					45	4918	29th IBON 41	E	R
					46	4919	29th IBON 43	E	R
					47	4920	29th IBON 44	E	MR
					48	4921	29th IBON 49	E	R
					49	4926	29th IBON 65	E	R
					50	4928	29th IBON 70	E	R
					51	4930	29th IBON 75	E	R
					52	4949	29th IBON 170	E	MR
					53	4955	10th EMBSN 5	E	R
					54	4957	10th EMBSN 8	E	R
					55	4963	10th EMBSN 20	E	R
					56	4966	10th EMBSN 29	E	R
					57	5117	IC-437886	I	MS
					58	5176	IC-437955	I	R
					59	5177	IC-437956	I	MS
					60	5179	IC-437958	I	MR
					61	5180	IC-437959	I	R
					62	5181	IC-437960	I	R
					63	5214	IC-437996	I	R
					64	5374	IC-438160	I	MS
					65	5459	IC-438257	I	R
					66	5519	EC-492144	E	MR
					67	5522	EC-492147	E	R
					68	5527	EC-492152	E	R
					69	5566	EC-492193	E	R
					70	5569	EC-492196	E	R
					71	5571	EC-492198	E	MR
					72	5593	EC-492220	E	R
					73	5594	EC-492221	E	R
					74	5601	EC-492229	E	MR
					75	5609	EC-492238	E	R
					76	5616	EC-492254	E	R
					77	5638	EC-492285	E	R
					78	5960	DWR49	I	R
					79	6027	VJM-360	I	R

Contd ...

S. No.	BCU No.	Name	Origin	Disease Reaction
80	6031	VJM-389	I	R
81	6034	VJM-507	I	R
82	6038	VJM-515	I	R
83	6040	VJM-522	I	R
84	6079	Keel	E	R
85	6080	Schooner	E	MR
86	6124	IC-438277	I	MR

BCU No. = Barley Coordination Unit accession number, E = Exotic, I = Indigenous

Of the entire material screened, none of the accessions could be termed as immune to leaf blights at any of the location. A number of lines were recorded as resistant or moderately resistant (Table 1). However differential response was observed at different locations at early stages of diseases spread. Many accessions were observed with slow disease spread as compared to others, though the highest disease score may be the same at the end of season. Based on the overall compilation, 28 accessions (based on at least two year's observations in field) could be termed as resistant out of 5458 accessions screened during four crop seasons. Another group of 58 accessions was observed as moderately resistant as indicated in the table 1. Rest of accessions were in susceptible to highly susceptible group, in some cases the extent of susceptibility was so high that it could not produce the spikes and grain with almost 100% yield losses. The details of the resistant and moderately resistant accessions under field screening are given in table 2.

These observations were further confirmed during poly house artificial inoculation screening in three crop seasons, leaving no chance of escape. The 28 resistant and 58 moderately resistant accessions identified under field screening were further evaluated under poly house artificial inoculation for another three years. Under this screening, 68 accessions were confirmed as resistant and eight as moderately resistant. Another eight accessions were recorded as moderately susceptible and two as susceptible (Table 1). The variations observed between field and poly house screening for resistance as some of the moderately resistant accessions of field screening either recorded in resistant or moderately susceptible/susceptible accessions in poly house screening. These variations either could be due host and pathogen interaction under conducive conditions in poly house or

recording error at certain location under multilocation evaluation. Also in open screening at hot spot locations like Varanasi and Faizabad apart from the inoculum supplied from one source, the local more aggressive pathotypes of leaf spot might have been there which was not available in the poly house recording. There is also possibility of differential recording of MR/MS reaction under field conditions by different persons, as it is only the visual recording and not a measurement character. Finally the repetitive recording in poly house for three seasons have confirmed the results as reported in Table 3 along with their names, source/origin and highest disease score observed during evaluation.

The results indicate that the resistance level as well as the number of resistant accessions is scanty in the barley germplasm material and unlike rusts there is nothing which can be termed as immune to the spot blotch in India. However the genotypes grouped as resistant were able to keep the disease level on the plant at very low level with very small spots which were not spreading further like the susceptible genotypes. These genotypes hold promise for utilization in the barley improvement for irrigated conditions having resistance to the spot blotch. All these sources are from different geographic regions/origin and may carry diverse resistance genes, making it useful for breeding programme. However their diversity at genetic level needs further confirmation by traditional inheritance studies or the molecular markers approaches.

The change in barley cultivation in India from traditional rainfed feed barley under minimal input conditions to irrigated optimally managed malt type barley is further making it important to incorporate resistance to leaf spot. The present study will provide very useful knowledge about the promising genetic resources maintained in our collection in the country and promote their utilization, as so far such material are lying unutilized in absence of proper evaluation.

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