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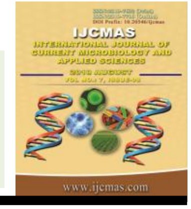

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Characterization of Wheat and Barley Entries for Foliar Blight Resistance

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A B S T R A C T

The most economic way to manage the foliar blight of wheat is through resistance breeding. The present investigation was carried out to gather information about the hundred entries possessing resistant to spot blotch at field under epiphytotic condition of 2016-17 crop season. Among twenty five entries of wheat, ten entries i.e. GW 322, GW 492, GDW 1255, Raj 4315, Raj 3765, VA 2015-30, VA 2015-41, JD 2015-18, VD 15-26, and VD 2016-1 were found with no infection of foliar blight in all three stages hence their values of AUDPC were zero. While, the highest score of foliar blight were recorded in two varieties; Bansi and A-9-30-1 with 89 and 79 respectively, in hard dough stage. Among barley entries, three entries *viz.*, PL 751, VW 2016-7 and RD 2715 were associated with highest severity score ranging from 69 to 79 so categorized as moderately susceptible to susceptible reaction and their values of AUDPC were ranged from 1605 to 1672.5. Values of AUDPC for all entries were ranged from 0 to 1657.5 as compared to susceptible varieties, Bansi and A-9-30-1 which recorded with AUDPC values of 2122.5 and 1672.5 respectively. It was observed that out of seventy five entries of wheat, fifty eight and nine entries were highly resistant and resistant while among twenty five entries of barley, three and four entries were highly resistant and resistant respectively to foliar blight. Thus, these diverse sources of resistance entries can be used for enhancing crossing programme for developing foliar blight resistant variety of wheat and barley.

Introduction

Foliar blight of wheat has been reported to be associated with *Alternaria triticina* Prasada and Prabhu and *Bipolaris sorokiniana* (Sacc.) Shoemaker because of their saprophytic nature of pathogen (Maraite *et al.*, 1998; Chaurasia *et al.*, 2000; Mishra *et al.*, 2011) and report has suggested that it also infect on barley (Khudhair *et al.*, 2014). The presence of high relative humidity which allows the canopy to remain wet for a prolonged period make favourable for infection and pathogen growth (Acharya *et al.*, 2011) and disease spreads when the temperature remain at >26°C (Chaurasia *et al.*, 2000), so making more vulnerable in late sown wheat (Duveiller *et al.*, 2005). *Alternaria* leaf blight is considered as most important disease in most of the wheat growing states of India (Prabhu and Prasada, 1970; Mishra *et al.*, 1989; Sharma *et al.*, 1998). Moreover, the pathogen has been reported from North Africa (Anahosur, 1978), Mexico (Waller, 1981), Bangladesh (Ahmed and Ahmed 1994), France (Logrieco *et al.,* 1990), Greece (Logrieco *et al.,* 1990), Egypt (Beshir, 1994), China (Guo, 2005), Argentina (Perello and Sisterna, 2006) and Iraq (Khudhair *et al.,* 2014). Infected seeds developed often shrivelled with a brown discoloration of the seed surface (Prabhu and Prasada, 1966). Infected seeds developed as small seeds with 46-75 per cent reduction in grain weight (Raut *et al.,* 1983). While, association of *Bipolaris sorokiniana* (Sacc.) Shoemaker in foliar blight of wheat and barley has been reported due to its wide spread prevalence and severe intensities with its increasing concern in India and South East Asia where warm and humid environments of 18 to 32^{o}C occur (Joshi *et al.,* 2002, 2007; Chand *et al.,* 2003; Kumar *et al.,* 2014). The pathogen occurs mainly in North-Eastern Plains Zone of India encompassing Eastern U.P., Bihar, West Bengal, Orissa, Assam and other North Eastern States (Chaurasia *et al.,* 2000). The disease was appeared in severe form in Uttar Pradesh on varieties HD 2329 and HD 2285 during 1990-91 which was mainly due to late sowing and warm humid environment in March (Singh *et al.,* 1993). In Gangetic plains of India, it is the major biotic constraint in wheat production where rice-wheat cropping systems were adopted (Duveiller *et al.,* 1998). Besides, the extensive use of conservation tillage practices may possibly be favourable for the higher intensity of spot blotch incidence in the South East Asia (Duveiller and Sharma, 2009). The yield losses of 27 to 56.6 per cent during 1998-99 were reported in North Eastern and North Western Plains of India due to the leaf blight (Satvinder *et al.,* 2002) and 6.3 to 50.6 per cent of yield losses have been reported due to foliar blight influenced by cultivars and agro climatic zones (Singh *et al.,* 2004). The most economical and effective strategy to manage the disease is planting of resistant cultivars (Duveiller 2004; Duveiller and Sharma 2009; Sharma *et al.,* 2007).

But the main cause for slow progress in resistance breeding for foliar blight has been suggested to polygenic nature of resistance (Dubin and Van Ginkel, 1991; Duveiller *et al.,* 1998; Joshi *et al.,* 2004b). While, several morphological characteristics of the host plant like waxy coating on leaf surface and leaf angle may be positively correlated with the resistance to spot blotch (Joshi and Chand, 2002). Moreover, Leaf tip necrosis (Ltn), a phenotypic marker is found to be associated with resistance to foliar blight pathogen which could facilitate selection for resistance breeding (Joshi *et al.,* 2004a). The search for new resistance donor varieties and their employment in hybridization programme for improving host resistance should be continued so as to check spreading of disease at its lowest level and ultimately it would help in improving yield. Thus, the present investigation was undertaken for screening of wheat and barley entries against foliar blight under epiphytotic conditions in the field.

Materials and Methods

Field experiment was conducted during 2016-17 crop season for the evaluation of wheat and barley entries for new source of resistance against foliar blight disease. Materials under study consist of seventy five entries including released varieties, advanced breeding materials of both aestivum and durum wheat along with twenty five varieties of barley. The entries were sown as two rows of one meter length for each entry with 20 cm distance between rows surrounded by two rows of infector in the field. In laboratory, the multiplication of inoculum culture were made by inoculating pure culture of both the pathogen i.e. *Alternaria triticina* and *Bipolaris sorokiniana* in autoclaved sorghum seeds in separate flask then kept in incubator to attain full growth. After full growth of pathogen has attained in the substrate, spore were harvested in distilled water which act as conidial suspension. Inoculation was done at tillering stage by spraying the conidial suspension having spore concentration of 10^6conidia/ml into the infectors by using hand sprayer during evening hours for ensuring successful infection (Chaurasia *et al.,* 1999). After 12 days of inoculation, the characteristic brown coloured spots developed on leaves and later coalesce to each other to form a large area of leaf blight.

Disease assessment were done by recording severity of disease observed on leaves at three different crop growth stages *viz*. flowering, milk and hard dough stage by using the double digit scale (00-99) (Saari and Prescott, 1975) (Table 1). The left and right side digit indicate the per cent severity score of blight on flag leaf (F) and flag-1 leaf (F-1) respectively, since these two leaves remain green at milk stage and contribute most to the grain filling process hence reduction of grain yield is directly related to disease severity in these two leaves (Kumar *et al.,* 1998; Singh *et al.,* 2005). The tested entries were categorized based on terminal disease severity by using described scale ranging from highly resistant to susceptible (Singh *et al.*, 2005) (Table 3). Then, area under disease progress curve (AUDPC), an appropriate parameter to distinguish the resistance of genotypes (Van der Plank 1968; Duveiller *et al.,* 1998), was calculated for each entry from the disease score recorded at different growth stages by the following formula (Roelfs *et al.*, 1992).

$$AUDPC = \sum_{i=1}^{n} \{(X_i+X_{i+1})\times t_i\}/2$$

Where X_i and X_{i+1} are disease severities on date i and date i+1, respectively

t_i is the number of days in between date i and date i+1

n is the number of observation recorded

Results and Discussion

It was observed that ten entries of wheat i.e. GW 492, GW 322, GDW 1255, Raj 4315, Raj 3765, VA 2015-30, VA 2015-41, JD 2015-18, VD 15-26, and VD 2016-1 were found no infection of foliar blight in all three stages so their values of AUDPC were zero (Table 2). The highest score of blight were recorded in two wheat varieties; Bansi and A-9-30-1 with 89 and 79 respectively, at hard dough stage. The entries were categorized based on their reaction as given in the Table 3. Among seventy five entries of wheat, it was found that fifty eight entries were having highly resistant reaction, nine entries were associated with resistant, followed by six entries with moderately resistant and there were only two entries *viz.*, Bansi and A-9-30-1 which were characterized with susceptible reaction against foliar blight of wheat (Fig. 1). While, among twenty five entries of barley, eighteen entries were found to have disease score ranged from 11 to 57 so their reaction also ranged from HR to MR. Six entries *viz.*, RD 2876, K 944, PL 844, BH 933, PL 751, and VW 2016-7 were associated with severity score ranging from 59 to 69 thus they were categorized as moderately susceptible reaction to foliar blight disease. Among twenty five entries of barley, it was found that three entries were having highly resistant reaction, four entries were associated with resistant followed by eleven entries were having moderately resistant and six entries were moderately susceptible (Fig. 1). While, the highest severity score of 79 were recorded in RD 2715 and categorized as susceptible reaction. Then, all hundred test entries of both wheat and barley were categorized based on their values of AUDPC (Table 4). Thirty two and eight entries of both wheat and barley were under ‘‘1-100’’ and ‘‘101-200’’ group respectively followed by seventeen and eighteen entries were under ‘‘201-500’’ and ‘‘501-1000’’ group respectively.

Fig.1 Reaction of wheat and barley entries against foliar blight

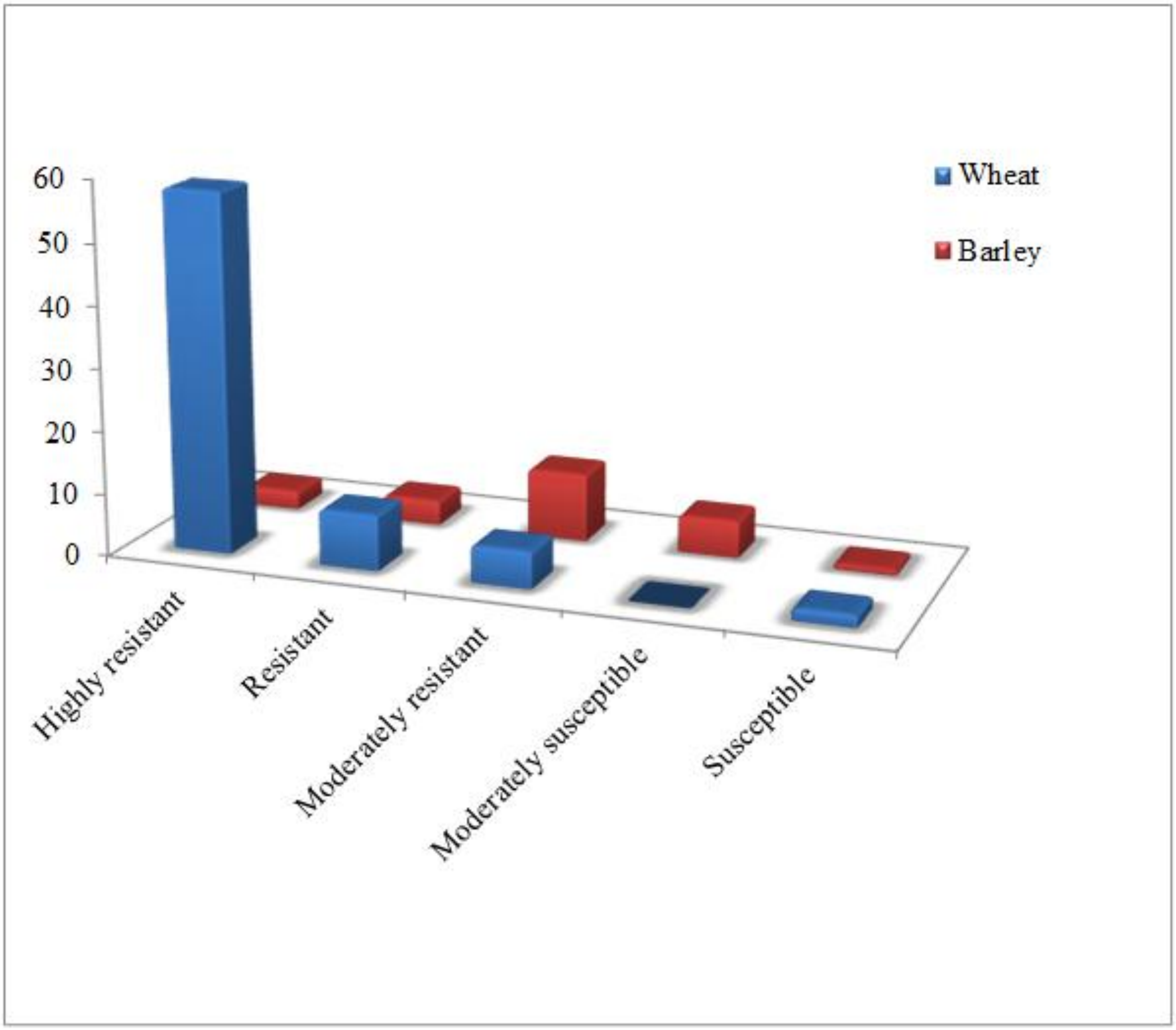

Table.1 Double digit scale for recording disease severity of foliar blight

0	No blight
1	Upto 10 per cent leaf area coverage
2	10 to 20 per cent leaf area coverage
3	20 to 30 per cent leaf area coverage
4	30 to 40 per cent leaf area coverage
5	40 to 50 per cent leaf area coverage
6	50 to 60 per cent leaf area coverage
7	60 to 70 per cent leaf area coverage
8	70 to 80 per cent leaf area coverage
9	80 to 90 per cent leaf area coverage

Table.2 Reaction of wheat and barley entries against foliar blight during 2016-17

S. N.	Entry	Foliar Blight Score (dd)			AUDPC	Reaction
	Wheat	Flowering	Dough	Hard Dough		
1	GW 480	00	00	01	7.5	HR
2	GW 491	00	00	01	7.5	HR
3	GW 492	00	00	00	0	HR
4	GW 493	00	01	01	22.5	HR
5	GW 483	00	01	02	30	HR
6	GW 495	00	01	01	22.5	HR
7	GW 498	00	01	12	105	HR
8	GW 499	01	11	12	262.5	HR
9	GW 500	11	12	12	352.5	HR
10	GW 501	01	11	12	262.5	HR
11	GW 502	13	34	34	862.5	R
12	GW 504	23	37	38	1012.5	MR
13	VA 2015-09	01	02	12	127.5	HR
14	VA 2015-11	03	05	15	210	R
15	VA 2015-14	01	02	12	127.5	HR
16	VA 2015-18	11	12	13	360	HR
17	VA 2015-21	00	00	01	7.5	HR
18	VA 2015-25	00	01	01	22.5	HR
19	VA 2015-26	13	23	24	622.5	R
20	VA 2015-30	00	00	00	0	HR
21	JD 2015-10	00	01	01	22.5	HR
22	VA 2015-38	00	01	01	22.5	HR
23	VA 2015-41	00	00	00	0	HR
24	VA 2015-43	00	00	01	7.5	HR
25	JD 2015-18	00	00	00	0	HR
26	VA 2015-46	12	14	16	420	R
27	VA 2015-08	00	01	11	97.5	HR
28	VA 2015-42	00	01	11	97.5	HR
29	VA 2015-44	11	12	13	360	HR
30	VA 2015-49	13	15	15	435	MR
31	VA 2015-53	00	01	01	22.5	HR
32	VA 2015-55	12	13	23	457.5	R
33	VD 15-6	00	01	01	22.5	HR
34	VD 15-7	00	00	01	7.5	HR
35	VD 15-9	12	22	24	600	R
36	VD 15-13	00	01	01	22.5	HR
37	VD 15-14	01	11	12	262.5	HR
38	VD 15-17	01	12	12	277.5	HR
39	VD 15-18	00	01	01	22.5	HR
40	VD 15-21	13	25	36	742.5	MR
41	VD 15-26	00	00	00	0	HR
42	VD 2016-1	00	00	00	0	HR
43	VD 2016-2	00	00	01	7.5	HR
44	VD 2016-3	01	11	11	255	HR
45	GW 451	01	12	12	277.5	HR

46	GW 496	00	01	01	22.5	**HR**
47	GW 322	00	00	00	0	**HR**
48	GW 366	00	01	01	22.5	**HR**
49	GDW 1255	00	00	00	0	**HR**
50	GW 11	14	28	29	742.5	**R**
51	GW 503	15	18	29	600	**R**
52	GW 173	00	00	01	7.5	**HR**
53	GW 1338	01	02	03	60	**HR**
54	GW 1339	00	01	11	97.5	**HR**
55	GW 1340	00	01	02	30	**HR**
56	GW 1341	16	29	39	847.5	**MR**
57	HD 2864	00	01	01	22.5	**HR**
58	LOK 76	00	01	01	22.5	**HR**
59	LOK 1	00	01	11	97.5	**HR**
60	GW 2008-153	12	22	36	690	**MR**
61	Raj 4315	00	00	00	0	**HR**
62	NIAW 2302	11	12	13	360	**HR**
63	Raj 3765	00	00	00	0	**HR**
64	VL 892	13	24	36	727.5	**MR**
65	DL 1012	00	00	01	7.5	**HR**
66	PHSL-5	01	01	01	30	**HR**
67	GW 397	13	24	35	720	**R**
68	BWL 1664	00	01	11	97.5	**HR**
69	PBW 707	01	03	13	150	**HR**
70	DBW 14	00	01	01	22.5	**HR**
71	DBW 217	00	01	11	97.5	**HR**
72	NW 6094	01	02	12	127.5	**HR**
73	QLD 46	01	01	11	120	**HR**
74	BANSI	36	79	89	2122.5	**S**
75	A-9-30-1	26	59	79	1672.5	**S**
Barley						
76	RD 2784	26	37	38	1035	**MR**
77	BH 980	15	26	37	780	**MR**
78	BH 922	13	25	36	742.5	**MR**
79	KB 1369	24	37	48	1095	**MR**
80	RD 2875	13	25	38	757.5	**MR**
81	RD 2876	23	45	59	1290	**MS**
82	UPB 1040	12	13	27	487.5	**R**
83	EIBGN 76	11	12	36	532.5	**MS**
84	IBYT-HT 10	00	01	13	112.5	**HR**
85	BH 922	01	02	13	135	**HR**
86	RD 2696	02	13	27	412.5	**MR**
87	K 944	25	37	67	1245	**MS**
88	HUB 210	25	36	48	1087.5	**MR**
89	PL 844	24	46	68	1380	**MS**
90	BH 933	23	45	57	1275	**MR**
91	UPB 1040	12	23	27	637.5	**R**
92	UPB 1036	12	13	26	480	**R**
93	BH 970	11	24	26	637.5	**R**

94	RD 2035	03	25	36	667.5	**MR**
95	RD 2052	23	46	49	1230	**MR**
96	RD 2552	15	47	48	1177.5	**MR**
97	RD 2715	26	59	79	1672.5	**S**
98	PL 751	36	58	69	1657.5	**MS**
99	Raj 4132	00	01	11	97.5	**HR**
100	**VW 2016-7**	**27**	**59**	**69**	**1605**	**MS**

Table.3 Categorization of disease reaction based on severity score of foliar blight

Double digit scale	Disease reaction
00-13	Highly resistant (HR)
14-35	Resistant (R)
36-57	Moderately resistant (MR)
58-78	Moderately susceptible (MS)
>78	Susceptible (S)

Table.4 Categorization of wheat and barley entries based on AUDPC

AUDPC	Entries
0	GW 322, GW 492, GDW 1255, Raj 4315, Raj 3765, VA 2015-30, VA 2015-41, JD 2015-18, VD 15-26, VD 2016-1
1-100	GW 173, GW 480, GW 483, GW 491, GW 493, GW 495, GW 496, GW 1338, GW 1339, GW 1340, LOK 1, LOK 76, DL 1012, Raj 412, PHSL-5, BWL-1664, DBW14, DBW 217, HD 2864, VA 15-06, VA 15-07, VA 15-08, VA 15-13, VA 15-18, VA 15-21, VA 15-25, VA 15-38, VA 15-42, VA 15-43, VA 15-53, VA 16-02, JD 15-10
101-200	GW 498, VA 15-09, VA 15-14, BH 922, IBYT-HT-10, PBW 707, NW 6094, QLD 46
201-500	GW 451, GW 366, GW 499, GW 500, GW 501, UPB 1040, UPB 1036, RD 2696, NIAW 2302, VA 15-11, VA 15-14, VA 15-17, VA 15-18, VA 15-44, VA 15-46, VA 15-49, VA 15-55, VA 16-03
501-1000	GW 11, GW 397, GW 502, GW 503, GW 1341, GW 2008-153, VA 15-9, VA 15-21, VW 15-26, BH 980, BH 922, RD 2875, EIBHN-76, UPB 1040, BH 970, RD 2035, VL 892
1001-1500	GW 504, RD 2052, RD 2552, RD 2876, RD 2784, KB 1369, K944, HUB 210, PL 844, BH 933
1501-2000 and above	RD 2715, PL 751, VW 2016-7, Bansi, A-9-30-1

While, five entries were under higher values of AUDPC ranging from ‘‘1500-2000 and above’’ group which were characterized with moderately susceptible to susceptible reaction in field condition (Table 4).

The above findings were also supported by similar findings which reported that out of sixty two wheat genotypes evaluated against spot blotch under natural epiphytotic conditions, eight genotypes *viz*., HD-2967, HD-3043, HP-1102, HS-277, JAUW-598, PBW-660, PBW-692 and VL-907, were observed as resistant having disease severity of 34.26 to 35.0 per cent and AUDPC values of 330.90-402.80 while twenty four genotypes were observed as moderately resistant having disease severity of 39.45 to 57.0 per cent and AUDPC values of 429.60-742.10 (Singh *et al.*, 2018). Similarly, screening of two hundred wheat germplasm accessions against spot blotch has revealed that four and seventy eight accessions were found to be highly resistant and resistant respectively, on the basis of their AUDPC values over two years which could be act as valuable source of resistance for the development of spot blotch resistant varieties of wheat (Latwal *et al.,* 2016).

From the result of above findings it can be concluded that entries which exhibits highly to moderately resistant reaction with lower values of AUDPC suggested that disease development were quite slow in these entries under high disease pressure of artificial epiphytotic condition in the field condition. Thus, these diverse sources of resistant entries can be used for enhancing resistance breeding programme for development of foliar blight resistant variety of wheat and barley.

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