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Evaluation of wheat entries against black rust of wheat (*Puccinia graminis* f.sp. *tritici*)

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ABSTRACT

The experiments were conducted to evaluate nine four entries against black rust of wheat at two locations *i.e.* Vijapur and Junagadh under artificially created epiphytotic condition during *Rabi* season of 2016-17. The result revealed that seventy two and fifteen entries found resistant and moderately resistant to black rust at Vijapur. While, seventy four and fourteen entries showed resistant and moderately resistant against black rust at Junagadh. Lok 1 found susceptible to black rust with severity of 60 and 40 at Vijapur and Junagadh, respectively. Based on their ACI value, it was found that ninety three entries showed partial resistance against black rust of wheat which can be included in effective breeding programme for the development of resistant varieties of wheat to mitigate the problem of black rust of wheat. While, Lok 1 showed ACI value of 50 which characterized as susceptible to black rust of wheat at both the locations.

Key words: Black rust, epiphytotic condition, partial resistance, average coefficient of infection

Black or stem rust of wheat caused by *Puccinia graminis* f.sp. *tritici* is a major threat to global wheat production and it is an important disease mainly in Central and Peninsular zone of India where warmer climatic condition prevails during the crop season which favours the development of disease. Although, not the most widespread among the three wheat rusts, black rust has the potential to cause a great damage when an epidemics occurs (Dean *et al*., 2012). Severe epidemics of black rust of wheat were occurred in the United States during 1919, 1920, 1923, 1927, 1935, 1953 and 1954 (Roelfs, 1978). Yield losses incurred due to black rust ranged from 9 to 33 per cent in Scandinavia in 1951 and 5 to 20 per cent in Eastern and Central Europe in 1932 (Zadoks, 1961). Its epidemics have occurred sporadically mainly in the warmer areas of Queensland and Northern New South Wales of Australia (Rees, 1972; Watson, 1981). Mehta (1952) reported Rs. 60 million annual loss in wheat and barley in India due to black rust. According to Prasada (1960), nearly one million tonnes of wheat costing about Rs.392 million destroyed during 1958-59 in India.

Utilization of genetic resistance is the most economical and environmental friendly control measure to manage for wheat rusts (Singh *et al.,* 2004; Pathan and Park, 2007) and development of resistant varieties is the main target of the Indian wheat programme for the management of black rust of wheat (Sharma *et al*., 2001). However, emergence or entry of a new virulent race of rusts may pose a serious threat to wheat production, especially with changing climate. Information on genetics of wheat rust resistance is widely available (Sharma, 1990; Sawhney, 1994, Tomar and Menon, 2001; Nayar *et al.,* 2001). Moreover, identification and utilization of

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new sources of durable resistance from various wheat relatives are ongoing task for enhancing the genetic diversity to black rust resistance. So, breeding for durable resistance by pyramiding multiple resistance genes, both major and minor ones, were also reported to be an effective strategy in managing wheat rusts (Singh *et al.,* 2001). Thus, the present investigation was undertaken to know the reaction of tested entries against black rust of wheat under artificially created epiphytotic condition at two locations *i.e.* Vijapur and Junagadh so as to ensure screening of more effective and reliable resistant entries against black rust of wheat.

MATERIALS AND METHODS

Multi locational experiments were conducted for the evaluation of wheat entries against black rust of wheat in artificially created epiphytotic condition at Wheat Research Station, SDAU, Vijapur and Wheat Research Station, Junagadh, Gujarat during 2016-17 *Rabi* season. The materials under study consist of ninety four entries including advanced breeding materials and released varieties of wheat. Two rows of one metre length of each entry was sown which was surrounded by two rows of infectors lines consisting of highly susceptible varieties on the entire border of the field. Two rows of infectors were also sown after 20 rows intervals each so as to check the dispersal of disease inoculum during the crop season. Mixed inoculum suspension of various races of black rust *i.e.* 11, 40-A, 40-1 and 40-3 was inoculated in infector's rows by injection method with the help of hypodermal syringe at the booting stage of crop to create an epiphytotic condition in the field. Inoculation in the infectors lines were done so as to maintain a heavy inoculum pressure of black rust throughout the crop season. After the disease has fully developed in the infectors, observations were recorded thrice in weekly intervals by using scale reported by Peterson *et al*. (1948) (Table 1). The severity was determined by visual observations, below 5 per cent severity, the intervals were Trace and usually 5 per cent interval was used from 5 to 20 per cent and 10 per cent interval between 20-100 per cent severity. Then, coefficient of infection (CI) was calculated from the final rust severity score (FRS) from the two tested locations by multiplying final rust severity score with constant values of response type *viz*. 0.2, 0.4, 0.6, 0.8, 1 for R, MR, X, MS and S respectively as shown in table 1 and later on CI values of two tested locations were converted to average coefficient of infection (ACI) for the assessment of field based partial resistance levels of tested entries by taking an average of two locations.

RESULTS AND DISCUSSIONS

Seventeen wheat entries *i.e*. VA 2016-05, VA 2016-12, VA 2016-13, VA 2016-14, VA 2016-18, VA 2016-19, VA 2016-23, VA 2016-24, VA 2016-27, VA 2016-28, VA 2016-30, VA 2016-36, VA 2016-37, VA 2016-38, VA 2016-40, VA 2016-44 and VA 2016-47 has completely free from black rust at Junagadh, while they were recorded with low level of disease severity ranging from TR to 10MR at Vijapur. Entry GW480 showed 20S and 60MS type of reaction at Vijapur and Junagadh respectively. Lok 1 showed susceptible reaction with severity of 60S and 40S at Vijapur and Junagadh, respectively. The overall reactions of tested entries at both tested locations are presented in fig.1. It indicated that seventy two (76.5 per cent) and fifteen (15.9 per cent) entries showed resistant and moderately resistant reaction at Vijapur, while seventy four (78.7 per cent) and fourteen (14.8 per cent) entries showed resistant and moderately resistant reaction at Junagadh (Table 2). Whereas, four entries *i.e.* GW498, GW501, GW322 and GW173 found moderately susceptible at Vijapur and four entries *i.e.* GW480, GW322, GW173 and VA2015-26 showed moderately susceptible at Junagadh. The susceptibility level of tested entries were very low *i.e.* 3.2 and 2.1 per cent at

Vijapur and Junagadh respectively. Field based partial resistance levels of the tested wheat entries were assessed through the ACI. Based on the ACI value, it was found that out of ninety four tested entries of wheat, ninety one entries showed high level of partial resistance since their ACI value ranged in between 0-16 and two entries *i.e*. GW480 and Lok76 showed moderate level of partial resistance as their ACI value ranged in between 30-34 in both the tested locations which suggested that these ninety three entries could be used as a new source of resistance for managing black rust of wheat. While, Lok 1 showed ACI value of 50 which characterized the susceptibility to black rust of wheat at both the tested locations (Table 2).

Varieties with ACI of 0-20, 21-40 and 41-60 were taken to possess high, moderate and low levels of partial resistance, respectively, while varieties with ACI values above 60 were taken to be susceptible as reported by Ali *et al*. (2009). Their result also supported the present findings where the experiments were conducted at six locations to asses field based partial resistance and suggested that based on the ACI value, out of thirty seven wheat varieties, the tested varieties were grouped into high (two seven varieties), moderate (nine varieties) and low levels of partial resistance (one variety) against yellow rust of wheat (Ali *et al*., 2009). Moreover, concerning with ACI value, ten varieties such as Sakha8, Sakha93, Giza144, Giza155, Giza156, Giza157, Sids4, Sids5, Sids8 and Beniswef4 with ACI value up to 20 were marked as possessing high level of partial resistance at both growing seasons (2010-11 and 2011-12) against leaf rust of wheat (Draz *et al*., 2015). Partial resistance assumed to be more durable as compared to resistance governed by single major gene, since it is inherited polygenically (Parlevliet, 1985).

CONCLUSION

From the present investigation, it could be concluded that out of ninety four tested entries of wheat, ninety three entries showed partial resistance under artificially created epiphytotic condition based on the values of average coefficient of infection. So, these promising entries could be efficiently used in the wheat breeding programme for the development of resistant varieties against black rust of wheat.

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Table 1 Scale for recording rust of wheat

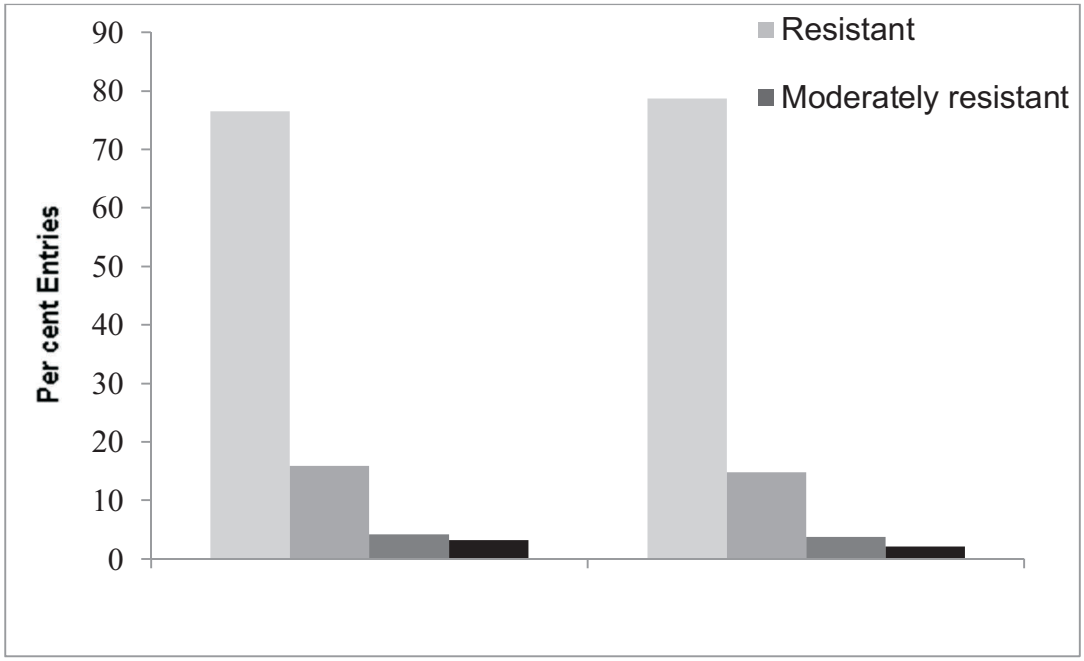
Reaction type	Response value	Category	Visible symptoms
0	0	Immune	No visible infection
R	0.2	Resistance	Necrotic areas with or without uredia
MR	0.4	Moderately resistance	Necrotic areas with small uredia
X	0.6	Intermediate	Variable sized uredia with necrosis or chlorosis and fully susceptible
MS	0.8	Moderately susceptible	Medium sized uredia with some chlorosis
S	1	Susceptible	Large sized uredia with no necrosis and chlorosis

Table 2 Reaction of entries against black rust of wheat (2016-17)

S.N.	Entry name	FRS at Vijapur	CI	FRS at Junagadh	CI	ACI
1	GW 480	20S	20	60MS	48	34
2	GW 483	10R	0.5	TR	0.2	0.3
3	GW 486	10R	2.0	TR	0.2	1.1
4	GW 491	10MR	4.0	TR	0.2	2.1
5	GW 492	10R	2.0	TR	0.2	1.1
6	GW 493	5R	1.0	5R	1.0	1.0
7	GW 495	10R	2.0	TR	0.2	1.1
8	GW 498	20MS	16	30MR	12	14
9	GW 499	10R	2.0	TR	0.2	1.1
10	GW 500	TR	0.2	5R	1.0	0.6
11	GW 501	20MS	16	30MR	12	14
12	GW 502	10R	2.0	TR	0.2	1.1
13	GW 504	TR	0.2	30MR	12	6.1
14	LOK 76	30S	30	30S	30	30
15	VA 2015-08	10R	2.0	20R	4.0	3.0
16	VA 2015-09	10MR	4.0	10R	2.0	3.0
17	VA 2015-11	10R	2.0	10R	2.0	2.0
18	VA 2015-14	5R	1.0	10R	2.0	1.5
19	VA 2015-18	10R	2.0	10R	2.0	2.0
20	VA 2015-21	TR	0.2	TR	0.2	0.2
21	VA 2015-25	5R	1.0	TR	0.2	0.6
22	VA 2015-26	5R	1.0	TMS	0.8	0.9
23	VA 2015-30	10R	2.0	10R	2.0	2.0
24	VA 2015-34	10R	2.0	20MR	8.0	5.0
25	VA 2015-38	5R	1.0	TR	0.2	0.6
26	VA 2015-41	10R	2.0	10R	2.0	2.0
27	VA 2015-43	20MR	8.0	20R	4.0	6.0
28	VA 2015-42	10R	2.0	20R	4.0	3.0
29	VA 2015-44	10R	2.0	40MR	16	9.0

30	VA 2015-45	10R	2.0	5R	1.0	1.5
31	VA 2015-46	TR	0.2	10R	2.0	1.1
32	VA 2015-49	10R	2.0	20R	4.0	3.0
33	VA 2015-53	10MR	4.0	10R	2.0	3.0
34	VA 2015-55	10MR	4.0	10R	2.0	3.0
35	VA 2016-01	20R	4.0	10MR	4.0	4.0
36	VA 2016-02	10MR	4.0	TR	0.2	2.1
37	VA 2016-03	10MR	4.0	5MR	2.0	3.0
38	VA 2016-04	5R	1.0	TR	0.2	0.6
39	VA 2016-05	TR	0.2	0	0.0	0.1
40	VA 2016-06	TR	0.2	TR	0.2	0.2
41	VA 2016-07	10R	2.0	20R	4.0	3.0
42	VA 2016-08	10R	2.0	20R	4.0	3.0
43	VA 2016-09	10R	2.0	20R	4.0	3.0
44	VA 2016-10	10R	2.0	TR	0.2	1.1
45	VA 2016-11	TR	0.2	5R	1.0	0.6
46	VA 2016-12	10R	2.0	0	0.0	1.0
47	VA 2016-13	10R	2.0	0	0.0	1.0
48	VA 2016-14	TR	0.2	0	0.0	0.1
49	VA 2016-15	10R	2.0	TR	0.2	1.1
50	VA 2016-16	5R	1.0	TR	0.2	0.6
51	VA 2016-17	10R	2.0	TR	0.2	1.1
52	VA 2016-18	10R	2.0	0	0.0	1.0
53	VA 2016-19	5R	1.0	0	0.0	0.5
54	VA 2016-20	10R	2.0	20R	4.0	3.0
55	VA 2016-21	10R	2.0	TR	0.2	1.1
56	VA 2016-22	10MR	4.0	20R	4.0	4.0
57	VA 2016-23	5R	1.0	0	0.0	0.5
58	VA 2016-24	10MR	4.0	0	0.0	2.0
59	VA 2016-25	10MR	4.0	TR	0.2	2.1
60	VA 2016-26	10MR	4.0	TR	0.2	2.1
61	VA 2016-27	TR	0.2	0	0.0	0.1

62	VA 2016-28	TR	0.2	0	0.0	0.1
63	VA 2016-29	20MR	8.0	20MR	8.0	8.0
64	VA 2016-30	TR	0.2	0	0.0	0.1
65	VA 2016-31	10R	2.0	5R	1.0	1.5
66	VA 2016-32	10R	2.0	5MR	2.0	2.0
67	VA 2016-33	10R	2.0	TR	0.2	1.1
68	VA 2016-34	5R	1.0	10MR	4.0	2.5
69	VA 2016-35	TR	0.2	20MR	8.0	4.1
70	VA 2016-36	10R	2.0	0	0.0	1.0
71	VA 2016-37	TR	0.2	0	0.0	0.1
72	VA 2016-38	5R	1.0	0	0.0	0.5
73	VA 2016-39	TR	0.2	TR	0.2	0.2
74	VA 2016-40	TR	0.2	0	0.0	0.1
75	VA 2016-41	5R	1.0	TR	0.2	0.6
76	VA 2016-42	10R	2.0	5R	1.0	1.5
77	VA 2016-43	TR	0.2	TR	0.2	0.2
78	VA 2016-44	TR	0.2	0	0.0	0.1
79	VA 2016-45	10R	2.0	20R	4.0	3.0
80	VA 2016-46	TR	0.2	10MR	4.0	2.1
81	VA 2016-47	10R	2.0	0	0.0	1.0
82	VA 2016-48	10R	2.0	20R	4.0	3.0
83	VA 2016-49	10R	2.0	20R	4.0	3.0
84	VA 2016-50	5R	1.0	5R	1.0	1.0
85	VA 2016-51	5R	1.0	20MR	8.0	4.5
86	GW 496	10MR	4.0	20R	4.0	4.0
87	GW 322	10MS	8.0	30MS	24	16
88	GW 366	10R	2.0	20R	4.0	3.0
89	GW173	10MS	8.0	30MS	24	16
90	GW 11	10MR	4.0	20MR	8.0	6.0
91	GW 451	5R	1.0	TR	0.2	0.6
92	HD 2864	10R	2.0	TR	0.2	1.1
93	HI 1544	10MR	4.0	5R	1.0	2.5
94	LOK 1	60S	60	40S	40	50


Resistant
Moderately resistant
Per cent Entries
90
80
70
60
50
40
30
20
10
0