



Screening of Pakistani Wheat Landraces to Stem Rust (*Puccinia graminis* f. sp. *tritici*) resistance under field conditions

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Abstract

The Stem rust of wheat caused by *Puccinia graminis* f. sp. *tritici* (Pgt) has been the major biotic stress responsible for threatening the production of wheat in Asia and other parts of the world. Stem rust has continuously been in surge of destroying wheat genome especially after its race Ug99 that surfaced in Uganda in year 1999 that suppressed vital stem rust resistance genes. In order to trace genetic resources inside the wheat genome; a set of 112 landraces was evaluated for stem rust resistance under field condition, a small village Bhulo Bhatti at Taluka Jhuddo in District Mirpurkhas a hot spot of stem rust in southern Pakistan. The results indicated that 80% landraces were susceptible to intensity of stem rust at Jhuddo, 4% moderately susceptible, 11% moderately resistant while 17% shown moderately resistance moderately susceptible types of reactions and 1% shown resistance according to modified Cobbs Scale.

Keywords: Wheat, stem rust, Landraces, moist climate of Sindh

Introduction

Wheat (*Triticum aestivum* L.) is pivotal crop of cereals family Poaceae. It has been cultivated throughout the world for fulfillment of essential energy needs. It is on the second largest among cereals after maize (Braun, et al., 2010). It is very nutritious containing carbohydrate, vitamins, fats, minerals, protein and some antioxidants (Bolourchi, et al., 1981), (Birdsall, et al., 1981). Pakistan is on the sixth among the largest producers of the wheat in the world (Anonymous, 2011), more than 45 thousands hectares are under the cultivation of wheat. Stem rust is present in many countries of the world (Schumann and Leonard, 2000), including, USA, Kenya, Iran, Yemen, India and Pakistan. Study on stem rust was done by (Mirza, et al., 2010) in Sindh, reported that Sindh was predominating with varieties TD-1, TJ-83, kiran sarsabaz and bhakar. Local stem rust was present in many parts of the Sindh included, Badin, Thatta, Jhuddo, Sajawal, Matli and Talhar. The stem rust appears as red color pustules or uredinia on the leaves, mostly on the sheaths, glumes and awns (Hogg, et al., 2010). It appears as red, brown and brick color appearance on the leaves, stem, spikes, glumes and awns in the wheat field (Singh, et al., 2004); (Pretorius, et al., 2000). Rust fungus is known as heterocious, since for completing its life cycle, it needs to have two different hosts, alternating between a telial host and aecial host on Poaceae and berberidaceae respectively (Luig, 1985). It is also known as macro cyclic (DeBary, 1866). Stem rust infections have been reported at different parts of Pakistan and majority of its cultivars lack resistant to new emerging pgt race of stem rust at Kenya (Mirza, et al., 2010).

Landraces have been extremely adaptable in look are morphologically recognizable and have a definite genetic reliability. The local names have been given to them by farmers. A landrace has vital features. Some are measured as late and some are considered early maturing. Each landrace has its own appearances for the adoption of soil, according to the classification of peasants themselves, as weak and strong, light and heavy, warm or cold, wet or dry. They may also be classified according to their use among cereals (Zeven, 1998) diverse and are used for porridge, flour and 'bulgur', whole constituents of the population of plant are improved to social practices local climatic conditions and pests and disease but very valuable, they are diverse genetically. Landrace is a variety chosen by farmers based on their ability to resist tic and abiotic conditions of environment and resulting high yield as well as their high potential to defend pathogens (Harlan, 1975). They may also be categorized according to their use among cereals .The objective of this study was to screen germplasm of Pakistani wheat landraces against Stem rust resistance at Jhuddo which is supposed to be the hot spot for Stem rust in Sindh, Pakistan.

Materials and Methods

Wheat germplasm

Germplasm of wheat landraces were collected from USDA National Small Grains Collection (NSGC) in Aberdeen, ID, United States (Table-1).

Location

The nursery was plantd in a small village at Bhulo Bhatti in Taluka Jhuddo of district Mirpurkhas, located at 200 km away from district Hyderabad, Sindh, Pakistan.

Experiment

A nursery of 112 lines of wheat landraces was planted in single meter row, each row 30 cm apart. Susceptible check Morocco was planted after every 20th row and as spread borders around the nursery to ensure uniform infection of Stem rust pathogen.

Standard crop practices for example, use of proper irrigation, fertilizer, and weeding; advised by the agriculture extension department and followed by farmers were followed from sowing to maturity,

Disease assessment

The rust response was recorded after the heading stage upon natural occurrence of stem rust on the susceptible check Morocco according to the scale given in figure1. Rust severity was also assessed according modified Cob scale (Peterson, *et al.*, 1984). Scale used for assessment of stem rust reaction types at adult plants of wheat under field conditions.

Modified Cobbs Scale was used for the assessment of rust severity in adult wheat plants Table.3. Reaction

types shown by rusts. Measurements of Cobbs scale infections are mentioned in Fig.1 and Fig.2 and their description is mentioned in Table.2.

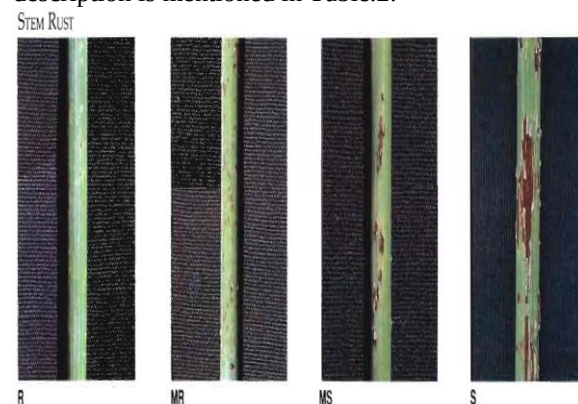


Figure 1: Scale used for assessment of stem rust reaction types at adult plants of wheat under field conditions.

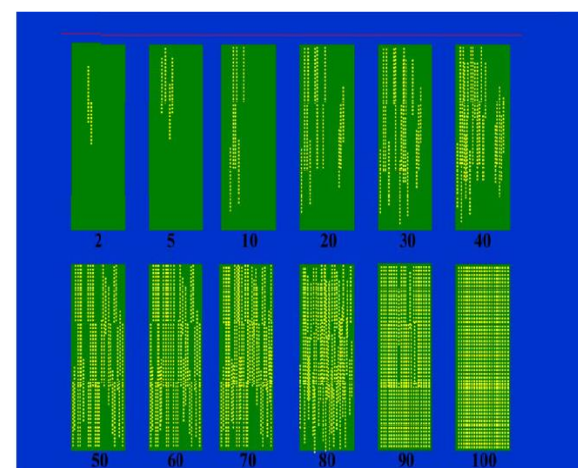


Figure 2: Modified Cobb Scale used for the assessment of rust severity in adult wheat plants (Peterson *et al.*, 1948).

Results & Discussion

Screening of wheat landraces for stem rust resistance under field conditions

Testing of Pakistani landraces at the location of Jhuddo showed that the majority of landraces were susceptible to stem rust fungus. Landraces showed the resistant type of reaction was counted only one and few were MRMS and MR typed for stem rust infections, while majority were found susceptible and their severity ratio was from 60S to 100S. Morocco was used as control check and was planted around nursery. It showed 100% susceptible response. Those which showed MR type of reaction should be used in breeding for getting resistance, whereas those landraces which were MRMS are recommended for the marker study for finding minor genes among them.

Table 1. Details of Pakistani Landrace wheat used in experiments.							
S.#	PI	Name	Province	S.#	PI	Name	Province
1	40951	Type no.11	Punjab	57	210914	T 15	Punjab
2	40953	Type no.13	Punjab	58	210915	Punjab 8A	Punjab
3	181087	8639	Sindh	59	210916	Punjab 9D	Punjab
4	182079	S-3	Sindh	60	217544	13940	Punjab
5	182084	S-10	Sindh	61	217545	C 518	Punjab
6	182086	S-11	Sindh	62	217546	C 250	Punjab
7	182087	S-12	Sindh	63	217547	C 217	Punjab
8	182088	S-13	Sindh	64	218119	14997	Punjab
9	182089	S-14	Sindh	65	219737	14053	KPK
10	182090	S-16	Sindh	66	219744	14086	KPK
11	182091	S-17	Sindh	67	219747	14100	KPK
12	182096	S-22	Sindh	68	219748	14101	KPK
13	182097	S-23	Sindh	69	219749	14103	KPK
14	182098	S-24	Sindh	70	219752	14224	KPK
15	182102	S-28	Sindh	71	220071	C 217	Punjab
16	182103	S-29	Sindh	72	220072	C 228	Punjab
17	182105	S-31	Sindh	73	220073	C 250	Punjab
18	182106	S-32	Sindh	74	220074	C 271	Punjab
19	182107	S-33	Sindh	75	220075	C 273	Punjab
20	182109	S-36	Sindh	76	220076	C 518	Punjab
21	182110	S-38	Sindh	77	220077	C 591	Punjab
22	182111	S-39	Sindh	78	250236	K 427	KPK
23	182115	S-46	Sindh	79	250237	K 630	Punjab
24	182116	S-47	Sindh	80	250411	K 474	AJK
25	182117	S-48	Sindh	81	250412	K 481	AJK
26	182120	Bikaner ii	Sindh	82	250413	K 494	Pakistan
27	182121	Punjab C217	Sindh	83	250414	K 575	Pakistan
28	182122	Punjab C409	Sindh	84	250584	K 278	Punjab
29	182123	Punjab 9D	Sindh	85	250585	K 289	Punjab
30	182124	Tatta	Sindh	86	250586	K 382	Pakistan
31	182126	Moro of Sind	Sindh	87	250628	K 378	Punjab
32	189739	S-518	Sindh	88	250629	K 379	Punjab
33	189743	49575	Sindh	89	250630	K 380	Punjab
34	189744	49576	Sindh	90	250631	K 381	Punjab
35	189753	49586	Punjab	91	250633	K 384	Punjab
36	189757	1	Punjab	92	269998		FATA,
37	189758	2	Punjab	93	269999		KPK
38	193383	N/A	Punjab	94	270000	S. Gandom	KPK
39	193385	N/A	Punjab	95	270002	Gandom	KPK
40	193388	N/A	Punjab	96		562	KPK
41	193389	N/A	Punjab	97	270016	756	KPK
42	210896	C 217	Punjab	98	270022	779	AJK
43	210897	C 245	Punjab	99	270023	821	KPK
44	210898	C 247	Punjab	100	270038	C 258	KPK
45	210899	C 248	Punjab	101	270039	C 273	KPK
46	210900	C 250	Punjab	102	270040	Panjabi	Punjab
47	210901	C 256	Punjab	103	270042	C 228	KPK
48	210902	C 258	Punjab	104	270043	C 217	KPK
49	210903	C 269	Punjab	105	270050	1006	AJK
50	210904	C 271	Punjab	106	323342	8y5839-376a-3a-3a	Punjab
51	210905	C 273	Punjab	107	323345	D19008-52M-Y3M-2y	Pakistan
52	210906	C 288	Punjab	108	323346	Mexipak 65	Punjab
53	210907	C 518	Punjab	109	388216	FAO 33.352	Sindh
54	210908	C 591	Punjab	110	520333	Peshawar 9	Pakistan
55	210909	BB 14	Punjab	111	572784	86PK1287-001.14	KPK
56	210913	T 11	Punjab	112	572840	86PK1327-001.02	KPK

Table 2: Response of Pakistani wheat landraces to stem rust at Jhuddo.									
S.#	PI	Stem rust (Observations)			S.#	PI	Stem rust (Observations)		
		I	II	II			I	II	II
1	40951	40MS	80S	80s	57	210914	10MR	30MRMS	30MRMS
2	40953	40MS	80S	80s	58	210915	30MS	30MS	40MS
3	181087	40MS	80S	80s	59	210916	40MS	40MS	40MS
4	182079	40MS	80S	80s	60	217544	20MS	40MS	40MS
5	182084	60MS	80S	80s	61	217545	20MS	20S	30MRMS
6	182086	40MR	60MS	80s	62	217546	40MRMS	60S	80S
7	182087	40MR	60MS	80s	63	217547	50MS	80S	80S
8	182088	40MR	60MS	80s	64	218119	50MS	80S	80S
9	182089	R	20MR	30MRMS	65	219737	50MS	80S	80S
10	182090	20MRMS	30MRMS	30MRMS	66	219744	50MS	80S	80S
11	182091	50MS	60S	90S	67	219747	50MS	80S	80S
12	182096	50MS	60S	80S	68	219748	50MS	80S	80S
13	182097	50S	60S	80S	69	219749	40MRMS	80S	80S
14	182098	50S	60S	90S	70	219752	40MS	80S	80S
15	182102	80S	80S	80S	71	220071	40MS	80S	80S
16	182103	R	20MR	30MRMS	72	220072	10R	10MR	10MR
17	182105	R	20MR	80S	73	220073	R	20MR	30MRMS
18	182106	20MR	20MRMS	30MRMS	74	220074	R	20MR	30MRMS
19	182107	20MR	60S	80S	75	220075	R	20MRMS	30MRMS
20	182109	20MR	50MS	80S	76	220076	60S	80S	80S
21	182110	20MR	60MS	80S	77	220077	40S	80MS	80S
22	182111	20MR	60MS	80S	78	250236	20MS	80MS	80S
23	182115	60S	80S	80S	79	250237	40MRMS	80S	80S
24	182116	60MS	80S	80S	80	250411	80S	80S	80S
25	182117	60S	80S	80S	81	250412	20MS	40MRMS	30MRMS
26	182120	60S	80S	90S	82	250413	10MR	10MR	30MRMS
27	182121	60S	80S	80S	83	250414	40MS	60MS	60S
28	182122	60S	80S	80S	84	250584	80S	80MS	80S
29	182123	60S	80S	80S	85	250585	20MR	40MS	90S
30	182124	60S	80S	90S	86	250586	40MS	80S	80S
31	182126	60S	80S	80S	87	250628	R	20MR	80S
32	189739	60S	80S	80S	88	250629	60MS	80S	80S
33	189743	50S	80S	80S	89	250630	60MS	80S	100S
34	189744	50S	80S	100S	90	250631	50MS	80S	80S
35	189753	40MRMS	80S	80S	91	250633	50MS	80S	80S
36	189757	30MS	80S	80S	92	269998	20MR	50MS	80S
37	189758	30MS	80S	80S	93	269999	20MR	50MS	80S
38	193383	30MS	80S	80S	94	270000	80S	80S	90S
39	193385	10MRMS	20MRMS	30MRMS	95	270002	40MS	80S	80S
40	193388	40MS	80S	80S	96	270003	40S	80S	100S
41	193389	40MS	80S	80S	97	270016	60S	80S	80S
42	210896	20MR	10MR	10MR	98	270022	60S	80S	90S
43	210897	20MR	20MS	40MS	99	270023	60S	80S	100S
44	210898	R	10MR	10MR	100	270038	20MR	40MS	100S
45	210899	R	10MR	20MR	101	270039	R	10MR	10MR
46	210900	R	10MR	10MR	102	270040	R	10MR	10MR
47	210901	R	10MR	10MR	103	270042	50MS	80S	80S
48	210902	R	20MRMS	30MRMS	104	270043	40MS	80S	80S
49	210903	R	10MR	10MR	105	270050	20MS	60S	80S
50	210904	R	R	R	106	323342	30MRMS	80S	100S
51	210905	20MRMS	30MRMS	30MRMS	107	323345	40MS	80S	80S
52	210906	10MR	20MS	40MS	108	323346	80S	80S	80S
53	210907	20MS	20S	80S	109	388216	80S	80S	100S
54	210908	40MRMS	40MRMS	30MRMS	110	520333	20MR	30MRMS	30MRMS
55	210909	60S	80S	80S	111	572784	10MR	10MR	10MR
56	210913	30MRMS	30MRMS	30MRMS	112	572840	10MR	10MR	10MR

Results of screening nursery of Pakistani landraces tested at Jhuddo are given in table 2 whereas frequency distribution of genotypes showing different resistance response is displayed in figure 1. Field response was recorded for rust intensity by using modified Cobb's scale. Planted nursery at Jhuddo location showed that 80% of Pakistani wheat landraces were highly susceptible to Stem rust (60 to 100S). Moderately susceptible infections (10 to 40 MS) were recorded in wheat landraces: Punjab Type 8A, Punjab Type 9D, C 288, 13940. While 17% of wheat landraces (Peshawar 9, K 481, S-14, S-16, S-29, S-31, C258, C591, T11, T15, C518) showed moderately resistant to moderately susceptible (10 to 30, MRMS) type of reactions. Landraces 86PK1287-001.14, 86PK1327-001.02, C 273, Panjabi, C 250, C217, C247, C248, C250, C256 showed MR(5 to 10) type of reaction and their percentage was 11%. Landrace 210904, shows R (Resistance) type of reactions.

Morocco was planted after every twenty lines as well as border around the landraces. Severity rate of Morocco ranged from 60S to 100S according to modified Cobbs scale.

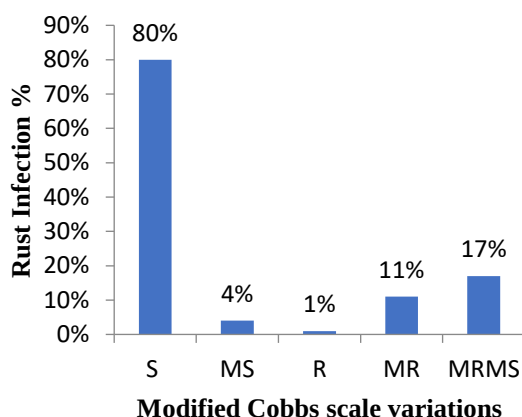


Figure 3. Frequency distribution of Stem rust severity infections in Pakistani wheat landraces tested at Jhuddo.

Discussion

Stem rust infections are very common, especially in Sindh province especially Jhuddo, Badin, Kunri are supposed to be the hot spots (Mirza, *et al.*, 2003). Stem rust infections were reported at various parts of the country in 2008 (Khanzada, 2008). Stem rust attacked Pakistani major cultivars in 2001 followed by 2005-2010[10]. The majority of Pakistan cultivars were tested against pg race Ug99 in Kenya and were found susceptible. Along with modern cultivars, wheat landraces also have disease resistance potential against stem rust as well as other types of rust diseases (Chabane, *et al.*, 2007). The nursery was planted in a small village of Jhuddo of district Mirpurkhas, located

at 200 km away from district Hyderabad, Sindh. The nursery of 112 lines of wheat landraces was planted in single meter row, each row 30 cm apart. Susceptible check Morocco was planted after every 20th row and as spread borders around the nursery to ensure uniform infection of stem rust pathogen. Proper cultural practices were used from sowing to maturity, as use of proper water and fertilizer and weeding. We found that 80% of Pakistani Wheat landraces were susceptible to the deadly stem rust pathogen and only 1% was resistant to stem rust pathogen. The highest severity of the stem rust pathogen at Jhuddo location implies that this location is hot spot of the pathogen and can be used for screening of wheat material and identification of pathogen virulence and race-diversity. Our current study on screening of Pakistani wheat landraces at Jhuddo showed that majority of wheat landraces were susceptible against stem rust fungus. In similar study, (Mirza, *et al.*, 2010) screened Pakistani seventy one commercial wheat varieties against stem rust under the field conditions at Jhuddo, Matli, Badin in province Sindh Pakistan

Conclusions

Results of this study concluded that majority of wheat landraces were susceptible against stem rust fungus at Jhuddo. Only 1% (210904) shown R (Resistance) type of reactions. Pakistani landraces have potential to resist severity of stem rust infections and in future these landraces may be screened for their hidden genetic resources and to be used in molecular breeding with modern cultivars.

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