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Short Communication

Resistance Against African Stem Rust (*Puccinia graminis tritici*) Race Ug99 in Advanced Wheat Lines and Varieties Developed by Public Breeding Programmes in NWFP, Pakistan

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Abstract. Stem rust is an important disease of wheat worldwide. Under the CIMMYT/ICARDA facilitated testing at Kenya, 105 lines/varieties from Pakistan were screened against novel stem rust race Ug99 during 2006. All entries were found vulnerable to Ug99. North West Frontier Province (NWFP) of Pakistan is under potential threat from this stem rust race and wheat material from the region also displayed clear cut susceptibility except var. Suleman-96 and Dera-98 which demonstrated M-MSS type reaction. Resistance of these genotypes can be enhanced if effective stem rust resistance genes are incorporated in their backgrounds because both are locally adopted varieties in NWFP.

Keywords: stem rust, wheat lines, Ug99, resistance

Rust fungi are obligate biotrophs that grow and reproduce only in living plant tissue and have 5000 or more species that collectively cause diseases of most crops, ornamentals, and many other plants (Eckardt, 2006). For example, rusts caused by *Puccinia* species are some of the most important diseases of wheat and other small grain crops worldwide (McIntosh *et al.*, 1995). A new wheat rust epidemic is currently building in east Africa with the appearance of a highly virulent strain of *Puccinia graminis* f. sp. *tritici* called Ug99. This race is perceived as a threat to global wheat production and has led to the establishment of a global rust initiative (GRI); it is a consortium coordinated by CIMMYT and ICARDA, and involves agricultural research institutes from over 30 countries (CIMMYT, 2006) to mount an international campaign to combat its spread. Stem or black rust, caused by *Puccinia graminis* f. sp. *tritici* (Pgt), is known historically for causing severe losses to wheat production. However, it has been controlled effectively through the use of Sr31 gene which provided the main component for stem rust resistance in many wheat cultivars. It continued to remain effective until recently, when the above mentioned isolate of Pgt with virulence to Sr31 were detected from Uganda in 1999 (Pretorius *et al.*, 2000). Similar virulence was observed in Kenya in 2003 and 2004 (Wanyera *et al.*, 2006).

Race Ug99 is now widespread in wheat growing areas of Kenya and Ethiopia, and many popular cultivars have become susceptible to it. This race is expected to migrate further to northern Africa through Arabian Peninsula and then to Middle East, West Asia and eventually to South Asia as recently happened with Yr9-virulent *Puccinia striiformis* race (Singh *et al.*, 2004). Due to the anticipated fear, the challenge and priority is to identify/develop suitable resistant cultivars in a relatively short time and implement appropriate strategies to replace the susceptible cultivars before Ug99 migrates out of eastern Africa. As a first step in this direction, 105 wheat genotypes were collected from all over Pakistan and shipped to Kenya for assessment of their vulnerability to Ug99 and to identify wheat germplasm that displays resistance. Pakistan's material along with wheat lines/cultivars currently grown in likely migration path of Ug99 were field screened in a nursery experiment during 2006 at Kenyan Agricultural Research Institute (KARI), Wheat Research Station at Njoro, Kenya. Each test entry was raised in two rows of 2 m length in strips of small adjacent plots. Standard inoculation and scoring protocols were adopted as described by Roelfs *et. al.*, (1992) and Peterson *et al.* (1948).

Resistance status summary of 105 wheat lines/varieties against Ug99 are presented in Table 1 while detailed results of genotypes collected from NWFP are presented in Table 2. None of the genotypes collected from all over Pakistan exhibited resistance to Ug99 (Table 1) which is very strong indication/confirmation of a very narrow genetic base of our wheat material to this race of pathogen. Reducing the area under susceptible cultivars by replacing with genotypes

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having different genetic background is the best strategy if major losses are to be avoided. The huge area in Pakistan is under the predominance of Inqilab-91which has proved highly susceptible to Ug99 (Singh *et al.*, 2006). Findings regarding NWFP material (Table 2) revealed three groups based on mean stem rust severity. Group-1 with the severity range of 50-60% included Khushal-69, Sarhad-82, Pirsabak-85, Saleem-2000, PR-89, PR-88, PR-84, PR-87, MPT-4(2005-06), MPT-5(2005-06), DN-38, DN-44, CT-99022 and NRL-2017. Group-2 with the severity range of 40-45% included MAYA/PVN, Tarnab-73, Khyber-87 and PR-83, while Suleman-96 and Dera-98 were having 20% severity and were placed in Group-3. All tested genotypes displayed clear cut susceptibility except Suleman-96 and Dera-98, which demonstrated M-MSS type reactions over assessment dates. Furthermore, both Suleman-96 and Dera-98 released in late 1990s have comparatively low average coefficient of infection (ACI) value of 15.

Table 1. Resistance status of 105 wheat lines/varieties from Pakistan against stem rust race Ug99

Province/Institution	No. of entries	% Susceptible entries
Punjab	47	96
NWFP	20	90
Baluchistan	9	100
Sindh	5	100
National Agricultural Research Center, Islamabad	24	100

Table 2. Response of wheat lines and varieties developed by public breeding programs in NWFP, Pakistan against African stem rust race Ug99

Variety/line	Breeding institute	Parentage	Mean rust severity*	Reaction range*	ACI*
MAYA/PVN	CCRI Pirsabak		40	S	40
Khushal-69	CCRI Pirsabak	21931-CHAPING053/ ANDESSIB/3/Y50/4/C271	55	S	55
Sarhad-82	CCRI Pirsabak	AU//KAL/BB/3/WOP	50	S	50
Pirsabak-85	CCRI Pirsabak	KVZ/BUHO//KAL/BB	50	S	50
Tarnab-73	ARI, Tarnab	WT(E)SON64	45	S	45
Suleman-96	CCRI Pirsabak	F6.74/BUN//SIS/3/VEE#7	20	M-MSS	15
Saleem-2000	CCRI Pirsabak	CHAM6//KITE/PGO	55	S	55
Khyber-87	CCRI Pirsabak	KVZ/TRM//PTM/ANA	40	S	40
PR 89	CCRI Pirsabak	?	55	S	55
PR-88	CCRI Pirsabak	?	55	S	55
PR-84	CCRI Pirsabak	KAUZ/STAR	50	S	50
PR-87	CCRI Pirsabak	MUNIA/CHTO//AMSEL	60	S	60
PR-83	CCRI Pirsabak	ATTILA/3/HUT/CAR// CHEN//CHEN/CHTO14/ATTILA	40	S-MSS	38.5
MPT-4(2005-06)	CCRI Pirsabak	?	50	S	50
MPT-5(2005-06)	CCRI Pirsabak	?	50	S	50
Dera-98	ARI, D.I.Khan	?	20	M-MSS	15
DN -38	ARI, D.I.Khan	ATTILA	60	S	60
DN-44	ARI, D.I.Khan	JUP/ALD'S'//KLT'S'/ 3/VEE'S'/6/BEZ//TOB/8156/ 4/ON//3/6*TH/KF//6*LEE/KFA5	55	S	55
CT-99022	NIFA-Tarnab	URES/JUN//KAUZ	50	S	50
NRL-2017	NIFA-Tarnab	AMSEL/TUI	60	S	60

* = all three parameters were based on two assessments recorded at weekly interval

It is an alarming situation with regard to rust migration and vulnerability of wheat germplasm developed in this province to Ug99 because NWFP serves as a gateway for the entry of new races of the rust pathogens originating in the Middle East and Central Asia and rust spreads in the wheat fields of Pakistan from this source (Rajaram *et. al.*, 1998). If Ug99 follows the same migration pattern as the Yr9 virulence, this province may suffer huge losses. It is suggested that elite material in hand (other than Kavkaz or similar wheats with the 1BL.1RS translocation) should be tested in Kenya and different combinations of effective stem rust resistance genes i.e. 22, 24, 25, 26, 27, 29, 32, 33, 35, 36, 39, 40, 44 and Tmp (Wanyera *et al.*, 2006) should be incorporated in adopted cultivars (i.e. Suleman-96 and Dera-98) to further improve their resistance for avoiding future epidemics due to this disease.

References

CIMMYT 2006. *The wheat rust threat*, CIMMYT E-News, vol. **3**, no. 10, 2006.

Eckardt, N.A. 2006. Identification of rust fungi avirulence elicitors. *The Plant Cell* **18:** 1-3.

McIntosh, R.A., Wellings, C.R., Park, R.F. 1995. *Wheat Rust: An Atlas of Resistance Genes*, pp. 200, CSIRO, Publications, East Melbourne, Australia.

Peterson, R.F., Campbell, A.B., Hannah, A.E. 1948. A diagrammatic scale for estimating rust intensity on leaves and stems of cereals. *Can. J. Res. Sect. C.* **26:** 496-500.

Pretorius, Z.A., Singh, R.P., Wagoire, W.W., Payne, T.S. 2000. Detection of virulence to wheat stem rust resistance gene Sr31 in *Puccinia graminis* f. sp. *tritici* in Uganda. *Plant Dis.* **84:** 203-2917.

Rajaram, S., Hobbs, P.R., Heisey, P.W. 1998. *Review of Pakistan's Wheat and Maize Research System.* CIMMYT report. p. 16, CIMMYT, Mexico, DF, USA.

Roelfs, A.P., Singh, R.P., Saari, E.E. 1992. *Rust Diseases of Wheat: Concepts and methods of disease management*, pp. 81, CIMMYT, Mexico, DF. USA.

Singh, R.P., William, H.M., Huerta-Espino, J., Rosewarne, G. 2004. Wheat Rust in Asia: Meeting the Challenges with Old and New Technologies. In: *Proc. 4th International Crop Science Congress*, Brisbane, Australia, http//www. cropscience. org.au.licsc2004.

Singh, R.P., Hodson, D.P., Jin, Y., Huerta-Espino, J., Kinyua, M.G., Wanyera, R., Njau, P., Ward, R.W. 2006. Current status, likely migration and strategies to mitigate the threat to wheat production from race Ug99 (TTKS) of stem rust pathogen. *CAB Reviews* **54:** 1-13

Wanyera, R., Kinyua, M.G., Jin, Y., Singh, R. 2006. The spread of stem rust caused by *Puccinia graminis* f. sp. *tritici*, with virulence on Sr31 in wheat in Eastern Africa. *Plant Dis.* **90:** 113.