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SHORT COMMUNICATION

Diversity for Stem Rust (*Puccinia graminis* f. sp. *tritici*) Resistance in Durum Wheat (*Triticum turgidum* ssp. *durum*) Germplasm

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Three hundred durum wheat genotypes showing field resistance to stem rust since 2003 under heavy inoculum pressure could be classified in to seven diverse resistance groups based on their seedling and adult-plant responses to two important stem rust pathotypes *viz.*, 40A (62G29), the most prevalent one, and 117-6 (37G19), the durum-specific one. Present information should be useful in providing guidelines for utilizing diverse resistance sources toward broadening of stem rust resistance base in durum improvement programmes.

Key Words: Diversity for rust resistance, Durum wheat germplasm, Stem rust resistance

India produces >90 million tons of wheat from an area of >25 million hectares, to which the contribution of durum wheat is about 5%. However, durum wheat has a special niche in Indian wheat economy for at least two reasons. Indian durum wheat is typically purchased by the private trade at a price premium, mainly for processing of high value products. In addition, durum wheat is preferred over bread wheat for several local food preparations. Durum wheat is mainly grown in the central and peninsular parts of India, where stem rust is one of the major disease problems of wheat crop. Cultivation of resistant varieties is the most effective, economic and eco-friendly method of disease management. Broadening of resistance base through utilization of diverse resistance sources is necessary for enhancing the durability of resistance in view of the continued evolution of the stem rust pathogen.

A total of 1105 durum wheat germplasm accessions including released varieties, advance generation lines, land races and indigenous as well as exotic genetic stocks were evaluated for field resistance to stem rust at IARI-RS, Indore during *rabi* 2002-03 under heavy inoculum pressure using mixtures of important stem rust pathotypes. In all, 300 genotypes showing adequate level of resistance (terminal rust severity up to 10S) to stem rust were selected and are being tested year-after-year for ascertaining the stability of resistance. They have been observed maintaining their stem rust resistance till date (authors' unpublished observations). An attempt was, therefore, made to gain an insight in to the extent of diversity among these genotypes through seedling and adult plant tests with two stem rust pathotypes 40A (62G29) and 117-6 (37G19). These pathotypes were chosen since the former is currently the most prevalent one (Anonymous, 2013), while the latter is one of the most virulent ones to durum wheat germplasm (Mishra *et al*., 2009) among the stem rust pathotypes occurring in India.

The avirulence/virulence characteristics of these pathotypes based on seedling tests (SC Bhardwaj, *personal communication*) are given below:

40A (62G29) – P *Sr7a*, *Sr13*, *Sr21*, *Sr22*, *Sr24*, *Sr25*, *Sr26*, *Sr27*, *Sr30*, *Sr31*, *Sr32*, *Sr33*, *Sr35*, *Sr36*, *Sr37*, *Sr38*, *Sr39*, *Sr40*, *Sr43*, *SrTmp* / **p** *Sr2*, *Sr5*, *Sr6*, *Sr7b*, *Sr8a*, *Sr8b*, *Sr9a*, *Sr9b*, *Sr9d*, *Sr9e*, *Sr9f*, *Sr9g*, *Sr10*, *Sr11, Sr12, Sr14*, *Sr15*, *Sr16*, *Sr17*, *Sr18*, *Sr19*, *Sr20*, *Sr23*, *Sr28*, *Sr29*, *Sr 34*, *SrMcN*

117-6 (37G19) – P *Sr5, Sr8a, Sr8b, Sr9b, Sr22, Sr24, Sr25, Sr26, Sr27, Sr28, Sr30, Sr31, Sr32, Sr33, Sr35, Sr36, Sr37, SrTmp* / **p** *Sr2, Sr6, Sr7a, Sr7b, Sr9d*, *Sr9e, Sr9f, Sr9g, Sr10, Sr11, Sr12, Sr13, Sr14, Sr15, Sr16, Sr17, Sr19, Sr21, Sr23, Sr29, Sr34, SrMcN*

The seedling tests were conducted at 20-22^{o}C ± 2^{o}C using standard glasshouse procedures (Nayar *et al*., 1997). The seedlings tested for resistance were raised in 10 cm clay pots. Seedlings with primary leaf fully

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expanded and second leaf just emerged (generally 8-10 days old) were spray inoculated with aqueous suspension of uredospores of the individual test pathotypes, freshly collected from the actively sporulating pots of 'Agra Local' maintained in isolation in the glasshouse. Agra Local served as 'susceptible check'. Inoculated pots were incubated in moist chambers for 16-24 h, and were then transferred to glasshouse benches. Infection types (ITs) on the seedlings were recorded 12-15 days after inoculation on a 0-4 scale. The Infection Types (ITs) 3, 3^+, 34 and 4 produced by a pathotype on a host line indicated susceptibility to that pathotype, whereas lower ITs ('0;' '1', '2' and 'X') indicated resistance (Nayar *et al*., 1997).

The adult palnt tests were conducted for two successive crop seasons during 2010-2012 in field nurseries isolated with paired border rows of maize. Around 50 seeds of each of the test lines were dibbled in 1.0 m long rows, planted 30 cm apart. Rust spreader rows consisting of mixtures of highly susceptible wheat varieties were planted after every 20 test rows, and all around the experimental plot. Beginning 55-60 days after sowing, the disease spreader rows were inoculated using hypodermic syringes and sprays with aqueous suspension of the uredospores of the test pathotypes, freshly collected from actively sporulating `Agra Local' pots maintained in isolation in the glasshouse. Disease scores were recorded combining the disease severity as per the modified Cobb's scale (Peterson *et al*., 1948), and the host response (Roelfs *et al*., 1992). Lines showing up to 10S reaction were classified as `resistant'.

Seven diverse groups for stem rust resistance were recognized among the test genotypes, based on their seedling and adult-plant responses to the two pathotypes, as listed below:

Group I. Resistant to both the pathotypes in both the growth stages (seedlings and adult plants) (No. of genotypes = 161)

AKDW 3347, AKDW 4256, B 101, B 206, B 212, B 414, B 662, Baxi dwarf, C 34, C 61, CIMB 1574, CIMB 1632, CIMB 1633, CIMB 1640, CIMB 1649, CIMB 1655, CPAN 1311, CPAN 6012, CPAN 6038, CPAN 6040, CPAN 6083, CPAN 6118, CPAN 6120, CPAN 6138, CPAN 6200, CPAN 6201, CPAN 6236, D 83, D 658, DBP 02-13, DD 276, DD 629, DD 703, DD 711, DD 2518, DR 140, DW 222, E 4282, ED 2398-A, Guji 'S', GW 1139, GW 1170, GW 1172, GW 1182, GW 1202, GW 1207, GW 1209, HD 363, HD 4672, HD 4685, HD 4703, HD 4708, HG 41, HG 42, HG 101, HG 113, HG 179, HG 195, HG 282, HG 320, HG 363, HG 378, HG 391, HG 402, HG 589, HG 764, HG 888, HG 1312, HI 8592, HI 8627, I 2334, I 2567, I 2577, I 2601, I 2644, I 2701, IDSN 47, IWP 5007, IWP 5050, IWP 5057, IWP 5061, IWP 5065, IWP 5070, Jairaj, JBL 89, JD 01-37, JD 01-46, JD 96-40, JD 98-2, MACS 2067, MACS 2846, MACS 3125, MACS 3425, MACS 3453, MACS 3493, MACS 3503, MACS 3507, MP 311, MPO 3-19, MPO 3-21, MPO 3-23, MPO 3-24, MPO 195, MPO 622, NI 8097, NIDW 9, NIDW 29, P 6046, PDSN 668, PDSN 671, PDSN 672, PDSN 689, PDSN 691, PDSN 692, PDSN 694, PDSN 702, PDSN 703, PDSN 704, PDSN 705, PDSN 707, PDSN 708, PDSN 709, PDSN 711, PDSN 713, PDSN 1025, PDSN 1026, PDSN 1027, PDSN 1036, PDSN 1074, PDSN 1083, PDSN 1084, PDSN 1085, PDSN 1086, PDSN 1087, PDSN 1088, PDSN 1089, PDSN 1090, PDSN 1091, PDSN 1092, Raj 6069, Raj 6516, Raj 6562, RD 773, RD 815, RD 893, RD 930, RKD 97, RS 749, S 21, Trinakria, UPD 45, VD 97-15, VD 2000-40, VD 2001-30, VD 2001-37, VD 2001-46, VD 2001-55, VDR 2001-2, VDR 2001-10, VDR 2002-2, and Yuk.

Group II. Resistant to 40A in both the growth stages, but seedling susceptible and only adult plant resistant to 117-6 (No. of genotypes = 48)

AKDW 4258, AKDW 4339, Baxi 422, Bijapur 487-2, Castel Porziano, CIMB 1469, CIMB 1474, CIMB 1538, CIMB 1545, CIMB 1555, CIMB 1564, CIMB 1583, CIMB 1585, CIMB 1588, CIMB 1589, CIMB 1593, CIMB 1645, CIMB 1648, CIMB 1651, CPAN 6018, CPAN 6028, CPAN 6053, CPAN 6117, CPAN 6137, D 104, DBP 02-08, DD 653, DON 174, E 4291, HG 110, HG 418, HG 419, HG 434, HG 517, HG 590, I 2498, I 2595, IDSN 38, IWP 5013, IWP 5019, JD 01-14, Keerthi, Line 1172, MPO 3-20, MPO 615, NI 7444, RALLI-1, and WH 804.

Group III. Resistant to 40A in both the growth stages, but susceptible to 117-6 in both the growth stages (No. of genotypes = 49)

AKDW 4240, B 138, B 224, B 276, C 23, C 32, C 42, CPAN 6127, CPAN 6131, CPAN 6140, D 34, D 88, D 292, D 294, DD 279, DD 702, DR 155, HD 4562, HD 4696, HD 4707, HD 4709, HG 30, HG 43, HG 622,

HG 623, HG 677, HG 716, HI 171, HI 8498, HI 8591, HI 8634, IWP 5093, JD 01-12, JD 01-32, MACS 3061, MPO 414, P 7073, P 7100, PBW 34, PDW 289, RD 895, RD 932, VD 2001-06, VD 2001-14, VD 2001-15, VD 2001-17, VD 2001-20, VD 2001-35, and WG 7143.

Group IV. Only adult-plant resistant, but seedling susceptible to 40A, and susceptible to 117-6 in both the growth stages (No. of genotypes = 01)

Baxi 470-27

Group V. Resistant to 117-6 in both the growth stages, but seedling susceptible and only adult plant resistant to 40A (No. of genotypes = 13)

CIMB 1464, CIMB 1667, ED 155, ED 1096, Gulab 'S', HG 316, I 1221, I 1360, ID 1169, N 5749, NI 5779, NI 7121, and WH 213.

Group VI. Resistant to 117-6 in both the growth stages, but susceptible to 40A in both the growth stages (No. of genotypes = 01)

MPO 501

Group VII. Adult-plant resistant, but seedling susceptible to both the pathotypes (No. of genotypes = 27)

BD 72, Bijiga Red, CIMB 1537, CIMB 1550, CPAN 6019, CPAN 6132, E 1058, E 4303, E 7798, ED 2177, HI 162, HI 167, I 1142, I 1568, I 1805, I 7805, I 15171, I 15173, I 15177, I 15186, ID 1128, ID 1264, ID 1278, MPO 503, Saver Local 'S', Yal Forte, and Yuma.

The above listed 27 genotypes (Group VII) which showed seedling susceptibility, but adult-plant resistance to both the test pathotypes are of particular interest from the viewpoint that most examples of durable rust resistance are of adult-plant type. These genotypes need to be studied further for characterizing the resistance genes present in them. Only two genes for adult-plant resistance to stem rust *viz.*, the recessively inherited gene *Sr2* derived from *Triticum turgidum* var. *dicoccum* cv. Yaroslav Emmer (McIntosh *et al*., 1995), and the undesignated dominant gene present in durum cultivar 'Glossy Hugenot' (Hare, 1997) are known to be of tetraploid (AABB genomes) background origin (McIntosh *et al*., 2013).

Relatively little work has been done on the diversity for stem rust resistance in durum wheat germplasm based on multi-pathotype tests. At least 18 diverse groups for stem rust resistance were recognized among 71 durum genotypes based on their seedling reactions to 24 pathotypes (Mishra *et al*., 2011). In a recent study, 107 durum wheat genotypes could be classified in to eight diverse groups for stem rust resistance based on their seedling responses to five durum-virulent stem rust pathotypes (Mishra *et al*., 2015). However, the present study had a more focussed approach, as both seedling and adult-plant responses to two very important stem rust pathotypes including the most prevalent, and the most durum-virulent ones formed the basis of assessing diversity for resistance in durum genotypes with proven field resistance. Hence, the information communicated here should be useful in providing guidelines for utilizing diverse resistance sources toward broadening of stem rust resistance base in durum improvement programmes.

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