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HYBRID NECROSIS AND CROSS-COMPATIBILITY IN WHEAT

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ABSTRACT

One hundred and thirteen accessions of common wheat were studied for the presence of necrotic genes. Fifteen accessions were found to be noncarriers and the remaining 98 were Ne_2 carriers. Among the noncarrier lines, CPAN 1946, CPAN 1973, PBW 166 and VL 490 are also promising donors of yellow and brown rust resistance and of some desirable seedling traits.

Key words: Hybrid necrosis, seedling traits, wheat, yellow and brown rust resistance.

Hybrid necrosis, causing gradual death or debility of F_1 hybrids, is often noticed in the intra- and interspecific crosses of wheat (*Triticum aestivum* L. em Thell.). Two complementary genes, Ne_1 and Ne_2 [1, 2], are reported to cause hybrid necrosis. C 306, a drought tolerant variety of common wheat was reported to be Ne_1 carrier [3] and its crosses with rust resistant exotic material often show necrosis. The present investigation has been carried out to determine the genes for necrosis in different rust resistant stocks of wheat, commonly used in the crossing programme at Gurdaspur. The F_1 and accessions forming normal F_1 hybrids with C 306 were evaluated for resistance to rusts and seedling traits to identify the promising crosses.

MATERIALS AND METHODS

One hundred and thirteen accessions of common wheat, maintained in the crossing block at Regional Research Station, Gurdaspur, were crossed with two testers, C 306 (Ne_1 Ne_1) and WL 711 (Ne_2 Ne_2). The F_1 hybrids and their parents were grown in fields at Gurdaspur and Ludhiana. The genotypes of the parents with respect to necrotic genes were determined from the F_1 phenotype. The parents and F_1 were evaluated under artificial epiphytotics in the field for yellow rust (*Puccinia striiformis* West.) and brown rust (*P. recondita* Rob. ex Desm.) according to the modified Cobb's scale. For the epiphytotics of yellow rust a mixture of races A, G, K, 14, 20A, 24, 38, and 38A, and for brown rust a mixture of races 77, 77A, 77A-1, 104, 104B and 162 were used.

Data for seminal root number, coleoptile length and seminal root length were recorded in the Seed Technological Laboratory, Ludhiana, after germination in blotters in a BOD incubator at 25°C after 192 h of incubation. Seedlings with more than 5 cm long coleoptile and seminal roots were considered normal and suitable for recording data.

The F_1 hybrids, resistant to both the rusts, were backcrossed with C 306. The selfed grains were used to raise F_2. The F_2 and backcross progenies were evaluated under artificial epiphytotics of yellow and brown rusts in the field at Gurdaspur.

Table 1. Breadwheat varieties classified according to necrotic genes

	Noncarriers (ne_1 ne_1 ne_2 ne_2)	
Pato (B)	CPAN 1887	CPAN 2019
Emeck 132	CPAN 1946	PBW 166
CPAN 1283	CPAN 1949	VL 490
CPAN 1496	CPAN 1973	HW 840
CPAN 1842	CPAN 1994	K 8319
	Ne_2 carriers (ne_1 ne_1 Ne_2 Ne_2)	
TZPP-Y54A	CPAN 1335	PBW 153
Bonanza 55	CPAN 1419	PBW 154
Garazo	CPAN 1444	PBW 155
CNO's'-Sty × Tob.	CPAN 1557	PBW 156
Pj62-Wrt × Cal	CPAN 1689	PBW 161
BB-Nor 67	CPAN 1695	PBW 163
CNO-Nor 67	CPAN 1703	PBW 164
CoCo-Inia × CNO-Son 64	CPAN 1745	PBW 174
BB-Nor 59	CPAN 1747	PBW 175
Tobari 66	CPAN 1748	HD 2009
Tanori 71	CPAN 1759	HD 2190
Nova Parate	CPAN 1822	HD 2278
Nopo-Cal × Zpz	CPAN 1829	HD 2394
Kal-BB × CC	CPAN 1869	WG 2104
Tob 66-Bowen-Tob × Nopo	CPAN 1885	WG 2109
Tab-8156	CPAN 1927	HB 100-62
Combination	CPAN 1958	HB 117–107
CNO's'	CPAN 1959	HB 189
55370	CPAN 1961	HB 190
57557	CPAN 1967	HB 622
58487	CPAN 1980	HW 122
58490	CPAN 1987	HW 167
E 4870	CPAN 1990	HW 171
E 4995	CPAN 2002	HW 502
E 6006	CPAN 2005	Raj 2232
E 6160	CPAN 2010	Raj 3037
E 8667	CPAN 2012	Raj 3069
E 8678	CPAN 2016	J 415
E 8682	CPAN 2024	K 629019
E 8684	PBW 65	NI 8188
UP 230	PBW 124	VL 436
UP 334	PBW 138	WL 410
UP 2191	PBW 145	

RESULTS AND DISCUSSION

None of the 113 accessions crossed with WL 711 produced necrotic F_1, showing that none of these are Ne_1 carriers. In crosses with cv. C 306, only 15 stocks produced normal F_1 hybrids (Table 1). In all other cross combinations with C 306, the F_1 were necrotic. This shows that Pato (B), Emeck 132, CPAN 1283, CPAN 1496, CPAN 1842, CPAN 1887, CPAN 1946, CPAN 1949, CPAN 1973, CPAN 1994, CPAN 2019, PBW 166, VL 490, HW 840 and K 8319 are noncarriers and the remaining stocks are Ne_2 carriers.

Among noncarrier stocks, CPAN 1887, CPAN 1946, CPAN 1949, CPAN 1973, CPAN 2019, PBW 166, VL 490, HW 840 and K 8319 were free from yellow rust at both stations (Table 2). C 306, a wheat variety known to be susceptible to races K and 13 of yellow rust at seedling stage [4], was free from yellow rust at both locations. This showed that race K, which was included in the basic inoculum could not compete with other races and got eliminated during multiplication, resulting in nonvirulence on C 306.

Table 2. Comparison of seminal root length, coleoptile length, seminal root number and yellow rust reaction of different noncarrier varieties and C 306

Variety	Seminal root length (cm)	Coleoptile length (cm)	Seminal root number	Yellow rust reaction at	
				Ludhiana	Gurdaspur
Pato (B)	15.5	11.3	3.6	30S	0
Emeck	17.1	8.1	4.1	5S	0
CPAN 1283	13.9	12.3	3.3	30S	30S
CPAN 1496	18.3	12.6	4.6	60S	30S
CPAN 1842	14.7	9.9	3.8	10S	30S
CPAN 1887	15.1	13.1	4.7	0	0
CPAN 1946	14.7	14.3	3.0	0	0
CPAN 1949	14.4	13.8	3.9	0	0
CPAN 1973	16.6	11.8	3.4	0	0
CPAN 1994	12.8	11.7	4.0	0	20S
CPAN 2019	9.7	6.7	3.3	0	0
PBW 166	19.3	12.2	4.9	0	0
VL 490	17.0	11.4	3.9	0	0
HW 840	16.8	10.9	3.2	0	0
K 8319	14.8	12.1	3.1	0	0
C 306	16.6	13.1	4.8	0	0
Mean	15.5	11.6	3.9		
SEm	0.6	0.5	0.1		

The testers, C 306 and WL 711, and two noncarriers (CPAN 1283 and CPAN 2019) were susceptible to brown rust (Table 3). Four noncarrier stocks, CPAN 1946, CPAN 1973, PBW 166 and VL 490, were free from brown rust at both stations. All the remaining noncarrier stocks developed tR to 30R intensity of brown rust.

The F_1 hybrids of CPAN 1973 and PBW 166 with both the testers as well as of CPAN 1946 and VL 490 with WL 711 were free from both the rusts at both stations. The F_2 and backcross generations of these parents produced segregates resistant to both the rusts. CPAN 1946, CPAN 1973, PBW 166 and VL 490 could, therefore, be used as reliable sources of yellow and brown rust resistance.

Table 3. Brown rust reaction of noncarrier parental stocks and their F_1 hybrids under field conditions at Ludhiana and Gurdaspur

Noncarrier	Ludhiana			Gurdaspur		
parent (P)	P	P × C 306	P × WL 711	P	P × C 306	P × WL 711
Pato (B)	tR	40S	60S	10R	30S	80S
Emeck 132	5R	60S	20S	5R	80S	60S
CPAN 1283	20S	20S	20S	10S	20S	80S
CPAN 1496	0	15S	20S	tR	60S	80S
CPAN 1842	0	20S	10S	5R	20S	80S
CPAN 1887	tR	30S	40S	10R	30S	80S
CPAN 1946	0	10R	0	0	0	0
CPAN 1949	tR	5R	10R	0	10R	20R
CPAN 1973	0	0	0	0	0	0
CPAN 1994	0	tR	0	5R	0	0
CPAN 2019	30S	50S	20S	60S	60S	60S
PBW 166	0	0	0	0	0	0
VL 490	0	20R	0	0	0	0
HW 840	5R	10S	10S	0	20S	30R
K 8319	5R	80S	50S	30R	80S	60S
C 306 (Ne_1 tester)	60S	—	—	80S	—	—
WL 711 (Ne_2 tester)	80S	—	—	80S	—	—

C 306 had a favourable combination of high seminal root length, coleoptile length and seminal root number. A favourable combination of these traits ensures safe establishment of seedlings in arid regions [5]. Genotypes Emeck 132, CPAN 1496, CPAN 1973, PBW 166, VL 490 and HW 840 were comparable or superior to C 306 for seminal root length; CPAN 1496, CPAN 1887, CPAN 1946 and CPAN 1949 for coleoptile length; and CPAN 1887 and PBW 166 for seminal root number. Strain CPAN 1496 was superior to C 306 for seminal root number and length; PBW 166 for seminal root number and length; and CPAN 1887 for coleoptile length and seminal root number. Intermating of these stocks among themselves and with C 306 is expected to yield a favourable combination of the seedling traits for rainfed cultivation. The resistance of PBW 166 to yellow and brown rusts would add another useful trait for exploitation.

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