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Genetics of leaf rust and leaf blight resistance in different crosses of common wheat.

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Abstract. Leaf blight caused by *Alternaria triticina* (HLB) and leaf rust caused by *Puccinia triticina* are two of the important diseases of wheat that are widespread in India. Postulating the genes in most of the released cultivars, a chi-square test applied for HLB and leaf rust separately. The HLB reaction in the F_2 generation was a 3:1 (susceptible:resistant) ratio was observed in two crosses, and we conclude that the susceptible reaction is governed by a dominant gene(s) in both the crosses. A 15:1 ratio fitted in three crosses showed that susceptible reaction is governed by duplicate gene(s). Tests also were used for leaf rust reactions to check the validity of expected ratio in the F_2 generation. The 3:1 ratio (susceptible:resistant) fit three crosses and this resistant type reaction is governed by a dominant gene(s). Two crosses fit a 15:1 ratio indicating a resistant type infection governed by duplicate gene(s).

Introduction. Among cereals, wheat is ranked second after rice and is the staple food, especially in northern India, where most people are vegetarian. The crop is grown successfully between an altitude of 30°0–60°0 N and 27°0–40°0 S. Wheat is extensively cultivated under diverse agroclimatic conditions in India covering most of the states except Kerala. All wheat cultivated in India is spring type but grown during the winter. Wheat, the main food crop of India, contributes significantly to the central pool. The cultivation of wheat in India started very early, during prehistoric times and, thus, the origin of wheat is still a matter of speculation. Wheat research to develop high-yielding cultivar and improve management techniques started about a century ago in India. A large number of valuable cultivars were bred and released for commercial cultivation. These cultivars were tall and mainly suited to low-input management with low yield potential. However, a turning point came in the history of wheat breeding during mid-1960s with the introduction of semidwarf, photo-insensitive, high-yielding Mexican wheat breeding material developed at CIMMYT under the guidance of Nobel Laureate Dr. Norman E. Borlaug. These cultivars were tested under the All India Coordinated Wheat Improvement Project and, as a result, three genotypes, Lerma Rojo, S 308, and Sonora 64, which out yielded the old tall wheat cultivars, were released for general cultivation in major wheat-growing areas of India.

Wheat is cultivated on over 217.53 x 10^6 ha in world with 610.87 x 10^6 metric tons produced during 2007–08. The wheat-growing area in India is about 28.00 x 10^6 ha with highest production of 78.4 x 10^6 tons (Anonymous 2008). Globally, the maximum area under wheat is in China followed by U.S.A. and India. In terms of production per unit area, the U.S.A. stands first followed by the Russian Federation. In India, wheat is the main cereal crop and is second only to rice. Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Bihar, Haryana, Maharashtra, and Gujarat are the major wheat-growing states in the country.

Three species of genus *Triticum*, *T. aestivum* subsp. *aestivum* (bread wheat or common wheat), *T. turgidum* subsp. *durum* (macaroni wheat), and *T. turgidum* subsp. *dicoccum* (emmer or khapli wheat) are grown in India. Common wheat, with 2n = 6x = 42 chromosomes, is the most important and mainly grown for chapatti making on a wide area. *Triticum turgidum* subsp. *durum* is grown in some states primarily for pasta products. Stem, leaf, and stripe rust have been major concerns for quite some time, because rust epidemics before or during flowering are most detrimental. The symptoms for stripe rust (also called yellow rust and glume rust) caused by *P. striiformis* usually appear earlier in the spring than symptoms for leaf or stem rust. Leaf rust (also called brown rust) is one of the most common wheat diseases in the world. Rough estimates of up to 40 percent yield losses due to leaf rust at various flag leaf severities and different growth stages have been reported (RL Bowden, personal communication). Leaf rust can inflict serious yield losses in epidemic years (Joshi 1976; Kolomer 1996). Although the disease has more or less been contained in India because of research efforts over the last 50 years, efforts to identify novel genes conferring resistance to this disease need to be continued because of fast evolution of the leaf rust pathogen (Nayer et al. 1996, 2000). So far, nearly 60 genes conferring resistance to leaf rust have been identified and designated *Lr1* through *Lr60* (Mclntosh et al. 2007). Germ plasm collections have been evaluated India for resistance to leaf rust and many accessions the resistance cannot be ascribed to any of the known genes (Shiwani and Saini 1993; Saini et al. 1999). Resistance breeding is the most important control strategy, and its success depends on the identification of resistance genes in genotypes.

Foliar blight is an important disease of wheat occurring all over India, perticularly in major wheat-growing regions and ranks close to rust in destructiveness (Directorate of Wheat Research 1999). The disease occurs as a complex in which causal organisms are *Alternaria triticina* and *Bipolaris sorokiniana*. the disease has been observed from initial stage up to growth stage 47 on Zadoks Scale (Zadok et.al. 1974). The dominant pathogen is *A. triticina* and after growth stage 57, *B. sorokiniana* appears and causes significant damage (Chaurasia et al. 2000). A field heavily infected with *Alternaria* blight diseases presents a burnt look and crop loss may be more than 90 percent (Raut et al. 1983).

Materials and methods. Seven bread wheat cultivars were obtained from Directorate of Wheat Research, Karnal (DBW 14, HUW 468, HUW 533,GW 273, PBW 502, DL 788-2, and PBW 443). The material was grown in a randomized block design with three replications at the Research Farm of Janta Vedic College (JVC), Baraut, Baghpat, during rabi season 2005–06. Each genotype was sown in a 3.0-m three-row plot, keeping the plant-to-plant and row-to-row distance of 10 cm and 23 cm, respectively. All recommended agronomic and cultural practices were adopted to ensure a good crop. A total of five straight cross combinations, I (DBW14/HUW468), II (DL788-2/PBW502), III (DBW14/HUW533), IV (GW273/HUW468), and V (PBW443/HUW533) were attempted and sufficient seed was ensured for each cross. The F_1 generations of all five combinations were advanced at Lahaul and Spiti (HP) during summer 2006. In addition, the BC_1 and BC_2 populations of each combination also were obtained in summer nursery. This way, a complete set of breeding material comprising the seven parents, five each of the F_1, F_2, BC_1, and BC_2 generations was obtained and planted along with an infecter row during the rabi season 2006–07 at JVC. The plot size for the parental lines, F_1s, BC_1, and BC_2 was two 2.5-m rows; each F_2 population was grown in 10 2.5-m rows plot. The entire plot was surrounded by one row with an infector cultivar to create epidemic conditions in the plots.

Result and discussion. ***Leaf blight.*** The inheritance of Helminthosporium leaf blight resistance in bread wheat was studied in five crosses that were screened under artificial epidemic conditions by spraying with a spore suspension of a mixture of virulent races. Plants with less than 46 percent of the leaf area infected were considered resistant and those with a greater leaf area infected were considered susceptible. The F_1s of most all the crosses had a susceptible reaction, indicating dominance of susceptibility over resistance. The chi-square analysis test fit a ratio of 3:1 (3 susceptible:1 resistant) plants in the F_2 generations of crosses I and III, suggesting that the susceptible reaction is governed by dominant gene(s). Plants in the F_2 generation of crosses II, IV, and V segregated 15:1 (15 susceptible:1 resistant), suggesting that susceptibility is governed by duplicate gene in the progenies of these crosses (Table 1, p. 36). These findings are similar to those of Narula et al. (1971) and Kulshrestha et al. (1976) who reported that a susceptible reaction was inherited as a dominant gene in bread wheat. Kaur et al. (2003) reported the susceptible reaction is governed by two dominant genes with complementary effect.

Table 1. Segregation in the F_2 generation of five crosses of bread wheat to foliar leaf blight in the field after artificial inoculation. * Significant at 0.05 % level (X^2 value 3.841 at 1 degree of freedom).

Cross combination	Total plants	F2 reaction						
		Observed		Expected		Expected ration	X^2	Gene action
		S	R	S	R			
DBW14/HUW468	60	49	11	45.00	15.00	3:1	1.422*	Dominant
DL788-2/PBW502	60	56	4	56.25	3.75	15:1	0.017*	Duplicate
DBW14/HUW533	60	48	12	45.00	15.00	3:1	0.800*	Dominant
GW273/HUW468	60	56	4	56.25	3.75	15:1	0.017*	Duplicate
PBW443/HUW533	60	57	5	56.25	3.75	15:1	0.445*	Duplicate

Leaf rust. The inheritance of leaf rust resistance in wheat was studied in five crosses that were screened under artificial epidemic conditions by spraying with an aqueous suspension of urediospores of pathotype 77-5. The parents, F_1s, and F_2 generations also were evaluated for disease severity against pathotype 77-5 at adult-plant stage under field conditions. The leaf rust response and severity was recorded in the F_2. The F_1 plants of all the crosses showed a resistant type reaction, indicating dominance of resistance over susceptibility. The chi-square analysis gave a good fit for a 3:1 (3 resistant:1 susceptible) ratio in the F_2 of crosses II, IV, and V, suggesting that resistance is monogenic dominant (Table 2). A 15:1 (15 resistant:1 susceptible) ratio was found in crosses I and III, indicating that resistance in these crosses is governed by duplicate gene(s). Leaf rust is widespread in India. Most of the released cultivars and advanced varietal trial entries are susceptible to the highly virulent pathotype121R63 (Nayar et al. 2001). These findings agree with those of Nayar et al. (1993, 1997), Datta et al. (2004), Basandrai et al. (2004), Haghparast et al. (2004), and Honrao et al. (2004).

Table 2. Segregation in the F_2 generation of five crosses of bread wheat to leaf rust in the field after artificial inoculation with pathotype 77-5. All F_1 plants had a resistant reaction. * Significant at 0.05 % level (X^2 value 3.841 at 1 degree of freedom).

Cross combination	Total plants	F2 reaction						
		Observed		Expected		Expected ration	X^2	Gene action
		S	R	S	R			
DBW14/HUW468	60	56	04	56.25	3.75	15:1	0.018*	Duplicate
DL788-2/PBW502	60	42	18	45.00	15.00	3:1	0.800*	Dominant
DBW14/HUW533	60	46	14	45.00	15.00	3:1	0.087*	Dominant
GW273/HUW468	60	56	06	56.25	3.75	15.:1	1.440*	Duplicate
PBW443/HUW533	60	51	09	45.00	15.00	3:1	3.200*	Dominant

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ITEMS FROM ITALY

CONSIGLIO PER LA RICERCA E LA SPERIMENTAZIONE IN AGRICOLTURA, Unità di ricerca per la valorizzazione qualitativa dei cereali (CRA–QCE), Via Cassia, 176, 00191 Rome, Italy.

Behavior of wheat cultivars in organic farming tested at the seedling stage with Stagonospora nodorum.

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The Septoria disease complex is caused by two pathogens, *Phaeosphaeria nodorum* (anamorph *Stagonospora nodorum*) and *Mycosphaerella graminicola* (anamorph *Septoria tritici*) that frequently occur together on the same plant in Italy. Both the fungi attack the epigeous parts of the plant with similar symptoms and can cause quantitative and qualitative damage. *Septoria nodorum* also infects the kernels with damage to the grain. Because *S. nodorum* is a seedbome fungus, infected seed is an important source of primary inoculum and can be a more dangerous vehicle of infection for organic farming than in conventional agriculture.

The agronomic, qualitative, and phytopathological aspects concerning National Organic Network of many cultivars of durum and bread wheat have been studied in Italy for some years (Perenzin et al. 2010; Quaranta et al. 2010, Iori et al. 2010). In 2009–10, data collected from field surveys again showed the prevalence of Septoria disease complex on both durum and bread wheats, confirming an increase in the economic importance of this plant disease already observed in recent years. Data related to naturally acquired diseases were reported by Iori et al. (2010).

Our aim was to analyze the behavior of same wheat cultivars at the seedling stage artificially inoculated with *S. nodorum* in greenhouse that were previously observed in field for Septoria disease complex. Seventeen bread wheat and