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Research Article

Screening of advanced lines and commercial varieties of wheat against karnal bunt disease

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Abstract

Two hundred and forty four advanced germplasm lines and commercial varieties of wheat, received from wheat Research Institute, Faisalabad, were screened for the sources of resistance against karnal bunt disease by artificially inoculating the germplasm with sporidial suspension of the fungus. The screening revealed 16, 9, 18, 40, 58 and 112 lines/ varieties to be highly resistant, resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible to karnal bunt disease of wheat respectively. The sixteen highly resistant advanced lines were V-02192, V-03079, V-04022, V-04178, V-05011, V-05020, V-05023, V-05025, V-05039, V-05136, V-05144, V-05150, V-06122, V-06126, V-06127 and V-06138. The resistant lines were V-01078, V-03138, V-04048, V-04076, V-04171, V-04183, V-05132, V-05152, V-08794, while moderately resistant lines were V-02156, V-04157, V-04189, V-04611, V-05010, V-05097, V-05610, V-06121, V-06123, V-06125, V-06131, V-06133 and the commercial cultivars Blue silver, WL-711, SA-42, SH-2002, Manthar and Shafaq-06. The remaining advanced lines and commercial cultivars were moderately to highly susceptible.

Keywords: Wheat, Karnal bunt disease, germplasm accessions, screening, resistance vs susceptibility.

Introduction

Wheat (*Triticum aestivum L.*) is an important food crop of Pakistan and is grown in winter months of November to April. It is cultivated on 8494,000 ha with total production of 23520,000 tones and average yield of 2769 kg/ha (Anonymous, 2007). This is an extremely low yield as compared to that of other wheat producing countries of the world. Many factors contribute to low yield in Pakistan, diseases being one of the factors. Karnal bunt or partial bunt, caused by *Tilletia indica* Mitra, is one of the smut diseases of wheat. The disease was first detected in 1931 at Karnal in Haryana, India and hence it is called Karnal bunt (Mitra, 1931). Though the disease is native to South Asia but subsequently it has been reported from Iran, Syria, Afghanistan, Iraq, Mexico (Joshi et al., 1983), Nepal (Singh and Dhaliwal, 1989) and United States (Ykema et al., 1996). The disease remained less damaging till late 1970 but subsequently severe epidemics started occurring coinciding with the change over to high yielding irrigated, semi dwarf and high fertilizer input farming.

The pathogen infects the ovaries in the emerging wheat heads and converts the grains partially or completely into dark colored powdery masses of teliospores. The diseased fields emit a foul smell like that of rotten fish due to trimethylamine. Karnal bunt can reduce wheat yields. There is no estimate of losses, due to this disease, occurring in Pakistan (Shakoor et al., 2014), However, survey in India conducted during the years of heavy disease revealed a total loss of almost 0.5 percent, but in some fields where 89 percent of the kernels were infected, the yield losses ranged from 20-40 percent in highly susceptibly varieties (Anonymous, 2004). Brennan et al. (1990) estimated the economic losses from Karnal bunt of wheat in Mexico to be US $ 7.02 million per year. Besides yields losses, Karnal bunt can reduce wheat flour quality due to fishy, unpalatable odour and taste, if a grain lot contains 1-4 percent infected seed (Bonde et al., 1997; Hussain et al., 1988; Mehdi et al., 1973; Sekhon et al., 1980). If in a grain lot 5 percent of the grain is infested, the quality of the flour recovery and chemical changes in composition of flour and gluten contents cause poor dough strength (Sekhon et al., 1980; Gopal & Sekhon, 1988). Karnal bunt is also a disease of quarantine interest and it affects the international trade of commercial wheat grain and movement of wheat germplasm through out the world. Thus presence of diseased grain in wheat lots can cause economic loss to wheat exporting countries (Bonde et al., 1997, Babadoost, 2000; Butler, 1990).

Karnal bunt differs from other diseases of wheat in that the pathogen, *Telletia indica* Mitra infects plants during anthesis and it sporulates on the same generation of the host which it infects. Neither all spikes of plant nor do all grains in spike are affected by the disease and usually a few irregularly distributed kernels are bunted (Mitra, 1935; Bedi et al., 1949; Dhaliwal et al., 1983). Infection of individual kernels varies from small points of infection to completely bunted kernels but completely infected ones are rare (Chona et al., 1961). The embryo of the infected kernels usually remains undamaged except when infection is severe (Cashion and Luttrel, 1988) but the endosperms of the kernels get shrunken to varying degrees. At maturity severely infected kernels are filled with teliospores of the pathogen which serve as primary source of inoculum. The spikes of infected plants are generally reduced in length with less number of spikelets (Mitra, 1937). During harvest, infection sori are broken resulting in contamination of healthy seeds, soils, equipment, machinery and the vehicles with the liberated spores. The spores may be blown by wind for long distances.

The teliospores of the Karnal bunt fungus can survive in soil for more than 5 years (Krishna and Singh, 1983; Babadoost et al., 2004; Bonde et al., 2004). Although many control strategies have been suggested for the management of Karnal bunt disease and the strategies include seed treatment with hot water and solar energy, seed treatment with fungicides and soil drenching with fungicides (Anonymous, 2005). However, the results were not convincing, the cheapest and the most feasible method of Karnal bunt control is the use of host resistance and breeding for varieties resistant to Karnal bunt disease. This paper reports on the screening of advanced lines and commercial varieties of wheat for the sources of resistance against Karnal bunt disease of wheat.

Materials and Methods

Two hundred one advanced lines and forty three commercial varieties of wheat germplasm received from Wheat Research Institute, Faisalabad, Pakistan were screened against Karnal bunt disease in the field experimental area of the Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan by artificially inoculating the germplasm with sporidial suspension of *Tilletia indica*. The screening was carried in the *Rabi*- season of 2006-2007. Each of the germplasm line was sown in a single row subplot of 3 meter length with row to row spacing 30 cm and plant to plant distance 15 cm. A cultivar Pak-81 was included as a highly susceptible check. At boot leaf stage each of the ten heads of each entry were inoculated with 3 ml of sporidial suspension (10,000 sporidia/ml) of *T. indica* with a hypodermic syringe, starting from mid February to mid March, as and when a wheat line approached to its boot leaf stage. The sporidial culture of *T. indica* was prepared by following the method of Torres et al. (1982). Boot inoculation was carried following the procedure of Singh and Krishna (1982) and Aujla et al. (1980). For the preparation of sporidial suspension five culture slants, each in a 250 ml flask, were taken and culture layers along with some PDA were removed and aseptically hand mashed thoroughly in 750 ml distilled water taken in a 1000 ml beaker. The sporidial suspension thus obtained was filtered through muslin

cloth and the solution was diluted further to get about 10,000 sporidia/ml of water. This sporidial suspension was then used for boot inoculation. The inoculated plants of each test line/ variety were tagged and labeled. To facilitate infestation, the field was irrigated to lower the temperature and to increase the relative humidity. All the agronomic practices were uniformly applied. Inoculated heads were harvested between 20 to 30th April as and when they reached maturity. Heads of each line were hand threshed and the total numbers of grains and infected grains in the inoculated heads were counted and disease incidences (i.e. percent infected grains) were thus calculated. The level of resistance/susceptibility of each of the test lines/varieties was assessed by using the following modified disease rating scale of Aujla et al. (1989).

Grade in the disease rating scale	Percent grain infection	Level of resistance/ susceptibility
0	No infection at all	Highly resistant
1	Less than percent infected grain	Resistant
3	1.1-2 percent infected grains	Moderately resistant
5	2.1 to 5 percent infected grains	Moderately susceptible
7	5.1-10 percent infected grains	Susceptible
9	More than 10 percent infected grain	Highly susceptible

Results and Discussion

The screening of 201 advanced lines of wheat revealed that 16, 9, 12, 33, 44, and 87 lines were highly resistant (immune), resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible, respectively (Table 1). Sixteen highly lines were V-02192, V-03079, V-04022, V-04178, V-05011, V-05020, V-05023, V-05025, V-05039, V-05136, V-05144, V-05150, V-06122, V-06126, V-06127, V-06128 while the nine resistant lines were V-01078, V-03138, V-04048, V-04076, V-04171, V-04183, V-05132, V-05152 and V-08794. The twelve moderately resistant lines were V-02156, V-04157, V-04189, V-04611, V-5010, V-05097, V-5610, V-06121, V-06123, V-06125, V-06131 and V-06133. The remaining advanced lines were moderately to highly susceptible.

Out of 43 commercial cultivars screened against Karnal bunt disease, none was found to be highly resistant or resistant. However, 06, 07, 14 and 16 cultivars were found to be moderately resistant, moderately susceptible, susceptible and highly susceptible (Table 1). The six moderately resistant cultivars were BWP-97, SA-42, SH-2002, Blue Silver, Shafaq-06 and Manthar. The seven moderately susceptible cultivars were Chris, Crow, Fontana, Pavon, Moracco, Dirk and Daman-98. The fourteen susceptible cultivars were Pak-81, Sahar, SA-75, Pb-76, Pb-81, Pb-96, Faisalabad-85, Parwaz-94, Uqab-2002, GA-2002, Inqlab-91, Kohsar-95, Chakwal-96 and Chakwal-97 while the sixteen highly susceptible cultivars were C-271, C-273, C-518, C-591, WL-711, Chenab-2000, Faisalabad-83, Kohinoor-83, Local White, MH-97, Pb-85, Pasban-90, LH-26, Shalimar-88 and Yecora and MexiPak-85.

The highly and resistant advanced lines of wheat identified in the present screening, can further be exploited, as resistant sources against Karnal bunt disease, in breeding programmes for the development of disease resistant commercial cultivars after determining their genetics or these advanced lines can be released directly as commercial cultivars if these were found to possess other desirable agronomic characters.

The sources of resistance in the wheat germplasm against Karnal bunt disease are not uncommon. Aujla et al. (1980) reported ten wheat lines with only 1-5 percent grain infection among 286 lines screened by them. Earlier Gautam et al. (1977a) screened 96 wheat lines and reported lines with less than 1 percent infection. In a field screening trial of superior genetic stocks consisting of 350 lines Gautam et al. (1977b) found 160 lines with no infection. Aujla et al. (1985) screened germplasm under artificial epiplytotic conditions against Karnal bunt and reported 26 lines which remained disease free and 58 lines having 0-5 percent infection. The screening of 38 wheat lines, included in National Uniform Wheat Yield Trials (NUWYT) of 2004-05 at National Agricultural Research Council (NARC), Islamabad, Pakistan

revealed that all the lines were highly susceptible except 5 lines that remained free from grain bunt infection (Anonymous, 2005).

As regards the commercial cultivars, there is scarcity of resistance in them except a few moderately resistant cultivars. The scarcity of resistance in the commercial cultivars is a serious threat as regards the quarantine status of wheat of Pakistan. This scarcity of resistance in commercial cultivars against Karnal bunt disease across the border (Krishna and Singh, 1983) and in the country, has already been reported (Iftikhar et al., 1988; Anonymous, 2005).

Table 1: Level of resistance/susceptibility of advanced wheat lines and commercial cultivars against Karnal bunt disease of wheat

Grade in the disease rating scale and percent grain infection	Response of test line or cultivar against the disease	Advanced wheat lines	Commercial wheat cultivars
0 = No infection at all	Highly resistant or immune	V-02192, V-03079, V-04022, V-04178, V-05011, V-05020, V-05023, V-05025, V-05039, V-05136, V-05144, V-05150, V-06122, V-06126, V-06127, V-06128	-
1 = Less than 1% grain bunted	Resistant	V-01078, V-03138, V-04048, V-04076, V-04171, V-04183, V-05132, V-05152, V-08794	-
3 = 1.1-2% grain bunted	Moderately resistant	V-02156, V-04157, V-04189, V-04611, V-05010, V-05097, V-05610, V-06121, V-06123, V-06125, V-06131, V-06133	BWP-97, SA-42, SH-2002, Blue Silver, Shafaq-06 and Manthar
5 = 2.1-5% grain bunted	Moderately susceptible	V-03094, V-03285, V-04040, V-04122, V-04179, V-04188, V-04306, V-05003, V-05004, V-05009, V-05041, V-05042, V-05043, V-05044, V-05048, V-05049, V-05050, V-05053, V-05054, v-05055, V-05058, V-05060, V-05064, V-05065, V-05066, V-05067, V-05071, V-05072, V-05082, V-06069, V-09247, V-00BT08, V-00BT015	Chris, Crow, Fontana, Pavon, Moracco, Dirk, Daman-98
7=5.1-10% bunted grain	Susceptible	V-02156, V-03007, V-03079, V-03094, V-03138, V-04009, V-04022, V-04040, V-04048, V-04068, V-04112, V-04157, V-04171, V-04178, V-04179, V-04181, V-04188, V-04189, V-04309, V-04611, V-05006, V-05008, V-05056, V-05062, V-05070, V-05093, V-05132, V-05136, V-05144, V-05150, V-05152, V-05620, V-06124, YR9-SEERI-E45, YR10-E30, YR15-E27, YR18-E23, YRA-E27, YRA-E40ANZA, LR-2C, LR-10, LR-13, LR-26, V2KC-050	Pak-81, Sahar, SA-75, Pb-76, Pb-81, Pb-96, Faisalabad-85, Parwas-94, Uqab-2002, GA-2002, Inqlab-91, Kohsar-95, Chakwal-96, Chakwal-97
9=More than 10 percent grain bunted	Highly susceptible	D-05603, D-05604, D-05607, D-05608, D-05609, D-05612, D-05623, D-05625, D-05627, D-05630, V-04148, V-05085, V-05086, V-05087, V-05088, V-05090, V-05094, V-05096, V-05100, V-05101, V-05104, V-05105, V-05107, V-05113, V-05115, V-05119, V-05121, V-05122, V-06129, V-06130, V-06134, V-06135, V-06136,V-06137, V-06138, V-06139, V-06140, V-085205, V-087049, V-087094, LR-1, LR-2, LR-2B, LR-3, LR-3KA, LR-3BG, LR-9, LR-11, LR-12, LR-14A, LR-14B, LR-15, LR-16, LR-17, LR-18, LR-19, LR-20, LR-21, LR-22A, LR-22B, LR-23, LR-24, LR-25, LR-27, LR-28, LR-29, LR-30, LR-32, LR-33, LR-34, LR-35, LR-36, LR-37, LR-38, YR1-E1, YR1-E18, YR2-E35, YR5-E19, YR5-E25, YR6-APR-E38, RR6-YR7, E37, YR7-E36, YR7-E10, YR8-E20, YR8-E26, YR9-E39	C-271, C-273, C-518, C-591, WL-711, Chenab-2000, Faisalabad-83, Kohinoor-83, Local White, MH-97, Pb-85, Pasban-90, LU-26, Shalimar-88, Yecora, MexiPak-65

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