Registration of Spring Wheat Germplasm ND 751 Resistant to Fusarium Head Blight

ND 751 (Reg. no. GP-812, PI 642781) is a hard red spring wheat (Tritium aestivum L.) developed at North Dakota State University (NDSU), Fargo, ND, USA. ND 751 was released in January 2006 by the North Dakota Agricultural Experiment Station (NDAES) for its high level of resistance to Fusarium head blight (FHB) [caused by Fusarium graminearum Schwabe (teleomorph Gibberella zeae (Schwein.) Petch)] and its good adaptation to the northern spring wheat region of the USA. In addition, ND 751 combines resistance to the prevalent races of stem rust (caused by Puccinia graminis Pers. f. sp. tritici Eriks. & E. Henn) and leaf rust (caused by Puccinia triticina Eriks.) in the region.

ND 751 was derived from the cross ND 2709/3/'Grandin' (PI 531005) × 3/8'Ramsey/ND 622/4/ND 688/ND 674 made at NDSU by Dr. R. C. Frohberg in the fall of 1996. ND 2709 is a HRSW experimental line developed by the NDSU wheat breeding program from the cross 'Sumai 3' (PI 481542) × 'Wheaton' (PI 469271) /'Grandin. Sumai 3, a spring wheat from China, is arguably the most used source of resistance to FHB worldwide (Wilcoxon, 1993; Rudd et al., 2001). Grandin is HRSW cultivated released by the NDAES in 1989. Grandin × 3/8'Ramsey is an experimental line developed by the NDSU breeding program with good adaptation to North Dakota and resistance to leaf and stem rusts. ND 622, ND 688, and ND 674 are HRSW experimental lines, developed by the NDSU breeding program, with good adaptation to the wheat growing areas in North Dakota and good milling and baking characteristics. The F1 was grown in the greenhouse and the F2 was grown in the field at Casselton, ND, in spring and summer of 1997, respectively. Selection in the F2 generation was based on reaction to FHB, leaf rust reaction, and agronomic merits including plant vigor, height, and earliness. Two hundred spikes were selected from the F2, and advanced as F3, head-rows in 2-m-long row plots at Christchurch, New Zealand, in 1997–1998. In New Zealand, selection was based mainly on visual uniformity, lack of grain shattering, plant height, and lodging resistance. Ten spikes from each of 17 selected rows in the New Zealand nursery were harvested, threshed in bulk, and sown as F3, row plots at Prosper, ND, in the summer of 1998. Subsequently, 10 spikes from the selected F3 plots were threshed individually and grown as F4, single row 2-m-long plots for seed increase and generation advancement in at Christchurch in 1999. Twenty-seven selected rows from the New Zealand nursery were harvested as an F4, bulk and included in the preliminary yield trials (first year of yield testing) and hill plots in the FHB nursery at Prosper, ND, in the summer of 1999. The FHB nursery was inoculated with Fusarium graminearum using the spray inoculation method (Rudd et al., 2001) and overhead mist irrigation to enhance disease development.

ND 751 was produced from a bulk of one purified F4, plot among the 27 rows selected in 1999 at Christchurch. ND 751 was entered into yield trials as an F5 line at Casselton and Prosper, ND, in 1999 and subsequently tested in advanced (second year of testing for yield) and elite (third year of testing for yield) yield trials at four locations in 2000 and 2001, respectively. ND 751 was also tested in ND Variety Trials (NDVT) in 2002 and 2003 and in the Hard Red Spring Wheat Varieties Grown in Cooperative Plot and Nursery Experiments in the Spring Region (Garvin et al., 2003) commonly known as the Uniform Regional Nursery (URN) conducted in North Dakota, Minnesota, South Dakota, Nebraska, Montana, Wyoming, Washington, and Manitoba, Canada, in 2003. ND 751 was further tested for FHB from 2001 to 2003 in six location-years (two nurseries and 3 yr) in the NDSU FHB nursery grown under spray inoculation (Rudd et al., 2001) and overhead mist irrigation at Prosper, ND, and in five experiments under greenhouse conditions using the point inoculation method (Rudd et al., 2001) and overhead mist irrigation. ND 751 was further purified by selecting 200 heads from drill strips (F6) at Prosper, ND. Nonuniform rows were discarded and the remaining rows were bulked to form breeder seed.

On the basis of six location-years of testing in the FHB nursery conducted under field, spray inoculation, and overhead mist irrigation conditions, the FHB incidence (Stack et al., 1997) recorded for ND 751 (86%) was comparable to the moderately resistant cultivar Alsen (PI 615453) (88%) and significantly lower (p < 0.05) than the incidence for the susceptible check '2398' (100%) and the moderately susceptible check 'Pioneer 2375' (98%). However, FHB severity (Stack and Frohberg, 2000) recorded for ND 751 (29%) was significantly lower (p < 0.05) than Alsen (35%), 2398 (73%), and Pioneer 2375 (40%). Visual Scabby Kernels (VSK), also defined as Visual Damaged Kernels by Stack and Frohberg (2000), of ND 751 (18%) was significantly lower (p < 0.01) than scores recorded on Alsen (26%), Pioneer 2375 (31%), and 2398 (64%). Alsen was released in 2000 as the first NDSU HRSW cultivar with medium resistance to FHB and has been widely grown in the northern plains since 2001. Alsen, however, is moderately susceptible to leaf rust disease. In the five greenhouse tests, FHB severity and VSK of ND 751 were, respectively, 46 and 31% compared with 86 and 43% for Alsen and 65 and 42% for Pioneer 2375, and 92 and 82% for 2398. Deoxyxynivalenol (DON) toxin levels in grain of ND 751 (2.6 mg kg\(^{-1}\)) were significantly lower (p < 0.05) than all checks including Alsen (3.5 mg kg\(^{-1}\)), Pioneer 2375 (4.1 mg kg\(^{-1}\)), and 2398 (5.8 mg kg\(^{-1}\)). Data from the 2003 URN trials grown at Crookston and Saint Paul, MN (Garvin et al., 2003) showed that average FHB severity and VSK of ND 751 (11 and 8%) were significantly lower (p < 0.05) than 'Chris' (CIT 13751) (33 and 27%), Pioneer 2375 (39 and 15%), and ‘Steele-ND’ (PI 633862) (33 and 31%). ‘Steele-ND’ (PI 634981) (Mergoum et al., 2005) (38 and 20%), and ‘Glenn’ (Mergoum et al., 2006) (16 and 13%).

On the basis of 14 and 4 location-years of testing in the NDVT and elite yield trials, respectively, grain yield of ND 751 (3987 kg ha\(^{-1}\)) was similar to ‘Reeder’ (PI 615386) (4057 kg ha\(^{-1}\)) and ‘Parshall’ (PI 613587) (3940 kg ha\(^{-1}\)) but significantly higher (p < 0.05) than Alsen (3772 kg ha\(^{-1}\)). In the five same trials, grain protein of ND 751 was 153 g kg\(^{-1}\) compared with 155, 152, and 155 g kg\(^{-1}\) of Alsen, Reeder, and Parshall, respectively. Grain yield weight of ND 751 was 767 kg m\(^{-2}\) compared with 757, 767, and 759 kg m\(^{-2}\) of Alsen, Reeder, and Parshall, respectively. Water absorption was 65.2%, similar to Parshall (65.5%), Alsen (66.9%), and Reeder (65.3%). Mixogram mix time (after 3 h fermentation) performed by the HRSW quality laboratory at NDSU was 2.95 min compared with 2.65, 2.35, and 2.10 min for Alsen, Parshall, and Reeder, respectively. The mixing tolerance scored (15.3 min) was similar to Alsen (15.2 min) but significantly (p < 0.05) higher than Parshall (12.4 min) and Reeder (10.2 min). Loaf volume was 1171 mL compared with 1149, 1166, and 1097 mL of Alsen, Parshall, and Reeder, respectively. Similarly, flour yield of ND 751 was 707 g kg\(^{-1}\) compared with 695, 698, and 684 g kg\(^{-1}\), respectively, with 155, 152, and 155 g kg\(^{-1}\) of Alsen, Reeder, and Parshall, respectively. On the basis of 19 locations of URN in 2003, mean grain yield and volume weight of ND 751 were 4011 kg ha\(^{-1}\) and 777 kg m\(^{-2}\), respectively, compared with Steele-ND (4226 kg ha\(^{-1}\) and 770 kg m\(^{-2}\)), Keene (3950 kg ha\(^{-1}\) and 768 kg m\(^{-2}\)) and Chris (3077 kg ha\(^{-1}\) and 741 kg m\(^{-2}\)). In the those same trials, protein of ND 751 was 148 g kg\(^{-1}\) compared with 151, 155, and 155 g kg\(^{-1}\) of Steele-ND, Keene, and Chris, respectively.