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00Ar134-1, a spring wheat line of intergeneric origin

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1 **GERMPLASM DESCRIPTION**

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3 **00Ar134-1, a spring wheat line of intergeneric origin**

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12 **Abstract**

13 **Brar, G. S. and Hucl, P. J. 2016.** 00Ar134-1, a spring wheat line of intergeneric origin.

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15 00Ar134-1 is an intergeneric spring wheat line derived from *Elymus repens* (quack
16 grass). The line was developed as a potentially new source of resistance to Fusarium
17 head blight (FHB) of wheat. 00Ar134-1 is resistant to Fusarium head blight and as well
18 as leaf rust, stem rust, and common bunt. Although lower yielding and taller than
19 commercial cultivars, this line is of similar maturity and kernel weight. 00Ar134-1 can
20 potentially be used as a resistant parent for improving Fusarium head blight resistance
21 in common wheat.

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Key words: *Elymus repens*, intergeneric lines, 00Ar134-1, Fusarium head blight, wheat, Scab.

Introduction

Fusarium head blight, mainly caused by *Fusarium graminearum* Schwabe (teleomorph: *Gibberella zeae* Schwein. Petch) is one of the most devastating diseases of common wheat in Canada. The disease results in shrivelled, light-weight and chalky white Fusarium damaged kernels which contain mycotoxins such as deoxynivalenol (DON) and nivalenol (NIV). The line 00Ar134-1 is a spring wheat line of intergeneric origin and was developed as a resistant source to Fusarium head blight. The line was derived from *Elymus repens* (L.) Gould (syn. *Agropyron repens* L. P. Beauvoir, and *Elytrigia repens* L. Deskv. Ex. Nevski), which is a perennial grass with worldwide distribution (Zeng et al. 2013).

Pedigree and Breeding Methods

The line 00Ar134-1 was selected from the cross Crocus/Ar//AC Foremost where, Ar is *Agropyron repens*. The cross of *Triticum aestivum* (cv. Crocus) (Zale and Scoles 1999) and *A. repens* was made in 1999 at the Crop Development Centre (CDC) of the University of Saskatchewan. The *A. repens* parent was a native clone present at the University's Seed Farm Site. The F₁ hybrids were backcrossed with *T. aestivum* cv. AC Foremost (pollen parent) (Thomas et al. 1997) and embryo rescue procedures were used to recover the BC₁F₁ seedlings. The harvested seeds from BC₁F₁ plants were bulked

and advanced to the BC₁F₇ generation in bulk. The line '00Ar-134-1' was one of the lines derived from near-homozygous BC₁F₇ progeny and was subsequently evaluated for agronomic and disease resistance traits for six years (2009-2014) at Saskatoon, SK and Carman, MB.

The line has been tested for agronomic and disease resistance traits and compared with mainly Canada Western Red Spring (CWRS) wheat cultivar checks from 2009-2014 (Tables 1-3). All traits were evaluated at the Kernen Crop Research Farm and disease reaction in epiphytotic nurseries of the University of Saskatchewan at Saskatoon, except for the Fusarium head blight resistance evaluation, which was performed at the Fusarium head blight nursery of the University of Manitoba at Carman, MB. Cultivars: AC Barrie (McCaig et al. 1996), 5602HR, Waskada (Fox et al. 2009), AC Carberry (DePauw et al. 2011), and 06FL-1 were used for comparison and AC Barrie was used as a standard check for all comparisons. In 2010-2014, 06FL-1 was also included in the list of cultivars for comparison. The agronomic trials consisted of a randomized complete block with two replications and the plots consisting of five 3.7 m long rows spaced 20 cm apart. The seeding rate used was 250 seeds per square meter. An irrigated leaf and stem rust epiphytic nursery was established by planting leaf and stem rust susceptible spreader rows between 1.3 m long rows of the test entries. Inoculations on spreader rows were performed by spraying leaf rust (*Puccinia triticina* Erikss.) and stem rust (*Puccinia graminis* Pers.:Pers. f. sp. *tritici* Erikss. and E. Henn.) spores suspended in water. Representative leaf rust races detected in the previous years were used for inoculations (McCallum et al. 2011). Stem rust races used were: TPMK, TMRT, RHTS, QTHS, TPMK,

67 RTHJ, and RKQS (Fetch et al. 2011). Disease assessment for stem and leaf rust was
68 performed using the rating scale adopted from Peterson et al. (1948). Resistance to the
69 races L1, L16, T1, T6, T13, and T19 of common bunt [*Tilletia laevis* Kuhn in Rabenh. and
70 *T. tritici* (Bjerk.) G. Wint in Rabenh.] was assessed in a bunt nursery at Saskatoon
71 (Hoffman and Metzger 1976). Response to Fusarium head blight was assessed in an
72 irrigated nursery at Carman, MB from 2009-2014. Genotypes were planted in 1.5 m
73 long rows at sowing density of approximately 70 seeds per row. Plants were inoculated
74 by spraying macroconidial inoculum at 50% anthesis and again after four days after the
75 first inoculation. Mist irrigation was applied after the inoculation to maintain the
76 optimum humidity for disease development. The disease reaction of the genotypes was
77 assessed using an Fusarium head blight field Index $[(\% \text{incidence} \times \% \text{severity})/100]$ at 18-
78 21 days post inoculation. For Fusarium head blight resistance evaluation, additional
79 check cultivars FHB37 (resistant), AC Cora (intermediate), and CDC Teal (susceptible)
80 were used.

81 Seed from the field trials was used to assess a number of quality traits for genotypes at
82 the Grains Innovation Laboratory of the Crop Development Centre, University of
83 Saskatchewan. The quality parameters measured on the genotypes included grain
84 protein concentration, test weight and Hagberg falling number.

85 The data were analyzed using the PROC MIXED procedure in Statistical Analytical
86 Software (SAS ver. 9.4) (Littell et al. 2006) with years and replicates as random factors
87 and genotypes as fixed effects. The disease data for Fusarium head blight and bunt was
88 averaged over years prior to analyses. The standard error of the difference between

genotypes was calculated using DIFF function in the syntax and Fisher's least significant difference was calculated at a significance level of 5% ($LSD_{0.05}$).

To generate the seed stocks, spikes of 00Ar134-1 were selected from the field trials after rouging the plots.

Performance

AGRONOMY: Based on six years of field testing, the grain yield of 00Ar134-1 was similar to that of AC Barrie, 5602HR, 06FL-1, and Carberry (Table 1). Days to maturity for 00Ar134-1 were similar to 5602HR and Carberry (Table 2). Days to heading were similar to 5602HR, AC Barrie but significantly higher than the other checks (Table 1). Thousand-kernel weight of 00Ar134-1 was similar to all the checks. Plant height of 00Ar134-1 was significantly higher as compared with all the checks (Table 1). Despite the greater plant height, 00Ar134-1 performed similar to 06FL-1 and Waskada in terms of resistance to lodging (Table 1).

DISEASE REACTION: 00Ar134-1 was resistant to FHB in nursery (Table 2). 00Ar134-1 expressed better resistance to FHB than Carberry, which was the first FHB resistant hard red spring wheat Canadian cultivar carrying *Fhb1* (DePauw et al. 2011) and check cultivars. 00Ar134-1 expressed resistance to common bunt that was comparable to that of AC Barrie, which is an intermediate check for bunt resistance (Table 2). Although the bunt resistance was similar to that of AC Barrie and better than that of 06FL-1, it was not significantly different from 5602HR, Waskada, and Carberry (Table 2). Additionally, 00Ar134-1 was also resistant to leaf and stem rust (Table 2).

QUALITY: The grain protein concentration of 00Ar134-1 was similar to that of all checks (Table 3). Hagberg falling number for 00Ar134-1 was similar to that of Carberry and was not significantly different from 5602HR and 06FL-1 (Table 3). The SDS sedimentation value for 00Ar134-1 was significantly higher than that of 06FL-1 and similar that of the other checks (Table 3). Test weight was lower than that of the check cultivars (Table 3).

Availability of propagating material

Small quantities of seed are available from Plant Gene Resources of Canada, Curator of Seed Bank, Saskatoon Research and Development Centre, Agriculture and Agri-Food Canada, 107 Science Place, Saskatoon, SK, Canada S7N 0X2.

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Table 1. Agronomic characteristics of 00Ar134-1 and check cultivars at the Kernen Research Farm of the University of Saskatchewan, 2009-2014^a.

	Grain Yield (kg ha ⁻¹)	Days to maturity	Days to heading	1000- kernel weight (g) ^b	Height (cm)	Lodging (1-9) ^c
AC Barrie	3991	97.3	56.8	37.6	98.2	1.8
5602HR	4256	100.3	57.8	37.8	98.3	1.8
Waskada	4351	97.8	55.3	37.6	101.6	3.9
Carberry	4216	101.0	54.3	37.5	82.3	1.1
06FL-1	4175	96.8	54.0	37.3	97.7	2.8
00Ar134-1	3812	101.2	58.1	36.2	107.3	2.3
LSD _{0.05} ^d	490	2.8	1.7	3.4	3.9	0.4
No. of Station-years	6	6	6	6	6	6

^a06FL-1 was included in 2010.

^bMeasured only for 2009 and 2011.

^c0- Erect and 9- flat to ground level.

^dLeast significance difference, $P \leq 0.05$, includes the appropriate genotype by environment interaction variation.

Table 2. Response of 00Ar134-1 and check cultivars to Fusarium head blight (FHB), bunt, leaf rust, and stem rust in disease nurseries from 2009-2014.

	2009-2014		2009		2010		2011		2012		2013		2014	
	Mean FHB Index	Bunt ^b	LR ^d	SR ^{c,d}	LR	SR	LR	SR	LR	SR	LR	SR	LR	SR
AC Barrie	10	35	80 ^e	Tr	90	-	50	-	90	-	75	Tr	60	Tr
5602HR	13	20	Tr	MR	15	Tr	15	Tr	8	MR	20	MR	5	MR
Waskada	5	17	7	MR	40	-	35	MR	35	Tr	65	MR	70	MR
Carberry	8	17	0	R	25	MR	10	Tr	25	MR	20	MR	0	MR
06FL-1	5	73	- ^a	-	25	Tr	15	Tr	10	MR	20	MR	10	MR
00Ar134-1	6	34	10	Tr	Tr	Tr	20	Tr	2	MR	25	MR	5	MR
FHB37	6	-												
AC Cora	33	-												
CDC Teal	59	-												
No. of station- years	6	5												
LSD _{0.05} ^f	9	23												

^aNo data.

^bPercentage of plants infected with bunt.

^cDisease rating based on percentage of leaf area covered with pustules and host response: R = resistant (<20%), MR = moderately resistant (<40%-50% depending on host response), Tr = traces (<5%). Refer to Peterson et al. (1948) for disease rating scale.

^dLR = leaf rust, SR = stem rust.

^ePercent incidence: Tr (<5% plants infected).

^fLeast significance difference, $P \leq 0.05$, includes the appropriate genotype by environment interaction variation.

Table 3. End-use suitability of 00Ar134-1 and check cultivars measured on 2009 and 2011 grain samples.

	Grain protein concentration ^a (%)	Hagberg falling number (s)	SDS sedimentation (cc) ^b	Test weight (kg hL ⁻¹)
AC Barrie	15.1	416	65.0	80.4
5602HR	15.7	384	70.5	80.6
Waskada	15.1	406	66.0	80.8
Carberry	15.1	362	70.3	80.5
06FL-1	13.9	348	56.7	82.2
00Ar134-1	14.3	362	67.5	78.7
LSD _{0.05} ^c	1.5	28	6.1	1.3
No. of station- years	5	2	2	2

^aGrain protein concentration was measured from 2009-2014 (except 2010). 06FL-1 was included in 2010.

^bData from two years (2009 and 2014).

^cLeast significance difference, $P \leq 0.05$, includes the appropriate genotype by environment interaction variation.