

REQUEST FOR SUPPORT TO REGISTER BW5104**Crop Kind:** Spring Wheat**Type:** Canada Western Red Spring**Proposer:** R.D. Cuthbert, Swift Current Research & Development Centre, AAFC, Swift Current, SK.**Experimental Designations:** BW5104, B1761&AU018

Origin and Breeding: BW5104 is a doubled haploid genotype which derives from the cross AAC Concord/AAC Alida made at the Swift Current Research & Development Centre (SCRDC) of Agriculture and Agri-Food Canada, Swift Current, SK. AAC Concord is a registered variety with complete stem pith expression derived from a cross of Lillian/Journey//9505-LP03A. AAC Alida is a registered CWRS doubled haploid variety derived from the cross Carberry/99B61-AY30B5. The maize pollen doubled haploid (DH) technique was used to produce 910 haploid plantlets which were screened and selected with a molecular marker associated to the *Sst1* locus conferring stem pith expression. A total of 417 haploid plants were selected and retained for chromosome doubling. B1761&AU018 was in the first subset of 235 DH lines developed in 2018. Seed of individual DH lines was inoculated with common bunt and grown in 1.5 m long rows. A rust epiphytotic nursery was established by planting genotypes lacking genes for resistance to prevalent races of leaf and stem rust in every 12th plot and inoculating a sample of plants in each spreader row with representative rust races. Two spikes were selected from each of 67 disease resistant doubled haploid lines that also matured within the range of acceptable maturity and had strong stems of acceptable height. Seed from each head was combined and grown out in 5 m long rows near Temuco, Chile in 2018/19. Lines were harvested as individual rows as a source of seed for subsequent trialling. In 2019, 67 lines were assessed for agronomic performance and were grown in four row plots 3 m long in nurseries near Swift Current, Stewart Valley, SK, and Lethbridge, AB. Response to cutting by the wheat stem sawfly was assessed in a nursery designed to maintain a high population of the wheat stem sawfly. Response to Fusarium head blight was assessed in a specialized nursery near Brandon, MB. Response to stripe rust was assessed in a nursery near Lethbridge, AB. Response to leaf and stem rust was used as a selection criterion by assessing response to the rusts in an epiphytotic nursery near Morden, MB. Response to common bunt was assessed in a bunt nursery near Swift Current. Remnant seed from the yield trials was used to assess grain quality and kernel characteristics. Selected doubled haploid lines were screened for reaction to loose smut.

The above procedure resulted in the identification of the experimental doubled haploid line B1761&AU018 which met all of the selection criteria at each stage of selection. The experimental line B1761&AU018 was evaluated in the Western Bread Wheat 'A_1' test in 2020, and as BW5104 in the Western Bread Wheat C Registration test from 2021 to 2023.

BW5104 is neither a plant with a novel trait nor a genetically modified organism.

Performance and Adaptation:

Area of Adaptation: Wheat growing area of the Canadian prairies.

Strengths:

- Solid stem conferring resistance to wheat stem sawfly
- *Sm1+* orange wheat blossom midge tolerance
- Semi-dwarf with very strong straw
- Resistance to stripe rust, stem rust, leaf rust, and common bunt
- Grain yield within range of checks and not significantly different than AAC Brandon

Neutral traits:

- Test weight similar to checks
- Kernel weight similar to checks
- Intermediate FHB resistance similar to AAC Viewfield

Weakness:

- Grain protein less than checks
- Days to maturity longer than the checks

Description: Expression of the stem solidness trait is based on plants grown in the sawfly nursery near Swift Current in 2023. A subsample of ten stems per replication for each of four replications were split and rated on a 1 (stem cavity hollow and thin walled) to 5 (stem cavity completely filled with pith) scale. BW5104 is an awned experimental line with significantly more stem solidness than Lillian and CDC Landmark (Table 1). Response to stem cutting and toppling by the wheat stem sawfly near Pense, SK is lower than hollow stem checks within the Western Bread Wheat C Registration Test (Table 2).

Grain yield of BW5104 averaged over 34 site years (WBWC 2021-2023) was 1.0% higher than the mean of the checks (Table 3, Table 4) and was not significantly different than AAC Brandon, the highest yielding check (Table 3). Grain protein content of BW5104 was lower than the checks (Table 5). Test weight and seed weight of BW5104 was similar to the checks (Table 5). Resistance to lodging scores were desirably low and numerically lower than all of the checks which indicates very strong straw (Table 5). Plant height was between AAC Brandon and Glenn (Table 5). Days to maturity was later than the checks (Table 5).

Based on standardization $[(\text{observed value} - \text{mean}) / \text{standard deviation}]$ of all of the Fusarium head blight symptoms and deoxynivalenol (DON) data, BW5104 had a similar response to Fusarium head blight with similar levels of DON compared to AAC Viewfield (Table 6, Supplementary Table 1, Figure 1).

BW5104 expresses consistent resistance to prevalent races of leaf rust, stem rust, stripe rust, and common bunt (Table 7). It was determined that BW5104 is resistant to Orange Wheat Blossom Midge (OWBM) through a spike assay at affected WBWC sites in 2021 (Table 8).

BW5104 has quality milling and gluten strength parameters within the range of the checks (Table 9a, 9b). In 2021 and 2022, the end-use quality was deemed suitable for the CWRS market class.

Rationale to Seek Support to Register: Wheat stem sawfly is an increasing problem across the western prairies. Currently there are no CWRS varieties with solid stems to help combat this devastating pest. BW5104 has demonstrated near complete pith expression in stems and has resisted stem cutting and toppling by the wheat stem sawfly. Agronomic performance of BW5104 has been strong with yield not significantly different from the highest yielding check AAC Brandon. BW5104 expresses resistance to leaf rust, stem rust, stripe rust and common bunt. FHB reaction under epidemic nursery conditions has been intermediate and similar to AAC Viewfield. BW5104 has exhibited resistance to orange wheat blossom midge. BW5104 has high milling yield, desirably high falling number and gluten strength parameters within the range of the CWRS market class checks. Based on the data generated for BW5104, it would be a major benefit to farmers in areas of the prairies experiencing wheat stem sawfly outbreaks and drought stress.

Seed Stocks:

A random set of 72 single plants were selected in 2021 from a space planting of B1761&AU018 near Swift Current, SK. These were grown out as 72 Breeder Lines in hills in isolation near Irwell, New Zealand during 2021-22. The 72 lines were grown out again as 15 m rows near Indian Head, SK in 2022. Through final inspection and rogueing, 7 lines were removed. A total of 65 lines constitute the Breeder Seed. Approximately 500 kg of Breeder Seed was produced in 2022. The Breeder Seed was increased in 2023 near Indian Head, SK and produced about 1700 kg. To accelerate seed production, Breeder Seed was used to establish an seed increase near Irwell, New Zealand during 2023-24. Total seed stock available spring 2024 is approximately 400 kg of 2022 Breeder Seed, 400 kg of 2023 Breeder seed as well anticipated harvest of additional Breeder Seed and Foundation Seed from the 2023-24 New Zealand increase. Breeder Seed will be maintained by the Seed Increase Unit of the Research Farm, Indian Head, SK, SOG 2K0.

Table 1: Stem solidness rating of each of four internodes of BW5104 and checks on plants grown in Western Bread Wheat C Registration Test near Swift Current, SK., 2023. Letters indicate Duncan Grouping for trait ($p < 0.05$).

Entry	Internode 1 ^a	Duncan's Grouping	Internode 2 ^a	Duncan's Grouping	Internode 3 ^a	Duncan's Grouping	Internode 4 ^a (Peduncle)	Duncan's Grouping	Mean ^a	Duncan's Grouping
Glenn	2.4	B	2.0	C	1.7	C	1.6	C	1.9	DE
Carberry	2.4	B	1.8	C	1.5	C	1.5	C	1.8	DE
AAC Brandon	2.5	B	2.0	C	1.8	C	1.5	C	1.9	DE
AAC Penhold	2.2	B	1.9	C	1.7	C	1.5	C	1.8	DE
Faller	2.2	B	2.0	C	1.5	C	1.5	C	1.8	DE
CDC Landmark	2.3	B	2.0	C	1.9	BC	2.9	B	2.4	CD
AC Eatonia	4.0	A	3.8	A	3.5	A	3.4	B	3.7	B
Lillian	2.7	B	2.9	B	2.5	B	3.0	B	2.8	C
BW5104	4.2	A	4.3	A	4.1	A	4.4	A	4.3	AB
LSD _{0.05}	0.4		0.4		0.3		0.4		0.3	

^a Solidness rated on a 1 (stem cavity hollow and thin walled) to 5 (stem cavity completely filled with pith) scale. Analysis of solidness rating based on a subsample of 10 plants per replication of each of 4 reps.

Table 2: Mean visual assessment of percentage yield plot cut over three replicates by wheat stem sawfly in Western Bread Wheat C Registration Test near Pense, SK., 2023.

Entry	% Plot Cutting
Glenn	30.0
Carberry	30.0
AAC Brandon	26.7
AAC Penhold	30.0
Faller	35.0
BW5104	18.3
LSD _{0.05}	9.9

Table 3: Grain yield (kg ha⁻¹) and agronomic characteristics of BW5104 compared to check cultivars and mean of the check cultivars in the Western Bread Wheat C Registration Test, 2021-2023

Entry	Zone 1 ^a			Zone 2			Zone 3			2021-2023
	2021	2022	2023	2021	2022	2023	2021	2022	2023	
Glenn	2467	2748	2449	2517	4234	4513	4562	6222	5663	4050
Carberry	2610	2543	2855	2824	4328	4396	4417	6083	5637	4066
AAC Viewfield	2737	3181	-	2892	4821	-	5080	6395	-	-
AAC Brandon	2892	2651	2884	2943	4618	4806	4722	5941	6076	4309
Check Mean	2676	2781	2729	2794	4500	4572	4695	6160	5792	4142
BW5104	2539	2744	2934	2776	4507	4619	4548	5904	6441	4191
LSD _{0.05}	227	273	294	255	233	257	666	652	980	278
Site years	2	1	1	5	8	7	2	4	4	34

^a **Zone 1:** Swift Current (2021-22), Stewart Valley (2021, 2023); **Zone 2:** Indian Head, Lethbridge (2022-23), Kernen, Goodale, Pense (2022-23), Neapolis (2022-23), Scott, Watrous (2021-22), Yorkton (2022-23); **Zone 3:** Edmonton (2020, 2022), Lacombe, Melfort, Yorkton (2022-23).

Table 4: Grain yield as a percent of Check Mean of individual check cultivars and BW5104 in the Western Bread Wheat C Registration Test, 2021-2023

Entry	Zone 1 ^a			Zone 2			Zone 3			2021-2023
	2021	2022	2023	2021	2022	2023	2021	2022	2023	
Glenn	92	99	90	90	94	99	97	101	98	98
Carberry	98	91	105	101	96	96	94	99	97	98
AAC Viewfield	102	114	-	103	107	-	108	104	-	-
AAC Brandon	108	95	106	105	103	105	101	96	105	104
Check Mean	100	100	100	100	100	100	100	100	100	100
BW5104	95	99	107	99	100	101	97	96	111	101

^a **Zone 1:** Swift Current (2021-22), Stewart Valley (2021, 2023); **Zone 2:** Indian Head, Lethbridge (2022-23), Kernen, Goodale, Pense (2022-23), Neapolis (2022-23), Scott, Watrous (2021-22), Yorkton (2022-23); **Zone 3:** Edmonton (2020, 2022), Lacombe, Melfort, Yorkton (2022-23).

Table 5: Three year averages for agronomic characteristics of BW5104 compared to the check cultivars in the Western Bread Wheat C Registration test, 2021-2022

Entry	Maturity (days)	Height (cm)	Lodging (1-9)	Test Weight (KghL ⁻¹)	Thousand Kernel Weight (mg)	Protein (%)
Glenn	91.6	80	2.2	83.6	33.3	14.7
Carberry	91.7	76	1.8	81.7	34.9	14.8
AAC Brandon	91.7	75	2.7	81.4	34.4	14.8
Check Mean	91.7	77	2.2	82.2	34.2	14.8
BW5104	93.2	78	1.7	81.1	33.1	14.1
LSD ^a	1.2	3	1.5	0.6	1.7	0.4
Stations	31	33	5	34	34	34

^a Appropriate LSD to make comparisons of BW5104 to Glenn, Carberry, and AAC Brandon at p< 0.05 level of statistical significance. The LSD includes the appropriate genotype by environment interaction.

Table 6: Fusarium head blight reactions of BW5104 and check cultivars grown in the Western Bread Wheat C Registration Test, 2021-2023

2021	Morden				Carman					Ottawa
Entry	VRI % ^a	VRI Rating ^b	DON ^c (ppm)	DON Rating ^d	VRI % ^a	VRI Rating ^e	FDK ^f	DON ^c (ppm)	DON Rating ^g	VRI % ^a
Glenn	0	R	0.8	R	17	I	0.3	1.1	MR	26.3
Carberry	2	R	0.7	R	8	R	0.3	0.6	MR	46.7
AAC Viewfield	8	I	1.3	R	12	MR	0.1	1.2	MR	45.0
AAC Brandon	1	R	0.5	R	16	I	0.3	0.7	MR	40.7
BW5104	14	I	3.7	MR	13	MR	1.0	1.5	MR	32.5

^a VRI = Visual Rating Index = (percentage of infected heads x percentage of diseased florets on infected heads)/100

^b Morden 2021 VRI Rating Scale: R<=1.9, MR=2.0-7.0, I=7.1-16.7, MS=16.8-31.9, S=>32

^c DON = Deoxynivalenol (ppm)

^d Morden 2021 DON Rating Scale: R<=1.9, MR=2.0-3.7, I=3.8-6.8, MS=6.9-12.3, S=>12.4

^e Carman 2021 VRI Rating Scale: R<8.1, MR=8.2-14.7, I=14.8-29.4, MS=29.5-41.4, S>41.5

^f FDK = Fusarium Damaged Kernels

^g Carman 2021 DON Rating Scale: R<0.5, MR=0.6-1.6, I=1.7-2.5, MS=2.6-3.8, S>3.9

Table 6: continued

2022	Morden				Carman					Indian Head
Entry	VRI % ^a	VRI Rating ^h	DON ^c (ppm)	DON Rating ⁱ	VRI % ^a	VRI Rating ^j	FDK ^f	DON (ppm)	DON Rating ^k	VRI % ^a
Glenn	15	I	7.3	MR	23	MR	6.3	8.4	MR	4.3
Carberry	9	MR	9.0	I	29	MR	5.6	16.5	I	4.3
AAC Viewfield	25	I	10.7	MS	40	I	12.4	32.7	MS	4.7
AAC Brandon	11	I	7.5	MR	29	MR	3.7	10.9	I	2.7
BW5104	22	I	11.7	MS	44	I	6.5	18.9	I	9.7

^a VRI = Visual Rating Index = (percentage of infected heads x percentage of diseased florets on infected heads)/100

^c DON = Deoxynivalenol (ppm)

^f FDK = Fusarium Damaged Kernels

^h Morden 2022 VRI Rating Scale: R<=5.0, MR=5.1-10.3, I=10.4-25.3, MS=25.4-42, S=>42.1

ⁱ Morden 2022 DON Rating Scale: R<=3.2, MR=3.3-8.0, I=8.1-10.5, MS=10.6-25.9, S=>26

^j Carman 2022 VRI Rating Scale: R<=14.8, MR=14.9-30.4, I=30.5-45.4, MS=45.6-64.5, S=>64.6

^k Carman 2022 DON Rating Scale: R<=5.7, MR=5.8-10.6, I=10.7-22.3, MS=22.4-37.3, S=>37.4

Table 6: continued

2023	Morden				Carman					Indian Head			Ottawa
Entry	VRI % ^a	VRI Rating ^l	DON ^c (ppm)	DON Rating ^m	VRI % ^a	VRI Rating ⁿ	FDK ^f	DON ^c (ppm)	DON Rating ^o	VRI % ^a	FDK ^f	DON ^c (ppm)	VRI % ^a
Glenn	10	MR	10.7	MR	2.0	MR	1.9	1.4	I	31	15	8	18
Carberry	18	I	16.6	I	1.0	MR	1.0	1.0	MR	41	22	16	9
AAC Brandon	25	I	11.9	MR	2.0	MR	1.6	0.9	MR	59	29	10	30
BW5104	28	I	30.6	I	4.0	I	2.8	1.9	I	46	43	42	28

^a VRI = Visual Rating Index = (percentage of infected heads x percentage of diseased florets on infected heads)/100

^c DON = Deoxynivalenol (ppm)

^f FDK = Fusarium Damaged Kernels

^l Morden 2023 VRI Rating Scale: R<=7.5; MR=7.6-16.9; I=17.0-28.2; MS=28.3-47.1; S=>47.2

^m Morden 2023 DON Rating Scale: R<=6.3; MR=6.4-16.5; I=16.6-3.9; MS=35.0-42.3; S=>42.4

ⁿ Carman 2023 VRI Scale: R=0-0.52; MR=0.53-3.63; I=3.64-12.99; MS= 13.0-23.14; S=>23.15

^o Carman 2023 DON Rating Scale: R=0-0.28; MR=0.29-1.07; I=1.08-4.02; MS=4.03-8.10; S=>8.11

Supplementary Table 1: Visual symptoms, and DON accumulation of BW5104 and checks based on four reps in the 2022 Fusarium head blight nurseries near Morden, MB, and Indian Head, SK.

Entry	Indian Head			Morden	
	VRI % ^a	DON ^b (ppm)	FDK ^c	DON ^b (ppm)	FDK ^c
AAC Tenacious	0.0	3.0	4.9	1.4	2.4
AAC Hockley	4.9	27.8	34.0	4.7	8.1
AAC Starbuck	1.4	25.8	28.1	7.5	13.3
Glenn	7.9	31.2	35.3	9.4	13.0
Carberry	9.5	33.1	37.9	7.4	14.4
AAC Viewfield	11.8	85.0	55.4	9.3	12.8
AAC Brandon	8.4	46.1	47.8	8.1	13.0
Lillian	22.7	70.3	56.5	13.0	26.4
BW5104	6.6	92.2	59.4	14.1	16.1
LSD _{0.05} ^d	6.4	29.0	8.0	4.9	6.0

^a VRI = Visual Rating Index = (percentage of infected heads x percentage of diseased florets on infected heads)/100

^b DON = Deoxynivalenol (parts per million)

^c FDK = Percent Fusarium damaged kernels

^d Least Significant Difference (LSD) p< 0.05.

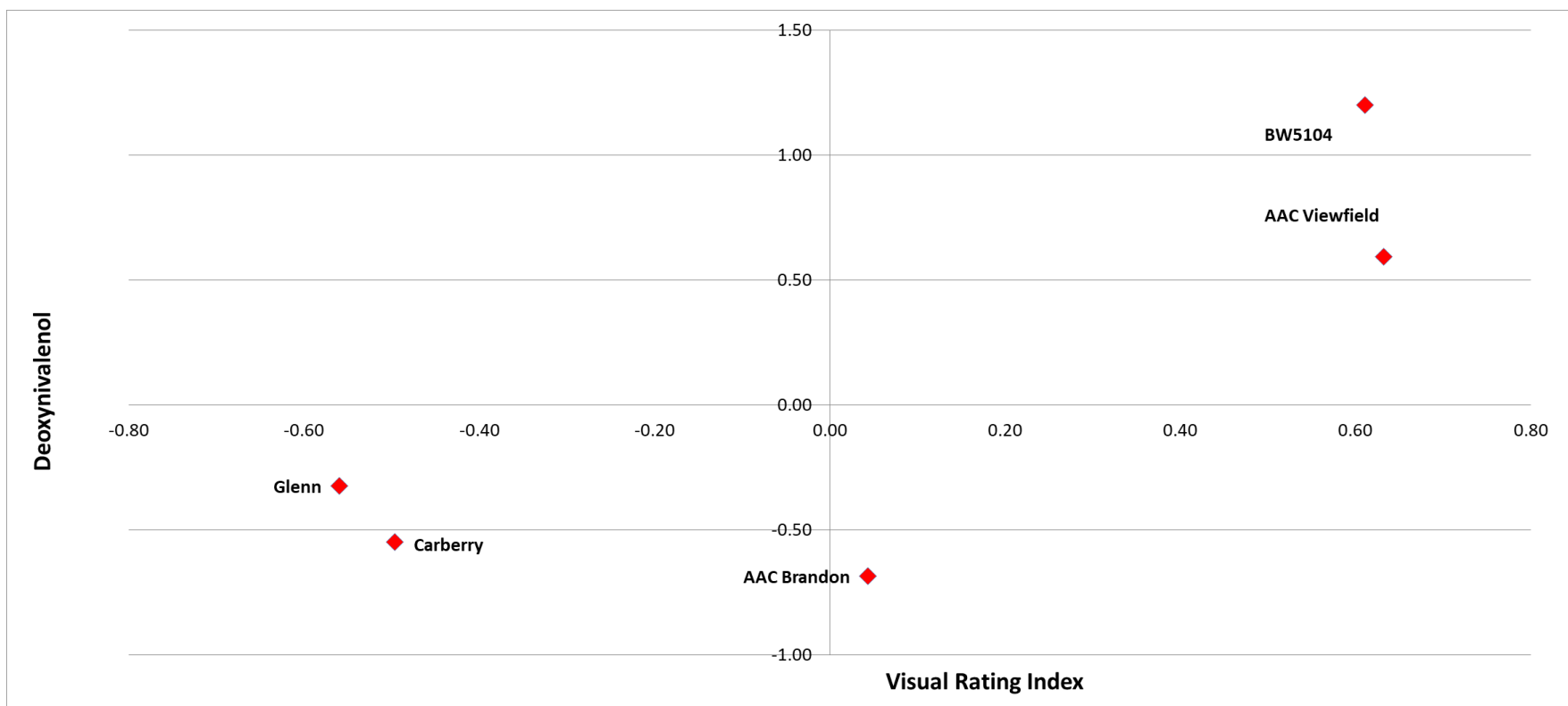


Figure 1. Horizontal axis is standardized values of 11 Fusarium head blight Visual Rating Index scores, and vertical axis is standardized values of 10 DON values. Data generated in FHB nurseries in Canada from 2021 to 2023 and is summarized in Table 6 and Supplemental Table 1.

Table 7: Disease reactions of BW5104 and check cultivars grown in the Western Bread Wheat C Registration Test, 2021-2023

Entry	Field Leaf Rust						Field Stem Rust			
	2021		2022		2023		2022		2023	
	Severity (%)	Rating ^a	Severity (%)	Rating ^a	Severity (%)	Rating ^a	Severity ^b	Rating ^c	Severity ^b	Rating ^c
Glenn	12	MR	38	I	6	R	1	R	1	R
Carberry	1	R	3	R	1	R	1	R	1	R
AAC Viewfield	11	MR	27	MR	-	-	1	R	-	-
AAC Brandon	8	R	17	MR	6	R	1	R	1	R
BW5104	0	R	0.0	R	0	R	1	R	1	R

^a Leaf rust rating scale based on severity: 0-10 R, 11-30 MR, 31-39 I, 40-60 MS, >60 S

^b Severity= Percent of the stem infected with stem rust using the Modified Cobb Scale.

^c Stem Rust Disease response: R=resistant, MR=moderately resistant, MS=moderately susceptible, and S=susceptible. I=intermediate in reaction

Table 7: Continued

Entry	Stripe Rust					Common Bunt					
	2022			2023		2021		2022		2023	
	Severity Rep 1 (%)	Severity Rep 2 (%)	Rating ^d	Severity (%)	Rating ^d	Severity (%)	Rating ^e	Severity (%)	Rating ^f	Severity (%)	Rating ^g
Glenn	20	15	MR	60	S	4	R/MR	14	I	11	I
Carberry	10	2	R	5	R	1	R/MR	10	MR	3	R
AAC Viewfield	25	5	MR	-	-	2	R/MR	58	S	-	-
AAC Brandon	15	5	MR	53	S	13	I	10	MR	12	I
BW5104	1	2	R	0	R	3	R/MR	2	R	0	R

^d Stripe Rust Rating: R<=10, MR 11-25, I 26-40, MS 41-49, S>=50

^e 2021 Bunt Rating: R/MR=<=4, I= 5-19, MS=20-34, S=35-100

^f 2022 Bunt Rating: R<5; MR= 5-11; I= 12-29; MS= 30-38; S>38

^g 2023 Bunt Rating: R<5; MR= 5-9; I= 10-20; MS= 21-26; S>26

Table 8: Orange Wheat Blossom Midge reactions of BW5104 and check cultivars grown in the Western Bread Wheat C Registration Test, 2021

Entry	2021				Reaction
	R ^a	S ^a	U ^a	T ^a	
Glenn	0	30	30	60	Susceptible
Carberry	0	40	20	60	Susceptible
AAC Viewfield	0	37	23	60	Susceptible
AAC Brandon	0	37	23	60	Susceptible
BW5104	13	0	47	60	Resistant

^a Each wheat head assessed separately and rated as either Resistant (R), Susceptible (S), or Undamaged (U) from a Total number of heads assessed (T). For lines classified as resistant, the seeds have been fed upon and damaged by the midge larva, however, no larva survive on the kernel. All seeds in the head are examined to ensure that it is truly resistant. The lines classified as susceptible have been fed upon and severely damaged by the midge larva and either the 3rd instar or the cast skin is present on the seed. As soon as one midge and related damage is observed, the head is classified as susceptible and the head is discarded. The lines classified as undamaged show no signs of midge feeding and also there are no midge/skins present. All seeds in these heads are examined to make sure they are all undamaged. Heading date and head selection play a big role in getting undamaged lines in areas where there is good midge pressure. Some lines display a combination of all three results and could be a factor of segregating genetics, volunteer heads collected, and, very importantly, heading date in relation to midge emergence in the field. Please note lines that are resistant will still display damaged seeds initially as the midge die after feeding on the seeds.

Table 9a: Summary of milling properties, using 74% extraction flour for all flour testing, of BW5104 and check cultivars and mean of the check cultivars based on the Western Bread Wheat C Registration Test, 2021-2023

Variety	Wheat and Flour Characteristics					Milling Performance			
	Wheat Protein (%)	Flour Protein (%)	Protein Loss (%)	Hagberg Falling Number (seconds)	Amylograph Viscosity (BU) Peak	Clean Wheat Flour Yield (%)	Flour Yield PB 0.50 Ash (%)	Flour Ash (%)	Starch Damage (%)
2021									
Glenn	14.8	14.1	0.6	305	573	74.7	79.0	0.40	7.7
AAC Viewfield	14.6	14.0	0.6	391	613	75.8	79.0	0.40	7.5
Carberry	14.7	13.7	1.0	385	587	75.4	79.5	0.39	7.2
AAC Brandon	15.1	14.2	0.9	331	427	76.0	79.5	0.39	7.3
2021 Mean of Checks	14.7	13.9	0.7	360	590	75.3	79.2	0.40	7.5
BW5104	14.1	13.4	0.7	402	510	76.7	79.0	0.40	8.0
2022									
Glenn	15.2	14.4	0.8	363	792	75.6	78.5	0.41	8.2
AAC Viewfield	14.7	13.9	0.8	439	728	75.1	78.0	0.42	7.6
Carberry	15.3	14.1	1.2	409	557	75.2	78.0	0.42	7.7
AAC Brandon	15.1	14.2	0.9	418	724	76.0	78.5	0.41	7.8
2022 Mean of Checks	15.1	14.1	0.9	405	690	75.3	78.2	0.42	7.8
BW5104	14.6	13.8	0.9	423	633	76.1	78.0	0.42	8.1
2023									
Glenn	14.4	13.7	0.6	362	567	75.5	79.5	0.39	8.3
Carberry	14.2	13.4	0.8	368	498	76.8	80.5	0.37	7.6
AAC Brandon	14.2	13.5	0.8	330	446	77.5	79.5	0.39	7.9
2023 Mean of Checks	14.3	13.5	0.7	353	504	76.6	79.8	0.38	7.9
BW5104	13.6	12.9	0.7	364	430	77.8	79.0	0.40	8.3

Table 9b: Summary of rheological and baking properties, using a 74% extraction flour for all flour testing, of BW5104 and check cultivars and mean of the check cultivars based on the Western Bread Wheat C Registration Test, 2021-23

Variety	Dough Characteristics						Baking Quality				
	Farino ^a Abs (%)	Farino ^a DDT (min.)	Farino ^a Stab (min.)	EXT ^b Area (cm ²)	EXT ^b Rmax (BU)	EXT ^b Length (cm)	Lean No Time (LNT) ^c Method				
							Abs (%)	Peak Time (min)	Mixing Energy (Wh/kg)	LV (cc)	LTR
2021											
Glenn	63.1	10.5	18.5	172	823	17.8					
AAC Viewfield	62.9	9.5	22.5	140	639	17.9					
Carberry	61.7	8.8	15.0	150	689	17.8					
AAC Brandon	65.0	8.5	12.5	117	476	19.4					
2021 Mean of Checks	62.6	9.5	18.5	154	717	17.8					
BW5104	62.0	9.0	36.0	158	850	15.5					
2022											
Glenn	65.8	8.8	11.5	156	660	19.2	74	3.9	11.4	805	0.55
AAC Viewfield	64.9	7.8	11.5	121	485	19.5	72	3.3	8.8	715	0.45
Carberry	64.6	6.3	7.5	104	393	20.5	72	3.2	7.5	710	0.47
AAC Brandon	67.0	7.0	8.5	82	327	19.3	74	2.9	8.8	755	0.41
2022 Mean of Checks	65.1	7.5	10.0	127	513	19.7	73	3.5	9.2	745	0.49
BW5104	63.9	7.3	11.0	126	559	18.2	71	4.0	9.6	760	0.54
2023											
Glenn	64.9	8.5	15.7	171	804	17.9	74	4.4	10.8	823	0.63
Carberry	63.0	7.0	10.5	149	618	19.8	72	4.1	11.1	770	0.60
AAC Brandon	65.6	7.1	9.9	111	462	19.6	75	3.4	8.9	784	0.48
2023 Mean of Checks	64.5	7.5	12.0	144	628	19.1	74	4.0	10.3	792	0.57
BW5104	62.9	6.3	12.0	126	610	17.5	72	4.7	12.1	799	0.61

^a Farinograph (Farino) descriptors: Abs = Water Absorption; DDT = Dough Development Time; MTI = Mixing Tolerance Index; Stab = Stability

^b Extensograph (EXT) descriptors: Rmax = maximum resistance;

^c Lean No Time (LNT): Abs = Water Absorption; WHR/KG = Watt-hour per kilogram; LV = Loaf volume; LTR = Loaf Top Ratio