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CULTIVAR DESCRIPTION

AAC Ryley Canada Prairie Spring Red wheat

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Abstract: AAC Ryley is an awned semidwarf hard red spring wheat (*Triticum aestivum* L.) that yielded significantly more grain than check cultivar 5700PR while maturing 1.9 d earlier and growing 5 cm taller. The seed size was significantly larger than 5700PR and 5701PR but the test weight was significantly lower than both checks. AAC Ryley expressed resistance to prevalent races of leaf rust, stem rust, and common bunt. AAC Ryley expressed intermediate resistance to loose smut and moderate susceptibility to *Fusarium* head blight. AAC Ryley is eligible for grades of Canada Prairie Spring Red wheat.

Key words: Triticum aestivum L., wheat, cultivar description, grain yield, disease resistance, semidwarf, grain quality.

Résumé : AAC Ryley est une variété demi-naine et barbue de blé roux de printemps (*Triticum aestivum* L.) dont le rendement dépasse sensiblement celui du témoin 5700PR, même si elle parvient à maturité 1,9 jour plus tôt et mesure 5 cm de plus. Les graines sont d'un calibre significativement plus élevé que celles des témoins 5700PR et 5701PR, mais leur poids spécifique est nettement plus faible. AAC Ryley résiste aux races communes de la rouille des feuilles, de la rouille de la tige et de la carie. La variété exprime aussi une résistance moyenne au charbon nu ainsi qu'une sensibilité moyenne à la brûlure de l'épi causée par *Fusarium*. AAC Ryley est admissible au classement dans la catégorie « blé roux de printemps Canada Prairie ». [Traduit par la Rédaction]

Mots-clés : Triticum aestivum L., blé, description de cultivar, rendement grainier, résistance à la maladie, demi-nain, qualité du grain.

Introduction

AAC Ryley, a hard red spring wheat (*Triticum aestivum* L.) cultivar, was developed at the Swift-Current Research and Development Centre (SCRDC), Agriculture and Agri-Food Canada (AAFC), Swift Current, SK. It received registration No. 7363 from the Variety Registration Office, Plant Production Division, Canadian Food Inspection Agency (CFIA, Ottawa, ON) on 23 Apr. 2013. AAC Ryley was granted Plant Breeders' Rights certificate No. 4960 by the Plant Breeders' Rights Office, CFIA, on 26 Nov. 2014.

Breeding Methods and Pedigree

AAC Ryley derives from the cross AC Vista/Alsen//HY485 made in 2003 at SCRDC, AAFC in Swift Current, SK. AC Vista derives from the cross HY344/Losprout 'S'//HY358*3/BW553 (DePauw et al. 1998). Alsen (Frohberg et al. 2006) derives from the cross of ND674/ND2710//ND688. HY485 is a breeding line developed at SCRDC from the cross CD87/AC Vista//9127:CS7C.

In 2004, about 6650 F_2 seeds were inoculated with common bunt [*Tilletia laevis* Kühn in Rabenh., and *T. tritici* (Bjerk.) G. Wint. in Rabenh.] races L16 and T19 (Hoffmann and Metzger 1976) and planted 10 cm apart in 90 m long rows. The rows were 23 cm apart with every second row planted with CDC Kestrel winter wheat (Fowler 1997), which is susceptible to leaf rust (*Puccinia triticina* Eriks.) and stem rust (*P. graminis* Pers.:Pers. f. sp. *tritici* Eriks. & E. Henn.). A leaf rust and stem rust epiphytotic nursery was established by planting genotypes susceptible to prevalent races of leaf and stem rust in every fifth spring wheat row and needle inoculating a sample of these plants followed by regular sprinkler irrigation.

Received 12 October 2016. Accepted 24 November 2016.

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Representative leaf rust races found the previous year were applied (McCallum and Seto-Goh 2006). The stem rust races used were QTHST (C25), RHTSK (C20), RKQSR (C63), RTHJT (C57), TMRTK (C10), and TPMKR (C53) (Roelfs and Martens 1988; Fetch 2005). From the disease nursery, 311 disease-free, semidwarf stature, strong straw and early maturing F_2 plants were selected, threshed individually, and further selected for healthy disease-free kernel characteristics.

The F_3 seed of 193 F_2 derived individuals was planted in 2 m long rows in a contra-season nursery near Lincoln, New Zealand. From these, 121 lines were selected on the basis of time to maturity comparable to the check commercial cultivars, plant height, straw strength, and shattering, and were harvested as individual rows. In the F_4 generation, seed of the 101 lines were grown in four-row plots with a harvested area of 2.76 m^2 near Swift Current, Indian Head, and Regina, SK, to assess agronomic performance. A single row of each F_4 line was also grown near Lacombe, AB, to select for adaptation to conditions in Central Alberta. Agronomic plots were harvested at maturity and the grain weight of each plot was measured. Seed weight and kernel attributes were measured on the same whole grain sample. A subsample was submitted to the Central Quality Lab, Cereal Research Centre (CRC), AAFC, Winnipeg, MB, to determine end-use suitability for the Canada Prairie Spring Red market class. Prior to harvest, five spikes had been collected from yield trial plots of each F_4 line at Swift Current, and up to 10 heads from F_4 rows that expressed adaptation to central Alberta were selected at Lacombe.

The best 33 families with 4–7 lines per family were grown as the F_5 generation in 2 m long rows near Irwell, New Zealand. Selection among families was based on grain quality and kernel attributes assayed on remnant seed from the F_4 yield trial. Experimental lines within acceptable families were selected on the same basis as in F_3. In the $F_{4:6}$ generation, 141 lines were evaluated in agronomic trials near Swift Current and Indian Head, SK, and Lethbridge, AB, following a protocol similar to that of the F_4 generation. Five spikes were collected from plots of each F_6 line grown near Swift Current prior to harvest. The same agronomic and end-use quality variables were measured in the F_6 as the F_4. In the F_7 generation, 49 families at 5 lines per family were grown as 2 m long rows near Irwell. Families were selected on the basis of grain quality and kernel attributes assayed on grain from the F_6 yield trial. In the $F_{6:8}$ generations, 101 lines were grown in agronomic trials near Swift Current, Indian Head, and Lethbridge. Grain was harvested and processed similarly to grain from the F_6 plots. In the F_4, F_6, and F_8 generations, reaction to leaf and stem rust was used as a selection criterion based on results of an epiphytotic nursery near Glenlea, MB. In the F_6 and F_8 generations, response to *Fusarium* head blight (FHB) was assessed in an FHB nursery near

Table 1. Grain yield of AAC Ryley compared with the check cultivars in the High Yield Wheat Cooperative test, 2009–2011.

	Yield (kg ha^{-1})												
	Zone 1[a]			Zone 2			Zone 3			Zone 4			Mean[b]
	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009–2011
5700PR	5701	3005	3607	4315	4402	4752	5764	5603	5423	6657	2420	3682	4659
5701PR	5702	3619	4232	4240	4355	5530	5704	5365	5692	5350	3775	6953	4925
Mean of checks	5701	3312	3920	4278	4378	5141	5734	5484	5558	6003	3098	5318	4792
AAC Ryley	6042	3679	4360	4376	4148	5382	5913	5717	5740	7107	3441	5463	5025
CV[c]	6.9	7.4	6.6	4	7.8	4.5	5.7	5.5	7.6	5.6	14.7	4.5	—
$LSD_{0.05}$[d]	288	191	298	124	271	234	254	241	522	553	807	510	229
No. of trials	5	5	4	5	4	4	4	4	4	1	1	1	42

[a]Zone 1 locations: Brandon, Glenlea, Indian Head, Rosebank, and Souris; Zone 2 locations: Beiseker, Kernen, Regina, Scott, Swift Current, and Three Hills; Zone 3 locations: Beaverlodge, Ellerslie, Lacombe, and Melfort; Zone 4 locations: Lethbridge (irrigated).
[b]Means are based on LS Means procedure of SAS. —, no value.
[c]Coefficient of variation.
[d]Least significant difference, $P \le 0.05$, includes the appropriate genotype × environment interaction variation.

Table 2. Three year means[a] for agronomic characteristics of AAC Ryley compared with the check cultivars in the High Yield Wheat Cooperative test, 2009–2011.

	Maturity (d)							
	2009	2010	2011	Mean	Height (cm)	Lodging[b] (1–9)	Test weight (kg hL^{-1})	Kernel size (mg)
5700PR	110.9	116.6	106.1	111.8	79.7	1.5	78.0	39.3
5701PR	109.7	114.6	104.4	110.2	81.5	1.8	76.7	39.4
Mean of checks	110.3	115.6	105.3	111.0	80.6	1.7	77.4	39.4
AAC Ryley	109.8	114.6	103.1	109.9	84.7	2.0	76	45.3
$LSD_{0.05}$[c]	0.6	0.8	3.0	1.5	2.6	0.5	0.6	2.1
No. of trials	14	12	8	34	40	14	32	32

[a]Means are based on LS Means procedure of SAS.
[b]Lodging rated on a scale of 1 (indicating that all plants in plot are erect) to 9 (indicating that all plants in a plot are lying horizontal).
[c]Least significant difference, $P \leq 0.05$, includes the appropriate genotype × environment interaction variation.

Portage la Prairie, MB. Selected F_8 lines were screened for reaction to a mixture of races T2, T9, T10, and T39 of loose smut [*Ustilago tritici* (Pers.) Rostr.] (Nielsen 1987) and races L16 and T19 of common bunt. Through this breeding process, the experimental line C0302-GB26E met all selection criteria at each generation.

C0302-GB26E was evaluated in the High Yield Wheat B test in 2008, and entered into the High Yield Wheat Co-operative (HYWC) test for 2009–2011 as HY1312. Annually, the HYWC consisted of 28 experimental lines and two check commercial cultivars grown in a 5 × 6 lattice design with three replications at up to 13 locations per year. The check cultivars were 5700PR and 5701PR. The variables measured and protocols followed in the HYWC test were described in the operating procedures of the Prairie Recommending Committee for Wheat, Rye and Triticale (Anonymous 2013). The MIXED procedure of SAS® (Littell et al. 2006) was used to perform yearly analyses for agronomic data with environments and their interactions considered random effects and cultivar treated as a fixed effect. Mean separation tests were performed using Fisher's protected least significant difference (LSD) procedure.

Response to several diseases was assessed in specialized disease nurseries from 2009–2011. Leaf and stem rust seedling infection types were assessed using stem rust races QTHST (C25), RHTSK (C20), RKQSR (C63), RTHJT (C57), TMRTK (C10), and TPMKR (C53) (Roelfs and Martens 1988; Fetch 2005), and leaf rust races MBDS (12-3), MBRJ (128-1), MGBJ (74-2), TDBG (06-1-1), TDBJ (70-1), and TJBJ (77-2) (McCallum and Seto-Goh 2006). Field evaluations of leaf and stem rust reactions, using leaf rust races representative of those found the previous year and the same stem rust races as for the seedling tests, were measured annually in epiphytotic nurseries near Glenlea. Reaction to FHB was assessed in artificially inoculated field tests conducted annually near Glenlea and Carman, MB, Ottawa, ON, Lévis, QC, and Charlottetown, PEI (Gilbert and Woods 2006). To determine the response to loose smut, a mixture of the prevalent races T2, T9, T10, and T39 was injected into florets at anthesis of plants grown in the field and the inoculated seed subsequently grown out and rated in a greenhouse (Menzies et al. 2003). To determine the response to common bunt, a mixture of prevalent races L1, L16, T1, T6, T13, and T19 was used to inoculate the seed planted in mid-April of each year near Lethbridge (Gaudet and Puchalski 1989). The race designations are those described by Nielsen (1987) for loose smut and Hoffmann and Metzger (1976) for common bunt.

A grain sample of HY1312 and the check cultivars from each location was submitted to the Canadian Grain Commission to determine grain grade and protein concentration. End-use suitability was determined on a composite sample made up from sites with grain samples representative only of the top Canada Prairie Spring wheat grades available. The quantity of grain from a location was adjusted to achieve a final composite protein concentration approximating that of the average for the crop that year. A consistent quantity of grain within a location for all experimental lines was used to make up the composite each year. All end-use suitability analyses were performed by personnel at the Grain Research Laboratory, Canadian Grain Commission, Winnipeg, MB, following protocols of the American Association of Cereal Chemists (2000).

Performance

AAC Ryley is a high grain yield, red seeded, awned, semidwarf experimental line. Averaged over 42 trials in 3 yr, AAC Ryley yielded more than the mean of the check cultivars (Table 1). AAC Ryley yielded 4.9% more the mean of the check cultivars and 7.9% more than 5700PR. The maturity of AAC Ryley was 2 d earlier than 5700PR (Table 2). AAC Ryley was 5 cm taller than 5700PR and 3 cm taller than 5701PR. Lodging of AAC Ryley was similar to the checks. The test weight of AAC Ryley was less than the checks (Table 2); however, the seed size of AAC Ryley was significantly larger than both 5700PR and 5701PR (Table 2).

Table 3. Reactions of AAC Ryley and check cultivars to leaf, stem, and yellow rust, common bunt, and loose smut in the High Yield Wheat Cooperative test, 2009–2011, grown at various locations.

	Field leaf rust					
	2009[a]		2010		2011	
	Severity	Rating	Severity	Rating	Severity	Rating
5700PR				S/R	10	R
5701PR	0	R	0	R	1	R
AAC Ryley	0	R	0	R	1	R
$LSD_{0.05}$[b]	6	—	10	—	—	—
	Field stem rust					
	2009		2010		2011	
	Severity[c]	Disease response[d]	Severity	Disease response	Severity	Disease response
5700PR	15	RMR	20	R	20	I
5701PR	3	R	7	R	5	R
AAC Ryley	5	R	5	R	5	R
$LSD_{0.05}$	—	—	—	—	—	—
	Yellow rust					
	2010				2011	
	Lethbridge		Creston		Lethbridge	
	Severity[e]	Reaction[f]	Severity	Reaction	Severity	Reaction
5700PR	5	R	2	S	30	I
5701PR	5	R	15	I	17	I
AAC Ryley	40	S	30	S	53	VS
$LSD_{0.05}$	—	—	—	—	—	—
	Common bunt					
	Lethbridge					
	2009		2010		2011	
	Infection[g]	Reaction	Infection	Reaction	Infection	Reaction
5700PR	4	R	2	R/MR	10	MR
5701PR	6	MR	21	MS	18	I
AAC Ryley	0	R	0	R/MR	0	R
$LSD_{0.05}$	14	—	19	—	10	—
	Loose smut					
	Glenlea					
	2009		2010		2011	
	Infection[h]	Reaction	Infection	Reaction	Infection	Reaction
5700PR	0	R	16	MR	25	MR
5701PR	32	MR	48	I	38	I
AAC Ryley	39	I	39	I	36	I
$LSD_{0.05}$	—	—	—	—	—	—

[a]Severity is the percentage of leaf area affected by leaf rust. Rating is the descriptive classification of disease based on percent severity: R (resistant) = 0%–10%, MR (moderately resistant) = 11%–30%, I (intermediate resistance) = 31%–39%, MS (moderately susceptible) = 40%–60%, and S (susceptible) > 60%. —, no value.

[b]Least significant difference, $P \leq 0.05$, includes the appropriate genotype × environment interaction variation.

[c]Severity is the percentage of the stem infected with stem rust using the Modified Cobb Scale.

[d]Disease response category: R = resistant, MR = moderately resistant, I = intermediate, MS = moderately susceptible, and S = susceptible. Ratings such as RMR indicate a range in disease response, in this example resistant to moderately resistant.

[e]Severity is the percentage of leaf area affected by stripe rust.

[f]Dominant pustule reaction in the case of yellow rust and descriptive classification in the case of common bunt and loose smut; categories: R = resistant, MR = moderately resistant, I = intermediate, MS = moderately susceptible, S = Susceptible, VS = very susceptible.

[g]Percentage of spikes with common bunt symptoms.

[h]Percentage of plants with loose smut symptoms.

Table 4. Response of AAC Ryley and check cultivars to FHB based on the High Yield Wheat Cooperative tests, 2009–2011, at Glenlea, Carman, Ottawa, Lévis, and Charlottetown.

	Fusarium head blight						
	Glenlea		Carman		Ottawa	Charlottetown	
	Index[a] (%)	Rating[b]	Index (%)	Rating	Score[c] (0–100)	Index (9 Aug.)	Index (12 Aug.)
	2009						
5700PR	40	MS	40	MS	37	—	—
5701PR	36	MS	29	MS	33	—	—
AAC Ryley	41	S	39	MS	38	—	—
$LSD_{0.05}$[d]	15	—	9	6	—	—	—
	2010						
5700PR	24	I	52	S	18	26	64
5701PR	26	MS	49	S	17	25	63
AAC Ryley	12	MR	46	S	39	29	73
$LSD_{0.05}$	20	—	10	—	12	18	20
	2011						
5700PR	14	I	50	MS	42	36	63
5701PR	21	S	43	MS	55	32	64
AAC Ryley	11	I	38	MS	43	49	74
$LSD_{0.05}$	—	—	—	—	9	15	21

[a]*Fusarium* head blight disease index = (percentage of infected heads × percentage of diseased florets on infected heads)/100; —, no value.
[b]Disease response category: R = resistant, MR = moderately resistant, I = intermediate resistance, MS = moderately susceptible, S = susceptible.
[c]*Fusarium* head blight score based on a scale of 1 (no symptoms of blight) to 100 (all florets in all spikes are infected with *Fusarium*).
[d]Least significant difference, $P \leq 0.05$, includes the appropriate genotype × environment interaction.

Table 5. Response of AAC Ryley and check cultivars to DON based on the High Yield Wheat Cooperative tests, 2009–2011, at Glenlea and Charlottetown.

	DON[a] (ppm)				ISD[b]				
					Glenlea				Charlottetown
	Glenlea			Charlottetown	ISD	Rating[g]	ISD	Rating	ISD
	2009	2010	2011	2011	2010		2011		2011
5700PR	24	26	4	25	40	S	4	I	15
5701PR	28	19	6	18	39	MS	5	MS	12
AAC Ryley	29	35	6	18	31	MS	4	I	12

[a]DON, deoxynivalenol.
[b]Incidence severity DON index = [(0.3 × incidence) + (0.3 × severity) + (0.4 × DON)].
[g]Response rating based on ISD. R = resistant, MR = moderately resistant, I = intermediate resistance, MS = moderately susceptible, S = susceptible.

AAC Ryley was resistant to leaf rust, stem rust, and common bunt; intermediately resistant to loose smut; and moderately susceptible to FHB (Tables 3–5).

Other Characteristics

Spike: Tapering to parallel sided, medium density, inclined attitude at maturity, medium glaucosity, white chaff colour at maturity.

Awns: Longer than length of spike, white colour.

Lower glume: Glabrous with medium width, long length.

Lower glume shoulder: Narrow, straight to elevated shape, with a long beak that is slightly curved.

Kernel: Medium hard, dark red colour, large to extra large size, elliptical shape, rounded to angular cheek, medium to wide width of crease with very shallow depth, and long brush hairs.

Germ: Medium size, round in shape.

End-use suitability: In general, AAC Ryley had quality parameters within the range of the checks and notably improved wheat and flour protein (Tables 6 and 7. The

Table 6. End-use suitability[a] for AAC Ryley and check cultivars and differences from the mean of the check cultivars in the High Yield Wheat Cooperative tests, 2009–2011.

	Wheat protein (%)	Flour protein (%)	Protein loss (%)	Hagberg falling no. (s)	Amylograph viscosity (BU)[b]	Flour yield 0.5 ash (%)	Flour ash (%)	Flour color[c] (agtron)	Starch damage (megazeme)	Particle size index
5700PR	12.4	11.6	0.8	353	593	78.2	0.43	79.5	8.2	54
5701PR	12.8	12.0	0.7	395	637	79.9	0.40	80.5	7.0	57
Mean of checks	12.6	11.9	0.8	375	617	79.1	0.42	80.5	7.6	56
AAC Ryley	13.1	12.4	0.6	382	472	78.8	0.43	82.5	7.5	57
SD[d]	0.05	0.05	—	15	5	0.34	0.005	0.9	0.08	0.9

[a]American Association of Cereal Chemists methods were followed by the Grain Research Laboratory, Canadian Grain Commission, for determining the various end-use suitability traits on a composite of 6–10 locations each year.

[b]Amylograph viscosity expressed in Brabender Units (BU).

[c]Flour color by Agtron was measured in 2009 and 2010.

[d]SD is the standard deviation based on repeated testing of Allis mill check samples and standard bake flour samples, with replicate tests carried out over an extended period of time each season, provided by Grain Research Laboratory, Canadian Grain Commission.

Table 7. Farinograph and baking characteristics[a] for AAC Ryley and check cultivars and differences from the mean of the check cultivars in the High Yield Wheat Cooperative tests, 2009–2011.

	Farinograph			Remix baking[b] (150 ppm ascorbic acid)							
Entry	Absorption (%)	DDT[c] (min)	Stability (min)	Baking absorption (%)	Peak time (min)	Mixing energy[d] (W-h kg^{-1})	Loaf volume	Loaf volume protein^{-1}	Appearance	Crumb structure	Crumb color
5700PR	66.5	8.2	10.7	63.3	3.2	6.5	938	80.6	8.6	5.1	5.9
5701PR	62.9	12.6	28.2	62.3	2.8	5.0	950	79.0	8.8	4.9	5.6
Mean of checks	64.7	10.4	19.5	63.0	3.0	5.8	945	80.0	8.7	5.0	5.8
AAC Ryley	65.7	10.9	14.5	64.7	3.1	5.5	915	73.6	8.7	5.5	5.8
SD[e]	0.2	0.4	2.6	1.4	NA[f]	0.3	0.2	45	NA	NA	NA

[a]American Association of Cereal Chemists methods were followed by the Grain Research Laboratory, Canadian Grain Commission, for determining the various end-use suitability traits on a composite of 6–10 locations each year.

[b]Remix baking process.

[c]DDT is the Farinograph dough development time, measured in minutes.

[d]Mixing energy expressed as watts per hour per kilogram.

[e]SD is the standard deviation based on repeated testing of Allis mill check samples and standard bake flour samples, with replicate tests carried out over an extended period of time each season, provided by Grain Research Laboratory, Canadian Grain Commission.

[f]NA, not available.

protein loss upon milling is desirably less than the checks. However, the loaf volume protein^{-1} was less than the checks. AAC Ryley is eligible for grades of Canada Prairie Spring Red.

Maintenance and Distribution of Pedigreed Seed

The 94 Breeder Lines originated from F_6-drived F_{10} single plants of C0302-GB26E grown near Swift Current in 2009, followed by growing as 108 pre-Breeder-Lines in 3 m long rows near Swift Current in 2010 and again as 15 m rows near Indian Head in 2011. Approximately 510 kg of Breeder Seed is available. Breeder Seed will be maintained by the Seed Increase Unit of the Research Farm, Indian Head, SK S0G2K0, Canada. AAC Ryley has been released for distribution and multiplication by SeCan, 501-300 March Road, Kanata, ON K2K 2E2, Canada.

Acknowledgements

We gratefully acknowledge the financial support of the Producer-Funded Wheat Check-Off (administered by the Western Grains Research Foundation); M. Steinley and B. Coward for statistical analysis support; D. Niziol and J. Fehr (AAFC, CRC) for providing end-use quality analyses; T. Fetch and B. McCallum (AAFC, CRC) for assessing reaction to stem and leaf rust; J. Gilbert (AAFC, CRC) for FHB reactions; J. Menzies (AAFC, CRC) for loose smut evaluation; D. Gaudet and T. Despins of (AAFC, Lethbridge Research Centre, Lethbridge, AB) for providing reaction to common bunt and stripe rust; S. Fox, G. Humphreys, and D. Brown (AAFC, CRC) for agronomic assessment and FHB nursery at Portage la Prairie; A. Brûlé-Babel (University of Manitoba, Winnipeg, MB) for FHB evaluations at Carman; K. Preston and N. Edwards (Grain Research Laboratory, Canadian Grain Commission, Winnipeg, MB) for end-use quality assessment; D. Gehl (AAFC Seed Increase Unit, Indian Head, SK) for multiplication of Breeder Seed; G. McClare, J. Powell, S. Friesen, D. Finlay, T. Greenwood, M. Olfert, J. Ross, L. Oakman, H. Campbell, and all members of the wheat genetic enhancement group at AAFC, Swift Current; M. Knelsen (AAFC, Regina, SK); O. Thompson (AAFC, Indian Head, SK); and B. Beres and R. Dyck (AAFC, Lethbridge, AB) for their assistance in conducting field trials.

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