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Cultivar description

AAC Cranbrook spring barley

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Abstract

AAC Cranbrook (registration #9545) is a six-row spring general purpose barley (*Hordeum vulgare* L.) cultivar derived from the cross Synasolis/OAC Chesley//Cyane using a modified bulk breeding method. AAC Cranbrook has 9% higher grain yield than Cyane and 4% higher grain yield than HY621-6R, and it has good lodging resistance. AAC Cranbrook performs well in Ontario.

Key words: *Hordeum vulgare* L., six row, general purpose barley, high yield

Résumé

AAC Cranbrook (numéro d'homologation 9545) est une variété d'orge de printemps à six rangs (*Hordeum vulgare* L.) d'utilité générale issue du croisement Synasolis/OAC Chesley//Cyane obtenu par la méthode d'hybridation massive modifiée. Le rendement grainier d'AAC Cranbrook dépasse celui de Cyane de 9 % et celui de HY621-6R de 4 %. Le cultivar résiste bien à la verse et donne un bon rendement en Ontario. [Traduit par la Rédaction]

Mots-clés : *Hordeum vulgare* L., six rangs, orge d'utilité générale, rendement élevé

Introduction

AAC Cranbrook is a high-yielding six-row barley (*Hordeum vulgare* L.) cultivar with good resistance to lodging. It was developed at the Ottawa Research and Development Centre (ORDC), Agriculture and Agri-Food Canada (AAFC), Ottawa, ON. AAC Cranbrook was tested as experimental code OB2930-35 in the Ontario Barley Orthogonal Registration Trials in 2019 and 2020. OB2930-35 received support for registration from the Ontario Cereal Crop Committee (January 2021) and it was registered on 22 April 2022 (registration #9545) by the Variety Registration Office, Canadian Food Inspection Agency, Ottawa, ON.

Pedigree and breeding methods

AAC Cranbrook was derived from a cross between Synasolis/OAC Chesley//Cyane made at the ORDC, AAFC, Ottawa, ON in 2009. The female parent was derived from Synasolis and OAC Chesley. Synasolis was derived from ACCA/QB.812.4 and OAC Chesley was derived from male sterile line (ms)/GB936624 crosses. The male parent Cyane was derived from a cross between QB.812.4 and Myriam.

The F_1 generation was grown in the greenhouse during the winter of 2010–2011. The breeding population was advanced using the bulk breeding method. The F_2–F_4 bulks were grown in the field at Ottawa from 2011 to 2013 for early generation advancement with no selection. In 2014, the population was grown in Ottawa and 184 heads were selected based on the maturity, height, and disease (when present) in F_5 generation. In 2015, the 184 $F_{5:6}$ lines were planted as head rows in Ottawa and 50 lines were selected based on maturity, height, disease ratings (when present), and lodging scores. In 2016, the 50 selected lines were planted in unreplicated $F_{5:7}$ microplots with three rows 5 m long and 18 cm between the rows and as single-row plots with 1.5 m in length in an inoculated *Fusarium* head blight (FHB) nursery. Plots were rated for maturity, height, lodging resistance, and over appearance or agronomic score, and FHB rows were assessed for FHB incidence (percentage of symptomatic spikes) using a linear scale of 1–5 representing incidence levels of less than 20%, 20%–40%, 40%–60%, 60%–80%, and greater than 80%, respectively. Row plots with disease incidence lower than 3 were harvested and evaluated for deoxynivalenol (DON) content at ORDC. Two lines (OB2930-35 and OB2930-50) were

Table 1. Mean grain yield and agronomic traits of the barley cultivar AAC Cranbrook and the check cultivars grown in the Ontario Barley Orthogonal Registration Trials in 2019[a] and 2020.[b]

Cultivar	Yield (kg ha^{-1})	Height (cm)	Heading (days)	Maturity (days)	Lodging (0–9)[c]
Cyane	4860	87	56	78	1.0
HY621-6R	5120	78	52	76	2.6
Check mean	4990	83	54	77	1.8
AAC Cranbrook	5310	82	56	78	1.5
$LSD_{0.05}$[d]	439	5	1.9	0.9	1.2
No. of trials	9	9	9	3	4

[a]Tested at Palmerston, Kincardine, Elora, Ottawa, and Osgoode.
[b]Tested at Palmerston, Kincardine, Elora, and New Liskeard.
[c]Lodging resistance is determined at maturity using a 0–9 scale (0 = all plants in plots are erect; 9 = all plants are lying horizontal).
[d]Least significant difference, $P \leq 0.05$ based on the appropriate cultivar × environment interaction variation.

Table 2. Mean grain characteristics of the barley cultivar AAC Cranbrook and the check cultivars grown in the Ontario Barley Orthogonal Registration Trials in 2019 and 2020.[a]

Cultivar	Test weight (kg hL^{-1})	Thousand kernel weight (g)	Protein (%)
Cyane	59.5	42.2	14.2
HY621-6R	61.8	43.0	13.4
Check mean	60.6	42.6	13.8
AAC Cranbrook	**59.5**	**41.6**	**13.2**
$LSD_{0.05}$[b]	1.7	2.5	
No. of trials	9	9	1

[a]Tested at Palmerston, Kincardine, Elora, Ottawa, Osgoode, and New Liskeard.
[b]Least significant difference, $P \leq 0.05$ based on the appropriate cultivar × environment interaction variation.

selected based on microplot assessment and DON content evaluation. These two lines were entered into preliminary yield trials with three replicates in Ottawa in 2017. Selection criteria included grain yield, test weight, and lodging resistance. Line OB2930-35 was further promoted into advanced yield trials with four replicates at Harrington, PE, St. Rosalie, QC, Ottawa, ON, Osgoode, ON, and Brandon, MB in 2018. The line OB2930-35 (AAC Cranbrook) was evaluated at the Ontario Barley Orthogonal Registration Trials in 2019 and 2020.

The Ontario Barley Orthogonal Registration Trials were conducted following the methods and procedures as described by the Ontario Cereal Crops Committee (https://www.gocereals.ca/procedures.php) and the trials were grown at six locations (Palmerston, Kincardine, Elora, Ottawa, Osgoode, and New Liskeard) across Ontario in 2019 and 2020. The trial was arranged in randomized complete block design with four replicates in each location and data from trial location with a coefficient of variation (CV) of <16% in grain yield were included in the statistical analysis. In 2019, data from New Liskeard, ON trial location were not used due to flood damage. In 2020, Osgoode, ON trial location was not planted due to COVID pandemic and data from Ottawa, ON trial location were not used due to the high inter-replicate variation of the grain yield data (CV > 16%). The data were analysed using the mixed model in SAS version 9.4 (SAS Institute Inc. 2020) with locations and replicates considered random and genotypes considered fixed, with a combined analysis over years. Genotypic means were separated by Fisher's least significant difference (LSD) test at a probability level of $P \leq 0.05$. AAC Cranbrook along with checks Cyane and HY621-6R was evaluated in artificial disease nurseries for reactions to net form net blotch (*Pyrenophora teres* f. *teres*) isolates WRS102 and WRS858, spot form net blotch (*P. teres* f. *maculata*) isolate MBV25, scald (*Rhychosprorium commune* (Oud.) J.J. Davis) isolate WRS2275, and reaction to seedling against spot blotch (*Cochliobolus sativus*) at the Morden Research and Development Centre, AAFC in Morden, MB for 2 years (2019 and 2020). In 2019 and 2022, AAC Cranbrook was also screened for spot blotch resistance at the adult stage at Brandon Research and Development Centre, AAFC in Brandon, MB.

AAC Cranbrook was also evaluated in irrigated FHB nurseries with two replicates in Ottawa, ON and with one replicate in Brandon, MB in 2019 and 2020 for *Fusarium graminearum* response based on DON accumulation (Legge et al. 2004). Analyses for DON concentration were done at ORDC, AAFC, using approximately 20 g kernel subsample from each plot. Samples were ground to a fine powder in a Retsch Ultra-Centrifugal Mill Type ZM-l (Brinkman Instruments Inc., Rexdale, ON) with a 0.75 mm wire mesh and a subsample of 1 g was used for DON analysis. The concentration of DON was determined by the competitive direct enzyme-linked immunosorbent assay procedure using monoclonal antibodies as described by Sinha et al. (1995).

Performance

Yield: In the Ontario Barley Orthogonal Registration Trials (nine site-years), the average yield of AAC Cranbrook was 5310 kg ha^{-1}, which was 9% higher than Cyane and 4% higher than HY621-6R. The yield of AAC Cranbrook was significantly higher than Cyane (Table 1).

Test weight: The average test weight of AAC Cranbrook was 59.5 kg hL^{-1}, which was similar to Cyane but significantly lower than HY621-6R (Table 2).

Table 3. Reactions of AAC Cranbrook and the check cultivars, Cyane and HY621-6R, to net blotch, scald, and spot blotch (seedling stages) grown at Morden Research and Development Centre, MB and spot blotch (adult stages) grown at the Brandon Research and Development Centre, MB in 2019 and 2020.

	Net blotch (0–10)			Scald	Spot blotch (0–9)	
Cultivar	102[a]	858[a]	MBV25[b]	2275[c]	1903[d]	Spot blotch (1–9)[e]
Cyane	6.5	3.5	2.5	MR	3.5	3.5
HY621-6R	3.5	5.0	4.0	R	4.0	4.5
AAC Cranbrook	**5.5**	**4.5**	**6.0**	**MR**	**5.0**	**3.0**

[a]Reactions to *Pyrenophora teres* net form isolates WRS102 and WRS858 (0 = resistant; 10 = very susceptible).
[b]Reactions to *Pyrenophora teres* spot form isolate MBV25 (reaction categories: 10 = VS; 9 = S; 7 = MS; 5 = MR–MS; 3 = MR; 1 = R).
[c]Reactions to *Rhychosprorium commune* isolate WRS2275 (MR = moderately resistant; R = resistant).
[d]Reactions to the *Cochliobolus sativus* isolate WRS1903 at the seedling stages (0 = no visible lesions; 9 = very large lesions).
[e]Reactions at adult stages evaluated at the Brandon Research and Development Centre in 2019 and 2020 (1–9 scale; 1 = no visible lesions; 9 = very large legions lesions).

Table 4. Deoxynivalenol concentration for AAC Cranbrook, general purpose checks (Cyane and HY621-6R), and the *Fusarium* head blight (FHB) checks (Stander (susceptible), Chevron (moderately resistant), and Quest (moderately susceptible)) in four FHB artificial inoculation tests at Brandon, MB and Ottawa, ON in 2019 and 2020.

	DON (mg kg^{-1})			
	Brandon		Ottawa	
Cultivar	2019	2020	2019	2020
Cyane	3.0	18.1	18.5	17.9
HY621-6R	9.8	58.4	28.5	21.5
AAC Cranbrook	2.3	23.9	22.6	10.0
Stander (S)	2.5	22.5	28.5	38.4
Chevron (MR)	0.2	4.4	5.5	NA
Quest (MS)	1.4	14.8	6.4	17.5

1000 kernel weight: AAC Cranbrook had lower 1000 kernel weight than the checks (Table 2).

Plant height: AAC Cranbrook was taller than HY621-6R but significantly shorter in height than Cyane (Table 1).

Lodging: At maturity, AAC Cranbrook had similar lodging resistance to Cyane (Table 1).

Heading date: AAC Cranbrook headed 4 days later than HY621-6R but was similar in days to heading as Cyane (Table 1).

Maturity: AAC Cranbrook took an average 78 days to mature, which is similar to Cyane and 2 days later than HY621-6R (Table 1).

Other characteristics

Plant: Erect juvenile growth; flag leaf is short to medium in length and narrow to medium width; upright flag leaf attitude; white auricles; strong flag leaf sheath glaucosity; V-shaped collar.

Spike: Six-row type, parallel shape, medium to dense spike density, medium spike length; very smooth lemma awns; medium (longer than length of glume) and rough glume awns; purplish lemma awn tip; green glume awn tip.

Kernel: Covered (hulled), 11.7 mm length, 3.7 mm width; long rachilla hairs; yellow aleurone; transverse crease basal marking.

Quality: Non-malting.

Disease reactions: AAC Cranbrook is moderately resistant to scald, spot blotch, and net form net blotch, whereas moderately susceptible to spot form net blotch (Table 3). It was susceptible to FHB and the DON content was similar to Cyane and lower than HY621-6R (Table 4). DON content of AAC Cranbrook was lower than the susceptible FHB check, Stander.

Maintenance and distribution of pedigreed seed

Breeder seed of AAC Cranbrook will be maintained by the ORDC, Ottawa, ON K1A 0C6, Canada. In 2020, AAC Cranbrook was planted in the greenhouse at the ORDC, AAFC, for purification and multiplication of seed. In total, 58 breeder lines were bulked and this F_{11} seed formed the first breeder seed. AAC Cranbrook has been released on an exclusive basis for seed production and marketing to SeCan Association, 400–300 Terry Fox Drive, Kanata, ON K2K 0E3, Canada.

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Thin Meiw Choo is retired.
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References
Legge, W.G., Therrien, M.C., Tucker, J.R., Banik, M., Tekauz, A., Somers, D., et al. 2004. Progress in breeding for resistance to *Fusarium* head blight in barley. Can. J. Plant Pathol. **26**: 436–442. doi:10.1080/07060660409507163.

Ontario Cereal Crop Committee. 2021. Operating procedures of the Ontario Cereal Crop Committee [online]. Available from https://www.gocereals.ca/OCCC_Regis_Oper_Procedures_August_2021_final.pdf (accessed 11 Februrary 2021).

SAS Institute Inc. 2020. SAS/STAT MIXED procedure. Version 9.4. SAS Institute Inc., Cary, NC.

Sinha, R.C., Savard, M.E., and Lau, R. 1995. Production of monoclonal antibodies for the specific detection of deoxynivalenol and 15-acetyldeoxynivalenol by ELISA. J. Agric. Food Chem. **43**: 1740–1744. doi:10.1021/jf00054a061.