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CULTIVAR DESCRIPTION

AAC McRae soybean

K. Yu, L. Woodrow, and C. Shi

Abstract: AAC McRae is a high yielding food grade soybean [*Glycine max* (L.) Merr.] cultivar with yellow hilum, high protein concentration, and acceptable processing quality for foreign and domestic tofu, soymilk, and miso markets. It has excellent soybean cyst nematode (SCN) (*Heterodera glycines* Ichinohe) and soybean sudden death syndrome (SDS) (*Fusarium virguliforme* O'Donnell & T. Aoki) resistance. AAC McRae was developed at the Agriculture and Agri-Food Canada (AAFC) Harrow Research and Development Centre (Harrow-RDC), Harrow, Ontario, and is adapted to areas of southwest Ontario with 3100 or more crop heat units and has a relative maturity group of 2.2 (MG 2.2).

Key words: Glycine max (L.) Merr., soybean, cultivar description, tofu.

Résumé : AAC McRae est une variété de soja [*Glycine max* (L.) Merr] à haut rendement de type alimentaire. Le cultivar se caractérise par des graines à hile jaune, riches en protéines et d'une qualité convenant à la transformation en tofu, en lait de soja et en miso, à l'étranger ou au pays. La variété résiste très bien au nématode du soja (*Heterodera glycines* Ichinohe) et au syndrome de la mort subite du soja (*Fusarium virguliforme* O'Donnell & T. Aoki). La variété AAC McRae a été créée au centre de recherche et de développement d'Agriculture et Agroalimentaire Canada (AAC) à Harrow, en Ontario, et est acclimatée aux parties du sud-ouest de l'Ontario qui enregistrent au moins 3 100 degrés-jours de croissance. Le cultivar fait partie du groupe de maturité relative 2.2 (MG 2.2). [Traduit par la Rédaction]

Mots-clés : Glycine max (L.) Merr., soja, description de cultivar, tofu.

Introduction

AAC McRae is a high-yielding food grade soybean [*Glycine max* (L.) Merr.] cultivar with soybean cyst nematode (SCN) (*Heterodera glycines* Ichinohe) and soybean sudden death syndrome (SDS) (*Fusarium virguliforme*) resistance developed at the Agriculture and Agri-Food Canada (AAFC) Harrow Research and Development Centre (Harrow-RDC), Harrow, Ontario. AAC McRae is intended for use in tofu, soymilk, and miso production in foreign and domestic markets. It is higher yielding than AAC Malden (Poysa et al. 2013), the check cultivar. In tests conducted at Harrow-RDC, AAC McRae exhibited acceptable quality for making tofu and soymilk. A Certificate of Eligibility for Certification no 2318-2020 was issued for OX-181 (AAC McRae) by the Canadian Seed Growers' Association on Dec. 2020.

Pedigree and Breeding Method

AAC McRae (tested as OX-181; SN11-0055-5-1 E) was developed from the cross, LD01-5907//OX752/X696-32-2/3/RCAT0601SCN with the last cross made in 2011. LD01-5907 is a SCN resistant soybean cultivar developed by the University of Illinois. OX752 is a breeding line developed at Harrow-RDC from the cross A83-378001/OX736. A83-378001 is a large-seeded breeding line developed by Iowa State University and released as LS301. OX736 originated from the cross Coles//Harcor*2/Raiden. X696-32-2 originated from the cross Vinton/Enrei//Harovinton (Poysa and Buzzell 2001). RCAT0601SCN is a SCN resistant soybean cultivar developed by the University of Guelph, Ridgetown Campus. AAC McRae was developed by pedigree selection. It is adapted to areas of southwest Ontario with 3100 or more crop heat units and has a relative maturity group (MG) of 2.2.

F_1 seeds were produced in the field during summer 2011 and planted in the greenhouse in the fall of 2011 at Harrow. The F_3 plants grown in the field at Harrow were selected for maturity, lodging and plant vigour, and threshed individually. Seed was sent to Puerto Rico for two generations of seed advancement by modified single

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Table 1. Performance of AAC McCrae and the check cultivar, AAC Malden, in Southwest Ontario, 2017 and 2018 AAFC trials.

Cultivar	Seed							Plant	
	Yield (t ha^{-})	Maturity (d)	Weight (g/100sd)	Protein (%)[a]	Oil (%)[a]	Sugar (%)[a]	Carb (%)[a]	Height (cm)	Lodging (1–5)[b]
OX-181	5.09	119	23.2	43.6	20.7	12.9	17.9	91	1.33
AAC Malden	4.95	122	22.6	44.6	19.6	12.7	18.2	87	1.25
SE	0.21	2.6	1.2	0.64	0.5	0.17	0.3	3.8	0.28
No. Sites	12	8	12	12	12	12	12	9	9

Note: Performance based on 12 trials conducted at Chatham, Harrow, Holiday Beach, Merlin, Ridge Town, and Woodslee in 2017 (BY17) and at Palmyra, Harrow, Holiday Beach, Merlin, Ridge Town, and Woodslee in 2018 (BY18). SE, standard error; Carb, total hydrolysable carbohydrates.

[a]Whole dry matter basis, by near infrared spectroscopy; total of sucrose, raffinose and stachyose.

[b]1 = no lodging to 5 = complete lodging.

seed descent in 2012. The F_6 plants were grown in a nursery at Harrow in 2013 with single plant selection based on maturity, lodging resistance, plant vigour, disease resistance, and seed size. The selected plants were threshed individually and additional selection was conducted on seed samples in the lab for uniformity of seed size, seed shape, hilum colour, and seed coat colour and integrity. The F_7 seeds were also selected for protein content by near infrared reflectance spectroscopy (NIR System 6500, Foss North America, Inc., Eden Prairie, MN) analysis. The F_7 plants were grown in a plant row combine harvest CH14 nursery in 2014 at Harrow with the MAD 2 design (Lin and Voldeng 1989). The line SN11-0055-5-1 E (also named as OX-181) was selected based on yield, maturity, lodging resistance, plant height, seed size, and per cent protein, oil, and sugars in the seed.

OX-181 was evaluated for agronomic performance and seed quality in two-row, two-replication preliminary yield trials (PY15) at Harrow and Woodslee in 2015; in five-row, two-replication advanced yield trials (AY16) at three locations (Harrow, Woodslee, and Malden, Ontario) in 2016; in five-row, three-replication yield trials at six locations (Harrow, Chatham, Ridgetown, Merlin, Woodslee, and Malden, Ontario) in 2017 (BY17); and in five-row, three-replication yield trials at six locations (Harrow, Chatham, Palmyra, Merlin, Woodslee, and Malden, Ontario) in 2018 (BY18). Selection criteria during yield testing were high yield, acceptable maturity and lodging, seed protein concentration, seed size, seed colour and appearance, high water uptake during soaking, and quality and yield of tofu. In 2018, seed of 50 individual $F_{7:10}$ plants were evaluated for uniformity and 26 $F_{7:11}$ plant rows were sown and purified to establish Breeder Seed. Breeder seed was produced by bulking seed of 22 uniform $F_{7:12}$ plots in 2019.

Performance

The agronomic performance of OX-181 and the check cultivar, AAC Malden in BY17 and BY18 trials, are presented in Table 1. OX-181 out-yielded AAC Malden by 2.8%. OX-181 matured about 3 d earlier than AAC Malden. The seed size of OX-181 was about 0.6 g 100^{-1} seed heavier than AAC Malden. The protein concentration of OX-181 was about 1% lower than AAC Malden. The average plant height of OX-181 was about 4 cm taller than the check but had a similar lodging score as the check.

OX-181 was also grown in the Early Group 2 Trials of the Ontario Conventional and Food Grade Soybean (OCFGSB) trials conducted by the Ontario Soybean and Canola Committee (OSACC) in 2019. In the Early Maturity Trials, the yield and protein content of OX-181 were 4.4% and 0.9% higher than AAC 26-15, respectively, and matured 2 d early than AAC 26-15.

Disease response

OX-181 had excellent field resistance to SCN. In a heavily infested field, OX-181 lines were rated 1 to 2 on a 1 = resistant, 5 = susceptible scale (Harovinton = 4.7; RCAT Ruthven = 1.2). In controlled temperature, replicated root inoculations with a mixture of SCN HG 1-7 types cysts, OX-181 showed excellent levels of resistance to SCN. The Female Index (FI) is a measurement of the ability of an SCN population to develop on a resistant soybean line. It is calculated from a replicated bioassay as the mean number of SCN females produced on an indicator line (in this case PI 88788), divided by the mean number of females produced on the standard susceptible cultivar Lee 74, multiplied by 100. OX-181 had an FI of 4.8, compared with 100 for Lee74 and 7.2 for PI 88788.

OX-181 had excellent level of field resistance to SDS in field tests conducted at Chatham, ON, in 2017; OX-181 was rated 4.17 for the SDS index on a 0–10 = resistant, 50–100 = susceptible scale according to the Southern Illinois State University rating system.

Processing quality

In tests conducted at Harrow, OX-181 exhibited satisfactory soymilk and tofu performance and quality characteristics in comparison with the processing check

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Table 2. Soymilk and tofu yield and quality of AAC McRae and Harovinton – 2016, 2017, 2018.

	AAC McRae	Harovinton	LSD
Water uptake[a]	2.23	2.20	0.04
Soymilk yield (l kg^{-1} protein)	16.87	16.53	0.39
Soymilk yield (l kg^{-1} bean)	7.25a	7.52b	0.11
Solids content of soymilk (%)	10.3a	9.6b	0.4
Sugar content of soymilk (%)	1.33a	1.15b	0.08
Soymilk colour (L)[b]	84.50	84.16	0.59
Soymilk colour (a)	0.84a	0.59b	0.16
Soymilk colour (b)	12.92	14.72	0.71
Tofu (GDL) yield (kg kg^{-1} protein)[c]	16.76a	16.31b	0.40
Tofu (GDL) yield (kg kg^{-1} bean)	7.22a	7.43b	0.13
Tofu (GDL) compression hardness (N)	1.37a	1.60b	0.07
Tofu (GDL) compression firmness (N mm^{-1})	0.26	0.30	0.05
Tofu (GDL) compression springiness (ratio)	0.79	0.82	0.05
Tofu ($CaSO_4$) yield (kg kg^{-1} protein)[d]	16.72a	16.33b	0.37
Tofu ($CaSO_4$) yield (kg kg^{-1} bean)	7.19a	7.44b	0.14
Tofu ($CaSO_4$) compression hardness (N)	0.77a	1.01b	0.17
Tofu ($CaSO_4$) compression firmness (N mm^{-1})	0.17a	0.21b	0.03
Tofu ($CaSO_4$) compression springiness (ratio)	0.64a	0.71b	0.06

Note: Seed of cultivars evaluated from trials grown in Harrow and Woodslee in 2016, 2017; Chatham and Woodslee 2018. Within rows, means followed by different letters differ significantly ($P < 0.05$). LSD, least significant difference between corresponding means ($P < 0.05$); N, hardness in Newtons and firmness in Newtons per mm.

[a](weight of hydrated beans after 16 h soaking at 20°C)/(initial weight of beans).

[b]Hunter Lab opponent colour scale; L, light (51–100) vs dark (0–50); a, red (+) vs green (−); b, yellow (+) vs blue (−).

[c]Tofu made with Glucono-delta -lactone (GDL) coagulant.

[d]Tofu made with calcium sulphate dihydrate ($CaSO_4$) coagulant.

cultivar, Harovinton (Buzzell et al, 1991) (Table 2). OX-181 is offered as a high-yielding, food-grade soybean cultivar with yellow hilum and excellent levels of resistance to SCN and SDS for the tofu and soymilk markets (Table 2).

Other characteristics

AAC McRae has an indeterminate growth habit, white flowers, green hypocotyls, grey pubescence, and grey pods. The seeds are dull yellow with a yellow hilum.

Maintenance and distribution of pedigreed seed

Breeder seed of AAC McRae is maintained by the AAFC Harrow-RDC, Harrow, Ontario. SeCan Association, 501-300 March Rd, Kanata, Ontario, Canada K2K 2E2, has exclusive rights to AAC McRae soybean for contract production of pedigreed seed for use in contract production.

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