

## CULTIVAR

# Registration of 'Rasmusson' Barley

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## ABSTRACT

'Rasmusson' (Reg. No. CV-345, PI 658495) is a spring, six-rowed, malting barley (*Hordeum vulgare* L.) released by the Minnesota Agricultural Experiment Station in January 2008. It was named after Donald Rasmusson, who worked as a barley breeder at the University of Minnesota from 1958 to 2000. Rasmusson has the pedigree M95/'Lacey' and is the product of advanced cycle breeding derived from crosses among elite breeding lines within the University of Minnesota breeding program. Rasmusson was released based on its superior yield performance across the Upper Midwest of the United States and surrounding regions in Canada and favorable malting quality, in particular, high malt extract. Rasmusson is resistant to spot blotch [caused by *Cochliobolus sativus* (Ito and Kuribayashi) Drechs. ex Dastur] and the prevalent races of stem rust (caused by *Puccinia graminis* Pers.: Pers. f. sp. *tritici* Erikss. & E. Henn).

'Rasmusson' (Reg. No. CV-345, PI 658495) is a spring, six-rowed, malting barley (*Hordeum vulgare* L.) cultivar released by the Minnesota Agricultural Experiment Station in 2008. It was named after Donald Rasmusson, who worked as a barley breeder at the University of Minnesota from 1958 to 2000. Rasmusson was tested in the Mississippi Valley Barley Nursery (MVBN) under the experimental line number M109 from 2001 to 2005 and was entered into American Malting Barley Association (AMBA) pilot malting evaluations in 2001 and plant-scale brewing evaluations in 2005. Rasmusson was released based on its superior yield performance, acceptable malting quality, and in particular, high malt extract.

Rasmusson is a selection from a cross between the parents M95 and 'Lacey', which in turn are derived from other elite breeding lines and cultivars developed at the University of Minnesota (Fig. 1). M95 was a cultivar candidate

evaluated in the MVBN in 1997–1998 and Lacey is a cultivar released in 2000 (Rasmusson et al., 2001). The pedigree of Rasmusson is an example of advance cycle breeding, in which parent selection is primarily from within a single breeding program (Bernardo, 2002). Other released cultivars from the Minnesota breeding program in the pedigree of Rasmusson are 'Manker', 'Cree', 'Morex', 'Robust', 'Excel', and 'Stander' (Rasmusson and Wilcoxson, 1979, 1983; Rasmusson et al., 1991, 1993). Parents from outside the breeding program include 'Bumper', 'Bonanza', 'Nordic', and 'Traill' and were introduced from four to seven breeding cycles before the cross that produced Rasmusson.

## Methods

### Early Generation Population Development

The cross leading to Rasmusson was made in 1996. The  $F_1$  seed was planted in the greenhouse and the  $F_2$  seed harvested in bulk. The  $F_2$  seed was planted in single-row plots 2 m in length with 30-cm row spacing. A single spike was harvested from each  $F_2$  plant, and a single  $F_3$  seed was planted from each spike in pots in the greenhouse in August 1997. A single seed was harvested from each  $F_3$  plant, and the  $F_4$  plants were grown in pots in the greenhouse in December 1997.

### Line Selection and Evaluation

A single spike was harvested and threshed from each of 250  $F_4$  plants tracing to Lacey/M95 and sown as head rows in Crookston, MN in April 1998. The breeding line that would become Rasmusson was selected as row number 4037 based on visual assessment of favorable maturity, plant height, lodging, and kernel plumpness and was assigned the experimental designation M96–80. A single spike from this selected  $F_{4.5}$  head row was harvested and planted as a row in Yuma, AZ in October 1998. The  $F_{5.6}$  seed

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**Abbreviations:** AMBA, American Malting Barley Association; FHB, Fusarium head blight; MVBN, Mississippi Valley Barley Nursery.

Published in the Journal of Plant Registrations 4:167–170 (2010).

doi: 10.3198/jpr2009.10.0622crc

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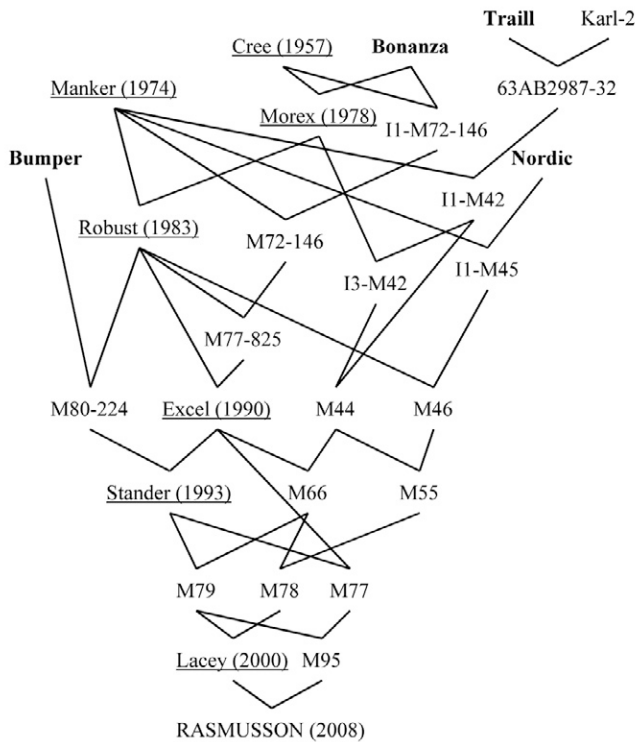


Fig. 1. Pedigree of Rasmusson. Cultivars in bold are from outside the breeding program. Underlined cultivars were released from the Minnesota Agricultural Experiment station with the year of release in parentheses.

harvested from this row was used for replicated field trials beginning in 1999.

Preliminary yield trials were conducted in 1999 at St. Paul and Crookston, MN in a randomized complete block design with three replicates in two-row plots 3 m in length spaced 30 cm apart and seeded at a rate of 108 kg ha<sup>-1</sup>. All subsequent yield trials were conducted in randomized complete block experiments with three replicates in 1.4- by 3-m with 18-cm row spacing and the same seeding rate. Yields were based on grain harvested from plots end-trimmed to 2.4 m in length. Percentages of plump kernels were determined by calculating the percent, by weight, of kernels that did not pass through a 0.24- by 1.9-cm sieve. Malt quality was evaluated on a 400-g subsample of a composite sample

**Table 1. Agronomic performance of Rasmusson and check cultivars from 2005–2008 Red River Valley On-Farm Trials (16 location-years).<sup>†</sup>**

Entry	Yield kg ha <sup>-1</sup>	Height cm	Plump %	Lodging 1–9 <sup>‡</sup>	Test weight g L <sup>-1</sup>
Robust	5337	84.6	74.9	4.5	548
Legacy	5730	81.5	73.7	4.0	536
Lacey	5982	80.0	81.2	4.4	575
Tradition	5676	81.0	81.0	4.1	564
Stellar-ND	5972	82.0	84.3	4.6	560
Rasmusson	6181	78.0	73.4	5.0	550
LSD ( $p = 0.05$ )	393	1.0	4.6	0.4	18

<sup>†</sup>The locations of Red River Valley On-farm Trials were Fergus Falls, Oklee, Perley, Strathcona, and Humboldt, MN.

<sup>‡</sup>1 = least amount of lodging, 9 = greatest amount of lodging.

from all the replicates of a trial by the USDA-ARS Cereal Crops Research Unit in Madison, WI. M96–80 was tested in St. Paul, Morris, and Crookston, MN in 2000 and continued in trials at St. Paul, Crookston, Morris, Stephen, and Roseau, MN from 2001 to 2009. It was assigned the cultivar candidate designation M109 and evaluated in the MVBN from 2001 to 2005. M109 was evaluated at the five locations of the Red River Valley On-Farm Trials from 2005– to 2008. Entries were solid seeded in 1.5- × 6.1-m plots in a randomized complete block design with two replicates at a seeding rate (corrected for seed count kg<sup>-1</sup> and percent germination) between 135 and 167 kg ha<sup>-1</sup>. M109 was evaluated in AMBA pilot malt tests with grain from the 2001 and 2003 crop years and in AMBA plant-scale brewing tests with grain from the 2005 and 2006 crop years. After favorable evaluation, M109 was released as the cultivar Rasmusson and added to the list of AMBA recommended cultivars in 2008 ([www.ambainc.org](http://www.ambainc.org)).

### Seed Purification and Increase

In 2002 approximately 50 single spikes were harvested in the F<sub>5,7</sub> generation and planted as head rows in St. Paul. All rows appeared uniform and were harvested and bulked to form the F<sub>5,8</sub> breeder seed.

### Statistical Analyses

All statistical analyses were conducted using SAS for Windows, version 9.2 (SAS Institute Inc., Cary, NC). Forty-two trials from the MVBN that included the comparison cultivars ‘Robust’, ‘Legacy’, ‘Drummond’ (Horsley et al., 2002), Lacey, and ‘Tradition’ were used in the analyses of agronomic traits. Legacy and Tradition are cultivars developed by Busch Agriculture Resources Inc. and are listed as approved malting quality cultivars by AMBA. Analysis of the yield trial data was based on the mean of the trial and was conducted both by location and across locations. Fourteen trials from the MVBN that included the above cultivars and the additional malting quality check Morex were used for malting quality analyses. Composite samples from each trial were malted, and the analysis was conducted across trials. Sixteen trials from the Red River Valley On-Farm Trials that included the cultivars Robust, Legacy, Lacey, Tradition, and ‘Stellar-ND’ (Horsley et al., 2006) were used in the analyses of agronomic traits. Mean separation tests were based on LSD ( $p = 0.05$ ).

## Characteristics

### Agronomic and Botanical Description

Rasmusson heads about the same time as the other cultivars (data not shown) but is about 2 cm shorter than Lacey (Table 1). The lodging resistance is slightly less than that of Tradition and Lacey. The spike has semi-smooth awns, short rachilla hairs, and banded glume hairs. The kernel has a white aleurone, veins with few barbs, and a crease that is V-shaped and narrow to closed at the base. The hull is adhering and wrinkled. Rasmusson has short rachilla

**Table 2. Grain yield (kg ha<sup>-1</sup>) for Rasmusson barley and check cultivars from ten locations evaluated in the Mississippi Valley Barley Nursery, 2001–2005.<sup>†</sup>**

Cultivar	CR	MO	FA	CA	OS	BO	SY	MA	HA	KE	Mean
Robust	5362	4232	4376	4384	3936	4416	5733	4494	4226	4393	4534
Legacy	5849	4399	3929	4434	4449	4859	6027	4573	4820	4660	4761
Drummond	6078	4297	4035	4944	4539	4611	5891	4931	4442	4536	4795
Lacey	6276	4253	4498	4695	4360	4886	6385	4877	4848	4516	4915
Tradition	6166	4632	4065	4927	4670	4887	6067	5026	4420	4400	4897
Rasmusson	6338	4836	4505	4615	4214	4786	6718	5208	4880	4861	5065
LSD ( $p = 0.05$ )	685	512	256	368	ns	264	533	516	572	378	149
# of trials	3	5	4	5	3	5	4	5	4	4	42

<sup>†</sup>The locations were Crookston, MN (CR), Morris, MN (MO), Fargo, ND (FA), Carrington, ND (CA), Osnabrock, ND (OS), Bottineau, ND (BO), Sydney, MO (SY), Madison, WI (MA), Hamiota, Manitoba (HA), and Kernen, Saskatchewan (KE).

**Table 3. Malting quality profile of Rasmusson compared to other cultivars in the Mississippi Valley Barley Nursery, 2002–2005 (mean of 14 trials).**

Cultivar	Kernel weight	Plump kernels	Barley protein	Malt extract	Soluble protein	Soluble/total protein	Diastatic power	$\alpha$ -amylase	$\beta$ -glucan	Free amino nitrogen	Turbidity
	mg	%					°ASBC	D.U.	mg L <sup>-1</sup>	ppm	
Morex	33.0	73.8	14.0	78.2	5.62	41.9	167.6	67.8	210	230	6.7
Robust	34.2	82.2	13.8	78.3	5.51	41.7	166.2	50.6	338	226	5.9
Lacey	35.2	86.9	13.3	78.9	5.47	42.2	167.1	61.6	173	226	13.6
Drummond	33.8	84.6	13.7	78.6	5.61	42.5	178.8	64.5	218	240	9.6
Legacy	33.0	82.0	13.5	78.6	6.10	46.7	165.6	75.1	328	269	6.0
Tradition	34.5	87.0	13.6	78.8	5.33	41.0	191.5	62.7	212	220	16.9
Rasmusson	34.8	83.2	13.3	79.4	5.57	44.2	171.4	62.3	244	238	12.6
LSD ( $p = 0.05$ )	0.9	3.4	0.4	0.4	0.15	1.3	7.6	3.2	52	17	4.2

hairs whereas Tradition, Legacy, Stellar-ND, and Drummond all have long rachilla hairs.

### Grain Yield and Quality Performance

Rasmusson was evaluated in the MVBN from 2001 to 2005 in a total of 42 environments (Table 2). Compared to the two most popular six-rowed cultivars, the yield of Rasmusson was 102.8% of Lacey and 103.5% of Tradition across locations. In on-farm trials conducted in the Red River Valley, Rasmusson yields were 103.3% of those of Lacey and 108.9% of Tradition. In terms of malting quality, Rasmusson has significantly higher malt extract compared with the other cultivars (Table 3). Soluble protein, diastatic power, and free amino nitrogen are very similar to those of the industry standard, Robust. The ratio of soluble to total protein,  $\alpha$ -amylase, and turbidity are slightly higher than those of Robust, while  $\beta$ -glucan and barley protein are slightly lower.

### Disease Resistance

Disease reactions were assessed in a combination of field and greenhouse assays conducted from 2002 to 2008 (Table 4). For each disease, cultivars were given a 1 (resistant) to 9 (susceptible) disease reaction score based on comparative data for at least two experiments. Septoria speckled leaf blotch (caused by *Septoria passerinii* Sacc.) and the net form of net blotch (caused by *Pyrenophora teres* f. *teres* Drechs) were evaluated in the greenhouse in 2006,

2007, and 2008 using the methods of Toubia-Rahme and Steffenson (2004) and St. Pierre et al. (2009), respectively. Stem rust (caused by *Puccinia graminis* Pers.: Pers. f. sp. *tritici* Erikss. & E. Henn.) and spot blotch [caused by *Cochliobolus sativus* (Ito and Kuribayashi) Drechs. ex Dastur] were evaluated in field nurseries at St. Paul, MN in 2002 and 2003 using the methods of (Steffenson et al. (1993) and Fetch et al., 2008), respectively. Fusarium head blight (FHB), (caused by *Fusarium graminearum* Schwabe [teleomorph *Gibberella zeae* (Schwein) Petch], was evaluated in the field at St. Paul and Crookston, MN in 2005–2008 using grain spawn and

**Table 4. Disease reaction of Rasmusson compared to other barley cultivars to stem rust, spot blotch, net form of net blotch, Septoria speckled leaf blotch (SSLB), and Fusarium head blight (FHB).<sup>†</sup>**

Cultivar	FHB	Net blotch		Spot blotch	Stem rust <sup>‡</sup>
		Net blotch	SSLB		
Robust	8	8	9	2	1
MNBrite	6	6	9	1	1
Lacey	8	8	9	2	1
Drummond	8	7	9	2	1
Legacy	7	5	9	2	1
Tradition	8	7	9	2	1
Rasmusson	8	9	9	2	1

<sup>†</sup>1 = most resistant, 9 = most susceptible.

<sup>‡</sup>Reaction to the dominant strain of the stem rust pathogen.

conidial spray methods described by Steffenson (2003). Rasmuson is resistant to current stem rust races present in the Midwest and has the same marker haplotype for the gene specific marker for the stem rust resistance gene *Rpg1* as Morex (Eckstein et al., 2003). Rasmuson is not resistant to race TTKS of *P. graminis* f. sp. *tritici*, also known as Ug99. It is resistant to spot blotch, but is susceptible to FHB, Septoria speckled leaf blotch, and the net form of net blotch.

### Availability

Breeder seed is maintained by the Minnesota Agricultural Experiment Station, St. Paul, MN 55108. U.S. plant variety protection of Rasmuson is pending (PVP Application No. 201000053. Seed for research purposes is available on request from the corresponding author for at least 5 yr. It is requested that appropriate recognition of source be given when this cultivar contributes to development of new germplasm or cultivars.

### Acknowledgments

The University of Minnesota barley breeding program is supported in part by the American Malting Barley Association, the Minnesota Agricultural Experiment Station, and USDA HATCH project MIN-13-030.

### References

Bernardo, R. 2002. Breeding for quantitative traits in plants. Stemma Press, Woodbury, MN.

- Eckstein, P., B. Rossnagel, and G.J. Scoles. 2003. Allele-specific markers within the barley stem rust resistance gene (*Rpg1*). *Barley Genet. Newsl.* 33:7–11.
- Fetch, T.G., Jr., B.J. Steffenson, H.E. Bockelman, and D.E. Wesenberg. 2008. Spring barley accessions with dual spot blotch and net blotch resistance. *Can. J. Plant Pathol.* 30:534–542.
- Horsley, R.D., J.D. Franckowiak, P.B. Schwarz, and B.J. Steffenson. 2002. Registration of 'Drummond' barley. *Crop Sci.* 42:664–665.
- Horsley, R.D., J.D. Franckowiak, P.B. Schwarz, and B.J. Steffenson. 2006. Registration of 'Stellar-ND' barley. *Crop Sci.* 46:980–981.
- Rasmuson, D.C., K.P. Smith, R. Dill-Macky, E.L. Schiefelbein, and J.V. Wiersma. 2001. Registration of 'Lacey' barley. *Crop Sci.* 41:1991.
- Rasmuson, D.C., and R.D. Wilcoxson. 1979. Registration of 'Morex' barley. *Crop Sci.* 19:293.
- Rasmuson, D.C., and R.D. Wilcoxson. 1983. Registration of 'Robust' barley. *Crop Sci.* 23:1216.
- Rasmuson, D.C., R.D. Wilcoxson, and J.V. Wiersma. 1991. Registration of 'Excel' barley. *Crop Sci.* 31:227.
- Rasmuson, D.C., R.D. Wilcoxson, and J.V. Wiersma. 1993. Registration of 'Stander' barley. *Crop Sci.* 33:1403.
- Steffenson, B.J. 2003. Fusarium head blight of barley: Impact, epidemics, management, and strategies for identifying and utilizing genetic resistance. p. 241–295. *In* K.L. Leonard and W.R. Bushnell (ed.) *Fusarium head blight of wheat and barley*. American Phytopathological Society, St. Paul, MN.
- Steffenson, B.J., J.D. Miller, and Y. Jin. 1993. Detection of the stem rust resistance gene *Rpg1* in barley seedlings. *Plant Dis.* 77:626–629.
- St. Pierre, S., C. Gustus, B.J. Steffenson, R. Dill-Macky, and K.P. Smith. 2009. Mapping net form net blotch and septoria speckled leaf blotch resistance loci in barley. *Phytopathology* (in press).
- Toubia-Rahme, H., and B.J. Steffenson. 2004. Sources of resistance to septoria speckled leaf blotch caused by *Septoria passerinii* in barley. *Can. J. Plant Pathol.* 26:358–364.