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Cultivar description

Monserrat (D): an irrigated barley variety for El Bajío

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Abstract

The Montserrat (D) variety has a high nutritional value due to its content of β-glucans (5.5%), protein (12.2%), and starch (67.2%) in grains, presents a potential yield of up to 7.5 t ha^{-1} for sowing dates from November 15 to December 15, reaches the heading stage between days 65 and 72 and grain physiological maturity between days 110 to 120, has a plant height of 0.8 to 0.95 m, is tolerant of stripe yellow rust (*Puccinia striiformis* f. sp. *Hordei* West) and leaf rust (*Puccinia hordei* Otth), and has a grain filling index of 581, a thousand grain weight of 40.38 g, and a hectoliter weight of 80 kg hl^{-1}, which decreases for planting dates on January 15 (77.6 kg hl^{-1}); in addition, it presents a high percentage of naked grain (85 to 95%), so it is suitable for consumption as food and fodder. It is recommended to use 100 kg ha^{-1} of seed for double-row sowing and apply the 180-60-00 fertilizer formula of nitrogen, phosphorus, and potassium, respectively. These characteristics make Monserrat (D) a good alternative for the production of barley grain in the region known as El Bajío in Mexico, at altitudes between 1 500 and 1 800 m, on Vertisol and Phaeozem soils.

Keywords:

barley, feed, genotype.

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Introduction

Cereals for human consumption, once harvested, are subject to multiple operations to be used. Currently, two-thirds of the world's barley production is used for fodder, about one-third for malting, and approximately 2% for human consumption (Newman and Newman, 2006). In Mexico, approximately 1% of the total area planted with barley is used for human consumption (SIAP, 2011).

The first variety of naked-grained barley was released in 1977 under the name of América (Esparza and Castilla, 1977), with the aim of being used in mixtures (Narwall *et al*., 2017). Naked barley generally contains high β-glucan contents, although conditioned by a recessive gene (*nud*) on chromosome 1 (7 h); the high content of β-glucans in barley is associated with the waxy endosperm characteristic linked to the *wax* gene (Richard, 1990, Pers. Comm.).

β-glucans can be incorporated as food ingredients in the form of hydrocolloids or powder using microparticulation. Glucans-β-D-1,3-1,4 (β-glucans) in cereals have a large number of functionalities that make them unique as components of the plant cell wall, dietary fiber, and functional activity in foods (Geng *et al*., 2022; Crisan *et al*., 2023). Some studies indicate that consumption of whole grain cereals, in particular oats, can lower blood pressure (Keenan *et al*., 2002); for their part, other authors indicate that β-glucans have properties that strengthen the immune system (Murphy *et al*., 2004).

This document aims to describe the new variety of barley Monserrat (D), which meets the quality requirements accepted by the food industry (SE, 2003), has good resistance to rusts, and shows good adaptation to the producing areas of El Bajío. The use of this variety made it possible to eliminate the process of pearling or hulling the grain (Felizardo and Freire, 2018); therefore, the nutritional value of the flour is increased because during the pearling process, compounds such as vitamins, antioxidants, minerals, and insoluble fiber found in the external part of the grain are eliminated, which will contribute to obtaining products of higher quality and, especially, higher nutritional value (Behall *et al*., 2006).

Origin

Its obtaining began with the crossing carried out in the spring-summer (SS) cycle of 2012; the F1 generation was planted in the autumn-winter (AW) cycle of 2012-2013 in the Bajío Experimental Field (CEBAJ), for its acronym in Spanish of the National Institute of Forestry, Agricultural and Livestock Research (INIFAP, for its acronym in Spanish). The segregating generations were planted alternately in the Valle de México Experimental Field during the SS cycle and in the CEBAJ in the AW cycle. Mass harvesting was carried out in generation F6 when uniformity in its agronomic characteristics was observed. Its genealogy is CV12-227-1C-2R-1C-0R.

Variety characteristics

Monserrat (D) is a variety with six rows in the head, for use in human food; it was generated in CEBAJ and released by INIFAP in 2024, for irrigated plantings in the autumn-winter cycle and has a spring growth habit. It has an intermediate vegetative cycle, presents a potential yield of 7.3 to 7.5 t ha^{-1} when sown between November 15 and December 15; in contrast, in lots established at the end of December, the yield was 5.3 t ha^{-1}, and in late sowing on January 15, it decreases to 3.8 t ha^{-1}, according to Avila *et al*. (2023) (Table 1).

Table 1. Multiple means test for yield and seed quality of barley varieties, Celaya, Guanajuato, Mexico.

Genotypes	Yield (kg ha^{-1})		Volumetric weight (kg hl^{-1})		Weight of one thousand grains (g)	
Forrajera 3 (2 h)	6 123.9	a	65.4	b	49.5	a
Monserrat D (6 h)	5 961.6	ab	76.4	a	38.5	cd

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Genotypes	Yield (kg ha^{-1})		Volumetric weight (kg hl^{-1})		Weight of one thousand grains (g)	
Alina (6 h)	5 639.6	ab	64.2	b	41	b
Estelar OH (6 h)	5 296	ab	63	bc	42	b
Maravilla (6 h)	5 267.7	ab	59.9	cd	39.8	bc
Esperanza (6 h)	4 951.2	b	57.8	d	36.2	d
MSD ($p \leq 0.05$)	1 051.1		3.9		2.4	

MSD= minimum significant difference; means with the same letter in each column are not statistically different.

Depending on the climatic conditions and the sowing date, the heading stage and physiological maturity occur between days 65 and 72 and 110 and 120, respectively; for its part, the plant height ranges from 0.8 to 0.95 m. The evaluation of diseases was carried out at the Bajío Experimental Field, in Celaya, Guanajuato, during the different autumn-winter cycles. Monserrat (D) showed tolerance to infections of stripe yellow rust (*Puccinia striiformis* f. sp. *Hordei* West) and leaf rust (*Puccinia hordei* Otth), which are the primary diseases affecting the crop (Rodríguez-García *et al*., 2023). Good plant health has been observed through several evaluation cycles in the El Bajío locality (Table 2).

Table 2. Degree of infection of the main barley diseases: Montserrat (D) *vs* Estelar-OH and Maravilla.

Varieties	Montserrat (D)	Estelar-OH
Stripe yellow rust	Not present	Not present
Leaf rust	TR*-20MR**	TR-10MR

*= tolerant to stripe yellow rust; **= moderately resistant.

The percentage of naked grain that Monserrat (D) presents after mechanical threshing ranges between 85 and 90%, and the remaining 10-15% corresponds to covered grain. The average physical and chemical characteristics of this variety at 10.1% moisture are as follows: protein (DB) of 12.2%, starch of 67.2% (DB), and weight of one thousand grains of 40.38 g. When sown from November 15 to December 15, it presented a hectoliter weight greater than 80 kg hl^{-1}; whereas it was 78.8 kg hl^{-1} in lots established at the end of December, and 77.6 kg hl^{-1} in late sowings on January 15. On the other hand, the grain retained in the oblong sieve, 6/64 x 3/4", was 81.3%, while in the 5/64 x 3/4" sieve, it was 93.8%, and the grain filling index is 581.

On the other hand, the content of β-glucans in analyses carried out in the barley laboratory of INIFAP presented an average of 5.5% in the grain, so it has properties that strengthen the immune system; the consumption of barley #-glucans in experiments with men reduced blood glucose and insulin resistance, mainly associated with obesity, hypertension, dyslipidemia, glucose intolerance, and type 2 diabetes. It presents good health in plants across several evaluation cycles in the localities of El Bajío.

Production areas

The primary current and potential production areas of Monserrat (D) are located in the states of Querétaro, Guanajuato, Michoacán, and Jalisco, where there are regions with semi-warm and semi-dry climates, with rainfall in summer and average annual temperatures of 18 to 22 °C, altitudes between 1 500 and 1 800 m and where Vertisol and Phaeozem soils predominate.

Agronomic management

The Monserrat (D) variety requires a density of 100 kg ha^{-1} of seed for sowing in double-row furrows and 120 kg ha^{-1} of seed in traditional sowing in beds or border strips (Solano *et al*., 2009). For Monserrat (D), 180 kg ha^{-1} of nitrogen (N) is recommended, depending on fertility, previous crop

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and availability of soil moisture. By using higher doses of N (300 kg ha^{-1}), the possibility of lodging increases, mainly due to the increase in plant height.

Therefore, a high dose of N does not guarantee high yields, but it does represent a greater economic investment that negatively affects the producer's profit. Regarding the application of phosphorus, Monserrat (D) responds well to doses of 60 kg ha^{-1}. On the other hand, the application of potassium is not recommended because previous evaluations have not found a response to its application. The suggested irrigation schedule for barley production in El Bajío is 0, 40, 70 and 90 days after planting (Pérez-Ruiz *et al*., 2016).

Conclusions

The Montserrat (D) variety is an alternative for the production of quality food due to its β-glucan content, high percentage of naked grain, and its high yield potential.

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