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Description of cultivar

H-77: a white grain corn hybrid for the High Valleys of Mexico

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Abstract

In the High Valleys of Mexico, 1.8 million hectares are planted with corn, of which 51% correspond to rainfed conditions. In recent years, the occurrence of rain has been delayed, reducing the growing season, a condition that requires corn hybrids with a shorter cycle that reduces the risk of damage from early frosts and that continue to conserve production potential. In 2013, the H-77 trilinear hybrid was identified due to its earliness and good yield, it adapts very well to the Region of the High Valleys of the Central Mexican Plateau, at altitudes of 2 250 to 2 600 m, in areas with irrigation, irrigation tip, residual moisture, and rainfed conditions. H-77 is a tall hybrid with an early intermediate cycle (160 to 170 days to maturity). It showed a plant height that varies from 210 to 240 cm and an ear height from 90 to 100 cm. The plant lodging shown by H-77 ranged from 3 to 12%, which represents minimal to moderate lodging values. Likewise, H-77 showed greater tolerance to common rust (*Puccinia sorghi*), head smut (*Sporisorium reilianum*), and ear rot (*Fusarium* spp.). The yield varies from 5.7 to 11.5 t ha^{-1}, under a density of 65 000 plants ha^{-1}. The type of ear is conical, with a length of 10 to 15 cm and 12 to 16 rows. The grain is creamy white in color and has a semicrystalline texture.

Keywords:

Zea mays L., corn parent lines, grain quality, yield.

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In the Central Region of Mexico, 1 882 298 ha are sown under rainfed conditions, of which 974 156 ha (51.8%) are sown in areas of the High Valleys (2 101 to 2 650 masl). Even though varieties are available for planting in this region, conditions related to climate change reflected in higher temperatures, drought, and flooding make it necessary to have intermediate-early cycle corn hybrids to ensure production under delayed sowing conditions.

In order to meet the need for hybrids for this condition, in recent years, the National Institute of Forestry, Agricultural, and Livestock Research (INIFAP), for its acronym in Spanish has developed new corn hybrids with high yield and grain quality, as well as low plant size, tolerance to lodging and the main diseases that occur in the High Valleys Region. These hybrids have been the product of the combination of parent lines from the High Valleys of INIFAP and the International Maize and Wheat Improvement Center (CIMMYT), for its acronym in Spanish (Arellano *et al*., 1997). Therefore, they are an alternative to maintain profitable production under conditions of limited and erratic rainfall and higher temperatures during the development of corn crops in the High Valleys of the Central Mexican Plateau.

Origin of the H-77 hybrid and genealogy of its parents

In 2013, the H-77 trilinear hybrid was identified in a group of 98 experimental corn hybrids due to its earliness and good yield. Its parents were developed through the pedigree method. In the single female cross, CML246 x CML242 are involved, whereas the male line is M-65. The origin and genealogy of each of the parent lines involved in the formation of the H-77 hybrid are briefly described below.

In 1990, the CML246 line was incorporated into INIFAP corn genetic improvement programs in the High Valleys. The CML246 line was derived from population 800, it is white, early, and semi-toothed and has an inbreeding level of S_{10}. This line was obtained by CIMMYT and its genealogy is: P800-C2-FS22-1T-2-3TL-1-2-7TL-B. The CML246 line is registered with the National Catalog of Plant Varieties (CNVV, for its acronym in Spanish) with the registration number: MAZ-2457-081122.

In 1990, the CML242 line was incorporated into INIFAP's corn genetic improvement programs in the High Valleys. The CML242 line is an inbred line obtained by CIMMYT, which was derived from the population 85, it is white, early, and semi-toothed and has an inbreeding level of S_7. The genealogy of the CML242 line is: Batan 8785-HS10-1-1-2TL-1-3TL-3-1TL-B and is registered with the CNVV with the registration number: MAZ-2458-081122.

On the other hand, the M-65 line was derived from the population (LMPVA)-12-1-2-3-2-2-1-1 and the origin of this line dates back to 2001 when the crossings of the M-39 line with early experimental lines began at INIFAP- Valle de México Experimental Field (CEVAMEX), for its acronym in Spanish. From F_2, inbred lines were derived, selecting the earliest and disease-tolerant ones in each generation.

In the S_6 generation, the combining ability tests were carried out with two single test crosses. M-65 was selected and the level of inbreeding was advanced to S_{12}, where it was part of the H-77 hybrid. This corn parent line was registered in 2019 with the CNVV with registration number: MAZ-2157-061119 and with breeder's title number: 2395.

Registration of H-77 with the National Catalog of Plant Varieties

In 2023, the H-77 corn hybrid (Figure 1) was registered with the National Catalog of Plant Varieties (CNVV), for its acronym in Spanish, under the National Seed Inspection and Certification Service (SNICS), for its acronym in Spanish, with registration number: MAZ-2513-150623 and with breeder's title number: 2393.

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Figure 1. Plant and ear appearance of the H-77 corn hybrid.

H-77 adaptation

The H-77 corn hybrid was adapted to the High Valleys Region of the Central Mexican Plateau, at altitudes of 2 250 to 2 600 m in the states of Hidalgo, Puebla, Querétaro, Michoacán, and Mexico, in areas with irrigation, irrigation tip, residual moisture, and rainfed conditions, with rainfall fluctuating between 550 and 800 mm, average annual temperature of 24 to 27 °C, and deep loam soils with good drainage.

Morphological characteristics

Table 1 presents the main morphological characteristics of H-77, of the female single cross (CML246 x CML242) and of the male line (M-65) based on the Technical Guide for the Varietal Description of Corn of the SNICS (SNICS, 2014), the Technical Guide of Corn (UPOV, 2009) and the Graphic Manual for the Varietal Description of Corn (Carballo and Benítez, 2003).

Table 1. Morphological characters of the H-77 corn hybrid, the CML246 x CML242 single female cross, and the M-65 male parent.

Characteristics	H-77 Hybrid	CML246 x CML242 Female parent	M-65 Male parent
Anthocyanin coloration of the sheath on the first leaf	Absent	Absent	Absent
Undulation of the blade margin of the upper ear leaf	Moderate	Slightly undulate	Absent

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Characteristics	H-77 Hybrid	CML246 x CML242 Female parent	M-65 Male parent
Longitudinal wrinkles on the upper ear leaf	Present	Present	Absent
Sheath color on the ear leaf	Green-dark green	Green	Strong
Pubescence on the sheath margin	Medium	Little	Little
Tassel covering by the flag leaf	Absent	Very	Absent
Anthocyanin coloration at the base of the glumes in the middle third of the main axis of the tassel	Strong-very strong	Weak	Strong
Tassel length (cm)	35.1-43	35.1-39	27.1-35
Anthocyanin coloration in stigmas	Absent	Present	Absent
Anthocyanin coloration in the leaf sheath in the middle part of the plant	Weak-medium	Absent	Strong
Ear length, from base to apex (cm)	10.1-15	10.1-15	10.1-15
Diameter of the ear of the central part (cm)	4.1-5	4.1-5	<4
Ear shape	Conical-cylindrical	Conical-cylindrical	Conical
Number of rows per ear	12-16	12-14	12-16
Number of grains per row on the ear	21-40	31-40	<20
Type of grain in the central third of the upper ear	Semicrystalline	Semi-toothed	Semicrystalline
Unshelled grain color	Creamy white	White	White
Grain endosperm color	White	White	White
Anthocyanin coloration of cob glumes	Absent	Absent	Absent

Agronomic characteristics

The agronomic behavior of the H-77 hybrid was experimentally evaluated from 2016 to 2018 in different states of the Central Mexican Plateau in soils that present rainfed conditions, residual moisture, irrigation tip, or auxiliary irrigation, in order to study the behavior of the yield as well as its agronomic characteristics.

H-77 is a hybrid with an early intermediate biological cycle (160 to 170 days to maturity), with male and female flowering at 72 days. It has a plant height that varies from 210 to 240 cm and ear height from 90 to 100 cm. The plant lodging shown by H-77 ranged from 3 to 12%, which represents minimal to moderate lodging values. Likewise, H-77 showed greater tolerance to the main diseases that occur in the High Valleys Region, such as common corn rust (*Puccinia sorghi*), head smut (*Sporisorium reilianum*), and ear rot (*Fusarium* spp.).

Its grain yield potential with densities of 65 000 to 70 000 plants ha^{-1} is from 5.7 to 9.5 t ha^{-1} in sowings under irrigation tip, residual moisture, and rainfed conditions, whereas under irrigated conditions, this hybrid reached yields of 11.5 t ha^{-1} and it represents values of 11 and 16% compared to the joint yield of commercial controls H-66 and H-70. The type of ear is conical, with a length of 10 to 15 cm and 12 to 16 rows. The grain is creamy white in color and has a semicrystalline texture.

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Characteristics of grain and tortilla

Considering the commercial and industrial parameters indicated by the NMX-FF-034/1 (SE, 2020) standard for the making of tortillas by the traditional method, nixtamal-dough-tortilla and nixtamalized flour, the grains of the H-77 hybrid meet the physical characteristics demanded, such as: creamy bright color (60% reflectance), intermediate size and hardness, as well as hectoliter weight (30.9 g, 53%, 75.6 kg hl^{-1}, respectively).

Due to its chemical components: protein, oil, and crude fiber (12.7%, 4.3%, and 1.07%, respectively), the H-77 hybrid is within the parameters reported for commercial toothed corn (Hernández-Galeno *et al*., 2023). Regarding its nixtamal-tortilla quality, the H-77 hybrid showed dough and tortilla yields of 2.04 and 1.56 kg of processed corn, respectively. Its tortillas are white and of good texture. Therefore, it can be processed by the fresh dough and nixtamalized flour industries.

Seed production of the parents of the H-77 corn hybrid

The increase of seed in the basic category (lines CML246, CML242, and M-65) and the multiplication of seed in the registered category [(CML246 x CML242) and M-65] is carried out at CEVAMEX located in Santa Lucia Coatlinchán, Texcoco, State of Mexico, whereas the certified seed (H-77) will be produced by interested producer organizations, microenterprises, or institutions of the agricultural sector in an agreement with INIFAP.

The recommended planting period for the production of certified seed of the H-77 hybrid in the High Valleys region is in April. To do this, it must be carried out in an isolated lot following the standards established by the National Seed Inspection and Certification Service (SNICS), for its acronym in Spanish. Regarding isolation by distance or time (Vallejo *et al*., 2008), the female:male ratio of 4:1 or 6:2 can be used, planting first the female parent and the male parent five days later, in order to synchronize between parents.

Population densities of 65 000 plants ha^{-1} are recommended in the female and male respectively; in this way, an average of 5 t ha^{-1} of processed seed is produced if there is good agronomic management.

Conclusions

In the region of the High Valleys of the Central Mexican Plateau and due to the wide adaptability of the H-77 hybrid, it could be planted on at least 75 000 ha in the state of Tlaxcala, 150 000 in Puebla, 200 000 in the State of Mexico, 90 000 in Hidalgo, 100 000 in Querétaro and 450 000 in Michoacán, where the new corn hybrid represents a new alternative for sowings under irrigation tip and favorable rainy seasons in the High Valleys, since it surpasses the H-70 and H-66 hybrids in yield. In addition, it has a greater tolerance to lodging, a characteristic that will allow mechanical harvesting, reducing cultivation costs and the risks of damage from early frost.

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