Description of cultivar

Venado H74: early corn hybrid for rainfed and irrigated areas of the Central Plateau of Mexico

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Abstract

Due to the climate change that manifests itself in irregular distribution of rainfall less amount of this or its incidence in delayed time and higher temperature, the problem of lack of early maize hybrids arises, especially for regions of low and medium productive potential of the central table of Mexico, which cover 1 million 200 thousand hectares of cultivated area. The hybrid of early corn Venado H74 was generated to respond to these conditions of climate change, since it is an early-cycle trilinear hybrid with a very favorable performance response in regions with altitudes of 2 500 to 2 650 meters above sea level, where average temperatures prevail. 10.4 to 13.8 °C and rainfall levels of 482 to 852 mm, it is tolerant to drought in the vegetative and reproductive stages and performs well in conditions of low chemical fertilization. Its yield has a range of 2.3 to 12.6 t ha^{-1} which surpasses the 50% creole varieties and 20% commercial hybrids. It presents its period of heading between 96 and 109 days at altitudes of 2 500 and 2 600 m, respectively, where other hybrids and commercial varieties reach it between 110 and 115 days. It is resistant to the charcoal of the spike (*Sphaceloteca reiliana*) and to the rot of the ear (*Fusarium* spp.) and has the quality of nixtamalera-tortillera. Venado H74, is a trilinear hybrid whose female parent renders 7.5 t ha^{-1} in the high valleys, which gives it 25% more profitability in the production of registered and certified seed compared to other commercial corn hybrids. Its plant size facilitates intensive sowing with 70 thousand plants ha^{-1} and with planting to 100 thousand plants ha^{-1} ha under irrigation has shown yields of 14 t ha^{-1}. The harvest can be done at 160 days with a moisture content in grain 25%, so the cob must undergo a drying process to reduce the moisture content of the grain to 14%. The main economic impact of Venado H74 is the difference of 3 to 4 t ha^{-1} over the yield of the creole variety, which represents 12 to 16 thousand pesos per hectare, which makes corn production profitable.

Keywords: *Zea mays* L., early maturity, semicrystalline white grain, trilinear hybrid.

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In the Central Plateau of Mexico, one million 689 thousand 572 hectares are planted with corn and are distributed in three production strata: 1) irrigation with high yield; 2) temporary with high performance; and 3) temporary with low performance, covering areas of 12.6, 48.3 and 39% of the total (Arellano, 1984). The effects of climate change in the high valleys are manifested in adverse environmental conditions of limited and delayed weather that affects the month of May and the presence of moderate intensity frosts or 'frosts' or drastic freezes during the month of September. which determine that the growing season is shortened to 140 days to obtain good harvests of quality corn.

It has been proposed that to achieve greater performance through multiple environmental conditions, genotypes that maintain a greater productive response to the environment with consistent or stable behavior and high yield are required (Kang, 1998; Lu'quez *et al*., 2002), this it is feasible based on the capacity of the genetic potential of the hybrid to buffer adverse agroclimatic conditions and the application of technological components such as the use of mycorrhizae, adequate population densities and an effective integral fertilization program. Early corn hybrids with high yield and grain quality, are an alternative to maintain profitable production under limited and erratic conditions of rain and higher temperatures during the growing season in the high valleys of the central table of Mexico.

Generation of the H74 hybrid

The corn hybrid Venado H74 generated from inbreds Mich 21 Comp.1-7-2-14-1-3 with level of inbreeding S_5, identified in its registry as M54 and Tlax. 151 SFC1-11-2-2-2 with inbreeding level S_4, registered as M55, both lines were generated by the pedigree method with *per se* selection. The origin of the M54 line is found in the creole variety called Michoacan 21, while that of the M55 line in the creole variety Tlaxcala-151. The crossing of these lines gave rise to the female progenitor M54 x M55. In the sources of germplasm Mich 21 and Tlax 151 there have been significant effects of general combinatorial aptitude (Balderrama *et al*., 1997).

The CML456 line is also involved in the generation of this hybrid as a male parent, this was derived from the early pre-mature white population and has S_4 inbreeding level and three cycles of massive increase, this line was obtained by the International Center for the Improvement of Corn and Wheat (CIMMYT) and its genealogy is: (crosses simple high valleys of INIFAP x Batan 8585-6) -B-1-1-1-2-BTL-B, Batán 8585-6 comes from the population 85 precocious white semidetached. The combination of lines from sources Mich 21 and Tlax 151 by lines of the population 85 show favorable effects of specific combinatorial aptitude (Arellano, 1998).

The process of derivation and selection of lines of the simple female crossbreed of the hybrid Venado H74 was carried out from 1946 to 1984. During the period from 1985 to 2009, experimental simple crosses of the female were obtained, evaluated and selected. The tri-linear hybrid Venado H74 was generated in 2009 and from 2010 to 2016, experimental evaluations and semi-commercial validation were carried out in localities of the High Valleys. In 2017, the documents required for official registration were submitted to the National Seed Inspection and Certification Service (SNICS).

In the Figure 1 shows the classical hybridization scheme for obtaining the hybrid Venado H74 from ears representative of the progenitors and the hybrid. It can be seen that the M54 progenitor is a small ear of conical type with round grain of semi-hardened texture and creamy color, while the M55 line is of long ear with irregular rows and thin pointed grain and semi-crystalline white. The crossing of both parents generates the female progenitor M55 X M54 that exhibits considerable heterosis in size and weight of the ear that is conical with grain of creamy white texture. While the male progenitor line CML456 has a small ear of conical shape with white semicrystalline type grain. The female parent when crossing with the male parent generates the combination that gave rise to the new trilinear hybrid Venado H74 of medium-sized cylindrical conical ear of regular rows with white semicrystalline type grain.

Figure 1. Schematic of obtaining the hybrid of early corn Venado H74 and phenotypic characteristics of the ears representative of the progenitors and the hybrid.

Registration of the corn hybrid Venado H74 in the national catalog of plant varieties

Based on the Production, Certification and Seed Trade Act in force in Mexico and after having met the requirements for registration, the hybrid of Venado H74 corn was registered in 2017 in the National Catalog of Varieties of Vegetables (CNVV) with the Provisional registration number: 3567-MAZ-1884-310118 / C.

Description of the morphological characteristics of hybrid Venado H74 and its progenitors

In the Table 1 shows the main morphological characteristics of the Venado H74, the simple female cross (M54 x M55) and the male parent CML456 based on the technical guide for varietal description (SNICS, 2014).

Table 1. Morphological characteristics of the Venado H74 corn hybrid, the M54 x M55 female simple cross and the CML456 male progenitor.

Characteristics	Variety description		
	Venado H74 trilinear hybrid	M54 x M55 Female progenitor	CML456 Male progenitor
Coloring of the pod by anthocyanins in the first leaf	Medium to Strong	Absent	Absent to weak
Shape of the tip of the first leaf	Rounded	Obtuse to round	Rounded
Angle between the ear leaf and the stem	Medium	Small	Very small
Form of the leaf	Slightly curved	Slightly curved	Slightly curved
Orientation of leaves above the upper ear	Semierect	Semierect to Semihorizontally	Erect to Semierect
Orientation of leaves under the upper ear	Semierect	Semierect - Semihorizontal	Erect to Semierect
Ripple of the laminar margin of the upper cob sheet	Absent	Absent	moderate
Longitudinal wrinkles on the upper cob sheet	Always present	Always present	Absent
Color of the pod on the cob leaf	Dark green	Green to dark green	Green
Pubescencia on the margin of the leaf of the cob	A lot	Medium to much	Medium to much
Coloring of anthocyanins in adventitious roots	Weak to medium	Weak to strong	Weak
Panicle coverage by the flag leaf	Absent a little	Absent to mild	Absent a little
Days to 50% flowering (anthesis)	66-72 (2 300 masl)	68-79 (2 300 masl)	73-79 (2 300 masl)
Coloring by anthocyanins at the base of the glumes	Absent to weak	Intermediate to very strong	Absent to weak
Coloring by anthocyanins in the glumes	Absent to weak	Absent to dim	Absent to weak
Shank length	27-43	27-43	27-35
Peduncle length	12.1-28	20-28	12-24
Female flowering	73-79 (2 300 masl)	73-84 (2 300 masl)	73 a 79 (2 300 masl)
Coloring by anthocyanins in stigmas	Absent to present	Absent	Absent to present
Coloring by anthocyanins in the leaf sheath	Absent or very weak	Weak to medium	Weak
Height of the cob	101-160	130-150	60-100

Characteristics	Variety description		
	Venado H74 trilinear hybrid	M54 x M55 Female progenitor	CML456 Male progenitor
Ear length	10 to 15	10 a 20	10 a 15
Diameter of the ear of the central part (cm)	4.1-6	4.1-6	4.1-5
Shape of the cob	Conical-cylindrical	Conical	Conical-cylindrical
Number of rows per corn	10 a 16	12 a 22	10 a 16
Number of grains per row on the cob	21-40	21-40	20-30
Arrangement of the rows	Spiral	Slightly spiral	Spiral
Type of grain in the central third of the ear	Intermediate	Semidentate-semicrystalline	Semidentate
Ungraded grain color	White-creamy	White-creamy	White- reamy
Endosperm color	White	White	White
Coloring of the glumes	Absent	Absent	White

Agronomic behavior of the hybrid Venado H74 in localities of High Valleys

The agronomic behavior of the hybrid Venado H74 was evaluated experimentally and in batches of commercial production from 2008 to 2015 in 23 representative localities of environments of deficient, intermediate and favorable weather or with irrigation of aid, with the purpose of studying better the behavior of the global yield and that of the interaction genotype x environment of performance.

At a global level, the yields varied from 2.3 to 12.6 t ha^{-1} and represent values of 90 to 126% with respect to the joint yield of commercial controls H-70 and variety creole. The number of days to male flowering ranged between 75 and 108, which correspond to sites located at altitudes of 2 250 and 2 650 meters above sea level, respectively, that is, at higher altitude, the emergence, development of the spike and dispersion of pollen is slower due to lower temperatures of the place. Regarding plant height, Venado H74 showed a plant size that varied from 170 to 230 cm, the highest plant height is usually associated with lower altitude environments and higher available humidity.

The planting that showed Venado H74 ranged between 5 and 10%, which represents minimum to moderate lodging values. The means through localities for yield, male flowering, plant height and planting were 8.2 t ha-1, 96.6 days, 203.5 cm and 7.1%, respectively. Throughout, the Venado H74 test environments were 14.2% higher in performance than the average commercial controls (Table 2). The response of this early hybrid to population densities of 60 to 100 thousand plants ha^{-1} was detected in the town of Coatlinchan, State of Mexico with yields of 8.8 to 14.2 under irrigation and 7.1 to 8.9 t ha^{-1} in rainy season, respectively (Table 2).

Table 2. Yield, percentage of yield with respect to the witnesses and plant characters of the hybrid corn Venado H74 by location and year in the Central Plateau of Mexico.

Location	REND (t ha^{-1})	(%) of control	FM (days)	AP (cm)	Root lodging (%)
2008					
Chapingo, State of Mexico (2 230*)	10.9	133	75	210	5
2009					
Calpulalpan, Tlaxcala (2 600*)	12.6	106	88	200	6
2010					
Zotoluca, Hidalgo (2 450*)	5.9	105	78	220	5
2012					
Benito Juarez, Tlaxcala (2 529*)	5	102	109	170	8
La Madalena Soltepec, Tlaxcala (2 530*)	7.1	142	103	170	8
San Luis Huamantla, Tlaxcala (2 450*)	10.3	103	107	200	5
San Jose Teacalco, Tlaxcala (2 581*)	7.6	96	107	201	7
San Nicolas Panotla, Tlaxcala (2 222*)	6.5	106	96	200	8
San Miguel P. Ixtacuixtla, Tlaxcala (2 521*)	8.6	103	96	200	6
S. Francisco Tetlanohcan, Tlaxcala (2 433*)	6	106	108	200	8
S. Cosme Xalostoc, Tlaxcala (2 474*)	2.3	90	102	200	10
2013					
Francisco Villa, Tlaxcala (2 536*)	7.7	106	94	200	7
San Nicolas Panotla, Tlaxcala (2 222*)	7.7	111	91	230	10
San Miguel Ixtacuixtla, Tlaxcala (2 478*)	11.2	131	86	220	5
Santa Fe, Cuapiaxtla, Tlaxcala (2 490*)	9	150	91	205	8
2014					
San Miguel, Ixtacuixtla Tlaxcala (2 521*)	5.2	114	96	205	10
San Damian Texoloc, Tlaxcala (2 225*)	8.8	127	99	218	7
2015					
Chapingo, State of Mexico (2 230*)	11.2	132	75	220	6
Coatlinchan, State of Mexico (2 230*)	9.4	114	77	230	5
Axocomanitla, Tlaxcala (2 200*)	10.4	113	86	224	6
La Magdalena Soltepec, Tlaxcala (2 530*)	7.8	105	92	210	9
Francisco V. Huamantla, Tlaxcala (2 525*)	9.4	122	96	194	7
Nexnopala, Altzayanca, Tlaxcala (2 512*)	8.4	113	95	215	8
Average	8.2	114.2	96.6	203.5	7.1
2016					
Coatlinchan, State of Mexico (2 230*) 60 000 plants ha^{-1}	Irrigation 8.8	Temporary 7.1	74	230	5
Coatlinchan, State of Mexico (2 230*) 80 000 plants ha^{-1}	Irrigation 10	Temporary 7	74	220	7
Coatlinchan, State of Mexico (2 230*) 100 000 plants ha^{-1}	Irrigation 14.3	Temporary 8.9	74	200	8

REND= performance; FM= male flowering; AP= plant height; *=Altitude in meters above sea level. Cultivars included in the average control H-70 and Variety Creole.

The agronomic management technology for the commercial production of the hybrid Venado H74 is indicated in technical brochure no. 13 for the production of H-70 (Arellano *et al*., 2011).

Seed productivity of the progenitors of the hybrid Venado H74 in localities of High Valleys

In the Valley of Mexico Experimental Field located in the town of Coatlinchan, Texcoco, State of Mexico at 2 240 meters above sea level, experimental grain yields were recorded for progenitor lines M54, M55 and CML242 of 2.6, 2.5 and 3 t ha^{-1}, respectively. In terms of yield and seed vigor characters, the lines indicated above were classified as stable when evaluated in three locations of High Valleys and Bajio (Hernández, 2018). Regarding the performance of the female progenitor M55 x M54 established in the field under irrigation at the planting date of May 20 in the town of Coatlinchán (2 230 meters above sea level), State of Mexico, a production of 10 t ha^{-1} was recorded (Virgen *et al*, 2009).

On the other hand, it was found that in plantings with producers from Espiritu Santo-Ixtacuixtla and Francisco Villa, both of Tlaxcala, located at altitudes of 2 430 and 2 530 m, respectively, the simple female cross gave 6.5 and 6.2 t^{-1}, respectively, with the population density of 83 thousand plants ha^{-1} and date of planting on April 19, these yields exceeded 1.5 and 3 t ha^{-1} of the female crosses of the commercial hybrids H40 and H50, respectively (Virgen *et al*., 2009; Virgen *et al*., 2010). In the localities of Texoloc, Benito Juárez and San Nicolás Panotla, Tlaxcala at altitudes of 2 225, 2 530 and 2 200 m, respectively, the female progenitor (M54 x M55) yielded 8.6, 6.9 and 6.4 t ha^{-1}, respectively (Virgen *et al*., 2013). The yield greater than 3 t ha^{-1} of the CML-456 line was obtained in Coatlinchán, State of Mexico and Texoloc, Tlaxcala, reaching 4 t ha^{-1} in planting on May 10 in Coatlinchán (Virgen *et al*., 2016).

The previous results indicate the possibility of obtaining very favorable seed yields from the parents and from the Venado H74 hybrid in localities located between 2 200 and 2 600 meters above sea level, which makes reliable and profitable the multiplication of certified seed of this new corn hybrid in localities of the High Valleys.

The recommended sowing period for certified seed production in the Central Plateu of Mexico is established in April, while the female - male sowing ratio is 6:2, where the male parent should be planted a week before the female, both under the population density of 65 thousand plants per hectare. The beginning of the detasseling period marks the emergence of the spikes, it is recommended to carry out this activity in six days and to consider in the last one, the elimination of the spike (Arellano *et al*., 2011).

Conclusions

In terms of the productive potential of the regions of the Central Plateau of Mexico and the adaptability of Venado H74, it is established that there are at least 75 thousand hectares in the state of Tlaxcala, 150 thousand in Puebla, 200 thousand in the State of Mexico and 90 in Hidalgo, where the new maize hybrid can participate successfully to increase yields under rainfed or irrigated crops.

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