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Cultivar description

Coztli Puma: an early free-pollinated yellow grain corn variety

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Abstract

In Mexico, corn (*Zea mays* L.) is the most important crop due to its sown area (7.4 million ha), its consumption of more than 200 kg person^{-1} year^{-1} and its role in the economy. However, Mexico imports 15.5 to 17 million t of yellow corn grain each year, these volumes are mainly destined for the livestock feed industry, as well as other destinations. In the Central Mexican Plateau (2 200 to 2 600 masl), in 1.5 million hectares sown with corn, in more than 50% of that area, the moisture for the crop comes from rainfall, which arrives late, insufficient and irregular, this forces late sowing and the crop to be affected by early frosts, since long-cycle varieties do not reach maturity and yields are low (1.2 t ha^{-1}). In 2021, Kuautli Puma, Mistli UNAM, and Coztli Puma were registered, corn varieties that could support grain production as they present earliness and high productivity in conditions of delayed rainfall, limiting environments, late sowing, and short frost-free period. This variety description describes the phenotypic characteristics and agronomic advantages of the yellow-grain free-pollinated variety named Coztli Puma. This variety yields an average of 7.9 t ha^{-1} and is an alternative for corn producers in Valles Altos. Coztli Puma was registered in the national catalog of plant varieties (CNVV, for its acronym in Spanish) and holds the breeder's title: 2849, granted on December 21, 2021.

Keywords:

Zea mays L., corn variety, early yellow grain, High Valleys.

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Mexico is the largest importer of yellow corn grain, with 17 million toneladas per year. This volume is destined to the industry for livestock feed, for the production of pigs, cattle, sheep, poultry, eggs, as well as other different destinations for consumption in the diet of Mexicans (https://www.jornada.com.mx/2022/05/21/delcampo/articulos/urgencia-produccion-maiz.html).

A fraction of these volumes is destined to produce starches and raw materials for the cereal and snack industry, which is now limited by the presidential decree, which prohibits the use of transgenic corn for consumption by Mexicans, this for the benefit of native corn and to privilege the biocultural wealth of Mexico and promote the construction of a comprehensive biosecurity that contemplates the application of human and environmental rights for the well-being of society as a whole (https://www.jornada.com.mx/2021/07/17/delcampo/articulos/decreto-presidencial-glifosato.html).

Historically, corn is the most relevant grain for Mexico due to its use in human diet, since its per capita consumption is 200 kg person^{-1} year^{-1}, and due to its cultivation area (7.4 million hectares) (SADER, 2020). The country is self-sufficient in the production of white corn, with 24 million tons, of which 13 million tons are destined for consumption in tortillas.

The large import of yellow corn makes it necessary to promote the increase in production of this type of corn, this requires improved varieties of yellow grain (https://www.jornada.com.mx/2022/05/21/delcampo/articulos/urgencia-produccion-maiz.html), with good productivity for use in the areas where this type of improved varieties are sown (which represent 25%). For 75% of the corn sowing area, there are thousands and thousands of native varieties, of 64 corn races, with specific adaptations (Luna *et al*., 2012; Espinosa *et al*., 2021).

In the Central Mexican Plateau (2 200 to 2 600 masl), in 1.5 million hectares for corn sowing, in more than 50% of this area, the moisture for the crop comes from rainfall, but the rainfall is delayed, insufficient, and irregular; this forced late sowing, affecting the crop due to early frosts, because the long-cycle varieties used do not reach maturity and their yield is low (1.2 t ha^{-1}) (García *et al*., 2018).

In 1981, the improved yellow grain varieties for the Central Mexican Plateau (2 200 to 2 600 masl), 'V-26 A' and 'Carrot Yellow', were registered. But more recently, the Corn Genetic Improvement Program of the Valley of Mexico, of the National Institute of Forestry, Agricultural and Livestock Research (INIFAP, for its acronym in Spanish) and the Cuautitlán Faculty of Higher Studies-National Autonomous University of Mexico (FESC-UNAM, for its acronym in Spanish), in 2009, commercially released the free-pollinated varieties V 54 A, V 55 A, both of yellow grain.

In 2017, the Oro Puma variety and the varietal hybrids HV 59 A and HV 60 A were registered (Espinosa *et al*., 2021). In 2021, the FESC-UNAM registered the varietal hybrids Kuautli Puma, Mistli UNAM and the free-pollinated variety Coztli Puma, yellow grain materials that could help increase the production of this type of grain since they present earliness and high productivity for delayed rainy season conditions, limiting environments, late sowings, short frost-free period (Espinosa *et al*., 2010; 2011).

This varietal description describes the phenotypic and agronomic characteristics, as well as relevant aspects of the Coztli Puma variety in relation to the varieties V54 A, V 55 A, HV 59 A, HV 60 A (Espinosa *et al*., 2021), which give it advantages for corn producers in the Central Mexican Plateau. Coztli Puma has the definitive registration number in 2021: 4209-MAZ-2292-110521/C, of the National Seed Inspection and Certification Service (SNICS, for its acronym in Spanish), in the National Catalog of Plant Varieties (CNVV, for its acronym in Spanish), it has the breeder's title: 2849, granted on December 21, 2021, valid until December 15, 2036.

The Coztli Puma variety was obtained from the balanced compound CB21F2, in which two recombination cycles were applied. Then the IA-MAE13-A selection was obtained and recombined for three cycles, then three cycles of stratified mass selection were applied to obtain the Coztli Puma variety, which yields 7 900 kg ha^{-1}, on average from 2017 to 2019, with a population density of 75 000 plants ha^{-1}. Coztli Puma is early (135 days to physiological maturity at 2 250 masl) and tolerant to lodging, has semi-crystalline grains and exceeds in yield the commercial variety V 54 A by 19.8% and the variety HV 60 A by 29.2%.

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In good conditions of rainfall, irrigation, and residual moisture, Coztli Puma yields best, from 9.7 to 11 t ha^{-1}. It can be managed agronomically with minimal tillage, without weeding or earthing up, due to its plant size and tolerance to lodging. The Coztli Puma variety can be sown from the end of May to the end of June. Coztli Puma does not produce tillers or plant unable to reproduce and sterile. It had a plant height of 228 cm, while the ear height is 112 cm.

The angle of insertion of the leaves above the main ear (angle formed between the central rib and the axis of the stem) is semi-erect (60-90°), the shape of its tassel, defined by the angle formed between the main axis and the lateral branches in the lower third of the tassel, is compact, the lateral branches of the lower third of the ear are rectilinear and very long (> 25 cm).

The leaf of the main ear in Coztli Puma is dark green. The ear is 15.1 to 17.2 cm long, with 14 rows and 29 grains per row (Figures 1a, 1b, 1c). The grain-to-ear ratio is 84%. The dough yield (1.6 kg of dough per kg of processed corn) is higher than that required by the dough-tortilla industry, the volumetric weight is 76.4 kg hl^{-1} and it has a flotation index of 12%. The production of Coztli Puma seed can be carried out in localities located between 1 900 and 2 650 masl during the spring-summer (SS) agricultural cycle, such as in localities in the Valley of Mexico, Cuautitlán Izcalli, Texcoco, and Zumpango, as well as other places in the states of Tlaxcala and Puebla.

Figure 1-Plant and ear appearance of the Coztli Puma yellow-grained corn variety.

At the Rancho Almaraz of Field IV of the FESC-UNAM, the high-registration seeds of the Coztli Puma variety, parent seed in original, basic, and registered quality, are increased, conserved, and kept. This seed can be purchased by interested seed producers to be multiplied and supplied to farmers for sowing in the Central Mexican Plateau. Coztli Puma is well suited to traditional producers with medium productivity, as well as to subsistence producers; as it is of yellow grain (for which there is a high demand), there could be a potential market of more than two million tons for the livestock products sector (Tadeo, 2004).

The average yield of Coztli Puma in the state of Mexico was 9 500 kg ha^{-1}, with a variation of 7 to 11.5 t ha^{-1}. This variety benefits corn producers who depend on rainfall for the establishment of their plots, who generally do not buy seed since they sow seed from their own plot. Coztli Puma represents an economical alternative for them since there are few varieties of yellow corn with this vegetative cycle and with the earliness of Coztli Puma (Espinosa *et al*., 2010; Espinosa *et al*., 2011).

To guarantee the genetic purity of Coztli Puma, the seeds of this free-pollinated variety, in the high-registration categories, should be increased in lots isolated from other lands sown with corn, at least 300 m apart for basic and registered seeds and 200 m for multiplying certified seeds; another option is to isolate for a period of time with a difference of 20 days in the sowing date, with respect to other

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neighboring corn of maturity similar to Coztli Puma, so that there is no coincidence of the flowering of the Coztli Puma seed production lot with other nearby lots.

Off-type or diseased plants should be removed in at least three stages, at 25 days, at 40 days and before flowering (pollen release), that is, at 70 days, at altitudes of 2 250 masl. At harvest time, the quality of the seed batch can still be improved by removing off-type, malformed or rotten or pitted ears. For the refreshment and maintenance of the original seed of the Coztli Puma variety, it is increased by fraternal pollination of plants from the rows of the variety to other plants of different furrows, which are known as uncompromised plants.

Conclusions

The seed of the Coztli Puma variety can be increased in isolated lots, in which it is allowed to recombine freely, but four rows could also be detasseled and leave a row with tassels that would pollinate the four contiguous ones, thus ensuring that there are no self-pollinations and keeping the genetic quality of the variety stable.

The registered and basic seed of the Coztli Puma variety can be purchased in Field IV of the Cuautitlán Faculty of Higher Studies-National Autonomous University of Mexico (FESC-UNAM, for its acronym in Spanish), from which certified seed can be increased under the supervision of the National Seed Inspection and Certification Service (SNICS, for its acronym in Spanish).

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