

Varietal description of two genotypes of manzano chili pepper (*Capsicum pubescens* Ruiz & Pav.)

Christian I. Galvez-Orduña¹; Pablo Andrés-Meza^{*1}; José L. Del Rosario-Arellano¹; Ricardo Serna-Lagunes¹; Jaime Mejía-Carranza²; José A. Vera-Heredia³; Otto R. Leyva-Ovalle¹; Joaquín Murguía-González¹; María E. Galindo-Tovar¹; Juan Del Rosario-Arellano⁴; Mauro Sierra-Macías⁵; Alejandro Espinosa-Calderón⁶; Margarita Tadeo-Robledo⁷; Noé Aguilar-Rivera¹; Luis E. Aquino-Solís¹

¹ Universidad Veracruzana. Facultad de Ciencias Biológicas y Agropecuarias, región Orizaba-Córdoba, Camino antiguo Amatlán-Peñuela. 94950, Peñuela, Amatlán de los Reyes, Veracruz, México. C.P. 94950.

² Universidad Autónoma del Estado de México, Centro Universitario UAEM Tenancingo. Carretera Tenancingo-Villa Guerrero Km. 1.5, 52400 Tenancingo, México.

³ Centro de Bachillerato Tecnológico Agropecuario (CBTA) No. 99. Camino hacia Xanxuanco. 94140, Coscomatepec de Bravo, Veracruz, México. C.P. 94140.

⁴ Universidad Interserrana del Estado de Puebla Chilchotla. Rafael J. García, Chilchotla, Puebla. C.P. 75070.

⁵ Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Campo Experimental Cotaxtla. Medellín de Bravo, México. C.P. 94990.

⁶ Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Campo Experimental Valle de México. Texcoco, México. C.P. 56100.

⁷ Universidad Nacional Autónoma de México. Facultad de Estudios Superiores Cuautitlán, Cuautitlán Izcalli, México. C.P. 54714.

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ABSTRACT

Objective: The objective of this research study was to obtain the varietal description of two varieties of manzano chili pepper in Las Montañas region, in central Veracruz, Mexico.

Design/methodology/approach: The varietal characterization module was established under greenhouse conditions. The markers recorded were in accordance with the International Plant Genetic Resources Institute for *Capsicum* and the Graphic Handbook for Variety Description of manzano chili pepper. The plants were characterized from seedling in greenhouse to adult plant. The agronomic management of the crop was carried out in accordance with the manual for the production of manzano chili pepper in Las Montañas, state of Veracruz.

Results: All qualitative markers were constant for the two varieties, MEXUVNE1-15-C2 and MEXUVCU1-16-C2, from seedling to fruit setting. In contrast, there were dissimilarities in plant height, and stem, leaf, flower, fruit and seed dimensions.

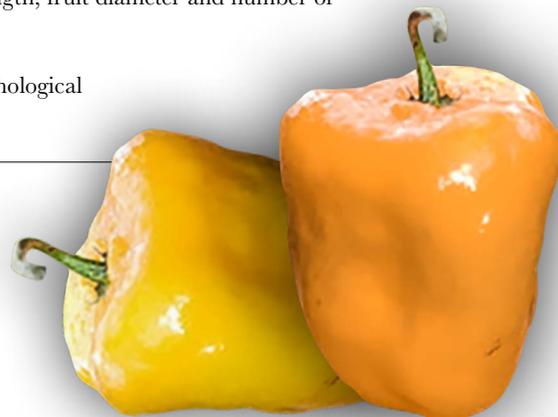
Study limitations/implications: The pandemic caused by COVID-19 was the main limitation, resulting in some markers not being recorded in a timely manner as indicated in the Graphic Handbook.

Findings/conclusions: Both varieties are very similar; however, the greatest distinction was in the quantitative markers, such as: plant height, fruit length, fruit diameter and number of seeds.

Keywords: High Mountains, novel variety, morphological markers, characterization.

INTRODUCTION

Capsicum is an economically important genus within the Solanaceae family (Hernández-Pérez *et al.*, 2020), it is made up by at least 31 species, although only five have



been domesticated: *C. baccatum*, *C. chinense*, *C. frutescens*, *C. annuum* and *C. pubescens* (Pérez-Castañeda *et al.*, 2015). The latter is the fifth most important species cultivated from the genus and has its origin in the high parts of the Andes; its introduction to Mexico was made at the beginning of the 20th century where it is cultivated in transition areas and of temperate climate, ranging from 1300 to 2400 masl (Pérez-Grajales *et al.*, 2004). Recent studies report the presence of this species in several states of the Mexican Republic such as Tamaulipas, Nuevo León, Chihuahua, Estado de México, Puebla, Oaxaca, Chiapas, Michoacán, Hidalgo and Veracruz (Hernández-Pérez *et al.*, 2020; Serna *et al.*, 2020).

Studies carried out by Leyva *et al.* (2018) evidence reservoirs of genetic material from *C. pubescens* with outstanding morpho-agronomic characteristics in family gardens and as associate crop with species of fruit and forest trees. However, there are still few studies that address aspects of identification and exploitation of the genetic material, morphological characterization of plant and fruit, and release of outstanding materials by producers for their use. In this sense, the production of manzano chili pepper in the region of Las Montañas, Veracruz, has not been outstanding because its cultivation is conducted primarily under rainfed conditions where the yield, use of improved varieties, and level of modernization are low, impacting directly on the productivity and profitability of the crop. Therefore, studies are necessary that lead to the varietal identification and characterization to increase the productivity of local farmers. Because of this, the objective of this research study was the varietal characterization of two genotypes of manzano chili pepper in Las Montañas, in the central zone of Veracruz, with registry purposes.

MATERIALS AND METHODS

The establishment of the varietal characterization plot was carried out in the Centro de Bachillerato Tecnológico Agropecuario No. 99 (CBTA 99) in the municipality of Coscomatepec de Bravo, located geographically at 19° 06' 58" LN, - 97° 02' 29" LW and altitude of 1396 masl. The experimental varieties MEXUVCU1-16-C2 and MEXUVNE1-15-C2, which come from manzano chili pepper fruits selected from plants with outstanding morphological characteristics, were characterized through the mass selection plan (Merino, 2019).

From each variety, 80 seeds that were free of pathogens were selected and then sown in black polyethylene 26×15 cm bags, peat moss[®] was used as substrate. Two seeds per cavity were deposited with the purpose of ensuring germination. The seedlings remained in the bags until they developed 8 to 10 true leaves. The plot was prepared before the transplant, to achieve a good sowing bed. During the transplant, a plant was deposited per cavity in the soil, at a depth of 0.4 m, distance between plants of 0.8 m and distance between rows of 1.5 m, to obtain a population density of 27,777 plants ha⁻¹. Because the soil is not homogeneous, the varieties were established under a completely randomized experimental blocks design with two replications. Each observation unit was constituted by one plant, with a total of 20 plants per block. The agronomic management of the crop was conducted in accordance with the manual for the production of manzano chili pepper for Las Montañas region (Andrés-Meza *et al.*, 2019).

Thirty-nine (39) varietal descriptions were recorded corresponding to each phenological stage according to the International Plant Genetic Resources Institute (IPGRI, 1995) for *Capsicum* and the Graphic Handbook for Variety Description of manzano chili pepper (SNICS, 2017). Descriptive statistics were used for the quantitative markers, such as the arithmetic mean, standard deviation, standard error, coefficient of variation and variance, which allowed estimating and describing the behavior of the different accessions in relation to each marker. For the qualitative markers, absolute frequencies were obtained for each category. All the analyses were conducted with the SAS/STAT[®] version 9.0. software (Castillo, 2007).

RESULTS AND DISCUSSION

Seedling

Both genotypes presented a medium pigmentation of the hypocotyl with green coloring of the oval type leaf and presence of anthocyanins in the stem. Seedlings present purple coloring of the hypocotyl, as well as intermediate pubescence (Figure 1). At 73 days after sowing (das), variety MEXUVNE1-15-C2 presented a seedling height of 11.02 ± 2.74 cm, and MEXUVCU1-16-C2 of 11.58 ± 4.19 cm (Table 1).

Mature plant

After transplant and during the growth period (194 das), nine qualitative markers were constant for both genotypes. It is important to highlight the presence of pubescence on the

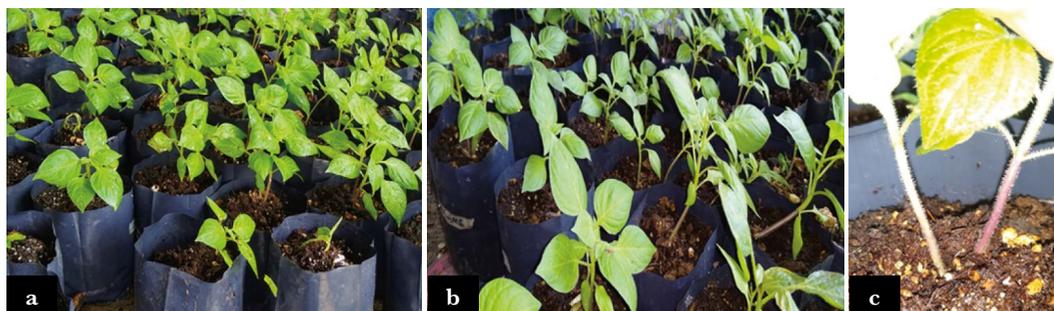


Figure 1. Seedling of manzano chili pepper (*Capsicum pubescens* Ruiz & Pav.); a) variety MEXUVCU1-15-C2, b) variety MEXUVCU1-16-C2, c) pubescence of the hypocotyl.

Table 1. Markers that correspond to a seedling in two varieties of manzano chili pepper (*Capsicum pubescens* Ruiz & Pav.).

Descriptor	Characteristics MEXUVNE1-15-C2	Characteristics MEXUVCU1-16-C2
Seedling: anthocyanin coloration of hypocotyl	Present	Present
Seedling height (cm)	11.02 ± 2.74	11.58 ± 4.19
Intensity of the anthocyanin coloration of the hypocotyl	Medium	Medium
Hypocotyl staining	Purple	Purple
Hypocotyl pubescence	Intermediate	Intermediate
Cotyledon leaf color	Green	Green
Cotyledon leaf shape	Ovate	Ovate

stem, elliptical shape of the leaf, dark color of the leaf, and absence of roughness on the leaves (Figure 2). When it comes to the quantitative markers, the genotype MEXUVNE1-15-C2 presented a plant height of 17.52 ± 6.50 cm, the number of shortened internodes from the first bifurcation was 0.84 ± 0.87 , the length of the internode of the lateral exterior branches was 3.45 ± 1.36 cm, the size of the lamina reached 9.92 ± 3.24 cm of length and 4.93 ± 1.72 cm of width, respectively. The genotype MEXUVCU1-16C2 presented a plant height of 16.53 ± 5.29 cm, the number of shortened nodes after the first bifurcation was 0.97 ± 0.90 ; likewise, the length of the internodes of the branches was 3.45 ± 1.36 cm and a lamina size of 10.91 ± 2.15 cm of length and 5.13 ± 1.17 cm of width (Table 2).

Table 2. Markers that correspond to the plant, stem and leaf, in two varieties of manzano chili pepper (*Capsicum pubescens* Ruiz & Pav.).

Descriptor	Características MEXUVNE1-15-C2	Características MEXUVCU1-16-C2
Plant: anthocyanin coloration of nodes	Present	Present
Plant: height (cm)	17.52 ± 6.50	16.53 ± 5.29
Plant: shortened internodes (after the first bifurcation)	Present	Present
Plant: number of internodes after the first bifurcation	0.84 ± 0.87	0.97 ± 0.90
Plant: length of internode on primary side shoots (cm)	3.45 ± 1.36	3.65 ± 1.32
Stem: intensity of the anthocyanin coloration of the node	Strong	Strong
Stem: pubescence	Medium	Medium
Petiole: attitude	Semi-drooping	Semi-drooping
Leaf blade: length (cm)	9.92 ± 3.24	10.91 ± 2.15
Leaf Blade: width (cm)	4.93 ± 1.72	5.13 ± 1.17
Leaf: shape	Elliptic	Elliptic
Leaf: intensity of green color	Dark	Dark
Leaf: profile of cross section	Concave	Concave
Leaf: rugosity	Absent	Absent



Figure 2. a) Pubescence of the stem, b) shape of the leaf, color, and absence of roughness, c) anthocyanin pigmentation of the nodes, and d) presence of shortened internodes after the first bifurcation.

Flowering

During the flowering period (213 das), the variety MEXUVNE1-15-C2 presented a plant height of 45.75 ± 19.10 cm, while the variety MEXUVCU1-16-C2 reached a height of 51.13 ± 18.76 cm (Table 3). The flower in both varieties has presence of anthocyanins on the anther, strong anthocyanin intensity of the petals, strong intensity of the style, and an upright stalk (Figure 3); likewise, the type of ovary that both genotypes present is superior.

Table 3. Characteristics of the flower in two varieties of manzano chili pepper (*Capsicum pubescens* Ruiz & Pav.).

Descriptors	Characteristics MEXUVNE1-15-C2	Characteristics MEXUVCU1-16-C2
Flowering plant height (cm)	45.75 ± 19.10	51.13 ± 18.76
Flower: anthocyanin coloration in anther	Present	Present
Flower: intensity of the anthocyanin pigmentation of petals	Strong	Strong
Flower: intensity of anthocyanin coloration in style	Strong	Strong
Peduncle: attitude	Erect	Erect



Figure 3. a) Petals: intensity of pigmentation, b) pigmentation of the anther, c) style: intensity of the pigmentation, d) growth habit of the stalk.

Fruit and seed

According to Pérez-Grajales *et al.* (2004) and Martínez-Estrada (2016), the manzano chili pepper fruit is a berry and can adopt different shapes depending on the number of locules. The variety MEXUVNE1-15-C2 presents a square shape with 2.70 ± 0.64 locules (Figure 4a and 4b), as well as fruit length and diameter of 4.78 ± 0.69 and 4.75 ± 0.72 cm, respectively. Likewise, it has a fruit weight of 41.96 ± 10.66 g and a pericarp thickness of 4.19 ± 0.80 mm (Figure 4c).

The variety MEXUVCU1-16-C2 also has a square fruit shape with 2.67 ± 0.66 locules (Figure 5a); it has a fruit length and diameter of 4.71 ± 0.69 and 4.57 ± 0.78 cm,

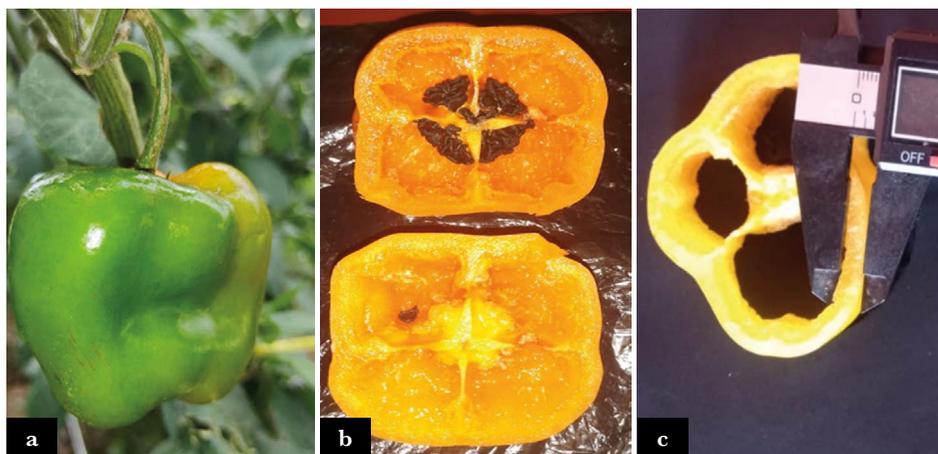


Figure 4. a) Shape of the fruit of variety MEXUVNE1-15-C2, b) number of locules, c) pericarp thickness.

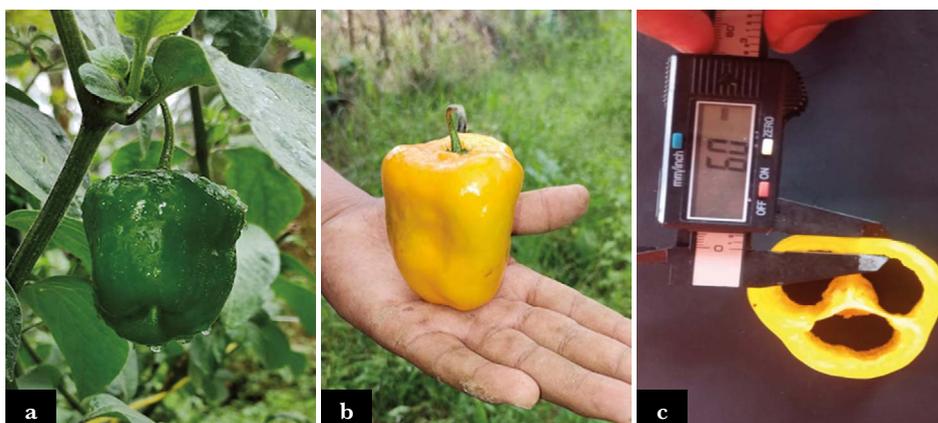


Figure 5. a) Fruit shape of the variety MEXUVCUI-16-C2, b) number of locules, c) pericarp thickness.

respectively. It has a dark green color before commercial maturity, while in maturity it becomes yellow with a dark and intense tonality (Figure 5a and 5b). The average weight per fruit was 38.93 ± 13.52 g, a pericarp thickness of 4.19 ± 0.81 mm (Figure 5c). According to Espinosa *et al.* (2014) and Escalera-Ordaz *et al.* (2019), the manzano chili pepper fruits that are cultivated under greenhouse conditions present superior or outstanding characteristics in comparison to the fruits cultivated in the open field and rainfed conditions.

Seeds of the manzano chili pepper are of medium size with dark brown color and hard testa, which makes its germination period longer than the other types of chili peppers within the genus *Capsicum* (Leyva *et al.*, 2018). The number of seeds per fruit for variety MEXUVNE1-15-C2 was 56.30 ± 18.50 , while for variety MEXUVNE1-16-C2 it was 51.22 ± 23.18 (Table 4).

Table 4. Markers for fruit in two varieties of manzano chili pepper (*Capsicum pubescens* Ruiz & Pav.).

Descriptors	Characteristics MEXUVNE1-15-C2	Characteristics MEXUVNE1-16-C2
Fruit: ratio length/diameter	Small	Small
Fruit: glossiness	Strong	Strong
Fruit: intensity of the green color at the beginning of commercial maturity	Dark	Dark
Fruit: intensity of the yellow color	Dark	Dark
Fruit: shape	Square	Square
Fruit: length (cm)	4.78±0.69	4.71±0.69
Fruit: diameter (cm)	4.75±0.72	4.57±0.58
Fruit: shape in cross section (at level of placenta)	Angular	Angular
Fruit: number of locules	2.70±0.64	2.67±0.66
Fruit: number of seeds	56.30±18.50	51.22±23.18
Fruit: thickness of pericarp (mm)	4.56±0.67	4.20±0.80
Peduncle: length (cm)	3.89±0.66	3.96±0.60
Peduncle: diameter (cm)	1.76±0.35	1.67±0.33
Fruit: depth of stalk cavity	Very deep	Very deep
Fruit: apex depth	Very deep	Very deep
Calyx: margin	Entire	Entire

CONCLUSIONS

There are similarities between the varieties MEXUVNE1-15-C2 and MEXUVCU1-16-C2 for the markers evaluated in each stage of seedling, adult plant and flowering. However, in the fruit setting stage they showed greater variation. These findings will allow starting the registry in the National Service of Seed Inspection and Certification (*Servicio Nacional de Inspección y Certificación de Semillas*, SNICS), on order to later produce seed and begin distributing it among producers.

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