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Characterization of native Ya'ax ik chili pepper (*Capsicum annuum* L.) in the Yucatan Peninsula

Castillo-Aguilar C. de la C.[1]; Reyes-Ek J. M.[2]; Bautista-Parra S. G.[2]; Chiquiní-Medina R.A.[3*]

[1] Colegio de Postgraduados, Campus Campeche, Sihochac, Champotón, Mexico, C.P. 24050.
[2] Tecnológico nacional de México. Instituto Tecnológico de Conkal, Yucatán.
[3] Tecnológico Nacional de México/Instituto Tecnológico de Chiná, Campeche, México, C.P. 24520.
* Correspondence: ricardochiquini@yahoo.com.mx

ABSTRACT

Objective: To morphologically characterize the Ya'ax ik chili pepper: wild chili (*Capsicum annuum*), native variety from the Yucatan Peninsula.

Design/methodology: Ya'ax ik chili pepper seeds were sown in 200-cavity polystyrene trays, and then the plants were placed in bags for hydroponics and were morphologically characterized using the *Capsicum* descriptor of the International Institute of Genetic Resources.

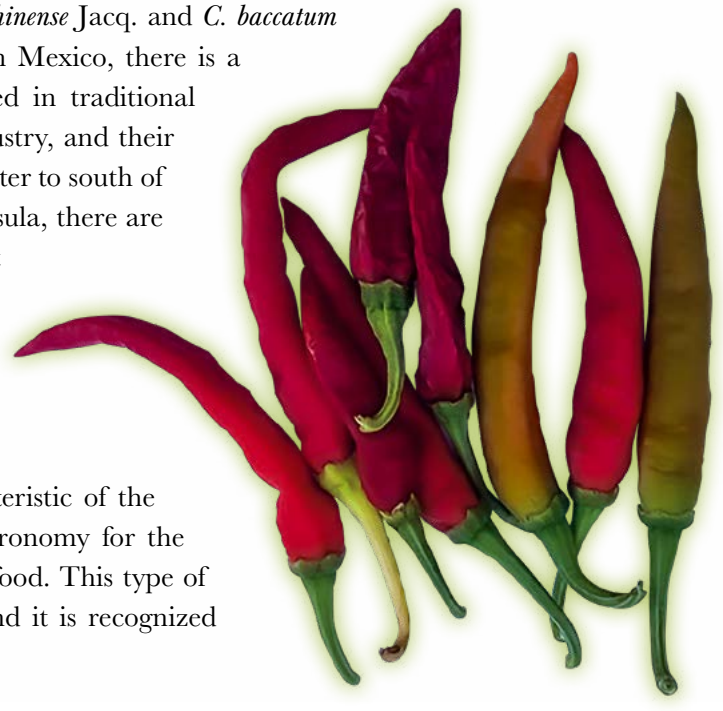
Results: The plant showed 118 cm and 34.8 cm of height and ramification width and width of the intermediate plant, hanging white flowers and green fruits in the early stage and red at maturity with 7.42 and 2.32 cm length and width. Additionally, tolerance to the virus caused by whiteflies could be observed.

Findings and conclusions: Plant with morphological characteristics susceptible to be genetically improved for its extensive farming, given the market acceptance of the fresh and dried fruit, supported by market prices.

Keywords: Morphological characterization, *Capsicum annuum*, native.

INTRODUCTION

Chili pepper (*Capsicum* spp.) was one of the first domesticated plants in the American Continent (Hernández-Verdugo *et al.*, 2012); the genus is constituted by around 30 species, which have a large assortment of fruit shapes, colors and sizes, of which the following have been domesticated: *C. annuum* L., *C. frutescens* L., *C. pubescens* (Ruíz & Pav.), *C. chinense* Jacq. and *C. baccatum* L. (Bosland and Votava, 2012). In Mexico, there is a great variety of chili peppers used in traditional cuisine, as well as in the food industry, and their diversity is found mainly in the center to south of the country. In the Yucatan Peninsula, there are different types of chili peppers that are characteristic of the region, such as habanero, chile dulce, chile Xcat ik. However, there are other types of native chili peppers grown in a smaller scale such as Ya'ax ik, which is characteristic of the region and used in the local gastronomy for the elaboration of pastes for regional food. This type of chili pepper is called wild chili and it is recognized



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for its rusticity and tolerance to drought, pests and diseases. It is a herbaceous plant with height of 0.40 to 1.0 m, red fruits in maturity, and *Capsaicin* content of 13.52 and 11.77 mg/ of dry weight (González-Estrada *et al.*, 2010), of which there is reference of seven ecotypes differentiated by the coloring of its mature fruit, which could be found in association with corn crops (Bautista-Parra, 2023, personal communication). Despite the importance of this type of chili pepper, there is little information about it, so the research study conducted was focused on the morphological characterization *ex situ* of the Ya'ax ik chili pepper.

MATERIALS AND METHODS

The morphological characterization of the Ya'ax ik chili pepper was part of the research project, "Collection, Morphological Characterization, Molecular Typifying, Conservation and Sustainable Use of the *Capsicum* Genus in the State of Campeche", study carried out in the Lol'ic (chili pepper flower) nursery located in the former Mérida-Motul highway, in front of the San Antonio Holactun Hacienda in the community of Conkal, Yucatán. Sowing was done on August 22, 2023, in polystyrene trays with 200 chambers using Peat Moss as substrate. The transplant was carried out 60 days after sowing in plastic bags for hydroponics with 600 caliber, 50 cm wide and 40 cm long, when the plants reached a height greater than 20 cm. The substrate used was 40% nitosol soil + 40% rendzine soil + 10% agrolite, mixture recommended for agricultural purposes. The plants remained under protected system conditions for three months, to later be taken to open air conditions. Integrated management of fertilization and pest and disease control was done, taking as reference the recommendations from Soria *et al.* (1999). The morphological characterization was carried out considering 10 plants, randomly arranged with three repetitions. Characteristics of the seedling, plant, flower, fruit and seed were evaluated through the *Capsicum* descriptor of the International Plant Genetic Resources Institute (IPGRI, 1995). The results from the morphological characterization of quantitative variables were found through the use of mean descriptive statistics, standard deviation, and coefficient of variation.

RESULTS AND DISCUSSION

The morphological characterization of the Ya'ax ik chili pepper determined represents one of the different ecotypes from this native chili pepper, according to producers from the rural communities; this agrees with what was cited by Aguilar-Rincón *et al.* (2010).

Seedling

The characterization of the seedling stage of the Ya'ax ik chili pepper does not exist, even though it represents an important stage for nursery keepers who determine the purity of the material reproduced and the most adequate conditions for plant material production, for its later establishment in the field. The Ya'ax ik chili pepper seedling presented an average emergence period of 8 to 10 days, which confers it similar germination characteristics to those of a native cultivated variety such as habanero chili pepper (*Capsicum chinense*) or chile dulce (*Capsicum annuum*), and at the same time differentiates it from chili peppers such as Maax (*Capsicum annuum*) and Pico paloma (*Capsicum frutescens*), which present germination

Figure 1. Plantation of Ya'ax ik chili pepper in the rural communities of the state of Yucatán.

and tiered emergence of the plant through the substrate, requiring more time for the establishment of the seedlings in the trays.

The Ya'ax ik chili pepper seedlings showed green intermediate coloring, oval shape of the cotyledon leaf, green color of the coleoptile with scarce pubescence, and length and width of 12.13±1.71 mm and 2.03±0.41 mm, respectively.

Plant

At the plant stage, the Ya'ax ik chili pepper could be established as a plant of annual life cycle, rustic and upright growth. Based on what was observed, it could be established that the life cycle of the plant and its duration is in function of the agronomic management and the environmental conditions. For the time which the plants remained under a protected system, they showed a more accelerated growth, while the growth speed decreased when they were taken out to open air conditions. Under the conditions of study, tolerance to the appearance of virosis transmitted by white fly was observed, for the time when damage to the plant was observable such as curling of the leaves (seven months). The Ya'ax ik chili plant was characterized by scarce tillering, angular stem, green, scarce pubescence, with presence of anthocyanins in the knot during the initial stages of growth, which disappeared as the plant grew.

The characteristic of the stem in angular shape differs from what was described by Aguilar-Rincón *et al.* (2010), who described a stem with cylindrical shape, which can be because of the different variants of this type of chili pepper in the region. The plants presented an average height and width of 118±9.40 cm and 68.5±14.33 cm, respectively, a slightly greater height than what was reported by González *et al.* (2014), who reported a height range of 0.40 to 1.0 m. This behavior is attributed to the management conditions granted under a protected system. Under growth conditions in rocky terrains, a plant with lower height has been observed. The scarce pubescence found in the stems of plants was considered to be a morphological characteristic of plants with a certain degree of

Figure 2. Shape of the plant stem and absence of anthocyanins in the knots.

domestication, which reduces its physiological and adaptive growth capacity under the environmental conditions of regulation of high radiation, which is related to hydric economy and gas diffusion, as pointed out by Molina-Montenegro (2008).

The density of ramification and leaves was intermediate, with an oval leaf shape of undulated margin, opaque green coloring, and scarce pubescence, which agrees with what was described by González-Estrada *et al.* (2014). The length of the mature leaf was 9.64±2.20 cm and the leaf width 3.48±0.62 cm.

The leaf density and ramification was intermediate, which can partly explain the plant's tolerance to drought, from the reduction of the leaf surface exposed to transpiration and therefore the water loss, in addition to the smaller size of its leaves, compared to the leaf size of chile dulce (11.35/5.72 cm) and Rosita habanero chili (14.78/77.64 cm), regarding the length and width rate of the leaf. This type of chili pepper under field conditions is cultivated in various types of soil, even in stony soils, where it adapts very well and the morphological characteristics of the plant make it adaptable to conditions of association crops and at the same time it can modify its expression with another type of management.

Figure 3. From left to right: Ya'ax ik chili pepper plant under protected system and open air.

Figure 4. Position of the hanging flower and Ya'ax ik chili pepper flower.

Flower

The flowers of the Ya'ax ik chili pepper are characterized by being solitary flowers (one per knot), white, with hanging position, medium size, annular constriction of the absent calyx, and round shape of the corolla. Quantitatively, the size of the corolla was 1.57±0.25 cm. The flowers presented a green bluish anther color, with white filament color, and exserted stigma. The flowers presented anther length of 2.95±0.54 mm and style length of 5.93±0.63 mm. Regarding the calyx, absence of pigmentation, an intermediate margin and absence of annular constriction were found.

One of the important characteristics of the flowers was that it was not lost by the plant, with the consequent low production of fruit and flowers with strong floral pedicels adhered to the flower and the stem, which confers the plant a characteristic of survival from the consequent production of fruit.

Fruit

The Ya'ax ik chili pepper fruits showed absence of anthocyanin spots, fruit color in intermediate orange stage, high setting, red coloring, without flowering vestiges. Long fruits with semi-coarse epidermis with placenta distributed along the fruit were observed, green in the early stage and red in maturity; the shape of the fruit in union with the obtuse

Figure 5. Ya'ax ik chili pepper fruits in mature state.

pedicel, persistent pedicel to the fruit and stem, mostly with two loculi, and mild transversal wrinkling of the stem, which agrees with what was described by Aguilar-Rincón *et al.* (2010). The average length and width were 7.42 and 1.03 cm, values within the range was established by González-Estrada *et al.* (2014).

The length of the fruit found was 7.42±0.55, with a width and weight of the fruit of 1.03±0.34 cm and 2.38±0.56 g, respectively, values that are within the range established by González-Estrada *et al.* (2014). The thickness of the pericarp of the fruit was 1.26±0.25 mm, with 15.33±8.16 seeds per fruit.

CONCLUSIONS

The morphological characterization of the Ya'ak ix chili pepper allowed a greater knowledge of the plant and its parts, which will allow producers to make decisions regarding the crop, and will support geneticists in the creation of programs of genetic improvement that satisfy the market demands in terms of yield and quality.

The morphological data obtained must be taken as preliminary, because of the existence reported of different ecotypes of the chili pepper, as well as the possible modifications from the environmental effect that can happen in the expression of the different morphological characteristics of the plant.

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