Colegio de Postgraduados

Productive performance of native chili peppers (*Capsicum* spp.) adapted to greenhouse conditions

Espinosa-Rodríguez, Mariana[1]; Antúnez-Ocampo, Oscar M.[2]; Guzmán-Olea, Ismaela; Flores-Hernández, Luis A.[2]; Maldonado-Peralta, María D.A[3]; Sabino-López, Juan E.[1*]

[1] Universidad Autónoma de Guerrero. Facultad de Ciencias Agropecuarias y Ambientales. Carr. Iguala-Tuxpan, km 2.5. Iguala de la Indepedencia, Guerrero, México. C.P. 40101.
[2] Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Campo Experimental Iguala. Carr. Iguala-Tuxpan, km 2.5. Iguala de la Independencia, Guerrero, México. C.P. 40000.
[3] Universidad Autónoma de Guerrero. Centro Regional de Educación Superior de la Costa Chica, Campus Cruz Grande. Carretera Cruz Grande-Ayutla S/N, CP. 41800. Cruz Grande, Florencio Villarreal, Guerrero, México.
* Correspondence: juanelias_sab@hotmail.com

Citation: Espinosa-Rodríguez, M., Antúnez-Ocampo, O. M., Guzmán-Olea, I., Flores-Hernández, L. A., Maldonado-Peralta, M. D.A., Sabino-López, J. E. (2026). Productive performance of native chili peppers (*Capsicum* spp.) adapted to greenhouse conditions. *Agro Productividad*. https://doi.org/10.32854/g2byfh27

Academic Editor: Jorge Cadena Iñiguez
Associate Editor: Lucero del Mar Ruiz Posadas
Guest Editor: Daniel Alejandro Cadena Zamudio

Received: January 18, 2026.
Accepted: April 15, 2026.
Published on-line: June 26, 2026.

Agro Productividad, 19(5). May. 2026. pp: 43-53.

ABSTRACT

Objective: To evaluate the productive performance of native chili pepper genotypes from Teticic, municipality of Olinalá, Guerrero, under greenhouse conditions.

Design/methodology/approach: The experiment was established in a greenhouse under a completely randomized design. The treatments consisted of seven chili pepper genotypes (Cascabel, Gallo gallina mediano, Gallo gallina grande, Larguillo chico, Larguillo grande, Mochiteco, and Serrano) from Teticic, municipality of Olinalá, Guerrero, with six replicates. Fruit size was evaluated based on polar diameter, equatorial diameter, and individual fruit weight. Yield per plant was assessed as number of fruits and fresh and dry fruit weight per plant. Fruit quality was evaluated based on firmness, total number of seeds, number of viable and empty seeds, and total seed weight (g) per fruit.

Results: The Mochiteco genotype produced the highest number of fruits per plant (607.50). The Gallo gallina grande genotype exceeded the fresh fruit weight of Mochiteco, Gallo gallina mediano, and Cascabel by 41.9, 44.3, and 47.5%, respectively. The Serrano genotype had 46.3% greater dry fruit weight than Cascabel. The greatest polar diameter was observed in Gallo gallina mediano, Serrano, and Larguillo grande, whereas the greatest equatorial diameter was found in Larguillo grande and Gallo gallina grande. The highest individual fruit weight was recorded in Gallo gallina grande and Gallo gallina mediano. Gallo gallina grande produced 27.02, 47.2, and 53.01% more seeds than Larguillo grande, Mochiteco, and Larguillo chico, respectively. Gallo gallina grande and Gallo gallina mediano produced more viable seeds, whereas Serrano produced more empty seeds than Larguillo grande and Mochiteco.

Limitations on study/implications: Chili pepper productivity was conditioned by phenotypic variation and the environmental conditions during crop growth. As a result, some genotypes adapted well to greenhouse conditions, whereas others showed a less favorable response.

Findings/conclusions: The cultivation of native chili peppers from Teticic, Olinalá, Guerrero, under greenhouse conditions represents an alternative for their conservation and potential use.

Keywords: *Capsicum*, genotype, yield, quality, seed

INTRODUCTION

Chili pepper cultivation (*Capsicum* spp.) originated in the Americas, where the greatest morphological diversity of this species is found (Rodríguez, 2018). Notable species include *C. baccatum*, *C. chinense*, *C. pubescens*, *C. frutescens*, and *C. annuum*; the latter was domesticated and propagated in Mexico (Aguirre and Muñoz, 2015). Among the main genotypes cultivated in Mexico are Jalapeño, Serrano, Habanero, Ancho, Mulato, Pasilla, and Piquín (Salinas *et al.*, 2010). In 2020, Mexico reported a production of 3,324,260 t, accompanied by an increase in yield per hectare from 13.86 t ha^{-1} in 2005 to 21.65 t ha^{-1} in 2019 (SADER, 2021). In 2021, a total area of 14,235,129.40 ha was planted with this crop in Mexico (DGSIAP, 2021). Chili pepper production in Mexico is closely linked to the development of protected agriculture through the use of structures and coverings such as shade houses, greenhouses, and macro tunnels, among others. In this context, in 2019, the average chili pepper yield reported under protected agriculture was 12.3 kg m^{-2}, compared with 1.8 kg m^{-2} in open-field production (SIAP, 2020). This indicates that the cultivation of commercial as well as native chili pepper varieties under protected systems favors increased yield (Escamirosa-Tinoco *et al.*, 2021). In addition, chili pepper production is influenced by genotype, climate, soil fertility, crop management, pest and disease control, and harvest and drying processes, whereas fertilization can generate secondary effects that may alter plant resistance or tolerance to biotic and abiotic stress factors (Hernández *et al.*, 2021).

The use of native varieties is attributed to their adaptation to diverse climates and soil types, which has contributed to their successful and widespread geographic distribution (Aguirre and Muñoz, 2015). Native chili pepper varieties have greater acceptance in local and regional markets, where they are consumed mainly as fresh and dried fruits to season a variety of traditional dishes (SAGARPA, 2016). However, most native materials are grown under rainfed conditions and are exposed to phytosanitary problems and environmental factors that directly influence crop productivity (Aguilar *et al.*, 2010).

One strategy to improve production yield and quality is the use of fertigation, container cultivation, and agronomic management practices that promote plant development and fruit set, thereby increasing productive potential and profitability (Bahena-Delgado *et al.*, 2012). In this way, local chili pepper varieties may gain greater national and international importance, with the possibility that producers will conserve and reproduce their native materials through seed storage techniques, since some do not select fruits with outstanding size and quality for seed production (Carrillo *et al.*, 2009; Andueza-Noh *et al.*, 2017). This suggests the need for studies focused on productivity in order to determine their economic importance and productive potential (Meneses-Lazo *et al.*, 2018).

In the Mountain region of Guerrero, Mexico, there is substantial genetic and phenotypic diversity among native chili peppers of economic and food importance due to their high demand and local consumption. These peppers are indispensable in the preparation of typical regional dishes, where this crop is regarded as a symbol of cultural identity, as in the rest of Mexico, which has contributed to its social and economic importance since the domestication of the crop (Herrera *et al.*, 2018). In this regard, DGSIAP (2021) reported for the state of Guerrero a planted area of 1,426.35 ha and a harvested area of 1,424.35 ha, with a production of 9,696.40 t and a yield of 6.81 t ha^{-1}. According to previous records, some chili pepper genotypes cultivated in the Mountain region of Guerrero include Serrano, Gallo gallina, and chile Gordo (Aguilar *et al.*, 2010). Therefore, the objective of this study was to evaluate the productive performance under greenhouse conditions of chili pepper genotypes from the Mountain region of Guerrero.

MATERIALS AND METHODS

Germplasm collection and experimental site

Visits were made to farmers' fields in 2020, and fruits from seven chili pepper genotypes (Table 1) were collected in the community of Teticic, municipality of Olinalá, Guerrero, Mexico (17° 52' 02" N, 98° 50' 54" W; 1,273 m). The fruits were placed in perforated brown paper bags and transported to the multipurpose laboratory of the Faculty of Agricultural and Environmental Sciences, Tuxpan campus, of the Autonomous University of Guerrero (18° 20' 38" N, 99° 30' 04" W; 775 m). Subsequently, the morphological characteristics of the fruits of each genotype were recorded (Table 1), after which the seeds were extracted and stored in airtight containers at room temperature (26.1 °C).

Seedbed establishment and transplanting

In 2021, seeds of each genotype were sown in 200-cell polypropylene trays filled with peat. One seed was placed in each cell at an approximate depth of 0.5 cm and covered with the same substrate. Irrigation was applied twice daily using well water. Transplanting was carried out 48 days after sowing (DAS), when the seedlings had reached approximately 15 cm in height and had developed four to five true leaves. One plant was placed per pot consisting of a 12 L black polyethylene bag filled with forest soil (pH: 7.11, EC: 4.78 dS m^{-1}, OM: 28%, bulk density: 0.35 g cm^{-3}, N: 188, P: 22.3, K: 136, Ca: 3978, Mg: 715, S: 82.9, Fe: 3.79, Zn: 3.13, Mn: 17.2, Cu: 0.11, and B: 0.21 mg kg^{-1}). Planting density was 4 plants m^2, arranged in a ridge-vent greenhouse covered with white polyethylene (70% transmittance).

Treatments and experimental design

The collected genotypes, considered as treatments, were Cascabel, Gallo gallina mediano, Gallo gallina grande, Larguillo chico, Larguillo grande, Serrano, and Mochiteco.

Table 1. Fruit characteristics of chili pepper genotypes from Teticic, Olinalá, Guerrero.

Genotype	Diameter (cm)		Individual dry fruit weight (g)
	Polar	Equatorial	
Cascabel	2.32	2.39	0.95
Gallo gallina mediano	8.19	3.63	5.69
Larguillo grande	10.05	1.97	4.11
Serrano	7.96	1.60	2.50
Mochiteco	4.07	1.37	0.95
Gallo gallina grande	8.75	4.46	6.83
Larguillo chico	10.22	3.31	3.02

These were distributed in the greenhouse under a completely randomized design with six replicates. The experimental unit consisted of one pot containing one plant.

Crop management

Crop agronomic management consisted of daily irrigation in the morning and afternoon, with an average of 4 L plant^{-1} day^{-1}, using the universal nutrient solution proposed by Steiner (1984) (Table 2). Its concentration was modified according to the crop's water requirements and phenological stage, beginning with an EC of 0.5 dS m^{-1} during the vegetative stage and increasing to 2.0 dS m^{-1} during fruiting. Pest prevention and control were carried out using chromatic traps and the application of ecological products (Escaminosa-Tinoco *et al.*, 2021). Harvest began 133 days after transplanting (DAT), when the fruits turned red. The fruits were then collected, placed in perforated brown paper bags, and transported to the multipurpose laboratory of the Faculty of Agricultural and Environmental Sciences, Tuxpan campus, Autonomous University of Guerrero, for measurement and drying.

Evaluated variables

Yield

Yield was quantified as the number of fruits and the fresh and dry weight (g) of fruits per plant over seven weeks of harvest, using an ISOLAB® Laborgeräte GmbH LS-EJ-2200AS balance. Fruit drying was carried out in perforated paper bags, which were placed in a forced-air drying oven (Riossa®, model HCF-62D) at 75 °C for 72 h.

Fruit and seed quality

In 30 fresh fruits randomly selected from each genotype, fruit size was measured based on polar diameter (cm), from the base of the peduncle to the apical end of the fruit, and equatorial diameter (cm), at the middle part of the fruit, using an electronic caliper (Stainless Hardened®). Individual fruit weight (g) was determined with an ISOLAB® Laborgeräte GmbH balance, model LS-EJ-2200AS. Firmness (kg cm^{-2}) was measured at the equatorial midpoint of the fruit using a penetrometer (Truper®, model FDV-30) with a conical tip. The total number of seeds, viable seeds, and empty seeds per fruit, as well as total seed weight per fruit (g), were quantified using the previously described balance. The obtained values were subjected to analysis of variance and Tukey's mean comparison test (α=0.05) using SAS®, version 9.0.

Table 2. Ion concentration in Steiner's nutrient solution for the fertigation of native chili pepper genotypes.

Concentration of the nutrient solution (%)	NO_3^-	$H_2PO_4^-$	SO_4^-	K^+	Ca^{2+}	Mg^{2+}
	meq L^{-1}					
25	3.00	0.25	1.75	1.75	2.25	1.00
50	6.00	0.50	3.50	3.50	4.50	2.00
75	9.00	0.75	5.25	5.25	6.75	3.00
100	12.00	1.00	7.00	7.00	9.00	4.00

RESULTS AND DISCUSSION

Yield

Differences ($p \leq 0.05$) were detected in the cumulative fruit yield per plant among the evaluated genotypes. Mochiteco produced the highest number of fruits per plant (607.50) compared with the other evaluated materials. In contrast, Cascabel and Serrano produced a similar number of fruits (Figure 1). These differences can be attributed to variability among genotypes, since some produce more fruits than others and differ in fruit size (Ramírez-Meraz *et al.*, 2015). This is consistent with the existence of numerous chili cultivars and races grouped into morphotypes with genetic variability that is transmitted from one generation to another within their populations under different environments (Rodríguez, 2018), which influences productivity. Similar results were reported by López-Gómez *et al.* (2017) in Habanero chili genotypes, in which the highest average was 425 fruits plant^{-1}.

In contrast, Moreno *et al.* (2014) reported 40 fruits plant^{-1} in Hungarian chili grown in sand with a nutrient solution. Similarly, Monge and Loria (2018), working with sweet pepper cv. FBM-9, recorded 29.71 fruits plant^{-1} under greenhouse conditions with pruning. This confirms that fruit production in chili crops is conditioned by various environmental factors and the production technology used, both of which modify fruit yield (Alemán *et al.*, 2018). In the same vein, Sandoval-Rangel *et al.* (2011) reported values ranging from 221.03 to 433.18 fruits plant^{-1} in Piquín chili.

Cumulative fresh and dry fruit yield showed differences ($p \leq 0.05$) among the evaluated genotypes. The greatest fresh fruit weight was observed in Gallo gallina grande, which exceeded Mochiteco, Gallo gallina mediano, and Cascabel by 41.9, 44.3, and 47.5%, respectively. Meanwhile, Gallo gallina grande, Serrano, and Larguillo grande and chico showed similar fresh fruit weights, ranging from 451.8 to 667.5 g plant^{-1} (Figure 2). In terms of dry fruit yield, only Serrano (124.5 g plant^{-1}) stood out, exceeding Cascabel

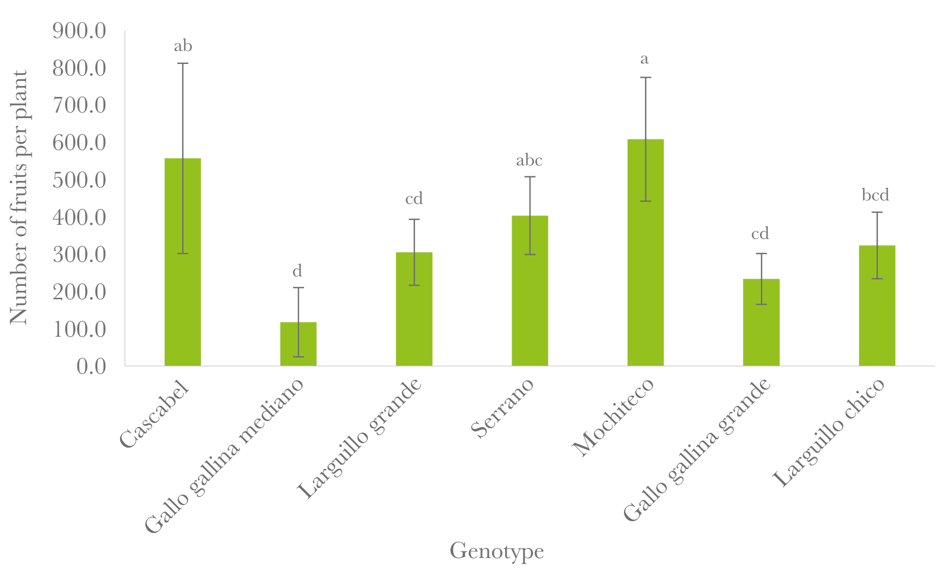

Figure 1. Number of fruits per plant in native chili pepper genotypes grown under greenhouse conditions. Means followed by the same letter are not statistically different (Tukey, $\alpha=0.05$). LSD=248.15.

(66.8 g plant^{-1}), which was the genotype with the lowest dry fruit yield, by 46.3%. In the remaining genotypes, dry weight ranged from 86.0 to 103.5 g plant^{-1} (Figure 3).

This behavior is related to the type and size of fruits produced by each genotype (broad, thick, or slender) (Aguilar *et al.*, 2010), as well as to the adaptive response of the plant materials to the production system and the environmental conditions that prevailed during growth (Galeote-Cid *et al.*, 2022). In this regard, chili pepper production in Mexico is characterized by the use of commercial varieties with high productive potential; however,

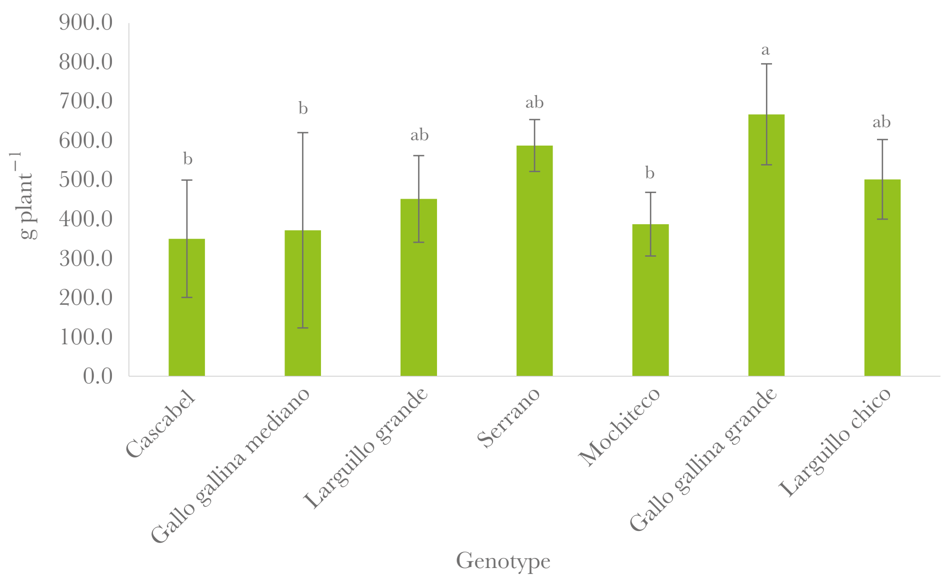

Figure 2. Fresh fruit weight per plant in native chili pepper genotypes grown under greenhouse conditions. Means followed by the same letter are not statistically different (Tukey, α=0.05). LSD=249.98.

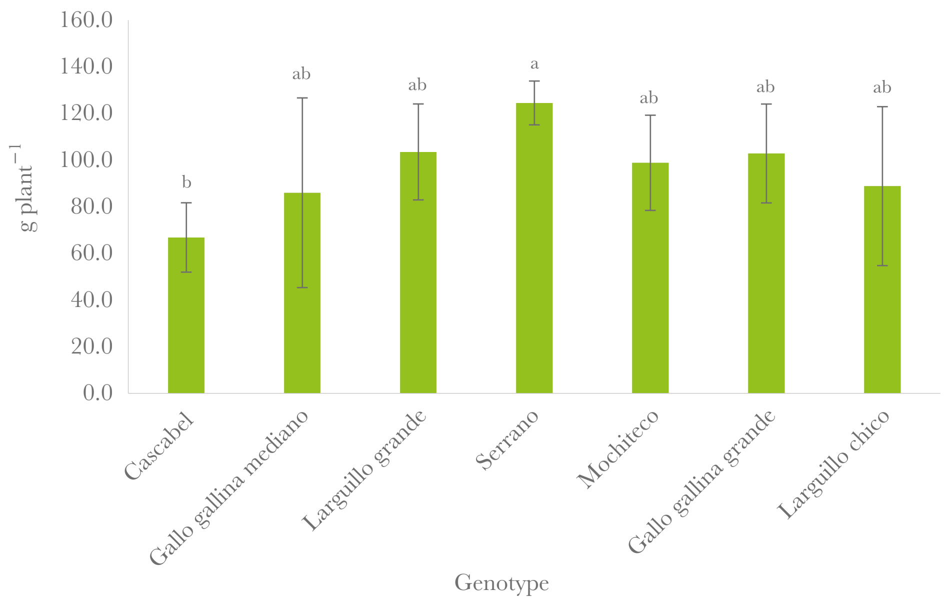

Figure 3. Dry fruit weight per plant in native chili pepper genotypes grown under greenhouse conditions. Means followed by the same letter are not statistically different (Tukey, α=0.05). LSD=45.308.

their use contributes to biodiversity loss in regions where native chili peppers are cultivated (Aguilar *et al.*, 2010). In improved varieties, yield has been reported to increase when the crop is established under greenhouse and hydroponic conditions. For example, fresh fruit yields of 1,220 to 1,518 g plant^{-1} have been obtained in Serrano chili (*Capsicum annuum* L.) using nutrient solution and substrates as the growing medium (Cruz-Crespo *et al.*, 2014). Likewise, Sandoval-Rangel *et al.* (2011) reported yields of 130.91 g plant^{-1} in Piquín chili (*Capsicum annuum* var. *glabriusculum*). It is important to note that fresh and dry yield in chili crops increases as the harvest period is extended (Azofeifa and Moreira, 2004). However, the determining factor in yield is the genotype, together with adequate root and shoot growth within the crop production system (Galeote-Cid *et al.*, 2022). Differences in yield between field production and protected systems for native chili peppers are due to the fact that greenhouse coverings modify environmental conditions inside the structure, such as radiation, temperature, and relative humidity, among others. This favors plant growth and may increase fruit yield by more than 600% compared with field production (Escamirosa-Tinoco *et al.*, 2021). In addition, protected systems allow better agronomic management, including pest and disease control. In this regard, San Juan *et al.* (2018) reported similar fresh fruit yields in chile de Agua (1,450 g m^{-2}) and Huacle chili (1,700 g m^{-2}) under protected conditions; in contrast, dry fruit yield was affected by the production system, with Huacle chili (474 g m^{-2}) tripling the yield of chile de Agua (157 g m^{-2}).

Fruit and seed quality

In relation to fruit quality, differences ($p \leq 0.05$) were found in fruit size and firmness (Table 3). Larguillo grande, Larguillo chico, Serrano, and Gallo gallina grande produced longer fruits, with values ranging from 7.73 to 8.15 cm. Likewise, Gallo gallina grande, Gallo gallina mediano, and Larguillo grande showed values from 8.10 to 14.19 cm for fruit width; however, Gallo gallina grande produced wider fruits than Larguillo chico, Cascabel, Serrano, and Mochiteco. Fruit size influenced individual fruit weight, such that Gallo gallina grande and Gallo gallina mediano produced fruits with the greatest individual weights, with values of 17.28 and 20.92 g, respectively. This diversity in fruit dimensions

Table 3. Fruit quality of native chili peppers from Teticic, Olinalá, Guerrero, grown under greenhouse conditions.

Genotype	Length	Width	Individual weight (g)	Firmness (kgf cm^{-2})
	cm			
Cascabel	2.40 d	5.26 bc	3.17 c	1.72 a
Gallo gallina mediano	6.71 b	8.10 ab	17.28 a	1.63 ab
Larguillo grande	8.15 a	10.68 ab	6.64 bc	2.03 a
Serrano	7.73 a	1.46 c	9.70 b	1.69 ab
Mochiteco	3.97 c	1.06 c	3.20 c	2.01 a
Gallo gallina grande	7.62 ab	14.19 a	20.92 a	2.12 a
Larguillo chico	8.05 a	6.93 b	7.57 b	1.15 b
DMS:	0.98	6.73	4.29	0.56

Means followed by the same letter within the same column are not statisti-cally different (Tukey, α=0.05). LSD: least significant difference.

and weight among chili pepper genotypes is due to the genetic characteristics of the populations themselves (Galeote-Cid *et al.*, 2022); it may also be associated with adaptation to the climatic and edaphic conditions, as well as the crop management practices provided at the production sites, whether in the field or under greenhouse conditions (San Juan *et al.*, 2018).

Meanwhile, the results obtained in this study exceed the values reported by Sanjuan-Martínez *et al.* (2022) in chile de Agua, Coxtle, Huacle amarillo, Huacle negro, Pasilla Mixe, and Tabiche, which ranged from 4.93 to 5.74 cm in length and from 4.27 to 4.80 cm in width. In contrast, individual dry fruit weight ranged from 4.48 to 5.56 g in Huacle chili (San Juan *et al.*, 2019). Likewise, Vázquez *et al.* (2010) reported fruit weights of 6.9 to 12.2 g in 19 Serrano chili varieties, values that fall within the range observed for Serrano (9.70 g) and Larguillo chico (7.5 g) in this study. Similarly, Tapia-Vargas *et al.* (2016) reported polar and equatorial diameters of 2.92 and 2.44 cm, respectively, and a fruit weight of 29.2 g, values similar to those obtained in the present study.

With respect to fruit firmness, Gallo gallina grande, Larguillo grande, and Mochiteco showed similar values; however, all three exceeded the firmness detected in Larguillo chico. These results were lower than those reported by Vázquez *et al.* (2010), who evaluated Serrano chili varieties (98 to 159 N cm^{-2}), a physical trait influenced by variety. Firmness is an important quality variable because fruit shelf life depends largely on it (López-Salazar *et al.*, 2019).

Differences ($p \leq 0.05$) were also detected in the number of total, empty, and viable seeds, as well as in seed weight per fruit (Table 4). The Gallo gallina grande, Gallo gallina mediano, Cascabel, and Serrano genotypes produced a similar number of seeds per fruit. However, Gallo gallina grande exceeded the number of seeds in Larguillo grande, Mochiteco, and Larguillo chico by 27.02, 47.2, and 53.01%, respectively. The same pattern was observed for the number of viable seeds, in which Gallo gallina grande and Gallo gallina mediano were similar, but both exceeded the remaining genotypes. In contrast, Mochiteco and Larguillo chico had the lowest number of viable seeds per fruit. By comparison, the number of empty seeds differed only between Serrano and Larguillo grande and Mochiteco, the

Table 4. Seed quality of native chili peppers from the Mountain region of Guerrero, grown under greenhouse conditions.

Genotypes	Seeds			Seed weight (g)
	Total	Viables	Empty	
Cascabel	91.13 ab	86.96 ab	4.56 ab	0.60 bc
Gallo gallina mediano	109.86 ab	106.60 a	3.46 ab	0.94 a
Larguillo grande	82.10 bcd	80.50 ab	1.60 b	0.64 b
Serrano	87.26 abc	80.33 ab	6.63 a	0.70 b
Mochiteco	59.26 cd	58.40 bc	1.20 b	0.50 bc
Gallo gallina grande	112.50 a	107.36 a	5.20 ab	1.07 a
Larguillo chico	52.86 d	47.63 c	5.70 ab	0.38 c
DMS:	29.61	28.95	4.61	0.23

Means followed by the same letter within the same column are not statistically different (Tukey, $\alpha = 0.05$). LSD: least significant difference.

latter two being similar to each other. The Serrano genotype had 75.86 and 81.90% more empty seeds than Larguillo grande and Mochiteco, respectively. Seed weight per fruit also differed among genotypes; the seed weight of Larguillo grande and Gallo gallina mediano was similar, but greater than that of the other materials. In contrast, Cascabel, Mochiteco, and Larguillo chico showed the lowest seed weight per fruit.

In this regard, Castillo-Aguilar *et al.* (2019) reported 59 and 131 seeds per fruit in two Xcat ik chili ecotypes. The same authors noted that differences in seed size and number are common even within the same genotype. Similarly, San Juan *et al.* (2019) quantified between 173 and 203 seeds in Huacle chili fruits, with seed weights ranging from 1.0 to 1.25 g. Hernández-Verdugo *et al.* (2012) reported 15.1 seeds and a seed weight of 2.9 mg in fruits from 19 wild chili populations (*Capsicum annuum* var. *glabriusculum*). In this context, the differences found in seed number and seed weight per fruit in the present study are attributed to phenotypic variation among the evaluated chili peppers. These variations are also influenced by the environment in which the materials are introduced (Hernández-Verdugo *et al.*, 2008; Hernández-Verdugo *et al.*, 2012), because some genotypes adapted rapidly to the environmental conditions that prevailed in the greenhouse, whereas others did not show a favorable response (San Juan *et al.*, 2018; Escamirosa-Tinoco *et al.*, 2021).

CONCLUSIONS

The productive performance of native chili peppers from Teticic, Olinalá, Guerrero, showed differences in fruit size, yield per plant, and fruit quality, which can be attributed to genetic variability and the environmental conditions that prevailed in the greenhouse during crop growth. The Mochiteco genotype stood out for producing the highest number of fruits. The Gallo gallina grande, Gallo gallina mediano, Larguillo chico, and Larguillo grande genotypes showed greater fresh fruit weight, whereas the Serrano genotype was characterized by greater dry fruit weight. Therefore, the diversity of native chili pepper genotypes from Teticic, Olinalá, Guerrero, cultivated under greenhouse conditions, is important for their conservation and potential use.

ACKNOWLEDGMENTS

The authors thank the producers of Teticic, municipality of Olinalá, Guerrero, Mexico, for providing access and support for germplasm collection during the conduct of this research.

REFERENCES

Aguilar, V.H., Corona, P., López, P., Latournerie, L., Ramírez, M., Villalón, H., & Aguilar, J.A. (2010). Los chiles de México y su distribución. SINAREFI, Colegio de Postgraduados, INIFAP, IT-Conkal, UANL, UAN. Montecillo, Texcoco, Estado de México. 114 p.

Andueza-Noh, R.H., Latournerie-Moreno, L., Moran-Vázquez, N., Cervantes-Ortiz, F., & Mendoza-Elos, M. (2017). Respuesta fisiológica de la semilla de chile habanero (*Capsicum chinense* Jacq.) al almacenamiento. *Acta Universitaria 27*(6): 22-29. https://doi.org/ 10.15174/ au.2017.1395

Azofeifa, A. & Moreira, M.A. (2004). Análisis de crecimiento del chile jalapeño (*Capsicum annuum* L. cv. Hot), en Alajuela, Costa Rica. *Agronomía Costarricense 28*(1):57-67. https://doi.org/10.15517/rac.v28i1.61230

Aguirre-Hernández, E., & Muñoz-Ocotero, V. (2015). El chile como alimento. *Ciencia*. pp:16-238.

Alemán, R.D., Domínguez, J., Rodríguez, Y., Soria, S., Torres, R., Vargas, J.C., & Alba, J.L. (2018). Indicadores morfofisiológicos y productivos del pimiento sembrado en invernadero y a campo abierto en las condiciones de la Amazonía ecuatoriana. *Revista Centro Agrícola 45*(1): 14-23.

Bahena-Delgado, G., Bustos-Rangel, A.J., Broa-Rojar, E., & Jaime-Hernández, M.A. (2012). Comportamiento agronómico del chile criollo (*Capsicum annuum* L.) en fertirrigación con acolchado plástico y cubierta flotante en Xalostoc, Morelos. *Ingeniería Agrícola y Biosistemas 11*(1): 53-67. https://doi.org/10.5154/r.inagbi.2011.11.11014

Carrillo, E.P., Mejía, J.A., Carballo, A., García, G., Aguilar, V.H., & Corona, T. (2009). Calidad de semilla en colectas de chile de agua (*Capsicum annuum* L.) de los Valles Centrales de Oaxaca, México. *Agricultura Técnica en México 35*(3): 257-266.

Castillo-Aguilar, C.C., Jiménez, M., Chiquini-Medina, R.A., Quej-Chí, V.H., & Lara-Reyna, J. (2019). Caracterización varietal de dos ecotipos de chile Xcat ik (*Capsicum annuum*) del estado de Campeche. In: Cetzal-Ix, W., Casanova-Lugo, F., Chay-Canul, A.J., Martínez-Puc, J.F. (Eds.). Agroecosistemas Tropicales: conservación de recursos naturales y seguridad alimentaria, Tecnológico Nacional de México. Chiná, Campeche, México. pp: 30-337.

Cruz-Crespo, E., Can-Chulim, A., Bulgarín-Montoya, R., Pineda-Pineda, J., Flores-Canales, R., Juárez-López, P., & Alejo-Santiago, G. (2014). Concentración nutrimental foliar y crecimiento de chile serrano en función de la solución nutritiva y el sustrato. *Revista Fitotecnia Mexicana 37*(3): 289-295.

DGSIAP (Dirección General del Servicio de Información Agroalimentaria y Pesquera). (2021). Anuario Estadístico de la Producción Agrícola en 2021. Disponible en: https://nube.agricultura.gob.mx/cierre_agricola/.

Escamirosa-Tinoco, C., Martínez-Gutiérrez, G.A., Morales, I., Aquino-Bolaños, T., Cortés-Martínez, C.I., & Cruz-Andrés, O.R. (2021). Rendimiento de chile de agua bajo diferentes cubiertas de macrotúnel. *Revista Fitotecnia Mexicana 44*(3): 1-8.

Galeote-Cid, G., Cano-Ríos, P., Ramírez-Ibarra, J.A., Nava-Camberos, U., Reyes-Carrillo, J.L., & Cervantes-Vázquez, M.G. (2022). Comportamiento del chile Huacle (*Capsicum annuum* L.) con aplicación de compost y *Azospirillum* sp. en invernadero. *Terra Latinoamericana 40*(e828): 1-12. https://doi.org/10.28940/terra.v40i0.828

Herrera, A., Cervantes, F., Antuna, O., García, J.G., Rodríguez, D., Rodríguez, S.A., Andrio, E., & Mendoza, M. (2018). Deterioro de la calidad de la semilla de chile piquín de cuatro colectas en Querétaro & Guanajuato. *Revista Mexicana de Ciencias Agrícolas 9*(8): 1627- 1638.

Hernández, B.N., Tornero, M.A., Sandoval, E., Rodríguez, M.N., Taboada, O.R., & Peña, B.V. (2021). Crecimiento, rendimiento y calidad de chile poblano cultivado en hidroponía bajo invernadero. *Revista Mexicana de Ciencias Agrícolas 12*(6): 1043-1056. https://doi.org/10.29312/remexca.v12i6.2755

Hernández-Verdugo, S., López, R.G., Sánchez, P., Villareal, M., Parra, S., Porras, F., & Corrales, J.L. (2008). Variación fenotípica entre y dentro de poblaciones silvestres de chile del noroeste de México. *Revista Fitotecnia Mexicana 31*(4): 323-330.

Hernández-Verdugo, S., Porras, F., Pacheco-Olvera, A., López-España, R.G., Villarreal-Romero, M., Parra-Terraza, S., & Osuna, T. (2012). Caracterización y variación ecogeográfica de poblaciones de chile (*Capsicum annuum* var. *glabriusculum*) silvestre del noroeste de México. *Polibotánica* 33: 175-191.

López-Gómez, J.D., Villegas-Torres, O.G., Sotelo, H., Andrade, M., Juárez, P., & Martínez, E. (2017). Rendimiento y calidad del chile habanero (*Capsicum chinense* Jacq.) por efecto del régimen nutrimental. *Revista Mexicana de Ciencias Agrícolas 8*(8): 1747-1758.

López-Salazar, R., Peña, F.M., Sánchez-Bernal, F., Lozano, C.J., Benavidez, A., & González-Fuentes, J.A. (2019). Efecto de un fulvato de hierro sobre calidad y producción de frutos de chile Serrano. *Revista Mexicana de Ciencias Agrícolas 10*(6): 1367-1378. https://doi.org/10.29312/remexca.v10i6.1779

Meneses-Lazo, R.E., Garruña-Hernández, R., Latournerie-Moreno, L., Andrade-Torres, J.L., & Pérez-Gutiérrez, A. (2018). Caracterización fenológica y fisiológica de variedades experimentales de chile habanero con alto potencial agronómico. *Revista fitotecnia mexicana 41*(1): 67-74. https://doi.org/10.35196/rfm.2018.1.67-74

Mongue, J.E., & Loría, M. (2018). Producción de chile dulce (*Capsicum annuum*) en invernadero: efecto de densidad de siembra y poda. *Revista Posgrado y Sociedad 16*(2): 19-38.

Moreno, A., Rodríguez, N., Reyes, J.L., Márquez, C., & Reyes, J. (2014). Comportamiento del chile húngaro (*Capsicum annuum*) en mezclas de vermicompostarena bajo condiciones protegidas. *Revista de la Facultad de Ciencias Agrarias 46*(2): 97-111.

Ramírez-Meraz, M., Villalón-Mendoza, H., Aguilar-Rincón, V. H., Corona-Torres, T., Latournerie-Moreno, L. (2015). Caracterización morfológica de chiles silvestres y semidomesticados de la región Huasteca de México. *Agroproductividad 8*(1): 9-16.

Rodríguez, E. (2018). La diversidad genética de *Capsicum annuum* de México. En: Los chiles que le dan sabor al mundo. In: Aguilar-Meléndez, A., Vásquez-Dávila, M.A., Katz, E., & Hernández, M.R. (Ed.), pp. 52-67. Universidad Veracruzana, Xalapa, Veracruz, México.

SAGARPA (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación). (2016). Chiles y pimientos mexicanos. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (Ed). 42 p.

SADER (Secretaría de Agricultura y Desarrollo Rural). (2021). Disponible en: https://www.gob.mx/agricultura/prensa/crecio-2-7-por-ciento-la-produccion-de-chile-verde-en-mexico-en-2020-y-registra-mayor-demanda-en-los mercados-internacionales?idiom=es.

SIAP (Servicio de Información Agroalimentaria y Pesquera). (2020). Disponible en: https://www.gob.mx/siap.

Sandoval-Rangel, A., Benavides-Mendoza, A., Alvarado-Vázquez, M.A., Foroughbakhch-Pournavab, R., Núñez-González, M.A., & Robledo-Torres, V. (2011). Influencia de ácidos orgánicos sobre el crecimiento, perfil bromatológico y metabolitos secundarios en chile piquín. *Terra Latinoamericana 29*(4): 395-401.

San Juan, J., Ortiz, Y.D., Ortiz, F.E., & López, J.Y. (2018). Desempeño ex situ de dos chiles nativos de Oaxaca. *Revista Latinoamericana el Ambiente y las Ciencias 9*(21): 349-359.

San Juan, J., Aquino-Bolaños, T., Ortiz-Hernández, Y.D., & Cruz-Izquierdo, S. (2019). Características de fruto y semilla de chile huacle (*Capsicum annuum* L.) producido en hidroponía. *Idesia (Arica) 37*(2): 87-94.

Sanjuan-Martínez J, Ortiz-Hernández, Y. D., Aquino-Bolaños, T., Cruz-Izquierdo, S. (2020). Seed and seedling quality of three chilis (*Capsicum annuum* L.) native to Oaxaca, Mexico. *Ciência Rural 50*(9): e20190921. https://doi.org/10.1590/0103-8478cr20190921

Sanjuan-Martínez J, Ortiz-Hernández, Y. D., Aquino-Bolaños, T., Cruz-Izquierdo, S., Pérez-Pacheco, R. (2022). Evaluación *ex situ* de seis chiles nativos de Oaxaca en invernadero. *Revista Ciencias Agronómicas Aplicada y Biotecnología* 2: 101-107.

Salinas, R.M., E.A. Liévano, E.A., Ulín, F., Mercado, J.N., Petit, D. (2010). Caracterización morfológica y cambios durante la vida postcosecha de cuatro tipos de chile amashito (*Capsicum annuum* L.) variedad *glabriusculum* (dunal) Heiser & Pickersgill. *Revista Iberoamericana de Tecnología Postcosecha 11*(1): 92-100.

Steiner, A. A. (1984). The universal solution. ISOSC. En: proceedings of 6th International Congress on Soilles Culture. pp: 633-649. Wageningen, The Netherlands.

Tapia-Vargas, M., Larios-Guzmán, A., Díaz-Sánchez, D.D., Ramírez-Ojeda, G., Hernández-Pérez, A., Vidales-Fernández, I. & Guillén-Andrade, H. (2016). Producción hidropónica de chile habanero negro (*Capsicum chinense* Jacq.). *Revista Fitotecnia Mexicana. 39*(3): 241-245.

Vázquez, G., Ramírez, E.M., Mata, H., Ariza, R., Alia, I. (2010). Atributos de calidad y vida de anaquel de frutos de cultivares de chile serrano en México. *Revista Fitotecnia Mexicana 33*(4): 79-82.