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# AGRO PRODUCTIVIDAD

## Year-long evaluation of total soluble proteins in the trunk of two **pine** species from northeastern Mexico

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# Yield potential of onion genotypes in the Planicie Huasteca, Mexico

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**ABSTRACT**

**Objective**: To identify new generation onion genotypes with high yield per unit that meet the bulb quality characteristics required by the export market.

**Design/Methodology/Approach**: Eight onion hybrids with yellow bulb, six hybrids with white bulb, and three hybrids with purple bulb were evaluated. The experiments were established with drip irrigation and fertigation. The agronomic characteristics of the plant and the production and quality of the bulb were evaluated, using the USDA specifications for bulb width and shape. The experiments were carried out using a completely randomized block design, with three replications; the statistical analysis was performed using the SAS software, version 9.2.

**Results**: The best onion genetic materials for the Planicie Huasteca were the yellow bulb hybrids Wayne and Don Víctor, the white bulb hybrids Blanca Grande, Monja Blanca, and Don Alberto, and the purple bulb hybrid Rasta, all of which have high production capacity and bulb quality.

**Study Limitations/Implications**: Onion (*Allium cepa* L.) is the most extensive horticultural crop in the Planicie Huasteca, Mexico. Although regional producers establish outstanding genotypes, they require information about the new generation genetic materials, if they are to remain competitive in the export market. Therefore, the new genotypes with the best high yield potential and bulb quality must be evaluated to select those that meet the requirements of the market.

**Findings/Conclusions**: Yellow, white, and purple bulb onion genotypes with high production capacity that meet the requirements of the markets were identified.

**Keywords**: *Allium cepa* L., bulb quality, production, hybrids.

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## INTRODUCTION

Onion (*Allium cepa* L.) is an important source of food, for both urban and rural populations (Shigyo and Kik, 2007). In addition, the production of this crop has economic value (Omoloso and Vagi, 2001; de la Fé and Cárdenas, 2014), since it is the second most widely cultivated vegetable worldwide, only surpassed by tomato (*Lycopersicon esculentum* Mill) (Financiera Nacional de Desarrollo Agropecuario, Rural, Forestal y Pesquero, 2014). The United States is the first global importer and Mexico is its main supplier (Gómez, 2010; Valencia and Zetina, 2017). In the Planicie Huasteca of northeastern

Mexico (northern Veracruz, eastern San Luis Potosí, and southern Tamaulipas), onion is the most extended vegetable; during the autumn-winter cycle, its growing area fluctuates between 4,000 and 9,000 hectares (SIAP, 2022). Onion production is mainly sold to the export market. Yellow onion is the most produced crop (70%), followed by white onion (25%), and purple or red onion (5%) (Mata *et al.*, 2011). Local producers unknowingly grow varieties or hybrids that may not be appropriate for their region and, sometimes, producers report substantial losses, because the crops experience severe disease problems or the bulbs have limited production potential and quality (Velásquez and Reveles, 2011; Velásquez *et al.*, 2013). Although the producers of the Planicie Huasteca establish outstanding genotypes, they require information about the new generation genetic materials, if they are to remain competitive in the export market. Consequently, institutions such as the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP) must support the identification of outstanding onion varieties or hybrids (with higher yields and bulb quality) that will be able to adapt to regional conditions. They should also make this information available to the producers. Therefore, the objective of this study was to identify new generation onion genotypes that can obtain high yield per unit and that meet the requirements of the export market.

## MATERIALS AND METHODS

This research was carried out during the 2019-2020, 2020-2021, and 2021-2022 autumn-winter (A-W) cycles, at the INIFAP-Campo Experimental Las Huastecas, located in Villa Cuauhtémoc, Altamira Tamaulipas, Mexico (22° 34’ 6” N, 98° 10’ 5” W). Eight hybrids of yellow onion, six hybrids of white onion, and three hybrids of purple onion were evaluated, including the commercial hybrids used as control: Don Víctor (yellow onion), Carta Blanca (white onion), and Rasta (purple onion) (Table 1). The experiments were established with the dripping irrigation and fertigation technology developed by the INIFAP (Mata *et al.*, 2011). Eighty-five percent of the regional production in Mexico is sent to the United States; therefore, the agronomic characteristics and the bulb shape and quality were evaluated, based on the width, bulb shape, and quality classification specifications issued by the United States Department of Agriculture (USDA) (NOA, 2006; USDA, 2016). The genetic materials were established under open sky conditions and were divided into three groups, according to the color of the bulb (Table 1).

A completely randomized block design with three replicates was used for the field distribution. The experimental plot was made up of a 1.8 m wide × 5 m long bed and the harvest was carried out in 4 m at the center of the plot, resulting in a 7.2 $m^2$ useful area. Four rows of plants were established in each bed, with a plant density of 7 plants per lineal meter, resulting in 150,000 plants per hectare. The harvest started when the foliage bent over (an indication of the commercial maturity of the bulb). Based on the export standards, the following elements were recorded: days until harvest, total production, average bulb weight, exportation bulb, and predominant dimensions of the bulb (Asgrow, 2000; USDA, 2016). The combined statistical analysis of the three cycles of each variable was carried out using the SAS version 9.2 software (SAS, 2009).

**Table 1**. Onion genetic material evaluated under fertigation conditions in southern Tamaulipas at the INIFAP-Campo Experimental Las Huastecas (2019-2022).

| Group by bulb color | Number | Genotype |
|---|---|---|
| Yellow | 1 | Hornet |
| | 2 | Plethrora |
| | 3 | Vulkana |
| | 4 | Dulciana |
| | 5 | Don Víctor (Control) |
| | 6 | Veronica |
| | 7 | Tusker |
| | 8 | Wayne |
| White | 1 | Don Alberto |
| | 2 | Florentina |
| | 3 | Blanca Montejo |
| | 4 | Carta Blanca (Control) |
| | 6 | Blanca Grande |
| Purple | 1 | Rasta (Control) |
| | 2 | Sofire |
| | 3 | Red Sensation |

## RESULTS AND DISCUSSION

**Precocity at the time of the harvest**. In the Planicie Huasteca, precocity is an important characteristic for onion cultivation, because an early harvest is generally associated with a good sale price, both in the domestic and export markets. There were significant differences ($P<0.05$) in the overall analysis of variance of the genotypes (Table 2). Regarding its commercial maturity, the Vulcana yellow onion was the most precocious cultivar, followed by Tusker, and the Don Victor hybrid (control); from the transplant to the moment when the foliage bend over, the process took 96, 101, and 134 days for each of these cultivars, respectively (Table 2). Meanwhile, the most precocity to harvest was the Blanca Montejo white onion hybrid, whose foliage bend over at 105 days. Meanwhile, there were no significant differences regarding purple onions ($P>0.05$) (Table 2). Amarananjundeswara *et al.* (2020) carried out a study in Karnataka, India, using 28 onion genotypes and determined that onions reached their physiological maturity between 80 and 128 days. The difference between both studies could be the consequence of the evaluated genotypes and the environmental conditions.

**Bulb quality**. Most of the evaluated materials are of excellent quality. There was a high uniformity in size and bulb color. Most of the genotypes recorded a >95% export quality production. Nevertheless, the Monja Blanca white onion, Plethrora yellow onion, and Sofire purple onion total production recorded an export quality of 94, 93, and 84%, respectively (Table 3). Regarding the shape of the bulb, all the materials mostly recorded flattened globe and globe shapes (Figure 1). The Verónica and Sofire hybrids had a round bulb, while Dulciana had a flat bulb (Table 3). This variable is fundamental, because 85% of the onion production is exported to the USA (TRADE MAP, 2022).

**Table 2**. Precocity (days at the start of the harvest) in yellow, white, and purple onions, under in southern Tamaulipas. INIFAP-Campo Experimental Las Huastecas (2019-2022).

| Group by bulb color | Genotype | Days to harvest after transplanting | | | |
|---|---|---|---|---|---|
| | | A-W 2019-2020 | A-W 2020-2021 | A-W 2021-2022 | Average* |
| Yellow | Don Victor | 138 | 134 | 129 | 134 a |
| | Wayne | 137 | 116 | 131 | 128 ab |
| | Hornet | 134 | 112 | 123 | 123 ab |
| | Verónica | 130 | 116 | 115 | 120 ab |
| | Dulciana | 123 | 118 | 114 | 118 abc |
| | Plethrora | 123 | 110 | 108 | 114 bcd |
| | Tusker | 98 | 100 | 104 | 101 cd |
| | Vulkana | 92 | 100 | 97 | 96 d |
| White | Florentina | 139 | 143 | 134 | 139 a |
| | Blanca Grande | 139 | 147 | 123 | 136 a |
| | Don Alberto | 139 | 139 | 124 | 134 a |
| | Carta Blanca | 139 | 138 | 111 | 129 a |
| | Monja Blanca | 126 | 114 | 123 | 121 ab |
| | Blanca Montejo | 119 | 100 | 97 | 105 b |
| Purple | Rasta | 145 | 147 | 115 | 136 a |
| | Red Sensation | 129 | 146 | 127 | 134 a |
| | Sofire | 131 | 110 | 110 | 117 a |

*Amounts with the same letters are statistically equal (Tukey, $P<0.05$).

Production was classified by bulb size, according to the exports market quality standards (Asgrow, 2000; Gómez, 2010; USDA, 2016): 1) super-colossal (>10.8 cm width); 2) colossal (9.53-10.79 cm width); 3) jumbo (7.62-9.52 cm width); 4) medium (5.72-7.61 cm width); and 5) small (<2.54-5.71 cm width). Most yellow onions were super-colossal (or extra-large) and colossal, the sizes preferred by the export markets (Mata *et al.*, 2011), where northeastern Mexican yellow onion production is sold. The Wayne and Hornet hybrids recorded the biggest bulbs, with an average weight of 480 and 447 g, respectively (Table 3). Islam *et al.* (2007) reported a positive correlation with the fresh weight of the bulbs. White onions recorded mainly jumbo and colossal produce. The Blanca Grande genotype was the exception: it recorded a 455-g bulb average weight and was classified into the super colossal and colossal categories (Table 3). Purple onions had the smallest bulbs and were classified as medium, jumbo and, to a lesser degree, colossal. In statistical terms, the three evaluated materials were equal regarding average bulb weight ($P>0.05$) (Table 3). The preferred sizes of white and yellow onions are medium, jumbo, and colossal. Consequently, all the genetic materials had a high-quality exportation size, although the domestic Mexican market prefers jumbo- and medium-sized onions (Mata *et al.*, 2011).

**Total production of commercial-quality bulbs**

Significant differences ($P<0.05$) were recorded between the yield variables of the genotypes. The Wayne yellow onion hybrid recorded the highest yields, with an average

**Table 3**. Bulb quality and size characteristics of onion genotypes. INIFAP-Campo Experimental Las Huastecas (2019-2022).

| Bulb Color | Genotype | Export bulb (%) | Bulb shape | Bulb size | Bulb weight (g)* |
|---|---|---|---|---|---|
| Amarillo | Wayne | 98 | GL | C-SC | 480 a |
| | Hornet | 98 | FGL | C-SC | 447 a |
| | Dulciana | 96 | GL | C-SC | 426 ab |
| | Don Victor | 98 | GL | J-C-SC | 418 ab |
| | Plethrora | 93 | F | J-C-SC | 410 ab |
| | Verónica | 98 | R | J-C-SC | 386 ab |
| | Tusker | 98 | FGL | J-C | 319 b |
| | Vulkana | 95 | GL | J-C | 317 b |
| Blanco | Blanca Grande | 97 | FGL | C-SC | 455 a |
| | Carta Blanca | 98 | GL | J-C-SC | 424 a |
| | Don Alberto | 96 | FGL | J-C-SC | 412 ab |
| | Monja Blanca | 94 | FGL | J-C | 376 ab |
| | Blanca Montejo | 97 | GL | J-C | 374 ab |
| | Florentina | 95 | FGL | J-C | 372 ab |
| Morado | Rasta | 98 | GL | J-C | 345 a |
| | Red Sensation | 98 | FGL | M-J-C | 343 a |
| | Sofire | 84 | R | M-J-C | 329 a |

* Amounts with the same letter are statistically equal (Tukey, $P<0.05$); Bulb size: SC=Super-Colossal; C=Colossal, J=Jumbo, M=Medium, S=Small; Bulb shape: R=Round; GL=Globe; FGL=Flattened Globe; F=Flat.

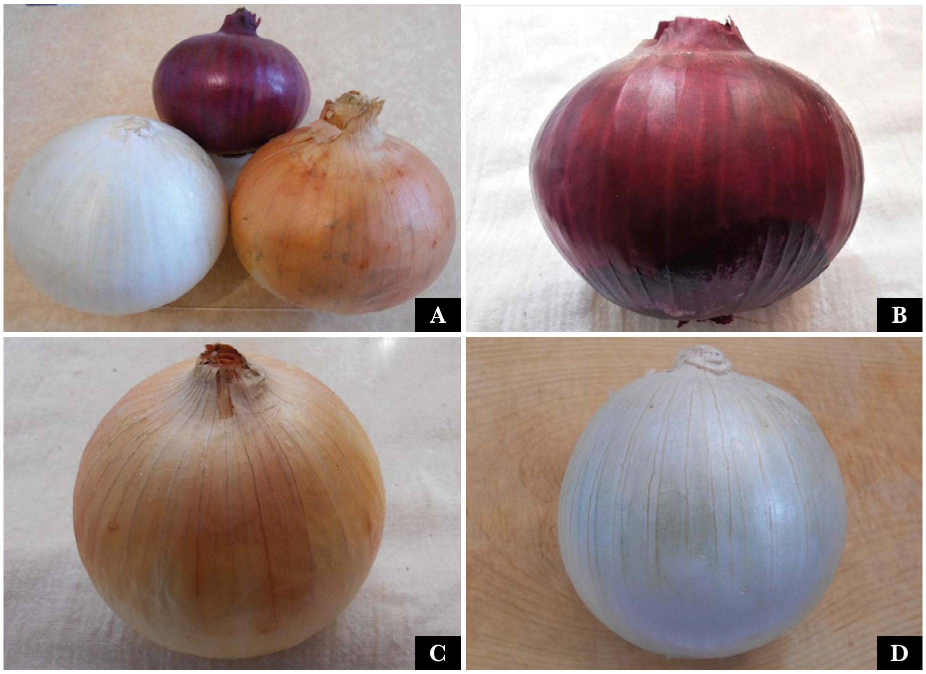


**Figure 1**. Onion bulbs. A) Group by bulb color. B) purple onion hybrid (Rasta). C) yellow onion hybrid (Wayne). D) white onion bulb (Blanca Grande).

production of 57.9 t $ha^{-1}$, during the three evaluation cycles. Ninety-eight percent of its production had exportation quality, surpassing the Don Victor hybrid (control), which obtained a 51.4 t $ha^{-1}$ yield, with the same percentage of exportation quality in its production. The Tusker hybrid recorded the lowest yield (39.5 t $ha^{-1}$), although 98% of its production had exportation quality (Table 3 and 4).

For their part, white onions recorded significant differences ($P<0.05$). The Blanca Grande genotype recorded the highest production (52.5 t $ha^{-1}$), 97% of which had exportation quality. Blanca Grande was followed by Monja Blanca, Don Alberto, Carta Blanca, and Florentina, whose yields fluctuated from 44.5 to 49.8 t $ha^{-1}$ and had a 94-98% exportation quality. The lowest production was recorded by the Blanca Montejo hybrid (40.3 t ha-1), 97% of whose production had exportation quality (Tables 3 and 5).

Purple onions recorded the lowest average production yield (37.5 t $ha^{-1}$) regarding the yellow and white onions, which obtained a 48.4 and 47.2 t $ha^{-1}$, respectively. The three purple onion genetic materials evaluated were statistically equal ($P>0.05$) regarding bulb production (Table 6). Overall, the Sofire purple onion genotype produced the lowest number of bulbs for exportation (86%). This situation could be the result of the high number of splitting bulbs (onions with double or triple bulbs in the same plant) and their characteristic jumbo-medium bulbs (Table 3).

**Table 4**. Production per cycle and average of yellow bulb onion genotypes. INIFAP-Campo Experimental Las Huastecas (2019-2022).

| Variety or Hybrid | Yield per Cycle t $ha^{-1}$ | | | Average* t $ha^{-1}$ |
|---|---|---|---|---|
| | AW 2019-2020 | AW 2020-2021 | AW 2021-2022 | |
| Wayne | 51.9 | 47.1 | 74.8 | 57.9 a |
| Don Víctor | 44.7 | 43.4 | 66 | 51.4 ab |
| Hornet | 32.5 | 44.4 | 73.4 | 50.1 ab |
| Plethrora | 42.9 | 46.5 | 60.1 | 49.8 ab |
| Verónica | 37.9 | 42.3 | 67.0 | 49.1 ab |
| Dulciana | 37.7 | 44.9 | 62.7 | 48.4 ab |
| Vulkana | 37.8 | 34.2 | 50.9 | 41.0 b |
| Tusker | 32.7 | 31.2 | 54.5 | 39.5 b |

*Amounts with the same letters are statistically equal (Tukey, $P<0.05$).

**Table 5**. Production per cycle and average of white onion genotypes, in southern Tamaulipas. INIFAP-Campo Experimental Las Huastecas (2019-2022).

| Variety or hybrid | Yield per cycle t $ha^{-1}$ | | | Average* t $ha^{-1}$ |
|---|---|---|---|---|
| | AW 2019-2020 | AW 2020-2021 | AW 2021-2022 | |
| Blanca Grande | 50.9 | 47.2 | 59.5 | 52.5 a |
| Monja Blanca | 41.4 | 40.7 | 67.2 | 49.8 ab |
| Don Alberto | 43.7 | 40.9 | 60.4 | 48.3 ab |
| Carta Blanca | 41.3 | 43.1 | 58.7 | 47.7 ab |
| Florentina | 39.3 | 41.8 | 52.3 | 44.5 ab |
| Blanca Montejo | 33 | 35.7 | 52.1 | 40.3 b |

* Amounts with the same letters are statistically equal (Tukey, $P<0.05$).

**Table 6**. Production per cycle and average of purple onion genotypes. INIFAP-Campo Experimental Las Huastecas (2019-2022).

| Variety or hybrid | Yield per cycle t ha$^{-1}$ | | | Average* t ha$^{-1}$ |
|---|---|---|---|---|
| | AW 2019-2020 | AW 2020-2021 | AW 2021-2022 | |
| Sofire | 35.6 | 28.4 | 52.3 | 38.8 a |
| Rasta | 36.9 | 32 | 47 | 38.6 a |
| Red Sensation | 26.2 | 34.7 | 44.2 | 35.0 a |

* Amounts with the same letters are statistically equal (Tukey, $P<0.05$).

## CONCLUSIONS

The best onion genetic materials in the Planicie Huasteca were Wayne and Don Victor hybrids (yellow onion), Blanca Grande, Monja Blanca, and Don Alberto (white onion), and Rasta (purple onion). These hybrids recorded a high productive capacity and had all the characteristics and qualities required by the market. Consequently, they meet all the requirements of the producers of the Planicie Huasteca region.

## REFERENCES


Amarananjundeswara, H., Priyadarshini, G., Doddabasappa, B., Vasudeva, K. R., Anjanappa, M., Prasad, P. S., y VeereGowda, R. (2020). Evaluation of white onion (*Allium cepa* L.) genotypes for growth, yield and yield attributing characters. *Journal Pharmacognosy and Phytochemistry, 9*(5):477-480.

Asgrow. (2000). Cebolla, factores que influyen en la calidad de los bulbos. Reporte Agronómico Asgrow. Sun Praire, WI, USA.

de la Fé, C. y Cárdenas, R. (2014). La producción de semillas de cebolla (*Allium cepa* L.), una realidad en Santa Cruz del Norte, Mayabeque. *Cultivos Tropicales. 35*(4):5-12.

Financiera Nacional de Desarrollo Agropecuario, Rural, Forestal y Pesquero. (2014). Panorama de la cebolla. Consulta 01 de marzo de 2012. http://www.financierarural.

Islam, M. K., Alam, M. F., y Islam, A. K. (2007). Growth and yield response of onion (*Allium cepa* L.) genotypes to different levels of fertilizers. *Bangladesh Journal of Botany, 36*(1): 33-38.

Mata, V. H., Patishtán, P., Vázquez, G. E., y Ramírez, M. M. (2011). Fertirrigación del cultivo de cebolla con riego por goteo en el sur de Tamaulipas. INIFAP-CIR Noreste, Campo Experimental Las Huastecas. Libro Técnico No. 4. México. 158 p.

NOA. (2006). Bring on the onions. National Onion Association. U.S.A. 8 p.

Omoloso, A., y Vagi, J. (2001). Broad spectrum antibacterial activity of *Allium cepa*, *Allium roseum*, *Trigonella foenum graecum* and *Curcuma domestica*. *Natural Product Sciences, 7*(1):13-16.

SAS Institute. (2009). Versión 9.2 para Windows. SAS Inst., Cary, NC, USA.

SIAP. (2022). Servicio de Información Agroalimentaria y Pesquera. Acciones y Programas. Cierre de la producción agrícola 2021. Consulta 26 de agosto de 2022. https://nube.siap.gob.mx/cierreagricola/

Shigyo, M. & Kik, C. (2007). Onion. Vegetable II. Fabaceae, Liliaceae, Solanaceae and Umbelliferae. In Handbook of Plant Breeding, 121-159.

TRADE MAP. 2022. Trade Map: Trade statistics for international business development. Fecha de consulta 26 de agosto de 2022. https://www.trademap.org/Index.aspx/.

USDA (United States Department of Agriculture) (2016). Onions Shipping Point and Market Inspection Instructions. Agricultural Marketing Service, Specialty Crops Program, Specialty Crops Inspection Division. USA. pp 109.

Valencia, S. K. y Zetina, E. A. M. (2017). La cebolla mexicana: un análisis de competitividad en el mercado estadounidense, 2002-2013. *Región y sociedad, 29*(70):133-153. https://doi.org/10.22198/rys.2017.70.a348.

Velásquez-Valle, R., y Reveles-Hernández, M. (2011). Detección del iris yellow spot virus en el cultivo de cebolla en Zacatecas, México. *Revista Mexicana de Ciencias Agrícolas, 2*(6): 971-978.

Velásquez-Valle, R., Reveles-Torres, L. R., Amador-Ramírez, M. D. (2013). Hortalizas y virosis en Zacatecas: Un patosistema complejo. *Revista Mexicana de Ciencias Agrícolas, 4*(8): 1267-1277.