

Comparative analysis of pecan orchards (*Carya illinoensis* Koch) in the Comarca Lagunera

María Gabriela Cervantes Vázquez¹

Ignacio Orona Castillo^{1§}

Cirilo Vázquez Vázquez¹

Manuel Fortis Hernández¹

José de Jesús Espinoza Arellano²

¹Faculty of Agriculture and Zootechnics, University Juárez of the state of Durango. Highway Gómez Palacio-Tlahualilo km 28. Ejido Venice, Durango, Mexico. Tel 01(871) 7118918. (cevga@hotmail.com, orokaz@yahoo.com, cirvaz60@hotmail.com, fortismanuel@hotmail.com). ²Autonomous University of Coahuila. Boulevard Revolución 151 Oriente, Torreón, Coahuila. CP. 27000. Tel. 01(871) 7128044. (jesusepinoza_612@yahoo.com.mx).

§Corresponding author: orokaz@yahoo.com.

Abstract

The cultivation of pecan nuts in Mexico and the United States of America is an important activity and the production of both countries represents more than 90% of world production, with the United States of America being the main producer and Mexico the second. However, the problem faced by producers is the broad intermediation in marketing and the lack of knowledge of the pecan nut market. The objective of this research work is to analyze the conditions of nut production and sale in pecan walnut orchards that include variables such as surface, varieties, yields, infrastructure and marketing aspects, with which better organization decisions can be made for the production and sale of the product. For the above, 24 surveys were applied to producers of different orchards taking into account the roster of nogaleros of the region of 396 in the year 2014. The sample was divided into three strata according to its production area. The results show that the production of tons per hectare in the three strata is higher than that reported nationally, that the Wichita variety is the most used in combination with varieties such as Western. Likewise, producers with lower yields receive less financial support for production, concluding that support programs for these producers must be defined based on the technical productive conditions that each garden size handles.

Keywords: pecan, producers, walnut.

Reception date: January 2018

Acceptance date: February 2018

Introduction

The pecan tree is native to the southeastern United States of America and northern Mexico (Gray, 1973). The first commercial plantations began in 1871, and the pioneer introduction of commercial plantations in Mexico was made in 1904, in the state of Nuevo Leon. According to Medina and Cano (2002), the Spaniards called the pecan tree nut tree and its fruit, the pecanera called “nut”. In different regions of the country it is different from other nuts with the name of walnut paper husk (Toole, 1965; Brison, 1976).

The world production of pecan nuts is headed by the United States and Mexico; together they contribute 93%. The first participates with 55% and the second with 38%, South Africa, Australia, and other countries contribute with the rest (International Nut & Dried Fruit, 2014). The pecan nut is the highest commercial activity in the eastern United States, it is grown throughout the south of this country. The top five producing states are: Georgia, Texas, New Mexico, Arizona, with Louisiana and Oklahoma, tied for number five (USDA-NASS, 2011).

The European Union is a market characterized by a strong trade deficit of nuts, with the United States as its main supplier. Among the main importing countries, is Spain, a country in which per capita consumption stands at 500 g (Camarena and Sanjuan, 2005). The production of walnut in Mexico has increased by about 80% in the last thirteen years, currently reaching around 110 thousand tons. The planted area reached 104 thousand hectares in 2013 (SHCP, 2014).

The per capita consumption in Mexico is around 0.650 kg (Baca, 2007), while in 2007 in the United States of America, consumption was around 0.752 kg. The largest volume of pecan nut is marketed without a shell, that is, almond, which weighs about 50% of the total weight of the nut. Consumers in developed countries are interested only in nuts of consistently high quality. The quality and therefore the prices, is judged by the consuming companies on the base of the color and the size of the seed, with preference in the big and slightly colored seeds (without damage by insects and fungi). The almond is packed under vacuum or in nitrogen and can be refrigerated for long periods of storage (up to 12 months) (FIRA, 2002).

The price is determined in the market of the United States of America according to the forces of supply and demand, as well as its quality determined by the size and color of the almond (Espinoza *et al.*, 2009). Ojeda *et al.* (2010), points out that it is necessary to implement strategies that allow adding value to the nut by carrying out market studies for walnuts, derived products and finding marketing alternatives. In addition, fluctuations in the price of walnut impact the demand for inputs. The cultivation of walnut in Mexico is of interest since it is the second world producer of this product.

Currently, the Pecanera industry is based on few cultivars of the known hundreds; “Desirable”, “Stuart” and Schley are grown in the Eastern United States of America and “Western” and “Wichita” in the West and in Mexico. “Western” is a selection made by EE Riesen in 1924. Wichita comes from a cross between Halbert x Mahan, from the Walnut Improvement Program of the United States Department of Agriculture and Livestock; was released in 1959 (Nuñez, 2016).

The Comarca Lagunera as a region occupies the fourth place at the national level of surface sowed with 8 641.99 ha, below Chihuahua and above Durango (SAGARPA-SIAP, 2013). The harmful organisms that affect the productivity of walnuts are pests and diseases; Del Toro (2013) points out that the control of these problems represents 15% of the production costs of the crop. Samaniego *et al.* (2008), states that the focus of infestation of pests known as boring worms starts in a defined area within the orchard and then spreads to the rest of the plantation, the smaller walnut trees are more easily attacked by them.

Despite the importance of cultivation in the country and in the Comarca Lagunera, it is necessary to generate information to guide decisions to support the nut producer, as well as aspects of organization and technical assistance that favor greater profitability and improve their participation in the value chain. The objective of this research work is to characterize pecan walnut groves by size of surface, emphasizing varieties, yields, infrastructure, and marketing aspects used, which would help to define support actions at the level of each of the strata of producers identified.

Materials and methods

The investigation was carried out in 2014 in the Comarca Lagunera, located at 102° 22 and 04° 47 west longitude and the parallels 24° 22 and 26° 23' north latitude, and a height of 1 100 and 1 150 meters above sea level, to which was applied a survey to a sample of producers with different garden sizes. The list of producers of the Comarca Lagunera was obtained with SAGARPA technicians, from which the sample size was determined with the formula of simple random sampling and stratified sampling reported by Fuller (2009).

$$n = \frac{t_{\alpha/2}^2 S^2}{d^2 + \frac{t^2 S^2}{N}}$$

Where: N= population size; n= necessary sample size; d= accuracy of the estimate or distance you want the estimator (sample proportion, p) to move away from the parameter (population proportion, P); in most cases, d is less than 0.1. It is recommended to calculate the sample size for different values of d. S= standard deviation of the known or estimated population from previous studies; t= value of the tables of t; α = level of significance of α , the most common is to establish $\alpha = 0.05$.

Once the sample size was determined, to distribute it proportionally to the size of the strata, the following expression of stratification was used:

$$nh = Nh * fh$$

Where: nh= size of the stratum sample; Nh= stratum size; fh= fraction of the stratum.

fh = n/N. Where: fh= the fraction of the stratum; n= sample size and N= population size.

Generating the stratification presented in Table 1.

Table 1. Stratification of orchards for the application of surveys to producers in the Comarca Lagunera, 2013.

Stratum	Size	Sample
1 (0.1 - 10 ha)	338	20
2 (10.1 - 45 ha)	45	3
3 (45.1 -160 ha)	13	1

Of a total of 27 questionnaires applied to nut producers (although the sample size was 24), 22 corresponded to small producers with a surface area of up to ten hectares, three were applied to characterize medium producers (between 10.1 to 50 ha) and two to describe the large producers (over 45.1 ha) of which this characterization was carried out.

In Figure 1, the municipalities that were surveyed are shown, as well as the surveys corresponding to each stratum. Secondary information sources such as SAGARPA-SIAP (2013) were used to analyze nut cultivation in Mexico and in the study area and the Microsoft Excel 2010 program was used to process the surveys.

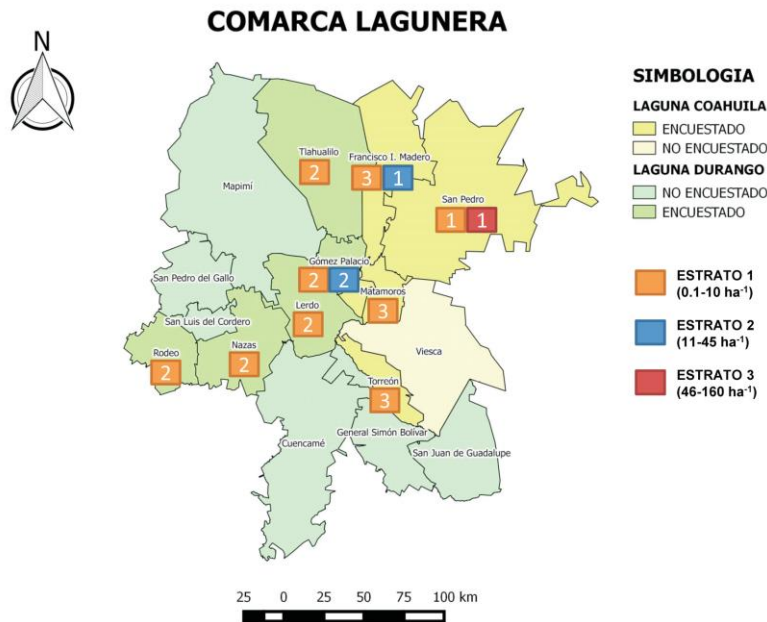


Figure 1. Municipalities surveyed in the Comarca Lagunera, 2013.

Results and discussion

Situation of pecan cultivation in Mexico

Based on the agricultural production statistics published by SAGARPA-SIAP (2013), the evolution of pecan nut cultivation in Mexico is shown in Table 2.

Table 2. Comparison of the national nut summary in Mexico for the years 2001, 2004, 2007, 2010 and 2013. SAGARPA-SIAP, 2013.

Year	Surface planted (ha)	Harvested surface (ha)	Production (t)	Yield (t ha ⁻¹)	PMR (\$ t ⁻¹)
2001	51 823	48 847	68 522.7	1.4	12 593.8
2004	65 684.6	51 328.4	81 500	1.59	35 573.4
2007	77 582	57 508.9	79 161.6	1.38	28 316.1
2010	88 054.9	69 548.8	76 627	1.1	53 722.3
2013	103 866.5	72 563.1	106 944.5	1.47	43 130.2

During the period 2001 to 2013 there was an increase in the planted area of 100.43%, in the harvested surface of 48.55%, in the production 56.07% and in the yield 5%. The states with the largest planted area are Chihuahua, Coahuila, Sonora and Durango (SAGARPA-SIAP, 2013).

Comparative analysis of pecan orchard in the Comarca Lagunera

Based on the defined stratification of orchards, the similarities and differences found between them are presented below.

Participation in production. With regard to the area destined for cultivation; the small, medium and large producers have an average area of 2.85, 21 and 55 ha, respectively, participating with 26.5, 26.8 and 46.8% of the cultivated area. To the regional production, they contribute 16, 23 and 61% of the production of walnut; that is to say, small producers, although they represent little more than a quarter of the nogalera surface, contribute a sixth of the production, with lower productivity being noticed in this stratum.

Yields. At a general level, the average nut yield was 1.73 t ha⁻¹, higher than the national one registered for the study year, which was reported as 1.47 t ha⁻¹. By strata of producers it was 1.24, 1.57 and 2.4 t ha⁻¹ for small, medium and large producers respectively. This explains the lower participation of small producers in total production.

Walnut varieties. The types of walnuts produced in the region are Western, Wichita, Creole and Choctaw, which represent 65.73, 30.58, 3.44 and 0.04% of the area destined for production. In comparison with what was found in the Comarca Lagunera, Foundation Produce Chihuahua AC. (2008) reports that the production comes from two improved varieties, Western Schley 85% and Wichita 15%. In Sonora, Coronado *et al.* (2015), reports the Wichita and Western varieties, using the latter as a pollinator; the percentages of each one are between 70-30 and 80-20%.

The participation of small, medium and large producers in the Comarca Lagunera is shown in Table 3.

Harvest period. At the level of the region, it was found that 63% of the producers start their harvest period in October and the rest in the month of September. The 70.4% of the producers finish the harvest in November and the rest in October. The months harvested by small producers extend

from October to November, while medium and large producers do so mostly in the period from September to November.

Table 3. Surface of pecan varieties by type of producer and their percentage share.

Strata	Western		Wichita		Creole		Choctaw	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
1 (1 - 10 ha)	35.3	22.7	20.8	28.9	6.1	75.3	0.1	100
2 (11 - 45 ha)	39.7	25.6	21.3	29.5	2	24.7	0	0
3 (46 - 60 ha)	80	51.7	30	41.6	0	0	0	0
Total	155	100	72.1	100	8.1	100	0.1	100

Age of the garden and type of irrigation water. The average age of the orchard was 27.5 years. By type of producer, the average age of the orchards was 27.2, 35 and 27.5 years in small, medium and large producers, respectively. The types of water used to irrigate the orchards come from the Nazas River and the deep wells. 92.59% of the orchards are irrigated with the first type of water, the rest uses deep well water.

In contrast to what was found with Orona *et al.* (2013) states in the study conducted in the state of Coahuila in the region known as “five springs” in the municipalities are Allende, Morelos, Nava, Villa Union and Zaragoza found that 87% of the walnut orchards in the north of Coahuila they are equipped with water-efficient irrigation systems, of which 84% is micro-sprinkling and the rest is dripping.

In the small producers, 95.5 of the surface is irrigated with river water and the rest with deep well, in the medium producers 66.7 of the surface is irrigated with river water and the rest with deep well water. Large producers use only river water to irrigate their gardens. Using river water minimizes production costs in the crop and favors the soil that is irrigated with the transport of organic matter dissolved in the water.

Financing in production. At the regional level, the producers that have financing services to produce are 74% and it is through the bank in particular or agricultural loans, in Table 4 it can be seen that small producers are the least favored in receiving these supports and the large producers are the most favored, which may have an impact on obtaining lower yields.

Table 4. Financing to produce and yield by strata of nut producers in the Comarca Lagunera, 2013.

Strata	Financing to produce (%)	Yield (t ha ⁻¹)
1 (1 - 10 ha)	9.1	1.2
2 (10.1 - 45 ha)	33.3	1.5
3 (45.1 - 160 ha)	100	2.4

Infrastructure for production. The producers that have infrastructure for harvesting and handling their production with a vibrator were 18.51%, with an 11.11% winery, with a 7.40% sorter, with a 3.70% crusher and cleaner. None of the respondents has a refrigeration warehouse, packer, dehuller, dryer. The proportion of producers and infrastructure is shown in Table 5, which shows that small producers need to strengthen these elements.

Table 5. Proportion of producers that have infrastructure for harvesting and handling pecan nuts.

Stratum	Vibrating	Cellar	Breaker	Sorter
1 (1 - 10 ha)	9	4.5	4.5	0
2 (10.1 - 45 ha)	67	100	0	33
3 (45.1 - 160 ha)	50	50	0	50

For the state of Chihuahua, Lopez *et al.* (2011) found that the vehicles and implements used by the nogaleros are backward models which indicates that in the near future the producers will have to invest part of their profits in the acquisition of this equipment.

Willingness to organize. Regarding the desire to integrate a association of nogaleros, in general 81% declared a positive response, the proportion of small, medium and large producers that are willing is 86, 67 and 50%, respectively. Contrasting with the desired with a study carried out in localities with greater presence of walnut trees in the Sierra Nevada de Puebla region, where the participation of the interviewees in associations for legally constituted production is low (26%), due to low confidence in the functioning of these, due to the abuse of power by the leaders and the diversified strategy of occupation and income of the producer (Luna *et al.*, 2013).

In the north of Coahuila Orona *et al.* (2013) found that 100% of the nogaleros are integrated into an Association for the production and sale of walnut.

The aspects that in the Comarca Lagunera would like to be served by this association would be related to receiving technical and marketing assistance for 52 and 100% of the small and medium producers, and for negotiating higher prices for their product, the proportion of producers that want this aspect is 47, 100 and 100% for small, medium and large producers.

Walnut marketing. In the sale of its nut, the producers that have a fixed buyer in general are 33% of them, while by small, medium and large producers, it is 32, 33 and 50%, respectively. The rest of the producers sell to the buyer that offers the best price. Walnut buyers are from Gomez Palacio, Torreon, Aguascalientes, Chihuahua and the United States. The proportion of commercialization by strata is shown in Table 6.

Incidence of pests and diseases in orchards. In general, pests occur in 35.39% of the gardens surveyed and 12.96% in terms of the presence of diseases. It was found that 11.11% could not control them due to lack of advice or follow-up. In relation to the incidence of pests present in the cultivation of walnut in the region, the ones with the greatest presence are the ruezno borer worm, the walnut borer and the black and yellow aphids, which affect 93, 74% of the orchards, respectively.

Table 6. Proportion of forms of commercialization and price by strata of nut producers in the Comarca Lagunera, 2013.

Stratum	Forms of marketing (%)	
1 (1 - 10 ha)	A	73
	B	18
	C	6
	D	0
	E	1
	F	2
2 (10.1 - 45 ha)	A	43
	B	57
3 (45.1 -160 ha)	A	10
	B	90

Where: A= bulk without previous selection; B= bulk selected by size; C= selected, packaged sale to wholesaler; D= selected, packaged retail sale; E= harvest peels in its own crusher; F= hectare sale (standing).

Other pests of lower incidence are the chinchas, cobweb, spittlebug, whitefly, tulip flower (regressive death of the rust) and quarry of the earring. The proportion of orchards affected by pests is observed in Figure 2, where there is a high incidence of pests in the three types of producers under study.

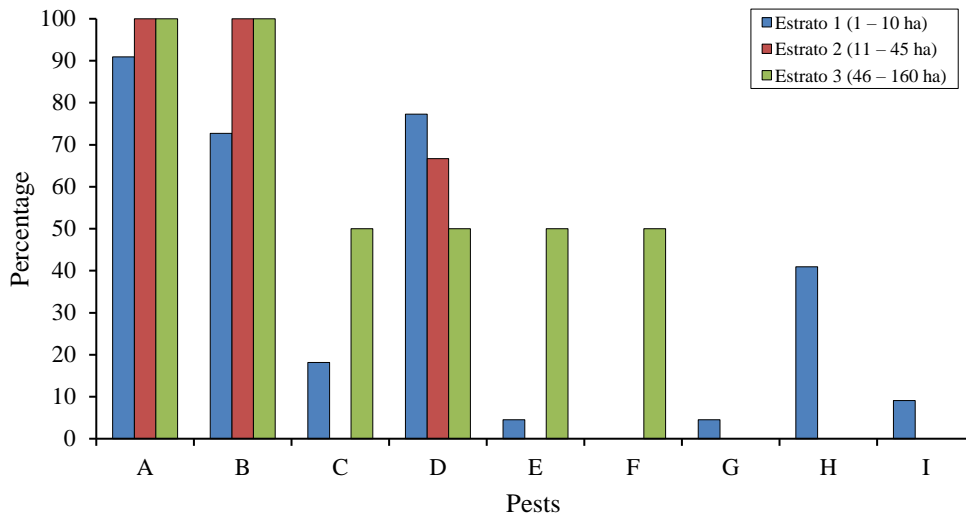


Figure 2. Proportion of orchards with incidence of pests in the Comarca Lagunera in 2013.

Training. Of the producers surveyed, those who receive training in the management of their crop mainly do so by the Local Board of Plant Health and Private Technicians. Of the farms surveyed more than half 51.85% receive training which is mainly oriented to the monitoring and control of

pests and diseases. The proportion by stratum indicates that of the small producers, 40% receive technical advice and control pests and diseases in 27%, while the medium and large producers in their entirety receive advice and make total control of pests and diseases.

Commercialization. With regard to the marketing channels, in the producers of stratum 1 bulk marketing predominates without prior selection because they do not have enough resources to carry out other forms of marketing; in stratum 2, the way of marketing in bulk without prior selection and bulk selected by size is balanced, and in stratum 3 the predominant form of marketing is bulk selected by size, in which these producers have better infrastructure and resources to make the selection of the nut.

Conclusions

The number of smaller orchards is greater and they participate with a lower percentage of production due to the lower registered yields.

The orchards of greater surface use smaller number of varieties in their production, concentrating in Western and Wichita, to smaller size of orchard a greater diversity of varieties is observed.

Larger orchards register more financing and training, which is reflected in higher yields per unit area.

The support infrastructure for nut production is low in all strata; however, small producers are the most deficient in this aspect.

Membership in an organization is limited; however, four out of five respondents are willing to be part of an organizational form that supports technical and marketing aspects, especially medium and large producers.

The producers with larger orchard size have fixed traders; the rest is subject to buyers who offer a better price for the product; commercial uncertainty is strongest in smaller orchards.

The ways to market the nut are more diversified in small producers. The medium and large producers market only in bulk without prior selection and in bulk selected by size.

It is observed that the greater the size of the orchard, the lower the incidence of the number of pests.

For all the above, the actions aimed at the technical strengthening of this product system should consider the differences identified in the different strata.

Cited literature

- Baca, M. G. O. 2007. Posicionamiento del cultivo del nogal. Presentación a nombre del Consejo Mexicano de la Nuez (COMENUEZ) en el evento del 50 Aniversario del Campo Experimental de la Laguna de INIFAP. Marzo de 2007. Matamoros, Coahuila.
- Brisson, R. F. 1976. Cultivo del nogal pecanero. 1^{ra}. Edición en español. Editorial CONAFRUT. México. 350 p.
- Camarena, G. D. M. y Sanjuán, L. A. I. 2005. Comercialización de la nuez pecan en el mercado europeo. Sociedad Mexicana de Administración Agropecuaria AC. México. Rev. Mex. Agron. 9(17).
- Coronado, G. M. A.; Meza, M. J. J.; García, P. M.; Hernández S. V. G. y Córdova, Y. A. 2015. Análisis de la inversión bajo distintos escenarios productivos del nogal pecanero en la Sierra de Sonora. Rev. Mex. Cienc. Agríc. 6(2):407-415.
- Del Toro, M. J. A. 2013. Control integrado de plagas y enfermedades y uso eficiente del agua de riego en el cultivo de nogal pecanero. Fondo Sectorial de Investigación en materia Agrícola, Pecuaria, Acuicultura, Agrobiotecnología y Recursos Fitogenéticos. SAGARPA. 4 p.
- Espinoza, A. J. J.; Salinas, G. H.; Orona, C. I. y Palomo, R. M. 2009. Planeación de la investigación del INIFAP en la Comarca Lagunera en base a la situación de mercado de los principales productos agrícolas de la región. Cuarta Época. Rev. Mex. Agron. Año XIII. 24 p.
- FIRA. 2002. Diagnóstico de la red nuez en el estado de Chihuahua, Residencia Estatal Chihuahua.
- Fuller, W. A. 2009. Samplig statistics. Ed. Wiley.
- Fundación PRODUCE Chihuahua AC. 2008. Agenda de innovación tecnológica para el estado de Chihuahua. México. 13-15 pp.
- Gray, O. S. 1973. Consider pollen when planting. The pecan quarterly. 7(3):24-25.
- International Nut and Dried Fruit. 2014. Global statistical review 2014-2015. https://www.nutfruit.org/wp-content/uploads/2015/11/global-statistical-review-2014-2015_101779.pdf.
- López, D. J. C.; Arras, V. A. M.; Salas, G. J. M.; Aguilar, V. A.; Robles, H. L.; Villalobos, P. E.; Rodríguez, A. A. 2011. Rentabilidad del nogal pecanero bajo sistemas de producción de mediana tecnología en Delicias, Chihuahua. Rev. Mex. Agron. 15(29):720-732.
- Luna, M. N.; Jaramillo, V. J. L.; Ramírez, J. J.; Escobedo, G. S.; Bustamante, G. Á. y Campos, R. G. 2013. Tipología de unidades de producción de nuez de castilla en sistema de producción tradicional. Agric. Soc. Des. 10(3):283-303.
- Medina, M. M. C. y Cano, R. P. 2002. Aspectos generales del Nogal Pecanero. *In*: tecnología de producción en Nogal Pecanero. Primera edición. INIFAP. Campo Experimental La Laguna, Matamoros, Coahuila. Libro técnico núm. 3. 222 p.
- Núñez, M. J. H. 2016. Nogaleros. Revista informativa y de interés para el sector nogalero de México. 11(36).
- Ojeda, B. D. L.; Arras, V. A. M.; Hernández, R. A.; López, D J. C.; Aguilar, V. A. y Denogean, B. F. G. 2010. Análisis FODA y perspectivas del cultivo del nogal pecanero en Chihuahua. Rev. Mex. Agron. 14(27):357.
- Orona, C. I.; Sangerman, J. D. M.; Fortis, H. M.; Vázquez, V. C. y Gallegos, R. M. A. 2013. Producción y comercialización de nuez pecanera (*Carya illinoensis* Koch) en el norte de Coahuila, México. Rev. Mex. Cienc. Agríc. 4(3):461-476.

- Samaniego, G. J. A.; Ramírez, D. M.; Pedroza, S. A. y Nava, C. U. 2008. Asociación entre pudrición texana (*Phymatotrichopsis omnivora*) e insectos barrenadores del nogal (*Carya illinoensis*). *Agric. Téc. Méx.* 34(1):21-32.
- SAGARPA-SIAP. 2013. <http://www.siap.gob.mx/>.
- SHCP. 2014. Panorama de la nuez. financiera nacional de desarrollo agropecuario, rural, forestal y pesquero.
- Toole, E. R. 1965. Pecan (*Carya illinoensis*). In: Fowells, H. A. (Comp.). *Silvics of forest trees of the United States*. Agriculture Handbook 271, Washington, D. C. 12-15 p.
- USDA-NASS. 2011. Annual non-citrus fruits and nuts summary. 1(2).