

The production and commercialization of pecan nut in Mexico

Ignacio Orona Castillo¹

Dora Ma. Sangerman-Jarquín^{2§}

María Gabriela Cervantes Vázquez¹

José de Jesús Espinoza Arellano³

Jesús Humberto Núñez Moreno⁴

¹Faculty of Agriculture and Zootechnics-Juarez University of Durango. Venice, Durango, Mexico. Tel. 871 7118918. (orokaz@yahoo.com; cevga@hotmail.com). ²Experimental Field Valley of México-INIFAP. Los Reyes-Texcoco road km 13.5, Coatlinchan, Texcoco, State of Mexico, Mexico. Tel. 01800 0882222, ext. 85353. ³Faculty of Accounting and Administration-Autonomous University of Coahuila-Torreón Unit. Torreón, Coahuila, Mexico. (jesusespinoza-612@yahoo.com.mx). ⁴Experimental Field Costa de Hermosillo-INIFAP. Pascual Encinas Félix No. 21, Colonia La Manga, Hermosillo, Sonora. CP. 83220. Tel. 55 38718700. (nunezhumberto@yahoo.com).

[§]Corresponding author: sangerman.dora@inifap.gob.mx.

Abstract

Mexico is the second pecan nut producing country and the first exporter of this product in the world. With the objective of proposing actions to favor the productivity of this activity, the operation of its production and commercialization was characterized in three of the most important nut production areas in Mexico: the Comarca Lagunera, Hermosillo (Sonora) and Jiménez (Chihuahua). For the above, two types of questionnaires applied in 2014 and 2015 were formulated. One was applied to a randomly determined sample of producers. The second was addressed to product marketers-processors. The results showed that the predominant garden sizes for the Comarca Lagunera and Jimenez are smaller than those of Hermosillo, where they are up to 800 ha. The number of pests is greater in the Comarca Lagunera and Jiménez. In Hermosillo, in addition, the producer has more infrastructure to manage the crop and the producers receive more technical and financial assistance, which explains the higher yields obtained. In the aspect of commercialization-transformation, the number of companies is greater in Jiménez, followed by Comarca Lagunera and in the end Hermosillo, a region that markets nuts to China directly by the producers. It is concluded that to improve production in the Comarca Lagunera and Jiménez Chihuahua, it is necessary to attend aspects of organization, training and financing, and to improve the commercialization in the three study areas it is necessary to create a system of information on prices and companies that allow it to the producer sell at the best price.

Keywords: Carya, marketing, production, walnut orchards.

Reception date: September 2019

Acceptance date: November 2019

Introduction

Pecan nut is a very important economic activity in northern Mexico and the southern United States. The five main producing states in the United States were: Georgia, Texas, New Mexico, Arizona, and Louisiana and Oklahoma, tied for fifth place (USDA-NASS, 2011) and in Mexico the states of Chihuahua, Sonora, Coahuila, Durango and Nuevo Leon. The production of this nut in Mexico has increased by about 80% in the last thirteen years (2003 to 2015) currently reaching around 110 thousand tons.

The planted area reached 104 thousand hectares in 2013 (Secretaría de Hacienda y Crédito Público, 2014). The cultivation of walnut in Mexico is of interest since in recent years it has positioned itself as an important player in the pecan nut market by occupying second place as a producer and first as a world exporter. The per capita consumption in Mexico is around 0.65 kg (Baca, 2007), while in 2007 in the United States of America the reported consumption was around 0.752 kg and in 2010 0.964.

The oldest archaeological evidence of its collection by humans for subsistence dates from 8 000 years before Christ (AC) during the Archaic period of America, in the Modoc Rock settlement, current state of Illinois-USA (latitude 38° north), corresponding to the northernmost limit of its geographical distribution. Archaeological evidence of its westernmost distribution dates back to 8 000 years ago recovered from Baker Cave in Val Verde County (longitude 101° west), in the state of Texas in the USA.

Its eastern boundary has been found in the state of Alabama in the USA (longitude 87° west), related to the Midwest Mississippi culture of the years 1050-1250 BC. To the south, the species is currently distributed to the state of Oaxaca in Mexico (latitude 17° north), although its historical limit of geographical distribution to the south is not supported by archaeological evidence if it is by genetic variation in plastids, which suggests that they are not the product of a recent introduction in the area (Gauke *et al.*, 2011).

Gray (1973) states that pecan walnut is native to the southeastern United States of America and northern Mexico, and that the first commercial plantations began in 1871 in the United States of America and the pioneer introduction of commercial plantations in Mexico was made in 1904, in the state of Nuevo Leon. Currently, pecan nut production comes mostly from plantations instead of natural forests, in the 2009-2011 period, 82% of US production was obtained from improved cultivars (Graham, 2013). The geographical distribution of pecan nut cultivation in North America is shown in Figure 1.

The main pests of this crop in Mexico are caused by the nut-boring worm *Acrobasis nuxvorella* (Neunzig), which affects a wide range of cultivars in a large geographical area, with a high level of affection. It affects the two main varieties (Western and Wichita) grown in Mexico. This insect, when completing four generations per year, is responsible for losses of up to 80% of the fruits, negatively hitting the profitability of the crop.

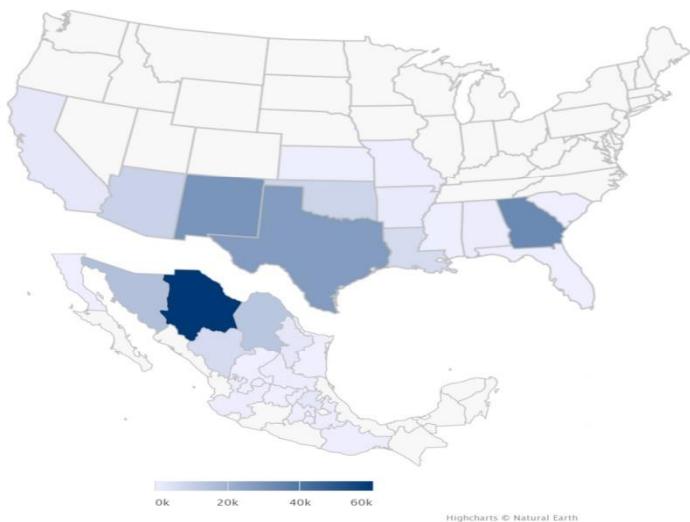


Figure 1. Geographic distribution map. The blue scale is directly proportional to the production in tons of pecan nut for the year 2014 (Suárez *et al.*, 2015).

Another insect that affects production is the rue auger worm (*Cydia cariana*), which is also found in most producing areas of Mexico. During the 2008 cycle it caused losses of 8.4% of the production of the state of Durango (SENASICA 2009). Del Toro (2013), mentions that harmful organisms affect the productivity of walnuts and their control implies 15% of the production cost of the crop. Mexico and the United States of America are the main producers of pecan nut, contributing about 93% of world production and the rest South Africa, Australia and Perú. Mexico is the world's first exporting pecan nut.

In 2016, the combined pecan nut production of these two countries was 271 000 t, of which Mexico participated with 52%, this presents an annual growth rate in production of 15.6%, while in the United States of America it was of 12.4%, Comité Mexicano del Sistema Producto Nuez, AC (2017). Potential markets with a strong real demand for pecans, such as Japan and Europe, could be an important opportunity to increase Mexican exports, diversifying the US market, traditionally the one preferred by Mexico.

Recent commercial results show that China, including Hong Kong, is a space with substantial growth over the past five years, which has become the second international market for American pecans. The quality of the nut is mainly considered by the percentage of almond, the size of the fruit, color, damages of the almond and others of minor importance. The almond content produced in the region in the varieties studied is good, considering that the majority of native trees yield above 40%.

In most varieties the nut size tends to decrease in older trees (Arreola *et al.*, 2002). In Mexico for the year 2016, the states with the largest area planted were Chihuahua, Coahuila, Sonora and Durango, as can be seen in Table 1.

Table 1. Value of production by states nationwide, SIAP-SAGARPA 2016.

Federative entity	Area (ha)		Production (t)	Yield (t ha ⁻¹)	Average rural price (\$)	Valor (\$)
	Seeded	Harvested				
Chihuahua	70 587.5	49 903.7	91 987.7	1.84	71 667.90	6 592 568.00
Sonora	12 214.3	8 897.5	18 326.1	2.06	68 922.10	1 263 074.10
Coahuila	17 653.5	13 017.6	14 500	1.11	66 133.20	958 928.60
Durango	6 562.7	5 413.7	8 921.3	1.65	68 277.30	609 120.80
Nuevo Leon	4 077.2	4 056.1	3 100.6	0.76	54 485.70	168 935.50
Media nacional	114 464.2	83 512.7	141 817.6	1.7	69 006.10	9 786 272.60

SIAP-SAGARPA (2017).

Because in these states it is where most of the pecan nut is produced in Mexico, the present study had as a general objective to conduct a study of the functioning of this productive system in the main representative areas of the crop and thereby detect the areas of opportunity or actions that must be carried out to strengthen the national nut producer sector both in the field of production and marketing, for which three zones were chosen: the Comarca Lagunera located in the states of Coahuila and Durango; the municipality of Jiménez, Chihuahua and that of Hermosillo, Sonora. Table 2 shows the area sown and harvested from pecans in the study areas, SIAP-SAGARPA (2017).

Table 2. Area planted in the areas under study, SIAP-SAGARPA 2016.

Study area	Area (ha)		Production (t)	Yield (t ha ⁻¹)	Average rural price (\$)	Valor (\$)
	Seeded	Harvested				
Comarca Lagunera	9 245.7	7 635.7	10 887.2	1.3	63 205.20	60 668.00
Hermosillo	7 239	6 175	14 202.5	2.3	70 055.00	994 956.20
Jimenez	11 235.1	8 840.5	17 662	2	72 976.70	1 288 910.20

SIAP-SAGARPA (2017).

It is noted that the Comarca Lagunera, although it has a larger surface area than Hermosillo Sonora, has lower total production due to the lower yield per hectare. Likewise, a lower rural price is observed for this area, probably due to the lower nut quality. Jiménez Chihuahua has the highest production potential, since the potentially harvested area is high.

Materials and methods

To characterize the pecan nut production process, two surveys were designed, one to producers and the other to marketers-processors, which were applied in each of the three producing regions, the gathering of field information for the Comarca Lagunera it was carried out in the months of October to December 2014 and for Hermosillo, Sonora and Jiménez Chihuahua in the months of June, July and August of 2015, due to the availability of time, economic and personal resources for it.

The second survey consisted of questions that served as an interview guide applied to these companies, the first section gathered information number of years of operation; the main business and headquarters of the same, sources of nut supply and destinations of fresh and processed product, annual volumes handled, types of product made with the nut, markets, prices and volumes sold, sources of financing and support needs for Strengthen your competitiveness. From the information obtained, the corresponding section was described. In the Comarca Lagunera two companies were interviewed; in Hermosillo, two and in Jiménez five. It should be noted that the total population of companies by region is unknown.

In order to determine the number of producers to be surveyed in each of the regions, the register of producers that manage local plant health boards, dependent on SAGARPA in each region, was used, where once the sample was obtained, the sample size was calculated, using the following simple random sampling formula (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= precision of the estimate or the distance that you want the estimator to move away from the parameter (population proportion), 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 population, known or estimated from previous studies. t= value of the tables of t; α = significance level of α , the most common is to set $\alpha= 0.05$

For the calculation of the variance (S^2) it was established in 13.022, obtained from data from a previous sampling in which the sale price of the nut was taken as a reference. The degree of confidence used was equal to five percent. The survey applied to producers included 23 questions, the analysis and processing of the surveys was done with the Microsoft Excel program. The sample size for each region is shown in Table 3.

Table 3. Sample size of producers surveyed by study region, 2014.

Region	No. of producers	Sample size	Questionnaires applied
Comarca Lagunera	396	24	27
Hermosillo, Sonora	86	7	9
Jiménez Chihuahua	121	9	12

The weighted price of the kilogram of pecan nut, was obtained by multiplying the value in pesos per kilogram of walnut by the percentage of each form of marketing adding up all the ways of marketing the nut that the producer had, since there are producers who sell in different percentages and at different prices your harvest.

Results and discussion

The first difference found in the study regions refers to the surface of the orchards, according to the register of producers, the average size for the Comarca Lagunera, Hermosillo Sonora and Jiménez Chihuahua is 8.7, 215.8, and 50.4, ha, respectively. Another difference refers to the type of irrigation used in its cultivation. In Comarca Lagunera 92% of the orchards irrigate with water from the dam, in Jiménez, Chihuahua this type of irrigation is 15% and in Hermosillo, Sonora is irrigated only with water pumped from the subsoil.

The previous situation puts producers who have water at an advantage when the crop requires it (those of Hermosillo, Sonora); not so, those that depend on the water provision in the dams and the tanning that governs the irrigation in their area (Comarca Lagunera and Jiménez Chihuahua). Regarding the two varieties used in their orchards, one to pollinate and the other to be pollinated, it is observed that while in the Comarca Lagunera and Jiménez Chihuahua region the proportion of Western walnuts is greater (65.7 and 80.8% respectively), in Hermosillo, Sonora is smaller (24.7%), using the Wichita pollinator in the first zone and in Hermosillo, the Western.

Regarding yields obtained per unit area, the producers of the Comarca Lagunera registered the lowest (1.4 t ha⁻¹), while those of Jiménez, Chihuahua and Hermosillo, Sonora registered 1.7 and 2.7 t ha⁻¹) which can be attributed to the less frequent availability in the irrigation carried out as well as the less technical attention that the orchards receive, since they are producers with smaller surfaces than those managed in Jiménez and Hermosillo.

The age of the orchards is similar in the three zones (27 years on average). Orona *et al.* (2013) indicate that in the north of Coahuila the average age of commercial orchards established with varieties other than Western and Wichita is 21 years, same that registered a yield of 1.4 t ha⁻¹, indicating that technical advice helps improve Walnut productivity. Regarding the level of equipment for harvest and post-harvest, the Hermosillo region, Sonora, is the most equipped, as can be seen in Table 4.

Table 4. Percentage of producers that have equipment and infrastructure, 2015.

Region	Vibrator	Warehouse	Warehouse Improvised	Warehouse with refrigeration	Breaker
Hermosillo	100	66	33	22	0
Jiménez	75	60	33	25	17
C. Lagunera	20	20	24	0	0
Region	Sorter	Baler	Husk Remover	Dryer	Cleaner
Hermosillo	66	90	10	90	66
Jiménez	50	25	15	25	60
C. Lagunera	12	0	0	0	6

Therefore, the lack of infrastructure is a point that needs to be addressed for the production of the nut, especially in the Lagunera Region. It should be noted that, in the Hermosillo region, Sonora the use of the nut dryer is a necessity, as it is a humid area located on the Pacific Coast, where defoliants are also used to harvest the nut, which increases costs of producer production.

The Hermosillo region has the lowest incidence of pests, followed by Jiménez Chihuahua and with more incidents and variety of these, the Comarca Lagunera. To reduce the problem of the husk borer (*Cydia cariana*) and nut borer (*Acrobasis nuxvorella*), in the state of Sonora there are actions that regulate the mobilization of vegetative material to the state, which prevents the introduction of these borers and other pests from various nut-producing regions. In the other two study regions, different species of *Chrysopa* and *Trichogramma* are released for the biological control of these borers.

The greater presence of pests in the Comarca is attributed to the less attention and technical assistance that the crop receives from the small producers that predominate in the area. The pests found here coincide with those reported by Nava and Ramírez (2002); Tarango (2005); Aguilar (2007). In the last three years Ávila-Rodríguez *et al.* (2015), found infestations and damages to the walnut foliage by a micro lepidoptera of the *Coptodisca* genus. Technical advice on the management of orchards is another marked difference.

Thus, while in the Hermosillo region, Sonora all producers receive technical assistance; in Jimenez, Chihuahua receives 66% and in the Comarca Lagunera, only 51%. Regarding being affiliated with some producer organization, it is observed that while in Sonora nine out of ten producers are; in Jiménez Chihuahua there are six out of ten and in Comarca Lagunera only 1.5 out of ten belong to an organization. The previous situation explains why the producers in the three regions studied have different levels of access to financial sources and technical assistance, being the organization of these which favors obtaining greater support.

Regarding ways to market the nut, in Hermosillo, Sonora is done in two ways: in bulk selected by size and selected packaged for sale to wholesalers; in Jiménez Chihuahua, apart from the aforementioned forms, it is selected, packaged and sold to wholesalers, and in the Comarca Lagunera, in addition to the forms marketed in Jiménez, Chihuahua, it is marketed husked and as standing gardens, this last form of nut sale It is done by producers who lack economic resources for the management of their crop, making it more practical to sell their garden before investing in it a resource that they do not have, thus ensuring a minimum income.

In receiving financing to produce it was found that the largest proportion of producers that receive it are those of Hermosillo, Sonora (55.5%). It is worth mentioning that in this region there are producers who do not receive it because they do not require it, their financial capacity is solved, while in Jiménez, Chihuahua and Comarca Lagunera this proportion is 25%.

The weighted price received by walnut producers in the Comarca Lagunera, Hermosillo, Sonora and Jiménez Region was 40.36, 73.1 and 61.03 pesos per kilogram, observing that these prices are lower for producers with smaller areas, which can be attributed to less bargaining power for the volumes sold, the quality of the nut sold or the type of buyer that is destined.

Marketers and nut processors in the study regions

Comarca Lagunera

In this area two companies were interviewed; the first has four years' operating in the region and the second twelve. The municipalities where the first one operates are those of San Pedro de las Colonias, Coahuila, Nazas and Peñón Blanco, Durango, based in Torreón, Coahuila. Purchase nuts in fillet presentation directly from producers for further processing and marketing in a bagged manner under different presentations and weight; natural walnut heart, praline nut heart, chocolate nut heart, pecan chocolate bites, pecan white chocolate bites, pecan bitter chocolate bites, roasted walnut heart with salt, etc., as well as nut used for pastry in halves, pieces and granillo and mainly serves the national market.

It is a modern company that widely uses the internet for marketing. Reports low marketed volumes (one hundred tons currently). It has delivery vehicles, cold rooms, baler, sorter, processing and processing equipment and self-financing. The second company is based in Parras de la Fuente Coahuila, located 120 kilometers from the Comarca Lagunera. It has purchases and sales via internet located in several cities of the Mexican Republic (Nuevo León, Veracruz, State of Mexico).

The volumes handled add up to two hundred tons per year, same that husks and transforms for distribution and sale along with other dehydrated fruits. He has been operating for eight years and the presentations in which he markets his nut is in hearts, pieces, granillo and nut powder for pastries. The market it serves is national and is managed with its own resources, although it has received support from the Shared Risk Trust (FIRCO, by its acronym in Spanish) and the Ministry of Agriculture, Livestock, Fisheries and Food (SAGARPA, by its acronym in Spanish).

Hermosillo, Sonora

Here, the two commercializing-processing companies of pecan nut interviewed were two. The first has eight years' operating there and the second eleven, both of Mexican capital. The second is a mainly marketing company. Born in the 1970s in El Sauz Chihuahua in 2012 began exporting nuts in husk to the United States of America. In 2014, it changed its headquarters to Torreon Coahuila (Comarca Lagunera), where it processes walnut (walnut halves, large piece, medium piece, small piece, granillos, granzon, nut powder and macadamia nut, and is supplied with nuts from Sonora, the Comarca Lagunera, Durango, Coahuila and Chihuahua. Its export markets are the United States of America (through six pecan companies) and China.

The commercialized-processed volumes of pecan nut fluctuate between 15 and 18 thousand tons of nut annually. They supply national market companies such as Bimbo, Sanborns, Nutri Select and El Alba; to six companies in the United States of America: Young Pecan, Harrel Nut Company, San Saba Pecan, The Green Valley Pecan, Navarro Pecan and Carter Pecan and two companies in China. It should be mentioned that in Hermosillo, Sonora there are producers directly integrated to the Chinese market by channeling the product through the Ports of Manzanillo, Colima and Guaymas, Sonora in 20-ton containers.

Chinese buyers contact the producer directly through buyers who come to the region to visit the orchards still standing, establish contacts with the producer and via telephone calls or via internet agree on the sale price. The transaction is made directly between the producer and the Chinese buyer.

Another of the companies interviewed is dedicated to the purchase and processing of all kinds of sweets and confectionery products, it is not specialized in nuts. Mainly to the praline of walnut, natural walnut, cellophane ball in different grammages. The volumes of walnut that its processes are channeled to the local market by stores that sell convenience products such as OXXO, Seven Eleven, among others.

Jiménez, Chihuahua

Five companies were identified, three of which have less than ten years operating in the region; mobilize volumes ranging between one thousand and five thousand tons per year with headquarters in Hermosillo Sonora, Delicias, Chihuahua and Cd. Juárez, Chihuahua, respectively. The first is sourced from walnut in Sonora and Chihuahua and the second from the main producing regions of Mexico. The third company is the smallest and youngest, has two years of operation and is the one that requires the most support and financing to move forward; unlike the other two, this one only buy, selects sells the nut to the big processing companies.

Of the other two companies identified, the first is a Mexican company that was born in 1982 in Delicias, Chihuahua, but also operates in the United States of America, processes all kinds of nuts, grapes, prunes and peanuts, the second was born in 1965 in the state of Oklahoma and has 32 years' operating in Mexico. Its main turn is the manufacture of rough equipment such as machinery for handling nuts, vibrators, cracks, cleaners, husking machines, sorting machines, mechanical harvesters, nut, pruning, husking, etc. and in addition it processes nuts of all kinds, including pecan.

The volumes processed annually by the first and second company range between seven thousand and nine thousand tons, respectively, the first is supplied by the local market, while the second, from all the producing regions of Mexico. They buy and export nuts in husk and without husk to the United States of America and the whole world, and they count on all the infrastructure of processing and transformation of the nut, besides mechanisms of distribution of their products. They are integrated companies from the production, commercialization, transformation and distribution of the pecan nut in Mexico and outside the country that have purchase and processing branches in the United States.

Marketing is done through social networks and its products are known throughout the world. They are self-financed companies with the ability to lend to nut producers and marketers who work for them.

Conclusions

In the characterization of the production system, similarities are found in the three regions regarding the age of the garden, although the Jiménez Chihuahua region has more years as a pecan nut producing area; the predominant sown varieties in the three sites are Western and Wichita with more than 90% although in different proportions per site; regarding the average yields obtained,

these are higher in the Hermosillo Sonora region, followed by Jimenez Chihuahua and the lowest in the Comarca Lagunera, this situation of lower yields is explained by the lack of technical advice, lower producer organization and the lack of financing to produce.

Therefore, it is necessary to support the Comarca Lagunera more with producer organization, technical advice and financing. The ways of marketing the nut is greater in the Comarca Lagunera than in Jiménez, Chihuahua and Hermosillo, Sonora; in the latter region there are only two ways to market: in bulk selected by size and selected packaged for sale to wholesalers. The higher weighted price of walnuts received by Hermosillo producers is due to the way in which they market their product and the final market that their product has; in this case China, since the other two regions commercialize in greater proportion with marketers from the United States, who finally supplies the European and Eastern markets.

The presence and operation of marketing companies-processors in the Jiménez region of Chihuahua is greater and it was the state of Chihuahua where the first companies of this type were born, later extending to the rest of the country. The growing birth and proliferation of commercialization - processing companies are due to the growing market of pecan nuts in the world, identifying family-type companies that take advantage of these areas of opportunity.

The destiny of the pecan nut from the Hermosillo, Sonora and Chihuahua region towards the Chinese market represents a new business opportunity in Mexico and opens up the possibility of new markets. This situation favors Mexican producers, whose nut is sold directly to the Chinese market without triangulation by US marketers.

To reduce productivity gaps between larger and smaller orchards and between regions, it is important to support the weakest link, represented by small producers, with the implementation of: financing programs to produce and market, technical advice especially in the area of pests and diseases and training in the management of the garden, especially in irrigation management; and strengthen the infrastructure of the orchards for a better management of the nut and to be able to sell with greater added value.

In the comparison between regions if you want to match Sonora, it is necessary to improve especially in the aspects of organization, training and availability of financing, aspects in which it far exceeds the other two regions studied.

Cited literature

Aguilar, P. H. 2007. Principales plagas del nogal en el estado de Coahuila. Sitio Experimental Zaragoza-CIRNE-INIFAP. Campo Experimental Saltillo. Zaragoza, Coahuila, México. Folleto técnico núm. 14. 8-18 pp.

Arreola Ávila, J. G.; Lagarda Murrieta, A.; Medina Morales, M. D. 2002. Tecnología de producción en Nogal Pecanero. Primera edición. INIFAP. Campo Experimental La Laguna, Matamoros, Coahuila. Libro técnico núm. 3. 222 p.

Ávila-Rodríguez, V.; Nava-Camberos, U.; Reyes-Carrillo, J. L.; de la Peña, C. G.; Márquez-Hernández, C. y García-Hernández, J. L. 2015. Primer reporte de Coptodisca lucifluella1 en huertos de nogal, Carya en México. Southwestern Entomol. 40(2):419-426.

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-INIFAP. Matamoros, Coahuila.

Comité Mexicana del Sistema Producto Nuez, AC. (2017). Estudio de mercado estratégico de la nuez pecanera. Disponible en <http://www.comenuez.com/assets/estudio-estrategico-nuez-pecanera-v11.pdf>. 112 p.

Del Toro, M. J. A. 2013. Fondo Sectorial de Investigación en materia Agrícola, Pecuaria, Acuacultura, Agrobiotecnología y Recursos Fitogenéticos. Control integrado de plagas y enfermedades y uso eficiente del agua de riego en el cultivo de nogal pecanero. 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. Rev. Mex. Agron. 13(24):758-773.

Fuller, Wayne. A. 2009. Samplig Statistics, 1st. Edition. Ed. John Wiley and Sons, Inc. 456 p.

García-Hernández, J. L.; Orona-Castillo, I.; González-Cervantes, G.; Valdez-Cepeda, R. D.; Murillo-Amador, B.; Troyo-Diéguez, E.; Fortis-Hernández, M. y Segura-Castruita, M. A. 2009. Interacciones nutrimentales y normas de diagnóstico de nutrimento compuesto en nogal pecanero (*Carya illinoensis*). Rev. Chapingo Ser. Hortic. 15(2):141-147.

Gauke, L. J.; Mendoza-Herrera, M. A.; Miller, A. J. & Wood, B. W. (2011). Geographic patterns of genetic variation in native pecans. Tree Genetics and Genomes. 7(5):917-932.

Graham, C. J. 2013. I International Symposium on Pecan and Other Carya in Indigenous and Managed Systems. In Native Pecan Germoplasm in Louisiana. 133-136 pp.

Gray, O. S. 1973. Consider pollen when planting. The Pecan quarterly. 7(3):24-25.

Herrera, E. A. 1995. Pecan growing in the Western United States. Hort Technol. 3(5):3-4. <http://horttech.ashpublications.org/content/5/3/200.short>.

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.

Nava, C. U. y Ramírez, D. M. 2002. Manejo integrado de plagas de nogal, In J. G. Arreola A. y I. Reyes J. [Eds.] Tecnología de Producción en Nogal Pecanero. Libro técnico núm. 3. Campo Experimental La Laguna-CIRNOC-INIFAP, Matamoros, Coahuila, México. 145-176. pp.

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.

Ramonet, R. R. 2017. Programa de protección fitosanitaria del nogal pecanero en Sonora. In: Memorias del Simposio Internacional de Nogal Pecanero. INIFAP. Primera edición. Hermosillo Sonora. 98 p.

Román, R. L.; Díaz, V. T.; López, A. J. E.; Watts, C.; Cruz, B. F.; Rodríguez, C. J. y Rodríguez, J. C. 2017. Evapotranspiración del cultivo de sandía (*Citrullus lanatus*) en la Costa de Hermosillo, Sonora, México. Terra Latinoam. 35(1):41-49.

SENASICA. 2009. Programa de trabajo de la campaña Manejo fitosanitario del nogal Durango. Servicio de Información Agroalimentaria y Pesquera- ecretaria de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación.

SHCP. 2014. Secretaría de Hacienda y Crédito Público. Panorama de la nuez. Financiera Nacional de Desarrollo Agropecuario, Rural, Forestal y Pesquero. 128 p.

SIAP-SAGARPA. 2016. Servicio de Información Agroalimentaria y Pesquera-Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. Informe del sistema producto nuez. 187 p.

SIAP-SAGARPA. 2017. Servicio de Información Agroalimentaria y Pesquera-Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. 46 p.

Suárez, J. A.; Obregón, S. E.; Urzúa, E.; Cervantes, M. J.; García, F. J. A.; Reyes, V. N. del C. y Urrea, L. R. 2015. Retos y oportunidades para el aprovechamiento de la nuez pecanera en México. Primera edición. Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco, AC. (CIATEJ). 3 p.

Tarango, R. S. H. 2005. Nogal en agenda técnica agrícola de Chihuahua. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA). 2^{da}. Edición. México, DF. 85-93 pp.

Toole, E. R. 1965. Pecan (*Carya illinoensis*). In: Fowells, H. A. (Comp.). Silvics of forest trees of the United States. Agriculture Handbook 271, Washington, DC. 12-15 pp.

USDA. 2011. United States Department of Agriculture-National Agricultural Statistics Service (USDA-NASS). 2011. Annual Non citrus Fruits and Nuts Abstract. 1(2).

USDA. 2016. Department of Agriculture, Agricultural Research Service, N. D. L. 2016. National Nutrient Database for Standard Reference Release 28 p. <http://www.ars.usda.gov/bhnrc/ndl>.

Wagner, Vandrame; Hazel, W. 2005. *Carya illinoensis* Pecan. In: Litz, R. E. (Ed). Biotechnology of fruit and nut crops. CABI. 234-246 pp.