



Traditional knowledge on integrated pest and weed management in chayote (*Sechium edule* (Jacq.) Sw.) crops from localities of Chiapas, Mexico

Conocimiento tradicional sobre el manejo integrado de plagas y malezas en el cultivo del chayote (*Sechium edule* (Jacq.) Sw.) en localidades de Chiapas, México

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Abstract

This research was carried out in Villaflores and Villa Corzo, located in Chiapas State of Mexico. Specifically, throughout an ethno-agronomical approach, semi-structured interviews were designed and applied to the chayote producers who were selected by random routes. The results indicate the 57.89% of chayote producers in both municipalities, have allowed to control weeds in their crops, and being a higher proportion represented by Villaflores. Given these concerns, they prefer to control weeds throughout traditional methods, basically using mattocks with frequencies of 15 to 30 days after sowing or two to four times per cycle of crop production. Both pest and diseases are mainly controlled throughout chemical methods application. A preference to perform control among periods of higher rainfall or drought is not distinguished. A considerable percentage, which reaches 44% of the interviewed population among both municipalities, report they do not need to control pests and crop diseases.

Key words: Crop cycle, ethno- agronomy, low-income families, participative - plant breeding, rustic methods, traditional agricultural technology.

Resumen

La investigación se llevó a cabo en los municipios de Villaflores y Villa Corzo en el estado de Chiapas, a través de un enfoque etno-agronómico, se diseñaron y aplicaron entrevistas semiestructuradas a productores de chayote seleccionados por rutas aleatorias. Los resultados indican que el 57.89% de los productores de chayote de ambos municipios controlan las malezas en sus plantaciones, siendo mayor la proporción en Villaflores. Para controlar las malezas prefieren usar métodos culturales, fundamentalmente con la ayuda de coas o azadones y con frecuencias de 15 a 30 días después de la siembra o de dos a cuatro veces por ciclo de producción del cultivo. Las plagas y enfermedades se controlan mayoritariamente a través de métodos químicos, sobre todo en Villaflores durante la fase de fructificación. No se distingue una preferencia a realizar el control entre las épocas de mayores precipitaciones o durante la sequía. Un porcentaje considerable, que llega a alcanzar 44% del total de la población entrevistada entre ambos municipios, refieren que no necesitan controlar las plagas y enfermedades del cultivo.

Palabras clave: Ciclo del cultivo, etno-agronomía, familias de bajos ingresos, mejoramiento vegetal participativo, métodos rústicos, tecnología agrícola tradicional.

Introduction

Chayote crops in Chiapas, Mexico are mainly developed under traditional growing systems with the use of local resources (Guevara, Rodríguez, Rosales, Ortiz, Gómez, Aguilar & Pinto, 2014). Chayote is produced in Mexico, essentially in home gardens and has a great diversity especially at fruit level (Cruz & López, 2005).

The reported researches of this crop, focused primarily on genetic traits (Cadena, Avendaño, Soto, Ruiz, Aguirre & Arévalo, 2008; Cadena, Arévalo, Ruiz, Aguirre, Soto, Luna & Zavaleta, 2006; Cadena, Arévalo, Avendaño, Ruiz, Soto, Santiago, Acosta, Aguirre, Cisneros & Ochoa, 2007; Cadena, Soto, Torres, Aguiñiga, Ruiz, Rivera, Avendaño & Santiago, 2013), physiological aspects of water relations and gas exchange, *in vitro* micro-propagation (Abdelnour, Bermúdez, Alvarenga & Rivera (2006); Alvarenga, Abdelnour & Villalobos (2007) and more recently, participative plant breeding (Avendaño, Cadena, Arévalo, Cisneros, Morales & Ruiz, 2014).

The nutritional properties and its popularity among local consumers, make this crop a prime importance in the familiar economy. In fact, is native from Mesoamerica, where a greatest genetic diversity exist. Therefore, is important to note that is grown by rustic methods in many regions of the world, and is one of the most affordable vegetables for low-income families (Alvarenga, Abdelnour & Villalobos, 2007).

According to Cruz, Cervantes, Ramírez, Sánchez, Damían & Ramírez (2015), the ethno-agronomical studies in Mexico have allowed to establish antecedents in the proposal developed at the National School of Agriculture in the 70's of last century by Efraim Hernández Xolocotzi, who called it as follows: studies of the "Traditional Agricultural Technology" (TAT, "Tecnología Agrícola Tradicional", in Spanish) (Hernández, Campos, Avendaño, Enriquez & Villegas, 2014). This definition comes after the research and collection of germplasm conducted throughout Mexico, particularly is the continuation of the developed vision in ethnobotany studies, where Hernández had achieved a great number of research and as well the education of many people (Cruz, Ramírez, Collazo & Flores, 2014; Cruz *et al.*, 2015; Hernández *et al.*, 2014).

Local science is the set of knowledge, which consists of traditional knowledge and unique perceptions to a culture or a given society. Generally, derived from everyday observations and experimentation with ways of life, production systems and natural ecosystems (Montesinos, 1999).

Even when some basic research are recorded in growing chayote, local knowledge about its

management are rare. Even when some basic research are recorded in growing chayote, local knowledge about its management are scarce. Hernández *et al.* (2014), conducted a study about growing chayote locally known aspects aimed primarily related to marketing chayote in the region of Central Valleys of Oaxaca, Mexico. They showed that in this region, has a large traditional knowledge of chayote, production is in home gardens and is cultivated and marketed by women. The chayote fruit selection and classification is by size, color, texture, consistency and quantity of wool, respectively.

This paper is the continuation of an ethno-agronomical research carried out in rural areas of Villaflores and Frailesca Villa Corzo municipalities of Chiapas-Mexico, which is a region related to local chayote crop management (Guevara, Coutino, Ruiz, Gutiérrez, Martínez, Galdámez, Gutiérrez, Mendoza, Aguilar & Rodríguez, 2013; Guevara *et al.*, 2014; Guevara, Rodríguez, Gómez, Pinto, Rodríguez & Perezgrovas, 2015).

According to Guevara *et al.* (2015), chayote producers in the Frailesca region, selected seeds of fruit with thorns regardless of color or size, the tendency to use fertilizer, either chemical or organic, is emerging in both locations, being slightly greater the use of chemical fertilizers in Villaflores, where almost a third of those interviewed producers apply it in some occasion. In both municipalities, the proportion of farmers using organic fertilizers is low, represents only 11.5 and 18% in Villa Corzo and Villaflores, respectively. Irrigation management also follows a predetermined trend by technical criteria. However, 90% of respondents frequently irrigated chayote plantations and the rest only when, by visual criteria, consider the crop needs (Guevara *et al.*, 2014). Marketing is informally established either through intermediaries or in local markets (Guevara *et al.*, 2013).

The aim of this research is to document the ethno-agronomic criteria for chayote crop, which is related to the chayote producers in Villa Flores and Villa Corzo municipalities of Chiapas-Mexico for an integrated pest management (IPM) is properly established.

Material and methods

The research was carried out in Villaflores and Villa Corzo, Chiapas-Mexico, between June and October 2010. Both municipalities, are located in the VI Frailesca, Villaflores Economic Region, at the geographic coordinates 6° 14' 01" N and 93° 16' 00" W, and at an altitude of 551 m. a. s. l. Villa Corzo is located at 16° 11' 05" N and 93° 16' 03" W and 584 m. a. s. l. (Figure 1).

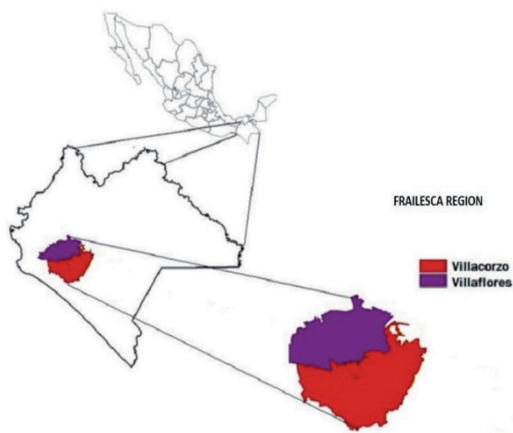


Figure 1. Location of the Villa Corzo and Villaflores municipalities in Chiapas, Mexico

Weather

In these municipalities, dominated warm and semiwarm climates groups, with abundant rainfall in summer. During the months of May to October, the average minimum temperature ranges from 12 to 21°C, predominantly from 18 to 21°C in 54.9% of the Frailesca region and 15 to 18°C in 37.8% of the territory. In the same period, the average maximum temperature ranges from 21 to 34.5°C, prevailing ranges of 30-33°C in 35.2% of the region, and from 27 to 30°C in 29.34% of the area. Rainfall in these months ranges among 1000 and 2600 mm. In the period from November to April, the average minimum temperature ranges from 9 to 15°C, with averages of 12 to 15°C in 92.96% of the region. The maximum ranges from 21-33°C, predominantly from 27-30°C in 49.3% of the region and 33°C in 27.2%.

Methods

The methodology used was based on ethno-graphic research, particularly the socio-anthropology based on the ethno-agronomic and ethno-botany to collect and systematize traditional knowledge and the most important aspects of the integrated pest management in chayote production system (Lira, Castrejón, Zamudio & Rojas, 1999).

From a tour of exploratory field, 60 producers was selected using random routes throughout the communities of both municipalities, to which was applied a semi-structured interview that generated information related to different indicators and variables that characterize the type selected integrated pest management system for chayote production at local level (Table 1).

Table 1. Indicators and variables in the analysis and interpretation of the local criteria for Integrated Pest Management (IPM) in the traditional production system of chayote in Villaflores and Villa Corzo municipalities, Chiapas-Mexico

Indicator	Variables	Codification
Weed control	Need to control	Control
		No control
		No need to control
	Type of weed control	Cultural control
		Chemical control
		Mixed control
Weed control frequency	Zero	
	By appreciation	
	2-4 times per productive cycle	
Integrated Pest and Disease Management	Need to control	Between 15 and 30 days after sowing
		Control
		No control
	Type of pest and disease to control	No need to control
		Chemical control
		Biological control
Chemical and alternative control		
Crop stages where need the most control	Biological and alternative control	
	No need to control	
	Zero	
	Inflorescence stage	
Crop stages where need the most control	Fructification stage	
	Rainfall season	
	Dry season	
	Permanently	
		At no stage (not affected)

Statistical analysis

To statistically analyze the data, the answers to survey questions were coded and then developed a database for statistically analyzed throughout the cross-tabulate test, following the criteria proposed by Cañadas, Batanero, Contreras & Arteaga (2011). The analysis was based on Chi-square test and contingency coefficient from an error probability ($p \leq 0.05$).

The results were based on the maximum number of producers that were identified during fieldwork, as a result of ethno-agricultural exploration, representing the target population for the analysis of results. It is represented in figures through proportions according to the criteria evaluated and according to the producers interviewed in each municipality (n) and relative to the total of both municipalities (N).

Results

Likely a result of the largest proportion of the producers of both municipalities trend to establish weed control, this traditional knowledge provides more accurate and reliable estimates of integrated pest management in chayote crops. For example, in Villa Corzo, this proportion reached 42.8% of respondent producers and compared to the total interviewed in both municipalities, 21% control weeds in their crops (Figure 2).

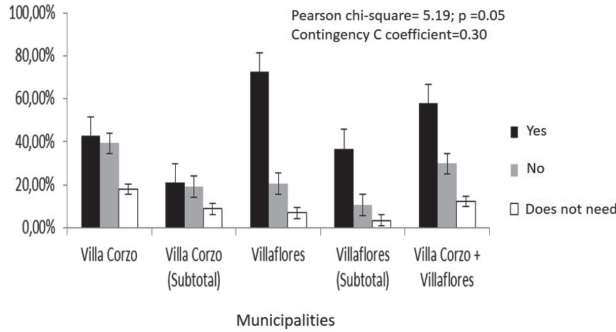


Figure 2. Chayote producers criteria of the Villaflores (n=29) and Villa Corzo (n=28) municipalities about weed control.

Figure 3, shows the type of weed and pest control which were the most predominated in both municipalities.

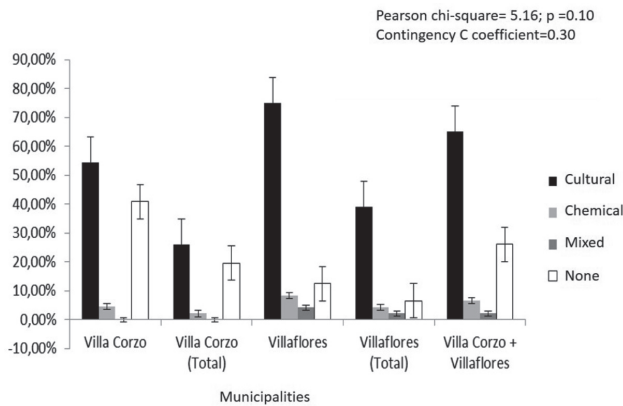


Figure 3. Types of weed control carried out by chayote producers from Villaflores (n=24) and Villa Corzo (n=22) municipalities.

The largest proportion of producers who perform such monitoring stood at Villaflores, which also 8.33 and 4.17% controls weeds through the chemical method or both by chemical methods in conjunction based on local knowledge. However, it is noteworthy that a relatively high proportion of producers does not control weeds (Figure 3), this trend being higher in Villa Corzo (40.91%) than in Villaflores (4.17%).

The frequency which producers establish weed control was statistically equal among municipalities (Figure 4). The highest percentage of respondent producers in Villa Corzo, they refer to control weeds two to four times per cycle of production between 15 and 30 days after planting. 10% make it by their own appreciation, without following any predetermined criterion.

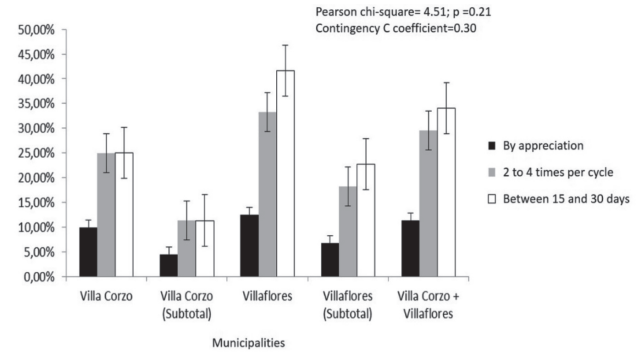


Figure 4. Frequency with which chayote producers establish weed control in Villaflores and Villa Corzo municipalities.

Pest and disease control

In Villa Corzo, 50% of interviewed farmers argue that currently, performs an increasing pest control for chayote crop and when it comes the total interviewed population in both municipalities, the proportion reaches a quarter of respondents chayote producers (Figure 4). In Villaflores, the proportion of chayote producers that establish control pests, both in relation to the sample location (67.8%) as compared to the total population (33.9%) is higher, without becoming a significant difference among municipalities; while the relative proportion to total population exceeds 28.6% of chayote producers who do not control pests (Figure 5).

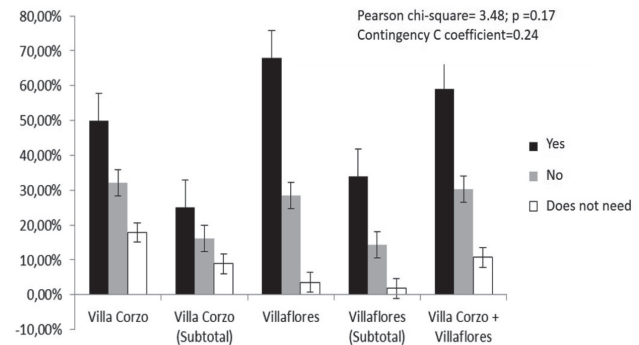


Figure 5. Criteria for chayote producers in Villaflores (n=29) and Villa Corzo (n=28) municipalities about pest control.

The largest proportion of producers who do not need to control pests chayote are located in the municipality of Villa Corzo (17.86%), much higher than the proportion calculated from the total interviewed among both municipalities. The lower proportions of producers who do not need to control crop pests are located in Villaflores with values of 3.6 and 1.8%, in both cases regarding municipal sample and the total, respectively (Figure 5).

In Villaflores municipality, predominate producers who use chemical to control chayote pest. The prevalence of this type of control as an option for pest management in Villaflores, provides more accurate and reliable estimates of relation to the total number of chayote producers interviewed in both municipalities, as well as for the total proportion of producers in both municipalities in relation to the total interviewed population (Figure 6). This difference related to Villa Corzo, answers may have greater access to providers agrochemicals with producers who live in the so-called capital of the Frailesca. Unlike Villa Corzo, where although it is true there is an incipient development of agrochemicals markets it is incomparable to that achieved in Villaflores.

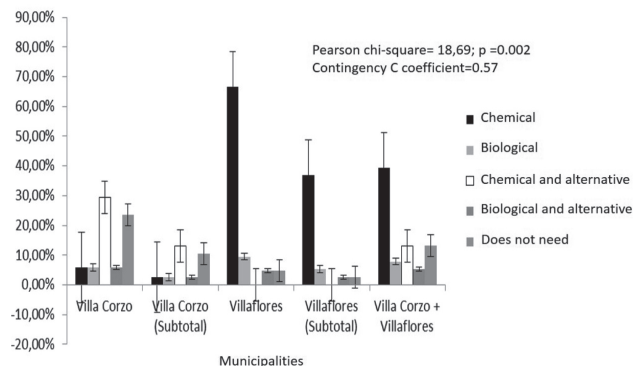


Figure 6. Type of integrated pest management at local level in Villaflores and Villa Corzo municipalities

Phenological phases of the chayote crop as well as the times of year when pest control for chayote cultivation is established, are relevant to the chayote producers in Villaflores and Villa Corzo, respectively. They differ from locality to locality and by stages and phases. Phenological phases in which mostly favor producers of Villa Corzo to control pests is flowering, slightly higher than those who prefer to control during the fructification stage (Figure 7), and significantly different from what is seen in Villaflores, where 39 % of producers prefer to control pests during the fructification stage against 11% who prefer to do when inflorescences are presented (Figure 7).

However, it appears that pests are not a serious problem for chayote producers, because the total population interviewed in both municipalities,

43.6% claims they need to control and only 5.13% continuously monitors crop pests. There is little information in the literature about the damage caused by pests and diseases in Chayote cultivation.

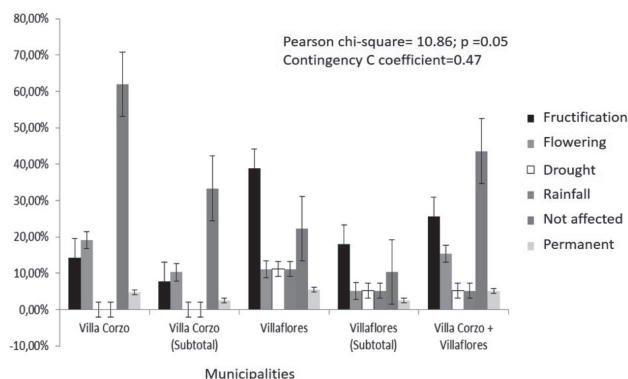


Figure 7. Phases and times of the year in which pest control is performed based on the proportion of interviewed producers in Villaflores and Villa Corzo municipalities.

Discussion

The largest proportion of producers established weed control in Villaflores location, with 72.41% of respondents in the municipality and 36.4% of both towns. Therefore, the total number of chayote producers in both municipalities, 57.89% performed this type of control and only 12.28% refers to not need to control (Figure 2).

From Figure 3, it can be argued that have allowed to confirm that farmers contribute from local knowledge to enrich the agro-ecological vision of integrated pest management in crops, as this from the point of view of Toledo (2005), also provides for the experiences of local chayote producers recognition and appreciation.

Alternatively, while relative to the total of producers interviewed in both municipalities, grouped Villa Corzo producers less frequently made control weed, as in any of the three frequencies the 10% of respondents were exceeded. By contrast, in Villaflores, 41.2% control weeds between 15 to 30 days after sowing, exceeding 33.3% of producers who establish two to four times per production cycle (Figure 4).

When interviewed population was analyzed, the highest percentage of chayote producers (34.09%) controls weeds at 15 and 30 days after planting, slightly higher compared to those who indicated that they performed two to four times per production cycle. Only 11.4% establish the integrated management throughout appreciation, which shows the chayote producers even under

a rustic and traditional system, reflect criteria defined on when and how often they need to control weeds, based on knowledge with a logic well established. In this regard, Mora (2008), states the traditional knowledge that farmers have about the natural environment and their production systems, enables them to perform better under adverse, environmental or market conditions, and achieve their production targets (Netting, 1993; Pimbert, 1994). Thus, the peasant that combine multiple strategies to ensure their income, usually based on their knowledge of their environment.

It is important to note that traditional researchers argue their decisions based on some limitations, especially in technological order. In order to obtain a greatest benefit or contribution to traditional scientific knowledge from this perspective, the researcher must change the inherited linear and one-dimensional vision of technical training on the one willing to reshuffle broadmindedness of their cognitive schema. Despite attempts to understand the complexity of farming systems, conventional approaches of agricultural sciences generally continue to benefit schemes linear and one-dimensional thinking. Given this, the breakdown of rigid thought patterns, under which agricultural scientists have formed, may start with different approach to the usual speeches in their professional practice (Figure 5). (Mora, 2008).

In rainy season, the fundamental affectations respond to fungal attack, whereas during the drought the main effects are caused by mites, whose involvement is increased after recent rainfall (Figure 7). As for the favorite time of year for producers of Villa Corzo and Villaflores, the obtained information does not correlates and cannot determine significantly differences in pest and disease control during the rainy or drought season (Figure 7). The proportions of chayote producers who claim to control pests and diseases during these months was zero in the case of Villa Corzo and barely exceeded 5% in Villaflores, even if it is assumed that rainy season is when increases the incidence of fungal diseases.

Conclusion

Weed control is part of management strategies for chayote producers in Villaflores and Villa Corzo, where it is best to choose for cultural control based on local knowledge in order to achieve a detriment chemical control or minimal use. This information is useful and facilitate a more precise integrated management program where they choose to either control weeds with frequencies ranging from two to four times per production

cycle up to 15 and 30 days after planting. Alternatively, for pest and disease control, chayote producers of Villaflores, prefer chemical control in front of cultural control during the fructification stage, compared with Villa Corzo producers, who believe that the latter do not need to control pests or diseases. In general, it is observed that the criteria are well defined in the integrated pest management and have allowed to respond to patterns which determine certain strategy based on their local knowledge.

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