Producers' cognitive perception of mite damage on papaya fruits †

[Percepción cognitiva de los productores sobre los daños por ácaros en frutos de papaya]

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SUMMARY

Background: Mexico is the third largest producer of papaya (*Carica papaya* L.) worldwide. *Tetranychus merganser* is an important pest mite that damages this crop. **Objective:** To identify producers' cognitive perceptions of the damage caused by *T. merganser* to commercial papaya orchards in the central area of Veracruz, Mexico. **Methodology:** A survey was conducted among 42 papaya producers, who completed a questionnaire to assess their perceptions of crop problems. Response variables were coded and weighted to set the following indicators: interpretation, recognition, impact on fruit quality, and management decisions. Subsequently, the relative weights of each indicator were determined to establish the perception index (PI). **Results:** The PI showed no relationship with the fruit quality indicator. However, a positive correlation was found with the indicators of interpretation, recognition, and management decisions. Papaya producers can identify mites and other pests affecting their crop, as well as the plant damage caused by *T. merganser*. This leads them to make management decisions based on the use of different acaricides. However, producers do not consider the relationship between mites and fruit quality. Although growers are aware of anthracnose damage, they did not perceive its management potential during flowering. **Implications:** Inadequate technical guidance may hinder the adoption of more effective and sustainable strategies. **Conclusions:** Growers perceive damage to papaya plants caused by *T. merganser*; however, they do not associate these effects with the fruit's loss of quality, which is penalized in marketing.

Key words: Acari; Tetranychidae; *Tetranychus merganser*; fruit quality; *Carica papaya*.

RESUMEN

Antecedentes: México es el tercer productor de papaya (*Carica papaya* L.). *Tetranychus merganser* es un ácaro-plaga que daña el cultivo. **Objetivo:** Identificar la percepción cognitiva de los productores sobre el daño ocasionado por *T. merganser* en los huertos comerciales de papayo de la zona central de Veracruz, México. **Metodología:** En una entrevista a 42 productores de papaya se aplicó un cuestionario para conocer cómo perciben los problemas del cultivo. Se codificaron y ponderaron las variables de respuesta para integrar los indicadores de interpretación, reconocimiento, efecto en la calidad del fruto y en las decisiones de manejo; posteriormente, se obtuvieron los pesos relativos de cada indicador para integrar el índice de percepción (IP). **Resultados:** El IP no mostró relación con el indicador de calidad del fruto; sin embargo, se encontró una correlación positiva con los indicadores de interpretación, reconocimiento y decisiones de manejo. Los productores de papayo pueden identificar los ácaros y otras plagas que afectan su cultivo,

† *Submitted March 9, 2026 – Accepted July 3, 2026.* http://doi.org/10.56369/tsaes.6894

ISSN: 1870-0462.
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así como los daños que ocasiona *T. merganser* en la planta, lo que los lleva a tomar decisiones de manejo basadas en el uso de diferentes acaricidas; sin embargo, no prestan atención a la relación entre los ácaros y la calidad del fruto. Aunque los productores conocen el daño causado por la antracnosis, no perciben su potencial de manejo durante la floración. **Implicaciones:** Una asesoría técnica inadecuada podría obstaculizar la adopción de estrategias más efectivas y sostenibles. **Conclusiones:** Los productores perciben el daño en la planta de papayo causado por *T. merganser*; sin embargo, no son capaces de asociar estos efectos con la pérdida de calidad de la fruta, lo que se penaliza en el mercado.
Palabras clave: Ácaros; Tetranychidae; *Tetranychus merganser*; calidad de fruto; *Carica papaya*.

INTRODUCTION

Papaya (*Carica papaya* L.) is an herbaceous tree with fruits that provide different nutritional benefits, including antioxidant vitamins (C, A, E, and folate), minerals (potassium, magnesium, and calcium), and fiber (Maurya *et al*., 2023). They also contain bioactive compounds such as carotenoids, flavonoids, and the enzyme papain, with antioxidant, anti-inflammatory, and digestive properties (Kumarasinghe *et al*., 2024). This fruit is produced in tropical and subtropical countries, lead by India, the Dominican Republic, Indonesia, Brazil, and Mexico. Approximately 14,654,817 t year^{-1} are produced worldwide, with the Americas accounting for 35% of global production. In Mexico, papaya production in 2024 was 1,142,854 t (FAOSTAT, 2026). In 2022, the country exported 203,170 t of papaya to 15 countries, accounting for 17% of its national production, with most of the exports directed to the United States (SADER, 2024).

Papaya producers face numerous challenges that limit yield and increase financial losses, including limited financing, losses during harvest and post-harvest handling, lack of marketing organization, changing weather patterns, insufficient training in crop management, and specifically, damages caused by pests and diseases (Kansiime *et al*., 2023; Atmaca *et al.,* 2024; Ramirez-Castañeda *et al.,* 2026). Ideally, control measures against a pest should be applied before its population density exceeds the level at which it causes economic damage, or economic injury level (EIL). Control measures must start at a lower density, defined as the economic threshold (ET), to prevent pests from reaching the EIL (Yang *et al.,* 2024). Both EIL and ET are difficult to estimate, as their values may vary with each crop, the pest's virulence, and treatment costs. Thus, producers rather use an action threshold (AT), based on their experience, and make subjective decisions when controlling the pests (Hoidal and Koch, 2021; Leach *et al*., 2025).

In papaya agroecosystems from Veracruz, Mexico, producers recognize mites as a primary cause of damage during plant development, resulting in reduced yield (Villanueva-Jimenez *et al*., 2025). Not only are leaves affected by mites, but also the quality of the fruit in its appearance (Abato-Zárate *et al*., 2018; Vargas-Madriz *et al*., 2025). In terms of food, "quality" is defined as the set of biological, physical, and chemical properties that meet sanitary, nutritional, and physical-mechanical requirements and achieve consumer satisfaction (Anis *et al*., 2022). The fruit's physical appearance is among the most important features used in its commercialization, so producers seek to satisfy consumer demand (Tarancón *et al*., 2021; Pons-Gómez *et al.,* 2023). In papaya fruits, grey spotting is recognized as damage caused by high populations of phytophagous mites; therefore, it is important to implement various control methods.

Producers' knowledge must be considered when proposing actions to ensure their implementation, and, in this case, to minimize economic losses in their agroecosystem. Very little research has examined the social dimensions of papaya producers' perceptions of mite damage and their control. Therefore, the purpose of the present study was to identify the cognitive perception of the producers of the damage caused by *T. merganser* in commercial orchards in the central zone of Veracruz, Mexico, through recognition of the pest, interpretation of pest problems, quality of papaya fruit, and pest management decision.

MATERIALS AND METHODS

To determine papaya producers' perceptions of the damage caused by the red mite, a sample of producers from the municipalities of the central region of Veracruz State was interviewed. The total number of papaya producers in the region was calculated with data obtained from the Dirección General del Servicio de Información Agroalimentaria y Pesquera (2024). The total cultivated area of 1949 ha was divided by the region's average orchard size per producer (4.6 ha), resulting in an estimated population of 423 producers.

Based on this population, a 10% sample (n = 42 producers) was selected for the survey (Table 1).

Table 1. Sample distribution of interviewed papaya producers in the central area of Veracruz, Mexico.

Municipality	Producers % (n)	Municipality	Producers % (n)
Cotaxtla	40.5 (17)	Alto Lucero	2.4 (1)
Tierra Blanca	14.3 (6)	Camarón de Tejeda	2.4 (1)
Puente Nacional	14.3 /6)	Tlalixcoyan	2.4 (1)
Paso de Ovejas	7.1 (3)	Pánuco	2.4 (1)
La Antigua	7.1 (3)	Soledad de Doblado	2.4 (1)

Specification of variables

Indicators for each variable (recognition, interpretation, pest management decisions, fruit quality indicators, and the perception index, PI) were weighted according to their relative importance, as identified in the literature and supported by the authors´ experience.

Perception is defined as a cognitive process that involves the recognition, interpretation, and assignment of meaning to stimuli, which together inform judgments about sensations derived from the physical and social environment (Salcedo *et al*. 2022). In the context of this study, perception of damage caused by *T. merganser* is defined as the process through which producers recognize and interpret damage symptoms and, based on this evaluation, make management decisions aimed at improving fruit quality.

Accordingly, perception is operationalized through four components: recognition, interpretation, pest management decision-making, and fruit quality.

Recognition is a process distinct from knowledge, consisting of identifying a person or object by matching a previously known idea. It also involves identifying an action, a person, or an object by its characteristics or properties (Betancur, 2018; Trinh, *et al*., 2022). In this context, it refers to the producer's ability to examine and identify papaya fruit characteristics to diagnose damage caused by mites or other factors, including insects, pathogens, or handling during harvest and transport.

Interpretation is the cognitive process through which individuals assign meaning to observed events (Díez, 2016). In this study, it refers to how producers explain and evaluate the causes and consequences of damage caused by pests, including spider mites, on papaya production and fruit quality.

Pest management decision-making is defined as the process of evaluating alternatives and selecting a course of action to address a specific problem (Farro e*t al.,* 2024). Here, it refers to the producer's selection of management practices based on their assessment of mite-induced damage in their orchard.

Fruit quality is defined as the degree to which a product satisfies market and consumer requirements (Petrescu *et al*., 2020). In this study, fruit quality refers to the physical and commercial attributes of papaya fruit that determine its acceptance in target markets.

Questionnaire Design

The questionnaire comprised five sections. The first section collected general information about the producer and their production systems (age, education level, cultivated area, municipality, variety, yield, and market destination). The following four sections covered the indicators of recognition, interpretation, management decision-making, and fruit quality (Table 2). Relative weights (RW) were assigned to each dimension based on their relevance and normalized to sum to unity, ensuring comparability across indicators.

An open-ended interview approach was employed to allow respondents to express their perceptions regarding crop management challenges, particularly those associated with pest damage. Additionally, a key informant was identified among respondents with detailed knowledge of commercialization processes in wholesale markets in Veracruz City and Mexico City.

Data Analysis

All variables were coded numerically prior to analysis. Indicators and variables were subsequently weighted to estimate their relative contribution following the procedure described by Zhou *et al.* (2024). Relative weights (RW) were calculated by multiplying the proportion of observations in each variable category by the weight assigned to its corresponding indicator, yielding a weighted contribution for each component.

Normalized indicator weights were then obtained so that they sum to unity (Table 2). The producers' perception index (PI) was calculated as the aggregate of the four component indicators: recognition, interpretation, pest management decision-making, and fruit quality.

Table 2. Operationalization of the producers' perception index.

Producers' Perception Index (integrated by the following indicators) and relative weight (RW)							
Recognition (of *T. merganser*) (0.35) *	RW	Interpretation (of pest problems) (0.1)	RW	Pest management decisions (0.35)	RW	Fruit quality (affected by mite damage) (0.20)	RW
Knowing the mite	0.50	Most important damages in papaya	0.40	Actions taken for mite management	0.10	Commercialization characteristics	0.25
Recognizing the period with greater presence	0.15	Main problems	0.15	Importance of controlling mite populations	0.05	Type of damage hindering commercialization	0.25
Recognizing the mite damages	0.35	Damage affects fruit quality	0.15	Products applied for mite control	0.20	Buyer requests a certain caliber	0.10
		Mite problems	0.10	Efficacy of products used	0.15	Fruit maturity stage	0.20
		Period with greater presence	0.15	Application frequency	0.15	Fruit consistency	0.20
		Damages lower the product price	0.05	Receives advice to apply them	0.10		
				Who advises them	0.10		
				Knows about other mite control tactics	0.15		

* Weighting of each indicator. Note: Relative weights (RW) were assigned to each dimension (recognition, interpretation, management decisions, and fruit quality) based on their relevance and normalized to sum to unity, ensuring comparability across indicators.

Descriptive statistics were computed using the normalized dataset. A Pearson correlation matrix was constructed to assess relationships among indicators and the PI. Subsequently, analysis of variance (ANOVA) was conducted on indicators that showed statistically significant associations with the PI.

To derive the categorized perception index (CATPI), PI values were classified into three levels (high, medium, and low) using heuristic criteria supported by graphical analysis (line plots). All analyses were performed using Statistica (StatSoft, 2020).

RESULTS AND DISCUSSION

In the interview of 42 papaya producers, most were mature to elderly, with 33% over 51 years old, 50% 41 to 50 years old, 10% 20 to 30 years old, and 7% 31 to 40 years old. This is consistent with reports by Coronado (2023), who mentions that the average age of producers in rural communities in Mexico is between 50 and 60 years. Also, most producers aged 50 and older have only an elementary school education.

Across the municipalities included in the study, the average cultivated area per producer was 3.55 ha (n = 42). In Cotaxtla, the average was higher, reaching 5.5 ha. This difference may be associated with the importance of papaya production in this municipality, as it has been one of the state's main producers.

Variables related to the producer and the agroecosystem (age, education, municipality, cultivated area, and yield) did not show a significant association with either the producers' perception index (PI) or its indicators ($p > 0.05$). However, variety did show a significant association with the PI ($p = 0.049$) (Table 3). This finding suggests that varietal differences may be associated with producers' perception of damage caused by *T. merganser*. Such differences could be associated with specific agronomic management requirements and market preferences linked to each variety (Treviño-Barbosa *et al.,* 2022), which may lead producers cultivating more susceptible or commercially demanding varieties to perceive crop damage as more severe, given its potential implications for yield and marketability. The lack of a relationship between the PI and variables related to the producer (age, education, municipality, cultivated area, and yield) may suggest a cultural effect, as producers belong to the same region (central Veracruz) and tend to follow similar management practices.

Table 3. Variables associated with the producers, the crop, and the producers' perception index. (p) = p-value

Producers and crop variables	Indicators				Producers' Perception Index (p)
	Recognition (p)	Interpretation (p)	Management decision (p)	Fruit quality (p)	
Age	0.2016	0.3074	0.6448	0.2159	0.6124
Schooling	0.4670	0.7081	0.7717	0.9031	0.8406
Municipality	0.9636	0.2408	0.4905	0.2768	0.5046
Variety	0.1037	0.4484	0.4563	0.1917	0.0490
Extent (ha)	0.5961	0.5099	0.3656	0.2270	0.8435
Yield (t ha^{-1})	0.3056	0.3482	0.2539	0.6628	0.5344

Almost all respondents sell their products in the domestic market, some supply the regional market, and only two reach the international market (Figure 1). According to the key informant, fruit is primarily commercialized at the Malibrán Market in Veracruz City and at the "Central de Abasto" in Mexico City. He indicated that in both markets, fruits are classified by quality (first, second, and third/fourth), based on physical characteristics such as size, appearance, and the presence of defects. He also noted that this classification determines the product´s price and commercial destination, with lower-quality fruits being directed to secondary markets or considered as losses. The quality of horticultural products is determined by pre- and post-harvest factors that influence their appearance, firmness, and the presence of defects, which in turn affect their commercial classification, shelf life, and market destination (De Wit *et al*., 2024).

In 2017, the largest planted area of papaya in Veracruz state was in the municipality of Cotaxtla, with 743 ha, followed by Tierra Blanca with 501 ha and Tlalixcoyan, with 450 ha (DGSIAP, 2020). However, when searching for papaya producers in these areas of the state, it was confirmed that the number of plots has been reduced. The respondents reported that several producers who previously grew papaya had switched to a more profitable crop, such as Persian lime, because it requires less care and investment than papaya.

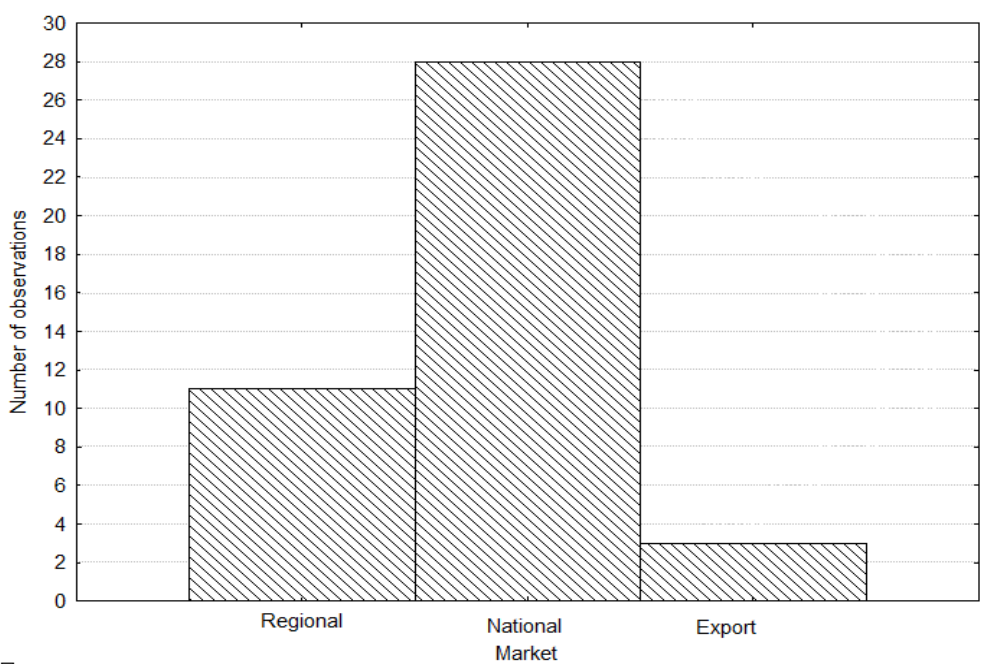

Figure 1. Commercialization of papaya in different markets by producers of the central area of Veracruz, Mexico.

Valencia *et al*. (2017) and Cisneros-Saguilán *et al*. (2023) reported that, despite the economic importance of papaya, producers face various challenges. These include financial constraints, the absence of technology and infrastructure, an inadequate marketing organization, and problems associated with climate change, viruses, and other pests. According to Granados *et al*. (2015), the costs of managing one hectare of papaya in Veracruz (including land preparation, acquiring improved seed, a large quantity of agrochemicals and application equipment, expenses for cultural work, and payments to agricultural laborers) were at least MXN$100,000 (≈ $5,714 USD). A few years earlier, Abato-Zárate *et al*. (2011) reported that producing papaya with a drip irrigation system required investing more than MXN$100,000 per hectare (≈ $5,714 USD) with a minimum of 2 ha. In turn, Zarrabal-Prieto *et al*. (2021) indicated that papaya production costs in the central region of Veracruz State range between MXN$83,000 and MXN$130,000 (≈ $4,743 USD to $7,429 USD). The substantial investment required for pest and disease control, fertilization, and land preparation explains these costs.

In 2024, papaya producers from Cotaxtla reported per-hectare production costs from MXN$150,000 to MXN$200,000 (≈ $8,571–11,429 USD, based on a constant exchange rate). This data was collected directly by the authors in the same year as the supplementary information, supporting its reliability.

The "red spider" mite, *Tetranychus merganser* Boudreaux (Acari: Tetranychidae), causes substantial damage to crop development and yield (Beristain-Moreno *et al*., 2025). In Cotaxtla, 96% respondents said they have seen mites in their crops, causing yellowing, deformation, and foliage drying, staining of meristematic tissue, and translucent leaves (Villanueva-Jimenez *et al*., 2025); however, half of the producers (48%) consider mites as the second most important problem during crop development, since 98% use acaricides in excess (Abato-Zárate *et al*., 2018; Beristain *et al*., 2024).

Producers have a clear perception of the damage mites cause to their crops from observed symptoms. They mentioned yellowing and gray leaf spots as the most important damage caused by mites. Parmagnani *et al*. (2023) reported that tetranychid mites can produce foliar discoloration and leaf drop on their host plants, which is consistent with the damage stated by respondents.

However, producers do not associate their ability to identify the presence of the pest and damages caused by mites on the plant with their impact on fruit damage associated with marketing, i.e., they dissociate damages caused to the fruit by *T. merganser* with the rest of the productive management process regarding the presence of this mite. The positive correlation between perception and interpretation indicates that, because producers can identify the main problems affecting crop production, they can make decisions that improve yield and product quality. This finding is consistent with Xu and Kong (2024), who demonstrated that both risk perception and pest knowledge directly influence producers' management decisions. Moreover, these factors shape the use of input and significantly impact crop yields. All producers mentioned three main problems affecting their agroecosystems: mites, followed by virus diseases (papaya ringspot virus, PRSV-p), and anthracnose (*Colletotrichum gloeosporioides* [(Penz.) Penz. and Sacc.]) as the third.

In the central area of Veracruz State, 96% of producers interviewed by Abato-Zárate *et al*. (2011) indicated that their crops were infested with mites, although they considered them to be the second most important problem during crop management. Alfaro-Valle *et al*. (2022) identified *Tetranychus merganser* as an emerging pest of significance in papaya production in Mexico, highlighting its presence in commercial orchards and its potential impact during crop development. Thus, mites constitute a recurrent phytosanitary problem in papaya production systems.

A significant correlation (Figure 2) between the producer's cognitive perception and the management decision ($r^2 = 0.5242$; $p < 0.000001$), as well as with the interpretation ($r^2 = 0.1820$; $p < 0.0048$) and the recognition ($r^2 = 0.4252$; $p < 0.000001$), but not with fruit quality ($r^2 = 0.0618$; $p < 0.1123$) was found. Furthermore, no statistically significant differences were observed among the perception indicators (recognition, interpretation, management decision, and fruit quality).

The relationship between perception and management decisions is mediated by recognition of the pest and the damage it may cause. Producers perceive these organisms as a serious problem in papaya production and therefore implement control measures, they consider necessary for proper crop management. The above is consistent with findings reported by Legwaila *et al.* (2022) who identified a similar pattern among tomato producers, in which management decisions are based on the perceived presence of mites and the damage they cause to crops. Milne *et al*. (2018) found a similar pattern among citrus producers during Huanglongbing management, in which decision-making perception depends, among other factors, on ensuring the pest is present, as well as on observations made.

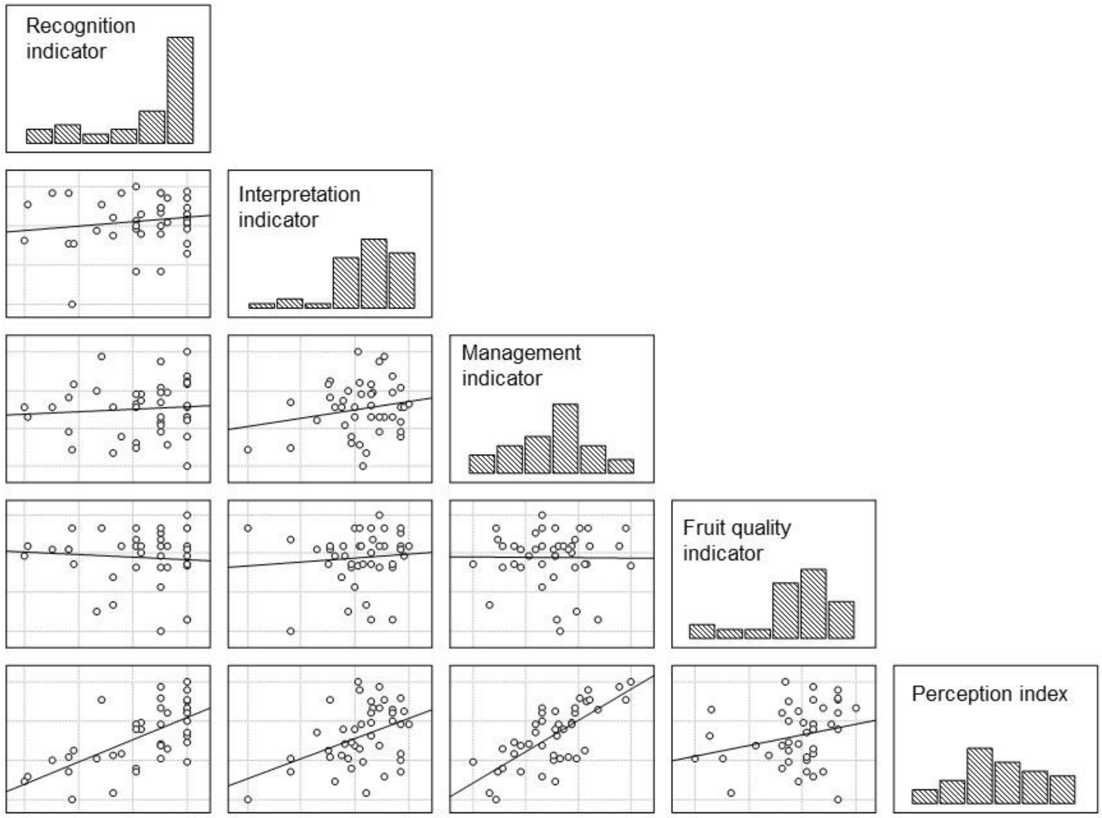

Figure 2. Correlation matrix of the perception index with fruit quality indicators, management decisions, interpretation, and recognition.

Because mites are a major problem, producers use specific acaricides such as abamectin, which is registered for the control of papaya mites and allows them to reduce population levels in their plots. They also use spiromesifen, a product introduced to the global market in 2009 and subsequently registered in some countries, such as Colombia, for the control of papaya mites; however, it is not registered for this specific use in Mexico. In addition, some producers still report the use of dicofol, a miticide that was widely used in the past. According to the official Mexican pesticide registry (COFEPRIS), dicofol is currently classified as having restricted or revoked status, with no authorization for use in general agricultural fields. This classification reflects the regulatory phase-out of dicofol in Mexico, in accordance with international agreements on persistent organic pollutants **(**COFEPRIS, 2025**).**

The utilization of these products, notably spiromesifen and dicofol, which do not conform to current regulatory standards, indicates a disparity between official recommendations and actual field practices. This situation may help reveals a disconnect between producers' perceptions of mite damage and fruit quality. Chemical control appears to concentrate primarily on mitigating the visible presence of the pest, rather than considering the broader implications for postharvest and commercial fruit quality.

Abato-Zárate *et al*. (2012) indicated that both abamectin and dicofol were effective against mites in papaya. However, producers must have a clear understanding of the agrochemicals they apply to their crops, as this is essential for effective pest control and for the prevention of the development of resistance to these molecules (İnak and Yorulmaz, 2022). Although most respondents reported receiving consulting services, they expressed interest in additional information on other pests affecting the crop and on proper control strategies that do not negatively affect production. Also, the indiscriminate use of agrochemicals raises concern among some producers who export their fruit, as their products may be rejected if they contain high residue concentrations.

Possibly, the producer's perception of recognizing pests and their damage allows them to identify the required actions to manage those pests. The latter might be why the fruit quality indicator did not show differences between the PI and the other indicators, since fruits in general meet the quality requirements for marketing. According to producers, the main defects that negatively affect or prevent the sale of papaya fruit are deformation (carpellody), anthracnose, and fruit skin damage (scratches and spots). Other studies on postharvest diseases in papaya have documented that anthracnose, along with other physiological disorders and superficial injuries, reduces fruit quality and limits its acceptability in consumer and export markets (Tan *et al*., 2022).

Producers also reported that anthracnose can cause substantial losses in papaya yield and commercial value, requiring multiple applications in the field and a treatment during postharvest. Because anthracnose appears after harvest, some producers do not consider this a significant problem in the orchard, even though it should be controlled when the fruit is still in the pre-climacteric phase (Maringgal *et al*., 2019); it affects the fruit's physical appearance, nutritional value, organoleptic characteristics, and postharvest shelf life, thereby limiting its marketability (Maringgal *et al*., 2019). Most respondents washed fruits in tubs with water and fungicides (mancozeb and tebuconazole) only during storage to prevent anthracnose and other fungal infections. During flowering and fruit development, these producers do not implement chemical or cultural management to prevent the disease. In this case, producers' knowledge of anthracnose management is incomplete, failing to perceive aspects of the microorganism's life cycle that could help them improve the efficiency of field management, since anthracnose can cause losses exceeding 50% of total production (Getnet *et al*., 2024).

The interpretation indicator (CATPI) differed significantly from the recognition and management decision indicators, but it did not show differences among the three perception categories (high, medium, and low) (Figure 3). Regarding pest recognition, the intermediate and high categories differed significantly from the low category, indicating that producers' perceptions differ when they recognize damage during periods of high mite presence than during other crop periods. The highest management decision category differed from the medium and lowest categories, with producers with a high perception of damage using more targeted chemical control. CATPI did not show differences across the three categories, indicating that producers perceive the main problems equally and assess the damage caused by different pathogens similarly.

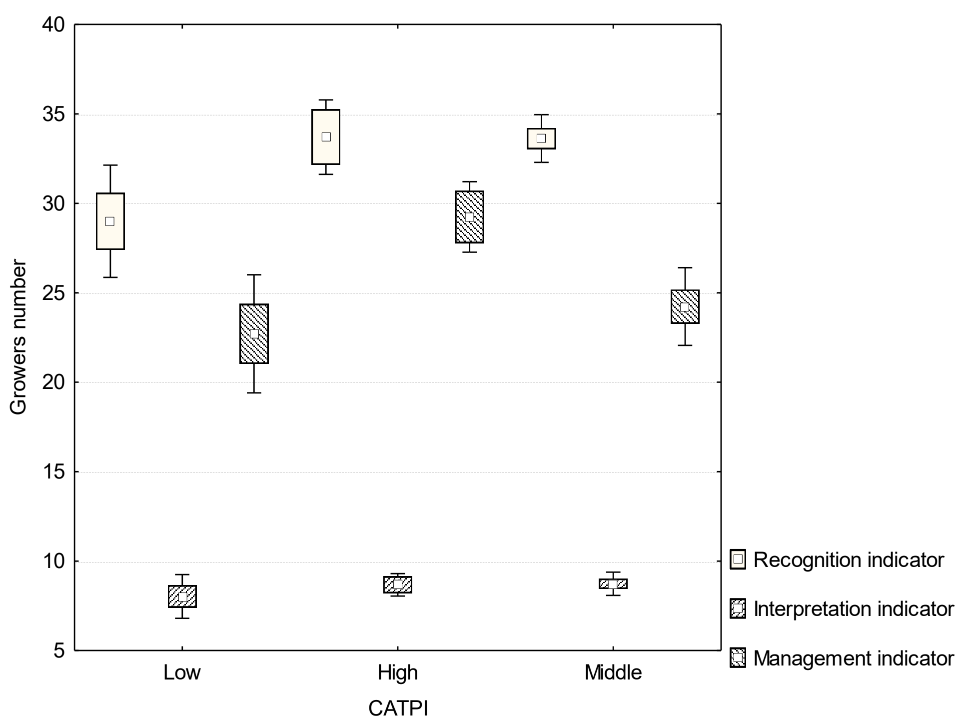

Figure 3. Categorization of perception index, in relation to the indicators with statistical differences. CATPI = Categorized perception index.

The recognition indicator showed a difference between the medium and high categories, compared to the low category. This might be associated with the need to inspect and analyze papaya fruit characteristics to diagnose potential damage. Such damage can be caused by various pest organisms, such as mites and insects, or by the way producers handle the fruit during harvest and transport. It also includes damage that can occur in the orchard from strong winds or exposure to sunlight.

The management decision indicator among producers in the high category, those using extensive chemical control, was significantly different from the other two categories, which lies in the ability of the first group to select more effectively those products recommended for mite control. Additionally, they are likely to use them at the most appropriate time and with greater effectiveness when advised by a technician. This led them to evaluate mite-induced crop damage based on their perception and, thus, to choose the type of operation that supports papaya production by reducing damage.

The main difficulties faced by papaya producers were high production costs and insufficient investment, leading to crop abandonment. Since perception is an incomplete cognitive process, it enables producers to recognize and interpret damage to papaya caused by detrimental agents and to decide on pest management strategies; however, it was dissociated from the product’s commercial quality in the case of damage caused by mites.

According to Constantine *et al*. (2023), producers’ knowledge, attitudes, and practices are decisive factors in decision-making, which directly influence crop management. In this regard, inadequate technical guidance may hinder the adoption of more effective and sustainable strategies.

The perceptions held by producers reflect their accumulated experience in crop management and provide valuable insights for shaping training programs and future research aimed at enhancing production systems. In this regard, small-scale producers with a basic education require practical, clear, and directly applicable training. Conversely, those with more extensive academic backgrounds may benefit from technical and strategic programs focused on optimization and scaling. Thus, these perceptions can be utilized to segment technical training according to the socioeconomic characteristics of the producers. This approach aligns with the findings of Constantine *et al*. (2023), who highlights that farmers’ knowledge, attitudes, and practices play crucial roles in agricultural decision-making.

CONCLUSIONS

Producers’ perceptions of papaya crop problems were associated with accurate pest identification and the most critical crop development period. They also identified the most important pest problems, with the *T. merganser* mite being the most notable. It allowed them to define the timing and type of management based on the presence or absence of mites, primarily by observing symptoms attributed to these mites. Although they “perceived” damage to papaya plants caused by *T. merganser*, they did not associate these effects with the fruit’s loss of quality, which is penalized in the market. However, for producers, the primary damage to fruit quality was caused by anthracnose; although they associated this fungus only with post-harvest problems, they did not “perceive” its management potential during the flowering phase.

Acknowledgements. Thanks to the producers who provided information for this research.

Funding. Thanks to CONACYT (now SECIHTI) for the scholarship provided to the first author.

Conflict of interest. The authors declare that they have no conflict of interest.

Compliance with ethical standards. Informed consent was obtained from all subjects involved in the study.

Author contribution statement (CRediT). **M.E. Beristain-Moreno** – Validation, methodology, investigation, data curation, writing original draft. **J.A. Villanueva-Jimenez** – Conceptualization, data curation, funding acquisition, methodology, project administration, supervision, writing-review & editing. **F. Osorio-Acosta** – Methodology, formal analysis, data curation, writing-review & editing, visualization. **G. Otero-Colina** – Writing - review & editing, conceptualization. **M. Abato-Zarate** – Writing - review & editing, conceptualization.

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