Colegio de Postgraduados

Producer practices, interests, and points of view regarding *Vanilla planifolia* Jacks ex Andrews wilt disease in a Totonac community

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ABSTRACT

Objective: To determine the socioeconomic profile of vanilla (*Vanilla planifolia* Jacks. ex Andrews) producers, their practices, interests, and points of view regarding vanilla wilt disease in the Dimas López community, Olintla, Puebla, Mexico.

Design/Methodology/Approach: A descriptive probabilistic study was conducted through semi-structured interviews with key vanilla producers (n=24). Data analysis was based on descriptive statistics.

Results: All producers were men, 70.8% were between 44 and 68 years old, 95.8% of them spoke Totonac as their native language, and 92% of them were farmers. Acahual was the predominant production system (84%). The maximum planting area was 0.25 ha. The species used as vanilla tutors were piñón (*Jatropha curcas*), pichoco (*Erythrina* sp.), and cocuitle (*Gliricidia sepium*). More than half of producers (62.5%) have found symptoms of wilting in their crops. Producers applied ash, calcium hydroxide, and sodium bicarbonate as a disease management practice. Producers are mainly interested in phytosanitation (58.3%), pollination (29.1%), plant nutrition (8.2%), and curing vanilla (4.1%).

Study Limitations/Implications: The results of this research are only applicable to the study area.

Findings/Conclusions: The Totonac vanilla producers in Dimas López are 44-82-years old. They use the acahual production system. Ash and lime are the main products used for the management of vanilla wilt. The main interest of vanilla producers is phytosanitation.

Keywords: *Vanilla planifolia*, sociodemographic profile, productive profiles, points of view.

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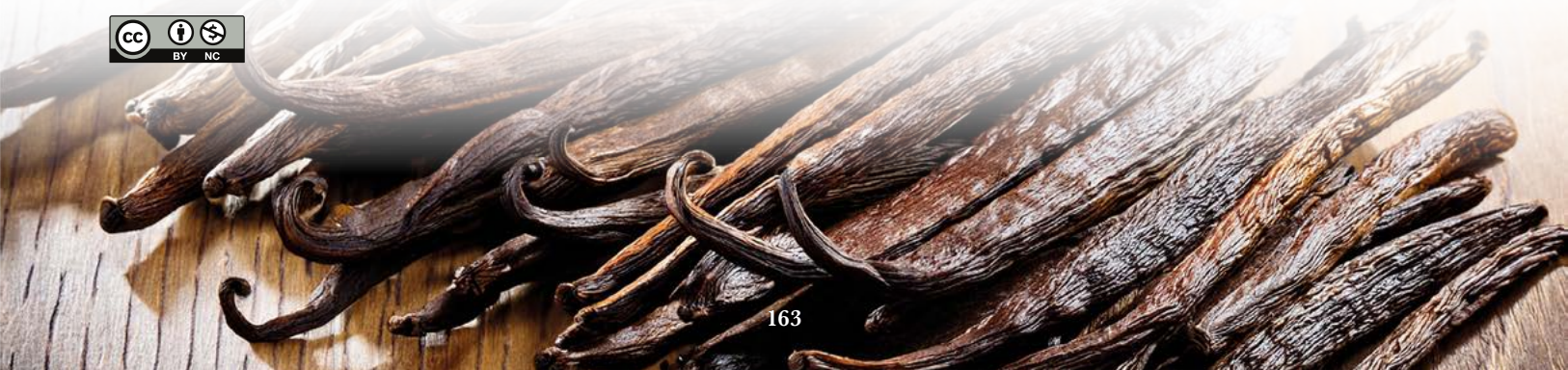
INTRODUCTION

The genus Vanilla comprises more than 110 species distributed in tropical or subtropical regions (Jiménez *et al.*, 2017). Due to its remarkable aromatic properties, the most commercially used species is *Vanilla planifolia* Jacks. ex Andrews (Orchidaceae) (Cervantes-Castillo *et al.*, 2019). Vanilla is native to Mexico and its main habitat is located in the Totonacapan region, which covers over 20 municipalities in the state of Veracruz and 19 in the state of Puebla. This region produces more than 80% of the total domestic vanilla production; therefore, the socioeconomic development of local producers is a major point to take into account (Rodríguez-Deméneghi *et al.*, 2023).



The vanilla grown in the Totonacapan region is widely recognized for its quality, which is the result of the aromatic compounds developed through a combination of natural factors and regional crop management practices (Santillan *et al.*, 2019). However, the vanilla domestic and regional sectors face significant productivity challenges, despite the good reputation of the product (Sánchez-Morales *et al.*, 2024). According to data from SIAP, vanilla production in the municipality of Olintla, Puebla only reached 0.96 t in 2023. This low productivity is mainly the consequence of the abandonment of this crop. The situation is made even worse by management challenges, such as the proliferation of diseases, particularly wilt. The *Fusarium oxysporum* f. sp. *vanillae* fungi causes wilt, rotting both roots and stem (Vargas-Valencia *et al.*, 2019; Kadir *et al.*, 2021).

The municipality of Olintla has specific weather and socioeconomic characteristics. It has a semi-hot sub-humid climate ((A)C(fm) type) with rain all year round (CONABIO, 2011). The area has slopes and low hills, crossed by streams and rivers. The predominant soil type is Lithosol, with a thin, stony, and calcareous texture. The land includes rainforests, agricultural areas, and grasslands, which impacts agricultural dynamics and development of agricultural activities, particularly vanilla cultivation (CONABIO, 2023).

This locality has abundant natural wealth and a diverse vegetation that includes trees, herbs, and shrubs. This agroforestry system is known as acahual and it is where vanilla is grown. Acahuals house both native and introduced species, which enhance the diversity and resilience of the ecosystem (Parada-Molina *et al.*, 2022).

Consequently, understanding the specific challenges faced by vanilla producers is fundamental to determine their priorities. Identifying local needs and practices can improve vanilla productivity and quality, as well as strengthen the resilience of producers to tackle current and future challenges in the sector (Reyes-Hernández *et al.*, 2022). A more prosperous future can be built for those involved in vanilla production, if they work together with local communities and other key participants. Therefore, the objective of this research was to determine the socioeconomic profile of the vanilla producers of the Dimas López community, Olintla, Puebla, as well as their practices, interests, and points of view regarding vanilla wilt disease.

MATERIALS AND METHODS

Study area

Figure 1 shows the study area. The research was conducted in the Dimas López community, municipality of Olintla, located at 516 m.a.s.l., in the Sierra Nororiental, state of Puebla, Mexico (INEGI, 2020).

Data collection

Field data were collected through semi-structured interviews with vanilla producers. The questions included three key aspects: a) sociodemographic profile; b) production profile; and c) points of view on vanilla wilt disease. These interviews analyzed both qualitative (sex, occupation, native language, and points of view and aspects of vanilla production) and quantitative variables (age, years of experience in vanilla cultivation, number of plants, and green vanilla production).

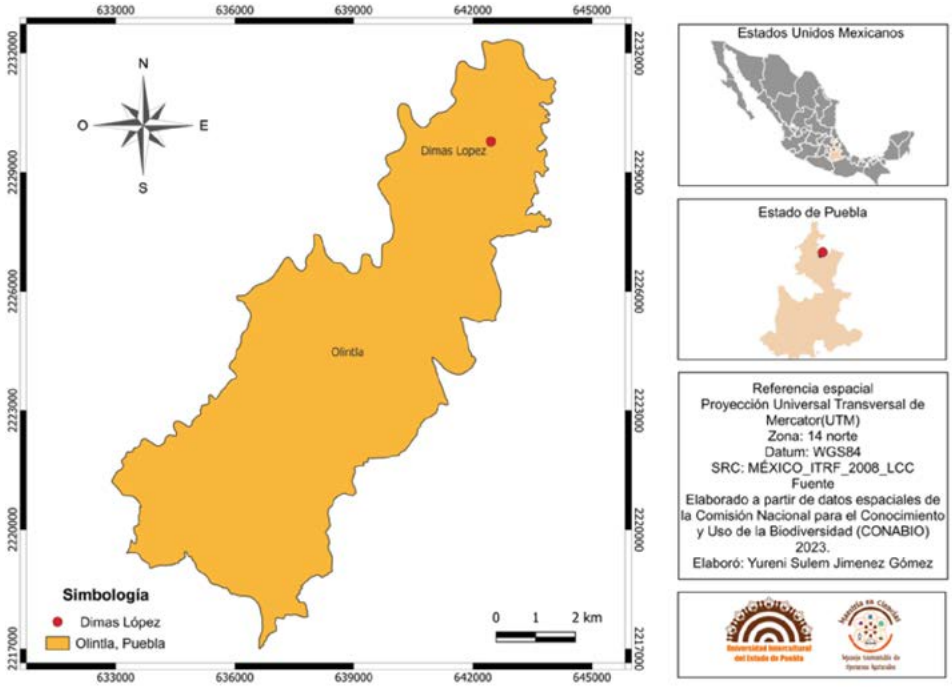


Figure 1. Geographic location of Dimas López, Olintla, Puebla.

In addition, the knowledge of the producer about the control of vanilla wilt, potential management alternatives, and other factors that could influence crop productivity and growth were established. Sixty-five producers participated in the sample (personal communication). However, only 35 out of this total were taken into account, due to their experience in vanilla cultivation (≥3 years). The following simple random sampling formula was applied (Castañeda-Guerrero *et al.*, 2020):

$$n = \frac{NZ^2_{\alpha/2}P_{nq_n}}{Nd^2 + Z^2_{\alpha/2}P_{nq_n}}$$

Where: N=population size (35 vanilla producers); $Z^2_{\alpha/2}$ =90% reliability; p=0.5; q=0.5; d=accuracy (0.1).

Therefore, n=24 semi-structured interviews were conducted as representative sample of vanilla producers from the Dimas López community. If required, the interviews were conducted in Totonac.

Data analysis

The collected data was organized in a database and analyzed using descriptive statistic methods. Both tables and graphs were used to visualize and better understand the patterns and trends found in the data.

RESULTS AND DISCUSSION

Sociodemographic profile

Table 1 shows the age of producers (44-82 years old). They were a diverse group, with different levels of experience and knowledge.

All interviewees were men, possibly reflecting the traditional role distribution in these communities. Totonac is the mother tongue of most of the participants (95.8%). Santiago-Hernández *et al.* (2023) also reported that a large part of the population in Olintla speaks Totonac. For its part, INEGI (2020) reported that 91.7% of the inhabitants of the municipality speak an indigenous language, either Totonac (99.6%) or Nahuatl (0.2%). Regarding their main occupation, 92% of interviewees were farmers, which highlights the importance of traditional agriculture in the community.

Productive profile

The plots used to grow vanilla were small (≤0.25 ha). Despite their size, these plots can be occupied by up to 200 vanilla plants (Table 2).

Although the area had ≤0.25 ha, plots can produce up to 20 kg of green vanilla. However, Rodríguez-López *et al.* (2024) reported that 40% of the producers from the Sierra Nororiental in the state of Puebla obtained up to 50 kg of green vanilla per production unit and production cycle, using traditional agriculture systems in <1,000 m^2 plots. This production results attests to the meticulous care and attention that producers pay to their

Table 1. Sociodemographic profile of vanilla producers in Dimas López, Olintla, Puebla.

Variable		Number	Value (%)
Sex	Man	24	100.0
	Woman	0	0
Age	44 to 56	9	37.5
	57 to 68	8	33.3
	69 to 80	6	25.0
	81 to 92	1	4.2
Occupation	Peasant	22	91.6
	Carpenter	1	4.2
	Muleteer	1	4.2
First language	Totonaco	23	95.8
	Spanish	1	4.2

Table 2. Productive profile of vanilla producers in Dimas López, Olintla, Puebla, Mexico.

Measure	Number of plants it has	Green vanilla production (kg)	Cultivation experience (year)
Maximum value	200	20	15
Minimum value	25	5	3
Mean	67	10	9.7

plants, as well as to the optimal environmental conditions that favor the growth and healthy development of vanilla.

Production systems

Acahual was the predominant (84%) production system. These results match the findings of Herrera-Cabrera *et al.* (2022), who also reported that *acahual* was the predominant system of the Totonacapan region. This system is characterized by intercropping with secondary vegetation, such as timber and fruit trees. Espinoza-Pérez *et al.* (2019) indicated that vanilla cultivation systems in areas with secondary vegetation achieve a greater balance between plant biodiversity and individual plant distribution, resulting in a better ecological balance.

Acahual is a suitable habitat for vanilla plants, since this agroforestry arrangement offers optimal conditions for their cultivation: an adequate level of shade (50-70%) and good ventilation favor a healthy plant development (Ibarra-Cantún *et al.*, 2018). However, 16% of production systems were plantations that used different tutor species, such as piñón (*Jatropha curcas*), pichoco (*Erythrina* sp.), and/or cocuitle (*Gliricidia sepium*). The diversity in production systems may reflect the adaptive strategies and lore applied to crop management. A remarkable example is *Erythrina* sp., which has a significant cultural value thanks to its multiple benefits: it is used in living fences, provides shade, enriches soil by providing organic matter to crops, and potentially restores degraded soils (Parra-Gil *et al.*, 2023). These findings suggest that agricultural practices have a regional coherence. Consequently, this phenomenon can potentially strengthen the importance of sustainability and productive efficiency.

Interests related to vanilla cultivation

Totonac farmers have a keen interest in various vanilla cultivation and production aspects. Their main interest was phytosanitation, which plays a key role, given the susceptibility of vanilla to diseases that damage very part of the plant, from the roots to the fruit (Figure 2).

Wilting and rotting are the most common diseases that impact vanilla production. Hernández-Martínez *et al.* (2020) have reported that pathogens such as *Fusarium* sp. are the main cause of vanilla diseases in the Huasteca Potosina region. This fungus penetrates the plants from the roots, causing the appearance of brown lesions (initial symptoms) in

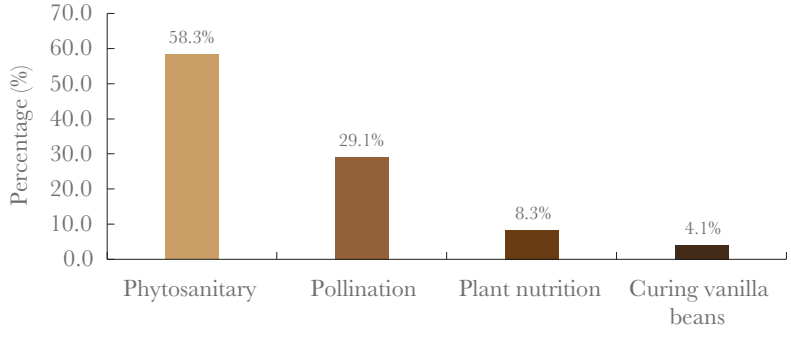


Figure 2. Interests of vanilla producers in Dimas López, Olintla, Puebla.

different parts of the plant. The initial lesions caused by the infection darken and dry the tissue, rotting the base of the stem and impacting the structure of the plant (Koyyappurath *et al.*, 2016). This process does not only weaken the plant, but also interrupts the nutrient and water flow, impacting its health and flowering capacity and, consequently, decreasing the quality and quantity of flowers (Flores-de la Rosa *et al.*, 2018). Pollination was another interest of producers, because the production of vanilla siliques (pods) depends on manual pollination. The rostellum in the flower acts as a barrier that prevents the pollen on the anther from reaching the stigma (Hernández-Apolinar, 2018). Producers invest time and effort in this delicate process, in order to guarantee the proper pod formation and to maintain high quality standards in the final harvest.

Producers were also interested in plant nutrition, since they understand the importance of providing their plants with the necessary nutrients for optimal development and abundant production. Incorporating organic matter into vanilla beds to enrich the soil with essential nutrients and increase its fertility is fundamental. Carrillo-González (2018) reported that organic fertilization is essential for vanilla production. Producers mainly use decomposing plant waste or compost to nourish their crops. However, no regulation currently exists for quality control or the optimal fertilization doses required for the appropriate development of vanilla plants.

Finally, producers were also interested in the curing vanilla. This term refers to the dehydration of the fruit, which also modifies its microstructure and activates enzymatic reactions that induce the characteristic aromas and flavors of vanilla. β-glucosidase is one of the most significant enzymes involved in this process (Vargas-Hernández *et al.*, 2021). Undoubtedly, curing vanilla (drying and dehydration) is fundamental in the production chain, because it transforms the raw material into a value-added product, highly demanded by both domestic and international markets (Jaramillo *et al.*, 2012).

Vanilla wilt disease: points of view and control

Seventy-one percent of the interviewees lacked information about the causative agent of the diseases that impact vanilla plantations. In addition, producers pointed out that they were unaware of the appropriate control practices and of the significant productivity challenge that these diseases pose to their vanilla plantations. Twenty-nine percent of the interviewees are aware about vanilla diseases and implement some type of control management —application of ash, lime (calcium hydroxide), and sodium bicarbonate— that have been somewhat effective for other crops.

According to Arias-Cedeño *et al.* (2021), ash contains not only essential macronutrients but also micronutrients, such as zinc (Zn) and copper (Cu) —metals required for a healthy plant growth. Although a minimal quantity is required, micronutrients are equally vital, because their deficiency can trigger physiological disorders in plants. Therefore, ash can contribute to crop development, functioning as a natural fungicide, since its alkaline nature creates an unfavorable environment for many pathogenic fungi (Romanowska-Duda *et al.*, 2024).

In addition, calcium hydroxide has fungistatic potential, preventing the spread of wilt disease in vanilla plants. Bubici *et al.* (2019) recorded that the application of calcium

hydroxide to the soil played a crucial role for the control of *Fusarium* wilt in banana (*Musa* sp.). This treatment is applied in the base of diseased plants and of nearby healthy plants, in order to raise the pH of the soil and to prevent the spreading of *Fusarium oxysporum* f. sp. *cubense*. In addition, calcium hydroxide is unexpensive, can be easily applied, and it is harmless to the environment and humans. These combination of characteristics make it an alternative for the control of diseases in agricultural crops, particularly when it is used to prevent pathogenic diseases (Cardona and Zapata, 2016).

Likewise, sodium bicarbonate has been effective for the control of postharvest rot. Guédez *et al.* (2010) proved its effectiveness for the control of postharvest fungi in Valencia oranges. These authors reported that sodium bicarbonate healed 80% of the wounds caused by pathogens of the genus *Penicillium* sp., highlighting its potential as a natural and safe treatment to protect crops after the harvest. This compound inhibits the expression and secretion of polygalacturonases, which are the enzymes responsible for the maceration of fruit tissues. Sandoval-Chávez *et al.* (2011) reported that low-pH environments improve the activity of these enzymes.

Vanilla producers also mentioned that wilt disease is more common during the rainy season. These comments match the reports of Reyes *et al.* (2020), who indicated that, while wilt disease impacts vanilla plantations all year-round, its incidence is most severe during the rainy season. In addition, vanilla plantations are extremely vulnerable to this disease before they reach 4+ years.

An encouraging fact is that 8% of interviewees have received technical assistance from government programs. Assistance can help producers to better understand vanilla diseases and to adopt more effective management practices. However, producers are still unaware and untrained regarding the management of diseases in vanilla plantations. Therefore, providing continuous technical support and training activities to producers is fundamental. On their own words, producers want to grow vanilla and receive technical assistance, in order to strengthen their capacity to tackle these challenges and guarantee a long-term crop productivity. During the interviews, producers were asked if they had noticed wilting signs in their vanilla plants and which part of the plant had the highest incidence (Figure 3).

Sixteen-point-six percent of the interviewees admitted they were unsure whether their plants had shown any sign of wilting. In addition, 20.8% stated that their crops had

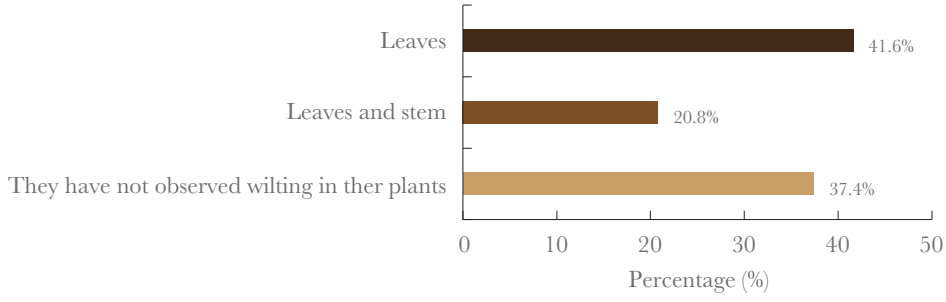


Figure 3. Location of wilt in vanilla plant, based on the experience of producers in Dimas López, Olintla, Puebla, México.

not shown any wilting symptoms, suggesting a more favorable situation. However, most of producers (62.5%) confirmed signs of wilting in their vanilla plants. This situation is worrying and highlights the seriousness of the problem, especially taking into account that wilting significantly impacts the productivity of vanilla plantations.

CONCLUSIONS

Dimas López producers are members of the Totonac community and grow vanilla in small plots (0.25 ha), using a low-yield production system known as *acahual*. They are deeply interested in the phytosanitation of their plants; therefore, improving disease management strategies and focusing on wilt and rot control in vanilla plantations are fundamental. Furthermore, producers are willing to implement pest and disease control practices to protect their crops. Taking into account the sociocultural context of the community is essential to guarantee that producers effectively apply and accept potential strategies.

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