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Investigation note

Coffee rust in Hueytamalco, Puebla

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Abstract

The Sierra Nororiental is one of the main coffee-growing regions in the state of Puebla, where the municipality of Hueytamalco stands out for its production and planted area. In recent years, production in this region has decreased considerably due to damage caused by coffee rust (*Hemileia vastatrix*). The objective was to know the management, incidence, and damage of coffee rust in the municipality of Hueytamalco, Puebla. Through statistical sampling, a sample of 67 coffee growers was determined. Fieldwork concluded in December 2018. Most producers reported the presence of rust on their farms. To manage the disease, they use different fungicides that are applied sporadically and without adequate technical assistance. Most producers think that the incidence of rust has increased and believe that this problem could increase significantly in the coming years. This situation has impacted the municipality's coffee yields; nevertheless, coffee growers expressed interest in continuing with the crop.

Keywords:

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Coffee is considered one of the most important crops in international agricultural trade (Flores, 2015); however, in recent years, there has been a decrease in yield and an increase in the production costs of the crop due to rust, which affects the economic stability of producers and in countries where the economy is highly dependent on this product (Arneson, 2000). In Central America, the presence of rust was reported, which reduced production by up to 30% (Dirección General de Sanidad Vegetal, 2013).

Mexico is one of the most important producers of coffee; nevertheless, its relevance has decreased. In 1987 it was the fourth largest coffee producer in the world, and by 2017 it ranked eleventh (CEDRSSA, 2019). This crop is important because it allows the support of 509 817 small coffee growers, is produced in 15 states of the country, and although its production has decreased in recent years, this product generates 4.5 million jobs (Robles, 2011).

Puebla is the third largest coffee producer nationwide, after Veracruz and Chiapas (Benítez-García *et al*., 2015). In 2021, the area planted with coffee in the country was 710 896 ha and had a production of 987 092 t, with an average yield of 1.48 t ha^{-1}; in the case of Puebla, the area was 70 693 ha, with a production of 149 549 t, so the average yield in the state was 2.3 t ha^{-1}, being higher than the national average and ranking first in yield in the country (SIAP, 2023).

Rust [*Hemileia vastatrix* (Berk. & Br.)] is considered the most serious disease of coffee, so it is of great economic importance for our country (SENASICA, 2016). Coffee rust appeared in the country since 1981 in the area of Soconusco, Chiapas. However, it did not cause damage as occurred in other countries, and with the implementation of cultural practices, such as shade regulation, pruning, and the application of copper-based preventive fungicides, they were maintained at economically acceptable levels of infection.

The disease not only generates losses in the quantity of coffee harvested but also puts the quality of the grain at risk (Amico, 2016). In order to avoid losses in the quality and levels of coffee production, the campaign against coffee rust began in 2013 as part of a comprehensive program for the control of the disease, where actions of sampling, training for technicians and producers, dissemination, cultural control, and chemical control were carried out, thus, the technical staff of the campaign would carry out actions aimed at fulfilling the objective of the strategy against coffee rust (Dirección General de Sanidad Vegetal, 2013).

This phytosanitary problem has impacted the economy of coffee growers and of the country. For Puebla, the severity with which rust occurred was high. It was detected in 14 municipalities, mainly in San Felipe Tepatlán, Cuetzalan, Zihuateutla, Xicotepec, Jalpan, Tlaxco, Zapotitlán, Huitzilan and Hueytamalco (Dirección General de Sanidad Vegetal, 2013). For the municipality of Hueytamalco, there is no precise information about the damage, management, and consequences of rust disease, so the objective of this work will focus on knowing the incidence, damages, and management that producers carry out regarding rust.

The study was conducted in seven localities in the municipality of Hueytamalco, which is located in the northeastern part of the state and occupies 0.9% of the state area. It has an altitude between 100 and 1 900 m. It has a total population of 26 115 inhabitants, and the main activity is agriculture. The dominant soil is Regosol with (52%), Andosol (25%), Phaeozem (2%), Nitosol (8%), Luvisol (1%) and Vertisol (1%) (Prontuario de información geográfica municipal, 2009).

Determination of sample size and analysis of information

Random sampling for proportions (Lohr, 2022) was used to obtain the information. The sampling frame was the 2017 coffee census (4 442 producers in the municipality). The presence or absence of rust in coffee crops was used as a variable, considering maximum variance (p_n= 0.5 and q_n= 0.5). A reliability of 90% and an accuracy of 10% were employed. The sample size was set to 67 coffee producers from the municipality of Hueytamalco, who were interviewed using a previously designed questionnaire. The analysis used descriptive statistics and tests such as one-sample t-test, independent samples t-test, and Mann-Whitney test.

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Hueytamalco coffee producers are mostly middle-aged, with an average of 52.22 years (s= 14.36). This result is similar to the study conducted by Ramírez and González (2006), where they found that the average age of the producers in the municipality of Cuetzalan was 52.83 years, which belongs to the same coffee-growing area. In the educational aspect, it was found that only a quarter of the producers have completed primary school, and only 3% finished a bachelor's degree.

Seventy percent of the interviewees have only one farm, and the average area planted with coffee is 1.99 (s= 2.07) hectares, and from this small area, they mainly obtain the resources for the survival of the family. According to Robles (2011), the area of the coffee production units in the country was 1.94 ha. Using a one-sample t-test, it was found that there is no statistical difference (t= 0.234; *p*= 0.816) between the national area and that in the municipality of Hueytamalco. These data place coffee-growing families in the municipality, as in most of the country, in conditions of poverty.

The situation is similar in the state of Veracruz, where producers own 2.3 ha on average (Apodaca-González *et al*., 2014). In another study conducted in the region of the high mountains of Veracruz (Gasperín-García *et al*., 2023), it was found that smallholdings persist, with less than 3 ha per production unit, and it is concluded that the income provided by the crop is not adequate for the sustenance of the family and they need to carry out economic activities outside agriculture.

The rust manifested itself with great intensity in the municipality of Hueytamalco, where 92.5%of the producers mentioned having an infestation in their crop. Most coffee growers (53%) mentioned that they have had talks and courses on the disease, with technicians from the municipality; it is worth mentioning that producers who live far from the municipal seat did not receive any type of advice or technical assistance. Of the producers with rust in their plantations, 62% of them reported the outbreaks to federal and state institutions.

Seventy-one percent of producers with rust on their land reported some type of control against the disease. Nevertheless, according to Escamilla (2016), the application of fungicides in inadequate doses is perhaps one of the main causes of the spread of coffee rust. Of the producers who did not carry out any control against the disease, 5.9% said that they were not interested in combating rust, 23.5% have no knowledge of how to do it, and the majority, 70.6%, commented that they did not combat the fungus due to the lack of advice.

These last two causes show that it is necessary to have more training for producers and on the other hand the urgency of greater advice from the institutions of the sector. Of those who took measures against the disease, 2.3% mentioned control using biological procedures, 9.1% expressed cultural procedures, and the majority (88.6%) said they used chemical procedures to combat the disease.

Of the percentage that uses chemicals, they said they spent from $ 800.00 to $ 1 200.00 in their purchase, and when the application is low, the expenditure is lower ($ 60.00 to $ 300.00). This situation is a big problem for producers because, in addition to reducing yields due to rust, they have to spend their scarce economic resources on the purchase of chemicals to control the disease. In this way, coffee-growing families are becoming increasingly impoverished.

Within the cultural method, the practices used are fertilization and pruning and finally, in genetic control, the main action is the planting of resistant varieties such as Costa Rica 95. Another significant percentage of producers (27%) combine the chemical and cultural methods, while 21% use only the cultural method. The remaining percentage makes indistinct use of these methods.

Of those who use the chemical method, 55% obtain the products from a government agency and 29% buy them in an establishment, the remaining percentage acquires them by other means. More than half of them (52%) said they knew when and how to apply them, and they use this method because it is effective, accessible, and inexpensive.

To combat rust, a high percentage of respondents (40%) said they would continue to fumigate as a control measure, while 31% said they would plant new varieties resistant to this disease, 17% do not know, and 6% said they would fertilize. In that sense, 91% of producers said they knew

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of new varieties resistant to rust, among them, the Costa Rica 95 variety stands out, followed by Colombia and Oro Azteca, the latter variety was released in 1995 by the National Institute of Forestry, Agricultural, and Livestock Research (INIFAP, for its acronym in Spanish) (Escamilla, 2016).

According to the results of the surveys, 63% said that Costa Rica was the variety most resistant to rust, although, in dialogue with the interviewees, they said they knew that it is low yielding, as well as a short life span. The incidence of rust, according to the opinion of the producers, was classified as severe. In the case of damage to the leaf area, 17% said that it was infested in 50%, another 17% said that the level of damage was 30%, 11% declared that the damage was 80%, another equal percentage perceived damage of 40%, the remaining 46% varied from 5% to 100%.

Given these results, 89% of respondents consider that variations in climatic conditions increase the incidence of rust, half of them attribute this circumstance to the increase in temperature, and 17% consider that it is due to moisture. On the damage caused by *Hemileia vastatrix* to the plantations, it could be observed, through the opinion of the producers, considering the control of fungus in Table 1.

Table 1. Percentage of damage caused by rust according to the control of the disease.

Level of damage	They control the rust				Total	
	Yes				No	
	Frequency	(%)	Frequency	(%)	Frequency	(%)
Very mild	2	4.8	0	0	2	3.4
Mild	10	23.8	3	17.6	13	22
Regular	4	9.5	4	23.5	8	13.6
Strong	18	42.9	9	52.9	27	45.8
Very strong	8	19	1	5.9	9	15.3
Total	42	100	17	100	59	100

From the analysis of the column of total damage, we found that the impact on the crop is serious since 61.1% of the plantations have strong or very strong damage. This situation persists between the group of producers who control rust and those who do not. In the first group, 61.9% consider the damage to their crop as strong or very strong, and in the group that does not control the disease, there is a slightly lower percentage (58.8%), but no statistical difference was found between the two groups according to the Mann-Whitney test (Mann-Whitney U= 340; p= 0.763). This indicates that the control of the disease does not depend on the damage caused to the crop.

When comparing groups that had some rust control and those that did not, regarding age, it was found that the group that performed practices against the disease had an average of 52.2 years of age (s= 12.91), and the other group had an average of 58.72 years (s= 16.61), although the group that controls the disease was older, no significant difference was found, according to the t-test (t= -1.657; p= 0.103), which shows that the age of the producers is not decisive in deciding to combat rust.

A similar situation occurred with the variable of area, an average of 2.23 ha (s= 2.26) of the group that carried out control and 1.64 ha (s= 1.80), without showing a significant difference (t= 0.981; p= 0.33) so that in the cultivated area of coffee, it is not one of the determining factors in the decision to combat rust by producers. The variable of yield showed an average of 998.73 kg ha^{-1} (s= 1188.475) in the group of coffee growers who controlled the disease and an average of 386.11 kg ha^{-1} (s= 474.281) was obtained in the group that did not do it, and in this case, a statistical difference was found (t= 2.11; p= 0.039). In this case, the relationship of the disease with yield is shown.

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Eighty-six percent of coffee producers know that rust is the most destructive disease of coffee plantations, therefore, 47% said that it had caused strong damage to their coffee plantations, especially defoliation of the plant, 13% affirm that the damage is regular, 21% described it as mild and 16% perceived it as very strong. Ninety-seven percent of producers said that this disease was a risk for coffee farming in their region because it decreases production and can wipe out plantations.

As for the damage caused by the disease, 53% say that the main one is economic since it has decreased production by 50%. The yield obtained in the municipality was 844.69 kg ha^{-1} (s= 1033.517), although it shows high variability as there are producers who did not harvest, and there is one that obtained the maximum yield with 5 t ha^{-1}. By the t-test for a single mean, the yield obtained is too low and statistically lower than the national average of 1 480 kg ha^{-1} and the average obtained in the state of Puebla of 2 300 kg ha^{-1}, with t= -4,636; $p< 0.001$ and t= -11.521; $p< 0.001$, respectively.

In Hueytamalco, coffee rust has caused the reduction of yields and therefore has degraded their income by up to 80%. On the other hand, 49% of the interviewees considered that coffee production is currently a regular business, 33% consider it a good business, 15% perceive it as a bad business, and only 1.5% consider it a very good business; contrary to what García-Alvarado *et al*. (2017) mention in a study conducted in the Copalita River basin in Oaxaca, where 76.5% of producers say that coffee production is no longer a business because there is no profitability and neither a fair market, even though it is produced with quality.

Of the total interviewees, 37% believe that few producers will abandon the plantations, and 1.5% consider that the majority will abandon them because of rust. Finally, the problem caused by rust to the national coffee farming, coupled with the economic crisis in the agricultural sector, has led to harvests with lower production in the last five decades (Escamilla, 2016), and despite the situation faced by the cultivation of the aromatic, the vast majority said that they would continue planting coffee since it is the only means of subsistence and stated that they did not intend to change the coffee crop for another.

Conclusions

The current system of coffee production in the municipality of Hueytamalco has not changed much since the years when it was the main and most important crop for the region, for this reason, it has been attacked very strongly by pests and diseases, specifically by rust, producers face this problem, which, since 2013, has had great importance due to the damage caused both at the level of production and economy.

Using fungicides without technical recommendations contributes to inadequate management and the spread of the disease. Although half of the producers receive advice from the municipality, this is not sufficient or substantial to control the disease, which contributes to the poor quality of the product, leading to a collapse in the prices paid to the producer.

In Hueytamalco, varieties with which cultivation began in the municipality are still used in most farms; this is one of the main causes of the increase in the disease. Producers consider this activity regular or unprofitable, and although rust has had a substantial economic impact, coffee growers do not plan to stop growing coffee.

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