






Socioeconomic characteristics of the broad bean (*Vicia faba* L.) (Fabaceae) production in the northeastern region of the State of Puebla, Mexico

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ABSTRACT

Objective: To determine the economic importance of broad bean (*Vicia faba* L.) (Fabaceae) cultivation in four municipalities of the northeastern region of the State of Puebla and to determine the knowledge level of growers regarding the symptoms, control methods, and damage caused by the chocolate spot.

Design/Methodology/Approach: Semi-structured interviews were applied focusing on production systems, phytosanitary management, and acceptance of biopesticides. The resulting information was subjected to a database descriptive analysis using the Microsoft[®] Excel package.

Results: The data output shows the importance and extension of the sowing, along with the phytosanitary problems faced by regional broad bean growers and finally the acceptance of biopesticide as a method to control the chocolate spot.

Study Limitations/Implications: There is not enough information and documents regarding the importance of the regional cultivation of broad bean as a source of sustenance.

Findings/Conclusions: The economic importance of broad bean cultivation was determined, along with the damages caused by the chocolate spot infection and the production systems used by the regional grower families.

Keywords: Production systems, broad bean, biopesticides, and chocolate spot.

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INTRODUCTION

Broad beans (*Vicia faba* L.) (Fabaceae) is a species with worldwide importance as food (Rojas-Tiempo *et al.*, 2012). It is the fifth most important crop in Mexico and it is grown in the states of México, Puebla, Tlaxcala, Veracruz, and Hidalgo. However, the most important Mexican state regarding broad bean production is Puebla with 16,083 ha, most

of which belong to several municipalities in the northeastern area of that state. Domestic yield ranges from 1.3 to 6.6 t·ha⁻¹ (SIAP, 2019). Yield loss is associated with the presence of pests (Lake *et al.*, 2019), particularly the *Botrytis fabae* Sardiña fungus, commonly known as chocolate spot. It causes necrotic spots in stems, leaves, flowers and pods and it can reduce annual production by up to 60% (Gahukar, 2012). The main strategy employed to control this pathogen is the use of highly toxic fungicides; however, pest management can increase production costs (Espinal *et al.*, 2010). Therefore, farmer lore regarding the management of broad bean crops should be documented, particularly, the way the control the chocolate spot, since their experience is a source of information for the organization and operation of traditional agricultural production systems in the northeastern region of the State of Puebla. Specifically, the study focused on the municipalities of Libres, Zaragoza, Tlatlauquitepec, and Zacapoaxtla, whose production makes Puebla one of Mexico's main broad bean growers.

MATERIALS AND METHODS

A semi-structured interview was designed to collect information from n=20 randomly selected growers from the municipalities of Zaragoza, Zacapoaxtla, Libres, and Tlatlauquitepec, in the State of Puebla. In total, n=80 growers were interviewed. The survey covered the characteristics of agricultural production systems, including years that the crop has been grown in the plot, obtaining, choosing, and storing seeds, established surface, use or management of fertilization programs, economic aspects (investment on the establishment and handling per hectare), yield, and markets in which the grain or pods are commercialized. Likewise, the answers to some questions provided the research team an overview of the identification of the pathogen (chocolate spot), its phytosanitary control, resulting losses, and finally the interviewees' opinion about the acceptance or implementation of biopesticides.

The municipalities were chosen according to their production record in the state's northeastern region. The surveys were carried out on May 2021. The resulting information was used to develop a database, which was subjected to a descriptive analysis (through the development of bar graphs and tables), using Microsoft[®] Excel.

RESULTS AND DISCUSSION

Puebla is one of the main growers of broad beans and most of the interviewees declared that they have grown this species for more than ten years (Rojas-Tiempo *et al.*, 2012) (Figure 1).

The interviewees from the municipalities of Zaragoza and Zacapoaxtla grow broad beans for self-consumption, while in Zacapoaxtla, Zaragoza, and Tlatlauquitepec, growers sell their production in the local area. Growers from Tlatlauquitepec, Zaragoza, and Libres sell their product on the regional market, while 97% of the production from Libres is sold in the national market.

Broad beans are the seventh most important crop in the world (Pérez, 2014). They have played a major role in the crop pattern of the study region for several years. Their sales in various markets provides an income for the local families, particularly in the

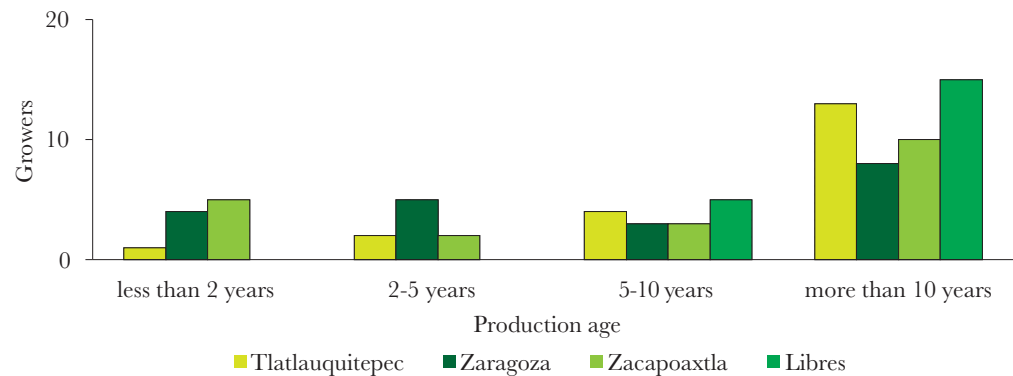


Figure 1. Years that growers from four municipalities in northeastern Puebla have cultivated broad beans.

municipality of Libres, where 95% of the growers mentioned it as their main source of income. Nevertheless, this agricultural activity is not the main source of income for 85, 80, and 70% of the growers from Tlatlauquitepec, Zaragoza, and Zacapoaxtla, respectively, given its low yield and the presence of diseases, which matches the findings of Doussoulin *et al.* (2015).

To establish the crop, 85 to 100% of the growers use native seeds and only 5% (from Zaragoza and Zacapoaxtla) acquire commercial seeds. This situation proves that growers still select and preserve local germplasm, based on traditional lore, which they have perfected through empirical experimentation. This practice contributes to the *in situ* preservation of this species (Díaz-Bautista *et al.*, 2008). This study found out that 93% of the farmers believe that seed health is the main criterion for the selection of the biological material that will be used in the next production cycle, while 55% consider that both the health and the size of the seeds are important. Additionally, Pérez-López *et al.* (2015) suggest that the selection process should take into consideration the phenotypical expression (stem length, branches per plant, pods per plant, seeds per pod, and weight of 100 seeds).

Since they sell all their harvest, 65, 85, and 80% of the growers surveyed in Tlatlauquitepec, Zaragoza, and Zacapoaxtla, respectively, buy seeds from other growers to establish their crops.

In the case of the municipality of Libres, 100% of the growers mentioned that they sow seeds from the previous harvest, which provides an opportunity to keep and safeguard local resources, in contrast with modern agriculture which has reduced regional genetic diversity (Duc *et al.*, 2010). Rojas-Tiempo *et al.* (2012) mention that the communities that make up the study area use two types of broad beans, identified by the growers as tarragona and cochinerita (according to their size). Based on the classification proposed by Cuberto (1974), they belong to the minor and quina varieties, respectively. In a personal communication, growers mentioned that they use tarragona seeds. In this sense, the northeastern region of Puebla is characterized by the use of local cultivars, such as tarragona, parraleña, and cochinerita (Herrera, Alvarado, Cabrera, Hernández, and Guevara, 2020).

In Tlatlauquitepec and Zaragoza, each growers sows from 1 to 2 ha, while most growers from Zacapoaxtla grow broad beans in less than 1.0 ha. This information is related with the exclusive use of the production for self-consumption, as well as with the technification

level, likely because their plots have scarce agronomical management. In the municipality of Libres, 80% of the growers cultivate broad beans in 2 to 4 ha. Although the only growers that establish more than 4 ha are located in Zaragoza and Libres, the highest yields per hectare were recorded in Libres (200-300 kg), followed by Tlatlauquitepec (150-250 kg). Growers from Zaragoza obtain a 100 to 200 kg yield, while the lowest yield is reported in the municipality of Zaragoza (Figure 2). The latter yield is lower than the 300 kg reported by Rojas *et al.* (2012) in the evaluation of a broad bean production system in which fertilization technological packages were implemented.

The economic investment per hectares varies between municipalities. In Zaragoza, Zacapoaxtla, and Tlatlauquitepec, investment is below MXN\$2,500 ha⁻¹, while it exceeds MXN\$4,000 ha⁻¹ in the municipality of Libres. Growers from Tlatlauquitepec and Libres use products to disinfect broad bean seeds, which is not the case in Zaragoza and Zacapoaxtla; the consequent presence of phytopathogens might explain the yield reduction (Orozco and Zúñiga, 2020).

Chocolate spot is considered one of the main broad bean diseases, both in Mexico and the rest of the world (Torres *et al.*, 2006). Ninety-one percent of the growers can identify the disease's typical symptoms; therefore, 75 to 85% of the interviewees from the municipalities of Tlatlauquitepec, Zacapoaxtla and Libres carry out preventive treatments, while 75% of Zaragoza's growers do not control the pathogen in any way. The economical resources that are allocated to the control are very low (MXN\$325.00 in Zacapoaxtla, MXN\$375.00 in Zaragoza, MXN\$650.00 in Tlatlauquitepec, and MXN\$800.00 en Libres). Perhaps this is one of the reasons behind the 50% or higher loses of economic yield, which matches the findings of Espinal *et al.* (2010), who mention that *B. fabae* reduces yield by up to 60%.

In this context, 100% of the growers in Tlatlauquitepec, Zaragoza, and Zacapoaxtla mentioned that they are unaware of any specific pesticide that controls chocolate spots, while 15% of the growers form Libres mentioned at least one. Meanwhile, 90 and 95%

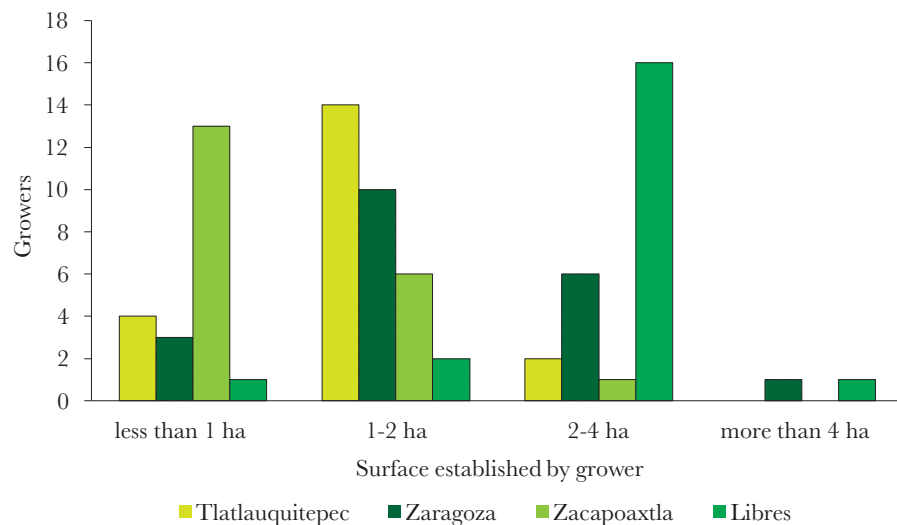


Figure 2. Area established with broad bean per grower in four municipalities of the northeastern region of Puebla, Mexico.

of the growers from Tlatlauquitepec and Libres, respectively, declared their interest and willingness to use some kind of biopesticide, as long as it reduces production costs and maximizes their yield. For their part, 75 and 8% of the growers of Zacapoaxtla and Zaragoza showed no interest in biopesticides. Nevertheless, Espinal *et al.* (2010) have reported that the application of *Trichoderma inhamatum*-based products to broad bean plants with chocolate spots symptoms improves the weight and length of the seedlings, the number and weight of the pods, the number of grains, and the fresh and dry weight of the grains, proving that agroecological products can efficiently control pathogens.

Likely due to the lack of technical consultancy services, some growers declare that they are not interested in alternatives for the control of chocolate spot; however, those who did show interest might act as models for the incorporation of biopesticides and positive regional results could convince their colleagues to adopt these alternative control methods. According to Nava-Pérez *et al.* (2012), the development of new biopesticides stimulates agricultural modernization. In agricultural production, biopesticides are ideal substitutes for traditional and highly toxic chemical products (Leng, Zhanhg, Pan, and Zhao, 2011).

CONCLUSIONS

Broad bean cultivation is not a recent practice in the study region: it has been part of the cultivation pattern for over ten years and the seeds that are sown are obtained from the previous harvest in the same locality. As a consequence of its low yield, this agricultural activity is not the main source of income for the growers of some municipalities.

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