# Chapter 4 Agroecological management of flora for pollinator reserves in Metztitlán, Hidalgo

# Capítulo 4 Manejo agroecológico de la flora para reserva de polinizadores en Metztitlán, Hidalgo

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**Abstract**

La Vega de Metztitlán is part of the Barranca de Metztitlán Federal Biosphere Reserve in the state of Hidalgo. There, the most important economic activity is agriculture, since 73% of the population of the municipalities that make up the area grow beans, corn, green beans, zucchini, tomato, chili, sorghum and walnut. The indiscriminate use of agrochemicals due to the implementation of three production cycles per year has caused a considerable reduction in beneficial fauna and a decrease in yields due to low or no natural pollination. With the objective of preserving pollinating insects in the Metztitlán ravine, an agroecological plot was established at the Universidad Politécnica Francisco I. Madero, Metztitlán Academic Unit, under strictly ecological management with the rational use of natural resources, as well as a control of pests and diseases based on plant extracts. For this purpose, the cultivation of sunflower (*Helianthus annus*) was implemented as part of the strategy to attract pollinating insects and thus determine their incidence. The results showed the presence of Hymenoptera in 90%, Lepidoptera, Coleoptera and Hemiptera 3% respectively in each order. For the prevention and control of pests, chili extract plus garlic was used, which had 95% efficiency. The agroecological management of crops is a sustainable alternative for the preservation, attraction and increase in the incidence of pollinating insects, considerably increasing final yields.

**Agroecología, Insectos, Repelentes, Orgánico**

**Resumen**

La Vega de Metztitlán forma parte de la Reserva federal de la Biosfera Barranca de Metztitlán en el estado de Hidalgo. En esta, la actividad económica de mayor importancia es la agricultura, ya que el 73% de la población de los municipios que conforman el área, se siembran frijol, maíz, ejote, calabacita, jitomate, chile, sorgo y nogal. El uso indiscriminado de agroquímicos a causa de la implementación de tres ciclos de producción al año ha ocasionado una reducción considerable de la fauna benéfica y disminución en los rendimientos por causa de la baja o nula polinización natural. Con el objetivo de preservar los insectos polinizadores en la barranca de Metztitlán, se estableció una parcela agroecológica en la Universidad Politécnica de Francisco I. Madero, Unidad Académica Metztitlán, bajo un manejo estrictamente ecológico con el uso racional de los recursos naturales, así como un control de plagas y enfermedades a base de extractos vegetales. Para ello se implementó el cultivo de girasol (*Helianthus annus*) como parte de la estrategia de atracción de insectos polinizadores y así determinar la incidencia de estos. Los resultados mostraron la presencia de himenópteros en un 90%, lepidóptera, coleóptera y hemíptera de 3% respectivamente a cada orden. Para la prevención y control de plagas se utilizó el extracto de chile más ajo él cual tuvo un 95% de eficiencia. El manejo agroecológico de los cultivos es una alternativa sustentable para la preservación, atracción y aumento en la incidencia de insectos polinizadores, aumentando considerablemente los rendimientos finales.

**Agroecology, Insects, Insect, Repellents, Organic**

## 4 Introduction

The agricultural area known as "La Vega de Metztitlán" is part of the federal Biosphere Reserve Barranca de Metztitlán in the state of Hidalgo. The most important economic activity in this area is agriculture, as 73% of the population of the municipalities that make up the area grows beans, maize, green beans, squash, tomatoes, chilli, sorghum and walnuts. The indiscriminate use of agrochemicals due to the implementation of three production cycles per year has caused a considerable reduction in beneficial fauna and reduced yields due to low or no natural pollination. In order to preserve pollinating insects in the Metztitlán ravine, an agro-ecological plot was established at the Polytechnic University of Francisco I. Madero, Metztitlán Academic Unit, under strictly ecological management with the rational use of natural resources, as well as pest control based on plant extracts. As part of the strategy to attract pollinating insects, the establishment of a sunflower crop (Helianthus annus) was also implemented in order to determine the incidence of these insects. In the worldwide erosion of biodiversity, dramatic evidence emerges of losses in the insects that carry out pollination activities, with bees (Apis mellifera) being the most relevant, which represents a major risk for agricultural production and food security.

About 60 to 90 % of plant species require a pollinator for their reproduction Kremen et al., (2007), the ecological, economic and conservation importance of the role they play in wild and cultivated flora Buchmann and Ascher, (2005). This work aims to determine the importance of agroecological use in crops and the implementation of insect-attracting plants to aid pollination.

### 4.1 Materials and methods

The present project was carried out at the Universidad Politécnica de Francisco I. Madero, Unidad Académica de Metztitlán, located at Domicilio conocido avenida Tepeyacapa, s/n. (Fig. 4).

**Figure 4** Location of the study area

For the establishment of the crop, the soil was prepared using a 12-disc harrow to condition the soil, in order to incorporate residues from the previous sowing, increase porosity, expose the harmful fauna present and decompact the soil. The tillage depth was 30 cm, according to the soil profile and the root capacity of the crop. The distance between furrows was 0.80 m. with a length of 30 m. in a total of 25 furrows. The established seed variety was Vicents Choice. Its main characteristics are short cycle, 60 days to flowering, medium size and resistance to low temperatures. Sowing was carried out on 20 May 2023, in soil with moisture at field capacity and manually, distributing the seeds at a distance of 15 cm between plants at a depth of 5 cm. For nutrition, the formula (20-30-10) of NPK plus micronutrients was applied to correct deficiencies, the dose used was 200 $g^{-1}$ in 15 l-1 of water. The applications were made at 15-day intervals over a period of two months. Irrigation was applied at three-day intervals, based on the requirements of each phenological cycle, taking into account the potential evapotranspiration factors.

The application system was by means of localized irrigation (cintilla) using a supply system made up of a pipe, a polyduct with a diameter of 2 inches and a 1.5 HP pump with 45 PSI with a flow rate of 20 l-1 per second. The duration of each irrigation was 3.5 l/hr with uniformity of the wetting bulb of the root system. The main pests that were present were: aphid (Aphididae), whitefly (*Bemisia tabaci*), leafhopper (*Brachystola magna*), diabrotica (Diabrotica L.), chinch bug (*Cimex lectularius*). Natural extracts based on garlic, hot chilli, cinnamon and neem were used to control these pests, at a dose of 200 ml-1 in 15 l-1 of water. The applications were made for preventive control. To determine the incidence of pollinating insects, daily counts were carried out in 5 sampling points per m2 during the flowering stage and later identified for classification.

### 4.2 Results and discussions

**Table 4** Incidence of pollinating insects per $m^2$

| Phenological stage | Hymenoptera | Lepidoptera | Coleoptera | Hemiptera | % |
|---|---|---|---|---|---|
| Flowering | 90% | 3% | 3% | 3% | 100% |

The results obtained according to the incidence of pollinating insects per square metre in the phenological stage of flowering are shown, where 4 different percentages were obtained according to the orders presented. Bees belong to the order of insects corresponding to Hymenoptera, and constitute the superfamily Apoidea, which includes seven families, about 425 genera and more than 20 000 species, Michener; (2000). In this case they occupied the highest percentage of occurrence despite the largely disturbed area. The pollination activities that bees provide to the ecosystem they inhabit are extremely important, as they help to preserve the integrity of the ecosystem Gallai et al. Despite modern agricultural management and practices, pollinating insect populations are declining at an alarming rate. Studies have shown that with entomophilous pollination, fruit size and weight increase considerably compared to fruit produced without the intervention of pollinators Guzman et al. Bees are known to be used for pollination of crops and native flora Roubik *et al*., (1991).

Table 4.1Plant density /ha$^{-1}$

| M linear | M linear/ ha$^{-1}$ | Plants/linear m | Plants /ha$^{-1}$ |
|---|---|---|---|
| 750 | 12500 | 7 | 5250 |

The results obtained from the density of plants /ha$^{-1}$ , with the linear metres established in the sowing area, are shown in order to determine the number of plants for the incidence and refuge of pollinating insects, as well as to associate the yield of neighbouring crops which benefit from the fertilisation provided. According to the density and taking into account the constancy of the bee with genotypes that increase pollen availability or devices that promote pollen transfer at the entrance of the hives Hatjina et al. (1999), could increase crop yields. The arrangement of the plants per m2 is a function of genotypes adapted for high densities, so it is suggested that growers define the variety with ideal botanical aspects and implement production improvement techniques with studies related to the cognitive abilities of the pollinator of each system. Aguirrezábal et al. (1996) argue that the available space offered by the receptacle tissue for new flowers to differentiate is a determining factor for the total number of flowers that can develop and therefore the total number of fruits.

**Table 4.2** Extracts used for pest control

| Pests | IA | Dose | % from efficiency |
|---|---|---|---|
| Aphid | Garlic extract *(Allium sativum)* | 200 ml$^{-1}$ /15 l$^{-1}$ of water | 85% |
| Whitefly | Chilli extract*(Capsicum annuum)* | 200 ml$^{-1}$/ 15 l$^{-1}$ of water | 95% |
| Bedbug | Cinnamon extract *(Cinnanomomum verum)* | 200 ml$^{-1}$ /15 l$^{-1}$ of water | 75% |
| Diabrotica | Neem extract(*Azadirachta indica*) | 200 ml$^{-1}$ /15 l$^{-1}$ of water | 50% |
| Leafhopper | Chilli + garlic extract*(Capsicum annuum + Allium sativum)* | 200 ml$^{-1}$ /15 l$^{-1}$ of water | 95% |

With the results of the applications made for the control of the different pests that occurred during the crop cycle, as well as the doses and the percentage of efficiency obtained. It is shown that the chilli extract plus garlic extract obtained 95% control for leafhoppers, the chilli extract obtained 95% for whitefly, the garlic extract 85% for aphids, the cinnamon extract had 75% efficiency in controlling the chinch bug and the neem extract 50% for diabrotica. The application of synthetic insecticides has so far been the most widely used tool to combat the insect. Hilje (1993) mentions that B. tabaci has the facility to develop resistance to insecticides, mainly due to its short life cycle and facultative parthenogenesis. Since 1987, worldwide, this species has developed resistance to 16 insecticides of different chemical origin in cotton plantations. Espinel et al. (2008). Because B. tabaci has the characteristics of resistance, it had to be treated preventively with short application intervals. Insecticides of botanical origin are classified as biochemicals and are an important group of natural crop protectants, which act slowly, incorporate mixtures of biologically active compounds and do not develop resistance in pests. In their basic form, botanical pesticides can be crude preparations of plants, such as powders of flowers, roots, seeds, leaves, stems and essential oils. Formulations are commonly concentrated or liquid extracts, Pavela (2016).

## 4.3 Conclusions

Agroecology is an alternative to minimise pollution in the use of synthetic pest control products and increase the incidence of pollinating insects.

The use of organic repellents used for pest prevention in the chili pepper extract for whitefly and leafhopper had a 95% efficiency.

The incidence of pollinating insects per $m^2$ occurred in the flowering phenological stage, with the order Hymenoptera being the most abundant with 90%, while the orders Lepidoptera, Coleoptera and Hemiptera were 3%.

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