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Weeds Associated to Habanero Pepper (*Capsicum chinense* Jacq.) in the Village of Muna, Yucatan, Mexico

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Abstract

The objective of this study was to know the weed species associated with the cultivation of Habanero Pepper (HP) in the municipality of Muna Yucatan, Mexico that could help to define the best weeds management strategies for producers in the region. Weed collection was made in a lot where the HP was about to be grown. The weed species were identified one week before the establishment of the crop (Jaguar variety). For taxonomic identification of weeds, images of the adult plant with flowers, fruits and seeds were taken, supported with herbarium. The Importance Value Index (IVI) was calculated. Fourteen species predominated from which 85.7% were of the wide-leaf type and 14.3% were narrow ones. The most predominant species were: *Euphorbia hyssopifolia* (Euphorbiaceae), *Megathyrsus maximus* (Poaceae) and *Parthenium hysterophorus* (Asteraceae) with the highest IVI's with 61.8%, 52.4%, 33.7% respectively. The appearance of weeds in lots of HP crop represents an important increase in the production costs. The identification of weed species represents a basic tool for an effective Weed Management Program.

Subject Areas

Agricultural Engineering

Keywords

Host Weeds, Identification, Weed Taxonomy, Noxious Weeds

1. Introduction

The term weed is extended almost all over the world to nominate an undesirable harmful species at a certain time [1]. It is a special form of highly successful vegetation growing in environments disturbed by man without having been planted [2]. Weeds are able to adapt at any environmental condition According to the change of its rapid colonization at short and long distance due to an efficient seeds dispersal.

The appearance of weeds in crops, such as the Habanero Pepper (HP), represents a production cost between 20% to 25% of the total cost during a cycle of six cultivation months [3].

On the other hand, it exerts a strong competition for nutrients, water and space; making harvest difficult and behaving as a host of several Geminiviruses and their vector: the whitefly (*Bemisia tabaci* Genn.) [4].

To minimize the problems caused by weeds to farmers, it is important to implement, prior planting, a management program with four phases: 1) To identify the weeds and its life cycle, 2) To know the available weed management options, 3) To remove all kind of weeds from the lot prior planting the Habanero Pepper and 4) To implement a combination of different effective methods for prevention and control purposes [5]. Based on the foregoing, the objective of this study was to know the weed species associated to the Habanero Pepper (HP) in a farm located in the municipality of Muna in the state of Yucatan, Mexico.

2. Materials

2.1. Location

The research was carried out during September to October 202 in the "*Leopoldo Arana Cabrera*" Agricultural Unit, in the municipality of Muna, Yucatan, Mexico, located at coordinates 20˚24'52" North latitude and 89˚44'31" west longitude where the previous crop was peanut (*Arachis hypogaea*). The soils are classified as *K'ankab lu'um* in the Mayan terminology and *Luvisol* in the classification of the World Reference Base (WRB) [6].

A surface of 0.5 hectares was selected where HP *Jaguar* Variety was about to be cultivated and weeds were identified, one week before planting, in an area of 12 squares of 0.25 m^2 each (50 × 50 cm) [7].

2.2. Taxonomic Identification

For the taxonomic identification of weeds, images and live adult plants with flowers, fruits and seeds were taken and compared with botanical information from different Mexican Institutions such as:

The National Commission for the Knowledge and Use of the Land, National Commission for the Knowledge and Use of Biodiversity (CONABIO, http://www.conabio.gob.mx/malezasdemexico/2inicio/paginas/lista-plantas.htm), the Scientific Research Center of Yucatan (CICY, http://www.cicy.mx/sitios/flora%20digital/index.php) and the National Herba-

rium of Mexico of the National Autonomous University of Mexico (MEXU, http://www.ib.unam.mx/botanica/herbario/).

3. Methods

Weed Collection

The, frequency of appearance, abundance and dominance of each species were recorded and the Importance Value Index (IVI) of each weed was calculated adapting the methodology described by Gámez López *et al*. (2011) [8].

The Importance Value Index (IVI) was developed by Curtis & McIntosh (1951) [9]. It is a synthetic structural index, developed mainly to rank the dominance of each species in mixed stands and was calculated as follows: IVI = Relative dominance + Relative density + Relative frequency [10] [11].

According to Campo and Duval (2014) [12], these three parameters are calculated as follows:

$$\text{Relative dominance} = \frac{\text{Dominance of each species}}{\text{Dominance of all species}} \times 100$$

$$\text{Relative Density} = \frac{\text{Number of individuals of each species}}{\text{Total Number of individuals}} \times 100$$

$$\text{Relative frecuency} = \frac{\text{Frecuency of each species}}{\text{Frecuency of all species}} \times 100$$

4. Results

Weed Species Found and the Importance Value Index (IVI).

The 14 weed species found on the HP plot are described in **Table 1** considering: common names according to different countries and regions, scientific names, botanical behaviors (A = Annual; B = Biannual; D = Dicot; M = Monocot; P = Perennial), geographical distribution and impact on agriculture crops.

The Importance Value Index (IVI) of each species are shown in **Figure 1** and the results are showing the presence of fourteen species of weeds one week before planting HP: *Amaranthus dubius*, *A. spinosus*, *Bidens pilosa*, *Boerthavia erecta*, *Crotalaria incana*, *Cyperus ligularis*, *Euphorbia hyssopifolia*, *Lonchocarpus rugosus*, *Megathyrsus maximus*, *Parthenium hysterophorus*, *Piscidia piscipula*, *Portulaca oleracea*, *Sida glabra* and *Waltheria americana*.

Of the total species, 85.7% were broad-leaved and 14.3% narrow-leaved. The species *Euphorbia hyssopifolia* (Euphorbiaceae), *Megathyrsus maximus* (Poaceae) and *Parthenium hysterophorus* (Asteraceae) were the most predominant ones with the highest IVI's with 61.8%, 52.4%, and 33.7% respectively.

They are species of considerable danger for HP because of their role as hosts of different diseases such as the *Meloidogyne incognita* nematode and the plague *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae), which efficiently transmits more than 100 viruses of the begomovirus group [13].

Table 1. Characteristics of the predominant weed species in the Habanero pepper lot.

Family	Scientific name	Common name	*Botanical behavior	Habitat	Impact	References
Amaranthaceae	*Amaranthus dubius*	Xtees (Maya), Quelite, Amaranto, Bledo (Mexico), Pira, Yerbacaracas, Atago (Venezuela), Spleen amaranth, Amaranth (USA)	A D	It is distributed in tropical and subtropical regions of the world and few in temparate ones	Host of root-knot nematode (*Meloidogyne incognita*)	[14] [15] [16] [17] [18]
Amaranthaceae	*Amaranthus spinosus*	K'iix tees (Maya), Amaranto espinoso, Bledo espinoso (Mexico), Spiny amaranth (USA)	A D	It is found in warm regions with wet and dry places but not in waterlogged soils; It grows better in high organic matter soils, with lime texture and sufficient nitrogen	It is considered a weed in 44 countries, affecting at least 28 different crops. It is an alternate host of nematodes such as *Meloidogyne acrita* and *M. incognita*, and pests such as *Spodoptera litura* (armyworm) and the tobacco virus	[17] [18] [19]
Asteraceae	*Bidens pilosa*	K'an tumbuub (Maya), Romerillo blanco Beggar tick, Black Jack, Spanish needles, hairy beggarticks (USA) Cadillo rocero (Venezuela) Amorseco (Peru), Daun jin zhan yin pan (China), Picão, picão-preto, carrapicho, shilco o pega pega (Brasil)	P D	Present in all tropical and subtropical regions of the world	It's an alternative host to common pests when no croping	[16] [20] [21] [22] [23] [24] [25]
Nyctaginaceae	*Boerthavia erecta*	Hierba blanca (Mexico), Anisillo, escorián , Golondrina (Chiapas, Mexico), Hierba del arlomo, Maravillita, Sanguinaria, Zanca de gallo, Tostón (Cuba), Erect spiderling (USA)	A D	It is originally from the United States Mexico, Central America and western South America. Nowadays, it is now reported as a cosmopolitan weed in tropical and subtropical regions of the world	It is reported as a host of whitefly nymphs and virus	[26] [27]

Continued

Fabaceae	*Crotalaria incana*	Frijolillo, Chipila, Sonajeras (Panama), Chinchino, cascabelillo, Tronador, (Mexico), Shakeshake, Fuzzy rattlepod, Wooly rattlepod (USA)	A P D	It is a legume growing in tropical and subtropical zones of Central and South America, and Africa	It is a sub-tropical legume with high value fodder able to fix atmospheric nitrogen to enrich poor soils. Nematodes can be controled by using it	[30] [31]
Cyperaceae	*Cyperus ligularis*	Coquillo (Mexico), Coquito, Chufa, Yellow nutsedge, Chufa flatsedge, Earth almond (USA)	P M	It is abundant in many crops, roadsides, fallow plots, vegetables, riverbanks. It grows well In warm and temperate climates, but it is not very tolerant to shade	In Mexico, it is considered one of the most serious weed problem	[28]
Euphorbiaceae	*Euphorbia hyssopifolia*	Hyssop Leaf Sandmat (USA), La Chupona, Hierba de la golondrina	A D	It grows in disturbed environments, including roadsides, fields and yards. It is found in the tropics and subtropics, the caribean región and and in the Lucayan archipelago of Florida	It is a host of begomovirus	[29] [30]
Fabaceae	*Lonchocarpus rugosus*	Xuul (maya), Carao macho (Costa rica), Palo de aro (State of México) Matabuey (Guatemala, Oaxaca Mex, Chiapas Mex), Pellejo de vieja (Oaxaca Mex) iit'it'ul (Chiapas Mex) Chaperno, Chapulaltapa (El Salvador), Cincho, Coyote, Quebracho (Honduras)	AM	It is distributed in Central America from Mexico to Costa Rica		[31]

Continued

Poacea	*Megathyrsus maximus*	Pasto guineo (Mexico), Pasto saboya (Ecuador), Yerba de guinea, Guinea grass (USA)	PM	It is native to Africa, and currently distributed and naturalized in tropical and subtropical regions. It is adapted to medium and high fertility soils	It grows successfully in a wide variety of well-drained and moist soils, being tolerant to shade. It is a high competitive weed against various crops. It has been cited in various parts of the world as a Important weed that affects all crops	[32] [33] [34] [35] [36]
Asteraceae	*Parthenium hysterophorus*	Parthenium (USA), Falsa altamisa, Altamisa del campo, Escoba amarga, Escobilla (México)	AD	It prefers humid and sub-humid tropical climates, showing a marked preference for high-fertility, clayey soils, but is capable of growing on a wide variety of soils	It is a host of Begomovirus; and capable of growing in a wide range of temperatures. It is one of the most invasive exotic plants around the world affecting the ecosystems and the socio-economy of the people.	[7] [28] [30] [37]
Fabaceae	*Piscidia piscipula*	Jabín (Mexico) Barbasco, Palo de agua, Chijol, Fish-poison-tree (USA), Fishfuddle, Dogwood (Jamaica), Guamá (Cuba)	AD	In Mexico it is found in the states of Tamaulipas, Veracruz, Campeche, Yucatán, Quintana Roo, Chiapas, Oaxaca, Guerrero, Michoacán, Colima, Jalisco and Nayarit. It is also found in Florida and in several caribbean islands		[38]
Portulacaceae	*Portulaca oleracea*	Verdolaga (Mexico), Purslane, Pursley, Little hogweed, Wild portulaca (USA)	AD	Its native distribution is Asia, Europe and America	It is an invasive and transformative species of ecosystems. It is among the 100 most harmful weed	[34] [39]

Continued

Malvaceae	*Sida glabra*	Escobilla (Mexico), Smooth Fanpetals (USA)	A y PD	It is distributed in the tropics and subtropics of both hemispheres	It is reported as a host alternate of Begomovirus in Latin America countries such as Colombia	[30] [40]
Sterculiaceae	*Waltheria americana*	Bretónica, Velvetleaf, Marshmallow, Monkey bush, Boater bush (USA)	PM	It's found throughout the warmer tropics and subtropics	It is a weed alternate host of begomoviruses	[30] [41] [42] [43]

*A = Annual; B = Binnual; D = Dicot; M = Monocot; P = Perennial.

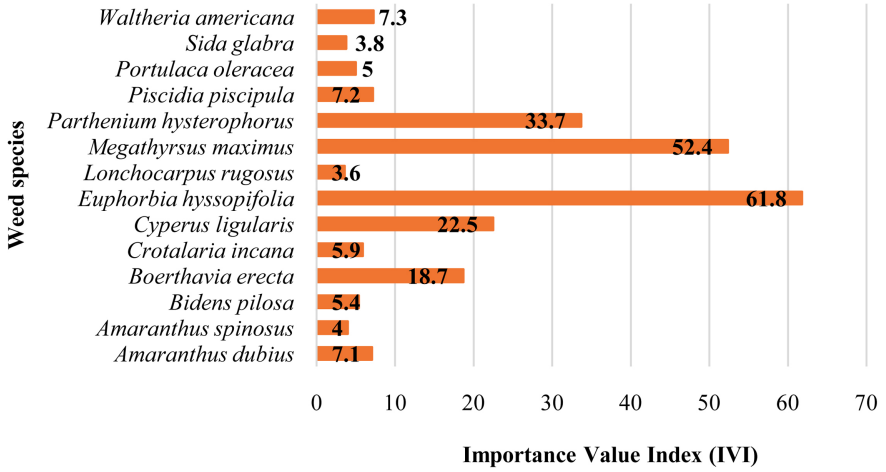

Figure 1. Importance Value Index (IVI) of weeds associated with the Habanero pepper plot in Muna Yucatán, Mexico.

The nematode *M. incognita* can cause production losses of at least 100 billion dollars in the world [44]. In addition, the genus *Meloidogyne spp.* is the ten most important genera of parasitic nematodes in the world reducing yields significantly [45] [46].

On the other hand, *Bemisia tabaci* is one of the most serious pests in greenhouse and field horticultural crops throughout the world [47]. It has a wide range of hosts, high fertility and high virus transmission capacity [14]. This pest causes direct damage through phloem feeding and toxin injection [15]. Indirect damage occurs when transmitting the Begomovirus [16] causing production losses of at least 95% [17].

5. Discussion

The HP producers annually alternate the HP with other annual or perennial crops [48]; therefore, tillage plays an important role in the dispersal of invasive weeds such as those described in Table 1. The higher presence of four species

with the highest IVI's (*E. hyssopifolia*, *M. maximus*, *P. hysterophorus*, and *C. ligularis*) is of considerable importance due to their role as competitors or hosts of pests and diseases. The *E. hyssopifolia* is a natural reservoir of *Begomovirus* and the whitefly *Bemisia tabaci* (*Gennadius*), considered as the main disease and plague of HP. The whitefly-host-weed interaction triggers the transmission of viral diseases in the first month after transplanting [49].

On the other hand, *M. maximus* (Guinea grass), is an herbaceous species used for fodder purposes and can be converted from an invasive weed into a potential cattle grass food. Its high seed production, germination capacity, viability, vigor, weight and size of seeds favor its wind dispersion [50].

On the other hand, Guinea grass produces three to four million seeds per kilogram [51]; good enough amount to be dispersed to the field until invading vast areas of the Mexican tropical and subtropical regions. Due to its erect growth habit and efficient architecture, it is a more efficient light receptor than other creeping growth species, reason to be a dominant weed [50].

6. Conclusions

Fourteen species of weeds were found one week before planting HP: *Amaranthus dubius*, *A. spinosus*, *Bidens pilosa*, *Boerthavia erecta*, *Crotalaria incana*, *Cyperus ligularis*, *Euphorbia hyssopifolia*, *Lonchocarpus rugosus*, *Megathyrsus maximus*, *Parthenium hysterophorus*, *Piscidia piscipula*, *Portulaca oleracea*, *Sida glabra* and *Waltheria americana*.

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Human activity, in many cases, plays an important role on weeds dispersal. The identification, description and specific forms of adaptation to the environment can contribute to devise a better weed control management in crop fields such as the HP.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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