



# Weeds Associated with an Orange Sweet Crop (*Citrus sinensis* (L.) Osbeck) in the State of Yucatan, Mexico

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## Abstract

The objective of this study was to determine the abundance, dominance, and coverage of weed species present in a developing sweet orange (*Citrus sinensis* L.) orchard in the state of Yucatán, Mexico. Weed collection was carried out in a sweet orange crop six months after transplanting, using the Valencia Late variety. For taxonomic identification, images of the adult plant with flowers, fruits, and seeds were taken, supported by an herbarium. The Importance Value Index (IVI) showed 8 predominate species, 48.73% with broad-leaves and 51.27% with narrow-leaves. The most predominant species were: *Cyperus rotundus* (Cyperaceae) and *Sorghum halepense* (Poaceae), with the higher IVI, at 100% and 40.3%, respectively. The presence of weeds represents a significant increase in the production costs in the sweet orange orchard, so its identification is essential for an effective weed management program.

## Subject Areas

Agricultural Engineering

## Keywords

Host Weeds, Identification, Weed Taxonomy, Noxious Weeds

## 1. Introduction

Citriculture is an activity of great importance in the state of Yucatán due to the area dedicated to its cultivation. Within the citrus production of the state, the sweet orange (*Citrus sinensis* L.) stands out with more than 15 thousand hectares,

a production of 199 thousand tons and a production value of more than 1171 million Mexican pesos [1].

Despite the great importance of the crop, average yields in the state are low ( $13.84 \text{ t}\cdot\text{ha}^{-1}$ ) and one of the factors that influence these yields is the presence of weeds, which affect the development and vigor of the trees due to the competition established for moisture, nutrients and also because they are hosts for pests and diseases [2] [3]. On the other hand, some weeds can release toxic substances, which can affect crop growth [4]. The presence of weeds in orange orchards can cause yield losses of up to 33% as a result of competition [5]. In addition, they create a favorable environment for pathogens that infect citrus trunks and roots, causing yield losses [6].

The most critical period for weed control in citrus orchards starts from the early stages of development up to 6 years of age, because young citrus trees produce very little shade to suppress weeds [7], this is more common in plantations with low densities. In Mexico, it is estimated that, in orchards with adequate weed management, yields of over 40 tons can be obtained, while in orchards with poor management (mainly in the flowering stage),  $12 \text{ t}\cdot\text{ha}^{-1}$  are obtained [8]. Given this scenario, weed management is a crucial practice for profitability in citrus orchards [9].

In the state of Yucatán, growers employ a combination of manual weeding in the crop rows and the application of various herbicides such as glyphosate and paraquat for weed management [10]. Chemical weed control, although very effective, has limitations such as: high costs in crop production (labor and agrochemicals), negative environmental impacts and development of herbicide resistance [11]-[13].

The continuous use of herbicides during the same agricultural cycle causes the emergence of resistant weed biotypes/populations [14], which in the end is economically unaffordable due to its high cost. An alternative to this problem is phytosociological studies, which are an essential tool for analyzing weed communities, because they allow understanding their composition, structure, and relationships with the environment [15]. These studies include the identification of species, the collection of quantitative data on their abundance and frequency of occurrence, and the use of indices to characterize the vegetation [16]. For proper weed management, it is necessary to identify the species present in the crop, as it is essential to determine which ones have greater ecological importance and competitive potential, as well as the environmental factors that contribute to their prevalence [17]. The objective of this study was to evaluate, through a case study, the abundance, dominance, and coverage of weed species present in a developing sweet orange orchard in the state of Yucatán, Mexico.

## 2. Materials

### 2.1. Location and Plant Material

This study was carried out in the Agricultural Unit “José López Portillo N°3”, in

the municipality of Muna, Yucatán, Mexico, located at 20°24'52.35" north latitude and 89°48'30.75" west longitude at 10 masl. In the months of September to December 2023 (dry season), in an orchard of *Citrus sinensis* (L.) Osbeck, Valencia Late variety, newly established at six months of age with a planting frame of 7 m × 7 m, in a soil Ak'al che' in Mayan terminology [18] and Gleysols in the World Reference Base (WRB) [19]. A 1.0 ha plot was selected to identify and quantify the weed population associated with *C. sinensis* (L.). A simple sampling model of weeds was implemented, using twelve squares of 1.0 m<sup>2</sup> (1.0 × 1.0 m) randomly located between rows of the crop.

## 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), the Scientific Research Center of Yucatan (CICY) and the National Herbarium of Mexico of the National Autonomous University of Mexico (MEXU).

## 3. Methods

### Weed Collection

Frequency of appearance, abundance and dominance of each species were recorded and the Importance Value Index (IVI) of each weed was calculated by adapting the methodology described by Gámez López *et al.* (2011) [19].

The Importance Value Index (IVI) was developed by Curtis and McIntosh (1951) [20]. It is a synthetic structural index, developed mainly to rank the dominance of each species in mixed stands. It was calculated as follows:  $IVI = \text{Relative dominance (a)} + \text{Relative density (b)} + \text{Relative frequency (c)}$  [21].

According to Campo and Duval (2014) [22], these three parameters are calculated as follows:

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

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

$$(c) \text{ Relative frequency} = \frac{\text{Frequency of each species}}{\text{Frequency of all species}} \times 100$$

## 4. Results

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

The 8 weed species found on the orange sweet 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.

**Table 1.** Characteristics of the predominant weed species in the sweet orange orchard.

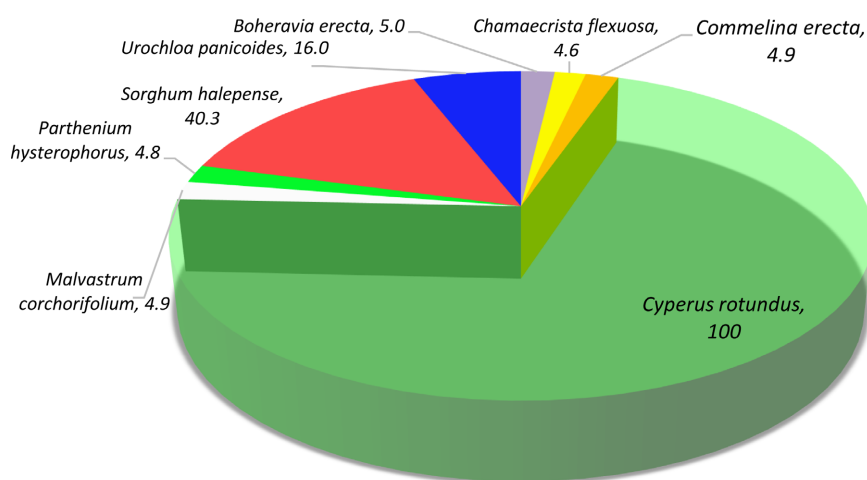
Family	Scientific name	Common name	Botanical behavior	Habitat	Impact	References
<b>Nyctaginaceae</b>	<i>Boerthavia erecta</i>	Hierba blanca (MEXICO), Anisillo, escorián, Golondrina (CHIAPAS-MEXICO), Hierba del arlomo, Maravillita, Sanguinaria, Zanca de gallo, Tostón (CUBA), Erect spiderling (USA)	A D	It is originally from the United States, Mexico, Central America and Western South America. It is reported as a cosmopolitan weed in tropical and subtropical regions of the world.	It is reported as a host of whitefly nymphs and viruses.	[23] [24]
<b>Commelinaceae</b>	<i>Commelina erecta</i>	Espuelitas, Hierba del pollo, Mataliste, hierba de Santa Lucía (ARGENTINA); Pah-tsa', X-habul-ha y yáax-ha-xiu, paj ts'a (MAYAN LANGUAGE-MEXICO); Erect dayflower, Whitemouth dayflower, Widow's tears (USA); Flor de la virgen, Hierba de lluvia (MEXICO); Nuub en nuub ojo, corrimiento xiiw (MAYAN LANGUAGE-MEXICO)	P D	No reference was found rest.	It is reported as a weed in rice, coffee, sugar cane, citrus, ornamental plants and banana.  It is not normally a worrying weed, but since it is not very susceptible to glyphosate, can become a problem in conservation tillage agriculture.	[25]-[28]
<b>Malvaceae</b>	<i>Malvastrum corchorifolium</i>	False mallow (USA), Sak xiiw (MAYAN LANGUAGE-MEXICO)	P D	Low and medium deciduous forest	No reference was found	[29]
<b>Cyperaceae</b>	<i>Cyperus rotundus</i>	Coquillo (Mexico), Coquito, Chufa, Yellow nutsedge, Chufa flatsedge, Earth almond (USA)	P M	It is abundant in 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 problems.	[30]
<b>Asteraceae</b>	<i>Parthenium hysterophorus</i>	Parthenium (USA), Falsa altamisa, Altamisa	A D	It prefers humid and sub-humid	It is a host of Begomovirus; and	[31]-[33]

		del campo, Escoba amarga, Escobilla (México)		tropical climates, showing a marked preference for high-fertility, clayey soils, but is capable of growing on a wide variety of soils.	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.
<b>Poaceae</b>	<i>Sorghum halepense</i>	Johnson grass, Aleppo grass, Aleppo millet grass (USA, South Africa); Evergreen millet (Australia); Arroz bravo (Brazil); Pasto Johnson (Colombia); Pasto polaco, Pasto ruso (Honduras); Zacate Yonson (Costa Rica); Aleppo-bartgras, Aleppohirse, Aleppomohrenhirse (Germany); herbe panache, herbe yaguidi (Haiti); Zacate Johnson, Sorgo de Halepo, Sorguillo, Zacate secencle, Triguillo, Sorgo de Alepo, Pasto ruso, Canutillo (Mexico); Baru grass, Palau (Pakistan); Halaiyansifrand (Saudi Arabia); durra, ograes (Sweden)	A P	Native to parts of the Mediterranean region and western Asia. It has been introduced in temperate, subtropical and tropical zones throughout the world.	It is mainly used as fodder for livestock and for hay production. However, in times of frost or drought, <i>S. halepense</i> has a high cyanide content, which is harmful to livestock. It acts as an alternative host to several insects, pathogens, and nematodes, which significantly affect crop production.
<b>Poaceae</b>	<i>Urochloa panicoides</i>	Yuyo blanco (Mexico)	P M A	It is native to Africa. It has naturalized elsewhere, including Australia, Argentina, India and the United States.	It generally grows in open fields, roadsides, disturbed and cultivated soils. <i>U. panicoides</i> has been reported to be a susceptible host of <i>Meloidogyne incognita</i> and a poor host of <i>M. javanica</i> . It also hosts the <i>Aceria tosichella</i> mite, which transmits viruses: Wheat Streak.

					Mosaic Virus (WSMV) y Wheat Mosaic Virus (WMoV).
<b>Fabaceae</b>	<i>Chamaecrista flexuosa</i>	Common name unknown	A D	It is originally from the America. It is found in savannas, dunes, beaches and open sandy forests, from southern Mexico to southeastern Brazil and northern Argentina, also in Cuba.	It is reported as pollinator plant for at least six species of Apidae bees. [42]

Note: A = Annual; B = Biannual; D = Dicot; M = Monocot; P = Perennial.

The Importance Value Index (IVI) of each species is shown in **Figure 1** and the results show the presence of eight species of weeds six weeks after planting sweet orange: *Chamaecrista flexuosa*, *Urochloa panicoides*, *Sorghum halepense*, *Parthenium hysterophorus*, *Cyperus rotundus*, *Malvastrum corchorifolium*, *Commelina erecta*, *Boerhavia erecta*. Of the total species, 48.73% with broad-leaves and 51.27% with narrow-leaves. The species *Cyperus rotundus* (Cyperaceae), and *Sorghum halepense* (Poaceae) were the most predominant ones with the highest IVI, at 100% and 40.3%, respectively (**Figure 1**).



**Figure 1.** Importance Value Index (IVI) of weeds associated to sweet orange crop.

## 5. Discussion

Weeds are plants that grow in undesired places without having been introduced voluntarily, and on the other hand, they present outstanding characteristics that

other plants do not possess, such as their high reproduction rate, ease of dispersal and a competitive ability [43] [44].

This was noticeable in this sweet orange orchard, where the land preparation activities carried out by the farmer, prior to the establishment of the crop, such as tillage, which involves breaking up the soil to prepare it, accidentally caused the dispersion of Johnson grass rhizomes (*S. halepense*) and bulbs, tubers, and rhizomes of nutsedge (*C. rotundus*), which over time become uncontrollable, causing these two monocotyledons to be the most predominant with the highest Importance Value Index (IVI), with 100.0% and 40.3%, respectively.

On the other hand, the low diversity of other species observed in this orchard can be attributed to the predominance of narrow-leaved species (*C. rotundus* and *S. halepense*), whose presence generates strong competition for resources. These species inhibit the development and proliferation of the rest of the broadleaf species, limiting their ability to establish and prosper in the orchard. These two species showed a high degree of adaptability and competitiveness in the environment, which caused a decrease in the diversity of the rest of the plant community.

It is important to note that in Mexico, one of the main problems limiting citrus productivity is the presence of weeds; this hinders fertilization, harvesting, pest and disease control, and, most importantly, compete for water, light, and nutrients, which leads to significant reductions in leaf area and, consequently, in tree yield [45]. In Yucatán, in the particular case of orange cultivation, the damage is greater and more visible in the early years of the plantation, which is why special attention must be given during this stage, as the presence of weeds, especially *C. rotundus* and *S. halepense*, if not controlled, can seriously affect the health, development, and vigor of the trees. As a result, citrus growers invest between 15% to 35% of production costs in weed control [45].

## 6. Conclusion

In this sweet orange orchard, narrow-leaved species predominated. Eight species were identified: *Chamaecrista flexuosa*, *Urochloa panicoides*, *Sorghum halepense*, *Parthenium hysterophorus*, *Cyperus rotundus*, *Malvastrum corchorifolium*, *Commelina erecta*, and *Boerhavia erecta*, belonging to six families, with Cyperaceae and Poaceae being the most represented, according to their highest IVI values: 100% and 40.3%, respectively.

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## Conflicts of Interest

The authors declare no conflicts of interest.

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