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The most important diseases affecting tomato crops and methods of prevention and control

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I. Abstract

The tomato (Lycopersicon milles esculentum) is the second most important vegetable crop globally and in the Arab world. It is an herbaceous plant belonging to the nightshade family (Solanaceae), which includes about 2000 species and 90 genera (Gerszberg et al., 2015). Tomatoes are considered an important agricultural vegetable crop, serving as both a food and processing crop, supporting some food industries and representing a significant source of national agricultural income. Despite the economic and nutritional importance of tomatoes, the local environmental and climatic conditions allow for year-round cultivation (Abdul Sadiq et al., 2020).

It is consumed either fresh or cooked and is used in many food industries, whether as a plant-based food or an economic crop of great economic importance in raising farmers' income, especially when it is grown on a large scale. Tomatoes can be used as a vegetable or served with rice and salads (Perveen et al., 2015).

Tomatoes have been found to have significant medicinal and nutritional benefits. Approximate analysis shows that fresh (ripe) tomatoes contain: 13 mg of calcium; 27 mg of phosphorus; 0.5 mg of iron; 3 mg of sodium; 244 mg of potassium; vitamin A; 0.6 mg of thiamin; 0.4 mg of riboflavin; 0.7 mg of niacin; and 233 mg of ascorbic acid (Waid and Hanna, 2012 et al., and Audrius, 2016).

II. Cultivated Area

The annual global production of this crop is estimated at approximately 152.9 million tons, valued at $74.1 billion (Rakha, 2011). Many tomato varieties are cultivated in Iraq, differing in their growing season and ripening time, making them available in markets year-round. These varieties include Wajdan, Newton, Reema, Zahab, Randy, Yasmin, Kousa, and many others There are different varieties, and they differ in characteristics such as ripening stage and nutritional level, as varieties grown in open fields taste better than those grown in greenhouses (Mikkelen, 2005 and Hussein et al., 2012). Tomato crops are also affected by salinity and grow in warm and humid regions (Maggio et al., 2004).

The annual tomato production in Iraq for 2017 was estimated at approximately 304,921 tons, cultivated on a total area of 55,523 dunams, with a yield of 5,492.6 kg/dunam. (Ministry of Planning, Central Agency for Statistics, 2017). Per capita consumption of tomatoes is estimated at 40-100 kg annually. Mediterranean and Arab countries are among the highest consumers of tomatoes. (Bergougnux) (2014) Tomato plants in all their growing regions are exposed to numerous agricultural pests, the most important of which are fungi, bacteria, viruses, and nematodes. Spots, blights, and wilts are among the most

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significant diseases affecting the foliage, causing substantial losses in both the quality and quantity of the crop (Kirankumar et al., 2008; Fayyad and Abbas, 2018) (Tapwal et al., 2011).

Important diseases affecting tomato crops:

1- **Early blight of tomato (Solani Alternaria)**

This is one of the most important diseases affecting tomato crops, causing significant economic losses for tomato growers worldwide (Esoinosa-Vazguez et al., 2019). Current estimates of losses from this disease range from 5-50%, particularly in the Solanaceae family (Chardhary et al., 2021). This disease severely impacts tomato production in terms of both yield and quality. It is prevalent in areas with abundant rainfall, high humidity, and moderate temperatures ranging between 22-28°C. These temperatures, combined with humidity and rainfall, promote rapid disease development during plant growth (Faroog et al., 2019; Dhaval et al., 2021).

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Signs of injury and damage:

Symptoms appear on older leaves as small, dark, circular spots. As the infection progresses, the spots expand into concentric rings, surrounded by a yellow halo. Over time, all the leaves turn yellow, then brown, dry out, and a large percentage fall off, exposing the fruit to direct sunlight. Fruits near the stem end are also affected, developing dark brown spots that tend towards black.

Prevention and Treatment:

Collect and burn crop residues to reduce the source of infection and use clean seeds from reliable sources. Use compounds that stimulate systemic resistance and spray plants with suitable fungicides such as Scor.

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2- Root rots caused by the pathogen: Rhizoctonia solani:

Signs of injury and damage:

This fungus is found in the soil and causes seedling death before and after germination, root damage, and then plant wilting. The disease begins with root rot and stem lesions, which appear as water-soaked spots that are brownish-red in color. Brown spots appear on the roots, and in severe cases, these spots enlarge and become black and rough to touch. (Gondal et al., 2019)

Prevention and Treatment:

Follow a crop rotation and avoid planting tomatoes, potatoes, and eggplants next to each other. Remove and burn infected plants. Pay attention to potassium fertilization. Spray with an approved chemical pesticide once every 15 days.

3- Root rots caused by the pathogen Pythium aphanidermatum:

Symptoms and Damage These appear as elongated water-soaked spots on seeds, seedlings, and roots approximately 3 weeks after planting. These spots can spread to the entire plant, causing rot in the small roots and basal stem tissues, leading to wilting and plant drop. The fungus *P. aphanidermatum* plays a major role in sudden death disease and causes severe damage to tomato plants grown under field conditions after irrigation at high soil temperatures. (Le et al., 2003)

Prevention and Treatment:

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Treat seeds before planting with a recommended fungicide. Pay attention to irrigation and improve drainage. Also, follow a crop rotation to avoid infection and use recommended and approved fungicides to control root rot and damping-off (Elshahawy et al., 2018).

4- Alternaria leaf spot disease caused by the fungus Alternaria alternata:

Alternaria leaf spot disease, caused by the fungus *A. alternata*, affects a wide variety of agricultural and horticultural crops, including tomatoes, potatoes, carrots, cauliflower, cabbage, broccoli, peppers, beans, apples, peaches, and various citrus fruits. It causes significant economic losses, especially when environmental conditions are favorable for the spread of the pathogen, such as in humid regions. High humidity and dew and rain (Rodinos et al., 2014, Akhtar et al., 2004, and Simmonis, 2000). The fungus *A. alterata* is widespread throughout the world. It has been isolated from most plant families. It lives in nature as a saprophyte on organic matter and plant remains (Guo et al., 2004). It causes leaf spot, flower rot, and fruit rot diseases in a wide range of plant families, reaching up to 380 families. Thomma (2003) found that the fungus A. alterata is a seed-associated fungus, in addition to being transmitted to plants via contaminated soil (Dubey and Patel, 2000, 2013).

Signs of injury and damage:

Symptoms appear as spots on the leaves. Infected plants have yellowing leaves that then turn brown. The infection begins with the lower leaves and progresses upwards. Necrosis is usually at the leaf margin and appears as brown spots. These spots enlarge and coalesce, causing leaf blight, which can affect a large part of the leaf blade. Dark layers have been observed within these spots on the leaf surface. Under conditions of high humidity, and as the infection progresses Leaves and flowers fall off, and the plant's ability to perform its vital functions, including photosynthesis, decreases, resulting in significant losses before fruit set and reduced yield (Akhtar et al., 2004; Al-Khairou, 2011). On the fruit, symptoms appear as sunken black spots on ripe tomatoes. When moisture is present, these spots heal and form a velvet-like layer on the fruit's surface (Akhtar et al., 2004). The fungus also affects the plant. A. alternata affects other parts of the tomato crop, specifically the stem, and is called Canker Stem. Symptoms appear on the stem and branches as sunken, dark brown, almost black, spots. Infection appears near the soil, where lesions form before harvest and kill the plant, where brown streaks appear in the Brandswagt et al. (2002) Vascular Tissues

Prevention and treatment:

Using biological control methods, especially for controlling vegetative diseases; following crop rotations in well-drained soils and planting resistant or tolerant seedlings; collecting and burning plant debris away from the field; reducing humidity around plants to prevent infection; removing weeds to eliminate them as a source of infection; moderate fertilization, especially nitrogen fertilization; increasing potassium fertilization, particularly during flowering and fruit set, to promote fruit firmness; spraying with one of the recommended fungicides for this disease every 10-15 days, depending on the severity of the infection and the surrounding weather conditions.

5- Fusarium wilt caused by the disease Fusarium oxysporum f. sp. Lycopersici :

Fusarium wilt disease in tomatoes is one of the most important diseases affecting tomatoes in Iraq, particularly in infested soils. Virtually every tomato farm is affected (Jarjis et al., 1992). This disease is considered a serious threat to tomato crops, not only in Iraq but also in the United States, particularly in sandy soils. It reduces yields by approximately 25% in almost all countries (Horinouch et al., 2007). The disease affects a wide range of vegetable crops, including tomatoes, eggplant, okra, pumpkins, peppers, and cucumbers, causing significant economic losses

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in both greenhouses and open fields (Muhammad et al., 2020). The disease spreads extensively on tomato crops, causing losses in susceptible varieties when warm weather conditions are conducive to infection. Losses are estimated at 30-40% of the total crop yield, and sometimes reach up to 80% (Kirankumar et al., 2008).

Signs of injury and damage:

General weakness in the plant because of the blockage of the vessels by the pathogen, which prevents the entry of nutrients to reach the leaves. Symptoms appear on large plants in the form of yellowing and drooping of the lower leaves, and in number, the leaves begin to fall off and then die. Sometimes, infected plants begin to wilt yellow on one side of the plant. When a cross-section or longitudinal section is made of the stem of the infected plant, we notice that the vascular tissues are colored brown, as well as the appearance of red spots on the root and the vascular bundles are colored and turn brown. These spots extend upwards to the area where the stem appears above the soil surface in the case of severe infection. This leads to stunting of the plants, their leaves turn yellow, and the roots die.

Prevention and Treatment

Treat seeds before planting with a recommended fungicide. Pay attention to irrigation and improve drainage. Follow crop rotations to avoid infection. Use recommended and approved fungicides to control root rot and seedling death.

6- Late blight caused by the pathogen Phytophthora infestans:

Signs of injury and damage:

Symptoms and Damage This disease affects all parts of the plant. Large, irregular, dark green, water-soaked spots appear on the stems, leaves, and fruits. These spots enlarge and turn dark brown. In humid weather, a grayish downy growth forms on the underside of the leaves, surrounding these spots. Large black and olive-colored spots also appear on the fruits, covering the affected tissues on the fruit surface. Phytophthora, which affects tomato plants, is one of the most widespread and economically damaging diseases. This disease can lead to a decrease in yield of up to 10-50%, and up to 100% in aerial plants. The disease begins during flowering and damages the leaves, stems, and fruits of the plant (Soylu et al., 2006).

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Prevention and Treatment:

Use resistant varieties, follow crop rotations, and avoid planting tomatoes and potatoes immediately after each other. Spray with an approved chemical pesticide every 10 days and use fungicide.

7- White mold or Sclerotinia sclerotiorum, the causative agent of the disease

Signs of injury and damage:

The infection appears on any part of the plant, especially on the stem near the soil surface, as small, watery spots that are brown or yellowish white in color. The infection may extend downwards, affecting the root system and the upper part of the stem, reaching the bases and petioles of the leaves, causing them to yellow and wilt. These spots turn into ulcers on the stem and branches, and white fungal growth and sclerotia (hardened fungal bodies) appear. These sclerotia are brown and gradually turn black inside the infected parts of the stems and branches, varying in size and sometimes reaching the size of a pea. The fruits are also infected, showing white fungal mycelium, becoming soft, and rotting rapidly (Ahmed et al., 2017; Fernando et al., 2004).

Prevention and Treatment:

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Treat seeds before planting with a fungicide. Plant tolerant or disease-resistant varieties. Practice crop rotation. Burn plant debris to eliminate sclerotia and infected plants. Maintain regular irrigation and avoid over-irrigation to minimize disease occurrence, as over-irrigation increases the risk. Plant in light, well-drained soil. Eliminate secondary hosts of the fungus, especially weeds, as this reduces the chances of infection. Use a recommended fungicide both preventively and curatively when symptoms appear on approximately 5% of the plants.

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