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## Fusarium wilt of tomato

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#### Abstract

Tomato is regarded as one of the most important commercial crops. Tomato is commercially grown in various parts of India. But it has high disease infestation rate. This crop has higher chances of disease attack. The fungal diseases like Fusarium wilt caused by *Fusarium oxysporum* f sp. *lycopersici* is one of the most important disease of tomato crop. This crop reduces the yield of tomato at a very high level. The pathogen *Fusarium oxysporum* f sp. *lycopersici* is a soil borne pathogen and can transmit through soil in tomato plants. This fungus firstly enters through the soil to the vascular plant tissues of roots and causes wilting of the plant and eventually causes the plant death. Drying of leaves, discoloration of lower leaves of plants and wilting of the plant are the major symptoms of Fusarium wilt. For the management of *Fusarium* wilting various resistant varieties of tomato should be used. The crop management practices like crop rotation, disinfection of tools and implements should be there, biological control, chemical control and cultural control should be opted. The proper management practices are very important for the control of Fusarium wilt in green house, glass house and field conditions. This review paper provides the complete information about the main diseases of tomato crop that is *Fusarium* wilt, its symptoms, cause of infection, life cycle of the pathogen and its preventive measures. The study of Fusarium wilt is very important mainly in the tomato crop because it causes great loss in the commercial production of tomato crop.

**Keywords:** Crop, disease, fusarium, infection, management, plant, tomato, wilting

#### Introduction

Tomato (*Lycopersicon esculentum*) is the most important crop. Basically, tomato is a fruit crop but it is grown as a vegetable for commercial production all over the world. Tomato is a very nutritious crop and contains various antioxidants and a large number of micronutrients. Tomato crop has various health benefits as it is used for the production of medicines, cosmetics and preservatives. Tomato is recommended by many dieticians for controlling cholesterol and helps in the reduction of weight. The average production of tomato in the year 2019-2020 is about 20.57 million tonnes. China is the largest producer of Tomato in the world. China produces about 56,423,811 ton of tomato in a year. India ranks second in the production of tomato crop. The production of tomato crop in India is 18,399,000 ton per year. The state Andhra Pradesh is the largest producer of tomato in India. The other major producer of tomato in India are Bihar, Uttar Pradesh, Madhya Pradesh, West Bengal and Orissa etc. Tomato crop is very sensitive towards diseases and insect pests. The infestation of diseases and insect pest attack on tomato crop is very high due to which it leads to the reduction in yield. Tomato crop is infected by a large number of diseases. Out of which the infection of disease *Fusarium oxysporum* is on high. The disease *Fusarium oxysporum* is caused by the causal agent or pathogen *Fusarium oxysporum lycopersici*. This species of the causal agent is one of the most important species of this pathogen<sup>[1, 3]</sup>.

The disease tomato wilt is one of the most dangerous disease of tomato and even causes total damage to the tomato field. The causal organism of Fusarium wilt that is *Fusarium oxysporum* is a soil borne pathogen that means the pathogen can persist in different types of soil for many years even without a host. This species of Fusarium is saprophytic in nature that means this can even grow on soil organic matter for a very long time. The infection starts spreading from the infected plants and infected tomato debris. If the infection is present in soil, then the healthy plant also gets infected due to the presence of pathogen in the soil. This pathogen also leads to the destruction of tomato plant roots and lower plant parts. The stem and roots start deteriorating and causes wilting of the plant. The brown colouration of the vascular tissue of tomato plant is one of the major symptoms of Fusarium wilting<sup>[15]</sup>.

All the fungal plant diseases are managed with the help of fungicides or the use of resistant varieties. Likewise, the fusarium wilt is also managed with fungicides and resistant varieties. Fungicides are the most important management practice which is used to control the plant diseases. Mainly the biological agent *Trichoderma* is also used to control the pathogenic diseases which are caused by the pathogens mainly fungi. This pathogen *Fusarium oxysporum* is found almost in the tomato growing fields worldwide. This pathogen firstly affects the vascular system of the tomato plant which leads to wilting of the crop. Fusarium wilt is considered as the most important systematic soil borne disease. This will cause a significant loss in tomato production both in field conditions and in green houses conditions. But various diseases management strategies are opted for the management of diseases. The management strategies opted for the diseases control are biological control, chemical control, cultural control, use of disease resistant varieties, crop rotation and management techniques etc. The use of resistant varieties is considered as the most effective method for the control of Fusarium wilt. This method is safe, environment friendly and easily applicable in the field. But now a days some pathogens also overcome from the resistant genes and cause attack to the tomato field. The chemical control is also the good method used for controlling the Fusarium wilt but this method has some residual effect. The chemical control method is used in a wide scale both in field conditions as well as in green house conditions. The fungicides used for the control of *Fusarium oxysporum* are Thiram, Benomyl, Prochloraz, Bavistin and Captafol etc. are used. These fungicides provide control from the fusarium crown, wilt and root rot diseases of tomato. But the disadvantage of these fungicides is that they have residual effect and leaves residues in tissues of fruits. For the control of Crown rot and root rot diseases of tomato, the application of Chloropicrin and methyl bromide is regarded as best. The fungicides containing Manganese sulphate, Ferric chloride and Copper chloride etc. are very useful for controlling the *Fusarium oxysporum* f.sp. *lycopersici* and it also provides resistance in susceptible tomato plants. The fungicide named as Captan or Vitavax is also use as a seed treatment and shows very good results for the control of *Fusarium oxysporum*. The combined use of Captan and Vitavax is also known as Vitavaxthiram is best for the control of fungal diseases. For the control of the pathogen *Fusarium oxysporum* f sp. *lycopersici* other fungicide in which combined use of copper oxychloride and Metamidoxime is used shows the synergistic effect. In green house and glass house conditions for the control of *Fusarium oxysporum* the application of Topsin- M and Thiram at the rate of 800mg/g of soil is highly effective. This application will reduce the population of *Fusarium oxysporum* up to 83% after 45 days of fertilizer application [3, 6, 14].

### Fusarium wilt

Tomato is a crop that can easily be grown in a variety of soil but, it will be better if the soil must be well-drained and. If the soil has a good supply of organic products then the yield will be enhanced. The same related crops like tomato, potato, pepper, and other vegetable cultivation should be avoided in the same land once in three years. Any cover crop, better if crop belongs to grass family could be much better for the crop rotation with tomato. Tomato is a crop that attracts many pests and diseases so to prevent the tomato from any pest or disease it is better to prefer certified seeds or resistant plants.

There are many diseases by which tomato is affected like bacterial wilt, early blight, late blight, septoria leaf spot, leaf mold, etc. but, among them, there is one disease which causes severe harm to tomato i.e. Fusarium wilt of Tomato (Borrers *et al.*, 2004) [11].

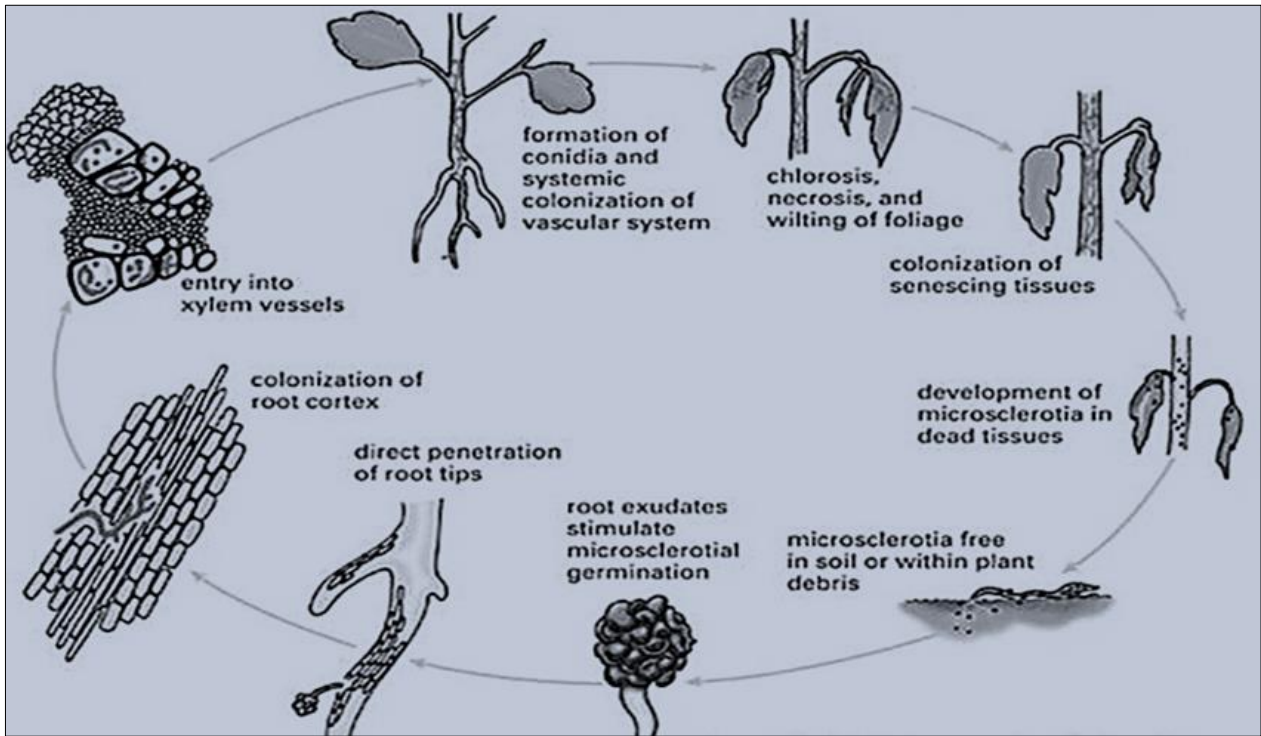
The fusarium wilt of tomato is caused by the fungus *Fusarium oxysporum* f.sp. *lycopersici*. This fungus is very severe that even the resistant variety can get affected by this (Akkopru *et al.*, 2005). The fungus enters a plant through the roots as it is a soil-borne disease, it affects the plant by blocking the xylem as we know xylem transport the water and nutrients to all parts of the plant but, after the xylem gets blocked then the transportation of water and nutrients will not possible and certainly, the plant production will be reduced. Not only tomatoes but other horticulture crops can also get affected by this fungus such as potatoes, peppers, and eggplants. Then the question arises what causes fusarium wilt in tomatoes? [2, 8, 12]

### Causes of Fusarium Wilt in tomato

As we discussed earlier *Fusarium* is a soil-borne disease and enter through the roots, as it developed in the soil so for years it remains in soil too and transmitted by various ways e.g. from the infected seeds if the seeds are infected then the plant emerge from that seed also get affected and it is a chance that it can also affect the plant around them, the seedlings which were grown in infected soil can also transmit the disease, the bottom of the shoe as any person walk through the affected soil the fungus get attached with the shoes and get transferred from one place to another same as shoes the fungus can also transfer from shovels and equipment which was used during the cultivation of any previous crop affected with fusarium wilt. The fusarium fungus needs a warm and dry condition to grow and the soil should be acidic with pH (5.0 to 5.6). There are a variety of tomatoes that are resistant to this disease but also can get affected if the root of the plant is affected with a root-knot nematode. The plant which gets affected with Fusarium wilt would not die but the growth of the plant gets stunted and over time it became more severe. We can identify fusarium fungus easily as it cannot be visible by our naked eyes but through the symptoms, we can know the plant is affected with fusarium fungus [4, 7, 9, 13].

### The life cycle of Fusarium Wilt

It is a soil-borne fungus and survives up to 5 to 10 years without any host and as we discussed earlier the soil should be acidic in nature and humidity should be high in this kind of soil the fungus easily grow and survive. The fungus enters through the root of the plant and blocks the xylem tissue and colonizes it, from there the fungus is transported into the whole plant. Due to the blockage, the leaves started to turn yellow and cause wilting as a result the plant eventually die. After the plant die development of microsclerotia in plant tissue started, and started to get spread in the soil the fungus produce some fungal resting structures known as chlamydospores which help the fungus to survive up to many years. After that, the root exudates stimulate microsclerotia germination, from the soil the fungus penetrates the root of new plant and affect those. Again the same thing repeat colonization starts in the cortex of root and enters into the xylem vessel and like previously formation of conidia and systematic colonization of vascular system as shown in (figure 1) [5, 8, 10, 12].



**Fig 1:** Life cycle of fusarium wilt

**Symptoms occur in plant due to fusarium wilt**

The symptoms of other wilts are also same as fusarium wilt, but we can identify the symptoms of fusarium wilts of tomato such as wilting, yellowing, dry leaves and stem discoloration [11].

**1. Wilting:** Due to the attack of fusarium fungus the plant get wilted, the wilt starts with single leaf or shoot of the plant as shown in (figure 2). The plant recover little bit at night when temperature come down but as the time passes the plant fully wilted and even watering them does not affect the plant [11].



**Fig 2:** Wilting in tomato

**2. Yellowing:** The leaves at lower side of the plant turn yellow in colour starting with one side of plant and gradually

move to whole plant covering them as shown in (figure 3) [11].



**Fig 3:** Yellowing of leaves

**3. Dry leaves and stem discoloration:** The dried and wilted leaves fall in the ground and if we open the stem length-wise

then we can observe some dark brown streaks as shown in (figure 4).<sup>[11]</sup>



**Fig 4:** Discoloration of stem and dried leaf

#### How to prevent or protect tomato from wilt

There is no cure for the *Fusarium* wilt as it survives in soil for many years it can resist anything, and eradicating this fungus is very difficult. But, still, there is some preventive method that can be helpful<sup>[16]</sup>.

- 1. Use of resistant variety:** Choosing the tomato variety which is resistant to *Fusarium* Wilt can be helpful, there are many varieties are available in the market, or choose the tomato variety which has VFN written on its packet because that variety will be resistant to both verticillium and *fusarium* too along with this it is also resistant to several nematodes<sup>[16]</sup>.
- 2. Sterile Potting Soil:** It is better to start with your seedling than others, with the use of sterile potting mix.
- 3. High soil pH:** As we know *Fusarium* fungus only survive if the soil pH is 5.0 to 5.6 by bringing the soil pH up to 6.5 to 7.0 will get difficult to survive.
- 4. Control nematodes:** If the root-knot nematodes are present in soil then an attack of *fusarium* wilt become much easier so, to control the *fusarium* fungus it is important to control root-knot nematodes<sup>[16]</sup>.
- 5. Do not cultivate:** Using a hoe or any cultivator around tomato plant should be avoided as it can damage the root and make way for the pathogens which can harm the plant easily<sup>[16]</sup>.
- 6. Disinfect tools:** Use of clean tools can reduce the chance of *fusarium* wilt, clean your tool before using it in another plant.
- 7. Crop rotation:** The fungus can survive in the soil for a long time and continuously cultivating tomatoes in the same field can increase the chances of attack of *fusarium* wilt. So, crop rotation of 5 to 7 years is required<sup>[16]</sup>.
- 8. Remove infected plants:** If any of the plants show symptoms like wilting, yellowing of leaves, dried off and discoloration of stem remove it as soon as possible because the fungus can transmit from one plant to another<sup>[16]</sup>.

#### Conclusion

The *Fusarium* wilt is caused by the pathogen *Fusarium oxysporum* f sp. *lycopersici*. This is a soil borne fungal pathogen and mainly damages the root portion of the tomato plant. Tomato is a commercially grown crop and is a very important crop for farmers. This disease damages the whole crop reduces the crop yield and leads to the death of the plant. The pathogen first enters from the soil to the roots of the

plant. Due to this the infection starts spreading in the vascular tissues of the plant. This will lead to the yellowing of leaves, discoloration of the stem, drying of lower leaves and causes wilting of the plant. All these symptoms cause final death of the plant. The management of this disease is very important. Various chemical control, cultural control, biological control is used for the management of the tomato crop. The use of resistant varieties, disinfection of soil, use of clean tools in the field is very important. This paper provides the complete information about the diseases *Fusarium oxysporum* f sp. *lycopersici*, its life cycle, symptoms, causal organisms and its management. The management of the *fusarium* wilt is very important for the proper growth and development of the crop and for achieving good and higher yield. Biological control are regarded as best control measure for the management of *Fusarium* wilt among all other control measure because this method is safe, easily applicable and is environmental friendly.

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