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MANAGING FUSARIUM DISEASES IN VEGETABLE CROPS

Yellowing and wilting cucumbers affected by Fusarium wilt.

INTRODUCTION

Fusarium is a genus of common soil-borne fungi. Most live as saprophytes on decaying plant matter while a few are also important plant pathogens. These plant pathogenic Fusarium fungi are necrotrophs (they feed



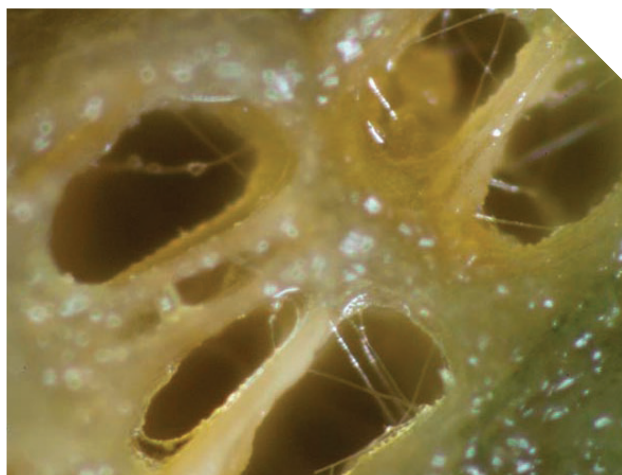
Banana-shaped Fusarium spores.

on dead plant tissue) – which implies they produce enzymes or toxins that kill plant cells as they invade.

Fusarium pathogens of vegetables produce characteristic banana-shaped spores (macroconidia), as well as other smaller, jellybean-shaped ones (called microconidia) and small resting bodies (chlamydospores and sclerotia). These chlamydospores and sclerotia can survive in soils for several years.

Wilt diseases

While there are many different pathogenic *Fusarium* species, some of the most damaging diseases are caused by strains of one species complex, *Fusarium oxysporum*. They cause vascular wilt diseases by entering the roots and colonising the water-conducting tissue (xylem) and then spreading up into stems where they secrete enzymes and toxins that destroy the surrounding tissue. This causes older leaves to yellow and plants eventually wilt and die.



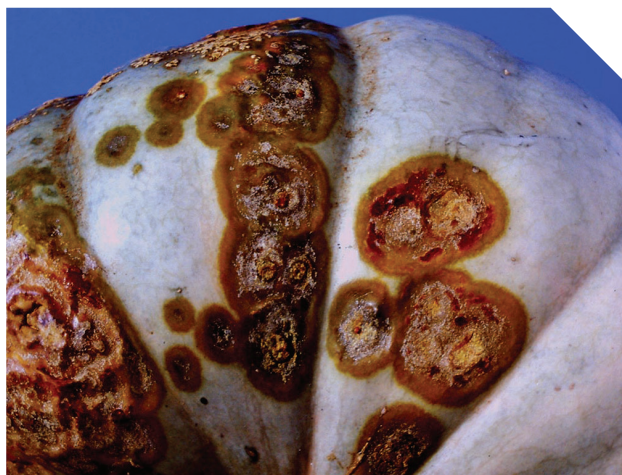
Strands of *Fusarium* hyphae growing inside cucumber xylem.

F. oxysporum has evolved into host specific sub-species (called formae speciales) and races which may infect some varieties of a plant species and not others. For instance the fungus that causes Fusarium wilt of cucumbers is called *F. oxysporum* f.sp. *cucumerinum* which is different to the fungal strains causing wilt diseases on spinach, watermelons, cauliflowers, tomatoes etc. There are at least three races of *F. oxysporum* f.sp. *cucumerinum* which means there are varieties of cucumbers with genetic resistance to races I and II. Unfortunately, the dominant race causing this disease in Australia is neither of these races and there are no commercial varieties of cucumbers available carrying resistance to this pathogen.

Not all Fusarium wilt pathogens are known to occur in Australia (see Table 1). Similarly, new Fusarium races appear around the world that may attack vegetable varieties that have previously been grown successfully. Therefore they can be biosecurity threats.

Table 1 Fusarium wilt causing strains (*formae speciales*) occurring on vegetables

HOST	f.sp.	AUSTRALIA
Beans	<i>phaseoli</i>	?
Brassicas	<i>conglutinans</i>	+
Capsicums	<i>capsici</i>	-
Celery	<i>apii</i>	?
Cucurbits		
Cucumbers	<i>cucumerinum</i>	+
	<i>radicis-cucumerinum</i>	-
Melons	<i>melonis</i>	+
Watermelons	<i>niveum</i>	+
Luffa	<i>luffae</i>	-
Bottle gourds	<i>laginariae</i>	-
Bitter melon	<i>momordicae</i>	-
Winter melon	<i>benincasae</i>	-
Eggplants	<i>melongenae</i>	-
Lettuce	<i>lactucae</i>	-
Onions (Alliums)	<i>cepaе</i>	?
Peas	<i>pisi</i>	+
Radish	<i>raphani</i>	?
Snake beans	<i>tracheiphilum</i>	+
Spinach	<i>spinaciae</i>	+
Tomatoes	<i>lycopersici</i>	+
	<i>radicis-lycopersicae</i>	+?



Fusarium rot of pumpkin caused by *F. solani*.

Vegetable diseases caused by other *Fusarium* species or strains

Other strains of *F. oxysporum* cause diseases of certain vegetables; for instance, *F. oxysporum* f.sp. *radicis-cucumerinum* causes a stem and root rot disease of cucumbers overseas. Similarly *F. oxysporum* f.sp. *radicis-lycopersici* causes a stem and root rot of tomatoes. There are also other *Fusarium* species that can cause fruit, stem and root diseases. Examples are: strains of *F. solani* causes fruit and stem rot of capsicums; stem and fruit rots of pumpkins and other cucurbits and beans; *F. lactis* causes internal fruit rot of capsicums overseas; and *F. avenaceum* causes dry rot of carrots; and several species are associated with crown rot of asparagus. Some *Fusarium* strains can be associated with seedlings damping off and they often form disease complexes with other fungal (e.g. *Rhizoctonia*) or oomycete (e.g. *Pythium* and *Phytophthora*) pathogens.

Source, spread and factors that favour *Fusarium* diseases

Fusarium spores can be a contaminant on seed and it can spread on seedlings in nurseries. Unfortunately, infected plants can be symptomless until they are

transplanted or when the plant matures. The fungi survive for many years in soil and are difficult to eradicate once they have become established on a farm. The *Fusarium* spores spread with soil and media, water, (Sciarid and Shore) flies, contaminated equipment and workers' hands, footwear and clothing. One important factor favouring *Fusarium* wilt diseases on many crops is ammonium nitrogen. Potassium deficiency has been shown to favour brassica yellows.

Different *Fusarium* wilt diseases are favoured by particular temperature ranges – generally higher soil temperatures favour disease, and soil temperatures over 20°C.

Plant stresses caused by imbalances in water, nutrition or heavy fruit load also favour disease development.

Management strategies

- Use resistant varieties – containing race-resistance genes
- Grafting onto resistant rootstocks
- Avoid ammonium (NH_4^+) fertilisers – nitrate fertilisers can suppress disease



Fusarium basal plate rot of leeks (left) and healthy plant (right). The plant on the right was grown in soil following a brassica biofumigant cover crop.



- Apply calcium supplements
- Avoid overwatering: use less more often; for soilless crops in substrates such as coir or sawdust ensure the medium does not remain saturated overnight, particularly in winter
- Preventative measures – crop and farm hygiene, and biosecurity: e.g. come clean – go clean
- Contaminated irrigation water can be treated by filtration, UV radiation, or with chemical disinfectants
- Control Sciarid flies and soil-borne insect pests – particularly at the seedling stage
- Remove, bury or compost infected plant waste
- Crop rotation (>3 years), cover crops (such as biofumigant mustards or sorghum), organic amendments (such as quality composts) can suppress diseases
- Microbial biocontrol bacteria and fungi, as well as plant defence activator chemicals (such as soluble silicates or chitosan) can suppress soil-borne diseases including Fusarium but are not specifically registered in Australia for disease control in vegetables
- There are no agrichemicals registered in Australia for use during cropping; soil fumigation can be used between crops.



Fusarium wilt of bunching spinach occurs mostly as a disease complex with root rot pathogens such as *Pythium* and *Phytophthora* species and *Rhizoctonia solani*.



Fusarium yellows of cauliflower.

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