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Dead stem disease of asparagus caused by Fusarium culmorum

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Abstract

Dead stem disease in asparagus is characterized by yellow dead stems with reddish lesions, mostly at soil level. There are two types of infection. The first one with lesions on the base of the stem at soil level, as a result of which the stem dies off. In the second type of infection the lesions appear higher up on the stems, while stems remain mostly green. The disease was proved to be caused by *Fusarium culmorum*. This fungus is mainly spread through the soil. Air dispersal was demonstrated but seems of little importance to disease incidence.

Introduction

One of the diseases in asparagus (*Asparagus officinalis* L.) is characterized by a yellowing and dying off of mature stems combined with reddish lesions (Fig. 1) on the stem mostly at or below soil level (Van Bakel and Kerstens, 1970). The stem becomes soft and shows a typical internal discoloration; subsequently it turns yellow and dies off. This type of infection occurs from the second half of July until the end of September. At the same time a second type of infection may cause lesions higher up on the stem which start as brown spots and soon become reddish with numerous conidia embedded in slime (Fig. 2). Stems with this second type of infection mostly remain green. This type of infection occurs less frequently than the first type.

Wollenweber and Reinking (1935) and Weise (1939) consider *Fusarium culmorum*

Fig. 1. A lesion caused by *Fusarium culmorum* on an asparagus stem at soil level.

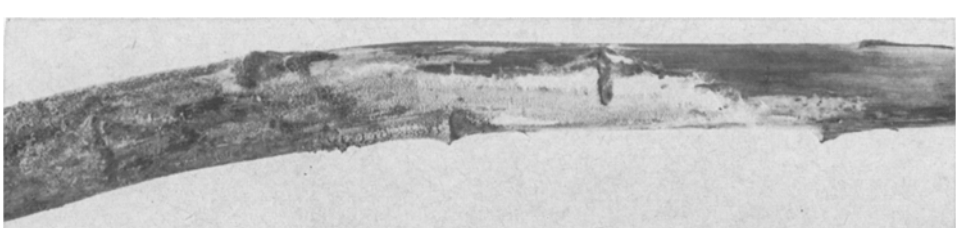

Fig. 1. Een aantasting door Fusarium culmorum van een aspergestengel nabij het grondoppervlak.

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Fig. 2. A lesion with slimy masses of conidia of *Fusarium culmorum* on the aboveground part of an asparagus stem.

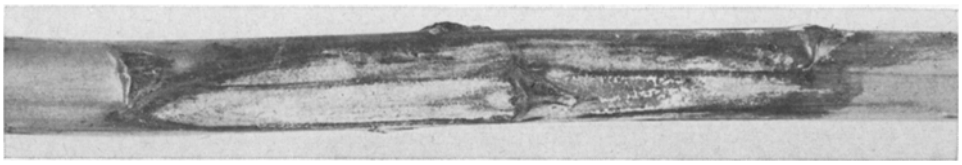

Fig. 2. Een vlek met slijmige conidiënmassa's van Fusarium culmorum op het bovengrondse deel van een aspergestengel.

to be the cause of footrot, the fungus penetrating the stems through wounds below soil level. Wind dispersal was not excluded. Other authors mention the presence of this fungus (Van der Vliet, 1955) or regard it as partly responsible for footrot in combination with Fusarium oxysporum (Van den Broeck, 1963; Kempenaers, 1961). This article reports an investigation on the cause of dead stem disease and the method of spread in the field.

Materials and methods

In 1968 and 1969 samples of stems showing (one or both of the) symptoms (described above) were taken from about 30 asparagus fields. Isolations were made on potato dextrose agar (PDA) using small pieces of tissue from stems, showing aboveground symptoms, as well as from stems with underground lesions. The fungi which developed were subcultured on PDA and identified. Pathogenicity was tested both on asparagus seedlings (Van Bakel and Kerstens, 1970) and on mature stems and reisolations were made. Again the fungi were subcultured on PDA, identified and tested.

Meteorological data were collected to throw light on the development of the disease in the field. Soil temperature was measured at 5 day intervals at 10 cm below soil level. Data concerning rainfall were obtained from the official weather reports of the Royal Netherlands Meteorological Institute and are given as total mm of rain in 24 hours (Anon., 1971).

In 1969 and 1970 the spread of the disease was determined on four fields (two in each year) on which the disease had already occurred for several years. On these fields two experimental plots of 20 × 18 meters with 50 × 10 plants each were marked. Each week the locations of both types of diseased plants (stems) were plotted on a map. To demonstrate the air-dispersal of the fungus, open Petri dishes with modified PCNB agar (Papavizas, 1967) were hung vertically between the plant rows in the centre of each field. The exposure time was five minutes and the dishes were opened towards the wind at a height of 10 cm above soil level. The sampling sites were at Grubbenvorst and Lottum in 1970 and St. Odiliënberg and Vlodrop in 1971.

Results

Inspection of a great many asparagus fields showed that the disease is restricted to light and sandy soil and varies in severity. Asparagus fields were found with only a few infected plants and others with about 50% of the plants attacked. As a rule not

every stem of an infected plant showed symptoms.

From stems showing the red lesions the same fungus (species) could always be isolated. According to the taxonomy of Wollenweber and Reinking (1935) this fungus appeared to be *Fusarium culmorum* (W. G. Smith) Sacc. Inoculation of asparagus seedlings and mature stems with this fungus resulted in symptoms identical with those in the field. The inoculation succeeded only when the stems were wounded. Reisolations from artificially infected seedlings and mature stems produced again *Fusarium culmorum*. Therefore we consider this fungus to be the cause of the disorder.

The fungus seemed to spread in the field at random and not from a localized source of infection. Reddish lesions of type 1 usually first appeared about 5–10 cm below soil surface. The lesions extended much faster upward than towards the crown. In most cases the fungus did not reach the crown (the crown is about 25 cm below the soil surface) while on the aboveground part of the stem is usually spread over a length of about 20 cm. Lesions of the second type of infection extended equally in both directions, rather slowly covering about 5 cm in two weeks.

Weekly records, at one site in both years, of the number of plants becoming infected above soil level (A) and of those infected below soil level (B) are given in Fig. 3 and 4. In these figures the incidence of the disease in the field, the soil temperature and the daily rainfall are given for both years. From these diagrams it is clear that there is a positive correlation between soil temperature and the percentages of infections below soil level. Moreover there seems to exist also a correlation between

Fig. 3. Soil temperature, rainfall and percentages of infected plants above (A = – – –) and below (B = ——) soil level in 1970.

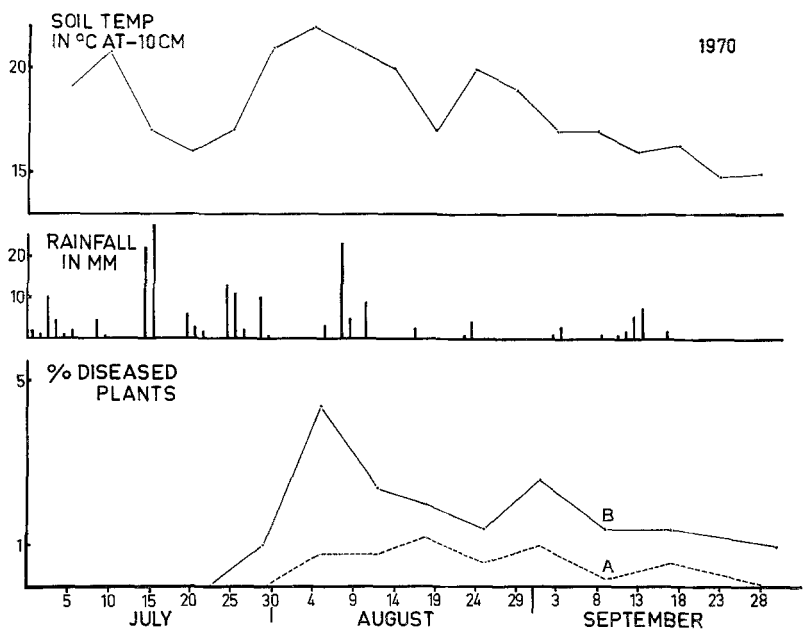

Fig. 3. Bodemtemperatuur, regenval en percentages planten die bovengronds (A = – – –) en ondergronds (B = ——) zijn aangetast in 1970.

Fig. 4. Soil temperature, rainfall and percentages of infected plants above (A = – – –) and below (B = ——) soil level in 1971.

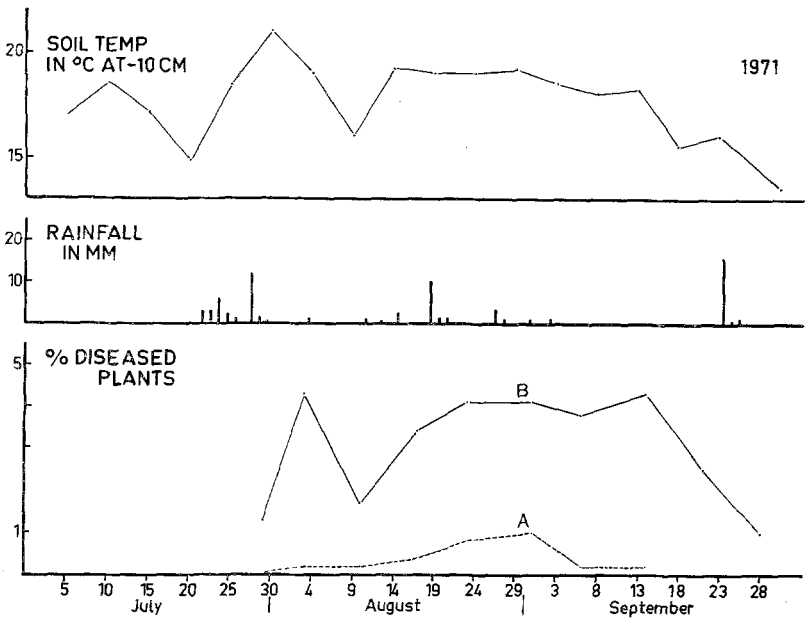

Fig. 4. Bodemtemperatuur, regenval en percentages planten die bovengronds (A = – – –) en ondergronds (B = ——) zijn aangetast in 1971.

rainfall and the occurrence of infection above soil level. The spread of the aboveground infection is not only related to rainfal but also to the direction of the wind. In the second half of August of 1971 the prevailing direction of the wind was between south and west. Of the seven stems newly infected above ground recorded on August 24 and 31, six were infected on the SW quadrant. From this it is clear that wind plays an important role in the spread on the fungus. Transport of conidia of the fungus by wind

Table 1. *Fusarium* species captured on open Petri dishes in asparagus fields at various sites.

	Grubbenvorst	Lottum	St. Odiliënberg	Vlodrop
Fusarium avenaceum (Fr.) Sacc.	x	x	x	
F. culmorum (W. G. Smith) Sacc.	x	x	x	x
F. dimerum Penzig	x	x	x	x
F. equiseti (Corda) Sacc.	x	x	x	
F. lateritium Nees ex Fr.	x	x		
F. oxysporum Sclecht.	x	x	x	x
F. sambucinum Fuckel	x	x	x	x
F. solani (Mart.) Appel & Wollenw.	x	x	x	x

Tabel 1. Op open Petri schalen in aspergevelden opgevangen Fusarium-soorten op verschillende plaatsen.

was also shown by the results obtained with open Petri dishes (Table 1). Although a medium selective for *Fusarium* species was chosen, a great many other fungal genera were captured. Representative of the following genera were involved: *Alternaria*, *Arthrinium*, *Arthrobotrys*, *Aspergillus*, *Aureobasidium*, *Botrytis*, *Cephalosporium*, *Chrysosporium*, *Cladosporium*, *Coniothyrium*, *Cylindrocarpon*, *Dendryphion*, *Drechslera*, *Emericellopsis*, *Epicoccum*, *Gliocladium*, *Gliomastix*, *Humicola*, *Hyalodendron*, *Menispora*, *Monilia*, *Metarrhizium*, *Paecilomyces*, *Papulaspora*, *Penicillium*, *Periconia*, *Philalophora*, *Phoma*, *Pycnostysanus*, *Pyrenochaeta*, *Scolecobasidium*, *Scopulariopsis*, *Sepedonium*, *Septonema*, *Sphaeronema*, *Stemphylium*, *Thysanophora*, *Torula*, *Trichocladium*, *Trichoderma*, *Trimmatostroma*, *Tritirachium*, *Verticillium*, *Volutella* and nonsporulating fungi.

Discussion

There are two types of infection in asparagus caused by *Fusarium culmorum*. The first starts below soil level, causing in most cases death of the stems. The second one starts somewhere on the green part of the stem, which usually remains green. The percentage of diseased plants represents a more correct measure for the spread of the disease in the field than the percentage of diseased stems (Fig. 3 and 4). The stems of any one plant are in very close contact with each other, so that spread between them depends on factors other than those affecting spread between stems of different plants. Nevertheless the spread between stems of the same plant is small. It seemed to us that the period for infection below soil level is apparently rather short and dependent not merely on soil temperature.

The spread of the fungus by air was demonstrated. We used the Petri dish method for three reasons: ease of manipulation, the remote situation of the fields and the need merely to demonstrate the presence of the fungus. As the conidia are embedded in mucus, rain also may be important, especially over short distances, and our observations indicate a correlation between rainfall and spread of the fungus. The disease incidence is dependent on other factors, such as length of humid period and the presence of wounds. The restriction of the disease to light sandy soils needs further investigation.

Acknowledgments

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Samenvatting

Dode-stengelziekte in asperge veroorzaakt door Fusarium culmorum

Dode-stengelziekte in asperge wordt gekenmerkt door het optreden van gele afstervende stengels en rose lesies vlak boven het grondoppervlak. Bovendien komen op het groene deel van de stengel aanvankelijk bruin gekleurde lesies voor die later rose verkleuren als gevolg van de vorming van sporen. Bij overlangs opensnijden van de stengel blijkt deze roodachtig verkleurd te zijn. Er zijn twee typen aantasting:

a. een infectie begint bij of beneden het grondoppervlak; als gevolg van deze aantasting wordt de stengel geel en sterft af, en
b. een infectie die ergens op het bovengrondse deel van de stengel ontstaat; de stengel blijft meestal groen.

Zoals uit Fig. 3 en 4 blijkt is de ondergrondse aantasting het belangrijkste voor het optreden van de ziekte. Dit type is gecorreleerd met de bodemtemperatuur, terwijl er aanwijzingen zijn dat regenval belangrijk is bij de verspreiding (tweede type aantasting) van de schimmel door de lucht. Waarom deze ziekte beperkt is tot de lichte zandgronden moet nog nader worden onderzocht.

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