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Wilt diseases in Gerbera

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Abstract

In The Netherlands, the glasshouse area used for cultivation of gerbera as a cutflower was strongly restricted in the past since dying off of the plants generally occurred and constituted a great risk for growers.

In most cases *Phytophthora cryptogea* appeared to be the cause of the disease and this fungus is probably responsible for the main difficulties in this crop since the introduction. Besides foot rot, caused by *P. cryptogea*, *Verticillium albo-atrum* and *V. dahliae* cause a wilt disease of gerbera. Newly developed cultural methods prevent heavy losses, resulting in a strong expansion of the culture.

Introduction

A great number of important phytopathological problems in flower growing are caused by soil-borne diseases. Many crops can only be grown successfully when soil sterilisaton before planting is a normal cultural practice. In the past, the introduction of a new crop has only temporarily solved the difficulties. At the Experimental Station for Floriculture in The Netherlands during the last 30 years, much research has been done on the control of soil-borne fungi and other organisms to help the growers in increasing production and quality.

A few years before the second world war, the "Transvaal daisy", *Gerbera jamesonii* hybr., was introduced into Dutch floriculture. Many persons knew the crop as a garden plant from tropical regions, primarily the former Dutch East Indies, or as a component of the wild flora in South Africa. When the first plants were grown at the Experimental Garden at Aalsmeer, it could be stated in the annual report that the gerbera was a desired cutflower, and its cultivation seemed promising.

The first experiments were carried out to study methods of cultivation and propagation, but in 1941 already "sudden dying off" became prevalent. Attempts to find the cause of this trouble were unsuccessful, though it was suspected to be a fungus disease. Since often most of a crop was lost before flowers were produced, only few growers were then interested in cultivating the plant.

In this paper research performed in The Netherlands will be reviewed to demonstrate how the pathogens causing wilt have been identified and gerbera has become an important cutflower (Table 1) as a result of better understanding of its needs and of host–pathogen relationship.

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Table 1. Yield of gerbera flowers in The Netherland and their value at the flower auctions in the period of 1950–1968 (From: Groenewegen, 1969).

Year	Yield (thousands of flowers)	Proceeds (thousands of guilders)
1950	590	55
1955	1 175	159
1960	2 744	454
1965	7 726	1812
1966	10 930	2431
1967	15 646	2953
1968	13 467	2711

Tabel 1. Bloemenproduktie en geldelijke opbrengst van gerbera's in Nederland gedurende de periode 1950–1968 (Groenewegen, 1969).

Development of research in The Netherlands

Disease symptoms, known as foot rot, were described by Noordam (1950), but no pathogenic fungi were isolated. This fact and the observation that gerbera plants grown in soil-less culture were kept healthy for 2 years (Wasscher and Croockewit, 1948, 1949) led to the assumption that the disease was caused by unfavourable soil conditions. A temporary improvement was obtained by keeping the hearts of the plants dry. For this purpose the soil was covered with gravel or vermiculite (van der Zwaard, 1952).

In 1951, Noordam in cooperation with Jaarsveld – who, as a staff-member of the diagnostical department of the Plant Protection Service (P.D.) at Wageningen had repeatedly isolated *Verticillium* from wilting gerbera plants – inoculated steam-sterilized soil with *Verticillium dahliae* Kleb. (ten Houten, 1953). In this experiment symptoms appeared 2 months after gerberas were planted with wilting remaining restricted to the inoculated sections of the benches. Thus the pathogenicity of *V. dahliae* to gerbera was clearly demonstrated. In 1950, gerbera was mentioned as a new host of *Verticillium albo-atrum* (Reinke & Berth) in California (Snyder et al., 1950), although the disease was already found in New South Wales in 1941 (Anon., 1941).

At the same time, von Arx (1952) made an inoculation experiment with *Fusarium oxysporum* Schlecht and two other fungi, isolated from gerbera with foot rot symptoms. His results indicate that *F. oxysporym* isolates can also be pathogenic to gerbera.

In 1958, infections of *Meloidogyne* spp. on gerbera were observed by Koek (Koek and Scholten, 1959). Moreover *F. oxysporum* was regularly isolated from wilting plants and since large numbers of free living nematodes were also present in the same soil, inoculation experiments were carried out with *F. oxysporum*, *V. dahliae*, *Pratylenchus penetrans* (Cobb), *Meloidogyne* spp. and which combinations of these fungi and nematodes. Gerberas, planted in soil inoculated with *V. dahliae* developed the same disease symptoms as in the experiment of Jaarsveld and Noordam: slow wilt, often connected with brown-reddish discoloration of the leaves, whereas a number of infected plants developed a new leaf rosette before they were completely killed. Internally the vascular system of roots, rhizome and petioles showed a brown discoloration; *V. dahliae*

could easily be reisolated from these tissues. Only occasionally plants died in the untreated control or in the soil inoculated with *F. oxysporum*, *P. penetrans* or with both organisms. In the treatments where *Meloidogyne* spp. were added to the soil, either alone or in combination with one of the fungi, many plants died rapidly, showing the typical foot rot symptoms, namely dark brown discoloration in the rhizome and basal parts of roots and stems, the infected tissues were water-soaked. These symptoms occurred independently from the infection of *Meloidogyne* on the roots however.

In 1953 an experiment was carried out to study the possibilities of foot rot control by means of steam sterilizing of the soil and by soil drenches with fungicides (Scholten, 1954a). From young plants wilting in the untreated control of this experiment, a phycomycete was isolated. This isolate could not be distinguished from the fungus isolated from China asters (*Callisthephus sinensis*), causing a dying off of these plants at that time (Scholten, 1954b). The isolate from China aster was indentified later as *Phytophthora cryptogea* Pethybr. & Laff[1]. In 1937, *P. cryptogea* was found to cause foot rot in gerbera in the U.S.A. (Tompkins and Tucker, 1937) where this crop appeared to be one of the most susceptible host plants (Middleton et al., 1944). In 1954, a phycomycete was repeatedly isolated from wilted gerbera plants by the Plant Protection Service (P.D.) at Wageningen, but unfortunately, identification remained unsuccessful.

In 1959 and 1960, experiments were carried out with gerbera in an installation with gravel culture (van Zon et al., 1961). When parts of plants that had been killed by foot rot were added to the nutrient solution, gerberas irrigated with this solution died rapidly. From the dying plants mainly pure cultures of a *Phytophthora* were isolated. In the following years the same fungus was also regularly isolated from wilting plants received from different nurseries, especially when parts of the infected tissue were first inserted into apple fruits. At the "Centraalbureau voor Schimmelcultures" at Baarn it could be proved that this *Phytophthora* belonged to the species *P. cryptogea;* oospores were produced in paired culture with a strain of *Phytophthora cinnamomi* Rands from rhododendron (Barrett, 1948). After mixing pure cultures with soil, potted gerbera plants developed wilting symptoms within a week and the fungus was reisolated from the decaying basal parts (Scholten, 1966).

Meanwhile Pag (1960) proved that *P. cryptogea* is the cause of foot rot of gerbera in Germany, where *Verticillium albo-atrum* also appeared to cause a wilting disease (Pag, 1961; Maatsch and Pag, 1961).

When methods of growing gerbera with artificially raised soil temperatures were used under commercial conditions, growers were impressed by a better health of their crops; the number of plants, killed by *P. cryptogea* was very low, as was demonstrated in some preliminary experiments (Leffring, 1965). Experiments with constant soil temperatures of 11°, 16°, 21° and 26 °C showed that, initially, at high temperatures, plants were more rapidly killed by *P. cryptogea.* However, because of a faster growth rate, more plants were able to survive than at the lower temperatures as is shown in Fig. 1 (Scholten, 1968). External disease symptoms were different at the four temperatures. At 21° and 26 °C, most of the leaves suddenly turned greyish green when they faded,

[1] In 1953, China asters were found to be attacked by *Phytophthora cryptogea* at two places in the centre of Aalsmeer, namely at the Experimental Station and at a nursery. These were the first records of this pathogen on asters in The Netherlands. In both cases, gerbera was grown in houses adjacent to aster fields. At the Station, where an almost complete loss of aster plants occurred, soil from the gerbera houses had been spread over the aster field in preceding years.

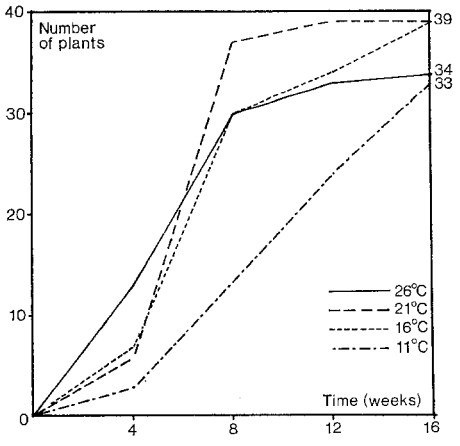

Fig. 1 Number of gerbera plants (from a total of 40) killed by *Phytophthora cryptogea* after inoculating the subsoil in a 16 weeks' experiment at four soil temperatures.

Fig. 1. Aantal gerberaplanten (40 per object) dat door Phytophthora cryptogea tot afsterving werd gebracht na inoculatie van de ondergrond in een proef gedurende 16 weken bij vier verschillende bodemtemperaturen.

while at 11° or 16 °C a purplish discoloration was often observed before withering; a discoloration, occurring generally when plants suffer from bad circumstances.

Wilting caused by *V. dahliae* was not influenced by soil temperatures; all plants in the inoculated soil showed typical symptoms after about 8 weeks. Inoculations with *F. oxysporum* and *F. avenaceum* (Fr.) Sacc. both isolated from gerbera, did not lead to the development of any symptoms at the four temperatures (Scholten, 1967).

Discussion

Isolating *P. cryptogea* from diseased tissue in petri dishes with agar often remains unsuccessful, especially when the plants were grown in soil. From the decaying parts as rhizomes, roots and petiole bases, a wide variety of saprophytic bacteria and fungi – among which various *Fusarium* species – generally develops. Since the investigations of von Arx (1952), no further positive results of inoculations with *Fusarium* spp. were obtained. Thus, fungi of this genus do not play an important role in wilting of gerbera in The Netherlands.

Different arguments support the assumption that *P. cryptogea* has been the cause of foot rot ever since the introduction of the crop.

1. Initially, gerberas were grown under moist conditions. Nowadays heaviest losses occur when the soil is kept very wet. Under such conditions *P. cryptogea* rapidly spreads over the soil surface, often producing a visible mycelium in the hearts of the plants. The temporary decrease in spread of the disease obtained by keeping the bases of plants dry (van der Zwaard, 1952), supports this observation.

2. The description of the disease symptoms by Noordam (1950) fit exactly those of a *Phytophthora* infection.

3. In 1953, *P. cryptogea* was isolated from wilting China aster plants (Scholten, 1954b). These plants were grown in soil previously used for the cultivation of gerbera, so the soil might have been infested causing the extremely high mortality of the asters.

4. The development of foot rot symptoms in gerbera plants after inoculating the soil with *Meloidogyne* may have been caused by an infection of *P. cryptogea*. The nematodes used in this experiment were multiplied on roots of tomato and tobacco

Fig. 2. Appearance of a 1-year-old gerbera crop in former years; many plants have been removed already, others show wilting symptoms caused by *Phytophthora cryptogea*.

Fig. 2. Het normale beeld van een éénjarig gerberagewas in het verleden: veel planten zijn reeds verwijderd, andere vertonen verwelkingssymptomen, veroorzaakt door Phytophthora cryptogea.

Fig. 3. Modern gerbera greenhouse with a healthy crop in full production.

Fig. 3. Moderne gerberakas met een gezond gewas, volop in produktie.

plants, grown in soil previously used for a crop of gerbera. In this crop, plants died and root knot symptoms were observed.

After the symptoms, caused by *P. cryptogea* on gerbera were known and the isolation technique was adapted by using apples as a growth medium for the fungus, it became quite clear that *P. cryptogea* is the most important soil-borne pathogen in gerbera growing. *Verticillium albo-atrum* and *V. dahliae* were isolated incidentally and their damage generally remained restricted. The infected plants showed a slower type of wilting, not connected with a basal rot.

Under commercial conditions, the results of research on foot rot and wilting, led to a reduction of the grower's risk. Keeping soil temperatures at 20° to 25 °C and growing the plants in raised benches with a good drainage system, decreased losses considerably. By growing seedlings in sterile media and by desinfecting the glasshouse soil, performed either with methyl bromide or with steam, economical important damage is restricted to a minimum level, if not prevented completely (Fig. 2 and 3). These measures must also be taken when the soil has not been used for the growth of gerbera previously, as was recently demonstrated in some new built houses where growers suffered bad losses, caused by *Verticillium* sp. Here the pathogen was present in the unsterilized soil, probably left by preceding agricultural crops or by infected weeds (Engelhard, 1957; Matta and Kerling, 1964).

A further improvement can be achieved when hybridisation with less susceptible types leads to more tolerant selections (Sparnaay, 1966). New developments in chemical control may offer promising prospects for eliminating *Phytophthora*, e.g. Dexon (p-dimethyl-aminobenzenediazo sodium sulfate) (Zentmyer et al., 1964).

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Samenvatting

Verwelkingsziekten bij gerbera

Schade door bodemschimmels heeft lange tijd een sterke uitbreiding van de gerberateelt in Nederland verhinderd. Hierin is verandering gekomen doordat een goede bedrijfshygiëne en verbeterde cultuurmaatregelen (grondontsmetting, grondverwarming, drainage) het risico voor de kweker aanzienlijk hebben verminderd.

De oorzaak van de belangrijkste ziekte in Nederland, het zogenaamde "voetrot", is de schimmel *Phytophthora cryptogea*. Er zijn verschillende argumenten die er voor pleiten dat deze vanaf de invoering van de teelt in Nederland verantwoordelijk is geweest voor de grootste moeilijkheden op de bedrijven. Daarnaast kunnen *Verticillium albo-atrum* en *V. dahliae* optreden als oorzaak van verwelkingsziekte.

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