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Root rot in crocus

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Abstract

In the root rot complex in crocus, three different causes have been identified. Under conditions prevailing in The Netherlands, free-living nematodes (*Pratylenchus penetrans* and *P. pratensis*) seem to be of minor importance. The present study has shown that roots are incidentally invaded by *Stromatinia gladioli;* the corms and leaf-sheaths appear to be less susceptible to this pathogen. Crocus is often planted in soil known to be contaminated by this fungus. It is not clear why root rot can only occasionally be ascribed to this cause. Further results indicate that *Pythium* spp. play a major part in the development of root rot.

Introduction

On sandy and sandy-peat soils planted with crocus, patches in the crop can often be observed where plants die prematurely. The first symptoms occur from May onwards, when the leaves of diseased plants show a slight silver-gray gloss, which is easily overlooked. Under dry conditions, the above-ground parts soon turn yellow and die. In humid soil the plants survive somewhat longer. Upon the appearance of the first symptoms in the leaves, close examination reveals that most or all of the roots are completely rotten.

After lifting, the corms as a rule do not show any symptoms. The damage is expressed in reduced growth of the young corms. The increase in weight – as compared to the weight of the corms at the time of planting – in a healthy crop varies from 100 to 150%; in the diseased patches, this percentage may be reduced to zero.

Slootweg (1956) mentions that the free-living nematodes *Pratylenchus penetrans* (Cobb) and *P. pratensis* De Man, can incite root rot in this plant species in The Netherlands. Further observation in this country has indicated, however, that in most cases destruction of the root system could not be ascribed to these eelworms.

Tomlinson (1952) describes a root rot in crocus used for forcing in England. His inoculation experiments demonstrated that a fungus, which he identified as *Pythium ultimum* Trow, was the cause of this disease.

In the present communication it is shown that *Stromatinia gladioli* (Drayt.) Whetz. is also able to cause root rot in crocus, and the relation to *Pythium* spp. is discussed.

Root rot due to Stromatinia gladioli

In November 1959, in a field on the island of Texel (sandy dune soil) with a known history of root rot in crocus, many corms were found left over from a previous crop. In the newly developed roots the first symptoms could already be observed: some of

the roots showed a light-brown discoloration over a length of 1 cm or more, others only small brown longitudinal stripes or lesions.

Isolations were made on cherry-extract agar and potato dextrose agar, after superficial disinfection in an alcoholic solution of sublimate (0.1 %) and washing in sterile water. On several pieces of root tissue, taken both from brown areas and from lesions, a fungus developed that seemed identical with *Stromatinia gladioli*.

The identity of the fungus was proved by inoculating one isolate from crocus roots and one of *S. gladioli* from gladiolus plants with symptoms of dry rot, onto gladiolus corms planted in pots in a glasshouse. In both cases the typical symptoms of dry rot in the corm flesh and the leaf-sheaths developed within six weeks.

In a second experiment, soil was artificially contaminated by mixing cultures of *S. gladioli* on rice, isolated from crocus roots and from gladiolus, with soil (250 ml dry rice was sterilized and inoculated with the fungus; after growth of the pathogen the rice was mixed with 2000 ml soil). Corms of crocus (*C. flavus* West, 'Yellow crocus') were planted in pots into which a 1-cm layer of contaminated soil was brought 0–1 (A), 2–3 (B), or 4–5 (C) cm under the base of the corms.

After 3 weeks, brown areas could be observed in the newly developed roots growing in contaminated soil. After 2 months, the roots of plants in all treatments were heavily attacked; in the controls, to which no contaminated soil had been applied, the roots were healthy (Fig. 1). In treatments A and B the root system was very poor compared to that of the controls, the brown discoloration reaching up to the base of the corm. In treatment C, the size of the root system was comparable to that in the control plants; infection apparently had taken place at a lower level, and in most cases the brown rot had not yet reached the base of the corm.

In the field on Texel mentioned above, crocus corms ('Yellow crocus') were planted on 18 November 1959 on untreated soil and on plots disinfected 8 weeks before plant-

Fig. 1. Root rot of crocus caused by *Stromatinia gladioli*. The corm on the left was planted on a layer of contaminated soil, 0–1 cm under the base. On the right: corm planted in uncontaminated soil.

Fig. 1. Wortelrot bij krokussen, veroorzaakt door Stromatinia gladioli. Links: de knol werd geplant op een laag kunstmatig besmette grond, 0–1 cm onder de knolbasis. Rechts: knol, geplant in onbesmette grond.

ing by the application of methylisothiocyanate (Trapex, 140 ml/m^2, injected at 20 cm depth) and metam-sodium (75 ml/m^2, washed into the soil with 25 litres water/m^2).

By the end of March, no differences could be observed in the above-ground parts between treated and untreated plots. The roots of plants growing in untreated soil appeared to be heavily infected, however. By the end of May, the leaves of all the plants in untreated plots were yellowing and the root system was completely destroyed; after disinfection with methylisothiocyanate or metam-sodium only slight or no symptoms of root rot could be observed. After lifting (1 July), 20% of the corms from untreated plots showed light to moderate symptoms of dry rot in the scales (often with small black sclerotia) and the flesh.

These observations indicate that the roots of crocus are much more susceptible to attack by *S. gladioli* than the corms, and that the fungus does not pass easily from the roots to the corms and leaf-sheaths.

Since crocus is usually grown in The Netherlands on soil known to be heavily infested by *S. gladioli* (due to intensive gladiolus production), it could be expected that this pathogen would prove to be the major cause of root rot. However, in most fields where root rot occurred, no relation with the presence of the dry rot fungus could be established. Only in a few other cases *S. gladioli* could be isolated from infected roots, and even then the symptoms in most of the roots were different from those caused by the dry rot fungus. Further studies have indicated that Phycomycetes, probably *Pythium* spp., play a far more important role.

Root rot due to Pythium spp.

In the spring of 1960, more than 20 samples of crocus plants showing symptoms of root rot, and growing on sandy soils in different locations were investigated. Some roots showed a small dark-brown or black zone. The part of the root beyond this point usually remaining in the soil when the plants were lifted. In some cases small pieces of rotten light-brown or whitish, water-soaked tissue were still attacked. In more advanced stages of attack the whole root was light gray and water-soaked, and the cortex could be easily removed from the central cylinder. Microscopical investigation of the water-soaked tissue showed the presence of oogonia and oospores of different types.

From many crocus samples, isolations were made on potato-dextrose agar. Several apparently identical colonies of Phycomycetes were obtained. Similar fungi were also isolated from gladiolus and iris with rotten, water-soaked roots, taken from a field in which crocus roots were attacked. Since these fungi failed to produce oogonia or sporangia on different media and under varying conditions, the isolations could not be identified.

Two isolates from crocus, one from gladiolus and one from iris, were grown on rice. The cultures were ground in a blender and mixed with soil, as described above for *S. gladioli*. On September 21, 1960, crocus corms (cultivars 'Remembrance' and 'Yellow') were planted in wooden boxes, a layer of contaminated soil being placed 1–3 cm below the base of the corms. Six weeks later, symptoms were visible in the roots of both cultivars, but only where soil had been contaminated with one of the crocus isolates (C1, see Fig. 2) After 3 months, however, the roots in all treatments were heavily infected, whereas those in untreated soil were healthy.

Fig. 2. Root rot of crocus caused by *Pythium* spp. A: Corms planted in soil contaminated with *Pythium* spp. isolated from crocus roots. B: Corms planted in uncontaminated soil.

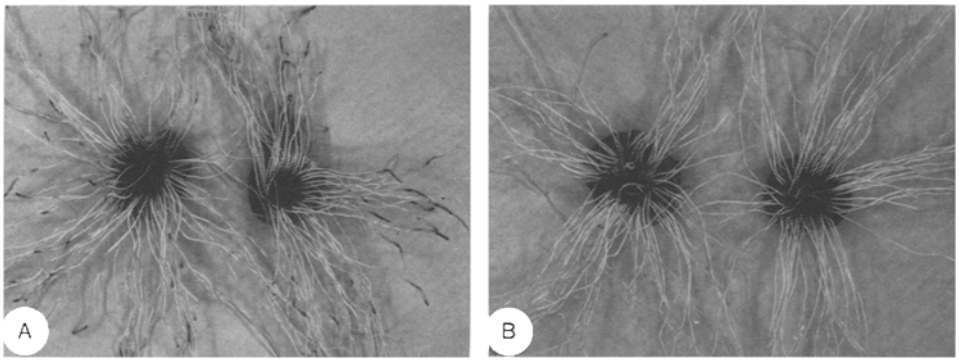

Fig. 2. Wortelrot bij krokussen veroorzaakt door Pythium spp. A: Knollen, geplant in grond die kunstmatig was besmet met een Pythium-isolatie uit krokus. B: Knollen, geplant in onbesmette grond.

Isolate C1 and a re-isolate were sent to the "Centraalbureau voor Schimmelcultures" (CBS) at Baarn, but could not be identified at that time, because under different conditions only globose hyphal swellings were formed, but no oogonia or sporangia. This isolate seemed to differ from *Pythium ultimum* (van Beverwijk, written communication). Since then, heterothallic species of *Pythium* have been found in The Netherlands (van der Plaats-Niterink, 1968). Probably, isolate C1 belonged to this group, but this cannot be checked because the material has been removed from our collection.

From the results of our experiment it may be concluded that species of *Pythium* isolated from diseased roots of crocus, iris and gladiolus can cause root rot in crocus.

Discussion

In crocus, as in so many other crops, root rot appears to be a complex phenomenon. At least three pathogenic organisms have been identified.

Pratylenchus, under the conditions now prevailing in The Netherlands, appears to be of minor importance, possible due to the fact that most sandy soils are regularly treated with nematocides (dichloropropane/dichloropropene or metam-sodium).

The role of *Stromatinia gladioli* in the root rot complex is not clear as yet. From the fact that most soils where crocus is planted are contaminated by this pathogen, it might be expected to be a major cause. Possibly, it is overlooked in most cases because the symptoms of root rot, due to *Pythium* spp. are much more pronounced and therefore more easily recognized in advanced stages of attack (i.e. when the first symptoms appear in the leaves). Disinfection of soils known to be infected with both pathogens with fungicides specifically active against Phycomycetes (e.g. Dexon) could prove the validity of this hypothesis.

S. gladioli is one of the most damaging parasites of gladiolus. In contrast to the situation in crocus, under conditions prevailing in The Netherlands, the corms, the basal parts of the sheaths, and the roots are invaded, the plants often being killed early in the season (Moore, 1939; Schenk, 1961). Root rot without infection of the

other organs seldom occurs; it has been observed incidentally in glasshouses and once in a field where the top-soil was extremely dry due to lowering of the water-table far below normal levels. In Florida, however, up to 90 % of the damage in gladiolus due to this pathogen is caused by root rot, especially in seasons with low rainfall in irrigated fields (Magie, 1954, 1956). In *Crocosmia* (*Montbretia*) a root rot caused by *S. gladioli* without infection of leaf-sheaths, has also been described (Boerema, 1961). Apparently, in both crocus and *Crocosmia* the roots are much more susceptible to attack than the corms and leafy parts.

Observations in the field and laboratory screening indicate that *Pythium* spp. are responsible in most cases for losses due to root rot. This conclusion is sustained by recent experiments done by Saaltink (unpublished) in our institute, in which good control of root rot was obtained by soil disinfection with Dexon just before planting. It is not known which species of *Pythium* plays a predominant role in causing this disease. In recent years Saaltink has made several isolates from diseased roots of crocus. The following species have been identificated by the CBS at Baarn: *P. irregulare* Buisman, *P. sylvaticum* Campbell & Hendrix, and *P. mamillatum* Meurs. No pathogenicity tests have been made yet, however.

In conformity with the results of our infection experiment, root rot in iris and crocus occurs in the same field (in gladiolus, root rot due to *Pythium* has never been found to cause any damage). Root rot in hyacinths, however, has not been found in fields where iris and crocus are infected, and inversely. Apparently, different species are involved here (Saaltink, 1969 and personal communication).

Samenvatting

Wortelrot bij krokus

Minstens drie pathogenen kunnen aanleiding geven tot de vorming van wortelrot in krokussen. Slootweg noemt in dit verband *Pratylenchus penetrans* en *P. pratensis;* onder de cultuuromstandigheden in Nederland, waar veel gronden gebruikt voor de krokuscultuur regelmatig worden ontsmet met nematiciden (dichloorpropaan/dichloorpropeen of metam-natrium), speelt deze oorzaak een ondergeschikte rol.

Door middel van inoculatieproeven werd aangetoond dat *Stromatinia gladioli*, de verwekker van het droogrot in gladiolen, de wortels van krokussen ernstig kan aantasten (Fig. 1). De knollen en bladscheden blijken veel minder vatbaar te zijn dan de wortels. In de praktijk worden krokussen dikwijls geplant op grond, die door intensieve teelt van gladiolen ernstig besmet is geraakt door deze schimmel. Het is nog niet duidelijk waarom slechts in enkele gevallen van wortelrot een verband met *S. gladioli* kon worden aangetoond. Mogelijk wordt in een later stadium (wanneer bovengronds symptomen worden waargenomen) de aantasting in de wortels gemakkelijk gemaskeerd door opvallender beelden veroorzaakt door *Pythium*.

Nader onderzoek wees uit, dat nog niet nader gedetermineerde schimmels uit het geslacht *Pythium* ook wortelrot tot stand kunnen brengen (Fig. 2). Ernstige schade in de praktijk komt meestal door deze oorzaak tot stand.

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