O.I. Tikhonov, V.K. Nedelko,
T.A. Perestova, USSR

PERIODS OF INFECTING AND DYNAMICS OF THE PROLIFERATION OF SCLEROTIUM BATATICOLA IN SUNFLOWER TISSUES

Sunflower diseases change both in quality and quantity under the influence of the environment, cultivation methods and selection. Earlier the chief sunflower diseases were rust and broomrape, a flower parasite, whereas today these do not do substantial harm owing to the progress made in selection. There are, however, some new aggressive excitants.

One of them is ashen rot caused by the fungus Sclerotium bataticola Taub. It is widespread in many principal regions of sunflower cultivation. A survey of the crops in three agroclimatic zones of the Knasnodar Territory (with insufficient, moderate and excessive moistening) has shown that the proportion of sick plants varies from 26% to 73%, depending on the zone in question.

We studied the character of the ashen rot's virulence between 1971 and 1973 in natural conditions, i.e. on the field (Table 1).

Table 1

The Influence of Sunflower Infection with Ashen Rot on the Seeds' Yield and Content

1971-73

Plants	Yield per head	Reduction of yield, %	Seeds' oil content	Reduction in oil content, %
Sick	53.3	35.7	49.2	1.4
Healthy	82.8	-	50.6	-

The table shows that ashen rot reduces the seeds' yield by 36% on average. The reduction was anything between 18% and 36%, depending on the zone.

The range of losses from ashen rot depends on the stage of the plant's growth and development at which it was most strongly affected by the disease, and also on the varietal specificities, degree of resistance, immunity to the excitant and the conditions of growing. Decreases in the seeds' oil content also vary from year to year.

The fungus has been studied in particular detail during the last 15 years. Works by W. Sackston (1958), A. Hristov (1969), M. Acimovic (1961, 1965) and G.V. Grisenko (1964, 1967, 1970) greatly contributed to the knowledge of the biological peculiarities of the causative agent. Nevertheless, many of the excitant's specificities have not been defined and must be further specified.

We have found that the ashen rot's excitant can cause the sharper changes in the ageing organism, owing to which the external symptoms of the disease appear on the surface part of the plant during the latter half of the vegetation period. Depending on the agro-climatic conditions the disease can make itself felt during and after flowering and at the subsequent stages. S. bataticola can infect plants which are weakened owing to the impact made on their growth and development by the unfavourable external conditions, very high temperatures and the insufficient moistening.

In order to study the period of infection and the routes along which the fungus penetrates and spreads in a plant and also the influence exerted by the disease on the structure of the tissues of the root and stalk, we conducted anatomical investigation of sick and healthy plants grown in a hothouse and on the field.

Tissues of the root and stalk grown in vessels were analysed from the stage of the

cotyledonous leaves to the budding stage in the field all the way from the start of the disease to the full manifestation of its external symptoms.

Under a sufficient quantity of infection agents and conditions favourable for the excitant's development, small yellow-brownish spots where the fungus has penetrated the root system, can be seen on the plant's underground part already at the phase of the cotyledonous leaves. Anatomical investigations have shown that the fungus penetrates not only into the root hair, but also into some epidermis sections of the adventitious and primary roots (Fig. 1).

During the phase of one pair of real leaves there are differences in the development of the root system between the healthy and sick plants. At this phase the place of the excitant's penetration is seen more clearly than during the preceding phase. The root system of the infected plant is developed weaker and the bulk of the root hairs is missing, because they have been fallen off during the disease.

At the phase of one or two pairs of real leaves the fungus penetrates the exodermis of the principal root and infects it. It also destroys the cell walls of these tissues.

At the phase of two or three pairs of real leaves the root system of the sick plants is two times as short as that of healthy ones, and the root is much curved and has pronounced dark brown spots.

During the phase of three pairs of real leaves all tissues of the adventitious root are strongly diseased and the fungus' micelium penetrates the plant's conducting system. Simultaneously the fungus spreads along the tissues of the principal root, penetrating its parenchyma. The latter has a porous structure and the fungus therefore first fills the intercellular spaces of this layer and then destroys the cell walls and fills the parenchyma's cells.

The fungus can penetrate into the hypoco-

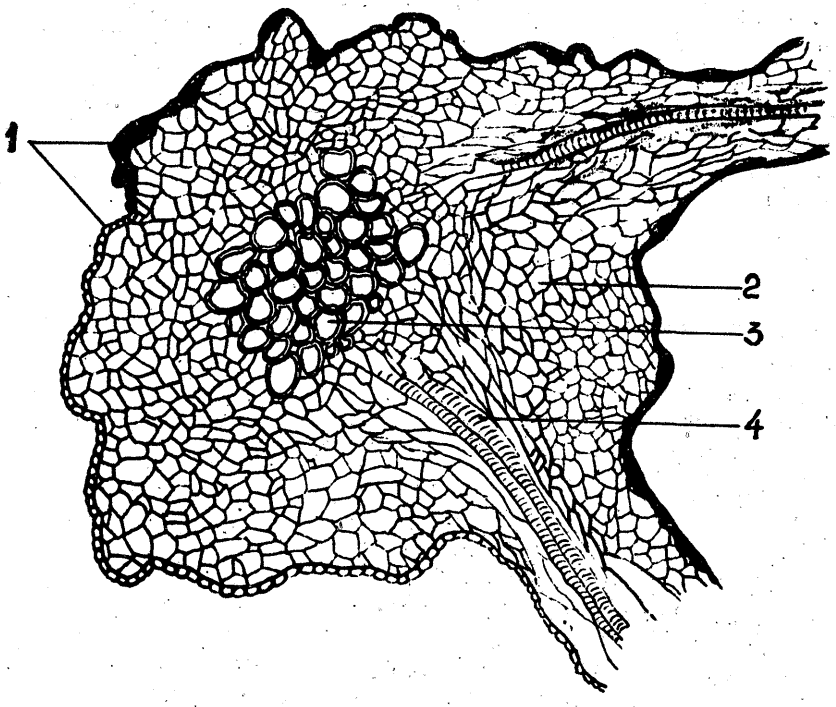

Fig. 1. Cross section of a spur root of a sunflower plant affected by Sclerotium bataticola Taub. (phase of cotyledonary leaves). Eyepiece 7^x, objective 10^x:
1 - affected (dark) and unaffected epidermis; 2 - main parenchyma; 3. - conducting system of a spur root; 4 - conducting system of an adventitious root

tyl through the plant's conducting system or when the hypocotyl's epidermis is in direct contact with the infection agent. Some sections of the hypocotyl's epidermis are afflicted with the ashen rot beginning with the phase of three pairs of real leaves.

At the phase of four or five pairs of real leaves mycelium penetrates the conducting system of the principal root and root neck, with the cells of the fungus' principal parenchyma being strongly affected and destroyed (Fig. 2). Subsequently the fungus spreads up the stalk along the conducting system. At this stage it was also found in the principal parenchyma of the stalk (Fig. 3). Microsclerotia are being formed in the tissues of the principal root and stalk.

Given the external symptoms of the disease, the investigation of the anatomical structure of the surface part of the sunflower stalk has shown that its conducting system is largely filled with the fungus' micelium and the covering tissues (epidermis) and the principal parenchyma of the stalk have been fully destroyed (Fig. 4). A large quantity of microsclerotia can be found under epidermis and in the middle of the stalk.

We have found that when there is an infection agent in the soil and favourable conditions for the excitant's development, plants are infected from the phase of the cotyledonous leaves, though the external symptoms of the disease are usually manifest on the surface during the latter part of the vegetation period.

The fungus penetrates the plant through the root hair and the exodermis of the root and root neck. During the early phases of the plant's growth and development, from the cotyledonous leaves to five or seven pairs of real leaves micelium spreads along the fungus' tissues while during the latter stages, ranging from budding to ripening, it spreads along the conducting system.

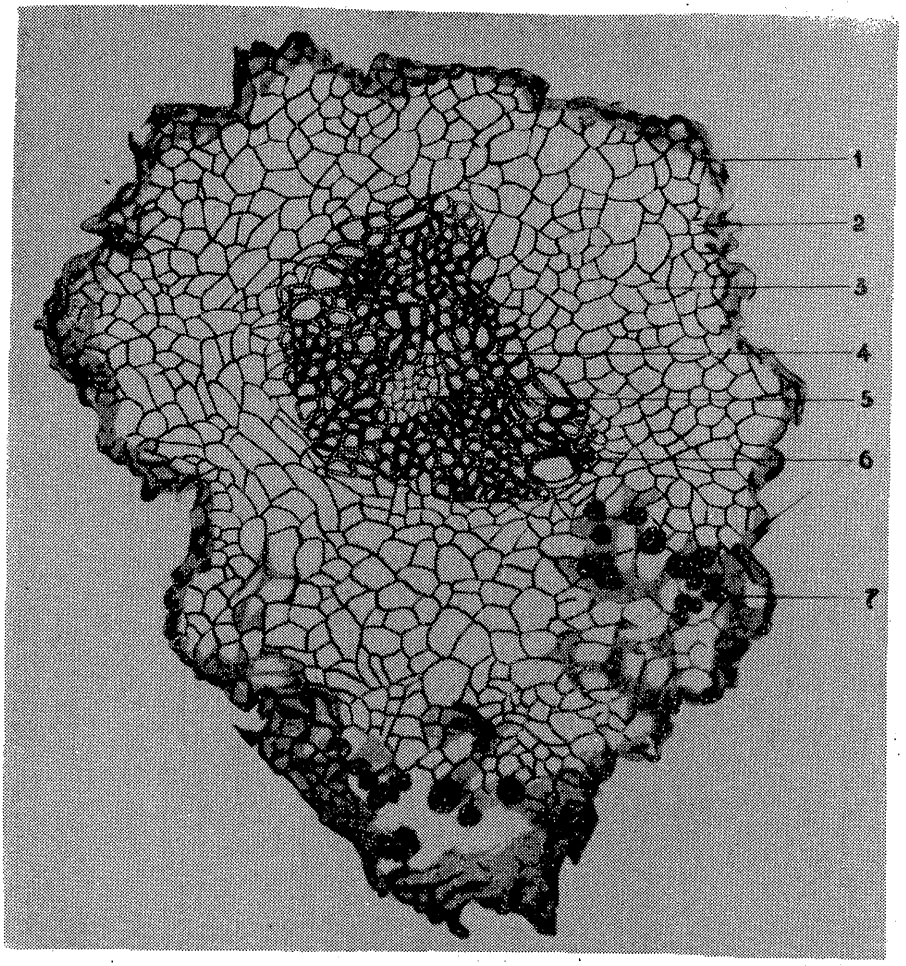

Fig. 2. Cross section of a spur root of a sunflower plant affected by Sclerotium bataticola Taub. (phase of 4–5 pairs of formed leaves) Eyepiece 7^x, objective 10^x:
1 – affected epidermis; 2 – exoderm; 3 – main parenchyma; 4 – conducting system; 5 – pith parenchyma; 6 – fungus in the conducting system and tissues; 7 – microsclerotia

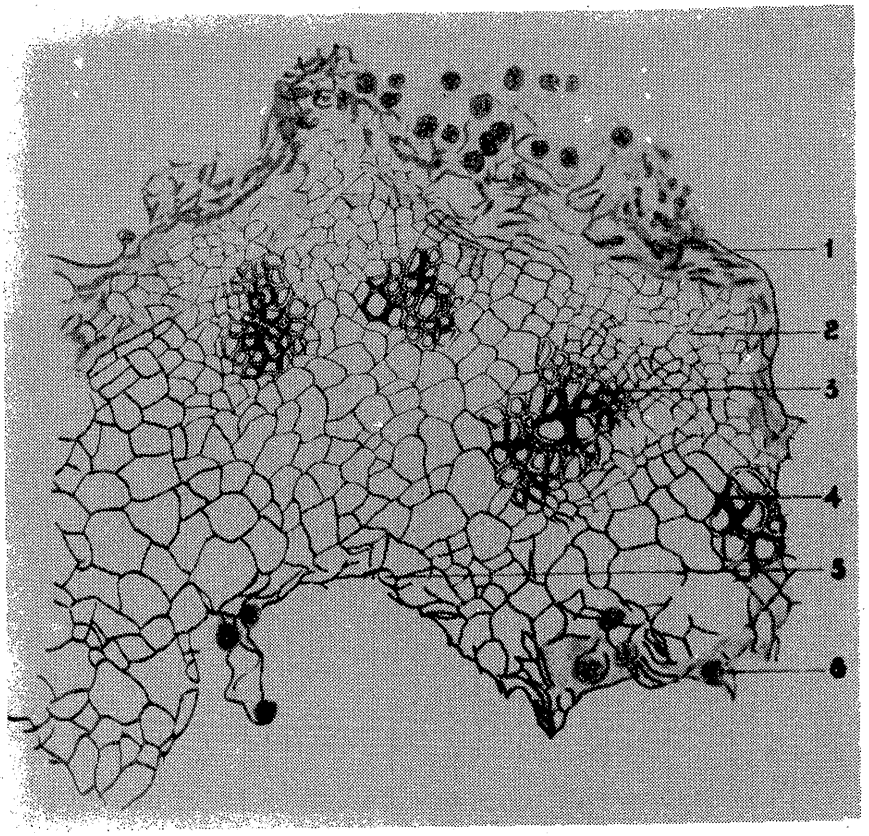

Fig. 3. Cross section of a sunflower stalk affected by Sclerotium bataticola Taub. (phase 4–5 pairs of formed leaves). Eyepiece 7^{x}, objective 10^{x}:
1 – affected covering tissues; 2 – main parenchyma; 3 – conducting system; 4 – fungus in the conducting system; 5 – pith parenchyma; 6 – microsclerotia

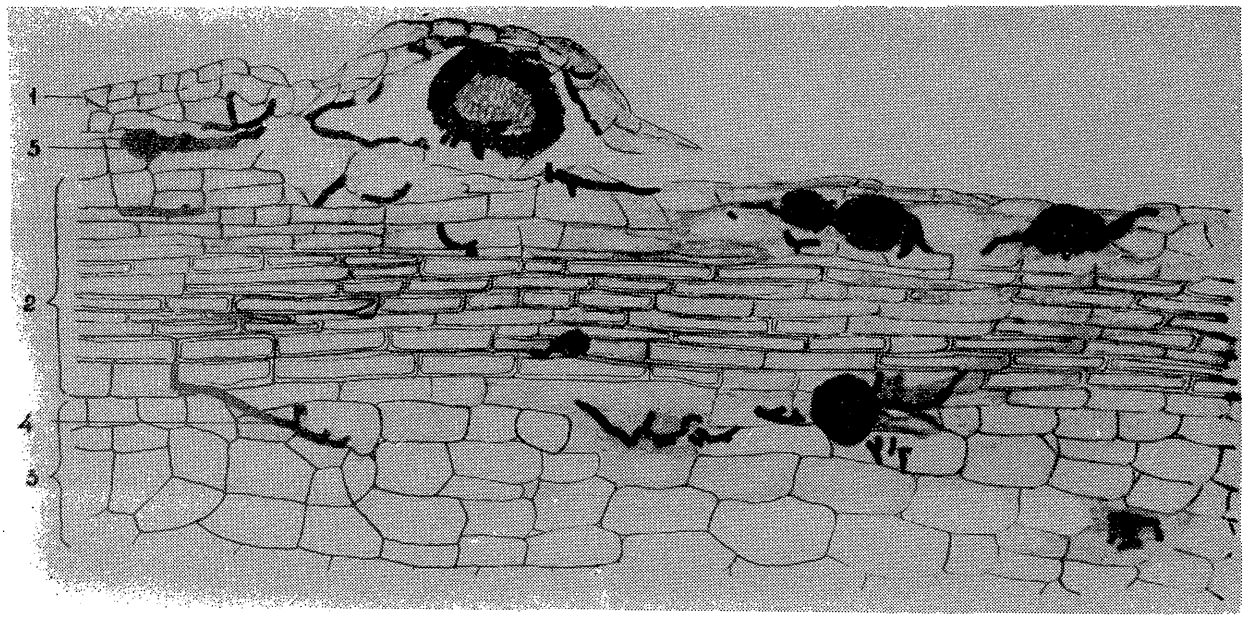

Fig. 4. Longitudinal section of covering tissues of a sunflower stalk affected by Sclerotium bataticola Taub. (before harvesting). Eyepiece 7^{x}, objective 10^{x}.
1 - remains of affected epidermis; 2 - affected parenchyma;
3 - piece of affected main parenchyma; 4 - fungus micelium;
5 - microsclerotium

When it penetrates the plant at the early stages of its development the fungus does not usually destroy the neighbouring cells. It first spreads in the tissues at a slow rate and only during budding and subsequently, when sunflower has a shortage of moisture and weakens, does the disease develop at a snowballing rate.

The ashen rot's excitant does not produce highly toxic substances, owing to which the plants are not wilted at the early stages of their growth and development.

When it afflicts the cells of sunflower tissues, sclerotium batoticola Taub. decomposes their cell shells, causing the occlusion of the vases and wilting of the plants.

Thus, anatomical investigation of sunflower tissues afflicted with ashen rot give grounds to include the excitant among the pathogenes possessing a fairly high degree of parasitism.