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A. TIITS

ON THE ETIOLOGY AND PATHOLOGY OF VIRAL PHYLLODIES OF PLANTS.

IV. The changes of generative organs in witches' broom-diseased raspberry

A. TIITS. TAIMEDE VIIRUSLIKE ROHEÕIELISUSTE ETIOLOOGIAST JA PATOLOOGIAST
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А. ТИЙТС. ОБ ЭТИОЛОГИИ И ПАТОЛОГИИ ВИРУСНЫХ ПОЗЕЛЕНЕНИЙ ЛЕПЕСТКОВ РАСТЕНИЙ
IV. Изменения генеративных органов у малины, заболевшей ведьминой метлой

Raspberry witches' broom (*Rubus* stunt) has been known in Estonia for more than 12 years. It was introduced into the collection of raspberry varieties of the Polli Experimental Station by the medium of Russian varieties (Tiits, 1966). Since the disease could not yet be eliminated, it has been possible to observe it on many raspberry varieties. Special attention has been paid to the symptoms of the disease.

Character of floral symptoms

The floral symptoms can be seen at the beginning of the development of the disease. In plants with a developed disease, one can observe symptoms of vegetative organs mostly, viz. the witches' broom growth of canes.

The floral symptoms are varied. Infected plants of many varieties form small, but normal-type flowers in most cases. In some varieties, there are proliferations of sepals, and some varieties (particularly 'Preussen' and 'Obyknovennaya iz Nikol'ska') develop malformed flowers. As the author described it in the case of clover phyllody (Tiits, 1969), the gradual transformation of more or less morphologically normal floral organs to flower prolification can be seen in the case of raspberry witches' broom as well. According to the range of those changes, the malformations could be arranged in the following four main groups.

Fig. 1. A flower with pod-like pistils.

Fig. 2. A flower in which some leafy carpels have axilarly secondary flowers.

Fig. 3. A secondary inflorescence. The other changed parts of primary flower (virescence of some petals, proliferation of sepals) can be seen there, as well.

Fig. 4. The clearly occurring proliferation of sepals.

1. Part of the flowers revealed morphologically slight deviations. They had normally developed sepals, petals, stamens and also a normal convex receptacle (torus); only the pistils were somewhat elongated and therefore similar to pods (Fig. 1).

2. A number of flowers had leafy carpels. In form, the carpels resembled simple bracts. No ovule traces were seen; on rare occasions, double leafy appendages of leafy carpels took the place of ovules.

3. The more changed flowers had secondary flowers which grew out from the axils of leafy carpels (Fig. 2). The homology of carpel and leaf is clearly seen in that case.

4. In extreme cases, the common axes of flowers developed growths, resulting in complicated prolifications. In place of the torus, there was a stem. The branches and bracts of the secondary flowers, similar to the previously described ones, were connected to the stem. As a result, the secondary inflorescence (Fig. 3) was similar to the primary one.

In all cases, the secondary flowers were morphologically normal.

It must be said that in malformed flowers of diseased raspberry, mainly the receptacle (torus) and femal parts is changed. The stamens are morphologically more or less normal. The petals are changed in few cases, only. If the petals are changed at all, it is in the same type as in the case of strawberry green petal disease. The changing of sepals (Fig. 4) is also not frequent in the infected 'Preussen' and 'Obyknovennaya iz Nikol'ska'. In the case of the progression of the disease (decline), the plants of the mentioned varieties lose their ability of flowering, like most of the infected varieties. (The vegetative organs — the shoots — do not attain the necessary height for the development of generative organs).

Discussion

The development of the prolification of flowers cannot be interpreted otherwise than as a counteragent to the development of floral organs in the primordial stage. It is confirmed by observations of flower initiation and primordial development, indeed. In infected plants, the floral primordia development is arrested. If, in the buds of noninfected plants, the sepals of the terminal flower primordium is generally distinct (stage IV-1* by late September, and the anther initials (stage IV-2) appear during October, in infected plants these stages can frequently not be seen before March or April. Therefore, the flower primordia do not pass stage IV-3 (carpels not yet covering the whole torus) before bud-burst, and under bud-burst conditions (gibberellins) the torus (more correctly, its meristem whose mission is not fulfilled and which has not ceased to grow, normally having faded by that time) may grow/develop in secondary inflorescence, while insufficiently differentiated carpels may grow on leafy appendages.

In this case, and in the case of various other witches' broom (yellows) type diseases, there must be a similarly acting substance which affects the hormone balance or acts as an inhibitor to the development of generative organs, and also as a promoter of the initiation of both, flowers and turions. It seems that the substance might be a secretion of the pathogen,

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* The following stages are distinguished in the development of raspberry (based on Prof. Fanny Kuperman's theory): I and II — morphogenesis of vegetative organs; III — forming inflorescence axes; IV — forming vegetative parts of flowers (IV-1 — forming receptacle and sepals; IV-2 — forming petals and anthers; IV-3 — forming carpels); V — forming archespores; VI — micro- and megasporogenesis; VII — forming gametophytes; VIII — gametogenesis; IX — flowering, fertilization and sygotogenesis; X—XII — forming fruits and seeds.

i. e. there could be a pathogen that has its own metabolism. Since viruses have no metabolism of their own, attention must be paid to the findings of mycoplasma-like bodies in thin sections of various plants suffering from the diseases of the discussed type (see Ploaie, Maramorosch, 1969). The endeavours of D. Atanasoff (1969) to save the "positions" of viruses as pathogens of witches' broom, or yellows diseases, with the hypothesis that the plant mycoplasma-like organisms may be innocent symbionts which serve as vectors of viruses, are obviously inappropriate. Although viruses have been found in witches' broom-diseased plants (see e. g. Tiits, 1962, 1966), they turn out to be not the causal agents of these diseases, but other, mechanically non-transmitted pathogens (Tiits, 1966; Тийтс, 1968).

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In the present paper the common name "witches' broom diseases" are applied, mostly. It has been derived from L. Bos' (1963) suggestion that this name has to be applied to all diseases which have witches' broom growth of vegetative organs or virescence, phyllody and/or prolification of generative organs.

Likewise, the name of the disease "Rubus stunt" (Prentice) has been replaced by "raspberry (or Rubus) witches' broom", beginning with 1962 (Tiits, 1962). If previously that name was applied for the character of turion initiation, at present it is evident that it is also correct in the case of the witches' broom growth and phyllody of generative organs.

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