Virus Yellows in Western Europe

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At present, virus yellows is without doubt the most important virus disease of the sugar beet, fodderbeet and mangold (stockbeet) in various countries of western Europe. A considerable amount of information has been assembled by the specialists working on this problem and some of the main points are discussed here.

History and Distribution of the Disease

According to Professor Hudig there was a serious outbreak of the disease in the Zeeland area of the Netherlands in 1912 and in literature outbreaks of a disease which may have been virus yellows have been mentioned even earlier. In 1934, Quanjer recognized the disease as a virus disease and in 1935 successful transmission by means of aphids was made both at Wageningen and Bergen op Zoom. In 1937 and 1938, the first attempts were made in field experiments to estimate the losses caused by this disease. A difficulty in the earlier years of work on this subject has been that beet leaves can turn yellow for many reasons. In some cases even now it is difficult for a specialist to recognize the disease without laboratory tests.

The disease is definitely known in the European countries of Sweden, Denmark, Western Germany, Netherlands, Belgium, England, Ireland, France, Switzerland and Austria. It seems to be penetrating into eastern Germany and according to some reports occurs also in Czechoslovakia, Jugoslavia and northern Italy. The most serious attacks of the disease up to now have occurred in England, Netherlands, Belgium, parts of western Germany and parts of Denmark. The incidence of the disease in the different countries varies considerably from year to year.

Symptoms of the Disease

The symptoms may vary considerably due to climatic conditions, variety, "strain" of virus, time of infection, etc. The main characteristics are:

1. Yellow to orange color of leaves or parts of leaves and in some varieties also small reddish spots or formation of anthocyanin;
2. Leaves thicker and brittle, breaking along a straight line when folded up;
3. Formation of "gum" in the phloem;
4. Accumulation of photosynthates in the leaf;
5. Stunting of growth.

The first yellow symptom often shows at the top of the leaf, **but** also sometimes at other portions. First of all a slight mottling and discoloration is seen and this develops gradually into bright yellow. At first, often only a sector of the leaf between two major veins becomes yellow. Another symptom, which by some specialists is ascribed to another "strain" of the virus, is the clearing of the veinlets in a part of the leaf. Also sometimes

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small necrotic spots develop which merge together to form larger necrotic spots *in* a later stage. Red spots are formed on some sugar beet varieties while in mangolds the anthocyanin sometimes completely covers the yellow color.

The thickening of the leaves and the yellowing are almost always correlated. Both in the greenhouse and in the field, however, plants can be found with thick, brittle green leaves in which the yellowing symptoms come later, especially when the weather is overcast for a long time. Mostly the yellowing does not begin on the oldest leaves but on somewhat younger leaves, while the heart leaves remain green.

Xhe gum formation in the phloem was discovered by Quanjer *in* 1934. It is, however, found in some green healthy plants also, but usually less prominent and therefore, cannot be used as a single, characteristic symptom for recognizing the disease.

Accumulation of starch and reducing sugars is always found *in* the yellow leaves unless these are old and already partly necrotic. The growth of the foliage is stunted, especially with early infections. Excessive development of weeds is therefore very often seen in fields *in* which virus yellows is prevalent.

In cases of doubt the use of the serological method of diagnosis is very helpful.

Vectors and Sources of Virus

The most important vectors are *Alyzus persicae* and *Aphis fabae,* although it has been proved that at least *in* greenhouse experiments some other aphids are also able to transmit the virus. Various other insects living in beet fields have been tested but, so far, apart from aphids, no other vectors have been found. In many cases *Myzu.s persicae* is the more dangerous vector as it moved around more in the fields, while *Aphis fabae* forms colonies on a plant or a group of plants. In some areas, however, *Aphis fabae* under favorable conditions develop in such numbers that without any help from *Myzus persicae* a hundred percent infection is reached. The spread of the disease by alate aphids is greater than that caused by apterous ones and it is still an unsolved problem as to which is the role of the alatae of other species which may feed but not breed on beets.

The plants susceptible for Virus Yellows all belong to the Chenopodiaceae or closely related families. The following sources of virus should be mentioned:

1. Wild plants of the families mentioned above.
2. Beet seed crops.
3. Mangold clamps.

Apart from *Beta mariiima,* which may play a role in some districts along the coasts, most of the weeds belonging to the Chenopodiaceae are annuals. In some countries and under mild weather conditions, however, some of these may overwinter and carry the virus. In parts of Belgium and some villages of the Netherlands the same may be the case with overwintering spinach. When beet stecklings are infected in summer or autumn the seed

crop will carry the virus early in spring and be a dangerous source of virus, as has been recognized in many countries.

The most dangerous source, however, in some European countries is formed by the mangold clamps present on many farms. These mangolds are used for feeding cattle even until May or June. In the clamps (pits) not only the virus overwinters, but also aphids live over winter on the sprouts. Under favorable conditions these aphids may breed in enormous numbers and a clamp may contain millions of aphids. When the clamp is opened in the spring, the alate aphids migrate to the fields and cause a primary infection as has been proved by the late Dr. Hellinga (Bergen op Zoom) as far back as 1942. Later on, aphids breeding in the field or migrating from other sources, e.g., peach trees) will spread the virus from these spots of primary infection. When great numbers of alatae are present in summer a few spots of primary infection are sufficient for a heavy outbreak of the disease.

In some cases no spots of primary infection are found. We have noticed this sometimes when the source of virus was a beet seed or spinach seed field with a high degree of infection from where great numbers of winged aphids moved early in summer. No transmission of this virus by seed has been found.

Losses Caused by the Disease

In England, losses were calculated at 4 to 5 percent of the yield of healthy plants for each week that symptoms are showing until mid-October. This comes to 40 to 50 percent for mid-June infections as compared with 30 to 40 percent for the same in experiments in Sweden and the Netherlands. Maybe the strain of virus used in the English experiments has been more severe. The sucrose content may be reduced by 1 or 2 percent. Also, there is an increase in noxious nitrogen and the purity of the expressed juice is lower. In the seed crop, losses of yield of over 100 pounds per acre per 10 percent increase in virus yellows may occur, as has been proved by Hull in England. The quality of the seed is also lower.

Influence of Cultural Practices

It has been found that early planting and high population have an effect. Young plants are more attractive to aphids and they prefer an open stand. Aphids will not colonize so much in a well closed stand, probably because they find an unfavorable ecoclimate. On the other hand, some aphid parasites develop better in a closed stand.

As a general rule it can be said that good farming practices, early planting, high plant population and, to some extent, the use of fairly heavy dressings of nitrogen will help the farmer to reduce the percentage of infection. In typical virus yellows years the effect from nitrogen will be limited.

Means of Combating the Disease

Apart from the cultural practices mentioned above, there are a few other methods of combating the disease.

Stecklings should be grown in areas where the environment does not suit the vector or where beets and other hosts of the virus are more or less

absent. This pracice has been adopted in Sweden, Netherlands and, in part, in England. Virus infection of stecklings has been reduced by growing them under cover crops. Spraying with systemic insecticides has also given good results with the exception of those cases where there are great numbers of viruliferous alate aphids about.

For mangold clamps the best advice, up to now, has been to feed the mangolds before the beginning of April. Experiments in the Netherlands, where on one of the islands all clamps were removed, have shown a reduction of virus yellows in 1950 and 1951. Experiments on fumigation of aphid-infected clamps have not been very successful.

Apart from the necessity of breaking the overwintering cycle of the virus in various hosts, there is a possibility for combating the disease in the commercial beet crop by using systemic insecticides. Although experiments have shown fairly satisfactory results, the possibilities are not yet sufficiently explored to know whether this will develop into a paying proposition for the beet grower.

The primary infection by aphids is not prevented by the use of systemic insecticides and, therefore, in cases where there is a large number of winged viruliferous aphids present, a high percentage of infection will occur *in* fields sprayed with systemic insecticides.

A resistant variety would undoubtedly be the best solution. Some of the specialists do not believe in resistance to virus yellows, but the recent work carried out at Bergen op Zoom and in other countries has shown that there are lines showing a higher degree of tolerance against this disease than others.

The work is difficult since symptoms are often more or less masked, but personally I feel sure that when breeder and pathologist work closely together it can be done. Not only will attention have to be paid to commercial varieties and breeders' lines, but we must thoroughly explore the behavior of the wild relatives of our sugar beet.