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THE CURLY TOP DISEASE OF VEGETABLES
IN THE PACIFIC NORTHWEST

by

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The curly top disease was a major factor in sugar beet production in the Pacific Northwest until resistant varieties became available. The same disease is very important on a large number of vegetable crops and also occurs on many native plants, weeds and ornamentals.

Nature and Spread of Curly Top

Curly top is a virus disease and is distributed from plant to plant by a single species of insect, the beet leafhopper, Eutettix tenellus. This insect takes up the virus by feeding on a diseased plant and afterward may carry the virus as long as it lives and inoculate every susceptible plant upon which it feeds. The beet leafhopper is a native insect and finds favorable breeding grounds in many parts of the semi-arid regions of Central Washington, Eastern Oregon, Southern Idaho and similar environments extending southward into Old Mexico.

Mustards, filaree, Russian thistle and many native and introduced plants are favorite hosts for the beet leafhopper and are also subject to the disease caused by the virus which is distributed by this insect. Many of these plants which are hosts for both the insect and the virus over-winter and many of the insects also survive. Both the beet leafhopper and the plants serve as sources of infection the following season. The spring brood of beet leafhoppers has abundant opportunity to acquire the virus from infected plants in the breeding grounds. The beet leafhoppers carry the virus with them into cultivated fields to which they migrate. This migration may be hastened when conditions in the breeding grounds become less favorable due to drying of vegetation in these non-cultivated areas. Observations by those studying the life habits of this insect have indicated that it can easily migrate 50 to 150 miles or more. There is some evidence that the leafhoppers travel with the wind which may explain their sudden appearance and abundance in some cultivated areas and their absence in others.

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Vegetable Crops Affected and Injury Caused by Curly Top

The curly top disease is very destructive as it occurs on the tomato, garden bean, spinach, garden beet, Swiss chard, pepper and some varieties of squash and pumpkin. It affects less severely cucumbers, cantaloups, melons and other vegetables.

Tomato -- On the tomato the disease has long been known as western yellow blight. The name, yellows, which is more descriptive of the symptoms on the tomato than curly top, has also been proposed. A young tomato plant is often killed outright. When the older plant is attacked it stops growing, the leaflets roll upward, become leathery and turn yellow. The veins at first may be purplish; fruits ripen prematurely and the whole plant gradually dies.

There is always an interval of some days from the time a beet leafhopper carrying the curly top virus feeds on the plant before the symptoms of the disease appear. High temperatures cause the disease to develop more rapidly. For this reason a wave of disease may sweep over the field a few days after the beginning of a period of hot weather or the disease may appear suddenly over a large part of the field. This is the reason uninformed growers often attribute the disease to hot winds.

Bean -- Garden beans in the seedling stage are killed outright. Older plants often drop their blossoms and young shoots, or the younger leaves may curl and stop growing. Affected plants may gradually yellow and die. In any case, severe infection results in dwarfed unproductive plants. Late in the season the disease may simply hasten maturity and prevent proper development of the crop.

Spinach -- Young plants are easily killed by curly top. The inner leaves curl and stop growing while outer leaves yellow and die. A winter crop is usually harvested before the disease appears. The disease often does kill many plants in the fall crop but these are usually removed in thinning or "blocking out" and little loss results. Commercial losses are negligible principally because the crop is grown when the disease is not prevalent.

Garden beet -- The garden beet, Swiss chard and mangel are very susceptible. Young seedlings are severely injured or killed. Young foliage on older plants curls and is dwarfed. Roots of beets or mangels are reduced in size and often are covered with thick patches of fine roots.

Pepper -- Curly top causes dwarfing in the pepper. Diseased plants in a field are noticeably shorter, smaller and more compact than normal plants. The upper leaves are curled, fruits remain small and the new growth appears to be clustered at the top of the plant.

Squash and Pumpkin -- The true squashes and many pumpkins are severely injured or killed in the seedling or young stages. New growth on older plants is dwarfed and the old leaves may yellow and die.

Cucumber, Cantaloup and Watermelon -- Generally, symptoms develop only at the tips of the runners, which are checked in growth. The whole plant is weakened and the quality of the fruit is impaired.

The Insect Carrier

The beet leafhopper, as mentioned above, breeds in weedy range lands and migrates to cultivated fields. The widespread occurrence of the insect and its habit of migrating from breeding grounds to areas at some distance make the problem of suppressing the insect a most difficult one and one for which no general recommendations are available at the present time. The United States Bureau of Entomology and Plant Quarantine, however, is devoting much study to the life habits and control of the beet leafhopper in the interest of the sugar beet growers as well as growers of susceptible vegetables.

Tests for Resistant Varieties

Extensive experiments have been carried out during the last few years by State and Federal research workers to find and develop resistant vegetable varieties which would grow satisfactorily in sections where the curly top disease was prevalent. Tomatoes, beans, beets, squashes and pumpkins have received special attention from the Federal investigators working in cooperation with the Oregon Experiment Station.

Tomato -- No cultivated varieties of tomato have been found which show satisfactory resistance although much of the work to date has centered on this vegetable. Attempts are being made to secure hybrids of the cultivated tomato with wild species which are somewhat resistant to curly top. This work of breeding and improvement is directed toward the development of a tomato variety resistant to curly top and suitable for the sections where the disease is destructive.

Bean -- More encouraging results have been secured in the case of the bean, squash and pumpkin. Resistance is found among the field bean varieties. The Burtner Blightless, California Pink, California Red, Jenkins and Red Mexican are the most resistant of the dry or shell beans tested. Strains of Red Mexican and Great Northern, resistant to both curly top and common mosaic, have been developed by the Idaho Experiment Station. The Burtner Blightless, a white pea bean, originated by a grower in Wasco County, Oregon, after whom it is named, may also be used as a snap bean for home consumption. Although thus used to some extent, it is less suitable than the common snap bean varieties for commercial canning. The popular varieties of snap beans are very susceptible to curly top while lima beans as a group show strong resistance.

Breeding for resistance in garden beans has been carried on for several years. A number of hybrid strains are in prospect to meet the need for resistant snap beans with wax and with green pods and in both bush and pole types.

Squash -- Many varieties of squash have been tested for resistance to curly top. Such popular varieties as Hubbard, Banana and Golden Delicious have been very seriously injured. Of the varieties tested, which belong to the species Cucurbita maxima, Marblehead is the only variety which has proved to be resistant. Certain strains of Marblehead are sufficiently resistant to be grown where curly top occurs in severe form. The strain known locally as the Yakima Marblehead is grown extensively in the Yakima Valley. Another strain or variety was developed

on the Hermiston project, and is known as Umatilla Marblehead. These strains are variable in fruit shape and color. Fruits are large but of excellent table quality and keep remarkably well in storage.

Pumpkin -- The species Cucurbita pepo includes many varieties commonly called pumpkins and some that are generally listed as squashes. Some varieties of this species are rather resistant and some very susceptible. Big Tom, Golden Oblong and Southern Field, of the Connecticut Field group, and some varieties in the Vegetable Marrow group have shown partial resistance. The Sweet Potato and Table Queen of the Fordhook group, Bush Scallop of the Patty Pan group, and Giant Crookneck and Giant Straightneck of the Crookneck-Straightneck group are extremely susceptible. The affected vines die early and produce few fruits under conditions of severe infection.

The other group of pumpkins, which contains very resistant varieties, belongs to the species Cucurbita moschata. Sweet Cheese or Kentucky Field, Calhoun and Large Cheese of the Cheese group, Tennessee Sweet Potato and the various varieties of Cushaw have all shown marked resistance. The varieties of the Cheese group are of most value for domestic purposes and commercial canning. Many of the other varieties of this group of pumpkins, while very resistant, require a longer season for development than is available in the Pacific Northwest. They are widely used in the southern states. They have the added advantage of being resistant to squash bug injury.

Practices That May Reduce Curly Top in Tomatoes

The practices mentioned below are designed for the home owner or small operator who finds it difficult to mature a crop because of curly top and who wishes to make a special effort to evade the disease. These measures, however, have only a limited value for the commercial grower.

Experiments conducted at the Umatilla Experiment Station have shown that shading reduces the amount of curly-top damage in tomatoes. The plants were grown under slat frames giving half shade or under frames covered with muslin cloth. The frames were not tight enough to exclude the leafhopper. However, the leafhopper prefers to feed on plants in the open, and for this reason apparently is less likely to transmit the virus to plants growing in the shade. In addition, it appears that plants growing in the shade, even though they are inoculated by the insect, are not as seriously injured as plants growing in the sun. It may be advisable to use slat or cloth-covered frames to a limited extent where experience shows that tomatoes cannot be grown without such protection.

Growers have in some cases reduced the amount of curly top damage by growing tomatoes in shade of trees or buildings or by using shade crops in the field. Tall-growing crops, such as sunflowers, have been used between rows to furnish shade, but plants that will grow rapidly and are tall enough to produce shade compete with the tomatoes for plant food and moisture and thus may reduce the crop. The value of a shade crop for any section can be determined best by the grower who tests such a shade on a portion of his field.

Temporary cloth shades have been successfully used by some home gardeners to cover individual rows of tomatoes in the garden. These have been put on as

soon as the plants were set out and removed when the plants began to crowd the cover. A cloth strip two yards wide is used. It is supported in the middle by low stakes set along the row and anchored along the edges by dirt or clods rolled over the edge of the cloth. One side of the cover is raised when weeding is necessary.

Delayed setting in the field has been tested experimentally at Hermiston, Oregon. Losses from curly top were reduced by this practice. The crop from plants set in the field at the usual time was a total loss. Plants set about three weeks later yielded part of a crop. The amount of curly top in the early, midseason, or late crop will depend, in part, on the abundance of the leafhoppers at the time these crops are growing. Also, older plants are definitely less susceptible than seedlings. Home owners can often afford to set out plants at different seasons and although many of the plants may be lost, some will usually escape the disease and give some yield even under the most severe conditions.

A recent publication from the Utah Experiment Station states that closer spacing of tomato plants in experimental plots has reduced the percentage of curly top and increased the yield. This was true when plants were spaced closer together in the row or when the number of plants in the hill was increased. Experiments in Utah indicate that under conditions existing there, the plants may be set at intervals as close as 6 inches in the row or in double-hill plantings in which 2 to 4 plants are set in hills at distances up to 6 inches apart in 42-inch rows. As a rule the amount of disease was reduced and the yields increased as the distance between plants was reduced. Closer spacing increased the cost of plants and setting but in epidemic years paid large dividends. Growers in the Pacific Northwest should test closer setting of plants on a small scale before adopting such a practice for general use in the field.

There may be some benefit derived from sowing seed directly in the field. The plants are not subjected to the shock of transplanting and can perhaps resist the disease to some extent. If allowed to stand thickly in the row many plants may be killed by curly top and still leave a number to develop and produce fruit. Seeding directly in the field has become a very common practice with commercial growers in the Yakima Valley of Washington.

In regions where curly top on tomato is severe, it is best to grow beets and tomatoes or other susceptible vegetables at a distance from each other. The leafhoppers like to feed on the beet and will tend to concentrate on the beet foliage where they naturally increase in numbers, and become a real menace to adjacent susceptible crops.