

# Beet free periods— the key to higher sugar beet yields

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**T**he sugar beet, a product of research, has been confronted with crisis after crisis in its role as a supplier of one of the cheapest and purest of foods. One of the most recent maladies to take heavy tolls in the production of this crop has been the aphid-transmitted yellowing virus diseases.

The yellowing virus diseases are serious hazards to stable production of beet and numerous other crops throughout the world. Since the dawn of agriculture, man has accepted these diseases as being induced by natural factors such as early ripening, drought, excessive moisture, nutritional deficiencies, or soil conditions.

The yellowing disease on sugar beet was first implicated as an infectious entity in 1936 in Europe and was recorded in the United States in 1951. Yellows was first reported from California in 1951, but photographic evidence indicates that it was present in the Salinas Valley as early as 1945 and perhaps as early as 1921. Following its discovery in 1951, yellows maintained epidemic proportions in California until 1968.

## Caused by viruses

The disease complex known in California as yellows is caused by two distinct, unrelated viruses—beet yellows and beet western yellows viruses. In addition, beet mosaic virus is commonly found infecting the same plants.

The epidemiology of these viruses is seriously affected by vector populations. Two other major factors are (1) the manner in which the vectors transmit the viruses, and the length of time they re-

tain them, and (2) the virus sources.

Aphid vectors transmit the beet mosaic virus in what is termed a non-persistent manner, and the beet yellows virus in a semipersistent manner. These viruses are retained by the aphid for a period of several hours to several days. Such transmission characteristics cause virus spread to be local; i.e., the disease incidence is high in areas adjacent to the virus source but quickly lessens with increased distance from the virus source. Distances of 2 miles are apparently effective barriers to the distribution of these viruses. The principal source of these two viruses is the beet itself, including escaped beets growing in waste places and overwintering beet fields.

Beet western yellows virus is much more widely distributed and occurs in greater abundance than any of the other beet viruses. The virus is transmitted in a persistent manner by its vectors and they may retain the virus for life. Virus distribution is much more general and widespread than the local distribution of the viruses that are transmitted in a nonpersistent or semipersistent manner. Beet western yellows, like beet yellows, spreads from beets—but western yellows may also spread from a number of common weeds and other crop plants.

## Early control efforts

Early studies on the yellows complex in California showed reduction in root yields ranging from 2.0 to 47.0 percent and reductions in sucrose content ranging from 0.1 to 3.1 percentage points. Natural infection in central California

*Beet yellowing viruses can be held in check by use of beet free periods*

caused a reduction in tonnage of 22.3 percent and a reduction in sucrose of 1.38 percentage points. Infection in the seedling stage leads to very heavy losses, whereas later infections cause proportionally less damage.

Epidemiological studies in California in the late 1950s confirmed European reports that there was a close correlation between virus yellows incidence and the proximity of overwintered beet fields. During this period of extremely heavy yellows losses, sugar beet growers and processors reached agreements to maintain a period of time between the completion of harvest of the old crop and the start of planting the new crop. These "beet free periods" varied for different areas within the beet growing districts in the state so that beet free and overwintering areas were separated. The beet growing districts initiated these programs over a period of several years but they were put into general use for the 1968 crop. During the beet free periods, there was an effort to prohibit any sugar beets in the ground within the beet free area and a cooperative effort was made to clean up weed beets.

A compilation of the sugar beet production data in California from 1910 to 1974 shows some interesting trends and gives new insight into the economic impact of beet free periods and the control of the yellowing viruses on sugar beet (see graph).

Yields of sugar per acre stood at about 2.0 tons in 1910, but declined severely with the much publicized ravages of beet curly top virus following World War I. Production markedly improved in the late 1920s and early 1930s with the removal from production of areas normally devastated by curly top and the introduc-

tion of curly top resistant cultivars in 1934. Production steadily increased until about 1950, when it reached 3.0 tons of sugar per acre.

This was a period of constantly improving curly top resistance and cultural practices. Other factors that contributed to the generally increasing yields included research and improvement in varieties, soil and crop management techniques, fertilization methods and materials, stand establishment, irrigation methods, deep tillage, and insect and nematode control.

### Yield decline

In spite of the introduction of varieties combining bolting, curly top, and downy mildew resistance, the introduction of hybrid varieties and of monogerm seed, increased use of nematicides and herbicides and of mechanical harvesting systems, the implementation of a beet leafhopper control program and of better fertilizer management, there was a period from about 1950 until the late 1960s when yields significantly declined.

The decreasing yields during this period of increasingly sophisticated sugar beet technology were directly related to losses due to the yellows virus complex. About 1950, the sugar beet industry began to overlap growing periods in various portions of the state, resulting in increased incidence of the yellows virus complex, accompanied by increasingly severe yield losses. Over this same period of time, the prevalent beet curly top virus isolates gradually increased in severity.

After the implementation of beet free periods for the 1968 crop, yields of sugar beets significantly increased. The large 1968 crop (see graph) and early rains

prevented completion of this harvest, resulting in a breakdown in the beet free periods and in high yellows incidence and low yields in 1969. Beginning with the 1968 crop, the commonly grown varieties were largely replaced by two hybrid sugar beet varieties with moderate resistance to virus yellows.

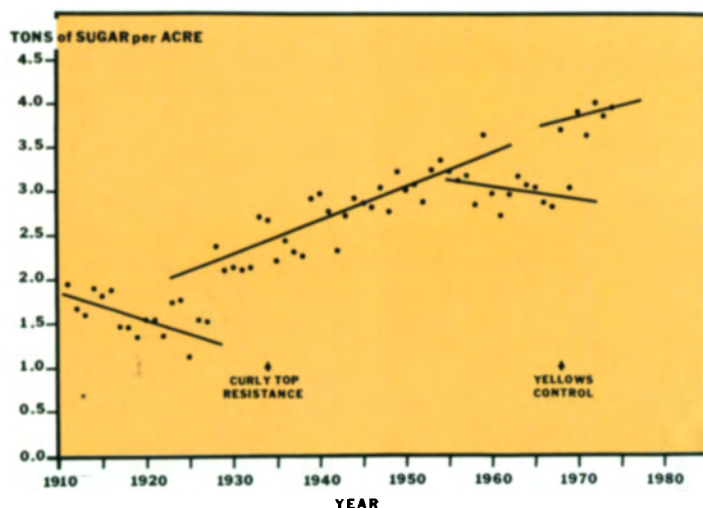
### Current successes

On a statewide average, sugar production was 0.86 tons per acre greater for the last five growing seasons (1971 to 1975) than for the period 1950 to 1967 (before the yellows control program and resistant varieties). This has meant an increase of \$217,969,000 received by farmers over this five year period, due in the most part to yellows control. Considering purchases made by growers, wages paid to farm workers, purchases by farm and factory workers, and expenditures of sugar beet tax revenues made by governments, yellows control has contributed over \$792,000,000 to the economy of the state. The impact of yellows control is fully comparable to the impact obtained with curly top virus control 40 years earlier.

This is only a small part of the financial benefit of sugar beet research to California growers and consumers. For instance, based on the yields of sugar per acre obtained in the last five years, over 10 million tons of sugar were lost between 1911 and 1967, due to diseases; improper cultural, irrigation, and nutrition practices; and less efficient cultivars. At 1971 to 1975 average prices, this is equivalent to losses of over \$1.8 billion to California growers and \$6.6 billion to the economy of the state—which dwarfs to insignificance the cost of the research which prevents such losses.

The beet yellowing viruses have not been eradicated. They occur in all beet growing districts of the state. The diseases have been held in check by the continued use of beet free periods, the cooperative effort to clean up weed beets, and the use of tolerant varieties. Any serious breakdown of this system could result in yellows infection early in the growing season with resultant heavy losses.

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Sugar beet production in California for the period 1911 to 1974. Four distinct production trends are related for the most part to virus diseases and their control. (Data collected by the California Beet Growers Association, Ltd.)