Sugar-Beet Mosaic Tests

disease may cause considerable reduction in yields of sugar and garden beets grown for seed

Henry H. P. Severin

Sugar-beet mosaic investigations conducted in California include tests on the host range, symptoms of the disease, properties of the causing virus, and various aspects of transmission by insects—especially aphids.

Sugar-beet mosaic is not a killing virus of sugar beets, mangels, or garden beets, and has nowhere in California proved important in commercial fields.

On the other hand, mosaic is a serious disease in sugar and garden beets grown for seed in California. When the stecklings or mother beets are infected before transplanting, considerable reduction in seed yield results.

The economic plants in one family which have been found naturally infected with the sugar-beet-mosaic virus are the sugar beet, mangel or stock beet, garden beet, Swiss chard and spinach.

Other plants including the common summer cypress, New Zealand spinach and the Havana-type and Primus variety of tobacco were experimentally infected with the virus during the investigations.

Six species of weeds were infected experimentally and may serve as reservoirs of the virus under natural conditions.

Investigations further disclosed 10 species in five families to be nonsusceptible to the disease.

Symptoms

The sequence of symptoms on host plants—and even on a single host plant—varies widely. The incubation period of the disease in sugar beets averages about eight days in the greenhouse and 25 days outdoors.

On sugar beets the first evidence of the disease in nearly all cases—and not readily discernible upon brief observation—is the presence of a few minute, yellow or pale green flecks on the youngest leaves. A definite clearing of the veinlets follows immediately, usually spreading within 24 hours over the entire leaf.

A widening and merging of the chlorotic—yellowing or fading—areas along the cleared veinlets of the green leaf marks the beginning of an irregular blotching type of chlorosis. The mosaic pattern may consist of green blotches in a faintly chlorotic leaf, or well-defined chlorotic blotches in the green portion of the leaf.

In these observations it was noted that three weeks after inoculation the blotching type of chlorosis frequently was replaced—particularly on the intermediate leaves—with chlorotic rings or dots.

Symptoms on mangels or stock beets are essentially the same as on sugar beets.

The most striking symptoms on garden, table or red beets are rings margined with red on the older leaves. In a later stage of the disease, a necrotic center appears, which enlarges in the ring, and may drop out and leave a hole in the leaf.

With some varieties of Swiss chard, the initial symptoms appearing on the youngest leaves are a few small, scattered chlorotic dots; on other varieties a clearing of the veinlets occurs, followed by mottling and by chlorotic rings surrounding green centers.

The foliage symptoms of sugar-beet mosaic are not evident on common summer cypress but the top shoots of the branches were stunted within nine days of inoculation.

The first symptoms on New Zealand spinach are small, irregular, chlorotic flecks along and between the veins.

Circular, chlorotic areas appeared on the Havana-type variety and on Primas tobacco.

Transmission

Insect transmission of the virus was obtained only with 15 species of aphids.

Four aphid species which multiply on sugar beets were found to transmit the virus, while 11 aphid species reared on other host plants proved also to be vectors of the virus.

Aphids which multiplied on sugar beets in the greenhouse and transmitted the virus were erigeron root aphid, bean or dock aphid, pea aphid and green peach aphid.

The aphid species reared on other host plants and which were found to be vectors of the virus were celery leaf aphid, celery aphid, rusty-banded aphid, cotton or melon aphid, bur clover or cowpea aphid, green apple aphid, cabbage aphid, yellow willow aphid, foxglove aphid, honeysuckle aphid, turnip or false cabbage aphid.

The bean or dock aphid, green peach aphid, and beet root aphid multiply on beets under natural conditions.

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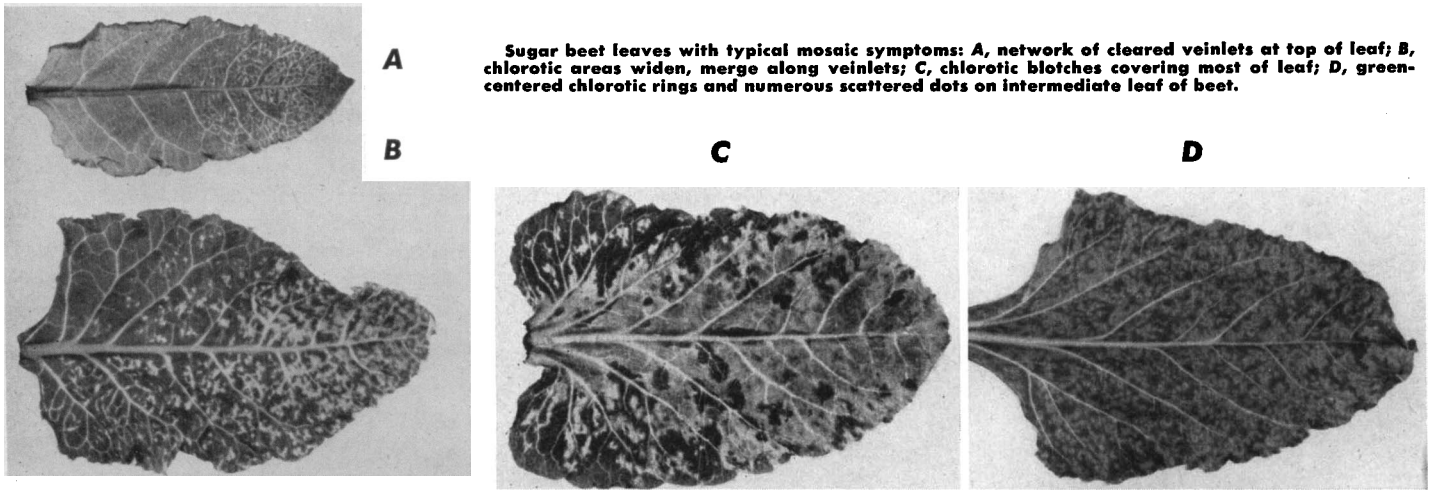

Sugar beet leaves with typical mosaic symptoms: *A*, network of cleared veinlets at top of leaf; *B*, chlorotic areas widen, merge along veinlets; *C*, chlorotic blotches covering most of leaf; *D*, green-centered chlorotic rings and numerous scattered dots on intermediate leaf of beet.

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In the tests at the Experiment Station the original sugar-beet-mosaic virus was obtained from a field of naturally infected sugar beets near San Pablo. Mechanical inoculation of healthy sugar beets grown under cover in the greenhouse was carried out to obtain a virus supply and this was maintained by continuous inoculations during the experiments.

The green peach aphid was used in most tests. Noninfective aphid were obtained by transferring mature, wingless aphids from populations collected in the field to favorable healthy host plants.

On the following day the offspring from the mature aphids were transferred to a second healthy plant and allowed to multiply. No symptoms appeared and the disease was not produced in any case.

In one instance aphids recovered the virus from a sugar beet infected with the virus one day before symptoms of the disease developed; in another instance, on the same day after the first symptom appeared; while in still others, one to two days after the earliest symptom developed.

Virus transmission by lots of 20 erigeron root aphid, pea aphid and the green peach aphid reared on mosaic beets were compared with that by mechanical inoculation.

Infections obtained with these three aphid species were 20%, 60% and 56% respectively, as compared with 96% by mechanical inoculation of the virus extract from the plants on which they were reared.

The transmission of the virus by 10 aphid species reared on other host plants varied from 8% to 76%, as compared with 88% to 100% by mechanical inoculation of juice expressed from the same mosaic beets on which the aphids were forced to feed.

With the green peach aphid, the percentages of infections produced were observed to increase with the number of aphids per plant.

Short feeding time of winged aphids on mosaic and healthy beets may be of significance in the natural spread of the disease, since lots of one, two, three, four and five green peach aphids gave infections averaging 0%, 25%, 25%, 40% and 45%, respectively, after having fed five minutes on mosaic and five minutes on healthy beets.

The retention of the virus by lots of 20 infective aphids varied from one to three hours under greenhouse conditions.

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SAMPLING

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with which a house is concerned is greater than used here, the per cent of error to be expected will be greater than that shown in the table. If the spread of values is less, the error will be less. To illustrate: If the prices used were lower as, say, $1.40, $1.26, $0.70, $1.00, $0.90, $0.50 and $0.40, for the successive classes respectively, the per cent of error for 1,000 boxes with a 1% sample would be 0.62% as compared with 0.70% in the table. Since all prices are lower, the proportionate spread of values is less and the per cent of error to be expected is less.

If the prices of only the last two classes of fruit were lower, say to $0.30 and $0.20 respectively, the per cent of error in our example would be 0.81%. It is greater than the 0.70% error shown in the table below because the lower value in the two classes increased the proportionate spread of value among the various classes.

These two illustrations represent about the usual variations to be expected by lemon houses because of variations in proportions of fruit in various classes and because of variations in prices. In practical application the difference may be ignored.

Application For Accuracy

A given degree of error in the table slopes downward from the left to the right. This characteristic is shown by the sloping line of dashes in the table, which represents the approximate position of an error of 1%. It is clear that a very low proportion of fruit may be taken as the sample for large lots, but that a much greater proportion is required in the sample for smaller lots. Roughly, a 0.1% sample is adequate for 5,000 or more boxes if an accuracy of 1% two times out of three is desired.

A similar accuracy is obtained for a lot of 500 boxes if a 1% sample is taken, or for a lot of 100 boxes if a 4% sample is taken. If comparable accuracy is to be obtained for all growers, regardless of size of lot, it would appear necessary for a packing house to take varying percentages from different sized lots. The smaller the lot the larger the percentage needed for a sample.

There seems to be little reason for taking more than about 4% of a lot for a sample. Beyond that percentage the increase in accuracy is very slight. To go beyond 4% would add greatly to the machine and labor requirements. That a material decrease in accuracy would occur for very small lots, as say 25 boxes, can be disregarded because under present practices in marketing and processing the error that exists in the credits given for such small lots is far greater than that shown here.

While more information is required than is now available to make a final decision, it seems likely that there will be little reason to take less than a 0.5% sample. Moreover, it would seem that labor which is employed in handling the sample should be fully employed at the task which is a rigorous, exact one and should have the operator's undeviating attention to assure accuracy.

Description of fruit by classes, proportions and credits used in caculating data.

Class	Grade	Size	No. of fruit per box	Proportions per box (per cent)	Proportions per unit (per cent)		Credits at receiving door, packing house per box (dollars)	Credits at receiving door, packing house per fruit (cents)
1	Ex. ch.	Large	182	26	20.87		1.80	.98901
2	Ex. ch.	Medium	234	34	35.10		1.66	.70940
3	Ex. ch.	Small	286	15	18.92		1.10	.38462
4	Ch.	Large	182	8	6.42		1.40	.76923
5	Ch.	Medium	234	10	10.32		1.30	.55555
6	Ch.	Small	286	5	6.31		0.90	.31469
7	Stan.	Average	234	2	2.06		0.80	.34188
	Total			100	100	av.	1.50	.6618

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Mathematical formulae for determining the per cent of error were developed by Prof. G. M. Kuznets, Division of Agricultural Economics, College of Agriculture, and Prof. P. G. Hoel, Department of Mathematics, Los Angeles.

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