Effect of Virus Yellows on Yield and Sucrose Content of Sugar Beet in Tests at Riverside, California

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Virus yellows of sugar beet was first recognized in Europe a number of years ago and it is now considered one of the most destructive diseases of that crop in that part of the world. Damage is reported to depend to a large degree on the age of the plants at the time of infestation and reduction in yield is more or less proportional to the length of time the plants are diseased. If infestation occurs by the end of June losses may reach 50 percent or more (1, 2)[2]. If infection takes place late in the season losses may be negligible.

Little evidence is available at this time regarding losses being caused by virus yellows in the United States. Undoubtedly virus yellows causes some reduction in yield in those areas where most of the plants are infected early in the season. However, thus far, yields have not indicated that the damage is as severe as that reported from Europe.

Experimental determination by plot technique of the damage virus yellows is capable of producing on sugar beet is not easily accomplished under most field conditions. The disease is spread largely by the green peach aphid, *Myzus persicae*, which is one of the most widely distributed and abundant of aphid species. In most areas where the sugar beet is grown the populations of this aphid are high enough to cause appreciable amounts of spread throughout the season. Even frequent applications of sprays have not been wholly effective in preventing spread. In most cases, therefore, it has been impossible to maintain check plots free of disease to serve as a measure of the reduction in yield in plots inoculated with virus yellows.

It has been observed that in certain inland areas of southern California aphid populations on sugar beet drop to very low levels during the hot dry weather of summer. It was thought, therefore, that it might be feasible to conduct virus yellows tests in such areas with a minimum of spread of disease from inoculated to check plots, if the planting date were delayed until the spring populations of aphids were reduced by parasites, predators and other factors. To test this hypothesis, an experiment was set up on the grounds of the Citrus Experiment Station of the University of California at Riverside, Calif., the spring of 1953 to determine whether more reliable evidence could be obtained regarding the damage virus yellows is capable of producing on sugar beet.

The land used for this experiment had been planted with sugar beet alternated with a cover crop and fallow for a number of years. To maintain the fertility of the soil at a high level a liberal amount of fertilizer is

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[2] Numbers in parentheses refer to literature cited.

necessary. An application of a 16-20-0 fertilizer was made at a rate of 250 pounds per acre before planting and an application of ammonium nitrate at the rate of 440 pounds per acre was made after thinning.

The experimental field was planted April 29 after aphid populations were reduced to low levels in beet fields in the area. Plants were thinned May 22 and the field was divided into 30 plots, each plot consisting of 4 rows of beets each 50 feet long. Half of the plots were selected by random-choice technique and inoculated with virus yellows June 22 and 23.

Plots 1 to 8, inclusive, were inoculated with aphids in small leaf cages clipped on the tip of a leaf on each plant. In plots 6, 7, and 8 the aphids were caged on plants during the middle of the day when the temperature was very high and the humidity very low and, undoubtedly, a great many of the aphids died before feeding. This accounts for the relatively low infection in these plants (Table 1). Plots 9 to 15, inclusive, were inoculated by placing a piece of diseased beet leaf, with about 10 aphids, on each plant. Under the conditions prevailing at the time, the aphids crawled from the diseased pieces of leaf to the healthy plants within a few minutes.

The source of virus for these inoculations was potted beet plants infected with a virus selection which caused relatively severe symptoms on sugar beet under greenhouse conditions.

All plants, including the checks, were sprayed with a systemic insecticide the day following inoculation and at 14-day intervals through August.

Tips of full-grown leaves of many of the inoculated plants began to turn yellow 1 5to 20 days after inoculation and yellowing increased in in-

Table 1.—Effect of Virus Yellows on Yield and Sucrose Content of Sugar Beet in Tests at Riverside, Calif., in 1953.

Inoculated Plots					Noninoculated (Check) Plots				
Plot No.	Plants Infected	Sucrose	Yield of Beets per Acre	Yield of Sucrose per Acre	Plot No.	Plants Infected	Sucrose	Yield of Beets per Acre	Yield of Sucrose per Acre
	Percent	Percent	Tons	Tons		Percent	Percent	Tons	Tons
1	91.8	14.20	13.584	1.920	16	1.4	13.65	22.229	3.034
2	93.1	14.95	15.313	2.289	17	2.0	13.90	25.439	3.536
3	92.9	15.30	18.277	2.796	18	3.5	16.20	26.427	4.281
4	84.1	16.25	12.843	2.087	19	0.8	15.65	30.152	4.716
5	70.4	15.15	17.042	2.582	20	1.5	16.35	34.331	5.613
6	16.1	16.10	27.415	4.414	21	2.0	13.05	26.674	3.481
7	15.6	14.80	21.735	3.217	22	0.7	15.05	29.144	4.386
8	82.0	16.45	19.759	3.250	23	4.7	16.55	29.885	4.946
9	91.3	15.25	19.265	2.938	24	0.7	16.10	30.625	4.931
10	79.3	14.95	18.771	2.806	25	0.7	16.05	32.108	5.153
11	57.6	12.00	23.958	2.875	26	3.1	16.20	25.499	4.121
12	94.7	16.10	15.807	2.545	27	2.0	16.35	30.132	4.926
13	85.6	16.60	19.018	3.157	28	2.1	15.35	30.152	4.625
14	90.9	15.80	17.042	2.693	29	0.0	15.45	33.343	5.151
15	94.6	14.60	21.241	3.101	30	0.7	13.75	26.180	3.600
Average		15.23	18.738	2.845	Average		15.31	28.815	4.433

tensity during the next two or three weeks. Some of the leaves developed yellow areas often distinctly delimited by larger lateral veins others were more or less uniformly yellow. No evidence of symptoms was observed on any of the younger leaves of the plants. These usually remained green until they were full-size and then began to turn yellow at the tips. Yellowing progressed downward as the leaves became older.

By July 21 the inoculated plots were clearly outlined as yellow spots visible for a considerable distance. The check plots remained green, except for an occasional yellow plant. Striking contrast between inoculated and check plots continued to be evident throughout the season but color differences tended to be less marked toward the end of the season.

Counts of diseased plants were made July 21, August 18, and October 13. Only the results of the counts made October 13 are shown in Table 1 but these results do not differ appreciably from those obtained from the other two counts. There was evidence of very little spread during the season; apparently practically all of the infection which occurred resulted from aphids introduced into the field from the greenhouse at the time of inoculation of the plots. The fact that the incidence of disease in the rows of check plots adjacent to diseased plots was no greater than that in the middle rows of the check plots supports the conclusion that there was very little disease spread during the season. The sharp color difference between an inoculated plot and an adjacent noninoculated plot is shown in Figure 1.

Figure 1. Plots of sugar beet in test to determine injury produced by virus yellows. Left, 4-row plot inoculated with virus yellows. Right, 4-row check plot free of disease. Photographed 60 days after plot at left was inoculated with virus yellows.

Infection in the check plots varied from none to 4.7 percent as shown in Table 1, whereas infection in the inoculated plots, except in plots 6, 7, and 8 in which most of the aphids used to inoculate the plants probably died before feeding, varied from 57.6 to 94.7 percent.

The plots were harvested November 3, 4, and 5. Yields are shown in Table 1. Yields per acre were calculated on the basis of total weight of beets in the middle two rows of each plot. Sucrose percent shown is the average of two 10-beet samples taken at random from the middle two rows of each plot.

The results show a rather wide range of variation in both tonnage and sucrose percent among check plots and also among inoculated plots, which no doubt reflects a marked lack of uniformity in the soil used for this experiment. Despite these variations, however, the effect of virus yellows in reducing yield of sugar beets is marked. Indicated reduction in weight of roots is 10.077 tons per acre and of sucrose 1.588 tons per acre or a reduction of 34.9 percent in weight of roots and 35.8 percent in sucrose per acre. The least significant difference at the 5 percent level is 2.775 tons of roots per acre and .507 tons of sucrose per acre, which shows that the results obtained are highly significant. The difference of .08 percent in sucrose in favor of the check plots is not significant statistically. Losses due to yellows in this test, therefore, appear to have been due almost entirely to reduction in weight of root.

This evidence indicates clearly that virus yellows, as it occurs in the United States, is capable of causing severe damage to sugar beet. However, the reductions in yield indicated in these tests probably are greater than those which occur under average conditions in commercial fields. These plots were planted somewhat later than is normal for the district and the plants were infected when relatively small. Both of these factors may have tended to increase the severity of the disease. Also, these plants were inoculated with a strain of yellows virus that, according to greenhouse tests at least, is more virulent than those commonly encountered under field conditions.

There is much evidence indicating that in general the strains of virus yellows prevalent in the United States are less virulent than those widely distributed in Europe.

Losses to be expected from virus yellows in the future may depend, in part at least, on prevalence and distribution of the more virulent forms of virus. It is reported that there is some evidence that the more virulent strains of the yellows virus have tended to become the dominant ones in Europe. Whether this will be true with strains in the United States remains to be determined. In any event, it seems probable that virus yellows may prove to be a disease of major importance in sugar beet production in the United States particularly in those areas in which sufficient numbers of diseased plants are available to serve as sources for early and extensive infection in each succeeding crop.

Literature Cited

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