

# Effects of Beet Western and Beet Yellows Viruses on Amino Acids in Sugar Beet

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The beet western yellows (radish yellows) virus, an entity capable of inducing foliage yellowing on sugar beet indistinguishable from that induced by some isolates of the beet yellows virus, is prevalent in California beet-growing areas (1)<sup>2</sup>. This virus alone and in combination with the beet yellows virus can cause serious losses in sugar production and is considered the cause of a major sugar beet disease (2).

Changes in the concentration of certain amino acids take place in the leaves of sugar beet plants infected with the curly top virus (4) and also with the beet yellows virus (5). A ratio of the concentrations of certain of the amino acids which decrease to those that increase (aspartic acid plus glutamic acid/citrulline plus alanine) in plants infected with the beet yellows virus has been shown to have possible significance in selection of plants for resistance to the virus (5).

It was desirable to determine the effects of the western yellows virus alone and in combination with the beet yellows virus on the concentration of selected amino acids and especially the effects on the previously mentioned amino acid ratio. The results of these investigations are presented herein.

## Methods

Leaf-tissue samples for amino-acid determinations were obtained from replicated field plots designed to determine the effects of the viruses on yield and sugar production. Plots 30 feet long and 3 rows wide were arranged in 4 Latin squares. The 4 treatments on the US 75 sugar beets consisted of uninoculated (control) plots, plots inoculated with a fairly virulent isolate of the western yellows virus, plots inoculated with a fairly virulent isolate of the beet yellows virus, and plots inoculated with both the western and beet yellows isolates.

One leaf disk,  $\frac{3}{4}$  inch in diameter, was removed from each of 12 mature leaves from different plants selected at random from each plot. The disks, taken approximately 2 months after inoculation of the plants, were composited for each plot and quick-frozen. The juice was expressed from the frozen disks at a pressure of 5,000 pounds, preserved in thymol and phenyl mercuric nitrate, and stored at 10° F. The samples were thawed,

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<sup>2</sup> Numbers in parentheses refer to literature cited.

shaken thoroughly, and centrifuged before portions were removed for analysis.

Concentrations of the amino acids were determined by single-dimensional paper chromatography by the ascending method on 9 by 11 inch Whatman No. 3 mm papers, using a water-saturated phenol solvent. The techniques used were those described by Fife (5).

## Results

The effects of the western and beet yellows viruses on the contents of certain amino acids are shown in Table 1.

Table 1.—Effects of the western yellows and beet yellows viruses on the concentrations of certain amino acids in sugar beet leaves at Salinas, California, 1959.

Virus used as inoculum	Aspartic acid (Mg %)	Glutamic acid (Mg %)	Citrulline + alanine (Mg %)	Ratio
				Aspartic acid + glutamic acid Citrulline + Alanine
None (control)	13.64 <sup>A</sup>	24.06 <sup>A</sup>	23.96 <sup>Aa</sup>	1.607 <sup>Aa</sup>
Beet Yellows Virus	4.71 <sup>B</sup>	10.73 <sup>B</sup>	79.31 <sup>Bc</sup>	0.208 <sup>Bbc</sup>
Western Yellows Virus	4.71 <sup>B</sup>	11.36 <sup>B</sup>	59.96 <sup>Bb</sup>	0.291 <sup>Bb</sup>
Beet Yellows Virus + Western Yellows Virus	3.89 <sup>B</sup>	11.06 <sup>B</sup>	95.56 <sup>Ba</sup>	0.194 <sup>Bc</sup>

<sup>A B</sup> For a given trait, 2 means having any superscripts in common are not significantly different from each other at the 1% level.

<sup>a b c</sup> For a given trait, 2 means having any superscripts in common are not significantly different from each other at the 5% level.

Analysis of the aspartic acid and the glutamic acid data indicates a highly significant reduction in the concentration of these acids in the leaves of western yellows and beet yellows affected plants. The interaction of the effects of the viruses was also highly significant for both amino acids.

The factorial breakdown of the citrulline content analysis shows that the beet yellows virus affected the citrulline concentration much more than did the western yellows virus. The interaction was significant only at the 5 percent level. The Duncan comparison (3) shows that both yellows viruses increased citrulline significantly. The beet yellows virus and the combination of beet yellows and western yellows viruses significantly increased the citrulline content over the content for those beets infected with the western yellows virus only.

The analysis of the data for the amino acid ratio (aspartic acid plus glutamic acid/citrulline plus alanine) shows a highly significant reduction in the ratio in both beet yellows and western yellows affected plants. The interaction of the effects of the viruses was also highly significant. The ratio in beets infected with both

yellows viruses was significantly lower than in beets infected with the western yellows virus alone.

The western yellows and beet yellows viruses induced essentially the same qualitative effect on the amino acids studied in this experiment. The amino acid patterns induced by these 2 viruses were quite different from those induced by the curly-top virus (4).

Significant differences were noted between isolates of the western yellows and beet yellows viruses in relation to the concentration of citrulline in affected leaves. Whether reactions such as these may be used to distinguish between isolates of these viruses will be determined by further research using different isolates of the viruses and studies of their effects on additional amino acids.

It is noteworthy that the interaction of the viruses in regard to all the amino acids studied was significant.

The ratio of aspartic acid plus glutamic acid/citrulline plus alanine apparently is of little value in distinguishing beet yellows and western yellows viruses. If, however, this ratio proves to be of value in indicating resistance of beets to the beet yellows virus, it may also indicate resistance to the western yellows virus.

### Summary

The concentrations of certain amino acids in leaves of sugar beet plants infected with the western yellows and beet yellows viruses were determined by paper chromatography. The concentrations of aspartic acid and glutamic acid decreased essentially to the same extent in plants infected with either the western yellows or beet yellows viruses. Citrulline plus alanine increased in plants infected by either virus. The beet yellows virus, however, affected the concentration of these amino acids to a greater extent than the western yellows virus. The interaction of the viruses in regard to all the amino acids studied was significant.

### Literature Cited

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