

Changes in Concentration of Free Amino Acids by Selection From Yellows Infected Sugarbeet Leaves

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Received for publication April 8, 1968

The concentrations of certain free amino acids are greatly altered in the leaves of sugar beet plants infected with beet yellows (2)² and with western yellows (1). The greatest changes occurred in newly matured leaves with chronic symptoms of the disease. In the leaves of some beet yellows-infected plants, the concentrations of aspartic and glutamic acids decreased as much as 70%. At the same time, glutamine increased and occasionally was more than double the concentration in the healthy controls. Progeny tests show that the concentrations of these amino acids are to a large extent under genetic control (3). This was demonstrated by simple mass selection for a high

amino acid ratio (concentration: $\frac{\text{aspartic} + \text{glutamic}}{\text{glutamine}}$) from a pop-

ulation of plants infected with beet yellows. The concentrations of aspartic and glutamic acids increased significantly (while that of glutamine decreased) in infected leaves of progeny plants relative to the concentrations in infected leaves of parent plants: i.e., the shift in the concentrations of these amino acids was toward that in healthy plants. These changes in concentration resulted in a higher amino acid ratio for infected plants of the selections than for infected plants of the parent.

It was evident, from the papergrams, that the concentration of other amino acids had changed in plants of the progeny. The concentration of total free amino acids was, therefore, determined to evaluate the net change. The results are summarized in this report.

Methods and Results

The methods have been described (4) for growing the plants, inoculation with the virus, sampling, and the determination of the concentration of the three individual amino acids in the leaf extracts. The concentration of total free amino acids was

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² Numbers in parentheses refer to literature cited.

determined in these same leaf extracts. The ninhydrin color was developed on narrow strips of paper (3) under the same conditions used to develop the papergrams for the determination of the concentration of the individual amino acids. The concentrations of total amino acids are reported as mg% glutamic acid which is used as the standard.

Highly significant differences were found between the selections and the parent in both the first and the second successive cycle for the concentration of total free amino acids, (Table 1). In beet yellows-infected leaves, the concentration was higher in the selections than in leaves of the parent. In leaves of healthy plants, the reverse was true.

Table 1.—Concentration of total amino acids in leaves of healthy and beet yellows-infected plants of the parent and of first and second successive selections.

Sibs of 1st & 2nd suc. selections	Selection pressure applied for		Concentration ¹ total amino acids		Ratio infected to healthy
	Amino acid ratio	root wt	healthy	infected	
			Mg. %	Mg. %	
US 75	Parent		218	108	.50
First selections					
DS-3	> \bar{X}	> \bar{X} + 2s	217	118	.54
DS-22	> \bar{X}	> \bar{X} + 2s	133**	128**	.96
DS-23	> \bar{X}	> \bar{X} + 2s	149**	113	.76
DS-24	> \bar{X}	> \bar{X} + 2s	175**	168**	.73
DS-9	> \bar{X}	> \bar{X} + 2s	191**	156**	.82
DS-7	> \bar{X}	> \bar{X} + 2s	176**	167**	.95
Mean			174	142	.82
Second suc. selections					
DR-6	> \bar{X} + 2s	> \bar{X}	142**	124'	.87
RS-9	> \bar{X} + 2s	> \bar{X} + 2s	140**	121	.86
RS-3	> \bar{X} + 2s	> \bar{X} + 2s	144**	180''	1.25
RS-2	> \bar{X} + 2s	> \bar{X} + 2s	140**	186''	1.29
RS-5	> \bar{X} + 2s	> \bar{X} + 2s	145**	136''	.94
Mean			142	149	1.05

¹ Calculated as glutamic acid.

*,** Significantly greater or less than the parent at the 5% and 1% levels respectively.

Of the selections tested, the healthy plants produced greater top and root weights than healthy plants of the parent. The increased demand for amino acids, to maintain larger tops and produce greater root weights, may account for the lower concentration of total amino acids in the healthy selections.

The concentrations of certain amino acids, other than aspartic, glutamic and glutamine, appear to be changed in both healthy and infected plants of the progeny. The concentrations of each of these three amino acids have been reported (3) for the parent and for each of the selections. The percentage of the total

concentration of free amino acids, made up by the combined concentrations of the above three amino acids, has been calculated for the healthy and infected plants of the parent and of the selections, (Table 2). In healthy plants of the parent, aspartic, glutamic and glutamine made up 42% of the total; whereas, in healthy plants of the first and second successive selections they comprised 48% and 80% of the total concentration, respectively. In leaves of infected plants of the parent, these three amino acids represented 57% of the total as compared to only 37% in the second successive selections.

Table 2.—Percentage of the total concentration of free amino acids made up by aspartic, glutamic and glutamine in healthy and diseased leaves of the parent and of the selections.

Newly-matured leaves of	Healthy	Diseased
Parent	42a	57d
1st sel. (mean of 6 sibs)	48b	47c
2nd suc. (mean of 5 sibs)	80c	37f

c > b (P = 0.01), c > a (P = 0.01), b > a (P = 0.10)

d > e (P = 0.05), d > f (P = 0.01), e > f (P = 0.01)

d > a (P = 0.05), c > f (P = 0.01), a > f NS

Summary

The concentration of total free amino acids was changed in leaves of sugarbeet plants by simple mass selection for a high amino acid ratio (concentration: $\frac{\text{aspartic acid} + \text{glutamic acid}}{\text{glutamine}}$)

from a population infected with beet yellows. The concentration of total amino acids was significantly higher in newly matured leaves of infected plants of first and second successive selections than in infected leaves of the parent. In healthy plants, the concentration was lower in leaves of the progeny than in leaves of the parent. The concentrations of amino acids other than aspartic, glutamic and glutamine were changed also.

Literature Cited

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