Beet Yellows Disease: Correlation Between Amino Acid Ratio and Tolerance with Respect to Percent Sucrose and Yield

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Extensive testing of first and second successive sugarbeet selections, made on the basis of a high amino acid ratio and root yield, has shown a steady increase in resistance to beet yellows over that of the parent variety US 75 (4).[2] The amino acid ratio is the sum of the concentrations of aspartic and glutamic acids, to that of glutamine, in newly-matured leaves of plants infected with a virulent strain of beet yellows virus (BYV). Second successive selections were significantly more resistant to beet yellows than the parent, as shown by superior yields and also by highly significant increases in percentage sucrose. The correlation between the amino acid ratio of selections (made on the above basis) and the percentage sucrose is positive and highly significant ($P > 0.01$) (4). In the same tests, the correlation between the amino acid ratio and yield of beets was positive and significant at the 10% level in tests involving the second successive selections.

The purpose of this communication is: a) to report the performance of a yellows-resistant selection (RS-3), made by mass selection on the basis of root weight and a high amino acid ratio; and b) to show that the same increase in the percentage sucrose, over that of the parent, was obtained in another selection (R-6) made on the basis of a high amino acid ratio alone.

Methods and Results

Both first and second successive selections were made from large populations of sugarbeet plants, of variety US 75, grown in the greenhouse under controlled nutritional conditions and inoculated with strain 5, of BYV (3). An outstanding second successive selection, RS-3, was field-tested 4 successive years to determine its tolerance to beet yellows, relative to that of the parent. The methods used, and the cultural practices followed in making the field tests, have been described (3,4).

The percentage sucrose and the yield of sugar per acre was significantly greater in the selection ($P>0.01$) than the parent for 4 years (Figure 1). In 1963 and 1964, the plants were inoculated with strain 5, of BYV. In these two tests, the yield of

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[2] Numbers in parentheses refer to literature cited.

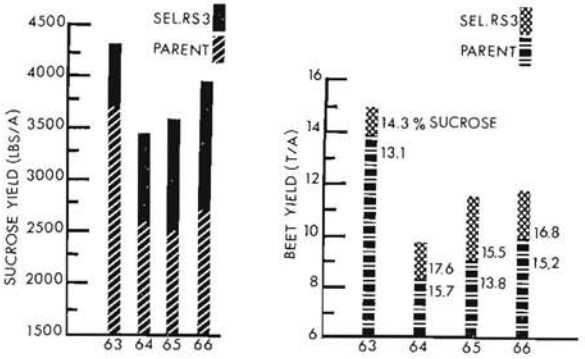

Figure 1.—Performance of a sugarbeet selection (RS-3) made on the basis of a high amino acid ratio and root weight.

beets of the selection was greater than the parent but the increase was not significant. The 1963 test was inoculated late in the season, after 47% of the total growing period had passed. This late inoculation would account, not only for the relatively high yield of roots (1) for that year, but also for the small difference in root yield between the selection and the parent.

The 1965 and 1966 tests were inoculated early, 5 weeks after emergence, with a more virulent (Brawley) strain of BYV. In these 2 tests the beet yield of the selection was significantly greater ($P>0.05$) than the parent. The data suggest that this selection, and others made on this basis, may show even greater tolerance to the most virulent strains of BYV, relative to that shown by the parent.

An earlier report (4) showed that significant improvement in both yield and percent sucrose was achieved by selection on the basis of a high amino acid ratio alone (R-6). The most striking increase occurred in the percentage sucrose, as shown in this report (Table 1). Except for the 1963 test, which was inoculated very late in the growing season, the percentage sucrose values for selection R-6, were very similar to the sucrose values for the second successive selections, which were made on both a high amino acid ratio and root weight.

A third successive selection, made on the basis of a high amino acid ratio and root weight is now being tested.

Discussion

Natural infection in replicated plots at Salinas, California, resulted in an average reduction in sucrose percent of 1.38 percentage points. It appears, from 4 years of testing, that the two selections, RS-3 and R-6, have sufficient resistance to beet yellows to more than restore the loss in percent sucrose caused by natural infection in the Salinas Valley.

Table 1.—Performance of sugarbeet selections based on high amino acid ratio and root weight versus high amino acid ratio alone.

	Selections and their amino acid ratios			
	DS-3 1st Sel.	RS-C 2nd Suc.	RS-3 2nd Suc.	R-6 2nd Suc.
	2.30	3.00	2.96	3.50
Test	Gain in % sucrose over parent			
	%-Pts.	%-Pts.	%-Pts.	%-Pts.
1960	0.6			
1962	0.8	0.5		
1963	0.8		1.2	0.3
1964	0.9	0.8	1.9	1.2
1965	1.4	1.1	1.7	1.6
1966	0.3	1.6	1.6	1.9
Amino acid ratio of parent, US 75,			1.20	

Selection basis for:

	A.A. Ratio	Root Wt.
DS-3	$> \bar{x}$	$> \bar{x} + 2s$
RS-C	$> \bar{x} + 2s$	$> \bar{x} + 2s$
RS-3	$> \bar{x} + 2s$	$> \bar{x} + 2s$
R-6	$\bar{x} + 2s$	$\bar{x}$ (Ambient)

Since the percentage sucrose has been significantly increased by selection on the basis of the amino acid ratio alone it appears that the percent sucrose may be increased in the roots of those yellows-tolerant selections made by conventional breeding methods by further selection on the basis of a high amino acid ratio.

Summary

Significant tolerance to beet yellows was obtained, both with respect to yield and percent sucrose, by mass selection from beet yellows-infected populations, on the basis of a high amino acid ratio in the leaves and root weight.

Selection on the basis of a high amino acid ratio alone (selection R-6) resulted in a highly significant increase ($P > 0.01$) in the percentage sucrose over that of the parent variety.

Literature Cited

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