A New Sugar Beet Variety, U.S. 56, for Fall and Winter Plantings in California

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NEED FOR VARIETIES low in bolting tendency for winter planting in California has long been recognized. When the first curly-top-resistant varieties were released they were found to bolt much more readily than some of the better European varieties and were not suitable for fall or winter planting. These facts, together with the need for varieties resistant to downy mildew, caused the addition of new objectives to the project of breeding sugar beets for curly-top resistance. Later, as sugar beet growing expanded into curly-top areas where fall and winter plantings were desirable, the demand for high curly-top resistance combined with resistance to bolting and to downy mildew grew stronger.

Range of Planting Dates

The relatively mild climate of California permits a wide range of planting dates with sugar beets grown for sugar. Imperial Valley fields are planted early in October. This date is only 6 to 8 weeks later than sugar beets are planted in the Salt River Valley of Arizona for seed growing by the method of overwintering in the field. In view of the fact that the winters in this nearby seed-growing area are not much colder than are those of Imperial Valley the need for a non-bolting variety for sugar production in the latter area becomes obvious. Winter planting is advantageous for a large portion of the San Joaquin Valley area and parts of the coastal districts. Non-bolting varieties must be used for these plantings. Plantings can be made in some of the districts as late as May and June but in these plantings bolting is not an important problem.

Breeding for Resistance to Bolting and Downy Mildew

An agronomic evaluation test including eleven varieties was planted near Salinas, California, December 6, 1934. Downy mildew was unusually abundant at Salinas and elsewhere in California in the spring of 1935. Indications of resistance to downy mildew and marked differences in bolting tendency were revealed by the Salinas test. The results as to bolting and downy-mildew infection with six of the varieties are given in table 1. U.S. 1 was the first curly-top-resistant variety released. U.S. 33 and U.S. 34 soon superceded it. The other three varieties were lower in bolting tendency. They included a variety, bred by Dr. G. H. Coons and his associates, subsequently designated U.S. 15. The other two varieties were R. & G. Old Type and S.L. 4913, a variety of high curly-top resistance.

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Further study of U.S. 15 led to its release for extensive use for winter plantings in California coastal areas. This variety, in addition to its resistance to bolting and moderate resistance to downy mildew, is also moderately resistant to curly top, closely comparable to U.S. 1 in this respect. Due to this characteristic and its resistance to bolting, U.S. 15 soon replaced Old Type for fall planting in Imperial Valley where curly top has occasionally caused large losses.

Table 1.—Bolting and downy-mildew infection results in test planted at Salinas, California, December 6, 1934.

Variety	Bolting 6-25-35	Downy mildew 4-25-35
	percent	percent
U.S. 1	90.8	25.4
U.S. 33	40.4	26.5
U.S. 34	62.6	30.8
U.S. 15	0.5	14.0
S.L. 4913	19.4	9.5
Old Type	7.8	17.5

Impetus to breeding for resistance to bolting and downy mildew was another outcome of the test at Salinas in 1934 and 1935. Dr. L. D. Leach of the Division of Plant Pathology, University of California, visited this plot in the spring of 1935 and observed the evidence of varietal differences in resistance and susceptibility to downy mildew. This led to a temporary cooperative breeding arrangement with the University with F. G. Larmer representing the Division of Sugar Plant Investigations. Leach's (1)[2] work resulted in the development of a strain of U.S. 33 improved as to downy-mildew resistance and equal to the original U.S. 33 in bolting tendency. The commercial U.S. 33 had been deteriorated in bolting tendency by reproduction under mild-climate conditions. The University later turned over Leach's selected material to the Division of Sugar Plant Investigations. After the improved U.S. 33 had been extensively evaluated it was released for commercial use.

Larmer's work on breeding resulted in the production of a strain of U.S. 15 improved in downy-mildew resistance and equal to the original variety in bolting tendency. He also made the primary selections which resulted in the development of the variety U.S. 56.

Origin of U.S. 56

A variety planting for a downy-mildew test was made by F. G. Larmer near Spreckels, California, in mid-January, 1938. Three hundred and twenty-one mother beets were selected the following summer for resistance to downy mildew and bolting from six of the strains included in the test. These six strains were developed in the curly-top resistance breeding work at Salt Lake City, Utah. One of these, later designated U.S. 23, was the progeny of selections from S.L. 4913. One was the progeny of non-bolting selections from U.S. 12 and U.S. 33. A third one was the progeny of non-bolting selections from U.S. 33 and two other numbers. The other

[2]The numbers in parentheses refer to literature cited.

three strains arose from clones which had been selected for non-bolting and curly-top resistance from U.S. 12, A-600, and several other varieties.

The selected mother beets were all planted in one group at Medford, Oregon, in October, 1938. The seed obtained from them in the summer of 1939 was labeled S.L. 948. Some of this seed was planted by Larmer at Salinas, California, September 2, 1939. Those that bolted (probably 95 percent) in that planting were removed. Finally, 107 mother beets were selected and planted at Ashland, Oregon. Of these, 58 survived and produced seed which was given the number S.L. 1-41.

A planting of S.L. 1-41 was made at King City, California, February 12, 1943, by the senior author. A refractometer and polariscope selection yielded 200 mother beets and of these 35 plants were saved. These were reproduced at Riverside, California, and the seed was assigned the number S. L. 356. Increases of this number in Oregon and Utah gave rise to the variety U.S. 56.

Comparison of U.S. 15 and U.S. 56

U.S. 15 replaced non-bolting European varieties for all fall and winter plantings in California. Commercial use of U.S. 15 was started in 1939. Critical evaluation in variety tests and subsequent extensive commercial use afforded enough information about the variety to make it useful as a standard for comparison. In bolting tendency it is better than R. & G. Old Type. It was originally moderately resistant to downy mildew and by reselection has been slightly improved in this respect. It has about the same degree of curly-top resistance as U.S. 1. The variety tends to be a sugar type and gives its best performance on soils of high fertility.

U.S. 56 has proved equal to or slightly better than U.S. 15 in downy-mildew resistance and in resistance to bolting. The bolting counts on May 26, 1947, in a test planted at Riverside, California, on August 21, 1946, gave the following bolting percentages: U.S. 56, 31; U.S. 15, 54; Old Type, 74. U.S. 56 is about equal to U.S. 15 in yield and sugar percentage when curly top is not a factor.

The most important characteristic of U.S. 56 in which it is superior to U.S. 15 is in curly-top resistance. A simple test in Imperial Valley, California, in the season of 1945-1946 revealed a distinct difference between the two varieties under the moderate curly-top exposure there that season. U.S. 56 exceeded U.S. 15 in yield by nearly 4 tons per acre. A test in 1946 in the San Joaquin Valley near Bakersfield, California, had a severe curly-top exposure. Due to an infestation of *Sclerotium rolfsii* the plot was not harvested but observations revealed that U.S. 56 seemed nearly as resistant to curly top as the original or first release of U.S. 22.

Tests of U.S. 56 in 1947

Many comparative tests including U.S. 15, U.S. 56 and other varieties were conducted in California in 1947. The results where curly top

was not a factor supported previous evidence that U.S. 15 and U.S. 56 are close competitors in the absence of curly-top damage. The results of some of the tests under curly-top exposure in the San Joaquin Valley will be adequate to indicate the performance of U.S. 56 under such conditions.

A grower-test planting, including U.S. 15 and U.S. 56, was planted on the ranch of John J. and Ike J. Peters near Cawelo in Kern County, California, on January 11, 1947, and harvested early in August. The yield of U.S. 15 was 22 tons per acre, while that of U.S. 56 was 34.6 tons per acre. The difference here in the performance of these varieties was due in part but not entirely to difference in curly-top resistance. There was more root rot due to Rhizoctonia evident in U.S. 15 at the end of the season. Lower vigor and less favorable color in U.S. 15 were noted in the spring before curly-top injury became conspicuous but the cause of this difference was not determined.

A grower-test planting with U.S. 15 and U.S. 56 planted in mid-December and mid-January near Five Points in western Fresno County, California, included strips of each variety. The results of this test, given in table 2, show that under the curly-top exposure there U.S. 56 yielded 8.1 tons per acre more than U.S. 15 in the December planting and 12 tons per acre more in the January planting. Due to frost injury the stand was not as good in the December planting as it was in the January planting. The reduction in yield with U. S. 15 was caused mainly by curly top even though the whole field was sprayed with DDT late in April for beet leafhopper and curly-top control. On May 6, U.S. 15 had 22 percent obvious curly top while U.S. 56 had only 1 percent A view of the December-planted strips is shown in figure 1.

Table 2.—Variety test on Frank C. Diener ranch near Five Points, Fresno County, California. Harvested July 22, 1947.[1]

Variety	Tons per Acre		
	Gross Sugar	Beets	Sucrose
Mid-December, 1946, Planting			
U.S. 56[2]	2.872	17.5	16.41
U.S. 15[3]	1.660	9.4	17.66
Mid-January, 1947, Planting			
U.S. 56[4]	3.619	21.3	16.99
U.S. 15[5]	1.622	9.3	17.44

[1]Data through courtesy of R. J. Tingley, Holly Sugar Corporation.
[2]Average of 2.84 acres.
[3]Average of 17.6 acres.
[4]Average of 2.84 acres.
[5]Average of 5.2.5 acres.

A comparison of U.S. 15 and U.S. 56 was made in a variety test at the United States Cotton Field Station at Shafter, California. Plantings were made October 11 and November 26, 1946. There was no spraying or dusting for beet leafhopper control. The harvest results are summarized in table 3. U.S. 56 gave 7.9 tons per acre more than U.S. 15 in the October planting and 11.7 tons per acre more in the November planting.

Outstanding results were obtained from another variety test planted at the United States Cotton Field Station, Shafter, California, on March

Table 3. Variety test at United States Cotton Field Station, Shafter, California. Harvested July 30, 1947.

Variety	Tons per Acre		Percent sucrose	Coeff. of app. purity	Beets per 100′ of row
	Gross sugar	Beets			
October 11, 1946, Planting					
U.S. 56	4.758	33.25	14.44	88.14	105
U.S. 15	3.894	26.39	14.75	88.62	106
Sig. Diff. (Odds 19:1)	.2996	1.543	.483	N. S.	
November 26, 1946, Planting					
U.S. 56	4.961	38.45	12.90	87.36	108
U.S. 15	3.508	26.83	13.09	87.36	110
Sig. Diff. (Odds 19:1)	.2938	1.791	.366	N. S.	

18, 1947, and not harvested until November 4-6, 1947. The plots were heavily infested with beet leafhoppers while the plants were small and there was an abundant supply of curly-top virus in adjacent plots of beets planted in the fall. The appearance of the plot in early June is shown in figure 2. A strip of the German variety, Old Type, in this test was so severely injured that no marketable beets were obtained from it at harvest. A strip of U.S. 15 gave a total yield, including non-marketable beets, of only 6.18 tons per acre. Other varieties replicated ten times gave average yields of marketable beets, tons per acre, as follows: U.S. 56, 34.47; original U.S. 22, 41.64; second release of U.S. 22, 46.99; third release of U.S. 22, 53.22. These results support other evidence to the effect that in plantings

Figure 1.—Grower-test planting on Frank C. Diener ranch near Five Points, Fresno County, California. Strip of U.S. 15 at left and of U.S. 56 at right. Seedstalks in background at right are in strip of U.S. 22. Planted mid-December, 1946. Photographed July 22, 1947.

where severe curly-top exposure is a possibility and where downy mildew and bolting will not be important factors varieties even higher in curly-top resistance than U.S. 56 are to be preferred.

Summary

The variety U.S. 56 represents an indirect synthetic mixture of curly-top-resistant material derived from several sources. Three of the sources were progenies originating from vegetative clones previously selected for non-bolting as well as for curly-top resistance. The other sources were: (1) a curly-top-resistant variety having moderate downy-mildew resistance; (2) the progeny of non-bolting selections from U.S. 12 and U.S. 33; (3) the progeny of non-bolting selections from U.S. 33 and two other numbers.

U.S. 56 is decidedly superior to U.S. 15 in curly-top resistance. It is about equal to that variety in downy-mildew resistance and slightly better than U.S. 15 in resistance to bolting.

Under moderate to very severe curly-top exposures U.S. 56 has excelled U.S. 15 by wide margins in tonnage of beets and sugar per acre. Under conditions where curly-top was not a factor, U.S. 56 and U.S. 15 have been practically equal in performance. U.S. 56 is the best variety now available for fall and winter planting in interior areas of California where curly top may be a factor and in coastal districts where curly top and downy mildew may be factors.

Figure 2.—Variety test at U.S. Cotton Field Station, Shafter, California. Replicated plots at left. Two-row strips beginning at center and reading left to right: Old Type, U.S. 15, U.S. 56, U.S. 22, and then 4 rows of U.S. 22/2. Planted March 18, 1947. Photographed June 9, 1947.

Literature Cited

(1) LEACH, L. D.
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