Results of Use of the Red-Marker Beet as a Top Cross Parent

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In order to obtain inbreds of high combining ability, some method must be used for efficient production of identifiable top crosses, the latter being a measure of general combining ability (2, 3)[2].

Male-sterile populations present no particular problems, as far as testing for their combining ability, since the number of usable male-sterile lines is limited by the intricacies of their isolation and the cross is identifiable as the seed produced. Consequently, several top crosses of male steriles with the top-cross tester parent can be made in one seed isolation.

With pollen-producing inbreds, however, the number should not be limited in order to increase the probabilities of isolating the highest combining inbred. Testing these pollen producers for combining ability, however, presents the problem of producing a large number of top crosses with identifiable crosses.

For pseudo self-fertile beets, a top-cross parent with a dominant marker character has been used to produce crosses which could be identified in the seedling stage (1, 4).

This paper reports a study of the use of the half-sugar, half-red garden beet, referred to as the red-marker beet, as a top-cross parent.

Material and Methods

Nine pseudo self-fertile varieties of sugar beets were selected from previous tests for high sucrose, high tonnage, leaf-spot resistance and curly-top resistance. It was desired to further inbreed within the most desirable of these varieties for high-sucrose, high-combining inbreds. The red-marker beet was used as a top-cross parent with each of the varieties and selection of the sources, in which to continue further work, was to be based on the top-cross performance.

Roots of each variety were planted so that every root had a red-marker beet on all four sides. Seed was harvested from approximately 50 plants of each variety and bulked according to varieties.

The amount of crossing was determined from germinations and the seeding rate adjusted accordingly. At thinning time, the top crosses were thinned to the intermediate red plant color of the cross, except where there were no crosses within the desired thinned spacing. In such cases a green plant was left. The degree of crossing differed among varieties, depending on coincidence of flowering times and on the degree of self sterility of plants within the varieties.

The field tests were conducted at Sheridan, Wyoming, Sidney, Montana, and Tracy, California, in 1955. Design of the tests was rectangular lattice at Sheridan and randomized block at Sidney and Tracy. Yield determinations were made from the entire plot of one row, 50 feet long. The tests at

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[2] Numbers in parentheses refer to literature cited.

Sheridan and Sidney were on 22-inch rows and the one at Tracy was on 30-inch rows. Two samples of 15 beets each were taken per plot for sucrose determination at Sheridan and Sidney and two 12-beet samples per plot were taken at Tracy.

At harvest time, all green beets, which had been left at thinning time for growth competition, were removed from the top-cross plots and corrections were made for missing portions of plots.

Data presented have been extracted from yield tests with 30 entries.

Experimental Results

Table 1 presents the tonnage yields of the varieties and their top crosses with the red-marker beet. Differences will be noted among the varieties, among the top crosses, and between the individual varieties and their top crosses.

At Sheridan the top crosses of the red-marker beet with US 75, 00263-0, 20648-0, and 30208-0 exceeded the yield of the respective varieties alone, while MW 391 exceeded its top cross.

At Sidney the crosses of H 18-40, 00263-0 and 20648-0 exceeded the yield of their respective varieties.

At Tracy, a high incidence of curly-top infection markedly influenced the tonnage yields. This occurrence probably accounts for the high yields of US 22/3 and US 75, while their crosses are considerably lower. The yield of the MW 391 top cross was also lower than MW 391, although this reduction could not be explained by a difference in percent of curly-top infection. The yield of the 30208-0 top cross exceeded the yield of that variety alone.

Table 1.—Tonnage Yield of Varieties and the Crosses with the Red-Marker Beet at Three Locations, 1955.

	Yield in Tons Per Acre							
	Sheridan, Wyoming		Sidney, Montana		Tracy California		Tracy, Percent Curly Top	
Variety	Variety	Top Cross	Variety	Top Cross	Variety	Top Cross	Variety	Top Cross
Red Beet	11.381		14.481		14.971		94.8	
US 22/3	19.253	19.316	20.232	20.744	40.621	26.611	3.1	78.0
US 75	18.129	20.745	20.711	21.772	39.918	32.982	1.7	69.4
Klein "E"	21.885	22.870	24.132	25.223	25.762	23.760	92.9	92.6
MW 391	22.654	19.743	23.556	22.310	25.725	20.601	90.6	89.6
H 18-40	19.042	18.560	19.228	22.403	23.612	19.926	92.7	89.8
00263-0	16.560	22.469	19.578	24.424	23.366	20.977	96.7	93.6
7017-0	18.574	18.320	18.661	20.555	21.067	17.880	91.4	91.2
20648-0	17.703	19.760	17.609	22.152	19.963	22.304	92.1	90.2
30208-0	16.312	22.008			14.744	22.577	92.1	94.2
3124-0			21.840	22.245				
LSD .05	1.889		2.115		3.881			
r (n 9)	-.12[1]		-.48[1]		+.77[2]			
r (n 7)					-.90[3]			

[1] Denotes non significance.
[2] Denotes significance at 5 percent level.
[3] Denotes significance at 1 percent level.

The correlation coefficients calculated for the yield of the varieties with their top crosses to the red-marker beet are also indicated in Table 1. At Sheridan ($r = -.12$) and Sidney ($r = +.48$), r values were nonsignificant. At Tracy ($r = +.77$), the relationship was significant at the 5 percent level. Omitting US 22/3 and US 75 and their crosses because of differential curly-top infection, the correlation coefficient ($r = -.90$) is significant at the one percent level.

Table 2.—Percent Sucrose Content of Varieties and Top Crosses with the Red-Marker Beet at Three Locations, 1955.

	Sheridan, Wyoming			Sidney, Montana			Tracy, California		
	Percent Sucrose		Difference from	Percent Sucrose		Difference from	Percent Sucrose		Difference from
Variety	Variety	Top Cross	Mean of Parents	Variety	Top Cross	Mean of Parents	Variety	Top Cross	Mean of Parents
Red Beet	10.21			8.84			11.48		
US 22/3	15.41	13.07	+.26	15.89	11.82	-.55	13.40	10.83	--1.61
US 75	15.34	12.84	+.06	15.41	12.38	-.25	12.92	10.33	--1.87
Klein "E"	15.60	12.51	—.40	16.04	12.12	-.02	13.79	11.17	--1.47
MW 391	15.56	12.70	-.19	16.07	12.71	-.28	13.53	10.51	—2.00
H 18 10	16.28	13.19	--.06	16.78	12.78	.03	13.61	11.08	—.57
00263-0	15.54	12.57	.31	16.12	12.63	-.15	14.05	11.66	—1.11
7017-0	15.77	12.85	—.11	15.82	12.08	-.25	13.50	11.46	—1.03
20648-0	16.88	13.51	—.01	17.86	13.22	-.13	15.06	12.17	-1.10
30208-0	17.78	13.75	.25				15.36	12.29	--1.13
3124-0				16.34	12.54	.04			
LSD .05		.51			.69			1.21	
r (n=9)		.89[3]			-.78[3]			+.82[2]	
r (n=7)								+.72[1]	

[1] Denotes non significance.
[2] Denotes significance at 5 percent level.
[3] Denotes significance at 1 percent level.

Table 2 contains the percent sucrose content of the varieties and their top crosses with the red-marker beet. Also presented are the differences, for the crosses, above or below the arithmetic mean of the two parents. At Sheridan and Sidney, the sucrose content for the crosses is very near the arithmetic mean of the parents, with higher sucrose varieties having higher sucrose top crosses. The top crosses at Tracy, however, are markedly below the expected figure of the arithmetic mean of the two parents. The higher sucrose varieties still have the higher sucrose top crosses, however.

Discussion

If the red-marker beet is taken as a suitable top-cross parent for indicating general combining ability, then those varieties which, in top-cross combination, exhibit a yield in excess of the varietal parent should be ones having dominant favorable yield factors not found in the red-marker beet parent.

It remains to be seen if the top-cross yields, which were in excess of the varieties, are a manifestation of general or specific combining ability. The nonsignificant correlation coefficients found at Sheridan and Sidney

would indicate that the yield of a variety *per se* could not be taken to indicate which ones contain the higher proportion of plants that are better general combiners.

The correlation at Tracy ($r = -.77$) was calculated including US 22/3 and US 75. As indicated in Table 1, there was a difference in curly-top incidence on these varieties and their top crosses. When they were omitted, the correlation changed to a negative value ($r = -.90$), indicating that the higher yielding varieties actually are made up of plants with low general combining ability. A notable exception to this is 30208-0. The negative relationship expressed by the r value is due to the lower yield of most of the top crosses compared with their parental variety yield. The lower top-cross yields, as compared to variety yields, could be due to a differential response to curly-top infection.

Sucrose content of the top crosses followed a pattern experienced in previous studies by many workers (i.e. the sucrose content of the top crosses was intermediate between the sucrose contents of the two parents). The results at Tracy under heavy curly-top infection were the notable exception to this. Here again, this could possibly be a differential response to comparable amounts of curly-top infection.

Summary and Conclusion

1. The red-marker beet with a dominant red plant color was used as a top-cross parent on nine varieties of pseudo self-fertile sugar beets. The top-cross plants were identifiable in the seedling stage and left at thinning time.

2. Yield data obtained from the varieties and their top crosses revealed that certain varieties at the three locations produced top crosses whose yields exceeded the yield of the varietal parents. This was taken to indicate that the varieties were high in general combining ability. However, future tests will show whether specific or general combining ability was responsible for the results obtained.

3. Correlations ($r = -.12, -.48, -.90$) between yields of varieties and their top crosses at the three locations indicated, in general, that the yield of the variety *per se* could not be taken as an indication of the level of general combining ability of plants within the variety.

4. Sucrose content, in general, was intermediate between the two parents, with higher sucrose parents yielding the higher sucrose top crosses.

References

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