Performance of Successive Generations of Two Sugar Beet Varieties

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During the early development of the sugar beet industry it was a generally accepted principle that continued selection was essential if quality and yielding ability were to be maintained in a variety. It was possible to do this using the steckling method of seed production from elite stock. However, with the advent of the overwintering method for seed production some two decades ago in the United States, the rate of seed increase from elite stock was materially less than for the steckling method, which made successive increases of each lot an acceptable practice if one were certain that no essential change would occur in later generations. Since the basic principle of loss in performance resulting from successive mass increases appeared open to question, some such increases, followed by performance tests, were made in the Great Western seed program to check out this principle.

Earlier tests as reported (1)[2] and (2) were promising and a general program of successive mass increases for commercial seed production adopted. During this time, performance tests have been conducted to assure safety in maintaining the general varietal characteristics, at least to the extent that if any change is detected, further increase would not be made.

In this paper the results for several generations of two important Great Western varieties of recent origin are presented. These varieties (304 and 359) have had a somewhat similar origin. Both resulted from a broad program of searching for types resistant to the leaf-spot disease, improving the various sources by family and progeny test methods, and finally bringing together the improved families from several original sources into respective polycrosses. Following these first polycrosses, there were two generations of family testing accompanied by selection within and between families.

In the Great Western system of numbering seed lots, seed from the first mass grouping of families is known as the "B" generation. One generation by mass increase of "B" seed results in the "C" or elite generation. Further successive mass increases become "commercial" seed and carry the prefix "GW" along with appropriate suffixes to designate year and location.

The comparative tests, for which data are included in the following tables, employed 12 replicates of each variety in either a Randomized Complete Block or Triple Rectangular Lattice design for each test. Plots as harvested were 6-rows wide and 18-feet long, all beets surrounding skips of 3 or more feet in length being discarded. Yields were then calculated on the basis of full stands for all beets harvested from 6 rows. Sugars and purities were obtained from all beets harvested from 2 rows of each plot.

Tables 1 and 2 include summaries of tests of the 304 variety for the two years, 1952 and 1953, at two locations and the 359 variety at the same locations for the four years, 1952 through 1955.

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[2] Numbers in parentheses refer to literature cited.

Table 1.—Summaries of Tests of the 304 Variety for the Two Years 1952 and 1953 at Longmont and Fort Morgan, Colorado.

Variety No.[1]		Tons Beets Per Acre			Percent Sugar Content		
Increase	Origin	1953	1952	Mean	1953	1952	Mean
C304	Gr. 459	24.20	20.77	22.49	16.67	15.52	16.10
GW304-49A	C304	23.37	20.25	21.81	16.77	15.08	15.93
GW304-49R	C304	23.49	19.95	21.72	16.68	15.35	16.02
GW304-49L1	C304	23.99	20.88	22.44	16.89	15.76	16.33
GW304-50L	C304	23.56	19.99	21.78	16.89	15.28	16.09
GW304-50A	GW304-49R	23.20	20.44	21.82	16.82	15.34	16.08
GW304-50R	GW304-49R	22.80	19.62	21.21	16.81	15.57	16.19
GW304-51A	GW304-50R	23.33	19.34	21.34	16.83	15.37	16.10
LSD 5% pt.		.60	.98	.58	.31[2]	.43	.27[2]

Variety No.[1]		Percent Bolters			Percent[3] Thin Juice App. Purity	Percent[3] Sodium
Increase	Origin	1953	1952	Mean	1953	1953
C304	Gr. 459	.56	.04	.30	93.99	.034
GW304-49A	C304	.49	.32	.41	93.28	.041
GW304-49R	C304	1.46	.18	.82	94.05	.042
GW304-49L1	C304	.63	.28	.46	93.81	.036
GW304-50L	C304	.66	.11	.39	93.64	.040
GW304-50A	GW304-49R	1.18	.25	.72	94.09	.038
GW304-50R	GW304-49R	1.28	.18	.73	93.65	.043
GW304-51A	GW304-50R	.66	.11	.39	93.91	.039
LSD 5% pt.		-	-	- -	.82[2]	.005

[1] Suffix includes year and location (A, R, L for Arizona, Oregon and Longmont, Colorado.

[2] No significant differences indicated by the "F" test.

[3] Fort Morgan only.

For variety 304 (Table 1) there is some indication of a reduction in yield for the 49A, 49R and 50L increases but the 49L1 increase was equal with C304, the parent of all of these increases. The average difference between the 50A and 50R increases for the two locations is slightly in excess of the difference of .58 tons required for significance at the 5 percent level although both were increases from the same lot. A reduction in yield of 1.15 tons per acre for 50R, the third increase, as compared with the original C304 is highly significant. In consideration of these variations in performance, the picture with respect to any loss in tonnage is certainly not clear. With the 49L1 exception, however, all increases are significantly below the original C304 in yield as an average for two locations. For neither sugar content nor purity is there any indication of any change with successive generations. For sodium, 5 of the increase lots were slightly but significantly

Table 2.—Summaries of Tests of the 359 Variety for the Four Years 1952 through 1955 at Longmont and Fort Morgan, Colorado.

Variety No.[1]		Tons Beets per Acre				Percent Sugar Content			
Increase	Origin	1955	1954	1953	1952	1955	1954	1953	1952
B359	Gr. 4610	-	-	24.22	19.37		-	17.13	15.80
C359-49L	B359	22.43	21.02	24.22	20.33	16.87	15.83	17.34	15.85
C359-50R	B359	22.30	20.07	23.90	19.70	16.65	15.76	17.34	15.77
GW359-50L	C359-49L	22.51	20.91	23.89	20.03	16.74	15.94	17.17	16.00
GW359-51A	C359-50R	22.28	20.97	24.10	19.74	16.51	15.63	17.07	15.57
GW359-51R	C359-50R	21.91	20.39	24.10	19.92	16.78	15.99	17.38	15.93
GW359-53R	C359-50R	22.13	20.65	-	- -	16.39	15.87	- -	- -
GW359-52A	GW359-51R	21.92	19.59	23.98	—	16.63	15.87	17.14	—
GW359-52R	GW359-51R	22.09	20.10	23.55	—	16.56	15.80	17.23	—
GW359-54A1	GW359-51R	22.10	-		—	16.42	- -	- -	—
GW359-54A2	GW359-52R	21.49	—	—	—	16.37	—	—	-
LSD 5% pt.		0.91	0.93	0.78	0.97	0.24	0.34	0.32	0.33

Variety No.[1]		Percent Bolters				Percent Thin Juice[2] App. Purity	Percent Sodium
Increase	Origin	1955	1954	1953	1952	1953	1953
B359	Gr. 4610	-	- -	0.49	0.00	93.71	.033
C359-49L	B359	0.39	0.04	0.49	0.00	93.42	.030
C359-50R	B359	0.81	0.27	1.57	0.00	94.09	.033
GW359-50L	C359-49L	0.93	0.04	1.11	0.14	93.47	.037
GW359-51A	C359-50R	1.08	0.16	0.56	0.14	94.09	.037
GW359-51R	C359-50R	1.12	0.24	0.90	0.11	93.36	.036
GW359-53R	C359-50R	1.08	0.16	-	- -	- -	- -
GW359-52A	GW359-51R	0.74	0.08	0.25	-	94.26	.038
GW359-52R	GW359-51R	1.66	0.39	2.50	—	93.88	.034
GW359-54A1	GW359-51R	1.28	—	- -	—		—
GW359-54A2	GW359-52R	1.43	—	—	—	—	- -
LSD 5% pt.		-	- -	—	—	• 0.76	.005

[1] Suffix includes year and location (A, R, L for Arizona, Oregon and Longmont, Colorado.)

[2] Fort Morgan, only.

above the original C304. For bolters, one might anticipate some differential, and for 1953 the differences between varieties are large enough to indicate some probable real increase for the 49R, 50A and 50R lots.

For Variety 359 (Table 2), there was no indication of change for any character except bolting in any successive increase prior to the 54A2 lot tested in 1955. This lot is essentially equal in yield to its immediate parent, 52R, and to its grandparent 51R, but as compared with the original C359-50R,

the apparent loss in yield is about equal to the LSD at the 5 percent level. There appears to have been some increase in bolters for the later generations, more or less, regardless of location of the seed increase.

As evidence that it is impossible to predict the performance of successive generations, it may be pointed out that 304 levelled out after the "C" generation, while there did not appear to be any apparent loss in performance for 359 through three increases after the "B" generation, with a possible slight loss in yield in the fourth.

Summary and Conclusions

Successive mass increases have been made without selection during the past 20 years or more as a general practice with Great Western varieties. As a constant check against any possibility of loss in yield or sugar, or changes in other important characters, generation studies have been continued year after year.

From previous reports and from the data included in this paper, certain instances of possible genetic changes usually losses in yielding ability, have been encountered. Generally they have been rather small and therefore difficult to determine with certainty.

It seems safe to conclude that quality, as measured by sugar content and purity, has remained constant through several generations of mass increase. Bolters have increased not greatly but rather definitely in some cases. A program of seed production by continued mass increase without selection appears practical and with little danger of serious loss in any important character for varieties having a heterogenous and broad base composition, such as were used in these tests. But it is important that each increase be checked for performance in comparison with the parental strains.

References

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