

Generation Studies of Sugar-Beet Varieties

H. EL BREWBAKER AND H. I. BUSH¹

It has long been the popular belief, particularly by Europeans interested in sugar-beet seed sales in the United States and Canada, that continued selection was necessary in order to maintain productiveness in a commercial variety. Two years ago the senior writer reported some preliminary results on the performance of direct increases of pedigreed and commercial lots of seed.² These studies have been continued; first, to develop more pertinent information on this subject; second, to obtain further evidence with respect to the performance and adaptability of our new productions, and third, to determine the effect of seed production under widely different conditions upon the productivity and agronomic characters of importance to the commercial beet grower.

Methods Used

All plots consisted of 4 rows by 30 feet in length at harvest for Longmont, Fort Morgan, and Brush, Colorado, locations. All 4 rows were harvested for yield with only the 2 center rows being taken for sugars. At Billings, Montana, the plots were 4 rows by 60 feet in length at harvest, the center 2 rows being taken for yield and half of these roots for sugar.

The tests at Longmont and Brush were planned using a "triple lattice" design with 9 replicates, while those at Billings were simple randomized blocks with 6 and 4 replicates, respectively, for A16-40A and A16-40W (table 2). Only those tests are included in this report where stands were very good, no material corrections for stand being necessary.

The various seed increases, and the tests herein reported, were made incidental to the regular sugar-beet improvement, seed production, and varietal test program of the Great Western Sugar Company. Under these conditions it has been obviously impossible to supervise every phase of the study, and while we have no reason to question the purity of the productions with respect to possible mixtures, either by off-pollination with some other lot, or of the seed itself, such possibilities must be admitted. For this reason the study becomes more of a practical one since it provides the comparisons necessary for intelligent direction of a sugar-beet seed-production program.

In referring to the various classes of seed used in this study they may be described as follows;

¹Agronomist and Statistician, respectively; Experiment Station, The Great Western Sugar Company.

²Brewbaker, H. E. Performance of Direct Increases of Pedigreed and Commercial Lots of Sugar Beets. Proceedings, A.S.S.B.T. 1:147-148. 1940.

Breeding group mixtures are made up of mass collections of seed from isolated groups of selected mother beets designed primarily for breeding purposes.

Pedigreed seed results from small plantings of transplanted or overwintered stecklings and represents the first mass or unselected increase of breeding families.

Commercial **seed** may result from the first or any later mass increase of either pedigreed or commercial seed lots.

In testing significance the *Isd* (least significant difference) used is based on the 5-percent point with odds of **19 :1**.

Results

The results presented in the following tables were limited to those cases where stands were good.

Increases of Breeding Group Mixtures, Pedigreed, and Commercial Lots.—The results for increases of breeding group mixtures to pedigreed seed are summarized in table 1.

Of these increases, 4 show significant losses with 1 significant gain in yield, and 2 significant losses with 1 significant gain in percentage of sugar. For all lots tested there was an average percentage loss of 4.68 for yield, 0.33 for percentage sugar, and 5.33 for total sugar.

Comparisons of pedigreed lots with their first-generation commercial increases are made in table 2 in terms of loss or gain for the increase in percentage of Standard (**GW18**).

The data summarized in table 2 are inclusive for those tests made during the past 3 years. In yield there were 2 gains and 6 losses which were significant. For percentage of sugar 3 of the increases showed gains and 5 showed losses of magnitude sufficient to be significant. As an average of all lots tested the increase generation showed percentage losses of 1.78 for yield, 0.50 for percentage of sugar, and 2.35 for total sugar. While these are not large there appears to be a trend in the minus direction for both yield and sugar. The direct increases of commercial lots are summarized in table 3.

Only 2 of the yield figures are significant, 1 of these being a 5.88 percent loss for GW31, and the other a 2.25 percent gain for GW42, these comparisons being made directly with the commercial parents in each case. None of the percentage of sugar gains or losses were significant. The general mean amounted to the very small net loss of 0.44 percent for yield, 0.79 percent gain for percentage of sugar, and 0.28 percent gain for total sugar.

The results indicate some lowering of the variability between the original and the increase when these are the first and second commercial increases (table 3) as compared with increases of breeding group mixtures (table 1) or pedigreed lots (table 2). It seems highly

Table 1.—Increases of breeding group mixtures to pedigreed seed.

Varieties		Where increased	Method for increasing	Where tested	Year tested	Loss or gain for increase in percentage of standard (GW18)		
Original	Increase					Yield	Percentage sugar	Total sugar
B40	GW1075	Colo.	Steckling	Longmont	1941	+ 2.03	+2.45	+ 4.20
B40	GW1075	Colo.	Steckling	Brush	1941	-10.42*	-3.95*	-14.75
B45	GW1070	Ariz.	O.W.	Longmont	1941	- 4.80	+4.51*	- 0.53
B45	GW1070	Ariz.	O.W.	Brush	1941	- 8.13*	+0.87	- 7.20
B45	GW1076	Colo.	Steckling	Longmont	1941	+ 0.09	+2.52	+ 3.24
B45	GW1076	Colo.	Steckling	Brush	1941	+ 8.79*	-1.27	+ 7.32
B46	GW1071	Ariz.	O.W.	Brush	1941	-12.35*	-2.48	-15.74
B46	GW1077	Colo.	Steckling	Brush	1941	-12.94*	-5.50*	-12.06
General mean						- 4.88	-0.33	- 5.33
1sd 5-percent point, Longmont 1941						6.61	2.58	—
1sd 5-percent point, Brush 1941						5.62	3.35	—

* = Significant on basis of 5-percent point.

Table 2.—Increases of pedigreed lots to commercial lots.

Varieties		Where increased	Method for increasing	Where tested	Year tested	Loss or gain for increase in percentage of standard (GW13)		
Original	Increase					Yield	Percentage sugar	Total sugar
GW1011	GW3	N.M.	O.W.	Longmont	1939	+ 0.80	-1.63	- 0.87
GW1011	GW1044	Colo.	Steckling	Longmont	1939	- 2.85	-0.27	- 3.16
GW1030	GW11	Ariz.	O.W.	Longmont	1940	- 2.59*	-2.14	- 4.87
GW1020	GW11	Ariz.	O.W.	Longmont	1941	+ 0.28	-1.19	- 0.90
GW1020	GW11	Ariz.	O.W.	Brush	1941	- 3.81	-1.47	- 5.27
GW1020	GW38	Ariz.	O.W.	Longmont	1940	- 3.25	-2.24	- 5.47
GW1020	GW38	Ariz.	O.W.	Longmont	1940	- 3.06*	+0.74	- 2.26
GW1038	GW8	Ariz.	O.W.	Longmont	1940	- 1.90	-2.22	+ 0.16
GW1038	GW8	Ariz.	O.W.	Fort Morgan	1940	+ 1.80	-2.40*	- 0.73
GW1038	GW8	Ariz.	O.W.	Brush	1941	-14.97*	-4.62*	-19.82
GW1052	GW10	Ariz.	O.W.	Longmont	1940	- 2.17*	+3.79*	+ 1.52
GW1052	GW10	Ariz.	O.W.	Fort Morgan	1940	- 0.81	+0.83	+ 0.08
GW1052	GW10	Ariz.	O.W.	Longmont	1941	- 2.08	-0.87	- 2.75
GW1052	GW10	Ariz.	O.W.	Brush	1941	+ 2.84	-2.81	- 0.80
GW1004	GW25	Colo.	Steckling	Longmont	1940	- 0.86	-3.02*	- 4.54
GW1012	GW6	Ariz.	O.W.	Longmont	1940	+ 0.31	-3.87*	- 3.35
GW1037	GW7	Ariz.	O.W.	Longmont	1940	+ 4.06*	+8.58*	+10.81
GW1059	GW41	Colo.	Steckling	Longmont	1940	+ 3.40*	-1.65	+ 1.86
GW1051	GW9	Ariz.	O.W.	Longmont	1940	+ 0.19	+6.95*	+ 6.50
GW1059	GW46	Colo.	Steckling	Longmont	1940	- 2.86*	-2.89*	- 5.75
GW1072	GW12	Ariz.	O.W.	Longmont	1941	- 2.64	-0.40	- 2.46
GW1 Chem.	GW40	Texas	O.W.	Longmont	1940	- 0.14*	-0.17	- 0.81
General mean						- 1.78	-0.50	- 2.35
1sd 5-percent point. Longmont 1939						6.33	4.21	8.44
1sd 5-percent point. Longmont 1940						2.17	2.80	4.27
1sd 5-percent point. Longmont 1941						6.51	2.98	—
1sd 5-percent point. Fort Morgan 1940						2.32	1.47	2.80
1sd 5-percent point. Brush 1941						5.62	3.35	—

* = Significant on basis of 5-percent point.

Table 3.—Direct increases of commercial lots.

Varieties		Where increased	Method for increasing	Where tested	Year tested	Loss or gain for increase in percentage of standard (GW18)		
Original	Increase					Yield	Percentage sugar	Total sugar
GW25	GW26	Colo.	O.W.	Longmont	1940	-1.82	+1.93	+0.17
GW25	GW31	Tex.	O.W.	Longmont	1940	-5.88*	+0.91	-4.93
GW26	GW33	Ariz.	O.W.	Longmont	1930	-1.83	+1.68	+0.17
GW28	GW37	Colo.	O.W.	Longmont	1940	-0.93	-0.66	-1.29
GW28	GW42	Colo.	Steckling	Longmont	1940	+2.25*	+1.72	+3.94
GW34	GW34-40	Colo.	O.W.	Longmont	1941	-1.08	+0.20	-0.87
GW34	GW48	Ore.	O.W.	Longmont	1941	+1.86	+1.52	+3.35
GW20	GW23	Colo.	O.W.	Longmont	1939	+3.25	+1.00	+5.00
GW21	GW27	Colo.	O.W.	Longmont	1939	+4.83	+0.47	+4.43
GW31	GW32	Tex.	O.W.	Longmont	1939	-5.31	-2.11	-7.30
General mean						-0.44	+0.70	+0.28
1sd 5-percent point, Longmont 1939						6.33	4.21	8.44
1sd 5-percent point, Longmont 1940						2.17	2.80	4.27
1sd 5-percent point, Longmont 1941						6.51	2.58	—

* = Significant on basis of 5-percent point.

Table 4.—Effect of location of seed production on yield of roots, percentage of sugar, and total sugar.

Varieties		Where increased	Method for increasing	Where tested	Year tested	Increase in percentage of standard (GW18)		
Original	Increase					Yield	Percentage sugar	Total sugar
GW25	GW26	Colo.	O. W.	Longmont	1940	99.90	100.20	100.18
GW25	GW31	Tex.	O. W.	Longmont	1940	95.84*	99.22	95.98
GW25	GW33	Ariz.	O. W.	Longmont	1939	101.43	98.10	99.60
GW34	GW34-40	Colo.	O. W.	Longmont	1941	98.57	100.73	99.80
GW34	GW48	Ore.	O. W.	Longmont	1941	101.43	102.05	103.52
GW1011	GW1044	Colo.	Steckling	Longmont	1939	99.20	100.75	99.94
GW1011	GW3	N.M.	O. W.	Longmont	1939	102.83	99.30	102.23
B45	GW1076	Colo.	Steckling	Longmont	1941	101.15	103.18*	104.37
B45	GW1070	Ariz.	O. W.	Longmont	1941	95.66	105.17*	100.60
B45	GW1078	Colo.	Steckling	Brush	1941	120.32*	99.53	112.75
B45	GW1076	Ariz.	O. W.	Brush	1941	103.40	101.87	105.14
B46	GW1077	Colo.	Steckling	Brush	1941	107.22*	98.12	105.31
B46	GW1071	Ariz.	O. W.	Brush	1941	107.81*	100.84	108.63
A16	A16-40W	Colo.	Steckling	Hillings	1941	103.19	99.20	102.40
A16	A16-40A	Ariz.	O. W.	Hillings	1941	85.41*	98.37	84.30
Average for Colorado Source (a)						106.95	100.08	106.40
Average for Arizona Source						98.70	100.80	99.01
1sd 5-percent point, Longmont 1939						6.33	4.21	8.44
1sd 5-percent point, Longmont 1940						2.17	2.80	4.27
1sd 5-percent point, Longmont 1941						6.51	2.58	—
1sd 5-percent point, Brush 1941						5.62	3.35	—
1sd 5-percent point, Hillings 1941						5.70	2.28	—

(a) GW34-40 and GW1044 not included.

* Varies significantly from standard on basis of 5-percent point.

probable that little real change has taken place resulting from this first increase of commercial to commercial, and that the chances are about equal for any gains or losses of real magnitude.

Effect of Location of Seed Production on Performance.—Several cases are available where comparisons of performance could be made between separate increases of the same original lot of seed in different locations. The results for these comparisons are summarized in table 4, the respective losses or gains for the "increase" under or over the "original" being put in percentage of the standard variety (GW18), which has been in all of our comparative variety tests for several years.

There appears to be some rather definite, although not consistent, evidence to indicate better yield, with slightly reduced sugar percentage, for Colorado as compared with Arizona increases. The one Texas increase of GAY31 as compared with the original ((1W25) showed a significant loss in yield, while the UW26 increase made in Colorado and GW18 in Arizona were both equal to the original.

The two increases of A¹6 were tested in separate variety tests, the two tests being adjacent, and in the same field. Stands were excellent in each, and while it is only possible to compare the performance of these two lots in percentage of the standard, the wide difference in yield between the two lots appears to be quite highly significant.

Discussion and Summary

When a preliminary report was made 2 years ago the need was expressed for further data in order to reach definite conclusions. Now that more data are available, we are still hesitant to generalize too far. We do believe, however, that the data presented indicate:

1. Predictions as to the performance of increases of breeding group mixtures or pedigreed lots are unsafe, and that comparative variety tests can only be relied on in such cases.

2. Direct mass increases of commercial lots of seed may be expected to approximate the performance of the original, at least so long as those increases are made under conditions where adverse natural selection does not appear to occur.

3. While the evidence is somewhat conflicting, there appears to be some indication of better performance from Colorado-produced seed as compared with Arizona-grown seed when tested in Colorado.

4. Extensive variety tests are indicated as an essential feature of any improvement program if the best varieties are to be provided for the commercial grower of sugar beets. In these tests, each successive generation increase should be included until it can be shown that no further change in the innate capacity to produce has been effected. Such increases could well be made on a small scale to provide seed for preliminary variety tests, and large commercial increases would be made only as justified by these preliminary tests.