Effect of Bolters on Yield and Sucrose Content of Sugar Beets

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In the growing of a commercial crop of sugar beets, the occurrence of seed stalks has long been considered undesirable. Usually the grower will instruct labor used in weeding the crop to break off any bolters present. Bolters in this case refer to both true and simulated seed stalks. The reasons for objecting to bolters in the commercial crop of sugar beets have not been well defined. One reason frequently given, however, is that bolting reduces root yield. An inquiry into the degree of reduction prompted the studies here reported.

Condensed in this paper are comparative data on yield and sugar content of roots from bolted and non-bolted (normal) plants of sugar beets as gathered on separate occasions at Fort Collins and Longmont, Colo.

Experimental Procedure and Results (Fort Collins)

The results were gathered in the year 1938 in conjunction with a date of planting test which included four sugar beet varieties. Beets from the border rows of the early planted plots were used for the bolting study. Bolting on these plots became evident soon after thinning. Normal beets and bolters of the following types were taken of hybrid 37-304 in such manner as to maintain identity of the type and relative positions of the beets harvested. The types as originally grouped were:

1. Early bolters; seed stalk and seed production comparable to second year growth.
2. Late bolters; more or less leafy seed stalks with bloom and some late seed production.
3. Very late bolters; short leafy seed stalk, no bloom.
4. Mixed bolters; one or more seeded stalks from low side buds, but main crown of beet nearly normal.
5. Normal, adjacent to each of above types of bolters.
6. Normal, second adjacent to each of above types of bolters.
7. Normal, third plant or more removed from each of the above types of bolters.

Preliminary examination of root weights indicated that Groups 2, 3 and 4 did not materially differ and therefore these groups were combined to form the late bolter group as presented in Table 1.

Table 1.—Mean Root Weight, Including Crown, of Paired Samples from Hybrid 37-304 and Calculated P Value for Likeness of Paired Means. Fort Collins, Colo. 1938.

Groups compared	Weights, respectively		Number of pairs	Probability
	Pounds	Pounds		
Early bolter and 1st adjacent normal	.618	1.356	76	P < .01
1st adjacent and 2nd adjacent normal	1.342	1.296	64	P > .6
1st adjacent and 3rd adjacent normal	1.318	1.280	29	P > .8
Late bolter and 1st adjacent normal	1.271	1.322	95	P > .5
1st adjacent and 2nd adjacent normal	1.399	1.391	81	P > .9
1st adjacent and 3rd adjacent normal	1.357	1.420	42	P > .6

[1] Agronomists, Experiment Station, the Great Western Sugar Company, Longmont, Colo. and Division of Sugar Plant Investigations, Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, respectively.

The data in Table 1 show that the only measurable effect on yield was the reduction in root size associated with early bolting. Subsequent to weighing the roots individually and analyzing the data statistically, using paired comparisons, the beets were topped (crowns cut off at lowest leaf scar), regrouped and reweighed for further comparisons. Sucrose percentage and apparent purity were determined for each group. From the average beet weights, yields in tons of beets per acre were calculated by using the theoretical plant population for 10 x 20 inch spacing. The data are summarized in Table 2.

Table 2.—Yield, Quality and Sugar Percentage for Groups of Bolting and Non-bolting Beets in Hybrid 37-304, Fort Collins, Colo. 1938. (Data Given as 2-plot Averages.)

Groups	Tons per acre	Sucrose percent	Coefficient of apparent purity	Gross pounds sugar per acre
Early bolters	7.90	11.5	90.0	1,820
Late bolters	15.66	12.4	90.6	3,934
Mixed bolters	18.56	12.6	91.5	4,698
Normal adjacent to early bolter	18.78	13.4	90.2	5,042
Normal, 3 or more plants removed from early bolter	17.31	13.4	91.3	4,624
General mean	15.64	12.67	90.73	4,023
L.S.D. 5% pt.	2.90	NSi	NSi	908

[1] Not significant by Z test.

Observations on the varieties Original Normal (German seed) and Great Western as made in connection with the date of planting test revealed a limited number of bolted plants. Weights and sugar analyses tabulated on these varieties followed the trend established for the hybrid variety reported in Tables 1 and 2.

An ample number of bolters were available for study in the variety U. S. No. 217. Thus, five groups of beets were taken from each of four replications, and a complete analysis made of this variety. The results are summarized in Table 3.

Table 3.—Yield, Quality and Sugar Production for Groups of Bolting and Non-bolting Beets in the Variety U. S. No. 217. Fort Collins, Colo. 1938. (Data Given as 4-plot Averages.)

Group	Tons per acre	Sucrose percent	Coefficient of apparent purity	Gross pounds sugar per acre
Early bolters	12.52	14.25	88.60	3,560
Late bolters	20.73	14.58	90.35	6,043
Very late bolters (Leafy, no seed)	20.36	14.95	89.08	6,078
Normal adjacent to early bolter	20.22	14.95	89.70	6,049
Normal, 3 or more plants removed from bolter	20.44	14.78	89.98	6,051
General mean	18.85	14.70	89.54	5,552
L. S. D. 5% pt.	3.10	NS[1]	NS[1]	834

[1] Not significant by Z test.

Results given in Table 3 correlate with previous tables in that the root yield of early bolters was much reduced. In Table 2 there is an indication that sucrose percentage is adversely affected by early bolting and in Table 3

the coefficient of apparent purity is marginally lower for the early bolter group. Considering these two factors there is a definite suggestion that early bolting reduced processing quality of the beet as well as yield.

Experimental Procedure and Results (Longmont)

During the 1951 growing season bolters were prevalent (3-4 percent) on one field of commercial sugar beets on the Experiment Station of the Great Western Sugar Company. This field was planted April 3, with seed of variety GW304. Hand labor was used in thinning, which was completed May 29. Bolters became conspicuous shortly thereafter. All bolters were left undisturbed until August 9 when 150 bolted plants were marked by placing stakes adjacent to the plant and the bolters broken off near the ground. These bolters were selected in locations where two or more bolters occurred within six feet of each other. Harvest of 15 samples of 10 beets per sample was made October 8 of groups A, B and C. A similar harvest was made November 7 of groups D, E and F. The groups as classified:

A. Early bolters; undisturbed until harvest.
B. Early bolters; stalks broken off near ground August 9.
C. Normal; beets not bolted.
D. Early bolters; produced seed.
E. Medium bolters; leafy stalk, no seed.
F. Normal; beets not bolted.

Table 4.—Root Yield, Sugar Content, and Sugar Production for Groups of Bolters and Non-bolters Harvested October 8. Longmont, Colo. 1951. (Data Given as 15-sample Averages.)

Group	Tons per acre	Sucrose percent	Pounds sugar per acre
A. Early bolters	12.27	14.95	3,669
B. Early bolters, stalks broken off Aug. 9	11.19	10.70	2,395
C. Normal non-bolters	18.26	15.07	5,504
General mean	13.91	13.57	3,856
LSD 5% pt.	1.65	.57	480
LSD 1% pt.	2.20	.77	647

The 10 beets composited for each sample of the three groups harvested on the same day were taken within as compact an area as possible. Crown tissue was trimmed off to the lowest leaf scar. Roots of each 10-beet sample were washed and clean weights and sucrose percentage obtained. The data summarized *in* Table 4 and 5 were analyzed statistically as a randomized

Table 5.—Root Yield, Sugar Content, and Sugar Production for Groups of Bolters and Non-bolters Harvested November 7. Longmont, Colo. 1951. (Data Given as 15-sample Averages.)

Group	Tons per acre	Sucrose percent	Pounds sugar per acre
D. Early bolter, seeded	11.86	15.47	3,669
E. Medium bolters, no seed	24.02	15.53	7,461
F. Normal, non-bolters	21.90	16.17	7,082
General mean	19.26	15.72	6.071
LSD 5% pt.	2.58	.34	823
LSD 1% pt.	3.48	.46	111

complete block experiment with three treatments and 15 replications. Yield per acre was calculated from the mean individual root weights, using 20,000 beets per acre as the average stand.

Tables 4 and 5 again reveal low yields for early-bolting beets which produce true seed stalks. Breaking the bolters off at a late date and near the ground level caused serious defoliation which was reflected by a low sugar content, (Table 4). The early-bolting, seed-bearing beets are hard and woody making topping and handling operations difficult. Without special care during hand or machine harvest, it is likely that most beets of the early-bolting type would be abandoned in the field.

Summary

Several comparisons, including different varieties of sugar beets, showed that early-bolting plants which formed true seed stalks produced only about one-half the yield of roots of normal plants. Root yields of leafy-type bolting plants which produced no seed and late-bolting plants which bloomed, but produced little or no seed, were comparable to root yields from normal plants.

The sucrose percentage and the coefficient of apparent purity determined on roots from bolting plants were either no lower, or only slightly lower, than for adjacent normal plants.

Bolters left undisturbed in the field did not affect the yield or sucrose percentage of adjacent normal plants. Neither was root yield of bolting plants improved by the practice of breaking off the seed stalks. A lower sucrose percentage was obtained on the roots of bolting plants from which the seed stalks were broken off. This suggests that there is danger of excessive defoliation if this practice is followed during the growing season.