Thermal Induction and Reversal in Relation to Beet Seed Production[1]

RAY A. PENDLETON[2]

STUDIES WITH BEET SEED production in various parts of the country have resulted in considerable accumulated knowledge of the temperature and light requirements to promote seedstalk formation in the biennial sugar beet plant. The subject has been reviewed in detail by Owen, et al. (1)[3].

Where beets are grown by the field-overwintering method it is desirable that induction of flowering be sufficient to insure all plants entering into seed production so as to maintain the varietal characteristics. Under western Oregon climatic conditions with late summer planting, induction of flowering is practically complete. Individual roots are generally rather small when winter dormancy is reached. Seedstalk formation starts with the resumption of spring growth, after which there is no further increase in root size.

Where beets are transplanted for seed production, as is the case with most red beets and some sugar beets, production per plant needs to be high to obtain economical yields with feasible transplanting rates. Seed yield per plant is to a high degree positively correlated with the size of the root, provided the root is in good growing condition. Under optimum conditions very large seed yields have been obtained with transplanted large size mother beets. However, it is not feasible to store very large roots in sufficient quantities for transplanting purposes.

Small beets that would grow and build up more food reserves and still produce seed well would be preferable to large beets for transplanting. It is possible to accomplish this with red beets. Plants completely thermally induced, as when stored at 40° F. over winter, can be made to revert partially toward the vegetative condition by holding them at somewhat higher temperatures for a time just prior to transplanting. After transplanting, increase in growth and food reserves will go on while the additional thermal induction necessary for flowering is being acquired. A comparable effect results with beets overwintered in the field and transplanted directly after short seedstalks have developed and been cut back. In such plants the apical dominance of the terminal bud generally results in so much suppression of the axillary buds that these do not grow sufficiently to acquire enough thermal induction to make them develop into seedstalks

[1]The experimental work was done in cooperation with the Oregon Agricultural Experiment Station and represents a joint contribution of the United States Department of Agriculture and that Station.
Published as Technical Paper No. 530 with the approval of the Director of the Oregon Agricultural Experiment Station. Contribution of the Department of Farm Crops.
[2]Associate Soil Technologist, Division of Sugar Plant Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture
[3]The numbers in parentheses refer to literature cited.

immediately after the removal of the apical shoot permits them to grow. While these axillary buds are growing vegetatively in the spring and acquiring the degree of thermal induction necessary for flowering, the roots increase in size and store more food reserves. Such increase in food reserves makes possible more seed production than where plants with complete thermal induction are allowed to bolt and flower directly after transplanting. Figure 1 shows the contrast in size of roots between a plant that went into the reproductive phase as soon as transplanted and two that made extensive vegetative growth before developing flowers.

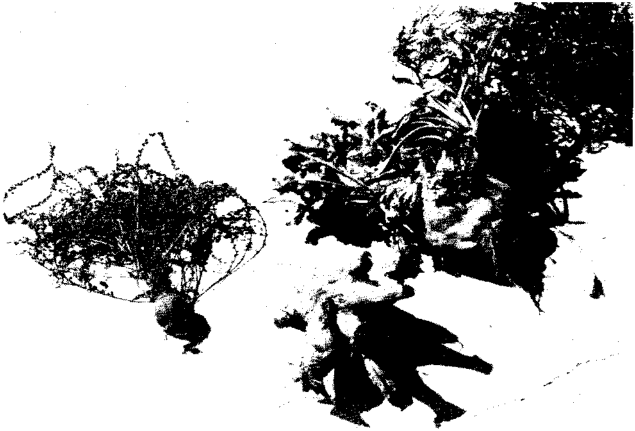

Figure 1. Detroit Dark Red table beets. Plant at left went into reproductive phase promptly after transplanting and without increase in root size. Other two plants had adequate thermal induction delayed and made extensive vegetative growth after transplanting and before flowering.

The results of an experimental test with red beets given different treatments before being transplanted are summarized in table 1. In this test the beets overwintered in the field had seedstalks about 6 inches long when transplanted. These seedstalks were cut back in one treatment and retained in the other. Those beets carried over winter in storage at 40° F. were held for about 2 weeks prior to transplanting at a mean temperature of about 48° F. The three lots of roots were fairly uniform in size at transplanting and averaged about 110 grams in weight.

Partial reversal of thermal induction or complete thermal induction prior to transplanting resulted in increased growth and accumulation of food reserves in the spring and consequently in increased seed production.

Table 1.—Results with transplanted table beets, 1946.

Method of overwintering	Root size at harvest	Plants fruiting	Seed yield Per plant	Per acre
	grams	percent	grams	pounds
Stored at 40° F.[1]	610	72	110	1,510
In the field[2]	327	88	105	1,930
In the field[3]	116	96	49	830

[1]Shifted to outdoor temperatures with mean of about 48° F. for 2 weeks before transplanting.
[2]Terminal seedstalks about 6 inches long cut back just before transplanting.
[3]Terminal seekstalks about 6 inches long not cut back.

Further evidence was afforded by field observations in 1947 in several red beet fields. A summary of conditions and yields is given in table 2.

Table 2.—Field results with transplanted table beets.

Transplanting date	Plants per 100 feet	Root weight per 100 feet	Plants fruiting	Seed per acre
		pounds	percent	pounds
February 20	60	15[1]	100	Not harvested
March 5	53	27	100	900
March 18	56	58	95	2,000
April 25	36	25	60	1,200

[1]These made no further growth after transplanting.

The plants in the field transplanted February 20 were so small, as a result of not growing in the spring, that an unsatisfactory crop of seed resulted. The plants transplanted March 18 made the greatest growth and gave the highest yield. Only 60 percent of those plants transplanted April 25 bolted but these gave a fair yield.

A fifth field was transplanted about May 1 with roots that had been stored in outdoor pits. About 2 weeks before transplanting these roots were removed to sacks where they tended to heat slightly. As a result they reverted to vegetative condition to such an extent that not over 30 percent produced seedstalks. The field was later abandoned.

The above observations indicate rather clearly that good yields of seed from transplanted table beets are associated with some retardation or reversion of the bolting tendency which is developed from field-overwintering in this climate or warehouse storage at 40° F. for 3 or 4 months. More investigation will be necessary to determine the exact conditions required to produce the desirable amount of retardation or reversion.

Studies with Reversion in Sugar Beets

The sugar beet varieties studied react to thermal treatments or cutting back the terminal bud in a manner comparable to that of the table beets but not to the same degree. Some preliminary trials were made in 1944 and 1945 of cutting back the terminal shoots in early spring after seedstalk initiation. A more branching seedstalk formation was secured but reduced seed yields resulted. In 1947, further trials in which combination thermal treatment and cutting back the terminal shoots were made to determine the effect on reversion of bolting. Transplanting, either with or without topping, and topping without transplanting in January or February produced no appreciable effect. However, when transplanted roots were held in the greenhouse for 10 days prior to transplanting in February, there was appreciable vegetative stimulus. Topping and transplanting in early April caused a moderate increase in vegetative activity but only small increased seed yields.

Except for some large mother beets, reversal of bolting in sugar beet roots under treatments thus far tried has not resulted in seed yields per plant which would be satisfactory for common transplanting conditions. Further information is needed on this point and investigations are being continued.

Summary and Conclusions

Both table beets and sugar beets grown for seed show a high positive correlation between size of root and seed yield per plant.

It is not feasible to store sufficient quantities of large roots for transplanting purposes. Therefore, where seed is to be grown from transplanted roots, it is desirable that more root tissue develop after the roots are transplanted.

This effect can be accomplished by retardation or partial reversal of thermal induction provided it can be held under control.

Topping back table beets transplanted in April had the effect of greatly stimulating vegetative growth and seed yield.

Progressive delay of transplanting stored table-beet roots caused corresponding increase in reversal of bolting and increased seed yield per plant, provided such delay was not carried to the point that a completely vegetative condition resulted.

Reversal of bolting in table beets could also be effected by short periods of exposure to warm greenhouse temperatures before transplanting, or by longer exposure to medium range outdoor temperatures.

The sugar beets studied show the same type of behavior as table beets in reversal of bolting but apparently not to the same degree.

It seemed to be much more difficult to control and hold uniform reversal in sugar beets than in table beets.

Topping sugar beets after seedstalks have been initiated in early spring has in most cases either reduced yield of seed per plant or caused a high mortality in the plants so that total yield was reduced.

Literature Cited

(1) OWEN, F. V., CARSNER, EUBANKS, AND STOUT, MYRON.
1940. Photothermal induction of flowering in beets. Jour. Agr. Res. 61: 101-124.