9. Stout, Myron, and Tolman, Bion. Factors Affecting the Germination of Sugar-beet and Other Seeds, with Special Reference lo the Toxic Effects of Ammonia. Jour. Agr. Res. 63: 687-713, illus. 1941.
10. Stout, Myron and Tolman, Bion. Interference of Ammonia, Released from Sugar-beet Seedballs, with Laboratory Germination Tests, flour. Amor. Soc. Agron. 33:65-69, illus. 1941.
11. Thompson, R. *C,* and Kosar, W. F. Stimulation of Germination of .Dormant Lettuce Seed by Sulfur Compounds. Plant Physiol. 14 :567-573, illus. 1939.
12. Tolman, Bion, and Stout, Myron. Toxic Effect on Germinating Sugar-beet Seed of Water-soluble Substances in the Seedball. Jour. Agr. Res. 61:817-830, illus. 1940.
13. Voss, J. Experimentell auslosung des schossens und prufung der schossneigung der rubensorten *(Beta vulgaris* L.). Angew. Bot. 18 :370-407, illus. 1936.

Winter Stecklings[1]

C. E. CORMANY[2]

In a sugar-beet breeding program such as ours it is highly desirable to go ahead rapidly with the current year's seed increase of many promising lines. Under our conditions this year's seed would normally be planted next spring or summer for the production of roots or stecklings which in turn would be stored during the following winter and then used for seed production in isolations the spring of the second year. Obviously, by producing stecklings during the winter immediately following the harvest of the new seed, a full year in this cycle can be saved.

The growing season in northern Wyoming, where the major portion of our breeding work is being done, is very short and sugar-beet seed does not mature until after the first of August and at times maturity extends well into September, depending upon varietal differences and other conditions. The period between harvest of the seed and killing frosts is too short for field production of stecklings of a usable size as is possible in southern Colorado where the total frost-

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free season is nearly 2 months longer (5)[3]. In order to have stecklings by the following spring it therefore remains for us to produce them in one of the following ways: (a) In the greenhouse by planting in the fall and early winter, harvesting in mid-winter and early spring and storing at suitable low temperature (36° to 40° F.) (1) (3) for at least 6 weeks before planting in the field; or (b) By producing the stecklings in field, plantings (4) under climatic conditions which allow for rapid fall growth of the seedling to suitable size before growth is arrested in mid-winter by cool temperatures, harvesting before active growth resumes in the early spring, and storing at the proper temperature until transplanting time.

This paper deals only with the observations and findings to date involved In the second method, or the production of winter stecklings under Phoenix, Arizona, conditions.

Discussion of Experiments

It was observed late in the winter of 1936-37 and again the following year, that stecklings taken from the commercial seed fields in the Phoenix, Arizona, area in late January and February produced seedstalks when planted the next spring. The possibilities for steckling production by this means to supplement the greenhouse steckling crop was indicated.

Accordingly, near Phoenix, on October 21, 1938, seed of 42 selected strains of sugar beets was planted by hand on lettuce ridges at 3-inch intervals in rows averaging 20 inches apart. Very few curly-top resistant varieties, usually heavy seed producers, were included. Excellent fall growth ensued. The 4,130 stecklings, ranging in size from approximately % to % inch in diameter, were harvested February 28, 1939, and placed in storage at Sheridan, Wyoming. These stecklings were transplanted in May in Isolation plots over a wide area in northern Wyoming under varying conditions of soil and care. Early losses, chiefly on areas where moisture conditions had not been kept favorable for starting early growth, amounted to about 70 percent of the transplanted roots. Seed yields under these varied conditions averaged 0.96 ounce per plant and ranged from .1 ounce to 2.4 ounces, depending largely on the care given and the variety used. The large stecklings produced more seed per plant than the small ones (4).

Encouraged by the favorable results of the first trial, seed of 55 selected strains was planted in two locations in October 1939 at Phoenix in 20-inch rows at the rate of 4 pounds per acre. No thinning was done. Unfortunately the plants at one of these locations were severely damaged by the curly-top disease carried to the field by the beet leaf-

[3]figures in parentheses refer to Literature Cited.

hopper *(Eutettix tenellus*, Baker). At harvest, March 4, 1940, all plants showing obvious symptoms of the disease were discarded and 34,354 stecklings were placed in storage at Sheridan, Wyoming, and Delta and Swink, Colorado. Transplantings from these stecklings the following summer at Delta, Colorado, showed in one case as much as 96 percent loss of plants for seed production due to curly top alone. An average of only 18 percent of the stecklings from the diseased field grew beyond merely starting and only 45 percent of those growing formed seedstalks, with an average production of 0.24 ounce of seed per plant.

Stecklings from the location not injured by curly top performed much better : 63 percent of the transplanted stecklings grew, 44 percent of the transplanted stecklings set seed producing from 0.09 ounce to 4.85 ounces per plant, with an average of 1,2 ounces.

Only 4 percent of the winter stecklings in 1939-40 were of curly-top-resistant stocks, usually heavy seed producers, and 96 percent were of non-curly-top-resistant stocks, ranging from extremely poor to fair seed producers.

At least one other commercial beet-sugar company's research department produced winter stecklings in this manner for 1940 use and reported favorable results.

Seed for the 1940-41 winter steckling crop was planted October 20, 1940, near Mesa, Arizona, in an area more removed from curly top occurrence. Only 8 percent of the 132 strains grown were curly-top-resistant stocks classified as heavy seed producers. The same method of planting the seed was used as the year before but stands were thicker and plants smaller at harvest. A total of 13,062 stecklings was harvested February 15 and stored at Sheridan, Wyoming. The average size of the stecklings was smaller than in previous years and early field losses greater (2). Thirty-eight percent of the transplanted stecklings produced seed at the average rate of 1.16 ounces per plant harvested.

While losses of plants after transplanting appear great, it should be remembered that these stecklings were placed in garden isolations under wide and varying conditions of culture and soil productivity and large losses should be expected. Under the best cultural and soil conditions, the early mortality losses were frequently less than 5 percent.

Seed production from all harvested stecklings during 3 years has averaged 1.10 ounces per plant, while full-grown roots stored in the root cellar have averaged well over 2 ounces per plant.

Conclusions

Observations and study indicate that better seed production from stecklings may result from planting the seed earlier in the fall and harvesting the stecklings during January, as there is danger of new growth actively starting in the plants in the field in the Phoenix area after the first of February, especially in the warmer winters. Stecklings harvested after new growth has started tend to produce vegetative plants rather than desirable seedstalks. This nullifies their value for seed production.

Based on the above experiences, seed for the 1941-42 crop of winter stecklings consisting of 196 selected strains, mostly non-resistant to the curly-top disease, was planted September 27, 1941, in hills 3 inches apart in 20-inch rows and the stecklings are to be harvested in mid-January 1942. A larger steckling should, result, from which more seed can be expected and the January harvest should make it possible to place the beets in storage before any normal spring growth has started.

The production of winter stecklings from the current year's seed crop makes it possible to save a full year's time with such breeding stocks in the northern latitudes of the United States. The process is comparatively simple and inexpensive as compared to greenhouse production of the same number of roots. A production of 1 ounce or more seed per plant harvested can be expected on the average. All winter stecklings should be grown in an area free from curly-top disease as this disease increases materially the losses of stecklings after transplanting and reduces seed production of bolting plants. Present observations indicate that September planting of the seed with January harvesting of the stecklings is the best practice. Improved techniques should result in the further use of this method since it is very desirable for our breeding program.

Literature Cited

1. Gaskill, John O., and Brewbaker, H. E. Storage of Sugar Beets Under Conditions of High Humidity and Low Temperature. Jour. Amer. Soc. of Agron. 31: 109-115. 1939.
2. Nuckols, S. B. Transplanting Sugar Beets in Utah and Idaho. U. S. D. A. Cir. 156. 1931.
3. Owen, F. V., Carsner, Eubanks, and Stout, Myron. Photothermal Induction of Flowering in Sugar Plants. Jour. Agr. Res. 61: 101-124. 1940.
4. Tracy, W. W., Jr. Sugar-beet Seed Growing in the Rocky Mountain States. IT. S. D. A. Farmers Bulletin 1152. 1920.
5. Weather Reports, United States Department of Commerce.