Heritable Differences in Germination of Sugar-Beet Seed at Low Temperatures

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In early spring plantings of sugar beets combinations of several factors are often encountered which hamper seedling emergence. One of the most common of these disturbing factors is low temperature. If soil temperatures are low, seedling emergence is slowed down very noticeably and general plant vigor is often affected, making workable stands difficult to obtain. Differences in seedling emergence between different varieties have been frequently observed in the field.

Varieties

A large number of sugar beet varieties were tested in the laboratory at both low and high temperatures. The results of only four of these are reported in this paper for illustrative purposes. SL 92 and SL 824 were selected to represent commercial self-sterile varieties, while the inbreds 867-1 and 9046A represent self-fertile curly-top-resistant inbred lines. All four of these varieties germinated more than 85 percent at 75° F. (See Figure 1) and all showed good seedling vigor at this temperature.

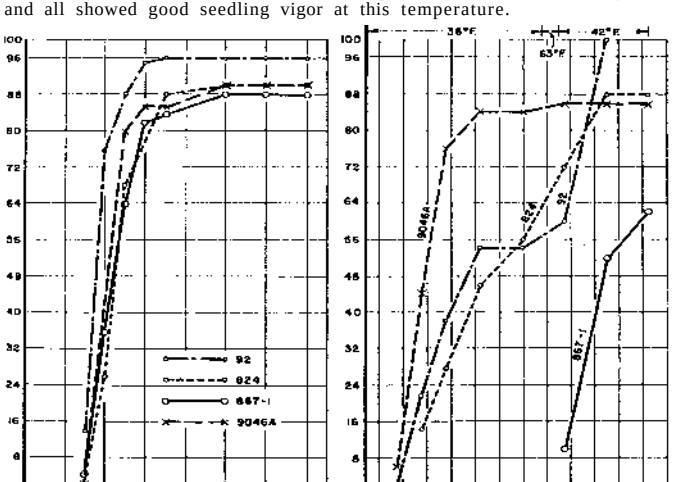

Figure 1.—Two curly-top-resistant varieties, SL 92 and SL 824, compared with two inbreds, 867-1 and 9046A. Left, germination rates at 75° F; right, germination rates at 36° F. for 44 days, 63° F. for two days followed by 42° F. for 15 days.

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[2] Numbers in parentheses refer to literature cited.

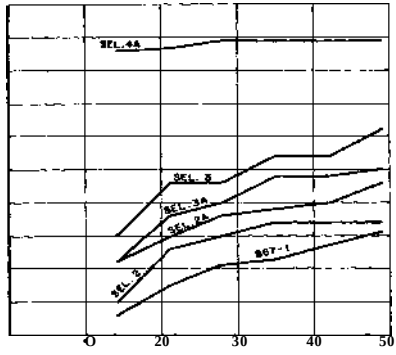

Figure 2. — Slow-germinating inbred 867-1 germinated at 43° F. and compared with reselections. Reselections 2 and 3 were reproduced by self-pollination whereas 2A, 3A and 4A were reproduced under open pollination. Reselection 4A differed greatly in vigor as well as in germination rate and is regarded as a probable outcross.

SL 92 is a curly-top selection from the widely grown commercial variety U. S. 22/3. It is a vigorous variety and germinates relatively fast even at low temperatures. SL 824, also known as U. S. 35/2, is a high-sugar variety selected from Tj. S. 22/3.

The inbreds 867-1 and 9046A were selected because they represent extreme differences. The germination of the inbred 9046A was remarkably fast at low temperatures as compared with other varieties, whereas 867-1 was extremely slow. Both of these inbreds were homozygous *rr* for white hypocotyl color (1)[2]. The inbred 867-1 is a highly non-bolting line, whereas 9046A is a moderately fast bolter.

Methods

Two temperatures, 75° F. for the high level and 36° F. for the low level, were used for most of the work although tests were conducted with other intermediate temperatures with the same varieties. In the low-temperature comparison illustrated in Figure 1, a temperature of 36° F. was maintained for 44 days, which then rose to 63° F. for two days and was then lowered to 42° F. for the remaining 15 days. The change in temperature during the test was not intentional as the refrigerating unit failed and the temperature of 63° F. was reached before the containers could be removed to a root storage cellar where the temperature was maintained at 42° F.

Blotters were used in the germination tests at high temperatures. At low temperatures a two-inch layer of soil was placed in containers and moistened to a desirable moisture content. The seeds were pressed into the soil surface and covered over with a one-inch layer of sphagnum moss to maintain moisture. In other tests at low temperature, 9-inch square metal pans li/2 inches deep were filled to a depth of one inch with coarse quartz sand and vermiculite (50:50 mixture by volume) and moistened to a desirable moisture content. The seed was dropped into shallow depressions in the sand surface. Metal covers were placed on each pan to prevent the

escape of moisture and to afford a suitable means of stacking. In the high-temperature tests at 75° F. daily counts were made while weekly counts were made in the low-temperature tests.

Experimental Results

At 75° *t.* the differences among the four varieties were rather small, but under the low temperatures the spreads between the varieties became very striking (Figure 1). The inbred 9046A gave outstanding results by its rapid germination at low temperature, whereas the inbred 867-1 was extremely slow at low temperature (Figure 1). The inbred 867-1 in other tests failed to show any germination at 36° F. for 50 to 60 days. The differences in vigor of seedlings between the two inbreds was also very striking *in* the low-temperature test. The inbred 9046A had exceptionally good vigor, whereas 867-1 had extremely poor vigor. SL 824 was nearly equal to SL 92 in germination rate at both low and high temperatures, but the seedling vigor at low temperature was much inferior to that of SL 92.

Selection for Increased Germination Rate

From the low-temperature test shown in Figure 1, the earliest seedlings to appear from the two self-fertile inbred lines were saved for seed production. Stecklings were transplanted to the field in early spring. Paper bags were placed over the inflorescences to obtain self-pollinated seed. However, both bagged and open-pollinated seed was saved separately and tested. Previous experience showed that these self-feitile inbreds are largely self-pollinated even under open pollination. Some individual plants showed an increase in germination rate over the parent in low-temperature tests.

Selection number 4A from the inbred 867-1 (Figure 2) produced seed with rapid germinating qualities far out of range as compared with the other reselections and the parental line. A high number of plants (66 percent) with the red hypocotyl color in this reselection indicated that it probably arose as an outcross in the previous generation. All other re-

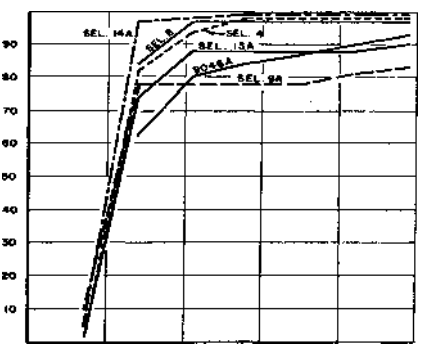

Figure 3. — Fast-germinating inbred 9046A germinated at 43° F. and compared with reselections 4 and 8 were reproduced under self-pollination whereas 9A, 13A and 14A were reproduced under open pollination.

selections from 867-1 were homozygous *rr* like the parental inbred. The general vigor of the seedlings of reselection 4A was also far superior to other selections. A similar outcross appeared in the inbred 9046A shown in Figure 3, selection 8, but here vigor of the reselection did not exceed that of the parent.

Discussion

Both rate of germination and vigor of seedlings were affected under low temperature. These characteristics seem to be heritable in certain varieties as they appear both in parental lines and reselections. Worthwhile attempts could be made for improvement of varieties by reselection work. Various methods of germinating the seed at low temperatures could be employed and seedling diseases could be considered at the same time. The "rag doll" method of wrapping up a bulk of seed, as employed by Ivanoff (2) in testing the resistance of oats to Victoria blight, is reasonably simple yet convenient for large quantities of seed.

It is believed that low-temperature tests could be run on all varieties of beets to gain a knowledge of their reactions under early spring field conditions. Through such knowledge one may better anticipate the percentage of emergence under prevailing conditions. Dr. L. Rasmusson described to the writer a procedure used in Sweden and William Gahan described a somewhat similar procedure used in Ireland. The Swedish method involves the use of a two-inch layer of crushed brick or the equivalent as a covering of the seed to simulate field conditions.

Other important factors which help determine good seedling emergence are moisture content, oxygen in the soil atmosphere, soil salts, seedling diseases, texture of the seedbed, etc. Undoubtedly all these factors play important roles in seedling emergence and differential response may be expected from different varieties. Laboratory tests may tell whether a variety is affected by one of these factors and whether improvement can be expected through reselection work.

Literature Cited

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