Monogerm Sugar Beets in the United States

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Monogerm sugar-beet varieties have not been developed in either Europe or America. Failure to develop such varieties is due to difficulties in detecting monogerm plants. Monogerm mutations are correlated with late-bolting ability and are ordinarily eliminated by natural selection. It is necessary to examine an enormous number of plants in different varieties to find monogerm races.

In 1948 an expedition to search for monogerm sugar beets was organized by the U. S. Department of Agriculture and the Curly Top Resistance Breeding committee with the assistance of the West Coast Beet Seed Company. In accordance with Dr. F. V. Owen's advice the plan involved two trips. I made the first trip in June to California and Oregon with Dr. Eubanks Carsner, Dr. J. S. McFarlane, Dr. R. A. Pendleton, Dr. H. Savitsky and Mr. Sam C. Campbell to choose seed-beet plantings with a wide choice of varieties and with the best opportunity for selection work. I made a second trip in July to Oregon for an intensive search for monogerm beets in selected fields just prior to the harvest period. I succeeded in finding five monogerm sugar-beet plants in the variety Michigan Hybrid-18 in a four-acre field with approximately 300,000 plants. This variety was the only variety in which I found true monogerm seed beets. I made a similar intensive search in Utah with Messrs. Myron Stout, C. H. Smith, Vernal Jensen and Dr. H. Savitsky in curly-top-resistant varieties, but it was unsuccessful. Plants having bilocular seed balls for the most part were found in all these varieties.

All five of the monogerm plants were late in floral development. More than half of their fruits were not ripe at the time of harvest. The selected plants were observed to be self-fertile during two generations. Approximately 75 percent of their progeny arose from selfing under open pollination. The selfed progenies consisted of very uniform monogerm plants which manifested considerable variation in time of bolting and flowering. F_1 hybrids between mono- and multigerm sugar beets were significantly more early bolting than the homozygous monogerm plants and produced variable F_2 progenies. F_1 progenies after selfing showed much greater variation in all characters than the progenies of selfed monogerm lines. Two of the five selections (races S.L.C. Monogerm 101 and 107) were very similar and it is evident that they originated from lines which had selfed for several generations. The other three selected races differed *in* characters of fruits, rosettes and seed beets.

The True Monogerm Sugar Beets

Only two of the five races, S.L.C. Monogerm 101 and 107, could be considered as true monogerm plants.

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1. The monogerm character appeared constant and not variable under different conditions, whether the plants grew at different times, in the greenhouse, or in the field.
2. The fruits were non-shattering, round and very uniform (Figure 1, upper picture) .
3. Races 101 and 107 have a similar new type of branching new to the genus *Beta:* either a lateral branch or a single fruit can be borne in the axil of a leaf, but never both together. The monogerm plants can be recognized by this character in the early state of seed-stalk development.
4. The monogerm character and this peculiar type of branching are recessive.
5. Monogerm beets give ordinary sugar-beet-type seedlings.
6. Monogerm plants showed a strong non-bolting tendency.

Correlation Between Type of Fruits and Type of Branching and Leaf Development

The seed ball represents an inflorescence which later becomes a fruit. The type of inflorescence or fruit is caused by the type of branching which is apparently connected with the mode of leaf development. Therefore, selection of the new type of fruits led to the isolation of some new sugar-beet races with a new type of leaf development and branching.

I found some differences in seedlings in different *Beta* species. I observed in Salt Lake City during 1948 and 1949 that in the wild monogerm species *Beta loniatogona* the first true leaf developed 5-15 days earlier than the second (Figure 1, lower left) . Branching in *B. lomatogona* differs from branching in the above-mentioned monogerm sugar-beet races because on the seed-stalk of *B. lomatogona,* besides a lateral branch, usually two monogerm fruits are borne in the axil of a leaf.

Development of one of the selected monogerm plants, N 100, resembles this *lomatogona-type* development. During two generations this line produced seedlings in which the first leaf appeared 3-10 days earlier than the second (Figure 1, lower right) . The type of branching in plant N 100 is similar to that in *B. lomatogona:* in the axil of a leaf the branch and one or two fruits are usually borne. Race N 100 has not been studied sufficiently, but it evidently bears, besides monogerm fruits, also some double-germ fruits.

I observed the same variation of mono- and double-germ fruits in another selection, race N 27. The progeny of this plant showed a new inherited type of leaf development: the appearance of seedlings with three cotyledons.

Conclusions

Genetic study of different monogerm races is being conducted at present in Salt Lake City.

Knowledge of monogerm inheritance will clear up the causes which bring about modifications of type of fruits and will explain also why all these modifications arose in one variety.

Study of genetics will explain the cause of correlation between monogerm fruits and some other accompanying characters such as late-bolting tendency, new types of branching (races 101, 107) and leaf development (races 27 and 100).

Figure 1. The upper portion of this illustration shows the branches of monogerm race S.L. 101 with matured fruits.

The lower lefthand illustration in Figure 1 shows the first true leaf of the wild monogerm species *Beta Lomatogona* which developed five to fifteen days earlier than the second.

The lower right hand portion of the illustration pictures the development of one of the selected monogerm plants which resembles this *lomatogona* type of development. During two generations this line produced seedlings in which the first leaf appeared three to ten days earlier than the second.

Establishing the mode of inheritance of the monogerm character and recovering linked genes will facilitate the breeding of monogerm varieties. This is especially important in connection with the use of the backcross method.

The backcross method must be used on a large scale in breeding work with the monogerm character. Monogerm sugar beet varieties are needed by the whole country. Most of the valuable varieties in the U. S. A. are planted in their respective areas because of resistance to different diseases or because of other valuable biological properties. The monogerm character should be incorporated into all of these varieties in the near future. The easiest way to attain this objective is by the use of the backcross method.

Many problems arise in connection with self-fertility of monogerm beets. All sugar beet varieties tend to be self-sterile. Therefore, it is necessary to obtain self-sterile monogerm races and biologically different self-sterile populations. It is very interesting to obtain male-sterile monogerm beets and make use of F_1 hybrid vigor applying Dr. Owen's method. But in this case it is necessary to have heritably different monogerm pollinators.

A comprehensive breeding program has been initiated with progenies of races 101 and 107 at Salt Lake City and at Salinas, California. These monogerm beets have been crossed extensively with various curly-top-resistant varieties, including slow-bolting types of special interest for winter plantings in California. Late-bolting monogerm progenies were used also for the purpose of maintaining the extreme non-bolting tendency. Unless unexpected difficulties arise, this cooperative breeding program should result in a sufficient amount of elite monogerm seed for the initiation of commercial monogerm sugar-beet plantings in 1952-1958.

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