Preliminary Yield Tests with F_2 Male-Sterile Monogerm Hybrid Sugar Beets

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Introduction

One advantage of the monogerm character in beets is the clear-cut single-gene type of inheritance (4") . Another advantage, at least for the immediate future, is the behavior of this character in Fj male-sterile hybrids. The monogerm, or multigerm, character is associated with reproduction and cannot be expressed in the vegetative beet. Therefore, the pollinators of monogerm F_1 hybrids need not be monogerm and this fact alone gives the breeder a great deal of flexibility. The pollinator of the F_1 hybrids may be any available multigerm variety or any beet, in fact, which possesses high combining ability, the required disease resistance, etc.

One objective of producing an F_1 monogerm hybrid was to supply the sugar beet industry with monogerm hybrid seed for mechanization studies. This work will be reported by other investigators. The present paper deals with yielding ability, curly top disease resistance and sugar content. Three F_1 monogerm male-sterile hybrids are reported which were developed very rapidly from the first available monogerm stocks.

Material and Methods

hi the spring of 1949 three well established type 0 (3) curly-top-resistant multigerm clones were hybridized with pollen supplied by Dr. V. F. Savitsky from his first monogerm beet S1_C 101 (4) . The term type O refers to the ability of a pollinator to produce F_1 populations, all individuals of which are completely emasculated in hybrids to cytoplasmic male steriles. It was soon learned that SLC 101 was not perfect with respect to type 0 but it approached the desired genetic constitution. In hybrids to male steriles SLC 101 usually produced some F_1 offspring which were classed as semi-male sterile, but without viable pollen.

The F_3 *Mm* hybrids between type 0 multigerm beets and the SLC 101 monogerm beet were grown for seed and F_2 populations were produced in 1950. In the same seed isolation F_1 *Mm* male sterile hybrids (MS x SLC 101) were also included. The isolation therefore produced two F_2 populations, one with normal cytoplasm and one with the S cytoplasm responsible for cytoplasmic male sterility (2). From each of these F_2 populations 3:1 segregation was observed for multigerm versus monogerm beets. In 1951 the multigerm segregates from these populations were eliminated by roguing in the bud stage and the process was repeated with some refinements in 1952. In separate isolations in 1951 and 1952 monogerm male sterile beets were also crossed to other multigerm pollinators for production of vigorous F_1 hybrids. The following descriptions apply to the hybrids discussed in this report.

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[2] Numbers in parentheses refer to literature cited.

Hybrid 120H15 was made by crossing monogerm male sterile beets obtained from the first backcross to SLC 101 with SL 120 as the pollinator. SL 120 was selected for very high curly top resistance from the commercial variety U. S. 22/3. This brought about some reduction in sugar percentage. The F_1 hybrid 120H15 was therefore expected to be good in curly top resistance but perhaps not too good in sugar content.

Hybrid 202H15 was made in 1952 by crossing the monogerm male sterile segregates produced in 1951 to the multigerm strain SJL 202 as the pollinator. SL 202 is high in curly top resistance and is higher in sugar percentage than SL 120, an improvement brought about by utilizing the high sugar variety U. S. 35/2 in its development.

Hybrid 211 HI5 was also made in 1952 by utilizing the same monogerm male sterile with SL 211 as the pollinator. SL 211 was the direct offspring of two of the type 0 multigerm clones with which SLC 101 was hybridized in 1949. Therefore, the production of hybrid 211H15 represents rather close breeding and some reduction in vigor was expected.

The male sterile monogerm hybrids were compared with the well known curly-top-resistant variety U. S. 22/3 (seed lot SL *96)* and also with the multigerm hybrid SL 944H1. This later hybrid was made by utilizing a male sterile equivalent of the curly-top-resistant inb;ed GT9 with SL 944

Table 1.—Results from Variety Tests in IS'32 and 1953 Comparing Monogerm Male-
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Variety	Monogerm or multigerm	Gross sugar per acre: Percent of U. S. 22/3	Gross sugar per acre: Pounds	Tons beets per acre	Percent sucrose
Shelley and Twin Falls, Idaho, 1952, 6[1] replicated plots each variety					
20H15	Monogerm	100	8,916	26.6	16.76
U. S. 22/3	Multigerm	100	8,915	26.5	16.82
44HI	do.	108	9,604	28.0	17.15
Taylorsville, Utah, 1952, 6 replicated plots each variety					
20H15	Monogerm	100	12,022	41.8	14.38
U. S. 22/3	Multigerm	100	11,984	43.2	13.87
44111	do.	108	12,920	45.3	14.26
Twin Falls, Idaho, 1953, 5 replicated plots each variety					
02H15	Monogerm	106	11,290	33.6	16.80
11H15	do.	97	10,299	31.4	16.40
U. S. 22/3	Multigerm	100	10,630	31.6	16.82
44HI	do.	108	11,517	34.9	16.50
Taylorsville, Utah, 1953, 5 replicated plots each variety					
02H15	Monogerm	110	11,880	39.6	15.00
11H15	do.	107	11,471	37.1	15.46
U. S. 22/3	Multigerm	100	10,760	29.5	18.62
44HI	do.	115	12,364	42.4	14.58
Granger, Utah, 1953, 5 replicated plots each variety					
02H15	Monogerm	106	11,427	33.6	17.02
11H15	do.	93	10,102	29.4	17.18
U. S. 22/3	Multigerm	100	10,824	32.8	16.50
44HI	do.	108	11,689	35.9	16.28

[1] In 1952 results from 3 replications grown by the Utah-Idaho Sugar Company at Shelley, daho, were combined with results from 3 replications grown at Twin Falls, Idaho.

as the pollen parent. SL 944 was a curly-top-resistant strain not greatly different from U. S. 22/3. The hybrid SL 944H1 usually performs better than U. S. 22/3. These two standards, U. S. 22/3 and SL 944H1, should illustrate the comparative yielding ability of the new male sterile monogerm hybrids.

Yield Comparisons

Results tabulated in Table 1 show practically the same yielding ability for the monogerm hybrid 120H15 and the commercial variety U. S. 22/3 in the 1952 tests. In 1953 the monogerm hybrid 202H15 showed an increase of 6 to 10 percent in gross sugar per acre as compared with U. S. 22/3. As expected the monogerm hybrid 211H15 was inferior in yielding ability but perhaps not as much so as might have been expected due to the close breeding used in its development. These results indicate that monogerm male sterile hybrids, equal in yielding ability to the commercial variety U. S. 22/3, may be readily produced from breeding stock now available. Further breeding work may be required to produce monogerm male sterile hybrids equal to the better multigerm curly-top-resistant hybrids which are now being propagated.

Curly **Top Evaluations**

Previous work (1) has shown that F. hybrids between culy-top-resist-ant and curly top-susceptible stocks are intermediate in degree of curly top resistance. However, when one parent is high in resistance and when the disease is only moderate in degree, the degree of resistance in the hybrid is fully dominant or nearly so. In variety tests reported in Table 1 curly top was encountered at all locations in 1952 but the F_x monogerm hybrid 120H15 showed no curly top injury. Again in 1953 there was considerable curly top *in* the susceptible Klein E variety in the test at Twin Falls, Idaho, but nothing more than a trace of the disease was evident in the monogerm hybrids 202H15 and 211H15.

Under an artificial curly top exposure conducted at Jerome, Idaho, in 1952 the monogerm hybrid 120H15 showed good curly top resistance, but not quite equal to that of U. S. 22/3. In 1953 the curly top exposure at Jerome, Idaho, was much more severe than in 1952 and even the highly resistant commercial variety U. S. 22/3 was severely injured in midsummer plantings. Here in a July 15 planting varieties were graded on an arbitrary basis from 0 to 10 depending upon the degree of resistance. U. S. 22/3 was able to continue growth but was definitely injured; it received grade 7. The monogerm hybrid 202H15 received grade 8. U. S. 33, an old curly-top-resistant variety and widely grown at one time, received grade 10. The best breeding stocks available received grades 4 and 5.

These observations showed that, although the monogerm hybrid 202H15 was slightly lower in curly top resistance than U. S. 22/3, nevertheless it was definitely better than U. S. 33. From this evidence it would seem safe to grow curly-top-resistant monogerm hybrids of this type commercially except where severe disease exposure is expected.

Summary

Multigerm beets emasculated genetically by cytoplasmic male sterility were hybridized with Dr. V. F. Savitsky's original monogerm line SLC 101 in 1949. Subsequent backcrosses to new monogerm pollinators, selected from SLC hybrids, produced relatively good male sterile populations in 1951 and 1952. These monogerm MS populations were hybridized with multigerm beets to produce vigorous F_1 hybrids. One of these F_1 hybrids was evaluated agronomically for yield and sugar content in 1952 and two hybrids were evaluated in 1953. Two of these monogerm hybrids were equal or superior in yield to the commercial variety U. S. 22/3, but produced less in gross sugar per acre than the multigerm M. S. hybrid SL 944H1, made with the curly-top-resistant inbred CT9.

The results indicate that monogerm male sterile hybrids equal in yielding ability to present commercial curly-top-resistant varieties may be readily produced from breeding stocks now available. Further breeding work will be required to produce monogerm MS hybrids equal to the better multigerm curly-top-resistant hybrids which are now being propagated.

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