Observations on F_2 and F_3 Generations of the Sugar Beet Hybrid, Leaf Spot Resistant Multigerm X Monogerm SLC 101

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F_1 seedlings *(Mm)* were received from Dr. V. F. Savitsky (1)[2] who had introduced the monogerm *(mm)* race of sugar beets in 1948. Roots of the leaf spot-resistant varieties U.S. 216 and N-71, occurring as the mother parent in the matings, were supplied to him from selections made under severe disease exposure at the Plant Industry Station, Beltsville, Maryland.

Observations on F_2 Generation

The *Mm* plants in the heterogeneous progenies obtained from the matings indicated above were identified by a genetic marker, *R.* In August, 1950, seeds from 64 F_1 plants were planted separately in a plot at the Plant Industry Station and the F_0 progenies were overwintered in the field. The following spring, as the stalks began to elongate, the F_2 plants were examined and those with flower buds in clusters were removed from the field before they had shed pollen. At first, some difficulty was experienced in establishing the limits of the parental phenotypes in the segregating populations since a few F_2 plants appeared to be intermediate with respect to the number of flowers in an axis. Twin flowers and double fruits had been observed, though rarely on plants of SLC 101, therefore it was thought that the occurrence of an occasional axis with twin flowers on an F_2 plant otherwise single was fortuitous or within the limits of expression of the *mm* genotype. However, if a single cluster of three flowers was found on an F_2 plant, it was classed as multigerm (M-) and removed from the plot. Also helpful in classifying the plants was the observation of Savitsky (1) that in monogerm sugar beets a branch and a flower do not arise in the same axis. After the final inspection, there remained in the plot 783 monogerm segregants for study.

The F_2 monogerm plants were strikingly unlike in vigor, leaf shape and type of fruiting branch. The tendency which had been observed in SLC 101 for fruiting branches to become fasciated, covered with small bracts, and more or less devoid of flowers, was frequently encountered in the F_2 progenies. The dark green, gauffered leaf characteristic of the unthrifty SLC 101 was found also in the monogerm segregants of all sizes, but not to the exclusion of the broad, rather smooth leaf type of the leaf spot-resistant parental lines. A vigorous, robust F_2 monogerm plant with an attractive foliage is shown in Figure 1.

The fruiting branches of the monogerm plants were enclosed in paper bags before anthesis and the seed set indicated unusual self-fertility. It has been pointed out by Savitsky (1) that the monogerm race of sugar beets is distinctly self-fertile, and this tendency has been transmitted strongly to the F, plants.

The monogerm segregants produced some striking variations from the normal. One plant was observed with peduncles 3-4 millimeters in length

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[2] Numbers in parentheses refer to literature cited.

Figure 1. A vigorous F_2 monogerm sugar beet.

and the fruits were suspended from the stems in a striking manner. In contrast to this plant, from which the "seed" would shatter with the least shaking, there were many plants with the fruits so closely grown to the stem they were not removed by ordinary threshing operations. Obviously both the easy shattering and the non-threshing types are objectionable. The majority of the F_2 monogerm plants produced fructifications in the ordinary manner, as shown in Figure 2.

There were conspicuous differences in seed size among the 783 monogerm segregants. A larger fruit than that produced by SLC 101 is greatly desired as an aid in precision drilling, which must be obtained if the full benefit of monogerm seed is to be realized. Also, a larger germ, giving rise to a more robust seedling, would be helpful. Therefore, seed size as indicated by size of fruit was considered an important selection character in the F_2 progenies and plants producing large fruits were given a high rating.

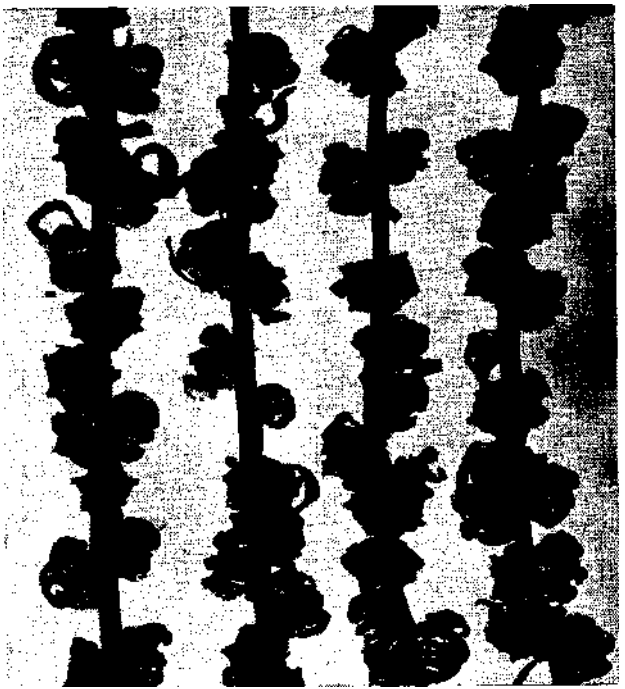

Figure 2. Fruiting branches of F_2 monogerm sugar beet showing excellent seed set.

The contrast in fruit size and size of true seed between the monogerm parent, SLC 101, and a monogerm F_2 plant (51101-460) is shown in Figure 3.

Plants were classified as to seed size by means of a set of screens with holes 6/64- to 12/64-inch in diameter. The seeds of a plant were passed through the set of screens and the portion retained on each was weighed separately. The screen size which would have retained at least 75 percent of the total was taken as the seed size of the plant. The seed size of all monogerm plants occurring in six rows, taken at random, was determined in this manner. The distribution of 200 plants in the various seed size categories is shown in Figure 4.

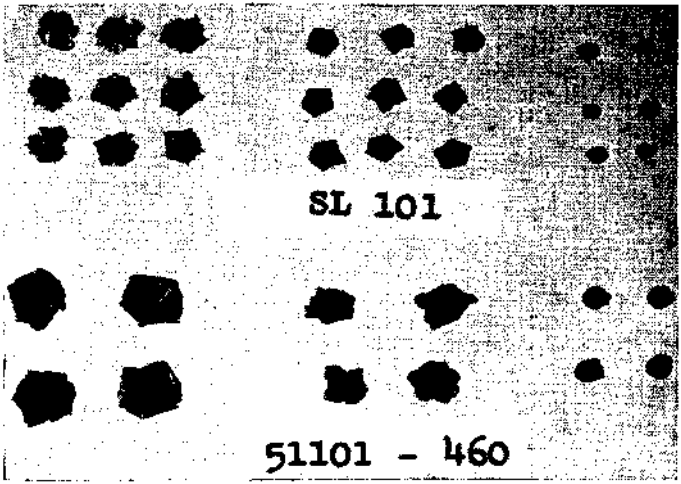

Figure 3. Comparison of fruit and seed size of SL 101, **the monogerm parent, and a large-seeded F_2 plant, No. 460. The natural fruits are shown on the left. In the center, the corky material has been removed by sulphuric acid treatment. On the right, representative seed sizes are shown.**

In a similar manner, the seed size of a few plants of the parental varieties grown elsewhere was determined and these have been shown in comparison with the F_2 monogerm plants. Plants of the monogerm parent SLC 101 occurred in the 7/64 and 8/64 categories, and plants of the multigerm parent U. S. 216 produced seed graded as 11/64 and 12/64. In the sample of 200 F_2 monogerm plants, 24 (12 percent) were graded as 7/64; 89 (44.5 percent)" as 8/64; 70 (35 percent) as 9/64; 16 (8 percent) as 10/64, and 1 (0.5 percent) as 11/64. There was a tendency for the seed size of the F_2 plants to approach that of the monogerm parent. Only one F_2 plant, seed lot 51101-460 (Figure 3), occurred in the same size category as the multigerm parent U. S. 216. However, 8 percent of the F_2 monogerm plants occurred in the 10/64 category which is comparable in size to small-seeded commercial varieties.

Observation on F_3 Generation

Seeds of the outstanding F_2 segregants were planted in field plots to observe the F_3 progenies as to disease resistance and vigor. Although seeds from open-pollinations were planted, the progenies under observation were essentially the result of self-fertilization, as indicated by the fact that 38 percent of the *rr* F_2 plants gave no *Rr* seedlings,, **and** as a **group they gave**

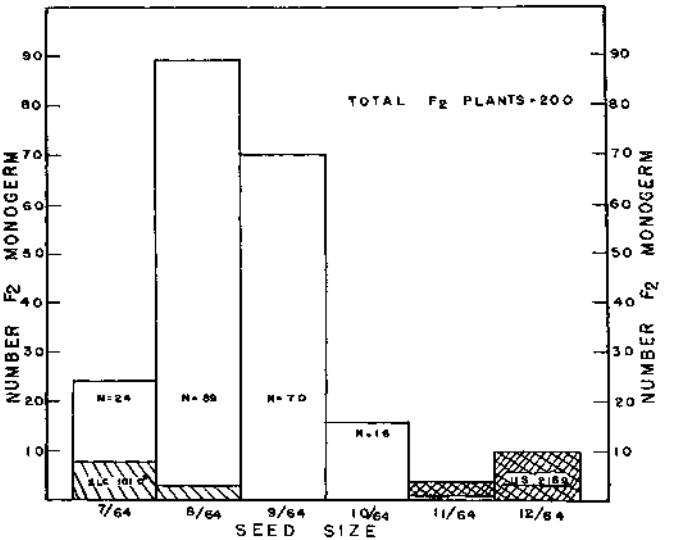

Figure 4. The distribution of F_2 monogerm segregants and the parental strains as to seed size. The seed size of a plant was taken as to the size screen which would retain 75 percent of the seed produced.

less than 2 percent. Since 50 percent of the pollen liberated in the plot should have carried the *R* gene, the absence of, or extremely low percentage of *Rr* seedlings, in the progenies of open-pollinated *rr* plants is remarkable for the sugar beet but it is in accord with the excellent set of selfed seed obtained in bags as previously mentioned.

The field plots were planted in early August and the mild autumn gave a growing season of sufficient length for the F_3 progenies to show marked difference in leaf spot reaction and vigor. The disease epidemic was not severe, but it was sufficiently intense to give a separation of the progenies of the selected F_2 plants into different categories as to disease reaction. The results are given in Table 1.

Seventy-two F_3 progenies of a total of 155 under test gave a leaf spot reading of 1, or they were placed in the same category as to disease reaction as the resistant parent, U. S. 216. If the disease exposure had been more intense and for a longer period, no doubt the 72 progenies reading 1 would have been separated further as to disease reaction. However, this

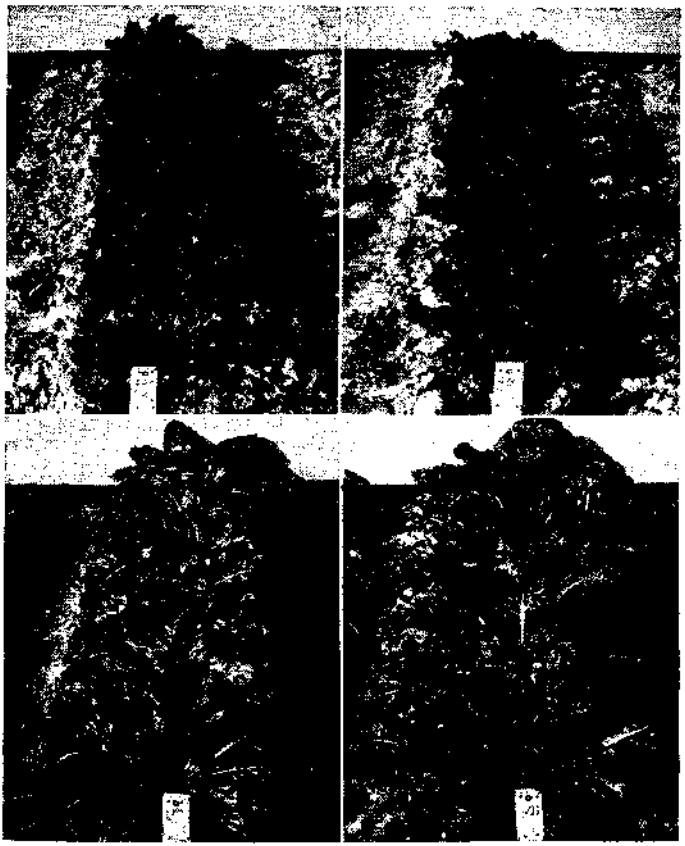

Figure 5. Upper left: SLC 101 showing gauffered leaves and unthrifty growth. Upper right: Monogerm F_3 line strikingly similar to the monogerm parent SLC 101. Lower left: Monogerm F_3 line extremely uniform for smooth open type of leaf. Lower right: Monogerm F_3 line outstanding in vigor and size of foliage bouquet.

preliminary field test served to locate the most leaf-spot-resistant lines obtained from the matings. The marked contrast in size of foliage bouquet and resistance observed in the monogerm F_3 lines is shown in Figure 5.

Although some of the F_3 lines are more leaf-spot-resistant, more vigorous and larger seeded than the monogerm parent SLC 101, it should be pointed out that they are below the level of productivity required of corn-

Table 1.—The Relative Leaf Spot Resistance of F_3 Monogerm Lines and the Parental Strains, SLC 101 and U. S. 216.

Source	Leaf Spot Reading[1]					Total
	1	2	3	4	5	
F_2 monogerm plants	72	47	22	7	6	155
SLC 101 monogerm parent	....	...	..	6	4	10
U. S. 216 multigerm parent	7	....	....	....	—.	7

[1] Scale of reading: 1 = no leaf blight
5 = severe blight on older leaves
2, 3, 4 — intermediate grades

mercial varieties. There remains the problem of hybridization to bring about through the vigor of hybridity acceptable acre yields of roots and sugar. Working with economic lines strongly self-fertile presents a new experience in sugar beet breeding, but there should be no difficulty in attaining the desired goal with the introduction of cytoplasmic male sterility as a means of producing hybrid seed.

Summary

Monogerm plants were recovered in the F_2 generation of the sugar beet hybrid, leaf-spot-resistant multigerm x monogerm SLC 101. Seed size in inches was determined for 200 monogerm F_2 plants. Twelve percent were graded as 7/64, 44.5 percent as 8/64, 35 percent as 9/64, 8 percent as 10/64, and .5 percent as 11/64. The 7/64 and 8/64 inch categories were the same as the monogerm parent SLC 101. One F_2 monogerm plant produced seeds 11/64, or as large as some plants of the multigerm parent, U. S. 216. Monogerm F_3 lines as leaf-spot-resistant as U. S. 216 and far more vigorous than SLC 101 were obtained from selected F_2 plants.

Literature Cited

(1) SAVITSKY, V. F.
1950. Monogerm sugar beets in the United States. Proceedings Amer. Soc. Sugar Beet Tech. 156-159.