Inheritance of the Number of Flowers in Flower Clusters of Beta Vulgaris L.

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The monogerm character, which is now being utilized in breeding work with sugar, fodder and table beets in America and in western Europe, originated from the line SLC 101 mm (4)[2]. A single basic recessive gene ***m*** is responsible for this character. Some other genes may modify the expression of the gene *m,* causing the appearance of a few "double-germ" fruits on monogerm plants (5) .

The present paper is devoted to a study of inheritance of the number of flowers in a flower cluster of *Beta vulgaris* L. and is limited to an analysis of genetical phenomena brought about by action of the basic genes. The term monogerm refers to one flower and only one germ for each fruit, whereas the term multigerm refers to two or more flowers or possible germs for each compound fruit or flower cluster (usually referred to here as the "cluster") . This flower cluster in multigerm beets on maturity becomes the seed ball (2) .

Materials

Due to the self-fertility of SLC 101 *mm,* all Fj hybrids with this line were found to be self-fertile. The self-fertility was retained in subsequent generations because all F_t, F_0, etc., hybrids were obtained through selfing (1 and 3) .

The hybrids studied originated from crosses of the monogerm beet SLC 101 *mm* with different multigerm races of sugar, fodder and table beets.

Methods

F, hybrids were obtained by exchanging pollinating bags. Some of the hybrids were obtained after emasculation and controlled pollination.

All F_T hybrids originated from crosses between two separate plants. The F_2 or F_3 hybrids originated from selfing single F_1 or F._> plants. For analyzing a large number of individuals from the same cross, several hybrid families were planted separately.

To count the number of flowers in a cluster, seeds from each F_1, F_2, or F, plant were harvested separately. In determining the number of seeds in a seed ball, a test sample consisting of 100 seed balls was used.

Data for only a part of the hybrids studied are presented in this paper.

Phenotypic Variation in the Number of Flowers in a Flower Cluster of a Homozygous Multigerm *(MM)* and a Heterozygous Multigerm *(Mm)* Beet

Monogerm beets grown under different environments remain monogerm, but the size of fruit varies. The size of fruits in multigerm beets also varies under different conditions. In multigerm beets, the change consists in **a** variation in the size of individual flowers in a seed ball as well as in their number. This complicates the genetic study of this character.

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[2] Numbers in parentheses refer to literature cited.

Table **1.—Variation** of Number of Flowers in the Flower Cluster in Fi Hybrids Between Monogerm and Different Multigerm Beets.

tion	Origin	Mono-__ germ beets	Number of multigerm plants and degree of multigerm condition — Degree of multigerm condition, number of flowers per 100 flower clusters as follows: 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350	N°- _multi- germ plants	Mean / S.D. / C.V. / S.E.M. — Analysis (excluding *mm* class) on flowers per 100 clusters
So	SLC 101 *mm*	1			
Population SL 92			5 2 5 3 11111	1 49	228.6 35.00 15.3 5.00
	Crosses of monogerm beets with multigerm populations				
	SL 92 x SLC 101 *mm*		11 8 9 11 16 5 3 1 2	57	192.6 19.23 10.0 2.55 24
	SLC 101 *mm* > SL824		12 15 2 4 3 3 111		197.1 25.60 13.0 2.65 18 188.3
	Egyptian x SLC 101 *mn*		11 2 3 4 4 111		22.29 11.8 5.26
	Crosses of monogerm beets with different multigerm lines				
	04 x SLC 101 *mm*		4 2 2 3 13 4	31	166.1 22.00 13.2 3.95
	9524-2-92 x SLC 101 *mm*		11 3 4 1	10	181.0 15.23 8.4 4.81
	9529-2 x SLC 101 *mm*		3 21 4 4 1	33	193.6 9.29 4.8 1.62
	MM Peragis x SLC 101 *mm*		1 5 5 14 13 3	23	213.5 23.47 10.9 4.89

There is a variation in the number of flowers in the flower cluster of individual multigerm plants. Even the flower cluster from the same inbred line or from the same clone contains a variable number of flowers.

Variation in the number of flowers in a cluster follows a peculiar pattern for each genotype. Races which have only a few flowers in a flower cluster usually produce only monogerm or double-germ fruits. Races with highly multiple fruits have 2, 3, 4 and 5 flowers per cluster. The number of monogerm fruits found among them was very small.

Similar variability in the number of flowers in a cluster can be observed *in* multigerm homozygous *(MM)* beets as well as in heterozygous beets *(Mm)* . In many instances the fruits of heterozygous plants *(Mm)* differ from the multigerm homozygous parent only by a larger percentage of monogerm fruits.

First Generation Hybrids

The most common biotypes of the multigerm beet SL 92 (a selection from the curly-top-resistant variety U. S. 22/3) are those with 200-250 flowers per 100 flower clusters. The average number of flowers per cluster *in* the individual biotypes from this variety varied from 190 to 350 per 100 flower clusters (Table 1) . Certain beet varieties have races wtih either a greater or a smaller number of flowers in a cluster.

The F, hybrids from crosses between multi- and monogerm beets have a smaller number of flowers in a cluster than those of the multigerm parent (Table 1) . Nevertheless, the number of flowers per cluster in the different Fj hybrid combinations fluctuated greatly (from 140 to 250 flowers per **100** flower clusters) .

A study of Fj hybrids obtained by crossing recessive monogerm beets with different multigerm plants belonging to the same variety can be regarded as an analysis ofthe gametes in this multigerm population. In this manner it is possible to show clearly the differences in genetic make up of individual populations. For example, all F_1 hybrids originating from crosses of monogerm beets with certain multigerm populations of the sugar or fodder beets were characterized by a greater variability in the number of flowers in a cluster than other F_1 hybrids to different multigerm genotypes (for example, a clone or individuals) . This proves that varieties of the sugar beet are made up of many genetically different races in regard to number of flowers per flower cluster.

First Back-Cross Generaton

In the b_T generation when a monogerm beet is backcrossed to an F_t *Mm* hybrid, 50 percent monogerm *mm* and 50 percent heterozygous multigerm *Mm* plants segregated out (5) .

Multigerm plants which originate from different backcrosses are found to be different in regard to number of flowers in a cluster (Table 2) .

The variability of the number of flowers in a cluster as it occurs in multigerm plants belonging to different backcross combinations also changes. Backcrosses which originate from crosses with populations have a wider range of variability than backcrosses produced from a cross between only two genotypes (Table 2) .

Table 2.—Variation of Number of Flowers in the Flower Cluster of Male-Sterile Backcross Hybrids.

Gener-ation	Origin	Monogerm beets	Number of multigerm plants and degree of multigerm condition: Degree of multigerm condition, number of flowers per 100 flower clusters as follows: 110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	No. multigerm plants	Analysis (excluding monogerm class) on flowers per 100 clusters: Mean	S.D.	C.V.	S.E.M.
	Crosses of monogerm beets with multigerm populations																						
F_1	*MM* x SLC 101 *mm*			3		5	5	6	13	34	47	30	13	11	3	6	4		180	190.6	30.79	16.15	2.29
b_1	(*MM* x SLC 101 *mm*) x 101 *mm*	43	2	3	1	5	5	3	2	6	7	5	1	2	1		1		44	170.9	33.25	19.46	5.02
	Crosses of different monogerm hybrid lines with heterozygote Mm																						
b_1	*Mm* (9333. SLC 101 *mm*) x N 769 mm	9							2	5	2								9	180.0	7.07	3.93	2.36
bi	*Mm* (9333. SLC 101 *mm)*								12	6									9	185.6	7.27	3.92	2.42
bi	*Mm* (9563. SLC 101 *mm)* x 9544-1-3 *mm*	8				1	1	1	3		3								9	175.6	16.67	9.49	5.56
	Crosses of heterozygous *Mm* beets with multigerm homozygous *MM*																						
bi	(MM x SLC 101 mm) *xMM*												5	7	8	7	2	2	31	230.0	14.14	6.15	2.54

Crosses **Between the Monogerm Beet and Races Which Have a Small Number** of **Flowers in a Cluster**

The inbred line SLC 100 has both mono- and double-germ seed balls. A plant with an average of 172 flowers per 100 flower clusters was taken for crosses representing this line.

Hybrids between the "few-germed" line SLC 100 and the monogerm beet SLC 101 are of interest because this type of segregation differs from that obtained from most of the hybrids between monogerm and multigerm beets.

Usually F_2 populations obtained from crosses between monogerm and multigerm beets are easily divided into two groups, one that includes only monogerm plants and another group in which all plants have multi-germ seed balls.

The F_2 hybrid from a cross between the "few-germed" line SLC 100 and the monogerm beet SLC 101 *mm* showed segregation for monogerm and double-germ fruits (Table 3) . Some of these F., plants were intermediate with 110, 120, 130, etc., flowers per 100 flower clusters. For this reason it is difficult in these particular populations to classify individuals for mono- or multigerm fruits.

The absence of distinct boundaries between separate genetical classes in F_2 hybrid plants is typical in the segregation of hybrids for quantitative characters. Quantitative characters are usually conditioned by the action of many genes. The F_2 frequency curves are often more or less regular and symmetrical and have but one principal mode.

The F_2 frequency curve for the hybrid from SLC 100 x SLC 101 mmis bimodal. One mode is formed by the monogerm types. The other mode is located on the opposite end of the curve and corresponds to the multieerm parent. Between them are located the different intermediate forms (Table 3) .

Three kinds of F_2 segregates were selfed and their progeny (F_2 lines) were studied in 1953. The progeny from F_2 monogerm plants produced, as always, monosrerm F_2 lines which did not segregate (Table 3) . The pro-genv from F_2 plants which had the greatest number of flowers in a flower cluster 172 flowers per 100 clusters) also did not segregate but consisted of plants which had predominantly double-germ fruits. The progeny from F,. plants which had an intermediate number of flowers in a cluster (134 flowers per 100 clusters) was found to be heterozygous and gave the same segregation as observed in the original F_2 population. In the offspring from this hybrid, F_2 or F_2 lines, there were no plants with three- or many-flowered clusters.

The monogerm SLC 101 *mm* was also crossed with another "few-flowered" race, G.W. 4821, received from Dr. H. E. Brewbaker of the Great Western Sugrar Company. The average number of flowers in this race is approximated 180-190 per 100 clusters. The F_2 hybrid from G.W. 4821 and SLC 101 *mm* had only mono- and double-germ fruits in varying proportions. Tn F_2 a segregation occurred for plants with monogerm (about

Table 3.—Variation in Number of Flowers per Flower Cluster in F2 and F3 Hybrids Between Monogerm and "Few-Flowered" Multigerm Beet Rraces.

Generation	Origin	Monogerm beets	Number of multigerm plants and degree of multigerm condition. Degree of multigerm condition, number of flowers per 100 flower clusters as follows: 110	120	130	140	150	160	170	180	190	200	210	220	No. multigerm plants	Analysis (excluding monogerm class) of flowers per 100 clusters: Mean	S.D.	C.V.	S.E.M.
																		Percent	
	Crosses, SLC 100 x 101 *mm*																		
P	SLC 100 "few-germed" multigerm								1						1[1]				
P	SLC 101, pure monogerm	1																	
F_1	SLC 100 x SLC 101 *mm*							1							1[1]				
F_2	SLC 100 x SLC 101 *mm*	8	3	4	1	2	3	4	7	4	2				30	153.3	25.37	16.54	4.63
F_3	N 241: monogerm progeny	21																	
F_3	N 242: from F_2 plant, 172 flowers per 100 clusters								2	4	17				23	186.5	6.47	3.47	1.35
F_3	N 243: from F_2 plant, 134 flowers per 100 clusters	12		1	1	2	2	3	9	5	5				28	167.0	18.98	11.37	3.96
	Crosses, G.W. 4821 x SLC 101 *mm*																		
P	G.W. 4821									1					1[1]				
F_2	G.W. 4821 x SLC 101 *mm*	17		1		8	3	9	2	6	10	3	2	3	47	173.0	25.27	14.61	3.67
	Crosses, G.W. 4821 x SLC 100																		
F_2	G.W. 4821 x SLC 100			1	1		2	2	2	7	7	1	1	1	25	177.2	12.64	7.13	2.53

[1] Frequency distributions not shown for parental lines or F_1 hybrid.

25 percent) and double-germ fruits (Table 3) . Plants with an intermediate number of flowers in a cluster were also observed. The latter had from 120 to 170 flowers per 100 clusters. The type of plants which had about 110 flowers per 100 clusters was absent in this hybrid. Therefore, the mono-germ-recessive plants in this F_2 hybrid did not overlap with plants which had "few-germed" clusters. However, in this hybrid the distinction between monogerm and "few-germed" types is still very slight. Plants with three-germed flower clusters in F_2 and F_3 were not observed in offspring from this hybrid.

Crosses of "Few-Germed" Races with Each Other

The "few-germed" inbred line SLC 100 was crossed with the "few-germed" race G.W. 4821. The F_1 hybrid had flower clusters consisting of a small number of flowers per flower cluster, about 170-180 per 100 clusters. In F_2 this hybrid segregated for "few-germed" forms (Table 3) , but mono-germ plants and plants with three-flowered clusters were absent.

Among the "few-germed" F_2 plants, the individuals with the smallest number of flowers per cluster produced about 72 percent monogerm fruits.

The same type of races, and even races with few flowers per cluster, were obtained by continuous selection for a number of generations within limits of the original inbred line SLC 100. Such "pseudo-monogerm" lines showed a very great variability with regard to number of flowers in a cluster. This phenomenon was observed not only on plants grown under different conditions (for example, in greenhousees during the winter and in the field during the summer) , but also on different branches of the same plant, if these branches had been formed at different seasons of the year. With the true monogerm *mm* beet such variability was never observed.

Crosses of the Monogerm Beet with the More Common Type of Multigerm Beet

Seed collected from a single plant in ordinary multigerm varieties has 2, 3, or 4 germs per seed ball. In these races the average number of flowers in a flower cluster varies from 200 to 250 per 100 clusters (Table 1) .

When this type of beet is crossed with SLC 101 *mm,* F_2 populations show a well-defined monohybrid type of segregation for the monogerm-recessive and the multigerm-dominant forms. These two classes are quite distinct because individual flowers numbering 110-150 per 100 clusters are absent. Table 4 gives frequency curves for six of these F_2 hybrids from the crosses of SLC 101 *mm* with the more common types of multigerm beets which occur in sugar, fodder or table beet varieties. The bimodal F_2 curves observed in hybrids between SLC 101 *mm* and the "few-germed" beet is also characteristic of F_2 hybrids between mul tigerm and monogerm beets.

The average number of flowers per cluster in multigerm segregates which occur among F_2 hybrids derived from crosses between monogerm and ordinary multigerm beets was greater than in F_2 segregates produced from a cross between monogerm and "few-germed" beets. However, the amplitude of variation for the number of flowers per flower cluster for the multigerm segregates remains almost the same for both types of F_2 hybrids. This is.

Table 4.—Variation of Number of Flowers in the Flower Cluster in F2 Hybrids Between Monogerm and Multigerm Beets.

Generation	Origin	Monogerm beets	Number of multigerm plants and degree of multigerm condition — Degree of multigerm condition, number of flowers per 100 flower clusters as follows: 110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	No. multigerm plants	Analysis (excluding *mm* class) on flowers per 100 clusters: Mean	S.D.	C.V.	S.E.M.
										Crosses between mono- and "few-germed" multigerm beets														
F_2	SLC 100 x SLC 101 *mm*	8	3	4	1	2	3	4	7	4	2									30	153.8	25.37	16.55	4.63
F_2	G.W. 4821 x SLC 101 *mm*	17		1		8	3	9	2	6	10	3	2	3						47	173.0	25.27	14.61	3.69
										Crosses between mono- and multigerm beets														
F_2	Janash 9333 x SLC 101 *mm*	19						1		5	16	19	5	2						48	195.6	10.90	5.57	1.57
F_2	Oberndorf 9567 x SLC 101 *mm*	10						1	1		2	13	6	3	3					29	204.1	15.47	7.58	2.87
F_2	SLC 101 *mm* x SL 824	13						1	5	8	20	8	2	1						45	188.7	11.79	6.25	1.76
F_2	SL 92 x SLC 101 *mm*	12						2	1	3	4	6	1	2						19	191.6	17.08	8.91	3.92
F_2	Mammoth 9565 x SLC 101 *mm*	6					1		4	2	4	2	2							15	184.7	16.85	9.12	4.35
F_2	Egyptian x SLC 101 *mm*	19						1	1	4	12	4	6	3	3	1	1			36	200.8	19.91	9.92	3.32
										Crosses between mono- and highly multigerm beets														
F_2	ZZ R. and G. x SLC 101 *mm*	9										3	7	3	2	2	3	3	1	21	227.9	22.26	9.77	4.54

due to the fact that hybrids from crosses with "few-germed" plants do not segregate for types with as many flowers per cluster and hybrids from crosses with highly multigerm beets do not segregate for "few-germed" types.

Some races of the sugar beet, and especially of the fodder beet, have seedballs with a very large number of germs (300 flowers per 100 clusters) . In such races fruits occur which often contain more than five or six flowers per cluster.

Segregation in F_2 hybrids obtained from crosses between SLC 101 *mm* and races of similar highly multigerm types follows the pattern of the monohybrid scheme (Table 4) . Differences in number of flowers per cluster between monogerm and multigerm segregates among F_0 hybrids in this case are even greater because, in spite of the striking differences between the two parental forms, the F_2 hybrids have no intermediate forms. The bimodal character of the frequency curves becomes even more apparent in this case, and the amount of variation for the number of flowers per cluster of multigerm segregates remains the same.

Discussion F_1

Hybrids

The multigerm character is not completely dominant over the mono-germ character. For this reason F_I hybrids, on an average, have fewer flowers per flower cluster than that of the multigerm parent. When a mono-germ beet is crossed with races of multigerm beets which have different numbers of flowers in a cluster, the different F_n hybrids will have a different number of flowers in their flower clusters. The difference in the number of flowers per cluster in F_I hybrids from crosses between mono- and multigerm beets depends on the number of flowers per cluster in the multigerm parent.

Differences in number of flowers per flower cluster observed among different F_i hybrids are shown also in the corresponding F_2 hybrids. These differences can be observed only *in* the multigerm segregates in the F,, generation.

F_2 Hybrids

All F_2 hybrids from crosses between a monogerm beet and "few-germed" or multigerm types of sugar, fodder or table beets had the following general characteristics:

1. All F,, hybrids segregated according to the monohybrid scheme. The number of flowers in the flower cluster of the multigerm parent did not affect the percentage of the recessive monogerm plants recovered.

2. Monogerm lines obtained from the most diverse F_2 hybrids and propagated for several generations never segregated for multigerm types. They retained their monogerm character also when they were crossed with each other. Self-pollination of multigerm F_2 plants produced F_3 lines, some of which were constant in their multigerm plants just as in the F_2 generation.

Monogerm plants were never recovered from crosses of "few-germed" plants to multigerm beets.

3. The frequency curves were bimodal. One mode is made up of monogerm plants and the other by multigerm plants. These two modes are found to be close to each other in F_2 hybrids from crosses between monogerm and "few-germed" beets. In F_2 hybrids between multigerm and monogerm beets, two modes are well separated from each other. Overlapping in the number of flowers in a flower cluster between mono- and multigerm beets is completely absent in such hybrids.

F_2 hybrids between monogerm and "few-germed" beets do not segregate for highly multigerm types. F_2 hybrids between monogerm and ordinary multigerm beets do not segregate for "few-germed" beets.

When "few-germed" races of beets were crossed with each other neither monogerm nor highly multigerm plants were obtained.

Any hybrid between monogerm and multigerm beet gave only mono-hybrid segregation. The segregates consist of only two parental types. The plants of new types never appeared. For this reason in the multigerm segregates in F_2 hybrids obtained from crosses between mono- and multigerm beets, the coefficient of variation and the amplitude of variation for the number of flowers in a flower cluster was not higher than in "few-germed" segregates in F_2 hybrids between monogerm and "few-germed" beets.

The coefficient of variation and the amplitude of variation for number of flowers per flower cluster of multigerm segregates does not change in F_2 hybrids, depending on an increase in number of flowers per flower cluster of the multigerm parent. But the average number of flowers per cluster of the multigerm segregates which appear in different F_2 hybrid combinations were quite different and depended on the number of flowers per cluster in the multigerm parent.

Although the number of flowers in a cluster constitutes a typical quantitative character, the inheritance does not correspond to the theory of multiple factors (polymeric genes) . Multiple factors inheritance is based on several genes which belong to different alleles. Consequently, the different hybrids for the same character segregate sometimes as monohybrids, sometimes as dihybrids or as polyhybrids.

When the differences for any quantitative character increase, the number of genes determining these differences increase at the same time. The segregation in F_2 is more complicated and the diversity of segregating plants increases. The value of the coefficient of variation also increases. Such appearances were not observed in the hybrids studied.

The coefficient of variation and number of flowers per cluster of multigerm segregates does not change in F_2 hybrids depending on increase in number of flowers per cluster of the multigerm parent. But the average number of flowers per cluster of the multigerm segregates which appear in different F_2 hybrid combinations were quite different and depended on the number of flowers per cluster in the multigerm parent.

The types of segregation in the hybrids studied could not be explained on the basis of the multiple factor hypothesis. To make this obvious the data obtained on segregation for the number of flowers per flower cluster was compared with the values which could be expected if the segregation of hybrids was controlled by several multiple factors.

Table 5.—Segregation for Multigerm and Monogerm Plants in F2 Hybrids.

Origin		Monogerm beets	Number of multigerm plants and degree of multigerm condition — Degree of multigerm condition, number of flowers per 100 flower clusters as follows: 110	125	140	155	170	185	200	215	230	245	260	No. multigerm plants
	Expected		0.02	0.23	1.05	2.81	4.91	5.87	4.91	2.81	1.05	0.23	0.02	24
	Expected		1	10	45	120	210	252	210	120	45	10	1	1024
ZZ R. and C. x SLC 101 *mm*	Observed	9							6	7	3	4	4	24
	Expected		0.7	6.0	21.0	42.0	52.5	42.0	21.0	6.0	0.7			192
	Expected		1	8	28	56	70	56	28	8	1			256
Multigerm x SLC 101 *mm*	Observed	79			1	6	23	69	63	22*	7	1		192
	Expected		0.7	4.4	11.0	14.7	11.0	4.40	0.7					47
	Expected		1	6	15	20	15	6	1					64
G.W. 4821 x SLC 101 *mm*	Observed	17		1	9	11	5	13	4	4				47
	Expected		1.87	7.48	11.22	7.48	1.87							30
	Expected		1	4	6	4	1							16
SLC 100 x SLC 101 *mm*	Observed	8	5	3	3	6	9	4						30

Insofar as monogerm plants segregated as a simple recessive *(mm)* in F_2 of all hybrids independent of the number of flowers per flower cluster of multigerm segregates, it could be supposed: 1. that all multigerm plants carried gene *M,* and 2. that multiple factors ($C_1C_2C_3C_4$ and C_5) controlled the number of flowers in the flower clusters of the multigerm plants.

In such case the genotypes of the parental plants would be as follows:

SLC 101 mm	mm c^ c_2c_2 c_3c_3 c_4c_4 c_5c.
SLC 100	MM C_1C_1 C_2C_2 c_3c_3 c_4c_4 c_5c_5
G.W. 4821	MM C_1C_1 C_2C_2 C_8C_a c_4c_4 $c.c_5$
Common types of multigerm beets	MM C_1C_1 C_2C_2 C_3C_3 C_4C_4 c_3c_5
R. and G. ZZ Variety	MM C.G, G_2C_2 C_3C_3 C_4C_4 C_5C_5

In Table 5 the data obtained for segregation are compared with the values expected according to the hypothesis of multigerm factors for the majority of hybrids. The observed numbers do not agree with the expected ones. Statistical evaluation of these data showed that the hypothesis of multiple factors could not explain the observed type of segregation in hybrids studied. The disagreement between observed and expected values could not be decreased also by the assumption that the segregation was controlled by higher or lower number (4 or 6-7) of multiple factors.

Therefore, it is more probable that genetical differences in any of these hybrids were caused by different genes from the same allele, than by different number of multiple factors. The hybrids which have been analyzed include the members of the multiple allele listed in Table 6.

Table 6.—Designation of Genes in the Multiple Allele *M-m*.

Designation of member of multiple allele	Name and origin of varieties or lines in which a given gene has been found
Symbol	
mm	Inbred line SLC 101 *mm* which bears monojjerm fruits.
$M^1 M^1$	Inbred line SLC 100. This line has fruits with few germs. Isolated from the same population, "Hybrid 18 Michigan," in which the SLC 101 *mm* was found.
$M^{Br} M^{Br}$	Inbred line G.W. 4821, which has double-germ fruits.
MM	A gene or a number of related genes occurring most frequently among various multigerm varieties of the sugar, fodder, or table beet. Has an "average" number of flowers (close to three) in flower cluster.
$M^z M^z$	A gene which determines the presence of a large numbr of germs in a seed ball. Isolated from variety Kleinwanzleben ZZ. This gene probably occurs in many varieties of beets.

The beet also includes a number of genes which modify the effect of the above mentioned basic gene. The gene modifiers are not allelic to the *m-M* alleles. They are not discussed in this article, nor is the problem of compounds for the *M-m* allele.

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