1. Normal growth as exemplified by the untreated normals.
2. Dwarf growth as produced by the untreated homozygous recessive mutants.
3. Extended growth resulting from additions of GA_3 to either the dwarf or normal phenotype.

Daily treatment with GA_3, then, changes both normal and dwarf growth. Early after treatment the dwarfs phenocopy the untreated normals, but soon the treated dwarfs copy the extended growth pattern such that the two phenotypes are indistinguishable. In terms of leaf form the three growth types are:

1. Normal growth characterized by long and narrow leaves.
2. Dwarf growth much shorter and wider leaves than type 1.
3. Extended growth much longer and narrower leaves than those of type 1.

Further experiments of this same nature will be made with larger populations and more frequent and complete measurements of leaf form than those used in this study.

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1. A sterile plant with S cytoplasm and S restorer genes.

In our 1961 MNL report (p. 20) on the genetic characterization of various sources of sterile cytoplasm it was pointed out that a single sterile plant appeared in the family from the cross A158H1♀ x (A158HxNY16)♂. By all tests source H is S type cytoplasm; NY16 contains S (and T) restorer genes. Thus, the heterozygous restored sterile A158H x NY16 would be expected to produce only fertile offspring when crossed as a male parent to the A158H sterile female, since in the presence of S cytoplasm pollen grains containing the nonrestoring allele abort and only the restorer allele is transmitted. It was suggested in the previous report that the exceptional sterile plant in the above test cross did have the major S restorer gene from NY16, but was not expressed in the residual genotype of the cross (which also contained 5 partially fertile plants). The single sterile plant, which was completely sterile and exserted no anthers, was pollinated by normal A158 (i.e. A158H1 (A158HxNY16) sterile plant x A158). In 1961 the progeny from this cross segregated 8 fertile and 9 sterile. Since A158 is free of S restorer genes, it is likely that the sterile female parent did in fact contain the S restorer genes.

Harry T. Stinson, Jr.

2. Segregation of T restorer genes in "reciprocal crosses."

In a previous MNL (1959, pp. 9-12) Jones reported that the heterozygous (Rf_1rf_1) restored sterile inbreds C103TF, HyTF and KrTF (TF = restored sterile) each produced a significant excess of fertile plants when crossed as pollen parents to T sterile single crosses. Genotypically all crosses were presumably T $rf_1rf_1Rf_2Rf_2$♀ x T $Rf_1rf_1Rf_2Rf_2$♂, and thus expected to segregate 1 fertile:1 sterile. The excess of fertile plants in these segregating progenies was attributed either to the presence of fertility modifier genes in the seed parent single crosses and in the pollinator inbreds, or to a selective mechanism favoring the Rf allele in the pollen. To obtain further information on the transmission and segregation of restorer genes, progenies from "reciprocal crosses" involving individual heterozygous restored sterile

plants were grown in 1960 and 1961. In making these reciprocal crosses a given restored sterile plant (T $\frac{Rf_1}{rf_1}\frac{Rf_2}{Rf_2}$) was crossed as a male parent to a sterile female tester ($\frac{T}{rf_1}\frac{}{rf_1}\frac{}{Rf_2}\frac{}{Rf_2}$), and as a female parent with the normal fertile version ($\frac{N}{rf_1}\frac{}{rf_1}\frac{}{Rf_2}\frac{}{Rf_2}$) of the sterile tester (crosses symbolized as T x TF and TF x N). As a check for the presence of genotypes which condition partial or full restoration in the absence of the major (Rf) restoring genes, progenies of the following types were also grown: sterile tester x normal version of restored sterile; sterile version of restored sterile x normal version of tester. Tassels were observed every other day, and classified as fertile (normal pollen production), sterile (no anther exserted), or partial fertile. The degree of fertility in the partial category was further estimated on the basis of the number of anthers exserted, the amount, if any, of pollen shed, and the time of anther exsertion in relation to silking. The heterozygous restored sterile inbreds studied, the number of backcross generations, and the source of the restorer genes (in parenthesis) were as follows: C103TF6(Ky21); HyTF6(C236); Oh51ATF6(I153); A158TF5(Ky21). Results are summarized below for each of the four inbreds.

C103TF6 - Five different heterozygous plants in the BC6 were tested with three different sterile seed parents and their normal counterpart male parents (Table 1). None of the C103TF plants gave a significant deviation from the expected 1:1 segregation as either a female or male parent, nor did any of the reciprocal crosses differ significantly in the proportions of sterile and fertile plants. The combined results for crosses of the type TF♀ x N♂, as well as of the type T♀ x TF♂, give good fits to 1:1 ratios, and the five families in each group appear to be homogeneous. Finally, the reciprocal crosses, as groups, do not differ significantly, and their combined totals fit a 1:1 ratio. In all progenies (grown in 1960), segregation of fertile and sterile plants was clear, with no partially fertile plants present. The control crosses of the kind mentioned above contained only completely sterile plants.

HyTF6 - Five different restored sterile plants were tested with four different steriles and their normal counterparts (Table 2). HyTF plant No. 8, crossed with C103T12 and normal C103, gave a poor fit to a 1:1 ratio as both a seed and pollinator parent, and the two families were homogeneous in containing an excess of sterile plants. The control crosses, HyT x C103, and C103T x Hy, produced all sterile plants. The control crosses for the remaining four test crosses contained some plants classified as partial fertiles, which exserted a few anthers abnormally late and shed little or no pollen. Phenotypically similar partial fertile plants were observed in the segregating test crosses, and on the basis of the control crosses were classified as sterile. The remaining four HyTF plants gave relatively good 1:1 ratios, and in each case the segregations in reciprocal crosses did not differ significantly. However, the five families of the type TF♀ x N♂ give a combined segregation deficient in fertile plants, a deviation from expectation significant at the 5% probability level; the families satisfy the test for homogeneity. In contrast, the pooled segregations for the five families comprising the reciprocal cross (T x TF) do not depart significantly from a 1:1 ratio, and these families also appear homogeneous. This difference in the behavior of the reciprocal crosses, as groups, borders on significance (P = .06). The results with HyTF are therefore inconclusive, but there may be a suggestion of a reciprocal cross difference. In any event, the results do not offer evidence for a significant excess of fertile plants when HyTF is used as pollinator.

Table 1 - C103TF6 crosses

Cross	F	S	P for 1:1	P for heterogeneity
C103TF6(15-6) x WF9	46	49	.75	
WF9T11 x 15-6	48	52	.70	
	94	101	.60	>.99
C103TF6(15-9) x (WF9 x 38-11)	61	48	.20	
(WF9T11 x 38-11) x 15-9	44	54	.30	
	105	102	.78	.12
C103TF6(15-14) x (WF9 x 38-11)	67	68	.87	
(WF9T11 x 38-11) x 15-14	60	57	.75	
	127	125	.85	.75
C103TF6(13-9) x (C106 x A158)	45	60	.15	
(C106T12 x A158) x 13-9	56	44	.27	
	101	104	.85	.07
C103TF6(14-5) x (C106 x A158)	62	66	.72	
(C106T12 x A158) x 14-5	59	69	.40	
	121	135	.38	.70
5 families combined:				
TF x N	281	291	.70	.40
T x TF	267	276	.70	.50
	548	567	.60	.78

Table 2 - HyTF6 Crosses

Cross	F	S	P for 1:1	P for heterogeneity
HyTF6(54-8) x C103	43	57	.17	
C103T12 x 54-8	33	47	.11	
	76	104	.04	.85
HyTF6(53-9) x (WF9 x W22)	41	49	.40	
(WF9T7 x W22) x 53-9	51	40	.35	
	92	89	.85	.20
HyTF6(54-4) x (WF9 x 38-11)	45	56	.28	
(WF9T11 x 38-11) x 54-4	91	82	.50	
	136	138	.87	.20
HyTF6(54-6) x (WF9 x 38-11)	39	45	.50	
(WF9T11 x 38-11) x 54-6	42	46	.70	
	81	91	.45	.85
HyTF6(53-1) x (C106 x A158)	40	48	.40	
(C106T12 x A158) x 53-1	57	51	.60	
	97	99	.70	.35
5 families combined:				
TF x N	208	255	.03	.98
T x TF	274	266	.70	.38
	482	521	.22	.06

A158TF5 - Three different restored sterile plants were crossed reciprocally with two different testers (Table 3). In five of the six families reasonably good 1:1 ratios were obtained; one family showed a poor fit. None of the reciprocal crosses differed significantly, and the pooled data for families of the type TF♀ x N♂ and of the type T♀ x TF♂ also do not deviate significantly from 1:1 ratios; the three families in each type of cross satisfy the test for homogeneity. The pooled reciprocal crosses also do not differ significantly from each other. There is thus no good evidence for abnormal segregations in the A158TF test crosses. The crosses with (WF9T x Oh51A) and its normal version contained a small proportion of partially fertile plants, but similar partial fertiles also appeared in the control crosses. These partial fertile plants were phenotypically similar to those reported above for the HyTF crosses, and were placed in the sterile category.

Oh51ATF6 - Only two restored sterile plants were tested, each with a different tester (Table 4). Each of the progenies involving one of the two Oh51ATF plants was deficient in fertile plants, and the reciprocal crosses were alike in this respect, each showing a significant departure from a 1:1 ratio. The second Oh51ATF plant produced a deficiency of fertile plants in one family and a significant excess of fertiles in the reciprocal cross, resulting in a highly significant difference in reciprocal crosses. The two crosses of the type TF♀ x N♂ give a total segregation which deviates significantly from the expected ratio, each family being deficient in fertile plants. The two families of the reciprocal T♀ x TF♂ cross are significantly different, one containing an excess of fertiles and the other an excess of steriles. The results with Oh51A restored steriles might be best explained on the assumptions that the single family containing an excess of fertile plants is exceptional, and that the two restored plants used in the crosses tended to produce a deficiency of fertile plants, perhaps because necessary modifier genes are lacking in certain offspring. However, none of the four families contained partially restored plants such as are frequently observed when modifier genes are segregating.

Summary: The above results indicate that the earlier finding of a significant excess of fertile plants in crosses of the type T $\underline{rf_1rf_1}$♀ x T $\underline{Rf_1rf_1}$♂ is not a general phenomenon. Only one of the 15 families in this category contained a significant excess of fertile plants, and none of the pooled segregation ratios deviated significantly from expectation. Crosses with HyTF, however, did suggest a difference in reciprocal crosses, those of the type TF♀ x N♂ showing a deficiency of fertile plants.

Table 3 - A158TF6 Crosses

Cross	F	S	P for 1:1	P for heterogeneity
A158TF5(69-1) x A	72	80	.50	
AT7 x 69-1	75	76	.90	
	147	156	.60	.70
A158TF6(69-4) x (WF9 x Oh51A)	94	70	.06	
(WF9T7 x Oh51A) x 69-4	63	53	.35	
	157	123	.04	.60
(A158TF6(69-5) x (WF9 x Oh51A)	85	90	.80	
(WF9T7 x Oh51A) x 69-5	59	47	.25	
	144	137	.70	.25
3 families combined:				
TF x N	251	240	.60	.15
T x TF	197	176	.28	.60
	448	416	.28	.60

Table 4 - Oh51ATF6 Crosses

Cross	F	S	P for 1:1	P for heterogeneity
Oh51ATF6(81-11) x(WF9 x Oh51A)	55	83	.02	
(WF9T7 x Oh51A) x 81-11	64	94	.02	
	119	177	<.001	.85
Oh51ATF6(81-3) x A	78	91	.30	
AT7 x 81-3	103	63	<.01	
	181	154	.14	<.01
2 families combined:				
TF x N	133	174	.02	.25
T x TF	167	154	.60	<.01

Harry T. Stinson, Jr.

3. Pollen transmission of T restorer genes by plants with sterile (T) and normal (N) cytoplasm.

A second aspect of restorer gene behavior investigated was a comparison of the segregation ratios produced by heterozygous ($\underline{Rf_1}\underline{rf_1}$) restorer male parents possessing T and normal (N) cytoplasm. The T and N restorer male parents were produced as follows: restored sterile lines of A158, Oh51A, and Kr which had been backcrossed 4 or 5 generations, selfed 3 or 4 generations, and shown by test crosses to be homozygous for the restorer genes (T $\underline{Rf_1}\underline{Rf_1}\underline{Rf_2}\underline{Rf_2}$) were crossed reciprocally with the respective normal lines (i.e. N $\underline{rf_1}\underline{rf_1}\underline{Rf_2}\underline{Rf_2}$) to give the two kinds of families, T $\underline{Rf_1}\underline{rf_1}\underline{Rf_2}\underline{Rf_2}$ and N $\underline{Rf_1}\underline{rf_1}\underline{Rf_2}\underline{Rf_2}$. In any given reciprocal cross the same two plants were used as parents. The original source of the restorer genes for A158 and Kr was Ky21, and the source for Oh51A was I153.