4. The snythesis of artificial allotetraploid corn strains.

In the last issue of the News Letter three methods were presented which could be used in the snythesis of an allotetraploid corn. To produce this artificial strain of corn, a corn genome must be modified by chromosomal structural changes so that it loses most of its pairing affinity with the standard corn genome. It is possible theoretically to do this by:

a. Combining many separately induced inversions on the same chromosome by crossing over.

b. Producing chromosomes with many inversions by the repeated irradiation of chromosomes which have inversions to start with. These chromosomes could be isolated by their enhancement of the effect of preferential pairing.

c. Creating structurally modified chromosomes by the isolation and recombination of structural rearrangements already present in the species (notably in exotic lines).

It is now believed that serious technical difficulties limit the feasibility of using any of these methods for the production of agronomically successful allotetraploids. These three methods in addition to being very tedious virtually make it necessary to work on the chromosomes individually. After each of the ten chromosomes has been modified, they would have to be put together and made homozygous. In the process, which would require many growing seasons, it would be difficult to keep the modified chromosomes intact.

Furthermore, the use of these methods makes it almost impossible to obtain more than a few different modified genomes because of the labor involved. Any variability for adaptive purposes would have to come from the standard corn genome used with them in the allotetraploid. Also, the quality of the genetic material cannot be controlled very easily. In the case of method c it is highly probable that agronomically poor genes would be picked up along with the structural rearrangements. When inversions are used as in methods a and b the inversion must be induced in agronomically good material to start with, since an inversion virtually blocks the exchange of genetic material within it. Back-crossing would not be successful.

However, there seems to be a practical method for the synthesis of a large number of different artificial allotetraploids. This method is suggested by the data reported in the preceding section. The procedure is to irradiate a wide variety of inbred lines for several generations. Selection would be practiced to eliminate gross chromosomal structural changes and deleterious mutations. At intervals these inbred lines would be crossed with each other or with unirradiated inbred lines and the hybrid would be doubled to form a tetraploid. The gene segregation patterns, quadrivalent frequencies, and the fertility of these tetraploids would be determined. How rapid the approach to allotetraploidy would be is undeterminable at this time. This is somewhat of a blind approach to the problem, as it would not be possible to analyze what has happened to the structure of the chromosomes after several generations of repeated irradiation.

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5. The duplication of specific chromosome segments by crossing translocations involving the same chromosomes.

The F_2 and in some cases the F_3 generations of translocation crosses for the duplication of the su_1, ae, y and wx loci have been obtained. It is highly probable that all of these loci have been duplicated. Considerable work remains to be done to isolate plants which are homozygous for the duplication and to prove that the selected loci are included in the duplicated segment.

One of the questions to be answered is - how functional are the pollen grains which contain duplications in competition with normal pollen? If they cannot compete successfully then we could not get a homozygous duplication. However, it has been determined that the duplication pollen is functional in a few cases where one of the parental translocations carried the recessive gene and the other parental translocation carried the dominant allele. In the F_2 generation the frequency of recessives should be 1/6 if the duplication pollen is not functional. In the case of the translocation cross of 9S.68-4L.03/9S.25-4L.33, the frequency of wx kernels was 15.27% which is significantly lower than 16.66%. If we let x equal the frequency of duplication pollen transmission and let r equal the frequency of recessive gametes then we can set up the formula:

$$r = 1/6 - 1/6x$$

$$\text{or,} \quad x = 1 - 6r$$

In this example x equals 8.38%. This formula may be derived by a consideration of the diagram below. It is assumed that the deficient gametes are non-functional on both the male and female sides. It is assumed that the three kinds of gametes, the two parental translocations and the duplication type, function with equal frequency in the female.