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Final Report

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Comparative Radiosensitivity Studies

In the Gramineae

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Comparative Radiosensitivity Studies in the Gramineae

The investigations conducted during the four years that this research was supported by the Atomic Energy Commission can be divided into the following areas:

1. Diplontic selection and its modification by X irradiation in a colchicine-treated grass hybrid.
2. Radioresistance of F_1 hybrids in the Triticeae.
3. Effect of type and level of polyploidy on radiosensitivity in five species of the Triticeae.
4. Average metaphase chromosome volume as an index of radio-sensitivity.

A resume of each of the above follows:

1. Diplontic selection and its modification by X irradiation in a colchicine-treated grass hybrid.

This investigation began with an attempt to control ploidy levels in colchicine-treated meristems of a sterile F_1 hybrid by interaction with X-irradiation. It occurred to me that in view of the expected radioresistance of polyploid tissue it might be possible to inhibit the growth of normal tissue in a chimeric meristem and permit the doubled tissue, produced by colchincine, to form new and fertile shoots in a predictable fashion.

This experimental material was a sterile, triploid hybrid between Agropyron cristatum and A. subsecundum. The sterility of the hybrid is due to failure of synapsis. Most of the 185 pollen mother cells interpreted at diakinesis had 21 clear univalents.

Many different combinations of colchicine treatments and dosage levels of X-rays were made. This plant is extraordinarily resistant to the usual effects of colchicine. We could not get enough hexaploid tissue in the promeristem of the shoot to test the hypothesis.

Much data was collected (see annual reports). However, the experiments can be quickly and honestly summarized as follows: Our attempts to produce a fertile hexaploid from a sterile triploid through interaction of colchicine and ionizing radiation were an unequivocal failure.

2. Radioresistance of F_1 hybrids in the Triticeae.

Potted plants of three F_1 grass hybrids and their respective parents were subjected to acute doses of X-rays ranging from 1 to 8 kR. The hybrids were: Sitanion hystrix X Agropyron trachycaulum, Agropyron cristatum X Agropyron subsecundum, and Agropyron trachycaulum X Hordeum jubatum. As measured by mortality, growth inhibition and dry weight, the hybrids were strikingly and consistently more resistant to the higher dosages of radiation than were their parents or any of the species studied. The radioresistance of the hybrids was not accompanied by unusually low average interphase chromosome volumes, nor by consistent marked increase in rate of growth. The heterozygosity of the hybrids is believed to be associated with their radioresistance in a manner not yet clear. (Radiation Botany 8: 1-6. 1968)

3. Effect of type and level of polyploidy on radiosensitivity in five species of the Triticeae.

Little or no correlation was found between type and level of polyploidy and sensitivity to acute X-irradiation, as measured by mortality, growth inhibition, and dry weight production, in the following species of the Triticeae: Agropyron cristatum, A. desertorum, A. trachycaulum, Hordeum jubatum, and Agrohordeum macounii. Genetic redundancy presumably present in the autotetraploid and auto-allo-octoploid did not afford significant protection from radiation damage. Radiosensitivity was not closely related to average interphase chromosome volume in these species. (Journal Heredity 59: 151-154. 1968)

4. Average metaphase chromosome volume as an index of radiosensitivity.

Investigations recently completed in our laboratory, and those of several other investigators, clearly indicate that the index of radiosensitivity most widely used at present---average interphase chromosome volume---has serious limitations. Large differences in ICV values are reflected in corresponding differences in sensitivity, but moderate or small differences may not be.

Our investigations suggest that average metaphase chromosome volume in somatic tissue may be a much more precise index of sensitivity. (See last progress report for discussion).

This work is currently in progress. Experimental materials possessing a wide range of chromosome number and size are being utilized. Data on average chromosome volume at mitotic metaphase for rye (Secale cereale), wheat (Triticum aestivum cv Delmar) and barley (Hordeum vulgare cv Bonneville) are virtually complete. I am gradually acquiring similar data for leopard lily (Fritillaria atropurpurea), stone crop (Sedum

stenopetalum) and a composite (Bradburia hirtella). Other species will eventually be added to the experiment. Four of these species (rye, wheat, barley, stone crop) will be subjected to appropriate levels of X irradiation in the next two months as they begin spring growth after over-wintering in the nursery. Measurements of growth inhibition, dry weight production and mortality will follow. Progress will be slow because I am completely without research funds.

The writer expresses his grateful appreciation for the opportunities provided him by financial support from the Atomic Energy Commission.

Publications During The Contract Period

Boyle, W.S. 1968. Radioresistance of F_1 hybrid in the Triticeae. Radiation Botany 8: 1-6.

_____ 1968. Effect of type and level of polyploidy on radiosensitivity in five species of the Triticeae. Journal Heredity 59: 151-154.

Boyle, W.S. and A.H. Holmgren. 1968. A cytotaxonomic study of a natural hybrid between Agropyron cristatum and A. subsecundum. Madrono 19: 277-280.

Bottino, P.J. 1965. Radiosensitivity studies on an interspecific hybrid. Journal Heredity 56: 225-228.

Braegger, D.R. 1967. Karyotype analysis as an index of radiosensitivity of a grass hybrid. M.S. Thesis, Utah State University.

Equipment Report

No equipment has been purchased or fabricated since the last equipment report.