barrier. A nonmechanical source provides the immediate energy to overcome the barrier. (ii) The mechanical stimulus activates a chemical reaction of about 16,300 cal of activation energy per mole, which in turn causes the permeability of the membrane to increase and ions to flow along their gradients (*7*).

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Frequency of Mutations Induced by Radiations in Hexaploid Species of Triticum

Abstract. The frequency of visible mutations induced by x-rays, phosphorus-32, and sulfur-35 was calculated in six hexaploid *Triticum* species. The species with spelted ears and winter habit showed a much lower mutation rate than the free-threshing, spring wheats.

Results from mutation experiments carried out during recent years in several countries in varieties of bread wheat (*Triticum aestivum* L.; $2n = 42$) have borne out Gustafsson's (*1*) statement that in this species "with suitable x-ray doses a mass mutating sets in." MacKey (*2*) has shown that over 30 percent of the mutations isolated in the progenies of irradiated plants of bread wheat result from either the loss or the duplication of the speltoid suppressor gene *Q* situated in the distal end of the long arm of chromosome IX [chromosome 5A according to the new system of nomenclature proposed by Sears (*3*)]. the hexaploid wheats, *T. spelta* L., *T. macha* Dek. et Men., and *T. vavilovi* Jakub., lack the *Q* factor; hence an experiment was undertaken for finding out the frequency and types of mutations induced by radiations in *T. aestivum* L., *T. compactum* Host., *T. sphaerococcum* Perc., *T. spelta* L., *T. macha* Dek. et Men., and *T. vavilovi* Jakub., the six commonly recognized hexaploid species. One stable and homogenous strain was chosen in each species; the *T. aestivum* and *T. macha* varieties used were awned and the rest were awnless. The *T. aestivum, T. compactum*, and *T. sphaerococcum* varieties were spring types, while the others had a winter habit.

Table 1. Frequency of mutations observed in the M_2 generation in *Triticum* species.

Species	Total M_2 families (No.)	M_2 families segregating for mutants (No.)	M_2 plants studied (No.)	Mutations in M_2 generation (No.)	Mutation rate (%): Segregating families	Mutation rate (%): Mutations per M_2 family
T. aestivum	338	88	6103	206	26.04	60.95
T. compactum	337	92	6335	253	27.30	75.07
T. sphaerococcum	333	82	6106	219	24.62	65.77
T. spelta	346	27	3390	36	7.80	10.40
T. macha	190	4	1987	13	2.11	6.84
T. vavilovi	147	3	1556	5	2.04	3.40

Dry seeds (5 to 6 percent moisture content) were treated with x-rays (11,000 and 16,000 r), phosphorus-32 (5 μc per seed), and sulfur-35 (5 μc per seed). One hundred seeds were used in each treatment, and the treated seeds were planted in the field along with the respective controls. The main tiller and one or two more tillers of each plant were selfed, and the second generation progenies were raised the following year by sowing the seeds from each plant in individual rows. While no visible mutations occurred in the control material, many such mutations were found in the progenies of treated plants. The population was scored for all phenotypically detectable mutations, and the mutation frequencies observed in the different species were calculated both in terms of the percentage of M_2 families segregating for mutations and the percentage of mutants per M_2 family (Table 1). Since the trend in the frequency and spectrum of mutations induced by the different treatments was similar in all the species, the pooled data are given in Table 1.

Statistical analysis showed that *T. spelta, T. macha*, and *T. vavilovi* had a significantly lower mutation frequency than *T. aestivum, T. compactum*, and *T. sphaerococcum*. The differences between species within each of these two groups were not significant. It is now known that *T. spelta, T. sphaerococcum*, and *T. compactum* are each separated from *T. aestivum* by a single gene: *Q* located on chromosome IX (5A), *S* on XVI (3D), and *C* on XX (2D), respectively (*4*). The number and location of the genes differentiating *T. macha* and *T. vavilovi* from *T. aestivum* have not yet been precisely determined, though there is evidence to suggest that only one or two genes may be involved in these cases also (*5*). A study of the relative frequencies of different types of mutations found during the present study in each species revealed that 31.07, 39.92, and 63.93 percent, respectively, of the mutations isolated in *T. aestivum, T. compactum*, and *T. sphaerococcum* could be attributed to the loss or duplication of the appropriate species differentiating locus (that is, *Q, C*, or *S*). The mutations found in *T. spelta* related mostly to awning or ear density, while a change to the *T. aestivum* type of ear and internode structure was the only type of mutation recorded in *T. macha* and *T. vavilovi*. Visible mutations can occur in a polyploid only at loci in which phenotypic buffering induced by duplications does not exist (*6*). These results suggest that the number of such loci, while generally few in hexaploid *Triticum* species, is relatively more in the free-threshing spring wheats (*7*).

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