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The main objective of the research work conducted in this Department is to produce maize hybrids with a high protein and oil content. The experiments performed in order to reach this target are theoretically twofold, part of them being connected with the increase of protein content and others being related to the analysis of the theoretical foundations of heterosis. The present study is an account of experiments connected with the increase of protein content.

For the production of hybrids, attempts were made to establish lines of genetically very different origin. One procedure is to produce lines from the existing open pollinated improved varieties with 10 to 11 per cent protein content. This method, however, provides for slow progress only.

Zea x Euchlaena hybrids.

Another source of this breeding work is the hybridization of Zea mays with Euchlaena mexicana. Variability in the F_1 generation is presented in Table 1. In order to transform the F_1 generation with a higher protein content into a maize variety of the cultivated type, repeated top crosses were performed (Table 2). This brought about a reduction of the average protein content to 14.1 per cent but the segregating generations allowed the selection of individuals with 15 to 16 per cent protein content.

Table 1
Protein Percentage in Intergeneric Crosses of Maize
(Gödöllő, 1957)

No.	Crude Protein %	No.	Crude Protein %	No.	Crude Protein %
1	17.1	9	14.8	17	17.5
2	12.9	10	14.4	18	15.4
3	13.2	11	15.5	19	15.6
4	13.2	12	16.6	20	15.5
5	12.1	13	15.0	21	14.5
6	14.0	14	13.1	22	14.1
7	14.5	15	12.8	23	12.2
8	13.4	16	14.4	24	15.8

Table 2
Protein Percentage Changes in Repeated Top Crosses
(Gödöllő, 1954-57)
(As Related to Absolute Dry Matter)

No.	Combinations	Variety at First and Second Top Cross	Protein Percentage		
			Before Top Crossing	After	
				First Top Crossing	Second Top Crossing
				1956	1957
1.	Zea x Euchlaena	Bankuti	16.6	12.2	10.7
2.	Zea x Euchlaena	F-korai (early)	15.6	14.2	14.1
3.	Zea x Euchlaena	F-korai (early)	17.5	14.0	11.1
4.	Zea x Euchlaena	F-korai (early)	17.5	14.0	10.3
5.	Zea x Euchlaena	Land variety	15.4	13.7	13.2

Breeding of biochemical mutants.

In 1958 an open pollinated variety (Fk) and different lines have been irradiated at dosage rates of 10 and 15 kr according to the usual methods. In order to accelerate breeding work, the X_1 has been investigated too, and only the grains of 300 selfed individuals with a protein content above 8 per cent were planted as the X_2 generation. Table 3 shows the variability of a part of the material.

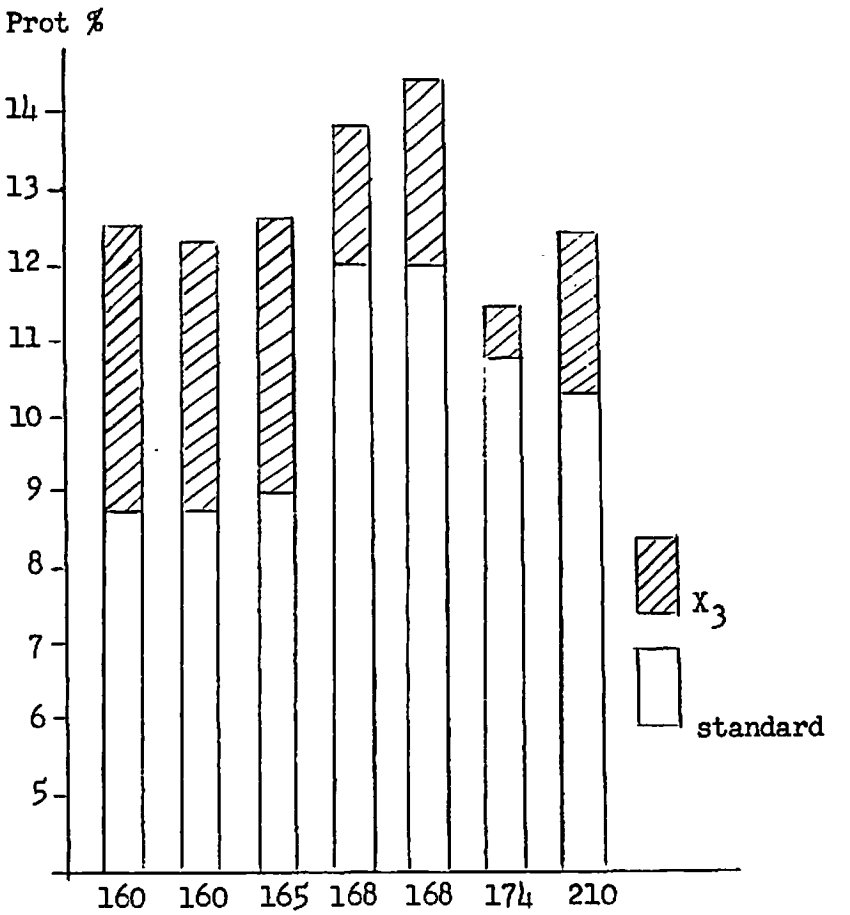
Table 3
Variability of the X_2 Generation Selected From the Irradiated X_1
(Gödöllő, 1958, 1959)

Dosage Applied (kr)	No. Of the Starting Material	Mean Protein Content	Variation Range in X_2		Absolute Deviation Per Cent
			From	To	
15	Fk	11.3	8.3	15.2	6.9
10	S 160	8.8	8.6	13.1	4.5
15	S 160	8.8	8.4	14.4	6.0
10	S 165	9.0	8.4	15.4	7.0
10	S 168	12.0	11.4	12.3	0.9
15	S 168	12.0	10.2	15.5	5.3
10	S 174	10.8	10.6	13.3	2.7
10	S 200	13.3	10.1	16.1	6.1
10	S 210	10.2	14.1	15.4	1.3

Each entry represents the mean value of individual analyses of 18 selfed ears from the 24 individuals of a plot. The mean values of the X_2 plots of the other lines showed a variation range from 0.9 to 7.0 per cent. Our expectations concerning a hereditary increase of the variation range of the material due to irradiation have been verified in the X_2 generation.

In the X_3 generation too, only the X_2 sub-lines with a protein content above 8 per cent were maintained. The protein percentage was, probably under the influence of meteorological factors, lower than in X_2. Figure 1 presents the mean protein percentage in the best X_3 lines obtained from the inbreds, as related to the standard variety "F" korai (early) and to the starting material.

Figure 1. Average Protein Content of X_3 Maize Lines (Gödöllö, 1960).



According to the data, we succeeded in obtaining forms with hereditarily higher protein contents from 6 lines.

This increase of the average values surpasses the 2.86 per cent increase observed in the first five years of the Illinois cycle and, consequently, it is more considerable than the progress obtainable by simple selection in 5 years. The principal value of this breeding method consists in the fact that differences can be hereditarily fixed, using a reduced material to a more favorable extent and in a shorter period, than using untreated material.

For a genetically more exact analysis of the effects of mutagens in 1962 further lines were irradiated. When the X_1 and the starting material were treated, the line C5 gave in 1962 the results shown in Table 4.

Table 4

Treatment	Value		Number of Ears Examined
	Minimum	Maximum	
Control	8.2	13.2	20
15,000 r	7.2	14.2	29
7,000 r	8.0	15.4	38
Neutron (500 REP)	8.5	14.5	22

The variation range increased once more here. A definite evaluation of the experiment will be possible on the ground of the data from the X_3 and X_4 generations.

Summary

With various methods, lines with a high protein content were obtained from which in the meantime some promising single and double crosses have been produced.

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1. Pachytene pairing in auto-tetraploid maize.

A study of pachytene associations in the pollen mother cells of a colchicine induced auto-tetraploid maize showed that (1) pairing is between homologous parts only of pairs of chromosomes at any point and (2) the four homologues may form two separate pairs or one or two exchanges of partner may take place in an association.

The data on the frequency of different numbers of exchanges revealed that the occurrence of one exchange does not interfere with the occurrence of a second one in an association since different numbers of exchanges fit a Poisson distribution.

Of a total of 195 associations, 80 showed association of all four homologous centromeres, 35 of these being with no exchange elsewhere in the association. The centromere associations probably represent points of exchange of partners located at the centromere. This is supported by the following consideration. Analysis of metaphase I configurations in 60 nuclei revealed that 74% of the possible multivalents are formed. An essential requirement for multivalent formation is one or more exchanges of partners in the pachytene association followed by formation of appropriate number of chiasmata distributed at appropriate places along the paired chromosomes in the association. However, only 48.7% of the observed pachytene associations showed one or two exchanges of partner. In addition to these, 19% of the observed pachytene associations were those with association of all four homologous centromeres