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Observations on Heterosis in *Zea mays* L. II.

Obserwacje nad heterozją u *Zea mays* L. II.

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This work is a continuation of the research on heterosis in maize, carried out in the Department of Genetics of the Warsaw University of Agriculture. The experiment was performed in 1961, its purpose, was to investigate the hereditary characters of the vigorous line No. 10 isolated by means of inbreeding the most vigorous plants in F_2 and succeeding generations of crossed inbred lines WD and W9. It seems that the possibility of selecting lines with a fixed vigorous growth from the progeny of crosses between inbreds exhibiting a high combining ability — should be taken into consideration for breeding purpose. In the production of hybrid seed such lines should be used by way of crossing with other inbreds.

The starting material for this research consisted of inbred lines WD and W9, first hybrid generation and line No. 10 with a fixed vigorous growth. Several crosses were done between line No. 10 and parental inbred lines WD and W9, also with F_1. Moreover, backcrosses of F_1 with inbred lines WD and W9 were also performed. The experimental material used in this study embraced 935 plants. The plants grew in 80 × 70 cm rows in rich soil well fertilized. At the end of August measurements were taken of the height of plants, length and width of leaves on the main stem.

The viability of pollen grains was examined for the relation between vigorous growth and a greater per cent of normal pollen grains. In this purpose the percentage of fully developed pollen grains was computed in the parental lines WD and W9, in F_1 and in line No. 10, the samples of pollen being collected from tassels in full flowering. The computations of the percentage of normally developed pollen was based on the examination of 20 fields of view of each plant with 10 plants being taken at random out of each investigated line.

The surface of the leaf blades on the main stem of each plant was computed according to Montgomery's formula (Tavčar, 1939). Next the total sum of the leaf surfaces on the main stem for each plant was

computed. The arithmetic mean values were obtained from the experimental data.

Table 1

Mean height of plants in cm at the end of vegetation

Line No. 10	F_1(WD×W9)	Line W9	Line WD
220 ± 2.16	163.53 ± 1.23	129.27 ± 1.28	114.10 ± 1.01

Comparison of arithmetic mean values in the progeny of crosses:

Line No. 10×F_1	l. No. 10×W9	No. 10×WD	F_1×W9	F_1×WD
207.68 ± 1.35	191.28 ± 9.26	187.64 ± 3.13	157.18 ± 1.06	145.53 ± 1.28
Differences	16.40 *	20.04 *	50.50 *	62.15 *
		3.64	34.10 *	45.75 *
			30.46 *	42.11 *
				11.65 *

On the basis of the observations on the percentage of normally developed pollen grains and computation of the experimental data it was possible to establish that the scale of variance for this trait in inbred line WD amounts from 65 to 85 % (the arithmetic mean $\bar{x} = 77.5 \pm 6.45$ %), in line W9: from 70 to 90 % ($\bar{x} = 85.0 \pm 6.55$ %),in F_1: from 85 to 100 % ($\bar{x} = 93.37 \pm 3.75$ %) and in line No. 10 : from 30 to 90 % ($\bar{x} = 86.7 \pm$ ± 2.05 %). From the above it may be seen that the average per cent of normally developed pollen grains in F_1 has increased considerably in comparison with the parental lines — this proves an increase of viability in F_1. Line No. 10, in spite of a most pronounced vigorous growth, is inferior in this respect in comparison with F_1 — this fact points to no dependens of pollen viability on the vigourous growth of plants.

In regard to the height of plants the data are given in Table 1. The upper row presents data expressing the arithmetic mean values in cm for the height of plants at the end of August. These data show distinctly that line No. 10 is superior in height in respect to the parental lines and F_1. That this kind of vigorous growth of line No. 10 is a hereditary fixed may be proved comparing the arithmetic mean values for the progeny of the crosses between line No. 10 and parental lines WD and W9 — and the arithmetic mean values for backcrosses between the same parental lines and F_1.

The following rows presented in Table 1 give the arithmetic mean values and their differences for the height of the progeny plants obtained from backcrosses and crosses between line No. 10 and parental lines WD, W9 and also F_1. All the differences are significant. The difference bet-

ween the arithmetic mean values for "W9 × No. 10" and "WD × No. 10" crosses is an exception it amounts to only 3.64 cm and is not significant. As concerns the mean height of the backcross progeny it appears to be smaller in crosses with WD than with W9 ($\bar{x}$ amounts to: for $F_1 \times W9 =$ = 157.18 cm, for $F_1 \times WD = 145.53$ cm). Thus the height differences remained in the same proportion to the differences between inbreds W9 and WD.

The difference between mean values appears to be similar in crosses between parental lines and vigorous line No. 10. It was possible to observe in this case that it is proportional to the difference between inbreds W9 and WD, however it has not been statistically proved (at the level $p = 0.05$).

If we assume that the vigorous growth of line No. 10 is hereditary fixed — then in crosses of this line with F_1 (WD × W9) the height of progeny plants should be the greatest. Experimental data have proved this assumption to be right. Crosses of F_1 with line No. 10 have given in effect plants much higher than in other crosses, however their height did not exceed the height of plants of line No. 10, the vigour of which, as it is known, is not connected with the stimulating effect of heterozygous state.

Table 2

Mean values for the sum of leaf surfaces on the main stem in cm

Line No. 10	F_1(WD×W9)	W9	WD
4455 ± 65.6	2730 ± 44.1	2075 ± 51.8	1995 ± 37.7

Comparison of arithmetic mean values in the progeny of crosses:

4225 ± 54.3	3750 ± 128.6	3570 ± 102.3	2430 ± 29.6	2360 ± 41.8
Differences	475 *	655 *	1795 *	1865 *
		180	1320 *	1390 *
			1140 *	1210 *
				70

The data bearing on the feature, characterizing the total sum of the leaf surfaces of the main stem, are presented in Table 2. The upper row of the Table gives the data concerning the arithmetic mean values for line No. 10, F_1 and parental inbreds W9 and WD. These data show that line No. 10 distinctly prevails over F_1 and inbred lines. The next rows of the Table plot the arithmetic mean values and differences between them for progeny plants obtained from backcrosses, also from crosses performed between vigorous line No. 10 and inbreds W9 and WD as well as with F_1. The differences between the arithmetic mean values are significant with the exception of the difference of crosses performed between

line No. 10 and W9 and also between WD, as well as between backcrosses: $F_1 \times W9$ and $F_1 \times WD$. The absence of significant differences in this case is connected with a rather indistinct accentuation of the prevailence in the growth of plants of the line W9 in regard to those of the line WD. Perhaps it may have been caused by the abnormal atmospheric conditions in 1961.

The vigorous growth expressed by the arithmetic mean value of the total sum of leaf blade surfaces in the progeny of the cross between line No. 10 and F_1 — shows a distinct prevailence in comparison with the mean values of progeny plants of crosses between this line and the inbreds W9 and WD as well as of backcrosses with F_1.

On the basis of experimental results it was possible to state that F_1 (W9 $\times$ WD) show vigorous growth in connection with the height of plants and the total sum of leaf surfaces on the main stem. Line No. 10, isolated from the most vigorous plants of the F_2 and succeeding generations — has exhibited in crosses with F_1 and inbreds W9 and WD a considerable predominance in vigour in comparison with the progeny obtained from backcrosses between parental lines and F_1. On this basis it may be stated that line No. 10 represents a stable line with a hereditary fixed vigorous growth.

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STRESZCZENIE

Badania nad heterozją u kukurydzy prowadzone są w Zakładzie Genetyki S.G.G.W.

W doświadczeniu wykonanym w celu zbadania własności dziedzicznych bujnej linii No 10 materiał eksperymentalny obejmował 935 osobników.

Wykonano szereg krzyżówek między linią No 10 a wyjściowymi liniami wsobnymi rodzicielskimi W9 i WD, a także mieszańcami F_1. Ponadto przeprowadzono wsteczne krzyżówki mieszańców F_1 z liniami WD i W9. Obserwacjom poddano cechę wysokości roślin w końcowym okresie wegetacji, rozmiary liści i sumę ich powierzchni na pędzie głównym. Na podstawie danych eksperymentalnych stwierdzono wyraźną przewagę w bujności mieszańców uzyskanych ze skrzyżowania F_1 z bujną linią No 10, w stosunku do potomstwa pozostałych krzyżówek. Srednie arytmetyczne dla cech wyrażających bujność mieszańców otrzymanych w wyniku krzyżowania linii No 10 z liniami wsobnymi WD i W9, wykazują istotną przewagę w stosunku do odnośnych średnich w potomstwie krzyżówek F_1 z tymi samymi liniami wsobnymi. Różnice te są istotne i statystycznie udowodnione.

Na tej podstawie można wyciągnąć wniosek, że linia No 10 reprezentuje linię z dziedzicznie utrwaloną bujnością.

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