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THE RELATION BETWEEN TEMPERATURE AND THE EXPRESSION OF THE GENE PIGMY-1 IN THE GROWTH OF THE PRIMARY ROOT OF SEEDLING MAIZE

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The expression of a single gene mutant in maize, especially in seed development in maize, has been studied in relatively few cases. An exception is Olmsted's (1951) study of the expression of the gene dwarf-1 in the root system. In the present study the primary root is again the focus of attention, but with reference to the interaction of temperature with a different gene—pigmy-1.

MATERIALS AND METHODS

The kernels for this study were obtained from the stocks of the corn research program in the Department of Botany, University of Minnesota. The particular seed lot used was the result of five generations of backcrossing onto Station inbred A188 following the introduction of this gene in the homozygous recessive state into the inbred.

Four hundred kernels were chosen at random from the seed lot, soaked in distilled water for 18 hours and then rolled in cheesecloth to remove the excess moisture. They were then dusted with Orthocide No. 75 and planted in a flat containing soil which had been sterilized by steam heat. The flat was placed in a greenhouse whose temperature ranged from 75 to 85° F. By the sixth day after planting the phenotypically pigmy-1 seedlings could be distinguished readily from their normal sibs. The seedlings were removed carefully from the flats and the soil was rinsed off of their roots. They were then classified by phenotype and by the lengths of their primary roots within the phenotype. The thirty most similar pigmy and thirty most similar normals were then selected out of the entire population of 400, each group being chosen from near the median of its size range.

The selected seedlings were re-planted, six of each phenotype in each of five cylindrical battery jars. The seedlings were alternated by phenotypes, being placed between the transparent glass wall of each jar and its lining of paper toweling; the jar was then packed with moist sphagnum.

Five temperature chambers, each accurate to 0.1° C, were available. Light and relative humidity were not controlled in these cabinets. The temperatures ranged from 10° to 30° C. in 5° increments. A battery jar containing six pigmys and six normal sibs was then placed in each of the temperature chambers. The

jars were left in the chambers for 15 hours to permit their contents to come to the temperature of the chamber. Measurements of root length were then made of each primary root of each seedling, from 12 hours to 48 hours after re-planting, at 12-hour intervals. The position of each root tip at the time of measurement was indicated on the outside of the battery jar by a mark made with a sharp wax pencil.

OBSERVATIONS

The total length of the primary roots from 12 hours to 48 hours after re-planting is shown graphically in Fig. 1. The growth curves are essentially arithmetic. Therefore the average increment and its standard error per 12-hour interval was calculated (Table 1). The rate of growth, when plotted against temperature (Fig. 2), also increases essentially arithmetically, except in the case of the normal sibs at the upper temperature limit; here the rate of elongation of the normal sibs appears to have achieved its maximum.

In every case the pigmy root grows at a significantly lower rate than does its normal sib at the same temperature (*cf.* Fig. 2 and Table 1). Thus, the pigmy root must be at a temperature of about 15° C. in order to grow at the rate of its normal sib at 10° C.; and must be at a temperature of about 30° C. to grow at the rate of its normal sib at 15° C. The higher the temperature, the greater the discrepancy in growth rates between the two.

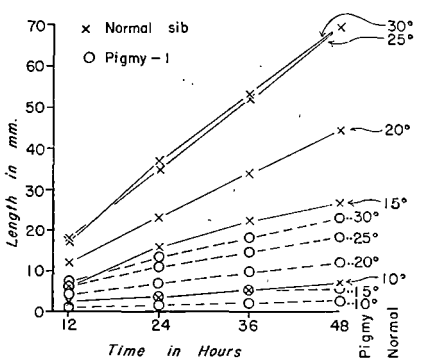

FIG. 1

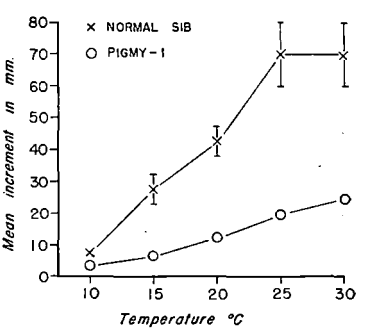

FIG. 2

There is still another difference from its normal sib in the expression of the mutant gene. Whereas the normal sib achieves its maximum growth rate at 25° C., the growth rate in homozygous pigmy is still increasing at 30° C. (*cf.* Fig. 2 and Table 1).

Thus our observations bring out, on the basis of the temperatures employed, two different types of response as evidenced in rate of elongation of the primary seedling root. One is that the pigmy

root grows at a much lower rate at any given temperature from 10° C. to 30° C. The other is that the pigmy root has not yet reached its maximum growth rate at a temperature (25° C.) at which the normal sib has already achieved its maximum rate of elongation.

In contrast to pigmy-1 stands the expression of the gene dwarf-1 with reference to temperature; as pointed out by Olmsted (1951), there is no significant difference between the growth rate of dwarf-1 primary roots and that of their normal sibs except below 13° C.

TABLE 1

Mean Increments in mm. of the Primary Root in Pigmy-1 vs. Normal Sib over a 48-hr. period.

Temp. °C	Increment in mm. Normal Sib[1]	Pigmy-1[1]
10	7± 1.5[2]	3±0.2
15	27± 4.6	6±0.7
20	42± 4.5	12±0.9
25	70±10.8	19±1.5
30	70±10.2	24±1.6

[1]Sample size = 6 at all temperatures both in Normal Sib and Pigmy-1.

[2]S.E. (for small samples)

LITERATURE CITED

OLMSTED, JOHN M. 1951. The influence of temperature on the somatic expression of a mutant gene (d-1) in some seedling organs of maize. M.S. Thesis, University of Minnesota.