TEMPERATURE AND SEEDLING EMERGENCE

by

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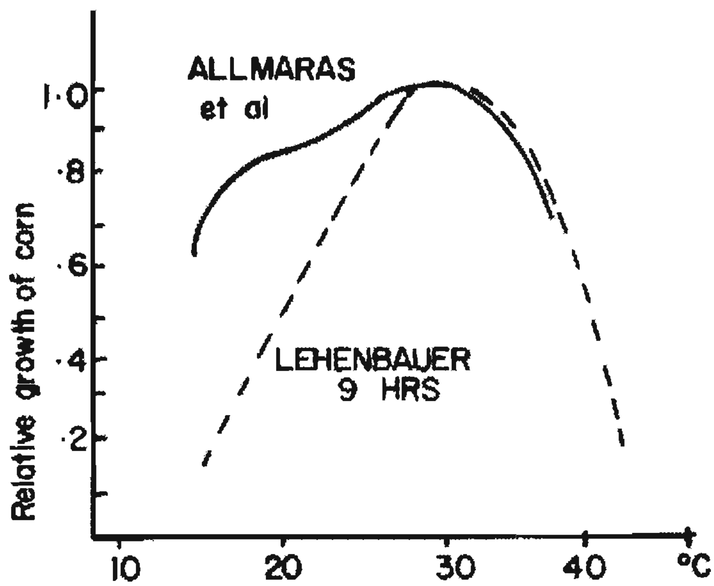
Effect of temperature on early plant growth has been investigated for a wide range of crop by several researchers in the past. The magnitude of soil temperature changes and its effects on corn growth has been discussed by Van Wyck et al (1959) and Burrow and Larson (1962). Lehenbauer (1914) and Willis et al (1957) have demonstrated, respectively, that variation in the root temperature and in the root and shoot temperature together had a marked effect on the rate of elongation of the shoot of corn.



Relative growth of corn as affected by different conditions of ambient root and shoot temperatures

Lehenbauer (1914) demonstrated that corn growth increased with temperature up to an optimum and then decreased with continued increasing temperature. The optimum relative growth was obtained around 31°C. In this studies soil and air temperatures were maintained at fixed levels. In greenhouse trials where a single average air temperature was maintained while root medium temperature was set at various fixed levels, Allmaras et al (1964) showed also an optimum growth rate at 31°C (Fig. 1).

Singh and Dhaliwal (1972) studied the effect of soil temperature on the rate of seedling emergence of various crops and plotted probits of per cent emergence against time. For each temperature they fitted a regression line of the form $Y = a + bT$ where

Y = probits of % emergence

a = constant

T = time in hours after sowing

The slope b was taken as an index of emergence rate. They observed that for maize at 40°C the percent emergence dropped by 40% and was 0 at 45°C, the optimum rate of emergence occurring at around 30°C.

With the development of maize production, attempts have been made to extend its geographic zone of culture. It implies, for the northern regions, the necessity of improving the tolerance to lower temperature, and involves seedling growth at low temperatures as well as survival after establishment and resistance to specific pathogens. Although conclusions from laboratory germination tests at low temperature differed sometimes from field performances, such could test procedures have been important in defining factors likely to impair seed viability (Bunting and Gunn 1973).

Despite the difficulties encountered, carefull screening techniques proposed by the breeders have led to the identification of varieties with tolerance to lower temperatures and chilling effect. Such varieties can be grown further north than ever possible before.

In the tropics the situation is at the other end of the spectrum and high temperatures can become limiting for maize growth, especially at early growth stages. At IITA, in early first season planting, when average temperatures are high, the maize breeder observed marked differences in germination and growth between lines. This indicated that susceptibility to higher temperature is associated with genetical characters.

Unfortunately, such "favorable" climatological condition providing the breeder with a simple and natural mean of selection for tolerance to high soil temperature only prevails for the very early planting.

Taking advantage of the decreases of soil temperature induced by the natural mulching provided by the no tillage practice (Data of Van Doren et al 1969, and Lal 1972 ...) the breeder developed a test of tolerance to high temperature applicable in all seasons by comparing germination under conventional and the above mentioned techniques. The higher the difference in % germination the greater the susceptibility to high temperature.

Such methods, however, require both time and space, as well as high labour input and are affected by soil micro-variability.

Greenhouse tests have been used by Dr. Lal (Walker 1969) to detect high temperature susceptibility of young maize plants, however, they require 2-3 weeks and only a small number of plants can be tested together. Moreover, most of such tests using seedlings are not realistic in the sense that they maintain a constant temperature throughout the medium in which the roots grow. In the field, the temperature gradient decreasing rapidly with depth, only the upper centimeters of soils are submitted to higher temperatures. Therefore, the germination phase is particularly affected by these high soil temperatures.

Fast and simple germination tests were carried out in our laboratory at various temperatures in agar - agar medium or on moist germination paper pads. A differential temperature germination test was finally set up by incubating seeds of various lines on germination pads at both 32° and 42°C. A "high temperature tolerance" index was proposed by calculating the ratio between germination counts at low and high temperatures after 48 hours. The higher the index the higher the susceptibility to high temperatures. Such a test can help the breeder in eliminating poorly germinating lines as well as high temperature susceptible ones. It is rapid and could permit the screening of a wide number of lines in a relatively short time.

However true genetical differences between lines could be better identified and defined with germination studies on a larger range of temperatures perhaps using the index of emergence rate of Singh and Dhaliwal as a screening tool. The lines with early growth tolerance to high temperatures would show a maximum index at such temperatures.

This technique could be used as one of the steps in the process of identification of a genotype adapted to high temperature conditions.

It was concluded that there was a need to study the relationship between different growth stages in tolerance to high temperature.

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