FD #74 2001 Final

Genetic Diversity of Peanut Germplasm for Base Temperature and Water-Use Efficiency

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Rationale and Objectives

Compared to most crops, peanuts are particularly susceptible to low nighttime temperatures (Bell et al, 1994). In the Texas High Plains, nighttime temperatures are often sub-optimal for peanuts during the early and late portions of the growing season. The rate of development increases more or less linearly as temperature rises above a base or threshold temperature (T_b). When temperatures are below T_b, plant development ceases. In general, T_b for peanuts is about 10 °C, or about 50 °F. This suggests that, for most peanut cultivars, growth and development will be very slow for much of the season in the Texas High Plains. If genetic sources for lower T_b could be incorporated into Texas material, then peanut production would become more feasible in the High Plains. Figure 1 shows the genetic variability for Tb found by Mohamad et al. (1988) for a small number of genotypes. Furthermore, In Texas and elsewhere where water supplies are limited, plant breeders have sought to increase the ratio of photosynthesis to transpiration, which has been shown to be negatively correlated with discrimination for ^{12}C and against ^{13}C ("carbon discrimination," or δ) for peanut (Hubick et al., 1986).

The objective of this study was simply to assess the degree of genetic variability for T_b and δ within Texas germplasm, and to compare T_b and δ values of Texas material to those of exotic materials. Based on the amount of variability for these physiological traits, we would decide whether to proceed further to examine their heritability.

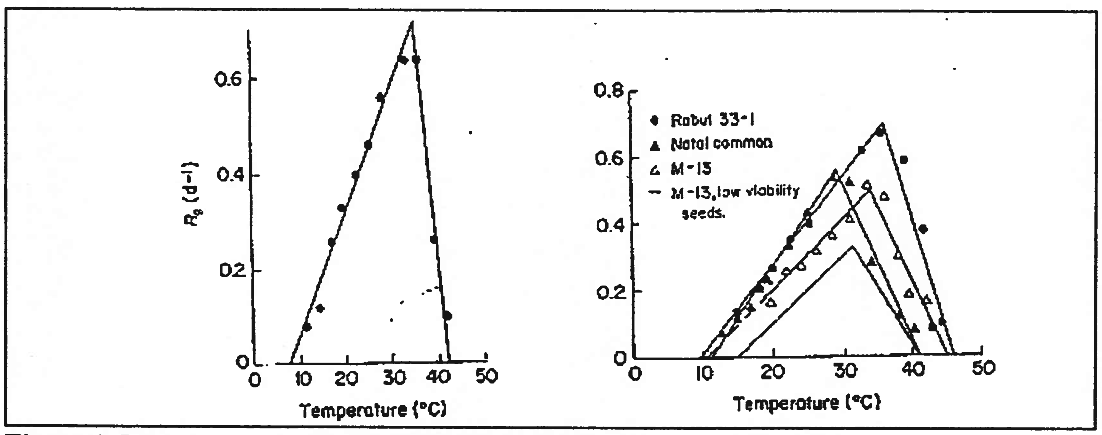

Figure 1. Base temperature of germination of three peanut genotypes, from Muhamed et al. (1988). The left- and right-most zero intercepts represent temperature base (T_b) and temperature ceiling (T_c), respectively.

Current Status

Figure 2. Germination percent of 44 peanut entries at 30° C

Since December we have had still another breakdown of the growth chamber, and are currently waiting for its repair. Additionally, a new chamber is on order. We did complete evaluation at 30 °C of a total of 44 entries (Fig. 2), which already shows a wide range of genetic variability for emergence rate at this particular temperature. These materials were furnished by Dr. Charles Simpson of Texas, Dr. Roy Pittman, curator of the USDA peanut gene bank in Griffith, Georgia, and Dr. Tom Isleib, peanut breeder at North Carolina, who provided hirsuta material. The North Carolina and gene bank material represent diverse peanut germplasm from high elevations or otherwise cool climates from throughout the world, including China, Bulgaria, Bolivia, Zimbabwe, Ecuador, Peru, and Texas (see Table 1). There are at least 200 seeds for each entry. Additionally, we have made arrangements to have ground leaf samples analyzed with a mass spectrometer at the Pantex facilities for carbon isotope discrimination. Finally, I brought back seeds of two local Chinese varieties that are grown at high altitudes near Xian. These are being grown out for seeds by Dr. Pittman in Georgia.

As temperature treatments are completed, we will be using the same statistical regression technique, which involves plotting rate of development (germination, emergence, and leaf appearance) against temperature, to calculate T_b . Similar procedures have helped identify sorghum cultivars from South Africa and Ethiopia highlands with T_b values as low as 6.5 °C, which is significantly lower than values reported thus far in the literature (see Fig. 3). Because of slow development at lower temperatures, we anticipate that this experiment will continue for three months after the old growth chamber is repaired, or the new one arrives. This will be followed by a processing period for carbon discrimination analyses. A supplementary report will be provided to the Texas Peanut Producers Board at that time that summarizes opportunities for genetic improvement of these traits.

We very much appreciate the support of the Texas Peanut Producers Board and are happy to answer any questions concerning this study.

Table 1. Characterization of 44 peanut entries being evaluated for temperature base (T_b) and carbon isotope discrimination (δ).

Background	**Plant Name**	**Seed Source**
China, Jiangxi	Jianqxi 1	ARS Genebank
Bolivia, La Paz	Mani Blanca	ARS Genebank

Bulgaria	Porto Alegre	ARS Genebank
Bulgaria	Spanish	ARS Genebank

(Con't)

Table 1 (con't). Characterization of 44 peanut entries being evaluated for temperature base (T_b) and carbon isotope discrimination (δ).

Background	Plant Name	Seed Source
Bolivia, Tarija	US 16	ARS Genebank
Zimbabwe	TGR 174	ARS Genebank
Zimbabwe	TGR 265	ARS Genebank
Zimbabwe	Kasawaya	ARS Genebank
Zimbabwe	TGR 879	ARS Genebank
Zimbabwe	Kasawaya	ARS Genebank
Bolivia, Tarija	US 832-4	ARS Genebank
China	INGKO SULIHUNG	ARS Genebank
China	Te Tow	ARS Genebank
Ecuador, El Oro	US 700-2	ARS Genebank
Peru, Cuzco	US 412	ARS Genebank
Peru, Cuzco	US 420	ARS Genebank
Ecuador	US 698-1	ARS Genebank
Ecuador, Loja	US 728-1	ARS Genebank
Peru, Huanuco	US 458	ARS Genebank
Bolivia, Chuquisac	US 621-2	ARS Genebank
Bolivia, Chuquisac	US 635	ARS Genebank
Ecuador	US 733	ARS Genebank
Ecuador, Loja	WWT-1357	ARS Genebank
Bolivia	Janide turitchi (T)	ARS Genebank
Texas	Coan	Charles Simpson
Texas	Flavor runner 458	Charles Simpson
Texas	Florunner	Charles Simpson
Texas	Georgia Green	Charles Simpson
Texas	Langley	Charles Simpson
Texas	Spanco	Charles Simpson
Texas	Tamrun 96	Charles Simpson
Texas	Tamrun 98	Charles Simpson
Texas	Tamspan 90	Charles Simpson
Texas	TX 901639-3	Charles Simpson
Texas	TX 962120	Charles Simpson
Texas	TP 301-1-8	Charles Simpson
Texas	US 224	Charles Simpson
Texas	7006	Charles Simpson
Hirsuta 01	L OAN	Sherwood Pendergraft (Isleib)
Hirsuta 2	L OAN	Sherwood Pendergraft (Isleib)
Hirsuta 3	L OAN	Sherwood Pendergraft (Isleib)
Hirsuta 4	L OAN	Sherwood Pendergraft (Isleib)
Hirsuta 5	L OAN	Sherwood Pendergraft (Isleib)

Hirsuta	6	L OAN	Sherwood Pendergraft (Isleib)

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gure 3. Germination rate of cold-sensitive (left) and cold-tolerant (right) sorghum genotypes. The point at which the line intersects the x-axis is Tb.

<u>References</u>

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