COMPARATIVE RESPONSES OF KAOLIANG AND OTHER GRAIN SORGHUM TYPES TO TEMPERATURE

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SORGHUMS are a typical warm-season crop. Planting them in soil at low temperatures is deleterious to rapid establishment and vigorous seedling growth. Perhaps considerable variation in low temperature tolerance exists among currently available genotypes, but little information is available on this.

Most sorghums originated in tropical areas near the equator (5), but Vavilov (5) places the origin of kaoliang in the Chinese center of crop origin. This center includes the mountainous regions of central and western China and their adjacent lowlands. Most kaoliangs are tall and have dry, woody, slender stalks. In general, they are sparsely leaved (3). Because of their northerly origin, it is reasonable that the kaoliangs might germinate and grow at lower temperatures than present-day grain sorghums grown in the United States (2). No critical data are available on this question, however, and only limited information is available on temperature-germination responses in sorghums. Martin et al. (4) germinated four types of sorghum in soil at temperatures ranging from 15° to 35° C. Emergence percentages varied from 62 at 15° to 81 at 30°. Days required from emergence to the 4-leaf stage were 24, 15, 12, 11, and 9, respectively, at 15°, 20°, 25°, 30°, and 35°. Similar results were obtained by Evans et al. (1), who found emergence through soil of 10 sorghum varieties to be significantly affected by temperature and the interaction of variety × temperature.

The present study was initiated to compare responses of standard grain sorghum varieties and kaoliangs at different temperatures.

EXPERIMENTAL PROCEDURE

Field Tests

Initiated in 1959, the experiments were continued in 1960. Six dates of planting were made, from late April to mid-June, using 6 kaoliangs with 3 standard grain sorghums as checks. The kaoliangs evaluated were Brown Waxy (P.I. 82335), Thick Rind and Dry (P.I. 136923), Manchu Brown (P.I. 171), Wetland Dwarf (P.I. 25240), White Waxy (P.I. 63923), and Chusan Brown (P.I. 25351). Standard grain sorghum varieties used were Norgham (early), Midland (mid-season), and Redian (late). Soil temperatures at the 2-inch depth indicated that the April plantings were sufficiently early to involve suboptimum soil temperatures. The experimental design was a split plot. Whole plots were planting dates and subplots were varieties. Data were obtained on rate (1959) and extent of final emergence (1959 and 1960).

Controlled-Temperature Studies

Laboratory growth chambers were used to provide temperature control (±2°). In the first experiment, the 6 kaoliangs and 3 standard varieties were germinated in Petri dishes and in flats of soil at 50, 60, 70, 80, and 90° F. Daily counts were made to obtain information on rate and extent of laboratory germination and emergence in soil. Early seedling growth in the soil series was measured by harvesting seedlings grown at each temperature 3 days after complete emergence. Each entry was replicated three times at each temperature.

A second experiment involved determining the actual and relative dry-matter increases of 3 kaoliangs and 3 standard varieties during a 7-day growth period. Paired rows of each entry were planted in flats in the greenhouse. Time of planting was adjusted so that degree of seedling development among entries would be similar (2-leaf stage). One row of 25 seedlings was harvested from each pair just before placing flats into the growth chambers at 55°, 65°, and 75° F. Dry weight per seedling from these rows was considered as a "base weight". After 7 days under controlled temperature, the seedlings were cut at the soil surface, dried, and weighed. The actual growth (increase in dry matter) and relative growth from the base weight could then be ascertained. Each entry was replicated three times in each temperature chamber.

A third experiment involved measuring the rate of emergence and dry-matter accumulation of 3 kaoliangs and 3 standard varieties. Seeds were planted in soil in 8-inch pots and placed in temperature chambers at 60° (below optimum) and 80° F. (near optimum). These temperatures were chosen so that more information could be obtained on comparative growth rates of kaoliangs and standard grain sorghums at suboptimum and near-optimum temperatures. Approximately 40 seedlings per pot were established.

Seeding harvests were taken at a "base date," which was considered as the date of complete emergence. Subsequent harvests were made 4, 8, 12, and 16 days later, a total of 5 harvests. On the "base date," plants were sampled so that 25 plants remained in each pot. At each remaining sampling date, six random plants were removed, dried, and weighed so that growth rate could be estimated. Data on rate and extent of emergence were also obtained. Each entry was replicated three times in each temperature chamber.

Statistical analyses of all data were carried out by the Kansas State University Statistical Laboratory.

RESULTS AND DISCUSSION

Germination and Emergence

Results of field tests are summarized in Table 1. Field emergence percentages are expressed as a percentage of laboratory germination to minimize bias due to differences in germination among seed lots. In 1959, stand establishment was limited by the low soil temperatures prevailing during early plantings. For 1959 data, analysis of variance revealed highly significant differences (1% level) among dates of planting, among entries, and for the date × entry interaction. The "standard variety" vs. kaoliang comparison also revealed a highly significant variance. Kaoliang entries were superior in field emergence, particularly in early plantings (low soil temperatures). As soil temperatures increased, the relative superiority of the kaoliangs decreased and, thus, the significant date × entry interaction.

On the average in 1960, kaoliangs and standard checks were not substantially different in field emergence. As noted by the high emergence percentages (based on laboratory germination), however, conditions were more favorable for emergence in 1960. Soil temperatures at a 2-inch depth during comparable periods were higher in 1960 than in 1959. Statistical analysis of the 1960 data revealed highly significant differences among dates, among entries,