LIGHT AND WATER STRESS IN MAIZE CULTIVARS IN THE LOWLAND TROPICS

by

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Maize production in the lowland tropics is limited by several environmental factors including low radiation inputs, high soil temperature in the early growth stages, high night temperature and irregular rainfall resulting in temporary drought stresses. In assessing climatic influence on the pattern of crop growth and development, the measurement of dry matter accumulation and distribution in various plant parts can yield valuable information of critical growth stages affected by the climatic variables which then allows identification of genetic material with desirable physiological traits suited to various environmental constraints.

The work reported here involves the influence of light and water availability where different planting densities have been used to imposed differing degrees of interplant competition in the field, and more detailed controlled studies of water stress have been conducted with single plants grown in pots.

Two field growing seasons have been completed using 3 maize populations, composite TZB (IITA improved breeding cycle 3), composite TZPB (IITA selection from CIMMYT planta baja) and a Nigerian liguleless composite ABCD. Each of the populations were grown at 3 planting densities of 25, 50 and 75×10^3 plants per hectare. Serial harvests were made at 8 specific growth stages during the life cycle to determine growth and development of the aerial plant components.

As plant density increased, a reduction in dry matter accumulation per plant occured but the loss in production per plant was more than compensated by increasing density. The dry matter partitioning and yield data are described in brief in IITA Annual Report 1974 (p.164). A delay in ear formation occured at high plant density with a delay in translocation of assimilate to the ear. Carbohydrate analysis of the plant parts is being conducted to obtain more detailed information of the role of the stalk as an 'intermediate' sink. Since crop growth rates were in the range 150-200 gm^{-2} $week^{-1}$ during the 6th-8th weeks after emergence, ear production *per se* seems to be a major limiting factor to yield in lowland tropical maize.

In the first season of 1974, the plants were under water stress for approximately 4 weeks prior to flowering and this was particularly evident in 2 of the 5 replicated plots grown on a more sandy soil with a low water-holding capacity and a lower rate of dry matter accumulation occurred.

A pot experiment was set up to determine the influence of drought stress at different stages of development of composite TZB. The pattern of water consumption is shown in Fig. 1 for unstressed controls (watered daily) and for plants subjected to a regular stress between 22 and 81 days after seedling emergence (watered every 3 day). Plants were also subjected to the same stress for 15-18 day periods during vegetative, flowering, and early grain filling stages, respectively. Growth analysis harvests were taken at 5 intervals during the life cycle. No difference in the rate of emergence of leaves in the different water-stress treatments was observed but leaf expansion was slower, with delay in ligule appearance, in stress plants. Leaf area and leaf dry matter production was reduced in the stressed plants but controls had a faster rate of leaf senescence. Plants stressed in the vegetative stage had reduced stem elongation but increased in height at the end of the stress period. Changes in the relative growth rate (R) in the different stress periods, shown in Fig. 2, were related to reduction in net assimilation rate during water stress. The effect of stress on ear components is shown in Table 1, and in the 22-81 day stress treatment, yield reduction was associated both with a lower kernel number and kernel weight. Stress in the vegetative phase had no effect on number or weight of kernels per ear whilst stress during flowering reduced both parameters. Water stress during grain-filling led to yield decrease by reduced weight of kernels. Thus water deficits during different stages of development affect yield through different components. A more detailed study of drought stress during the pre-flowering period of growth is being

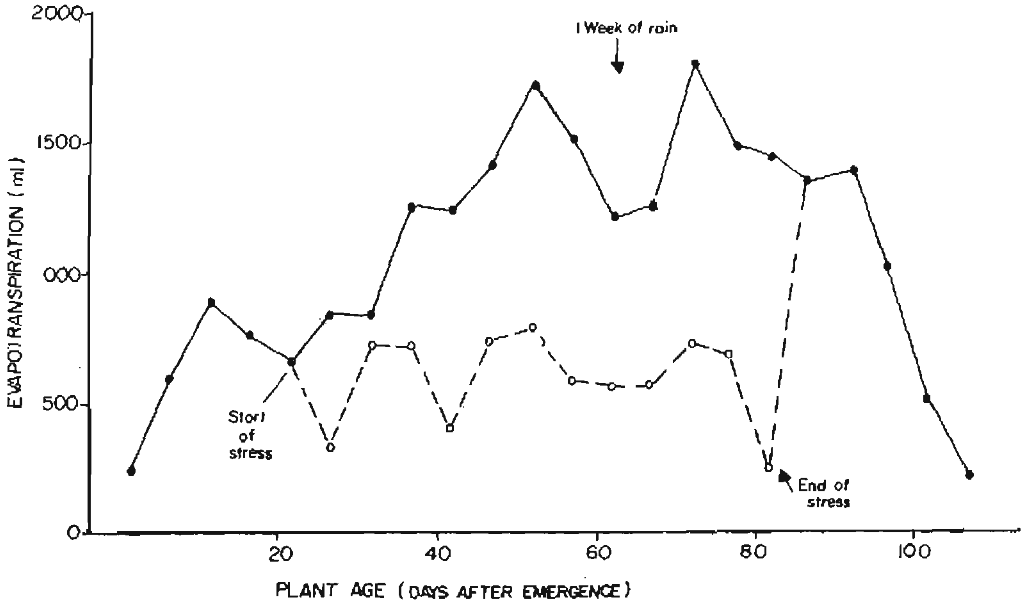

Fig. 1: Water consumption of maize (TZB) in pentades for unstressed (.) and water-stressed plants (o) grown in pots during the dry season.

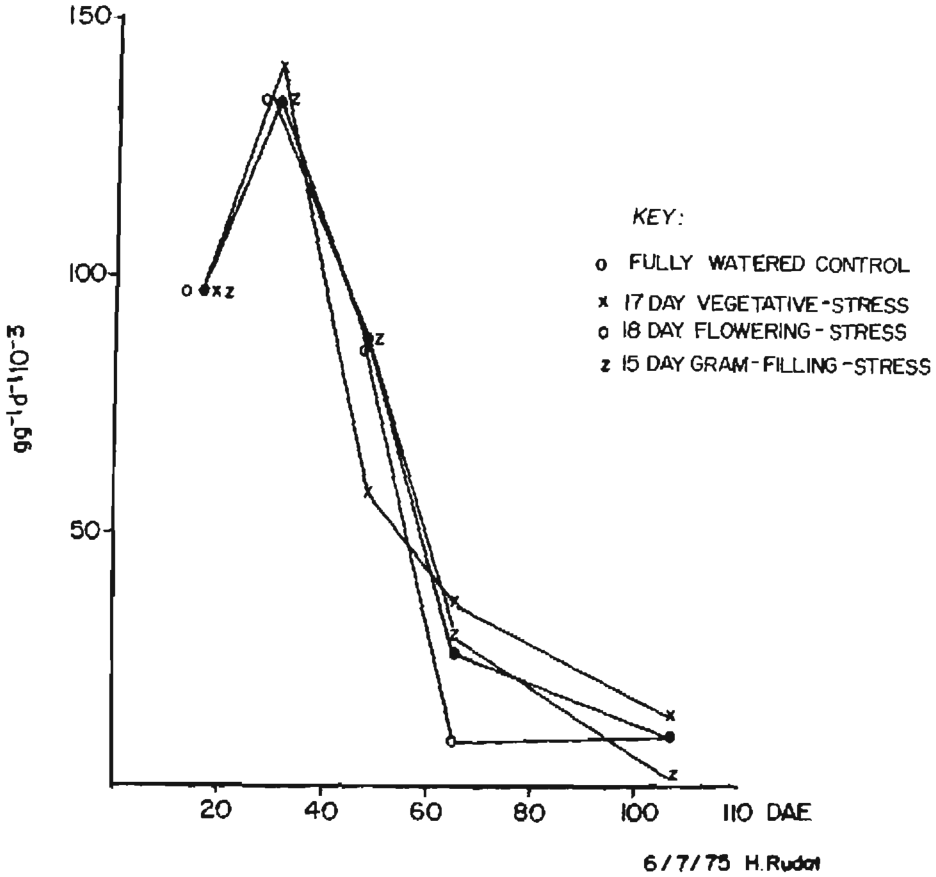

Fig. 2: Effect of water stress during different developmental stages on relative growth rate of maize composite TZB.

Table 1
Yield components in maize (TZB) under water stress

Water stress Treatment	No. of rows per cob	No. of Kernels per row	1000 Kernel weight(g)
Control	14	30	219
22-81 days	16	21	176
vegetative (j7d)	14	23	213
flowering (18d)	14	26	184
grain-fill (15d)	14	29	156

conducted since climatic data indicate a higher probability of water deficit at this stage of maize growth in the IITA area.