

Stomate Distribution of Three Pearl Millet Genotypes

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INTRODUCTION

Stomates regulate transpiration and carbon assimilation mainly by changing their apertures. Stomate number, distribution, size and shape can also be factors that regulate water use and may be considered in selecting plants for water limited environments. In this study, stomatal distribution and frequency were determined on a pearl millet hybrid and its parents grown under variable moisture conditions. This is part of a study in which stomatal regulation of photosynthesis and transpiration during the entire growing season are being evaluated.

PROCEDURE

A pearl millet hybrid and its parents were grown under field conditions at Campus Agricultural Center in Tucson during the summer of 1985. Each of the genotypes was exposed to a gradient of water stress created by a single line-source sprinkler irrigation system. Stomatal impressions of each genotype were taken at three selected stress levels using clear cellulose acetate. Such impressions were taken every 7 to 10 days on the youngest and fully expanded leaves until maturity. Impressions were also made late in the blooming stage on every leaf of four hybrid plants. Stomatal counts were made on each impression with a light microscope. Measurements of net photosynthetic and transpiration rates were also made.

RESULTS AND DISCUSSION

Comparison of stomatal densities showed that the female parent had a lower number of stomates per unit leaf area than the other genotypes. This was true for both sides of the leaf and at all stress levels (Figure 1a). The ratio of lower (abaxial) to upper (adaxial) stomate density was higher for the female than for the male or the hybrid.

Stress usually increased stomatal density on both sides of the leaves in all genotypes. Stress also increased the ratio of abaxial to adaxial stomates which may be interpreted as stomates on the lower leaf surfaces were more affected by stress. The stomate ratio for all genotypes and stress levels during the season ranged between 1.0 and 1.4. The highest ratio were observed on the female parent.

Stomatal densities increased during the season on both surfaces of the leaves in all the genotypes and at all stress levels (Figure 1a). Since measurements were made every 7 to 10 days on leaves that emerge periodically, the stomatal density increase during the season can be attributed to differences in the positions of the leaves on the plants. Counting stomates on all leaves of a plant supported this idea. Stomate densities of fully expanded leaves increased from the bottom to the top (flag) leaf (Figure 1b).

Similar results are reported for other crops (Cole and Dobrenz, 1970; Miskin and Rasmusson, 1970). Differences in stomatal frequencies are generally attributed to differences in leaf area (Gupta, 1961; Ciha and Brun, 1975). We found that as stomatal density increased, leaf area decreased. The flag leaf is exceptionally small but is denser in stomates and may probably be better in water use efficiency than other leaves.

Measurements of net photosynthetic and transpiration rates showed that both variables decrease from the flag leaf down to the bottom leaf. This followed the same trend as the stomate density. Photosynthesis and transpiration, however, do not depend only on the number of stomates because other factors such as leaf age, radiation penetration into the canopy and other factors can also be involved.

In summary, the results show that variability in stomate frequency exists among genotypes. However, whether this variability can lead to differences in water use is a question that needs to be evaluated. The results also show that stomate frequencies, photosynthesis and transpiration change with the position of the leaf. The variability in stomate frequency at different developmental stages may be of some advantage to the plant in adapting to a particular environment. Water stress seems to affect stomates of upper and lower leaf surfaces differently.

REFERENCES

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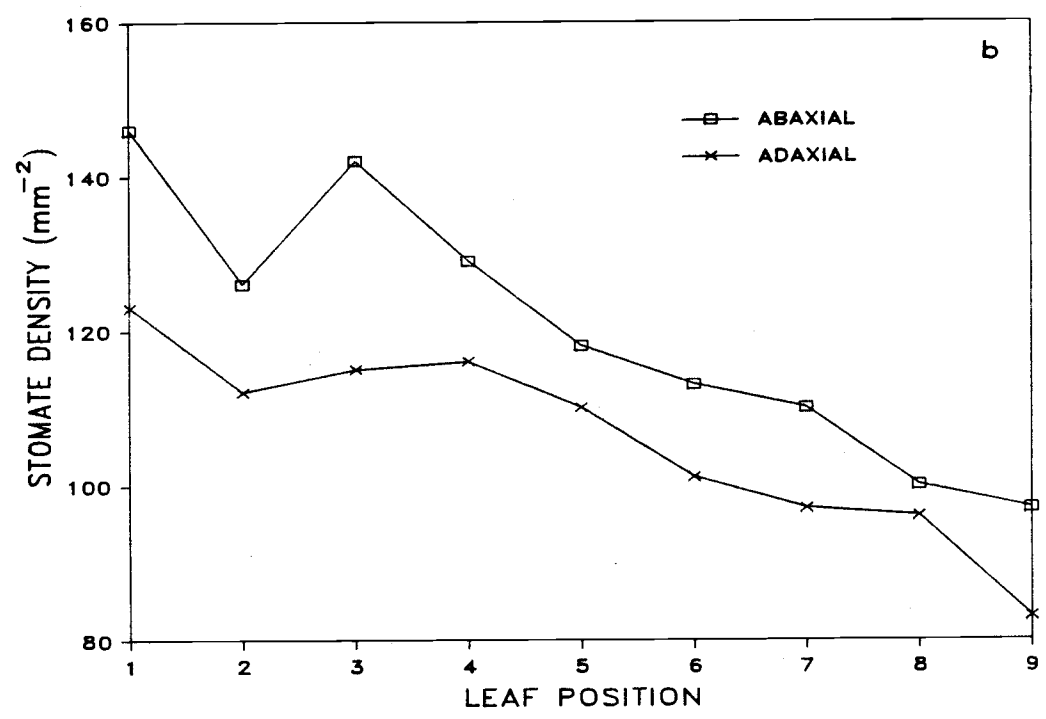
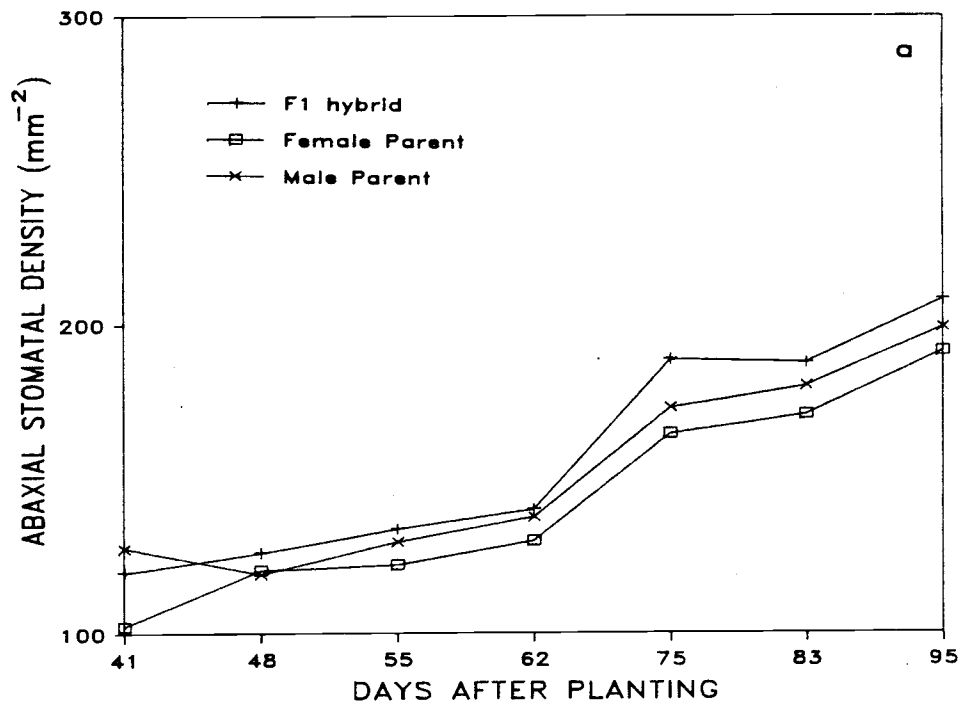


Fig. 1a. Seasonal changes in stomate densities of a pearl millet hybrid and its two parents at low moisture level.

Fig. 1b. Changes in stomate densities due to leaf position on the hybrid plants.

