A Parallel-Planted Irrigation Gradient System for Evaluation of Physiological Characteristics in Sorghum

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Summary

A sprinkler irrigation gradient system has been set up in Tucson to evaluate physiological and morphological responses of grain sorghum to varying levels of water stress. By planting a genotype in parallel rows which form a block running perpendicular to a single sprinkler line multiple water levels are possible with many plants available for study at each level.

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Evaluation of crop response to drought stress must involve growing plants under high as well as low moisture conditions. For field studies, some method of differential irrigation is required. A line-source sprinkler irrigation gradient system is an effective means of investigating crop drought response.

The basis of this irrigation system is that as the distance from sprinklers increases, water application rates drop. Genotypes planted perpendicular to single line of closely spaced sprinkler risers receive a whole spectrum of water applications depending on the distance from the line-source.

Such an irrigation system has been set up in Tucson to study drought response of sorghum. Single genotypes were planted on 1 meter beds in blocks consisting of fourteen 4.6 meter plots. A sprinkler line with risers every 6 meters was laid down parallel and adjacent to the end row. Replications were made by planting four blocks of each line, two on each side of the pipe (Figure 1.) This planting pattern is different from the perpendicular row planting used in most gradient systems and it provides a large number of plants for evaluation under each water level.

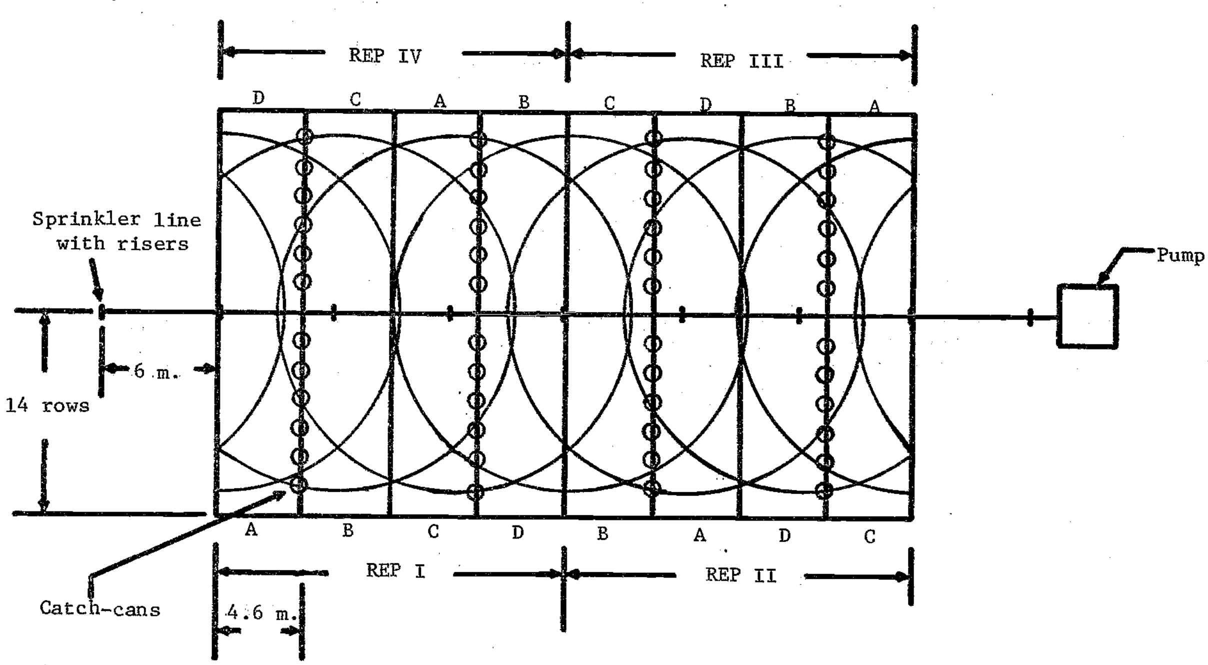

Figure 1. Field plan for sprinkler irrigation gradient system. Sprinkler patterns overlap uniformly to create a decreasing water application rate, as the distance from the irrigation line increases. Catch-cans are used to confirm this. Single genotypes are planted in blocks made up of 14 rows, each 4.6 meters long, running parallel to the sprinkler line. Replications are established by planting on both sides of the sprinkler.

The field received one pre- and one post-planting surface irrigation before the sprinkler system was installed. The sprinklers were first turned on thirty-three days after planting. Catch-cans were used to measure water applications. Plots closest to the pipe received maximum irrigation and subsequent plots further down the gradient each received approximately 14% less water than the one before it. The most distant row from the sprinkler received only 20% of the maximum irrigation in the first plot.

Physiological and morphological responses of the crop to different levels of drought can be evaluated by taking various measurements at each of the water treatment levels. Photosynthesis and transpiration measurements were taken on Combine Kafir-60 53 days after planting (Figure 2.) Photosynthesis of the uppermost mature leaf was taken using an infrared gas analyzer. Leaf transpiration rates were determined with a LI-1600 Li-Cor porometer. Temperature in the field on this day was 99°F (37°C).

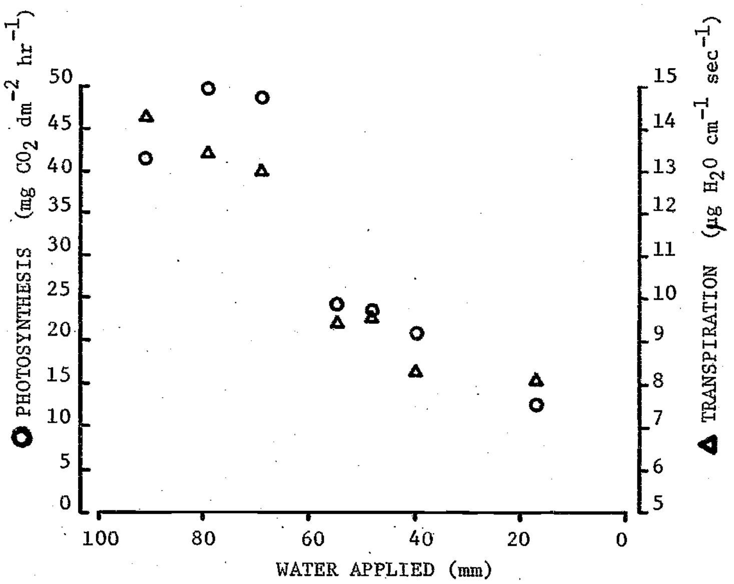

Figure 2. Photosynthesis and transpiration of CK-60 grown in the Tucson irrigation gradient system. June 17, 1983. Data represent the average of four replications at each water level.

Photosynthesis and transpiration rates declined similarly as water application rates dropped. This confirms that as drought stressed sorghum plants reduce water loss by closing leaf stomatal pores CO_2-uptake is also inhibited thus lowering total plant growth. The greatest drop in these two rates occurred in plots receiving about 65 mm. of water.