

## SPRINKLER IRRIGATION SCHEDULING IN HUMID AREAS WITH THE EASY PAN

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### ABSTRACT

The UGA EASY Pan Sprinkler Irrigation Scheduler is introduced as a simple, yet effective, method of scheduling irrigations in humid area row crop production. The device uses a wash tub, a toilet bowl float unit, and a covering screen. The unit can respond to both evaporation (as related to crop water use) and precipitation. The EASY Pan can be read from a distance allowing irrigation management personnel to determine crop water status without exiting a field vehicle. Preliminary field tests in South Georgia on peanuts and cotton indicate reasonable effectiveness when compared to standard irrigation scheduling approaches. Additional data is required to fully verify the pan's effectiveness. The simple nature of the unit allows in-field tests by farmers or other persons for their crop, soil and climate conditions.

### INTRODUCTION

Irrigation scheduling for efficient water management in humid areas remains as one of the critical needs in humid area row crop production under sprinkler irrigation. Many techniques have been recommended for use by farmers: checkbook, moisture blocks, tensiometers, computer models, etc. (Yoder et al., 1998). The vast literature on conventional irrigation scheduling methods will not be reviewed in this paper. Suffice it to say, if soil water is managed properly, i.e., it is replenished within an appropriate time period before plants are stressed, irrigation has a positive benefit toward crop production. In the humid area, irrigation historically was designed to "supplement" rainfall. If rainfall was satisfactory, irrigation applications could be postponed until water needs increased. Therefore, irrigation scheduling in the humid regions is a prime target for "neglect". If records and instrumentation are not maintained consistently, even through periods of rainfall, schedules are disrupted, and irrigation applications are poorly timed with inappropriate amounts of water being applied.

The relationship between pan evaporation and evapotranspiration under a crop

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canopy has been investigated and used extensively as an alternative to installed soil water sensors for irrigation scheduling (Wolfe and Evans, 1964; ). A relationship does exist between surface evaporation and consumptive use of crops, if certain conditions are met. A free water surface exposed to excessive wind and solar radiation may not respond the same as a plant canopy. If some form of "covering" or wind protection is provided for the pan surface, the relationship improves.

The typical Class A evaporation pan found in many weather station applications is the standard in evaporation measurements, but they are rather expensive (most are stainless steel) for individual farmer applications. The use of alternative, less expensive, evaporation measuring devices provided the foundation for the UGA EASY Pan.

The use of alternative evaporation-based devices is not new. Torres (1998) used a plastic bucket as a visual device for irrigation scheduling of sugarcane in Colombia. The device was designed to work as a rain gage and as a measuring device for evaporation. The bucket approach had two settings, one for irrigation of sugarcane younger than four months, and one for older than four months. The depth of the bucket was checked periodically to determine the need for irrigation. An overflow "hole" allowed excess rainfall to leave the bucket as the soil profile was returned to field capacity. The need to consistently check the plastic bucket elevation, eliminate algae growth and animal impacts, and maintain good working conditions over the long sugarcane growing season makes this particular approach ripe for damage and neglect. In addition, the user was still required to go to the bucket to obtain a water depth reading.

Westesen and Hanson (1981) reported results of irrigation scheduling using a wash tub as the evaporation scheduling device. Their approach used a no. 1 washtub with a wire screen on top to keep animals out. Their approach to managing water included a separate rainfall measurement to take into account effective rainfall conditions. The elevation of the pan and the raingage had to be read consistently while maintaining good bookkeeping records. Recommendations for "how much" rainfall was considered effective had to be calculated as well. The user was also required to go to the wash tub to get a water level reading. This particular approach worked reasonably well, but was poorly accepted by local farmers in Montana.

The problem with most of these techniques is the maintenance required, the additional time spent in determining the status of the water level in the tub, and whether the pan level truly represents soil water conditions. Experience with row crop farmers in South Georgia indicates that new technologies will be considered as long as it does not take too much time (or none of their time), does not interfere with field operations, is reliable, makes good recommendations, and is not too expensive.

A prime example of technology adoption for irrigation scheduling is the implementation of model-based systems like Irrigator Pro<sup>CS</sup> (a development of the USDA, ARS, National Peanut Laboratory, that is currently marketed through the Peanut Foundation, Inc., Davidson et. al, 2001). This particular system is currently available for peanut irrigation scheduling only. Other crops are anticipated to be added to the system, but the expert-system based recommendations will require significant development for some other crops. No widely used irrigation scheduling model techniques are currently being used for humid area applications for many of the potential crops that are being grown (cotton, corn, soybean, vegetables, etc.).

This paper describes the working characteristics of the UGA EASY Pan (Evaporation-based Accumulator for Sprinkler-enhanced Yield). How the pan works, its relationship to other irrigation scheduling technologies, and relative costs will be discussed. For additional information on the UGA EASY Pan (including construction schematics), the reader is referred to the Cooperative Extension Service Publications of the University of Georgia, Biological and Agricultural Engineering Department (Thomas et al., 2001).



Figure 1. The EASY Pan Irrigation Scheduler in operation on cotton research plots.

## MATERIALS AND METHODS

The EASY Pan Irrigation Scheduler includes a no. 3 galvanized washtub, a screen cover, a float system, and an indicator back plate (Fig. 1). The washtub has at least two holes drilled at 90 mm (3.5 inches) from the top of the tub. These holes allow excess rainfall water to be removed from the pan (as is similar with soil). The covering screen can include a variety of different materials.

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<sup>5</sup>The use of tradenames, etc. in this publication does not imply endorsement by the University of Georgia of the product named nor criticism of similar products not mentioned.

The primary purpose for the screen cover is to keep animals out and provide some level of limitation on the evaporation rate (Fig. 2). In tests in South Georgia, 25 mm (1 in.) to 50 mm (2 in.) mesh chicken wire has performed well with peanut irrigation. Standard window screen has worked well with cotton (see field test section). Since both these crops have very different relationships to pan evaporation, the limitation on air contact and the reduction in temperature for the free water surface reduces the evaporation rate when using the window screen.

The unique operating characteristic of the unit is the float and indicator arm. The float is mounted on an aluminum rod that can be lengthened or shortened based on the soil water holding characteristics, the rooting depth of the crop, and the management allowed depletion (MAD) for the crop. Since free surface evaporation is more available and consistent than soil water removal by plants, the relationship is strong, but is not always "one to one". However, on the average, which is the benefit of this type device, the relationship is good.

### Field Tests

Preliminary irrigation scheduling tests were conducted over a two year period to test the EASY Pan recommendations for irrigation scheduling. Two years of tests were performed on cotton and peanuts. The first application of the EASY pan was in 1995. The 1996 season was used to test the response of different screen materials on the evaporation from the EASY Pan. The peanut irrigation season in 1997 resulted in some logistics problems with the irrigation application system.

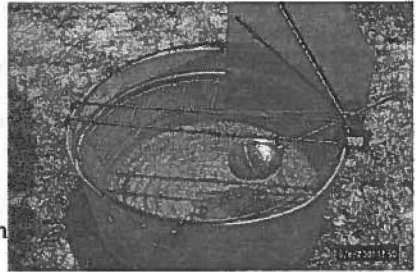


Figure 1. Entire system. When the water is full, the white indicator arm covers the black line. As water is removed, the indicator arm moves toward the red line (irrigate).

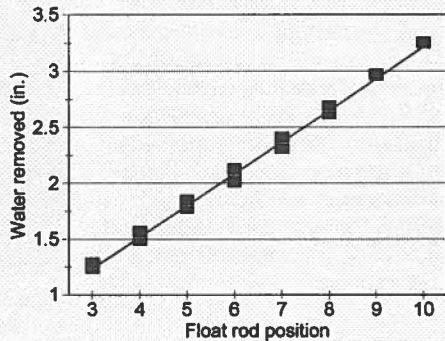


Figure 3. The relationship between water removed and the float rod position based on the indicator arm moving from field capacity, black line on the back board, to irrigation required, red line on the back board (15 degrees).

Those data are not included in this discussion. The following results are preliminary, but are indicative of irrigation scheduling trends between the different approaches. All field management, planting date, chemical application, and treatment information for the cotton and peanut field tests are available on the following web site:

<http://nespal.cpes.peachnet.edu/agwateruse/research/default.asp>.

1995 Cotton: Cotton (Georgia King) was grown on the Gibbs Research farm near Tifton, GA on a Tifton loamy sand in a randomized complete block design with five replications, using solid set sprinkler irrigation (Rainbird 35A PJ-ADJ-TNT sprinklers with #11, 11/64 in., nozzles for an 8 mm/hr application rate with all sprinklers operating full circle). Each irrigation plot was 14.6 m x 11 m. The treatments were: 1) soil water content scheduling: if the average soil water content in the 10 to 45 cm depth exceeds 35 kPa, schedule an irrigation for the next day, 2) irrigation schedule based on the Neogen Envirocaster<sup>®</sup> recommendations for cotton production, 3) the EASY Pan with 50 mm (2 in.) mesh wire screen and the float rod set at the 5 in. position, and 4) no irrigation.

1997 Cotton: Cotton (DP5415) was grown at the same research site and plot design as in 1995 with treatments (that are important to this discussion) of: 1) same as treatment 1 from 1995, 2) water applications based on the Extension Service checkbook scheduling method: replace needed water once each week, 3) the EASY Pan with standard wire window screen and the float rod set at the 5 in. position, and 4) no irrigation.

1995 Peanut: Peanut (Georgia Runner) was grown at the Gin House Field site in Tifton, GA, on a Tifton loamy sand in a randomized complete block design with four replications, using the same sprinklers as in the cotton trials on a 12.2 m x 12.2 m plot spacing. The treatments important to this discussion were 1-4, the same as the 1995 trial for cotton production: 1) soil water content scheduling, 2) Neogen sensors, 3) EASY Pan with 50 mm mesh wire screen, and 4) no irrigation.

## RESULTS

For each of the following results, some irrigation water was actually applied to the "no irrigation" treatment at the beginning of the season to get the crop up.

The 1995 cotton season resulted in the following yields (Fig. 4) and water applications (Fig. 5). The 1995 growing season was relatively dry. The EASY Pan had the highest recommended irrigation application, which was not reflected in the yield. This particular result was the primary reason for switching the screen material for the 1997 season.

The 1997 cotton season resulted in the following yields (Fig. 6) and water applications (Fig. 7). Irrigations scheduled with the EASY pan were slightly less (151.4 mm) than those applied by the control treatment (156.4). Very little difference in yield was reflected by those two treatments. The current Extension Service recommendations for cotton irrigation resulted in a relatively large application amount with no direct yield benefit for this trial. The EASY Pan irrigation recommendations appeared to be very similar to those based on soil moisture management.

During the 1997 cotton season, the position of the float arm was measured three times per week to determine the response characteristics due to evaporation and rainfall. Fig. 8 illustrates the degree change over time. The "0" degree value represents "field capacity" for the soil. Obviously, the pan is much more responsive to water application by precipitation or irrigation than would be expected with the soil. One characteristic of interest, is the EASY Pan response to "deficit irrigation". Irrigation events on 7/16 and 9/10 did not return the pan (or soil) to the field capacity (0 degree) position. Therefore, some of the rainfall following the 7/16 irrigation was effective toward replenishment of the soil water. The ability to manage irrigations while taking advantage of expected rainfall provides a more efficient use of available water resources in humid areas.

The 1995 peanut season resulted in very similar irrigation water applications between the control and EASY pan treatments (Fig. 9). Yield results for peanut

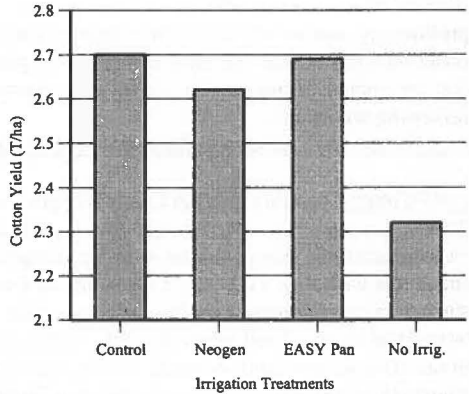


Figure 4. Cotton yield response for the 1995 season for the indicated irrigation treatments.

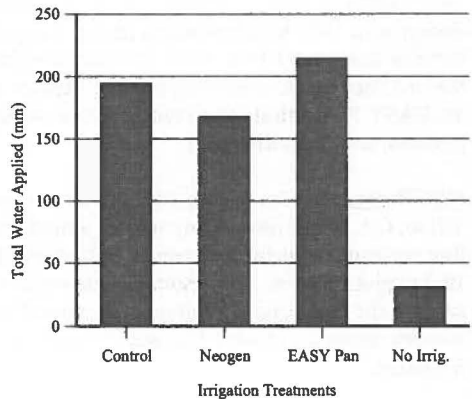


Figure 5. Total irrigation water applied during the 1995 cotton growing season.

under the three irrigation treatment scenarios were not different. Water required by both the Control treatment and the EASY Pan were essentially the same. This result indicates good agreement between the two methods in scheduling irrigations under the conditions tested.

Limited data were presented to indicate the relative response of the UGA EASY Pan for scheduling sprinkler irrigation on both cotton and peanuts. The EASY pan responded reasonably well as compared to other accepted techniques for irrigation scheduling. The screen material and the float rod position need to be selected to most accurately reflect the characteristics of the soil and crop. The few parameters that can be adjusted on this unit makes it easy to understand and apply to sprinkler irrigated crop production in the humid region.

The ability to determine the need for irrigation in the field without leaving a field vehicle is considered desirable by many farmers in South Georgia. The relative low cost (currently about \$100, in 2002 \$, if all components are purchased), and the available construction schematics allows farmers to create their own EASY Pan units. The potential for farmers to use the EASY Pan on other crops, following their own field testing, is also a reasonable assumption. The EASY Pan results indicate that it is a reasonable alternative for scheduling irrigations.

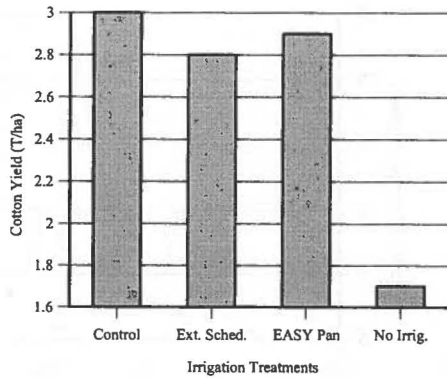


Figure 6. Cotton yield response for the 1997 season for the indicated irrigation treatments.

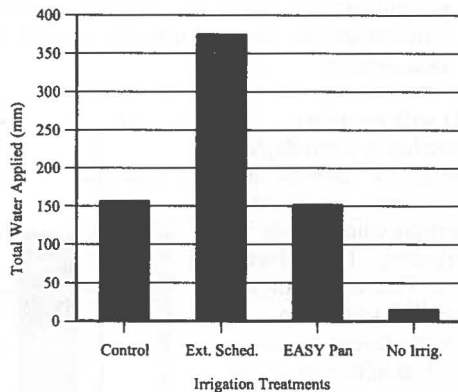


Figure 7. Total irrigation water applied during the 1997 cotton growing season.

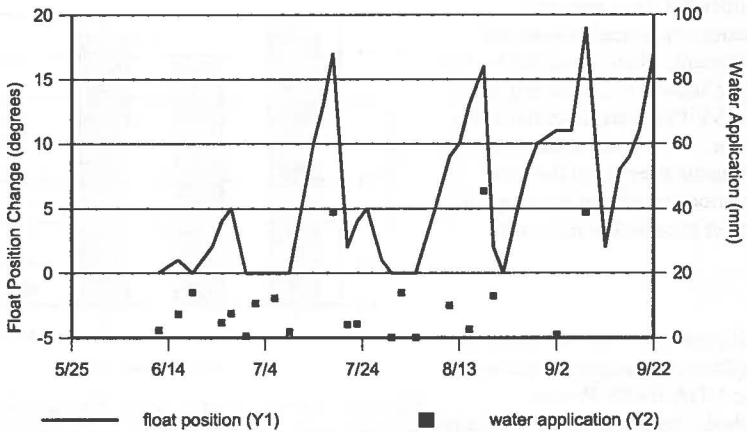


Figure 8. Response of the EASY Pan float indicator over the 1997 cotton irrigation season with rainfall/irrigation applications. Irrigation events were initiated after the float rod indicator reached 15 degrees away from the starting float position.

As with any other scheduling technologies, the EASY Pan does have limitations. It will not indicate when to stop irrigating. The unit works best if the surface of the pan is near the crop canopy height, so some method of raising the pan (recommendations include using cinder/concrete blocks) during the season is necessary. The EASY Pan does require some maintenance over a season to reduce algae growth and remove any foreign material that may have collected in the pan.

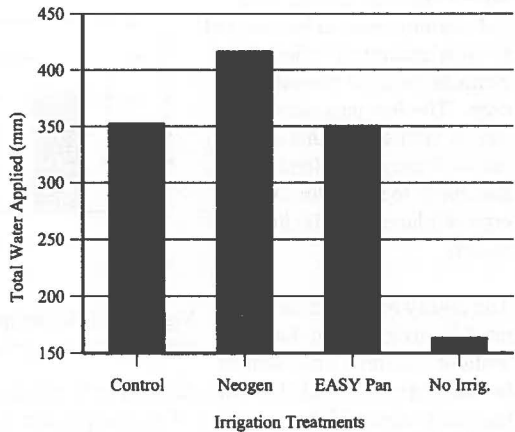


Figure 9. Total irrigation water applied during the 1995 peanut growing season.

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