Comparison of Irrigation Scheduling Methods on Wheat

Niel Biggs and Lee Clark

ABSTRACT

Several improved irrigation scheduling methods are available to farmers to reduce the amount of water used while not reducing crop yield. Each scheduling method has its own advantages and disadvantages. Because of the disadvantages, farmers have been slow in adopting some of the newer irrigation scheduling methods. This study compares two improved scheduling methods, the neutron hydro-probe and a simplified bookkeeping method using a personal computer, with the irrigation practices normally used by a farm manager to grow wheat. In addition to the traditional parameters of applied water and yield, the time and difficulty associated with each method were evaluated.

MATERIALS AND METHODS

The study was conducted at the Safford Agricultural Center from January through May, 1986. With the exception of irrigation scheduling, normal farm practices were used. The test plots were level in both directions; furrows spaced 40-inches and 200 feet long were constructed within the test plot. Each treatment consisted of four beds with a border between treatments.

The irrigation system consisted of two 2-inch siphon tubes per furrow on the scheduled plots and one 2-inch siphon per furrow on the "normal practice" plot. The siphon delivered approximately 33 gallons per minute. River water was used when it was available; otherwise, well water was used. A neutron access tube was installed in each treatment. The treatments were replicated four times and were randomly assigned within the test area.

The test area was uniformly pre-irrigated with approximately 12 inches of water on December 21, 1985. Yecora Rojo wheat was planted at a rate of 150 pounds per acre on December 19, 1985. Fertilizer consisted of 200 pounds per acre urea and 300 pounds per acre of 16-20-0 applied pre-plant. Weed control was 1.5 pints 2,4-D. Irrigation scheduling started February 18. The wheat was harvested on June 11. Only the two middle furrows in each treatment were used to calculate the yields.

RESULTS AND DISCUSSION

Normal Farming Schedule

The normal procedure a farm manager would use for scheduling the treatment became the study control. It resulted in 19.5 inches of irrigation water applied in three irrigations. This schedule, even though consuming more water than the other treatments, resulted in time periods with the lowest soil moisture during the growing season as shown on Figure 1. Soil moisture was determined with the neutron probe for each method throughout the season. Yield was 3683 pounds per acre. A comparison of the water applied and the crop yield is shown in Figure 2.

Neutron Hydro-Probe

This scheduling method resulted in the best irrigation with 14.3 inches of water applied in four irrigations. It also resulted in using more of the soil moisture at the end of the season as shown in Figure 1. The yield for this treatment was 4545 pounds per acre.

It took about two days to install the neutron access tubes and to take and process the soil samples needed to develop the calibration curve for the neutron probe. After the tubes were installed, readings were taken about once a week. Taking and interpreting the readings took about an hour each time.

Neutron probes cost $2000-$4000, depending on the model. Materials for the access tube are about $5 per hole, depending on the depth. Labor for installing the access tube was not calculated. Since the hydro-probe uses radioactive materials, special regulations and procedures apply. The operator must receive training and obtain a license from the appropriate government agency.

Computer Model

A computer model was selected that used a minimum of operator input but lacked the precision found in some other models. No weather data was required since the model used average consumptive use data. Input data required were water content at field capacity and wilting point (which were taken from a text book) and the initial water content at planting (which was assumed to be field capacity). Other inputs required were precipitation data and applied irrigation water.

Figure 3 compares the water content as calculated with the computer model and measured with the neutron probe; Figure 4 makes the same comparison for the 6-18 inch depth. Since any error resulting from using average consumptive use is cumulative, the calculated soil moisture values deviated from the measured values in the latter part of the irrigation season. It would be necessary (and the model makes provision for) the periodic adjustment of the calculated values to remove this accumulated error.

This scheduling method required 14.3 inches of water in four irrigations. When compared with the neutron probe (Figure 1), it did leave more water in the soil at the end of the season. Yield was 4635 pounds per acre.

The computer model requires 254K memory and a spread sheet software. A computer which meet these criteria cost $2000-$5000, depending on other options. In contrast to the neutron probe, the computer can be used for other purposes. It took about 20 minutes to initialize the model, and then it was run about every two weeks,taking about 10-15 minutes for each run.

Applications

The scheduling process showed the need for smaller, more frequent irrigations. This required doubling the water delivery rate to each furrow to push the water quickly down the furrow and reduce water losses to deep percolation and the leaching of nutrients. The leaching of nutrients and the occasional low water content for the normal farm watering schedule caused a significant decrease in yield over the other two treatments.

SUMMARY

The computer model for irrigation worked reasonably well and required the least operator input. In subsequent studies, this computer model will be compared with a more complex model requiring meteorological data.

Significant increases in yield and decreased water costs can be affected by improved irrigation scheduling.

Increased nutrient application would decrease deficiencies from nutrient losses where leaching occurs.

Figure 1 MOISTURE FOR SCHEDULING METHODS

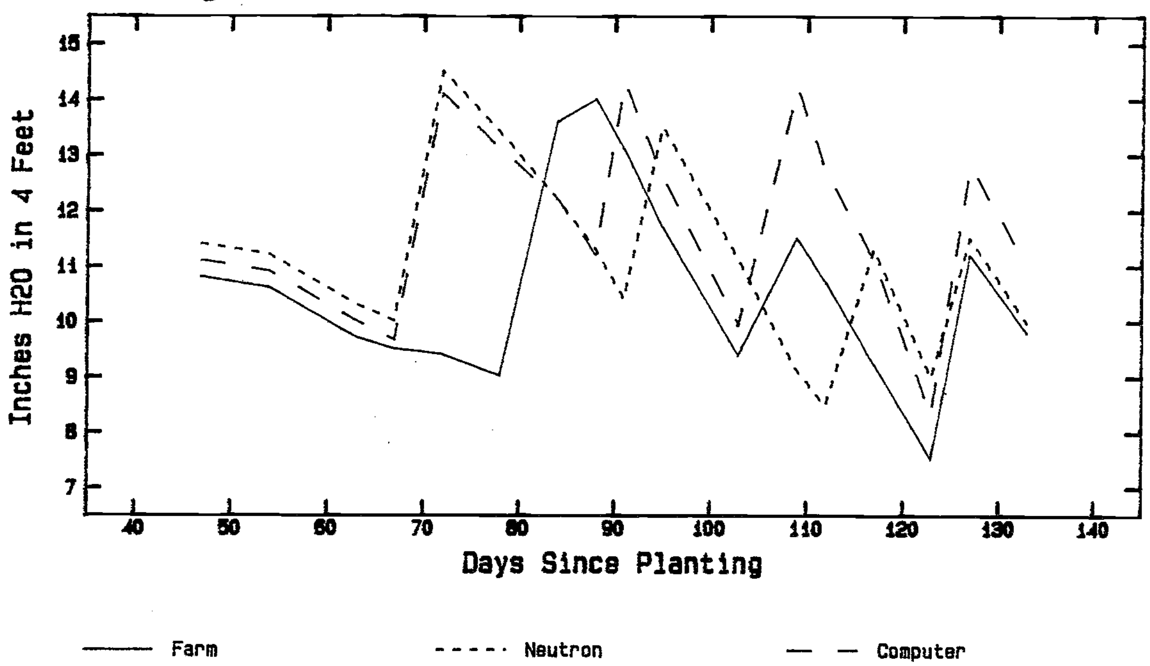

Figure 2 APPLIED WATER AND YIELD BY TREATMENT

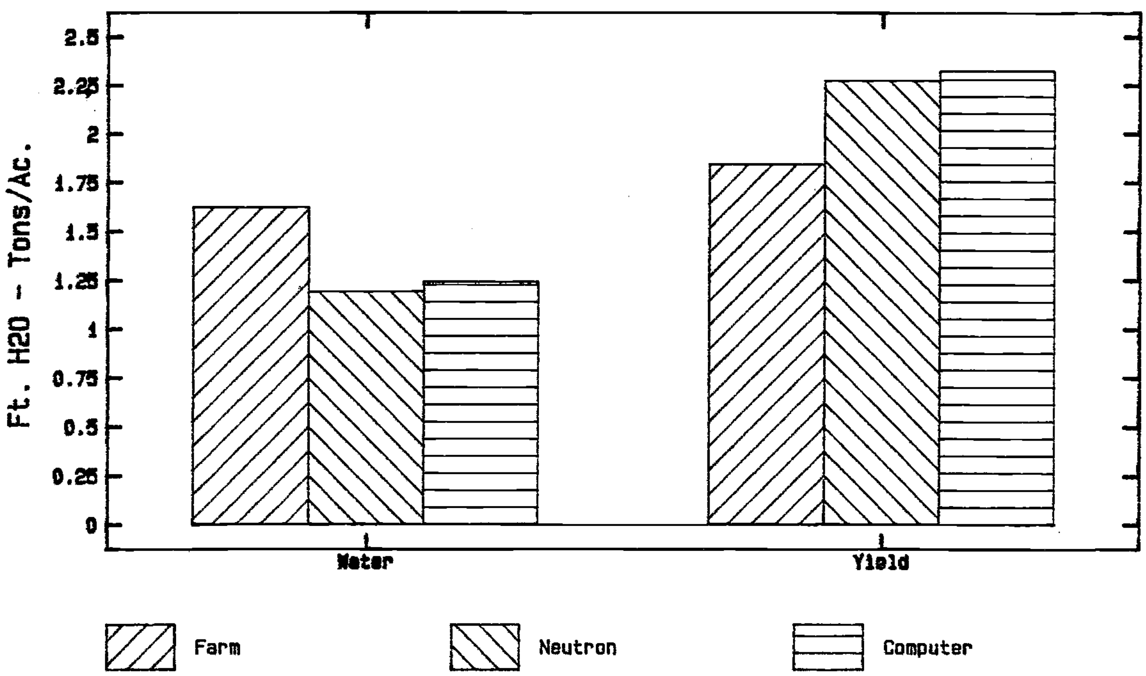

Figure 3 SOIL MOISTURE 0-6 INCH DEPTH

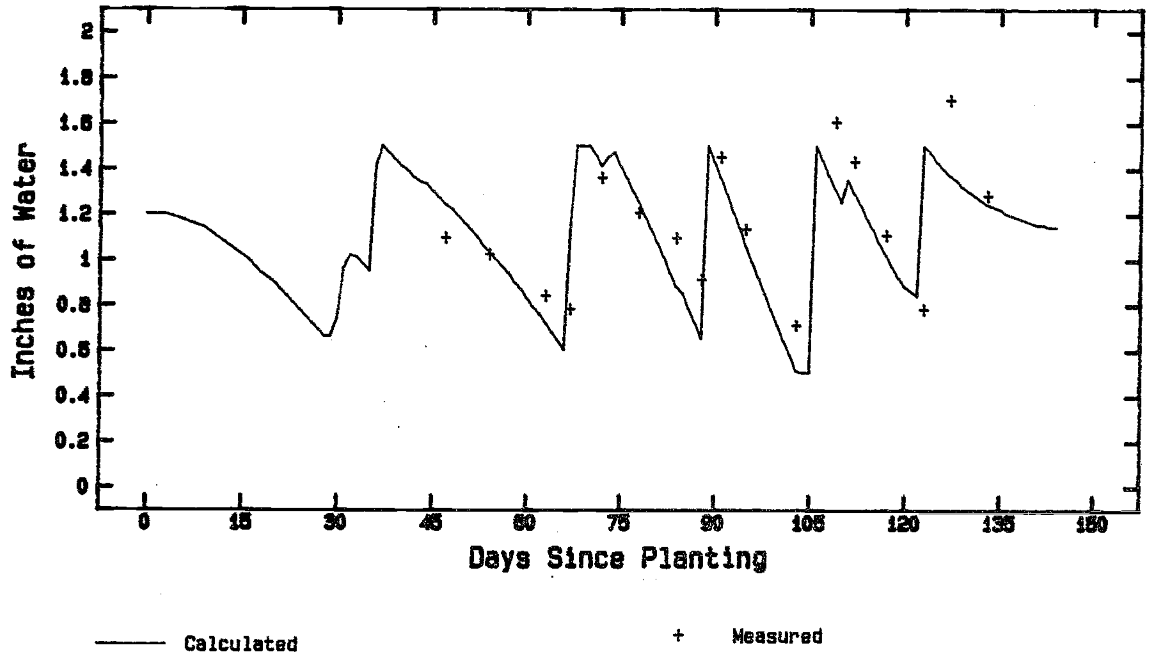

Figure 4 SOIL MOISTURE 6-18 INCH DEPTH