

EXECUTIVE SUMMARY

CROP REACTION TO PRE-PROGRAMMED DEFICIT IRRIGATION

Scheduling of irrigation requires farmers to be able to decide how much water must be applied to a crop with each irrigation and at what intervals to irrigate. Past research on the topic of irrigation scheduling led to the development of an easy to use computer program (BEWAB Version 1.2). The BEWAB irrigation scheduling program assists farmers by supplying them with preplant recommendations on how much water should be applied throughout the season and when to apply it. Although BEWAB makes provision for the selection of any target yield below the biological maximum, the data used to develop the procedure were obtained only under well-watered conditions. When irrigation water is in short supply, for instance during periods of restrictions on the use of water, farmers revert to deficit irrigation, thereby aiming for lower target yields in order to benefit more from rain. The need for this research arose from insufficient data on the interaction between pre-determined levels of deficit irrigation and the degree of adaptation of crops and crop yields to the drier soil conditions.

This project had the following objectives:

- To test the BEWAB irrigation management options under both well-watered (high target yield) and deficit supply (low target yield) conditions. The BEWAB program includes different options for managing the plant available water in the soil like starting the season with a wet soil and ending it either wet or dry or starting the season with a dry soil and ending it wet or dry.
- To determine the extent to which crops adapt to the drier soil conditions resulting from deficit irrigation.
- To quantify the effect of wet and dry pre-plant root zones on the evapotranspiration and crop development under well-watered and deficit conditions.
- To investigate the most efficient intervals between irrigations for different target yields and soils, for incorporation in the BEWAB irrigation scheduling program.

The line-source irrigation technique was used to gather the information needed to enlarge the list of crops in BEWAB to include also dry peas and potatoes, planted in September or January. Crops used in field experiments to test the management options were wheat, maize, groundnuts, dry peas and potatoes. These experiments were conducted on a deep red sandy loam to sandy clay loam soil most suitable for irrigation.

The different management options for the depletion or recharge of the plant available water in the root zone had no effect on crop growth or yields under well watered conditions with high target yields. With low target yields and deficit irrigation, the treatments that were irrigated according to the "end wet" option in fact ended dry. The reason for this was that applied water intended to build up the water reserve in the latter part of the season was taken up by the crops to produce yields in excess of target yields. It is recommended that any of the four options for managing the plant available water can be used under optimum well-watered conditions. With deficit irrigation where the intention is to conserve irrigation water for the next crop cycle, it will be wise to only use the two options that end dry.

The length of the interval between irrigations had a significant effect on plant reaction. With high target yields the best growth and yields were obtained with weekly irrigations, except for groundnuts which yielded best with irrigations every two weeks. Irrigations at two to three weekly intervals gave the best results in terms of yield and growth at low target yields. A procedure was developed with which the most effective interval between irrigations could be calculated taking into account crop and soil type, target yield and the selected management option.

It was confirmed that shorter intervals between irrigations, with an associated increase in number of irrigations required, increases opportunities for unproductive loss of water through evaporation from the soil surface. This decreases the water use efficiency or, stated differently, increases the total water needed to produce a specific yield. A procedure was developed to take the number of irrigations into consideration when calculating the amount of water needed to realise a chosen target yield.

It was confirmed that well planned deficit irrigation results in crops adapting to the drier soil conditions through shorter plants with smaller leaves, thus avoiding excessive transpiration. Incorporating the recommended improvements in the BEWAB irrigation scheduling programme will ensure better deficit irrigation scheduling at target yields that are lower than those obtained under optimum conditions of water supply.

It is evident from the preceding discussion that all the objectives of this project were fully met. The following aspects were identified as future research topics which could improve the value and applicability of this research:

- The proposed procedure for estimating the unproductive water losses through evaporation from the soil surface needs further refinement.
- A more cost effective procedure is needed to obtain or estimate the input variables for crops that are not presently included in BEWAB. This can possibly be done with the help of crop growth simulation models.
- The dynamic nature of the upper limit of plant available water in the soil profile for irrigation still needs further clarification under irrigation conditions.

The transfer of the technology developed through this research project will be done by the distribution of an updated version of the BEWAB programme for irrigation scheduling and water management to all current and future users. All the proposed improvements will be included in the revised version of BEWAB. The revised version of BEWAB will ensure more accurate and effective use of irrigation water under deficit supply conditions.