Optimizing Irrigation And Fertilization Using Lysimeters

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The amount of water applied (and its price) is an important factor in the profitability of irrigated field crops, especially in water-limited environments. Knowledge of actual crop requirements is the first step in optimizing irrigation regimes. The most accurate method to measure crop water requirement (evapotranspiration) is by water balance using weighing lysimeters.

A weighing lysimeter is a large soil tank that situated on a scale. By recording the changes in the soil tank weight, we can calculate the amount of water that enters (irrigation and precipitation) and the amount of water that exits through evapotranspiration and drainage. The main disadvantages of using weighing lysimeters in the field are that they are expensive to build and the maintenance is time-consuming. With the generous help of ICA in Israel, we built 16 in-situ lysimeters in semi-commercial scale permanent research plots at the Western Negev Desert Agro-Research Center (MOP Darom). Four permanent agricultural plots, each 1-hectare and divided into 16 subplots were each equipped with four weighing lysimeters of about two cubic meters. Water in the lysimeters reaching below the root zone (drainage) is weighed and collected for chemical analysis. This allows for evaluation of potential deep soil and groundwater contamination and agricultural management strategies to insure sustainability. We perform commercial crop rotations on every plot every year, in order to provide knowledge to local farmers representing their commercial crops of interest.

The permanent plots at MOP Darom have become a platform attracting collaboration of researchers from various disciplines

and organizations. These collaborations provide valuable data regarding the complex soil-water-plant-atmosphere interactions in the agro-system. This, in turn, allows us to perform detailed multi-disciplinary experiments at a relatively low maintenance cost.
We use the data from the experimental fields and lysimeters to calculate optimal irrigation schemes taking into account profitability and to provide detailed recommendations to farmers.

Example: Optimizing irrigation of peanuts

We have studied peanuts grown in the permanent fields since 2013. In the first year, we measured crop water requirements and in the following years we manipulated the amount and frequency of the irrigation, at different plant growth stages. During all these years, we measured the plant response, yield quantity and yield quality.
Our main results include:

1. Optimal irrigation depth (80-100 cm) before sowing increases germination and reduces water usage during the year. This enables under-irrigation during the season which increases the quality and quantity of the peanuts.
2. Increased irrigation in the flowering stage increases the quantity but reduces quality, which reduces the profitability from the field.
3. Reduction of water at the flowering stage decreases the foliage but increases the amount of peanuts suitable for export.
4. Precision is very important during the pod filling stage. Best results are when the plant is under moderate water stress and is forced to uptake the water from a relatively deep soil profile.
5. Tensiometers placed in the soil at 40 cm give the best representation of the water potential that the plants experience and can be used for decision support.

In a nutshell (pun intended), we found that increasing irrigation at the pod production stage increases the quantity of peanuts, while deficit irrigation at the pod filling stage improves the quality of peanuts.
From our results, an irrigation scheduling protocol was developed and published based crop factors and potential evaporation (Penman-Monteith equation). Potential evaporation data is readily accessible from meteorological stations, provided, for example, by a Ministry of Agriculture web site and smart phone application.
From an informal survey of farmers in the Western Negev - we estimate that this recommended protocol has been adopted by growers to alter irrigation scheduling in 60%-70% of local peanut fields.

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