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TACTICAL IRRIGATION MANAGEMENT USING THE WISE ONLINE TOOL

Allan A. Andales, Ph.D.
Associate Professor and Extension Specialist
Department of Soil and Crop Sciences
Colorado State University
Fort Collins, Colorado
Voice: 970-491-6516   Fax: 970-491-5676
Email: Allan.Andales@colostate.edu

INTRODUCTION

Improved irrigation water management (IWM) in approximately 2.3 million acres of irrigated farm land in Colorado can play a key role in water conservation, prevention of water pollution, and enhanced crop productivity. There is a need for a widely accessible decision tool that will increase the capacity of producers and water managers to determine real-time irrigation water demand for a field or region of interest. An online IWM system named Water Irrigation Scheduler for Efficient Application (WISE; http://wise.colostate.edu/) has been developed and pilot-tested in Colorado. WISE is accessible via a web browser, with soil profile water status information also accessible via mobile apps. Early in its development, a stakeholder committee (10 individuals) was formed representing progressive crop producers and advisers, researchers, conservation agency personnel, farm managers, and crop commodity group representatives to test and provide suggestions for improving the tool. In addition, WISE has been demonstrated at more than 15 producer- or conservation agency-conferences and workshops.

THE WISE APP

WISE (Andales et al., 2014) is a cloud-based tool that has been developed and deployed on the environmental Risk Assessment and Management Systems platform (eRAMS.com). The web browser interface is GIS-enabled with friendly graphical user interfaces. After the user draws the boundaries of an irrigated field, the tool automatically collects local soils and daily weather data from publicly available data sources such as SSURGO soils database from USDA-Natural Resources Conservation Service (NRCS) and the Colorado Agricultural Meteorological Network (www.CoAgMet.com). To completely set up a field for irrigation scheduling, the user also has to input the following information: (a) crop information: type, emergence or green-up date, managed root depth; (b) irrigation system information: type and application efficiency; and (c) soil information: initial soil moisture content at emergence or green-up. Once a crop type is selected, default values of crop coefficients (used to estimate crop water use from weather data) are provided. The crop coefficients incorporate the effects of crop development on water use. Advanced users can modify the default values to better represent their crop variety. The tool will then estimate the daily soil water deficit (net irrigation requirement) of the root zone using local weather data and user-inputted values of actual applied irrigation (inches of water entered into the pivot control panel, for example). An iPhone® or Android® app (Figure 1) on a smartphone can synchronize with the cloud server to display soil water status information for each individual field (Bartlett et al., 2015). Visit http://wise.colostate.edu/ to learn how to set up and use the tool.

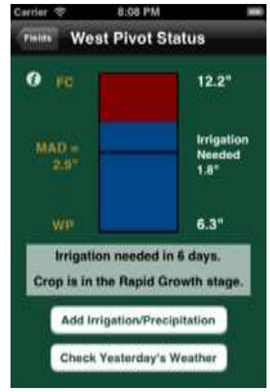

Figure 1. The WISE iPhone® app with a "water bucket" representation of soil water status of a field. Field capacity (FC) and wilting point (WP) show the upper and lower limits of plant available water (inches of water) in the root zone, respectively. The red bar shows the estimated amount of deficit or depletion (irrigation needed) relative to management allowed depletion (MAD).

EXAMPLE APPLICATION

When precipitation and irrigation water cannot meet seasonal crop water requirements, the amount and timing of irrigations become critical decision factors for managing crop water stress and optimizing crop production. At Fort Collins, Colorado, corn (Pioneer P9305AM) was planted on 5/15/2015 and grown under 3 irrigation treatments: (a) Opportunity irrigation (25 mm/week); (b) Limited irrigation (no irrigation from V5 to VT growth stages; otherwise same as opportunity); and (c) drought (only 1 irrigation, 13 mm, on 7/16/2015). Soil was strip-tilled and corn was irrigated with a linear move sprinkler system. Irrigations were not applied until 7/16/2015 because of sufficient rainfall (148 mm) and soil moisture prior to this date.

The WISE App was used to estimate the effects of the above irrigation treatments on daily actual corn evapotranspiration (ETa; consumptive water use) and water stress levels. Non-stressed crop ET (ETc) in WISE was estimated using Penman-Monteith reference evapotranspiration (ETr) multiplied by a non-stressed crop coefficient (Kc) (Allen et al., 1998). Daily ETa (mm/d) was estimated as: $ETa = ETr * Kc * Ks$

where ETr is tall (alfalfa) reference crop ET, Kc is the crop coefficient representing effects of crop growth on ETa (typically Kc ranges from 0.25 to 1.0 for corn), and Ks is the water stress coefficient calculated as: $Ks = (TAW – D) / (1 – MAD)\ TAW$

where TAW is total available water in root zone (mm), D is root zone depletion or deficit (mm), MAD is management allowed depletion (fraction; MAD = 0.5 for corn). The value of Ks is 1 if there is no water stress (if D is less than TAW * MAD) and becomes smaller as water stress becomes more severe (Allen et al., 1998). Daily ETr and rainfall was obtained by WISE from CoAgMet for use in calculating the daily soil water balance of the root zone.

Soil water content (mm H_2O/ mm soil) in the root zone was measured weekly using a neutron moisture meter (0 – 1500 mm depth, at 300 mm increments). Weekly observed ETa was calculated by water balance (DeJonge, et al., 2011). For each irrigation treatment, the cumulative ETa from WISE was compared to the observed ETa from water balance.

Relevant seasonal water balance components estimated by WISE are shown in Table 1. The daily corn ETa estimated by WISE showed expected responses for the 3 irrigation treatments (Figure 2): the same ETa amounts before 7/16/2015 when rainfall kept up with ET requirements; lowest ETa values for the limited irrigation treatment when irrigations were withheld (7/16 – 8/5) and recovery of ETa when irrigations resumed (8/6 onwards); and lowest ETa values under drought after 8/5/2015. The daily Ks curves showed no stress (Ks = 1) before 7/16/2015 and stress thereafter (Figure 3). The Ks tended to under-estimate the level of crop stress, which resulted in over-estimation of cumulative corn ETa (Figure 4) and irrigation water requirements. Although WISE tended to slightly over-estimate cumulative ETa for corn, it showed good overall agreement (index of agreement d = 0.80 – 0.97) with weekly observed values (Figure 4). This provided some evidence that WISE can effectively be used for tactical (day-to-day) irrigation scheduling, even under limited irrigation conditions.

Table 1. Seasonal water balance components (5/15/2015 – 9/17/2015) estimated by WISE for corn under 3 irrigation treatments.

Treatment	ETa, mm	P, mm	Irr_g, mm
Opportunity	418	168	279
Limited	352	168	152
Drought	285	168	13
P = precipitation; Irr_g = gross irrigation			

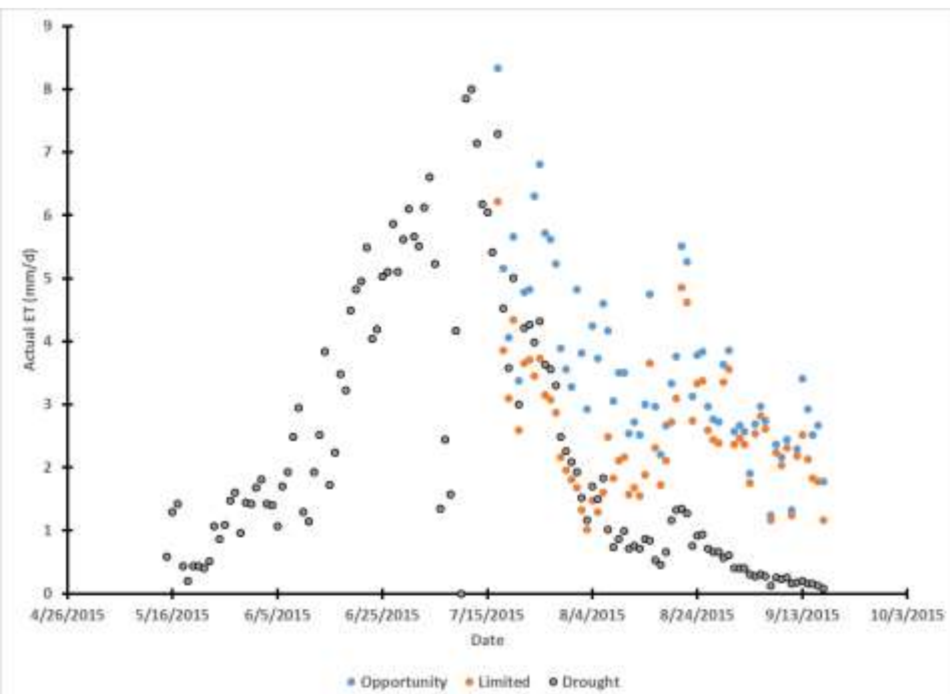

Figure 2. Daily corn ETa (mm/d) estimated by WISE for quantifying water stress under 3 irrigation treatments.

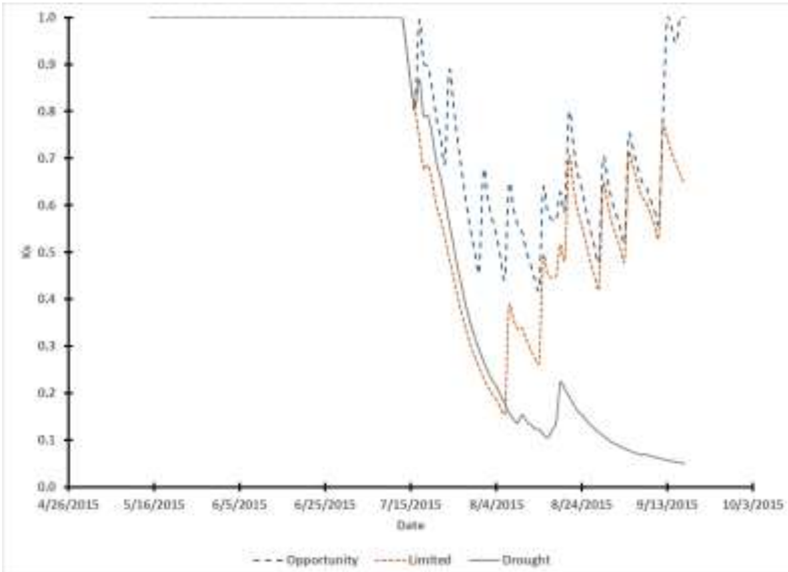

Figure 3. Daily Ks values estimated by WISE for corn under 3 irrigation treatments in 2015.

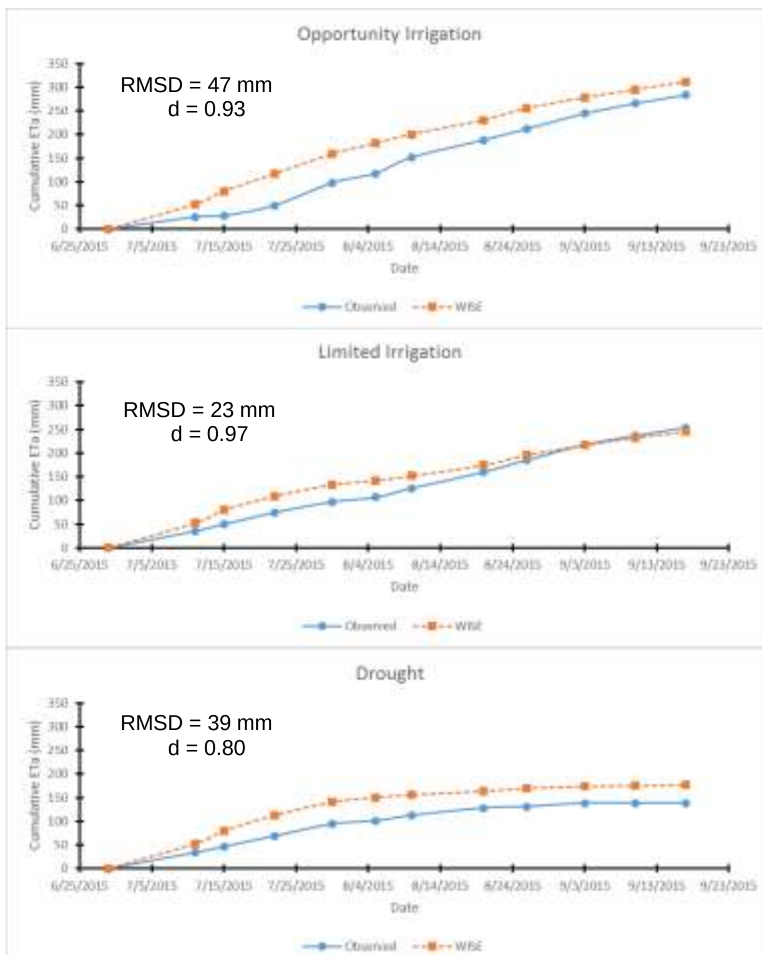

Figure 4. Observed and WISE estimated cumulative corn ETa (mm) for the period 6/29/2015 to 9/17/2015 under 3 irrigation treatments. (RMSD = root mean square deviation; d = index of agreement, which indicates perfect agreement if d = 1.0)

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