UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION

HIGH DESERT CROP NOTES

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Irrigation Management Field Day

Please join us at this informative event followed by a free BBQ meal. Bring your questions and curiosity and speak with experts about how you can improve your irrigation system.

Please see agenda in the attached flier with details on location and time.

Soil Moisture Monitoring and Irrigation scheduling in the High Desert

Andre Biscaro and Khaled Bali

Irrigation scheduling is the process used by irrigators or irrigation system managers to determine the correct frequency and duration of watering. In other words, it tells us when to irrigate and how much water to apply. Using irrigation scheduling can maximize grower's profits by reducing the amount of irrigation water and pumping energy, reducing crop stress and increase yield, and by preventing excessive leaching of expensive nutrients and pesticides.
Among different tools and methods that can be used to aid in irrigation scheduling, soil water tension (SWT) status and crop evapotranspiration (ET) have been successfully used throughout California and other western states.

➢ <u>Soil water tension (SWT)</u> tells you when to irrigate. Although grower's experience on detecting soil moisture content can be fairly accurate, the use of SWT sensors gives confidence about their decision with the push of a button. Soil water tension can be measured by different types of sensors; the most common sensors are watermarks (Granular Matrix Sensors, GMS) and tensiometers (Figure 1), produced by Irrometer Co., Riverside, CA.

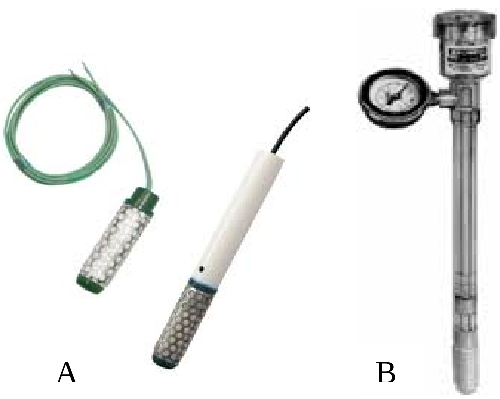

Figure 1. Soil water tension sensors: watermark (A) and tensiometer (B).

These sensors measure the tension (negative pressure) in the soil water system. Soil water tension is directly related to the energy needed by the plant roots to extract water from the soil. In other words, they measure how strongly water is held by the soil. The higher the STW, the drier the soil and the harder it is for the plant to extract water. Crop performance is related to the amount of tension the plant has to exert to move water from the soil into the plant roots. Therefore, SWT values have been estimated for different crops as the criterion for initiating irrigation events; however, be aware that soil texture, irrigation method and climate factors also influence the SWT thresholds for starting irrigation. For example, the SWT threshold for alfalfa on sand or loamy sand soils is about 40-50centibars, and about 90-120centibars on clay loam or clay soils.

Installing watermark sensors and tensiometers is simple but require a few precautions.
The sensors need to be installed in representative areas of the field, with similar soil texture and water needs. Keep in mind that soil texture can vary significantly inside of the same field. Therefore, it is extremely recommended to perform a representative soil sampling for texture analysis by subdividing the field in homogeneous sections or obtaining a soil map for the field to determine the texture of the soil.

Depth: accurate understanding of the root system for the average plant growth is crucial to determine the depth of the sensors. Installing the sensors at two or three depths per location is recommended.
The accuracy of the sensors relies on good contact with the soil. Filling the space between the sensor and the soil with slurry prepared with a finely grinded soil can improve the sensors accuracy, especially on sandier soils. Use this slurry also to backfill any void space between the cable and the hole or the pipe attached to the sensor and the hole. A PVC pipe can be attached to watermark sensors in order to make it easier to install and remove the sensors.

Reading and collecting sensor's data is simple and take only a few seconds. In the case of the tensiometers you only need to read the gauge at the top of the sensor. In the case of the watermarks, the most common way is to connect the sensors to a monitor/datalogger with a small screen where you can push a button and take the readings. In addition to displaying instantaneous SWT data, these monitors record the data throughout the season so you can create a graph and visualize how dry/wet the soil was throughout the season (Figure 2). You can also use a handheld meter to connect to the sensor's wire every time you take the reading.

Current technologies also allow the irrigation manager/grower to access sensors data remotely at his/her office/house. The data could be transmitted by radio or cell phone signals.

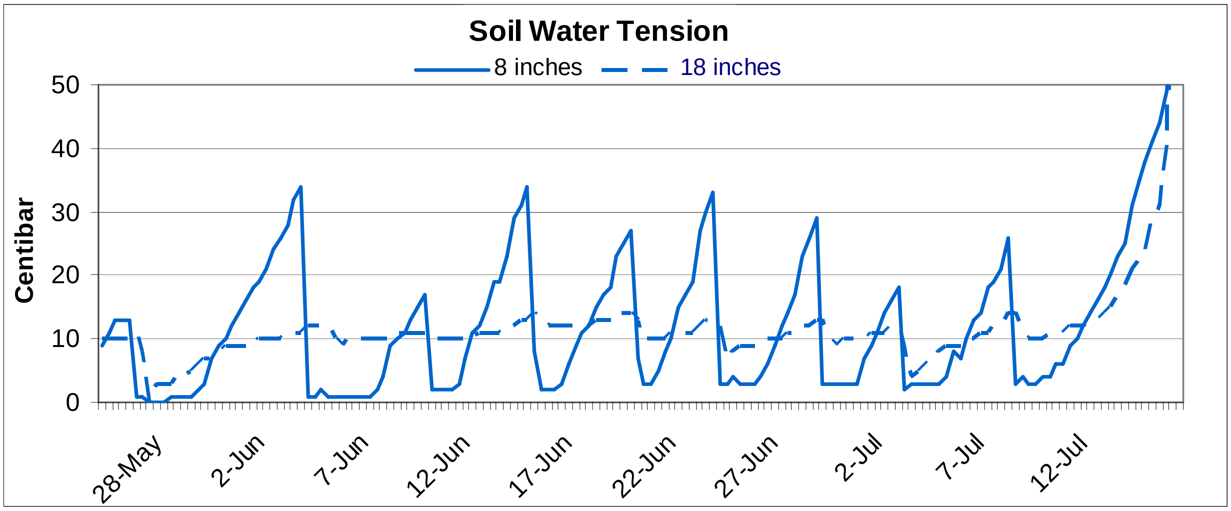

Figure 2. Soil water tension data of a sandy loam onion field located in Lancaster, CA, monitored at two depths (8 and 18 inches) in 2012.

Costs
The following are only approximate costs that I obtained while purchasing some equipment earlier this year so you can have an idea of what to expect to pay for one of these systems. For more accurate information, please contact Irrometer Co. and/or M.K. Hansen Co.

- Watermark: $35/sensor
- Tensiometer: $70
- Hansen monitor: $450
- Irrometer monitor: $450
- Handheld Watermark Soil Moisture Meter: $280

Please keep in mind that the costs with acquiring these equipments can be quickly recovered with increases in yield and quality and savings with water, energy and inputs.

➢ <u>Crop evapotranspiration (ET)</u> tells you how much water you need to apply. It is an estimation of how much water is lost to the atmosphere through evaporation (from soil and crop surfaces) and transpiration (from plant tissues). Crop ET can be calculated using data from weather stations spread throughout the state.

Those stations are managed by the California Irrigation Management Information System (CIMIS) and the data can be accessed online at no cost: http://wwwcimis.water.ca.gov
There are currently three active weather stations in the High Desert: Palmdale (#197), Victorville (#117) and Barstow (#134).
Each weather station measures how much water is lost to the atmosphere from standardized tall-season grass (or occasionally alfalfa, not common in California) surfaces over which the stations are sitting, and that is called Reference Evapotranspiration (ETo).
In order to calculate crop ET you only need to go to the CIMIS website, chose the closest station to you, download the ETo data and multiply that by the Crop Coefficient (Kc) of your crop: ET = ETo * Kc

Crop coefficient is a factor used to account for the differences in water use between your crop and the standardized grass/alfalfa surface of the weather station. Every crop has its own Kc, which varies according to the crop's growth stage, canopy coverage, irrigation frequency, and other factors. The bigger the plant the more it transpires, and consequently the higher the Kc. Figure 3 illustrates how Kc values and onion height vary throughout the growing season in Northern California, Tulelake.

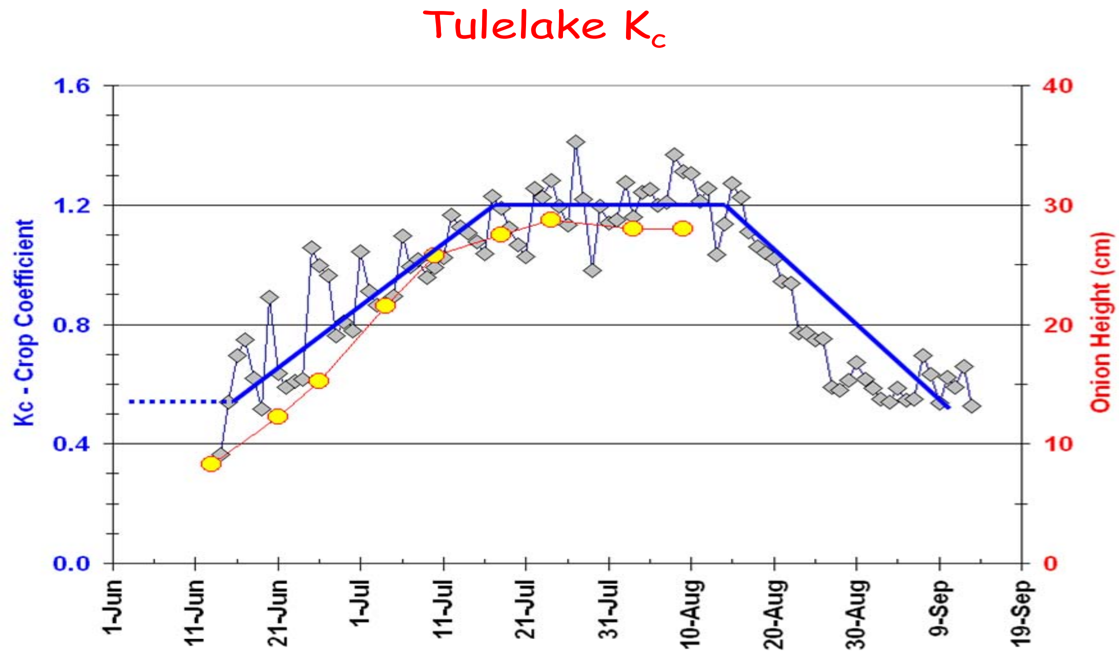

Figure 3. Crop Coefficient (Kc) values and onion height measured in a research trial in Tulelake, CA.

In the case of alfalfa it is more practical to use **average Kc** values over the season because of the difficulty in adjusting the actual coefficient due to rapidly changing Kc as the alfalfa grows between harvests (low = 0.30, peak = 1.25, average = 1.05, for most locations in California).

Therefore, the amount of water to be applied can be estimated by calculating crop ET since the last irrigation event minus any rain in case there is any.

It is also important to account for the irrigation efficiency of your irrigation system when calculating how much water you need to apply. Common irrigation efficiency values for overhead sprinkler systems are usually between 70 and 90%, and for drip irrigation between 80-90%. However, these values depend on several factors and can vary significantly. If you are interested in calculating the irrigation efficiency of your field, please contact me and I will assist you with measuring that.

Soil Water Tension and Soil Water Depletion

In addition to using evapotranspiration information, another good method to schedule irrigation is to combine SWT with soil water depletion data. By estimating soil water depletion based on readings from watermarks and tensiometers e.g., you can decide how much water you need to and apply only enough water to replenish the root zone depletion. Both SWT and water holding capacity vary according to soil texture; therefore the amount of water to be applied will vary according to soil type - clay soils hold significantly more water than sandy soils, for example. Table 1 illustrates how you can estimate the amount of irrigation water based on SWT readings for a silt loam soil with a maximum water-holding capacity of 1.5 in/ft.

Soil water tension (cb)	Soil water content (in/ft)	Depletion (%)	Amount per irrigation (in)
1.5	<10	0	0
1.38	10	8	0.12
1.26	15	16	0.24
1.02	20	32	0.48

Table 1. Amount of water to add per irrigation based on soil water tension values of a silt loam soil.

If you have any questions regarding using and installing tensiometers or watermark sensors, please feel free to contact me. Also, I did not include many details regarding specific Kc for each crop and how they vary throughout the season in order to make this article simpler. Please contact me in case you need such information.

Consulted literature

Successful Onion Irrigation Scheduling, by C.C. Shock, E. Feibert, L. Jensen, and J. Klauser. 2010

Irrigatino Monitoring Using Soil Water Tension, by C.C. Shock, R. Flock, E. Feibert, C.A. Shock, A. Pereira, and L. Jensen. 2005

Irrigating Alfalfa in Arid Regions, in Irrigated Alfalfa Management, by B. R. Hanson, K.M. Bali, and B.L. Sanden. 2008

Keep your eyes open for the Bagrada Bug

This is a new pest that has infested most areas in Southern California and that can cause significant damage to cole crops like cabbage and mustard. Although most of the commercial crops in the High Desert are not hosts of this pest, its spread could be devastating for some cover crops and gardens since there is no efficient control method at this point.
Please report any observation of this insect to the Agricultural Commissioner office,
(661-974-8802).

The Situation: The Bagrada bug (also called painted or harlequin bug*****) was first found in June 2008 in Los Angeles Co. California. Currently, it is widely distributed in southern California and also present in southern Arizona. Establishment of Bagrada bug in California is a new USA and Western Hemisphere record.

Damage: Bagrada bug is a major pest of crop plants in the Brassicaceae (Cruciferae), which includes important foods like cabbage, kale, turnip, cauliflower, mustard, broccoli, and radish. The Bagrada bug has also been recorded attacking papaya, potato, maize, sorghum, cotton, capers, and some legumes. Damage is inflicted on host plants when adults and nymphs insert their needle-like mouth parts and suck juices from the plant. Feeding results in large stippled or wilted areas on leaves. Often the growth of newly formed central shoots or heads of plants become stunted. Populations can build up quickly reaching damaging densities that require control. Heaviest infestations are typically observed in organic farms, community gardens, and residential vegetable gardens were little or no pesticides are used. Local residents, not familiar with this new stink bug, often think they have beneficial lady bugs, because Bagrada adults and larger nymphs are about same the size and have a similar bright coloration.

Identification: Adult Bagrada bugs are 5-7 mm long, and have black, shield-shaped bodies with distinctive white and orange markings. Adult females are larger than males. Nymphs are wingless and pass through 5 instars or developmental stages. Over the course of shedding the exoskeleton and growing, the wings gradually develop. First instar Bagrada bugs have reddish-brown heads and thoraxes and bright red abdomens. Later instars become darker (adding black color to their body) and develop wing pads. Eggs are oval, creamy-white, and turn orange as they age. Females lay eggs in the soil beneath host plants, but may also oviposit on leaves. Usually all life stages are present together on plants and adults are commonly observed in copulation.

Research: Very little is known about the identity and impact of biological control agents, in particular parasitoids, that attack eggs, nymphs, and adult Bagrada bugs. Despite the importance of this pest in many countries the biology, ecology, and population dynamics of this insect are not very well understood. Some progress in Europe has been made on chemical communication between Bagrada bugs.

*In the U.S., harlequin bug is used as a common name for another species, *Murgantia histrionica*.

Distribution: Bagrada bug is found in East and Southern Africa, Egypt, Zaire and Senegal. The global distribution of this pest also includes southern Asia and southern Europe (Malta and Italy). This pest is only known from southern California and southern Arizona in the USA.

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