Smart irrigation controllers evaluated by Texas A&M

THESE RESULTS courtesy of Guy Fipps, PhD, one of two authors of the study, "Evaluation of Smart Controllers: Year 2011, Result S1," along with Charles Swanson. The report was prepared for Task 2 of the Rio Grande Basin Initiative Irrigation Technology Center, Texas AgriLIFE Extension Service. This material is based upon work supported by the Cooperative State Research, Education, and Extension Service, US Department of Agriculture. Fipps is Extension Program Specialist, and Professor and Extension Specialist, Biological and Agricultural Engineering, Texas A&M. Swanson is AgriLife Extension landscape irrigation specialist at Texas A&M.

A smart controller testing facility was established by the Irrigation Technology Center at Texas

A&M University in College Station in 2008 in order to evaluate their performance from an "end user" point of view. The end-user is considered to be the landscape or irrigation professional (such as a Licensed Irrigator in Texas) installing the controller. Controllers are tested using the Texas Virtual Landscape which is composed of 6 different zones with varying plant materials, soil types and depths, and precipitation rates.

This report summarizes the results from the 2011 evaluations, when nine controllers were evaluated over a 152-day period, from April 11-May 29, 2011 and August 8-November 20, 2011.

Controller performance was analyzed for each seasonal period (spring, summer, fall). Controller

performance is evaluated by comparison to the irrigation recommendation of the TexasET

Network and Website (http://texaset.tamu.edu), as well as for irrigation adequacy in order to

identify controllers which apply excessive and inadequate amounts of water.

Programming smart controllers for specific site conditions continues to be a problem. Only two of the nine controllers tested could be programmed directly with all the parameters needed to

define each zone.

TOTAL IRRIGATION AMOUNTS

- When looking at seasonal irrigation amounts for the entire landscape, one controller was within +/- 20% the recommendation of the TexasET Network for all six stations during the Fall Evaluation Period.
- Two controllers applied more than ETo for all three seasonal periods.
- Seven controllers applied more than a simple ETc model (ETo x Kc, neglecting rainfall) for one or more seasons.

ADEQUACY ANALYSIS

- No controllers were consistently able (across all 6 stations) to adequately meet the plant water requirements for any season.
- For all seasons combined, 51 stations (37%) showed adequate irrigations, 48 stations (35%) showed excessive irrigation amounts and 39 stations (28%) irrigated inadequately
- Four controllers had five stations that provided adequate amounts of water for one or more seasons.
- Factors that could have caused over/under irrigation of landscapes are improper ETo calculations and insufficient accounting for rainfall. However, 2011 was a drought year with only 5.45 inches of rainfall. ET values recorded off the controllers were inconsistent and erratic throughout the study.
- Based on 2011, performance, controllers with on-site sensors generally performed better and more often irrigated closer to the recommendations of the TexasET Network than those controllers which have ETo sent to the controller. While water savings shows promise through the use of some smart irrigation controllers, excessive irrigation is still occurring under some landscape scenarios.

WHAT'S EXPECTED OF SMART CONTROLLER

The term smart irrigation controller is commonly used to refer to various types of controllers that have the capability to calculate and implement irrigation schedules automatically and without human intervention. Ideally, smart controllers are designed to use site specific information to produce irrigation schedules that closely match the day-to-day water use of plants and landscapes.

In recent years, manufacturers have introduced a new generation of smart controllers which are being promoted for use in both residential and commercial landscape applications.

However, many questions exist about the performance, dependability and water savings benefits of smart controllers. Of particular concern in Texas is the complication imposed by rainfall. Average rainfall in the State varies from 56 inches in the southeast to less than 8 inches in the western desert. In much of the State, significant rainfall commonly occurs during the primary landscape irrigation seasons. Some Texas cities and water purveyors are now mandating smart controllers. If these controllers are to become requirements across the state, then it is important that they be evaluated formally under Texas conditions.

CLASSIFICATION OF CONTROLLERS

Smart controllers may be defined as irrigation system controllers that determine runtimes for individual stations (or "hydrozones") based on historic or real-time ETo and/or additional site specific data. We classify smart controllers into four types: Historic ET, Sensorbased, ET, and Central Control.

Many controllers use ETo (potential evapotranspiration) as a basis for computing irrigation schedules in combination with a root-zone water balance. Various methods, climatic data and site factors are used to calculate this water balance. The parameters most commonly used

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JOHN MASCARO'S PHOTO QUIZ

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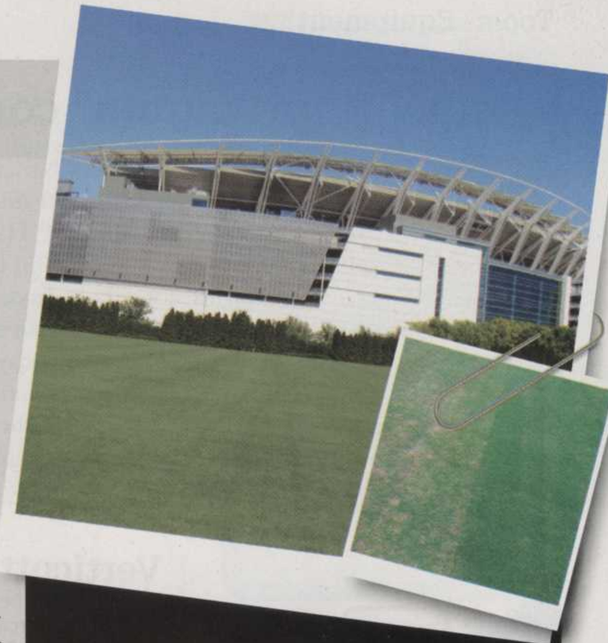
This Patriot bermudagrass installation is at the Cincinnati Bengals' practice facility. These two fields were rebuilt using 220,000 square feet of sod. The sod was delivered from a sod farm more than 600 miles away and about half the sod was about 10 months old and the other half was about 18 months old. The 18-month-old sod had also been overseeded and 3 weeks before harvesting the big rolls, the overseeded turf at the sod farm had been sprayed out. Due to the aggressive growth of the overseeded grass, the turf that had been overseeded (on the left) was thinner when compared to the non-overseeded turf on the right.

Interestingly enough, the overseeded turf, even though it did not look as good, was older and also easier to install because of its more mature root system. Even though the previously overseeded portion of the sod was initially about 3 weeks behind in growth, the sports turf manager reported that after a few weeks, growth had caught up and the fields will be in top shape for the football training camp at the end of July (see second photo). These photos are also an excellent side by side example showing the stresses overseeding warm season grasses with cool season grasses puts on the turf in the springtime. If the overseeded sod had not been more mature, it almost certainly would have taken even longer to grow out.

Photo submitted by Darian Daily, head groundskeeper at Paul Brown Stadium in Cincinnati, OH.



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include: ET (actual plant evapotranspiration); rainfall; site properties (soil texture, rootzone depth, water holding capacity); and MAD (managed allowable depletion).

The IA SWAT committee has proposed an equation for calculating this water balance. For more information, see the IA's website: http://irrigation.org.

TESTING PERIOD

The controllers were set up and allowed to run from April 11 to May 29, 2011 and from August 8 to November 20, 2011. Controller performance is reported over seasonal periods. For the purposes of this report, seasons are defined as follows: Spring: April 11 to May 29 (48 Days);

Summer: August 8 to September 4 (28 Days); Fall: September 5-November 20 (76 Days). ETo was computed from weather parameters measured at the Texas A&M University Golf Course in College Station, which is a part of the TexasET Network. The weather parameters were measured with a standard agricultural weather station that records temperature, solar radiation, wind and relative humidity. ETo was computed using the standardized Penman-Monteith method.

CONTROLLER PROBLEMS

Four controllers experienced problems during the course of the study.

1. Controller A had a capacitor leak during the course of the study. This resulted in the controller software operating but not being able to turn valves on.

2. Controller C had a sensor module failure that was discovered during a routine check of controller status (power), the manufacturer was notified and a replacement was installed.

3. Although programmed and installed correctly, the Controller F failed to operate 4 out of the 6 programmed stations. The controller is currently being analyzed for a possible software or hardware malfunction.

4. Controller H experienced communication problems multiple times throughout the study.

Controller alerts (beeping) occurred on at least two occasions during the evaluation period.

The manufacturer was notified of the problem and a signal amplifier was installed on the controller. However, it was later determined that the problem was a result temporary poor signal service by the signal provider company in the testing area (a bad tower).

5. Controller D had a recall issued in late 2011 due to possible sensor malfunctions. As a result this model was discontinued and will be replaced with a newer for the 2012 year test.

CONCLUSIONS

Over the past 5 years since starting our "end-user" evaluation of smart controllers, we have seen improvement in their performance. However, the communication and software failures that were evident in our field surveys conducted in San Antonio in 2006 (Fipps, 2008) continue to be a problem for some controllers. In the past 4 years of bench testing, we have seen some reduction in excessive irrigation characteristic of a few controllers.

Our emphasis continues to be an "end-user" evaluation, how controllers perform as installed in the field. The "end-user" is defined as the landscape or irrigation contractor (such as a licensed irrigator in Texas) who installs and programs the controller.

Although the general performance of the controllers has gradually increased over the past 4 years, we continue to observe controllers irrigating in excess of ETc. Since ETc is defined as the ETo x Kc, it is the largest possible amount of water a plant will need if no rainfall occurs.

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This year, three controllers consistently irrigated in excess of ETc even though more than 5 inches of rainfall occurred during the study. The causes of such excessive irrigation volumes are likely due to improper ETo values and/or insufficient accounting for rainfall.

Three controllers were equipped with tipping-bucket rain gauges which measure actual rainfall and six controllers were equipped with rainfall shutoff sensors as required by Texas landscape irrigation regulations. Rainfall shutoff sensors detect the presence of rainfall and interrupt the irrigation event. During the 2011 evaluation period, below average rainfall occurred as the result of a historic drought. The spring period had the most rainfall (2.83 inches), and no major differences in performance observed between controllers using rain gauges and those using rainfall shutoff devices.

This is in contrast to the 2010 study during which over 17 inches of rainfall occurred and controllers using rain gauges applied irrigation amounts much closer to the recommendations of TexasET.

For a controller to pass our test, it would need to meet plant water requirements (TexasET recommendations) for all six stations. Of the nine controllers tested, none successfully passed the test during all three irrigation season. However, one controller passed for the fall irrigation season. Results over the past 3 years have consistently shown that the majority of controllers over-irrigate (i.e., apply more water than is reasonably needed).

Generally, controllers with on-site sensors performed better and more often irrigated closer to the recommendations of the TexasET Network than those controllers which have ET sent to the controller.

Current plans are to continue evaluation of controllers into the 2012 year. For the 2012 study, three controllers will be replaced with newer models to reflect upgrades in software or sensor technology.

While water savings shows promise through the use of some smart irrigation controllers, excessive irrigation is still occurring under some landscape scenarios. Continued evaluation and work with the manufacturers is needed to fine tune these controllers even more to achieve as much water savings as possible. ■