Experiences with the UGA EASY Evaporation Pan for Irrigation of Cotton Grown in Midsouth Clay Soils

by

Steven J. Thomson, Daniel K. Fisher
USDA-ARS-APTRU
Stoneville, MS

Daniel L. Thomas
Coastal Plain Experiment Station
University of Georgia
Tifton, GA

Introduction

A novel, yet simple, device was developed by Thomas et al. (2002) to provide farmers with a visible indication of evaporation, which can be related to crop water use. The UGA EASY evaporation pan consists of a washtub with a float connected to an adjustable rod that is hinged to allow it to swivel (figure 1). The rod is connected to a pointer, which indicates crop water status against a back plate that can be seen from the road. The back plate has a black line that indicates field capacity and a red line that signals to the observer when to irrigate. The rod can be adjusted back and forth according to soil/crop combination and period of the season. For example, high frequency irrigation in sand might require high sensitivity (the rod with a shorter travel), while lower frequency irrigation in clay soils might require the rod to be extended. This study presents preliminary data on our experiences using the UGA EASY Pan irrigation scheduler for cotton grown in a Sharkey clay soil. Soil-water potential was monitored simultaneously at three depths to provide some indication (other than visual) of crop water stress and give an idea of the zone of root activity.

Procedures

The EASY Pan was installed in a grass lane between two semicircular field sections (hereafter called field 13) planted in cotton and irrigated by a single-tower center pivot. This location provided easy access and good visibility. The predominant soil was Sharkey clay, which had been subsoiled with a Paratill subsoiler the previous fall. Watermark Model 200SS soil water sensors were installed at 9, 18, and 27 inches depths, in four quadrants of the field. Sensors were read periodically in the morning using the Watermark 30 KTCD-NL meter. Soil temperatures at the 12-inch depth were measured using a thermocouple at the end of a long probe. These readings were used to compensate Watermark readings at all depths for temperature, using equations modified from those presented in Thomson and Armstrong (1987) for the Watermark Model 200 sensor. Insects and weeds were controlled using standard practices and the crop was irrigated according to the field manager's best "guess" and observation of the crop. Thus, the EASY Pan was simply monitored and used as a passive device.

Results

Figure 2 illustrates the seasonal trend of evaporation and water replenishment as registered by the EASY pan, retrofitted with a numbered gauge. The black line of the pan's back plate corresponded to a gauge reading of 4, and the red line (signal to irrigate) corresponded to a reading of 0.5. Differences in a scale reading had an approximate 1:1 relationship with differences in pan water level, at the rod's fully extended position.

In no case did the pan signal for irrigation, although the crop's visual condition clearly indicated a need for water before some rainfall or irrigation events. As indicated, travel on the float rod was set to fully extended position, to accommodate lower frequency irrigation customary for crops grown in clay soils. A simple adjustment of the float rod for shorter travel would have allowed pan readings to more closely match water requirements. For the pan we used, the indicator would also need to be offset downward, as all readings were above the range of field capacity and irrigation. In our case, a reading of 6.3 corresponded to saturated conditions, which was past the black line (scale reading of 4).

Cotton growth in field 13 has always lagged behind cotton grown in other fields, even with subsoiling. We have found that more frequent water application is usually necessary in this field to replenish a shallow rooted crop. Another cotton field (hereafter called field 4), planted in Tunica Clay was monitored simultaneously with another EASY pan. This field was furrow-irrigated, so water was not added to the pan by irrigation. Soil conditions in this field are very good for cotton growth, and soil moisture sensors indicated strong uptake deep in the root zone (data not shown). Spot checks on pan readings indicated that a slightly shorter travel of the float rod might still have been needed to indicate irrigation for this field, although visible stress was never observed before an irrigation or rain event.

Figures 3 and 4 indicate corresponding soil moisture readings during the season for our field. Two stations (Stations 9 and 10) were chosen to illustrate differences. The figures illustrate strong uptake in the shallow zone, but little uptake in the 18-inch zone until late in the season. By contrast, strong water uptake was observed deep in the root zone (down to 24 inches) in field 4 (data not shown). Differences between sensor readings at the two stations illustrate variability in vigor, soil differences, and probable proximity of sensors to active roots.

Interesting sensor trends can be seen in figure 5. Plots of soil water tension from the 9-inch depth showed an expected correlation with water uptake as registered by the EASY pan across dates, past July 2, 2002 (day 183). However, there is a distinct dividing line between sensor data before and after day 183. The cotton was beginning to show visible stress early in the season, but readings from the 9-inch sensors did not climb to values one might expect, or values observed at sensor stations in other experimental cotton fields. Soils were cracking around the sensors in field 13, possibly reducing contact and keeping readings depressed. A very heavy rain of 4.5 inches occurred for two days before day 183 and we suspect that this caused the soil to swell around the sensors, re-establishing good soil-sensor contact. This is evidenced by higher sensor readings and definable trends after day 183 (figure 5).

Conclusions and Observations

The EASY pan can be a good scheduling tool for crops grown in clay soils. We feel there is ample adjustment of the float rod for irrigation of crops grown in clay soils. We did notice some lack of consistency and quality control in construction of the pans, however. Two EASY pans were ordered at different times, and we noticed that lines on the back plate corresponded to different points of vertical travel for the float rod. For example, both pans could be filled to overflow and the pointers would rest at different points relative to the two lines. In our case, neither pointer rested close to the black line. The pointer could be bent to indicate properly, but a better method is needed. Thomas et al. (2002) suggested using a slotted and moveable back plate to allow shifting the two lines for proper alignment. An extension of this idea might be to allow both lines to be moveable independently by taping them to strips of metal and pivoting them at the bottom of the plate. Although the float rod can be moved to adjust the device's sensitivity, the ability to move each line might be an added convenience for practical use. Whatever modifications are chosen, simplicity of design and use should always be kept in mind.

As has been stated, we used the EASY pan as a passive instrument this year, and did not use it to schedule irrigation. Observed trends with both the EASY Pan and Watermark soil moisture sensors indicated how we might use this pan to modify irrigation schedules in the future. Although better guidelines for irrigation of cotton need to be developed, we have been irrigating to replenish 1.5 to 2 inches on all cotton fields during periods of high water use. Looking at sensor readings and observing the crop, it appears that another irrigation may have been warranted between day 196 (July 15) and day 205 (July 24) for field 13. The crop was showing signs of visible stress for three days before the 2-inch rain came before day 205. It was clear that each soil environment/crop combination had a different characteristic, as the cotton in field 4 showed no signs of visible stress before irrigation.

The pan could be used for furrow irrigation, but an estimate of water applied would have to be made so the proper amount could be added to the pan. The amount applied can only be estimated based on flowrate and duration of application, but this may be sufficient. Responses to wetting from soil water sensors may be used to judge uniformity of water application using furrow irrigation.

Disclaimer

Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the U.S. Department of Agriculture and does not imply approval of the product to the exclusion of others that may be available.

Acknowledgements

The authors would like to thank Lawson Melton, Erica Scott, and Lindsey Sandifer for data acquisition; J. Roger Bright for setup, calibration, and maintenance of the evaporation pans and sensors; Ashley Harris for timely data entry, graphing, and preliminary data analysis.

References

Harrison, K.A. and D.L. Thomas. 2001. Irrigation scheduling made easy – “How to” guide for UGA EASY scheduler. University of Georgia Cooperative Extension Service.

Thomas, D.L., K.A. Harrison, J.E. Hook, and T.W. Whitley. 2002. UGA EASY pan irrigation scheduler. http://www.ces.uga.edu/pubs/PDF/B1201.pdf. Accessed August, 2002.

Thomson, S. J. and C. F. Armstrong. 1987. Calibration of the Watermark Model 200 soil moisture sensor. Applied Engineering in Agriculture. 3(2): 186-189.

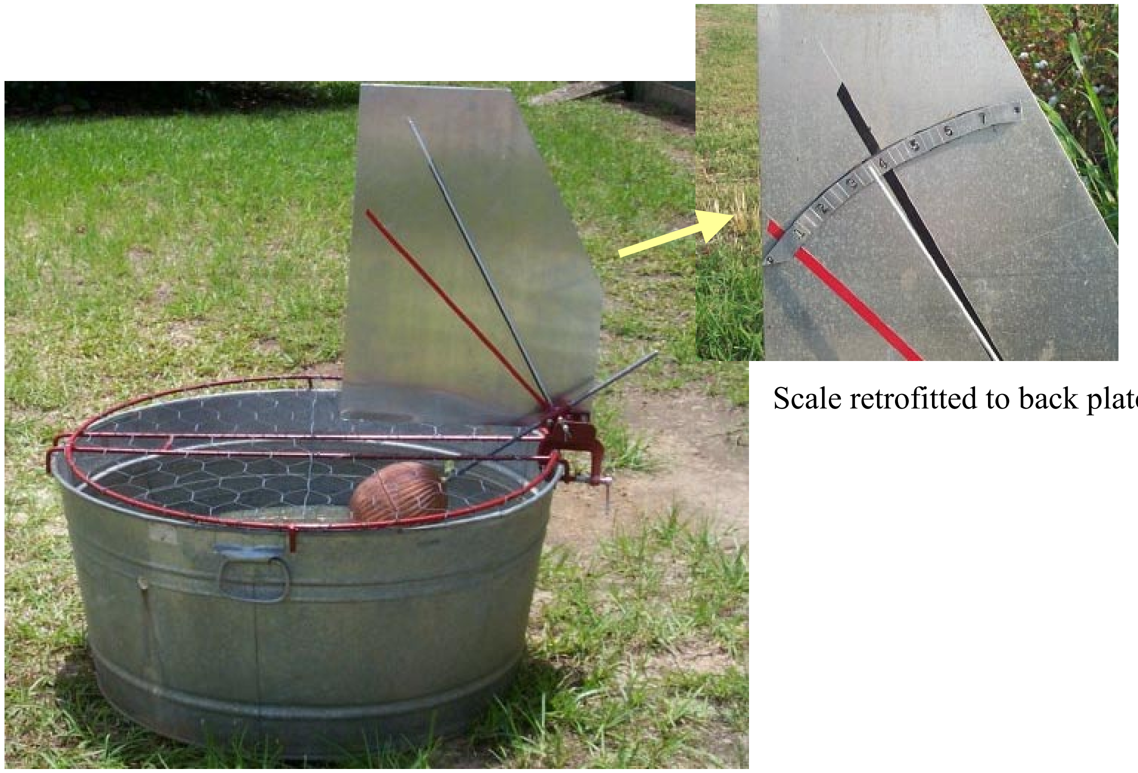

Figure 1. UGA EASY pan irrigation scheduler (from Harrison and Thomas, 2001)

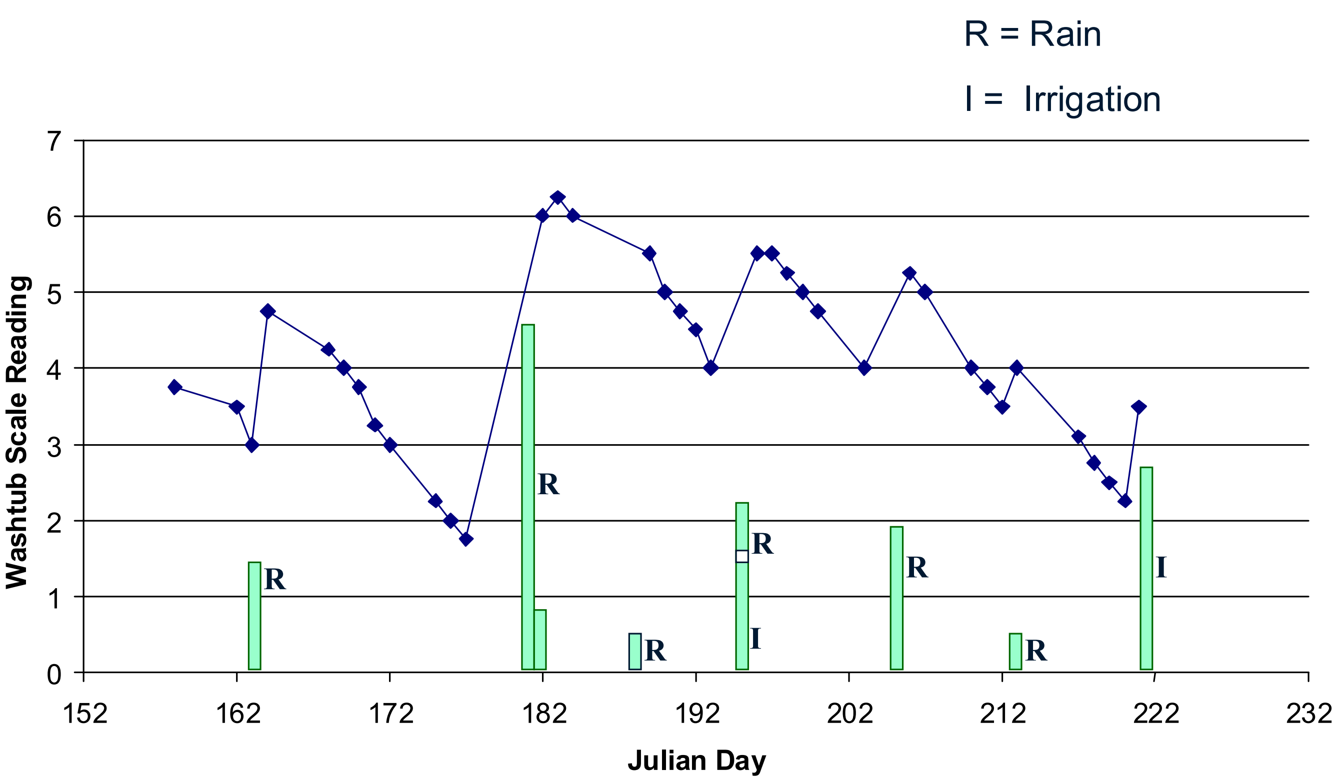

Figure 2. Plot of scale readings from the EASY pan showing rain and irrigation events. Y-axis represents washtub scale reading or inches applied by irrigation or rainfall

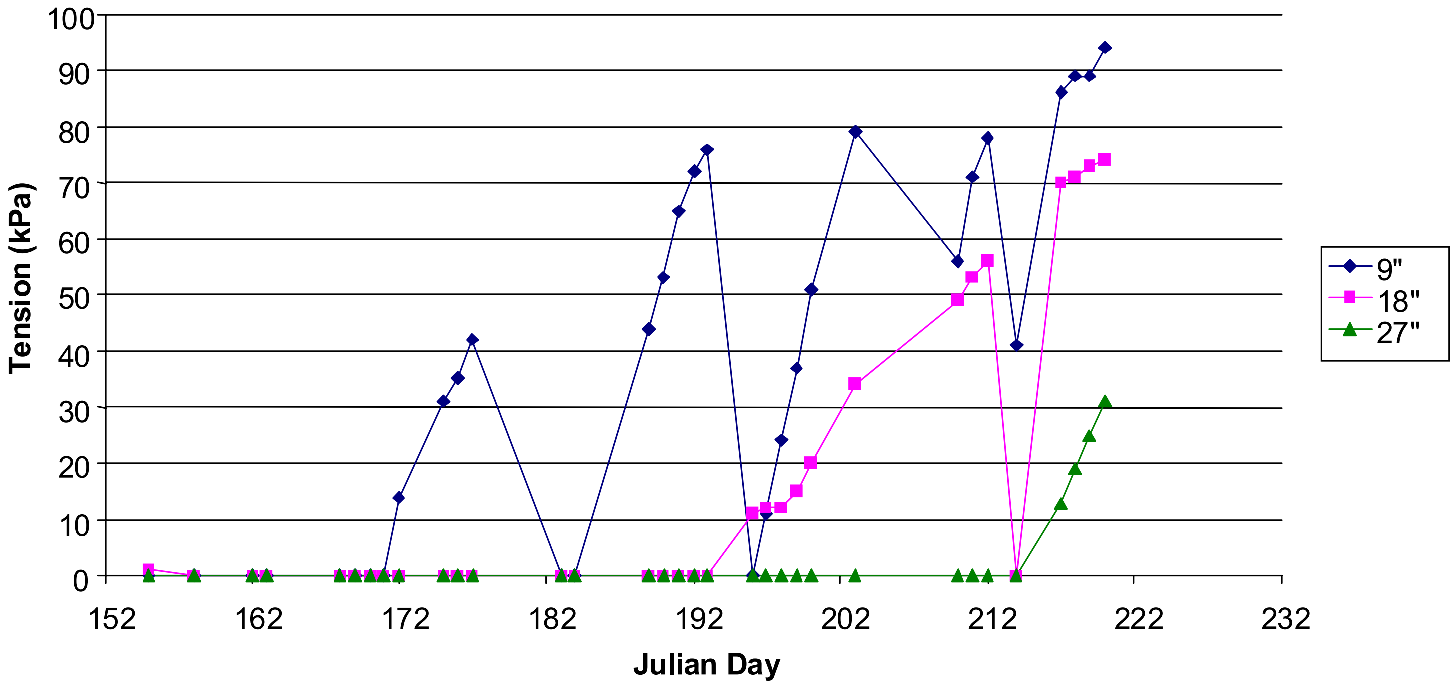

Figure 3. Watermark sensor readings (Station 10)

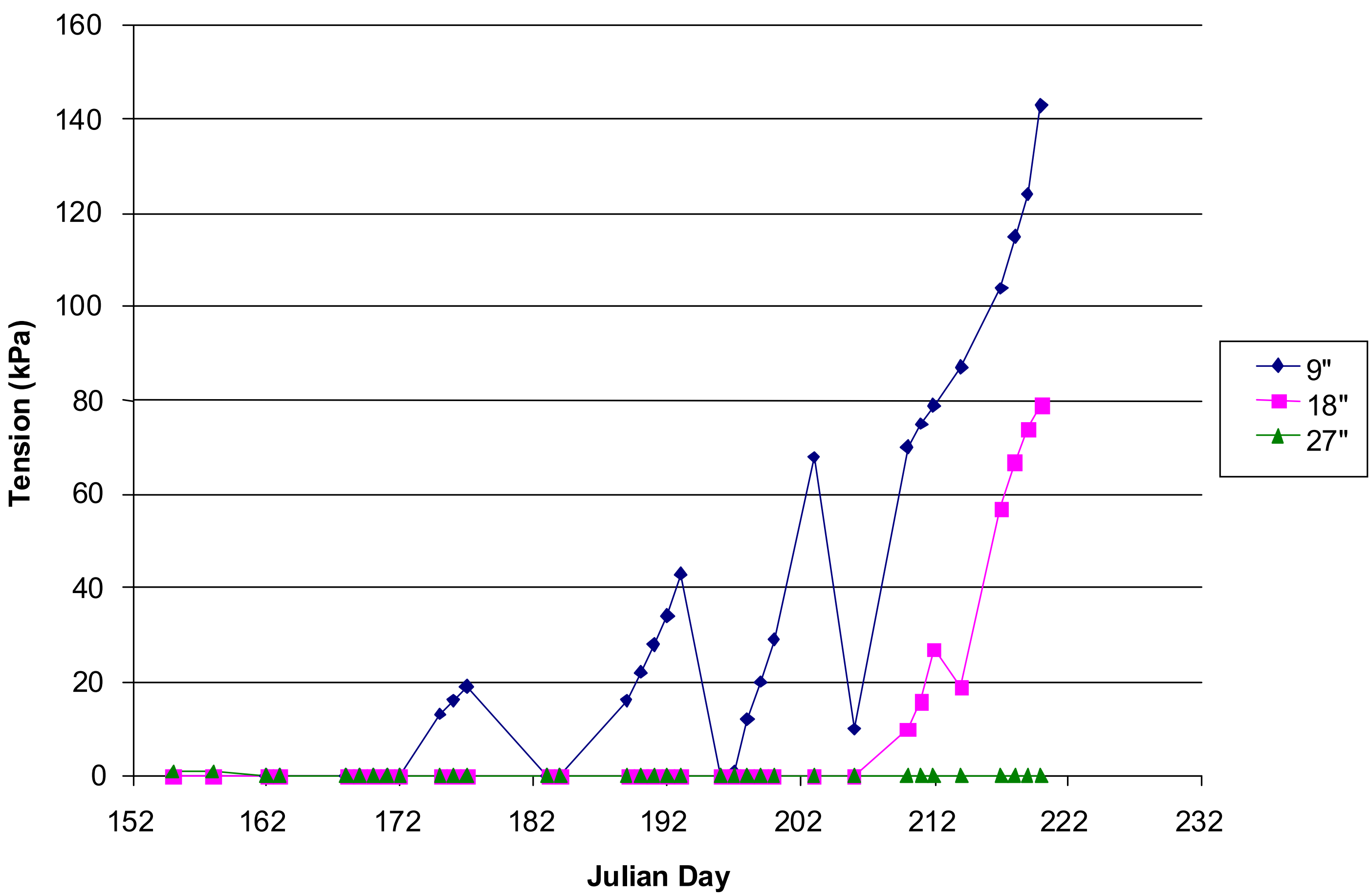

Figure 4. Watermark sensor readings (Station 9)

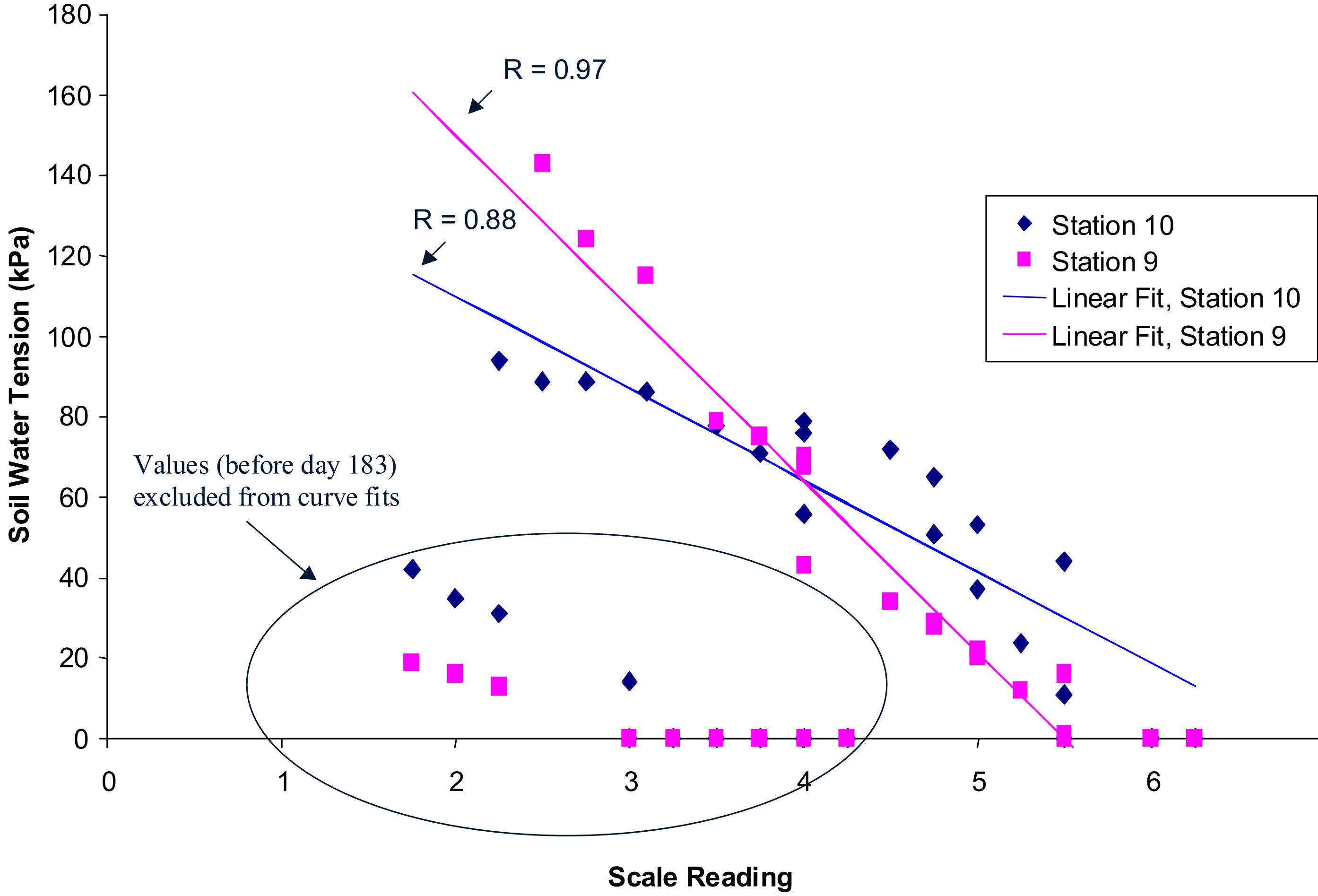

Figure 5. Scale readings from EASY pan vs. Watermark sensor readings.