A PROTOTYPE BALANCE MICRO LYSIMETER AS A CONTROL FOR AN IRRIGATION SYSTEM

ASA-CSSA-SSSA
2009 International Annual Meetings
PITTSBURGH

Arturo Chong Eslava.
Phytotecnia Department. Autonomous University of Chapingo
achong@correo.chapingo.mx

Introduction. Automatic irrigation systems usually use timers that star and stop pumps or open and close valves at determined times. Soil humidity sensors are also used to star or stop pumps accordingly to their calibration. Although it is possible to control soil humidity of a crop using these methods, they do not integrate plant development and growth and natural evaporation through the plant cycle.

Objectives. To design and built a balance micro lysimeter as a control element of a irrigation system. To probe that natural evaporation can be used to control an irrigation system.

Materials and methods. A balance micro lysimeter was designed to control the irrigation system's pumps and valves. The micro lysimeter is constructed as two metal boxes, the small one inside the big one. The small one is held by a spring mechanism and contains the soil. As the soil is at field capacity the small box moves down to a minimum and as it looses water it goes up until a chosen maximum. These movements close or open an electric circuit starting or stopping pumps or valves. An irrigated common bean crop was established using the micro lysimeter as a control for watering it.

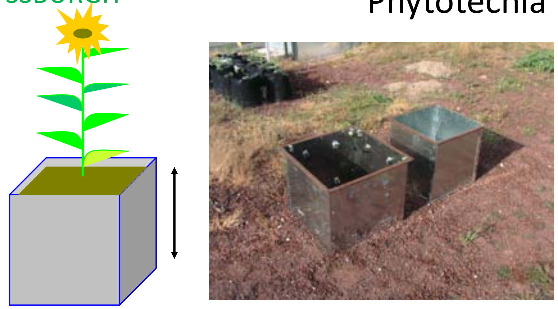
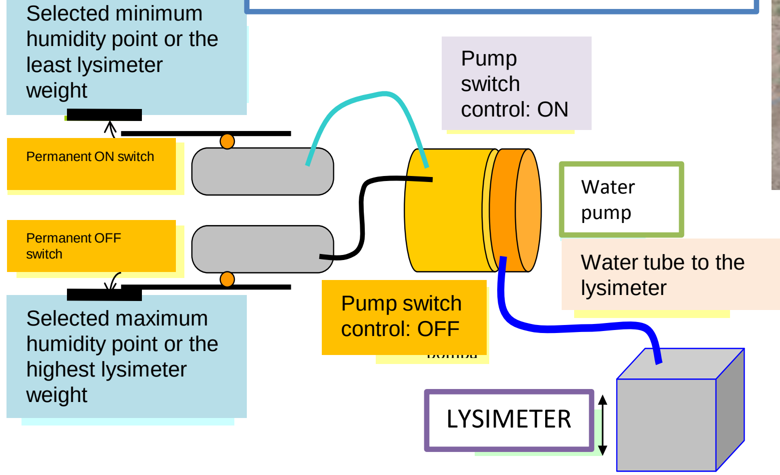


Figure 1. The metal boxes. The inside box contains the soil and is balanced by metal springs: up & down, as the soil water changes.

Figure 2. General system design. The permanent ON & OFF switches, water pump and the lysimeter.



Results. The balance micro lysimeter controlled acceptable the water system for the common bean crop, as long as the trial lasted. During raining days, the pump remained off because watering was not needed. At the beginning the switch positions, ON & OFF, needed to be calibrated as well the amount of water that filled the internal box. The water pump was on when the lysimeter weight reached the selected minimum. Common bean growth was acceptable for this initial trial.

Figure 3. The common bean crop growing inside the lysimeter during the initial trial.

Conclusion. The evaporation of a crop can be used for watering a crop. A balance micro lysimeter can be used to control an irrigation system.

Black T.A., G. W. Thurtell, and C. B. Tanne. 1968. Hydraulic Load-Cell Lysimeter, Construction, Calibration, and Tests. Soil Sci. Soc. Amer. Proc., Vol. 32. 623-629.
Dugas W.A., Dan R . Upchurch, and Joe T . Ritch. 1985. A weighing lysimeter for evapotranspiration and root measurements. Agronomy Journal. Vol. 77, 821-825.
Heatherly L. G., B. L. McMichael, and L. H. Ginn. 1980. A Weighing lysimeter for use in isolated areas. Agronomy Journal, Vol. 72, 845-847.
Ritchie J.T. and Earl Burnett. 1968. A Precision Weighing Lysimeter for Row Crop Water Use Studies. Agronomy Journal, Vol. 60, September-October. 645-649.

EFFECT OF WATER AVAILABILITY ON THE GROWTH OF COMMON BEAN

ASA-CSSA-SSSA
2009 International Annual Meetings
PITTSBURGH

Arturo Chong Eslava.
Phytotecnia Department. Autonomous University of Chapingo
achong@correo.chapingo.mx

Introduction. Water availability , from precipitation or watering, is maybe the most important factor for crop growth. The amount of water availability is going to affect the growth of plant vegetative structures: roots, leaf area, production of branches, etc. The general plant performance is also affected. Therefore, the reproductive structures are affected and also the plant yield.

Objectives. It was to define the effect of water availability on vegetative and reproductive plant structures and yield of common bean, and to define the optimums water amount for a high productivity.

Materials and Methods. Water amount of 189, 242, 292, 344, 394, 446, 550 and 601 mm were applied to Type I beans, sown in pots. Figure 1. Vegetative and reproductive structures were measurement. It was used six replications per treatment and an ANOVA analysis was performed.

Figure 1. Common bean pots and a general view of the experimental site.

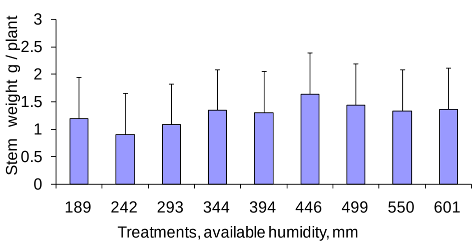
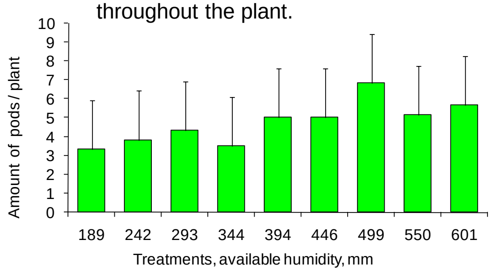
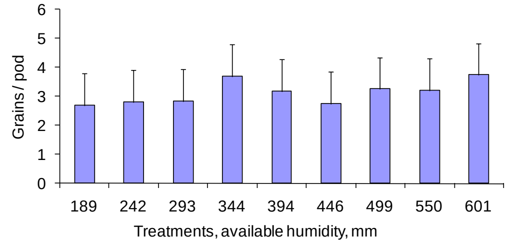


Figure 2.The stem dry weight was not statistically affected by the different water treatments. Although the 446 mm treatment produced the highest stem weight. The production of stems is maybe a variable that is not affected by the availability of water but its performance to storage, transport and translocate photosythates throughout the plant.

Figure 3. The number of pods per plant was a variable affected by the water availability. As a result of the plant vegetative structure performance each raceme was able to hold more fruits. The 449 mm treatment had the highest number of pods per plant. The 550 and 601 mm treatments reduced the amount of pods per plant, maybe because the excess water produced root problems.





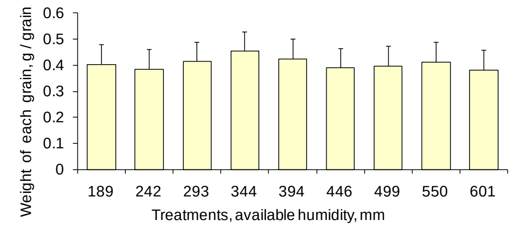
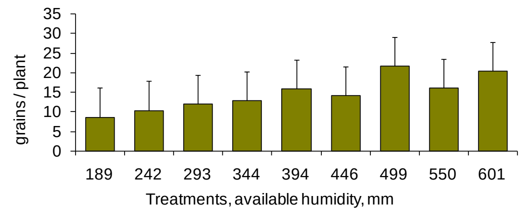


Figure 4. Grains per pod and the weight of each bean grain were not affected by the water availability treatments. The number of bean grains per pod probably is a genetic characteristic defined by the species than the effect of external factors. Also the weight of each seed is a species characteristic.



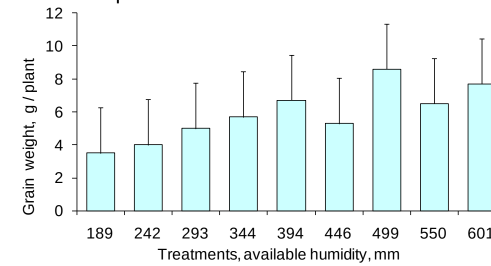


Figure 5. The number of grains per plant and the yield per plant were variables affected by the water availability. These variables are a direct result of the number of pod per plant than the effect of other morphological characteristic. The 449 mm treatment also produced the highest number and weight of seeds per plant. Also, the exceeded water may cause root problems, producing less pods per plant and therefore less grains and weight per plant.

Conclusion. Water availability affected the performance of vegetative structures than the morphological expression of these plant characteristics. The number of pod per plant was the reproductive structure that had a direct response to the water availability. As the plant had more water, each node was able to hold more racemes. The number of seeds per pod and the weight of each seed is probably a species characteristic.

Alves, A.A.C. and T.L. Setter. 2004. Response of cassava leaf area expansion to water deficit. Cell proliferation, cell expantion and delayed development. Annals of Bot. 94: 605-613.
Chavez, M.M., J.S. Pereira, J. Maroco, M.L. Rodríguez, C.P.P. Ricardo, M.L. Osório. I. Carvalho, T. Faria and C. Pinheiro. 2002. How plants cope with water stress in the field. Photosynthesis and growth. Annals of Bot. 89: 907-916.
Pastenes, C., P. Pimentel and J. Lillo. 2004. Leaf movement and photoinhibition in relation to water stress in field-grown beans. J. of Experm. Bot. 56(411): 425-433.
Taiz, L. and E. Zeiger. 1991. Plant physiology. The Benjamin/Cummings Publishing Co. Inc. California. 559 p.
Waisel, Y., A. Eshel and U. Kafkafi. 1991. Plant roots: the hidden half. Marcel Dekker, Inc. New York. 948 p.