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Technical and practical procedures with Irrigas® for irrigation management[1]

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INTRODUCTION

One of the main arguments of farmers in regions with irregular rainfall distribution, for not applying irrigation management practices, is the complexity and cost of such management systems. Therefore, the simplification proposal through the application of the Irrigas® System could be the answer that the sector has been demanding, from both research and rural extension, as this technology consists of a low-cost sensor that can be used by a wide range of farmer scales.

Irrigas® is a simple equipment that can be of great help to farmers in their daily irrigation management activities. Its basic function is to indicate whether the soil is moist or dry. In practice, it will contribute to informing the right time to irrigate and how much water should be applied to each irrigation.

This Technical Circular aims to demonstrate the functionality of the Irrigas® System, from its components, such as the choice and installation of sensors, and present results of a project developed in the North of the state of Minas Gerais, Brazil. It is important to highlight that this work is also a demand from cotton farmers in Zimbabwe, a country in Africa, through an international cooperation project that involves the institutions of Minas Gerais Agricultural Research Agency – Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG), Technical Assistance and Rural Extension Company of the State of Minas Gerais – Empresa de Assistência Técnica e Extensão Rural do Estado de Minas Gerais (Emater-MG) and the Brazilian Cooperation Agency – Agência Brasileira de Cooperação (ABC).

IRRIGAS® SYSTEM

This System Irrigas® was tested in the laboratory by researchers and its efficiency was confirmed by comparisons with tensiometers. In addition to the low cost, what also validates its use is the ease of installation and use in the field, such as manual reading, or even automated irrigation, if the farmer is interested.

Irrigas® is a system developed to save water and ensure plant growth. It consists one or more porous capsules connected by tubes to a transparent cuvette. The cavity of the porous capsule and the tube are always empty, free of water (Reis *et al*., 2018).

For irrigation management purposes, the capsule is introduced into the soil at the effective rooting depth. In this situation, the porous capsule enters water balance with the soil within a few hours.

When measuring the state of water in the soil, if the soil is “wet”, the air passage through the porous capsule is blocked when the cuvette is immersed in water, that is, water does not enter the cuvette because air does not leave the system through the pores of the capsule. On the other hand, when the soil dries out and the moisture drops below a critical value, the porous capsule becomes permeable to air passage (Calbo; Silva, 2005). Thus, when the soil is

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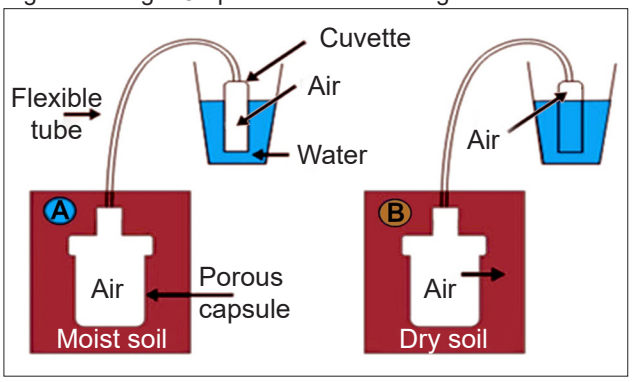
"dry", when the transparent cuvette is overturned in the water bottle, the air-water meniscus moves in it, in order to equalize with the water level in the bottle. When this occurs, the soil must be irrigated (Fig. 1).

Figure 1 - Irrigas® operational test for irrigation control



Source: Adapted from Calbo e Silva (2005) and Reis *et al*. (2018).
Note: Image improved by Dimas Renato Esteves.

The applications of Irrigas® to irrigation management are useful in a variety of environments, greenhouses, ornamental plant pots and various agricultural applications with irrigation systems such as drip, microsprinkler and furrows. The Irrigas® System sensors are robust and durable, and its physical properties are adjusted during manufacturing. A series of applications can be created from interesting models that can be adapted to each irrigation problem.

The low cost, ease of reading, and the fact that it is a robust sensor that does not require maintenance, make Irrigas® the sensor of choice, whether for irrigation management with manual reading or for automated irrigation management. And the reason for this is that it is not difficult to acquire and read an adequate number of Irrigas® System sensors necessary in each irrigation management application.

Type and choice

There are different types of Irrigas®, there are commercial ones, which are manufactured especially to indicate soil moisture, they are available with different capsule pore sizes but those with 15, 25 and 40 kilopascal (kPa) are the most commonly available.

The 15 kPa one has the thickest pores, the 25 kPa one has medium diameter pores and the 40 kPa one has very small pores. Common candle filters have medium diameter pores (≈ 25 kPa).

It is best to use the 15 kPa capsule when the crop is quite demanding on water. In the field, when soil moisture is monitored with Irrigas®, the 15 kPa capsule will indicate that we should irrigate much earlier than the 40 kPa capsule.

NUMBER OF IRRIGAS® SYSTEM SENSORS FOR EACH CROP AND INSTALLATION

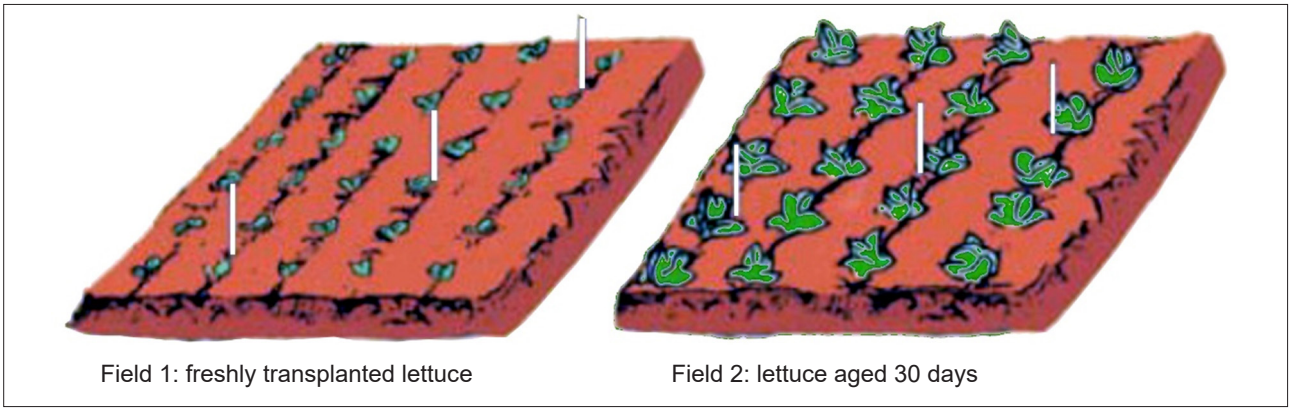
Just one Irrigas® is not enough to have good irrigation control, as the soil is not uniform, the plants grow differently and the amount of water applied by the irrigation system is not the same throughout the plot. Therefore, they must be installed in at least three representative locations, if possible one location at one end of the area, another in the central part and the third location at the other end, in diagonal direction. In each location, a shallower one must be installed, to indicate when to irrigate, and a deeper one, to indicate that the amount of water applied to each irrigation is not excessive. Therefore, in total, at least six Irrigas® units are needed per field.

A field corresponds to an area cultivated with the same crop, with the same age or phenological stage, in the same type of soil and irrigated by the same irrigation system. An area cultivated with cabbage, for example, must be treated separately from an area with tomatoes, as the crops have different water requirements. If the tomato plot has one part already producing and another part still beginning to flowering, the Irrigas® sensors must be separated into two fields and manage the irrigation of each one separately (Fig. 2) (Marouelli; Freitas; Costa Júnior, 2010).

Regarding installation, two Irrigas® System sensors are installed in each location, one deeper and the other shallower. A digger or a hoe can be used. We install the deepest one first, digging a hole as deep as the plant's roots reach or it can be set at an average depth of 50 cm. The capsule is placed flat at the bottom of the hole, leaving part of the plastic tube with the reading cuvette outside, and soft ground is placed on top, making sure that you lightly compact the ground with your hand so that the capsule is in perfect contact with the the soil. Otherwise Irrigas® will not work correctly (Marouelli; Freitas; Costa Júnior, 2010).

The shallower Irrigas® unit must be installed taking advantage of the same hole. First, the hole must be filled halfway with soil, that is, half the depth of the plant's roots or 50 cm. In the same way as the first, ground is placed on top of the capsule and lightly compacted with your hand. Then, the hole is

Figure 2 - Definition of the number of Irrigas® System sensors per field

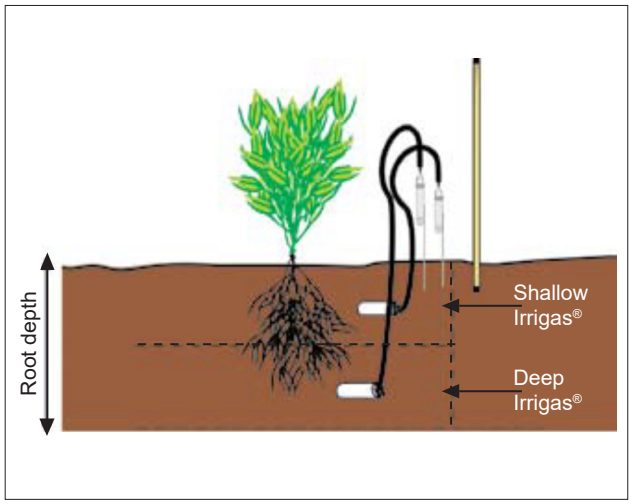


Field 1: freshly transplanted lettuce Field 2: lettuce aged 30 days

Source: Adapted from Marouelli, Freitas and Costa Júnior (2010).
Note: Control irrigation in each field separately.
Image improved by Dimas Renato Esteves.

filled with soil until it is level with the height of the plat or terrain, always compacting it by hand (Fig. 3) (Marouelli; Freitas; Costa Júnior, 2010).

Figure 3 - Installation of Irrigas® System sensors



Source: Marouelli, Freitas e Costa Júnior (2010).

IDEAL AMOUNT OF POINTS WITH THE IRRIGAS® AND ADJUSTMENT OF IRRIGATION TIME

To know when it is time to irrigate, at least two of the three points with Irrigas® installed in the field must indicate that the soil is “dry”. If all or two of them indicate that the soil is “wet” it means that it is not yet the right time to irrigate, as there is still enough water stored in the soil for the plants. In this case, wait to take a new reading the following day (Marouelli; Freitas; Costa Júnior, 2010).

The irrigation time can be adjusted on a trial and error basis as the irrigations are being carried out using the readings of the two Irrigas®, the shallowest and the deeper, according to the following recommendations:

a) the first irrigation must be done according to the operating time that the farmer was already using without applying irrigation management.
b) at the end of irrigation, all shallow Irrigas® should indicate that the soil is “wet”, remembering that it may take time for the capsule to reach humidity balance, which can be one hour on sandier soils, and up to four hours on clayey soils. If after this time the majority of shallow Irrigas® still indicate that the soil remains “dry” it means that the irrigation time was short. In this case, the next irrigation time must be increased by 20%.
c) the day after irrigation, the deep Irrigas® reading should be done. If these also indicate that the soil is “wet”, meaning that an excess of water was applied. In other words, the irrigation system was turned on for an excessive amount of time. In this case, next time you apply, reduce irrigation in 20%.

RESEARCH AND RURAL EXTENSION PROJECT

In January 2022, a research and Rural Extension Project was started in the Irrigated Perimeter of Jaíba, in the North of the state of Minas Gerais, Brazil, with the objective of establish indicators for the optimum irrigation depth and time per day, considering the phenological cycle of banana crop and the insertion of the Irrigas®, low-cost equipment to carry out

irrigation management, providing satisfactory yields in production and harvest quality.

Conducting the experiment

The proposal was to install Irrigas® System sensors in areas only of small farmers who work with banana crop. The work is coordinated by EPAMIG North, and has a sub-coordination and team partnership with the Emater-MG (Project with the coordination of researcher João Batista Ribeiro da Silva Reis, from EPAMIG North, Nova Porteirinha, MG, with the sub-coordination of the extensionist Igor Paranhos Caldas, from Emater-MG, Mocambinho, MG).

An initial training for farmers took place in which researchers and rural extension agents presented all the necessary procedures to efficiently handle Irrigas® System sensors, from installation to day-to-day routine in the field. Six sensors were installed in the areas of each selected farmers. Irrigas monitoring is carried out daily by the farmer and each one received an irrigation management control spreadsheet.

None of the selected farmers used an irrigation management methodology, therefore they followed an average that applied a certain irrigation time. From this initial time, management began to be done with Irrigas® and currently interesting results have been obtained with the reduction of irrigation time.

Examples of four farmers were obtained with the reduction of irrigation time through the use of Irrigas®. Before the Project, farmer José Carlos de Melo applied an irrigation time of 120 minutes, but currently with Irrigas®, he applies 90 minutes. Farmer Alberto Carlos da Silva, area whose soil is predominantly clayey, irrigated with an average time of 90 minutes, and after he joined the Project, he now irrigates with 70 minutes. Farmer Sinval Garcias de Farias achieved a 34% reduction in irrigation time, that is, from 240 to 150 minutes. Farmer Geraldo Doutor da Cruz achieved a 42% reduction in irrigation: from 120 to 70 minutes.

FINAL CONSIDERATIONS

Considering the effectiveness of the Irrigas® System's sensor implemented in the field, through the consequent training of farmers to use the equipment, optimal rates of reduction in energy costs on rural properties will be established, resulting from greater efficiency in the application of water, also highlight the saving of water, fertilizers and pesticides used in cultural practices.

Once these savings are achieved, the preservation of natural resources as a result of the optimization of water use, will also be a more constant factor, which culminates in the reduction of environmental impacts in rural areas. Related to this soil-water issue, the climate factor is also preponderant, as mainly semi-arid regions have been experiencing periods of more constant water scarcity. Therefore, the use of efficient and low-cost equipment becomes essential for effective irrigation management, also considering the possibility of higher yield rates in crops.

ACKNOWLEDGEMENT

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