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INFLUENCE OF TERRAIN DECLIVITY IN WET BULB PROFILEFROMTHE DRIP IRRIGATION.

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Abstract

The geometry informations of the wet bulb are important for the design of projects and management of drip irrigation, mainly to estimate the volume of wet soil, emitter flows and irrigation time. In this study aimed to determine the dimensions of the wet bulb formed by drippers with different flow on terrain with declivities. For this, soil moisture levels were determined throughout the soil profile after drip irrigation with three flow emitter associated with four declivity of terrain. According to the results, it was verified that the different terrain declivities and flows dripper influenced the wet bulb geometry and moisture distribution in your area, indicating the importance of relief in the positioning of emitters in drip irrigation.

Keywords: *Trickle irrigation, drippers, soil moisture*.

INTRODUCTION

Differently of population increase, the natural resources, including the water, are finite. And, due to increasing demand for these resources, words such as rationality, management and productivity are listened to more frequently (SALVADOR, 2014). Thus, the drip irrigation offers opportunities for optimizing these concepts, providing improvements in yield and efficiency of water use, influencing positively on the quality of food production (NOGUEIRA et al., 2000).

According to Tolentino Júnior et al. (2014) the drip irrigation is a technology that has been expanding quickly in modern irrigated agriculture. This irrigation technique is characterized by applying small volumes of water in high frequency and directly in the root zone of crops, preserving the soil at field capacity and preventing water loss by evaporation and percolation (FRIZZONE et al. 2012). This application results in a volume of wet soil, known as wet bulb.

The knowledge of the distribution of water in the soil is of great importance both for the dimensioning of irrigation systems as well as in its management, because the determination of emitters spacing, number of emitters and evapotranspiration rates depend on the previous information about the soil movement water (KELLER & BLIESNER, 1990; SOUZA & MATSUURA, 2004). Moreover, the high investments required in the implementation of this irrigation system can not provide financial returns to the farmer, if not used proper techniques of irrigation management aimed at rationalization of water use and increased productivity.

Thus, several studies have been developed for determining the dimensions and characteristics of the wet bulb associating differents flows, operation times and soil types (COELHO et al., 1995; NOGUEIRA et al., 2000; SOUZA & MATSUURA, 2004; RIVERA, 2004; BAKER et al., 2008; MAIA et al., 2010; LEVIEN et al., 2012; TOLENTINO JÚNIOR et al., 2014). And, although it is clear that the radius (horizontal dimension) is favored by capillary of soil, flow emitter, application time, and water retention capacity of the soil and, the wet depth (vertical dimension) is controlled by the gravitational force, ie, the drainage capacity of the soil, these relationships were not clearly been studied when associated with different terrain declivities, which may result in a wet bulbs with different geometric characteristics, when compared to the terrain without declivity.

It is worth point out that, in Brazil, are considered Permanent Preservation Areas (APP) or not cultivated areas, the hillside or parts of hillside, with declivity above 45°, equivalent to 100% in the line of maximum gradient and, top of hills, mound, mountains and sierras, with a minimum height of 100 meters and average slope larger than 25° (47%), in areas delimited from contour corresponding to two-thirds of the minimum height of elevation, always in the base, which is defined by the horizontal determined by plains or adjacent water surface or, in undulating reliefs, by sella point quota nearest of elevation (BRASIL, 2012). Observing, then, the existence under the law, of farmland in regions with not very restricted declivity values.

Thus, the aim of thisstudy was to determinethe dimensions of thewetbulbformed in thesurface dripirrigationassociated withdifferent flowsand declivitiesterrain.

METHODOS

The study was conducted at the Instituto Federal Goiano - Campus Urutaí, in Urutaí - GO, located at 17 ° 29'06 "S, 48°12'27" W and 712 meters of altitude, during the months from february to july 2014. According Köppen classification, the climate is Cwa, characterized as humid tropical, with dry winter and rainy summer, with rainfall and average annual temperatures of 2000 mm and 28°C, respectively.

The experiment was set up in factorial design 5x3, with three replications, and the treatments constituted by irrigation in four terrain declivities (0, 10, 20 and 30%, corresponding to 0; 5.70; 11.30 and 16.70°, respectively) by drippers autocompensantes in three different flows (4, 5 and 8 L h^{-1}).

A drip irrigation system was set up to enable the operation of only one lateral line with three emitters autocompensantes applying, simultaneously, the same flow along of declivity to be evaluated.

The time of system operation in each application was based on tomato crop, considering the final stage of the culture, crop coefficient of 1.10 (SANTANA et al., 2011), evapotranspiration of 5.40 $mmdia^{-1}$ (BERNARD et al., 2006), two days irrigation frequency, percentage of wetted area 40% (BLIESNER & KELLER, 1990), culture space of 1 x 0.4 m (MACEDO et al., 2005) and 90% application efficiency. Thus, the system operating times for the flows 4, 5 and 8 Lh^{-1}, were 32, 26 and 16 minutes.

For the determination of profile of the wet bulb, one hour after completion of the application of irrigation depth, disturbed soil samples were collected by a screw-type auger, and taken to the laboratory for determination of moisture content. This sampling was performed in order to cover the entire profile wetted, both at horizontal (surface) and vertical plane (depth), forming a gridded mesh. For this, in the horizontal plane, it was used a spacing of 10 cm and, in the vertical plane, it was used a spacing of 15 cm, taking as a reference the drip emission point.

In Table 1 are presented the physical characteristics of the soil studied, obtained as described in methods EMBRAPA (2011).

Table(1) Soil physical propertiesstudied indifferentsoil depths.

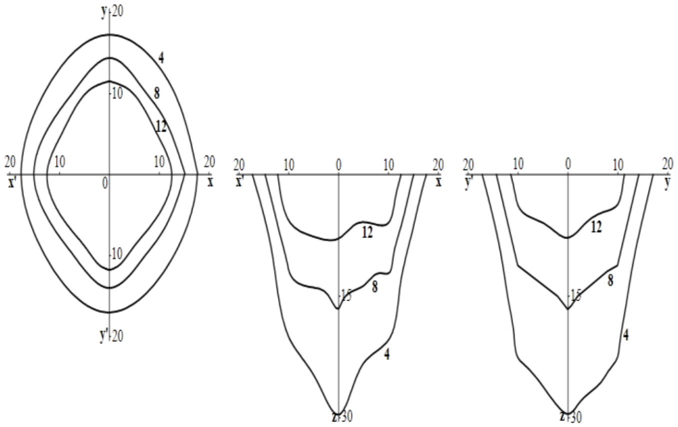
Depthof soil (cm)	ρs (g cm^{-3})	N (cm^3 cm^{-3})	Sand (g kg^{-1})	Silt (g kg^{-1})	Clay (g kg^{-1})	Textural Class
0-5	1,40	0,45	613	189	198	Sandy loam
5-15	1,33	0,49	577	187	236	Loam
15-30	1,30	0,49	563	162	275	Loam
30-45	1,25	0,51	536	113	351	Clay loam
45-60	1,24	0,55	518	120	362	Clay loam
60-75	1,34	0,50	535	133	332	Clay loam

Where: ρs is specific mass of soil and, N is total porosity.

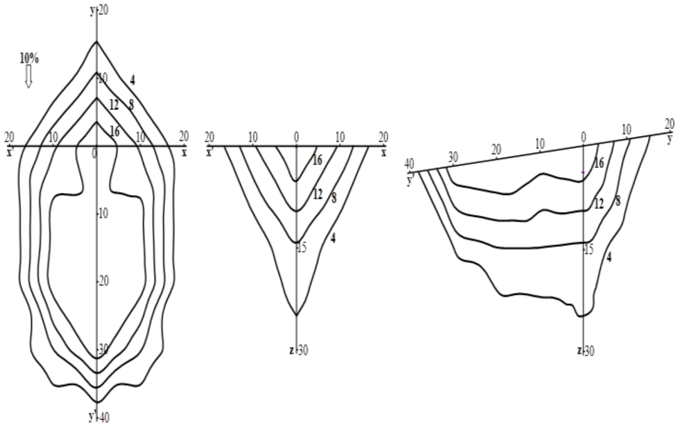
RESULTS AND DISCUSSION

In the Figures 1, 2 and 3 are presented the isoline of gravimetric moisture, in percentage, showing the distribution of water inside the wet bulb, in the xy plane (ground surface), xz (along the emission line) and yz (perpendicular to the emission line) for the flows 4, 5 and 8 L h-1, respectively.

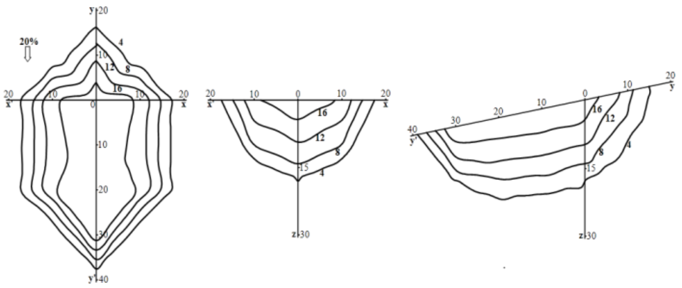
A



B



C



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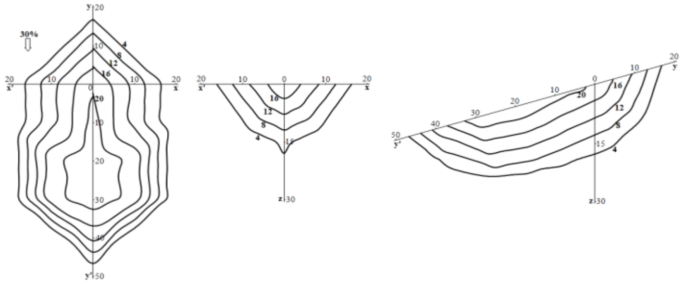
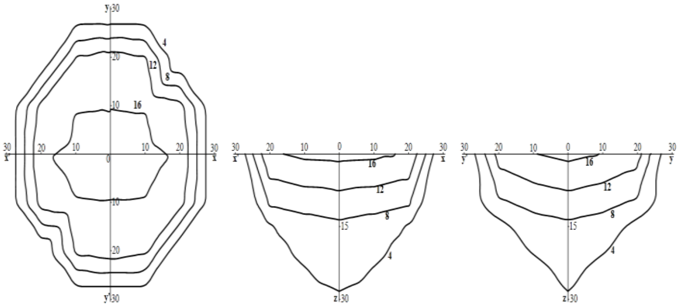


Fig(1) Isoline of gravimetric moisture, in percentage, for the flow of 4 L h^{-1}, on the declivity of: A) 0% B) 10% C) and 20% D) 30%. The axes are listed in centimeters, and z is the depth.

A



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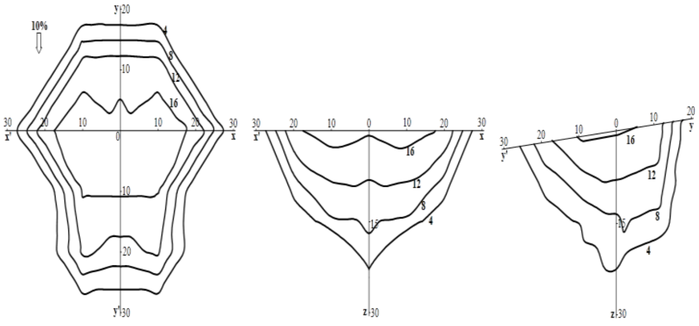

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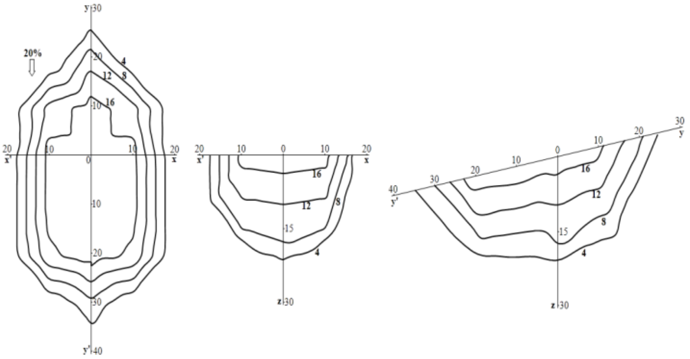

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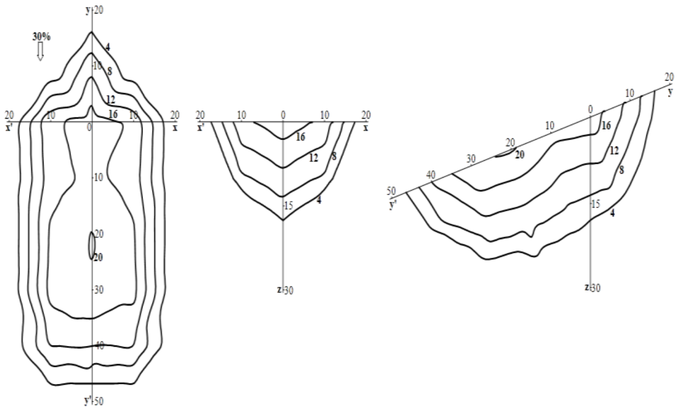
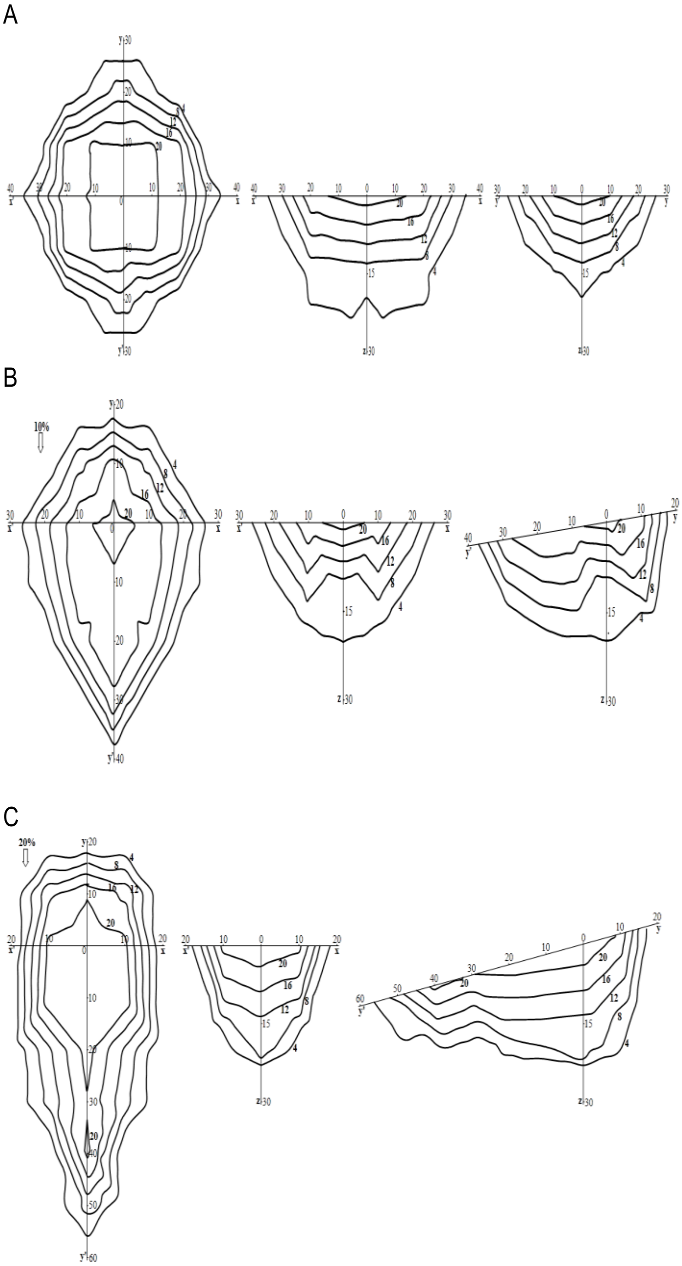
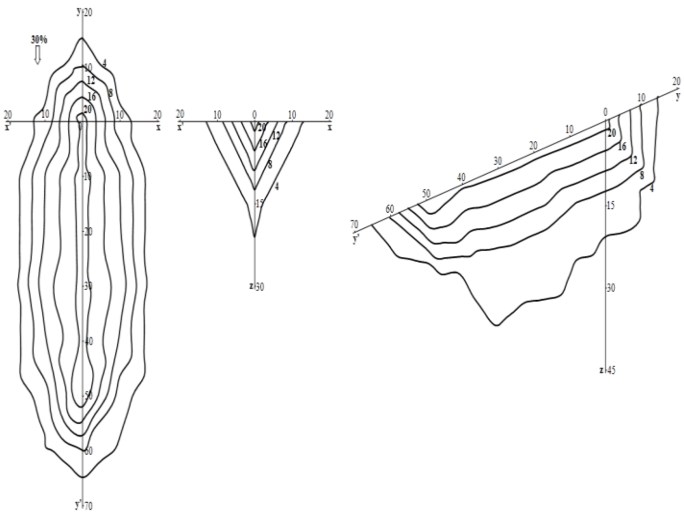


Fig(2) Isoline of gravimetric moisture, in percentage, for the flow of 5 L h^{-1}, on the declivity of: A) 0% B) 10% C) and 20% D) 30%. The axes are listed in centimeters, and z is the depth.



D



Fig(3) Isoline of gravimetric moisture, in percentage, for the flow of 8 L h^{-1}, on the declivity of: A) 0% B) 10% C) and 20% D) 30%. The axes are listed in centimeters, and z is the depth.

As the water infiltrate into the soil, the upper layers of soil will moistening from top-down, gradually, altering the moisture profile. As long as there water supply, the moisture profile tends to saturation in all the depth, and the surface will be, of course, the first level to saturate (BRANDÃO et al., 2006).

Thus, for all wetted bulbs profiles, it is observed that, due to of sample collection for determination of moisture content have occurred one hour after application of the irrigation depth, had not yet started the water redistribution movement in the soil profile, resulting in increased of the moisture content near of surface and decreases with soil depth.

Analyzing Figures 1, 2 and 3, it is observed that the terrain declivity affect the behavior of the water distribution into the soil, wherein increments on the declivity resulted in a higher tendency to displacement of front of the bulb wetting in the declivity direction . Barreto et al. (2008), evaluating wet bulbs through multiple cuts at trench, also noted the humid region development trend following the terrain declivity..

Observa-se, ainda, quando o terreno se encontrava nivelado (Figuras 1A, 2A e 3A),ocorreu maior migração radial da água na superfície do solo com incrementos na vazão do gotejador, formando-se bulbos mais abertos. Por outro lado, incrementos na vazão e declividade, proporcionaram menor percolação vertical da água, obtendo-se menores profundidade da umidade no perfil do solo, o que pode ser explicado devido ao fato de a água tender a se deslocar na superfície do solo antes de começar o processo de infiltração-percolação.

Moreover, it is verified when the terrain was in level (Figures 1A, 2A and 3A), there was greater radial migration of water on the soil surface with increases in the flow dripper, resulting in more open wet bulbs. On the other hand, increases in flow and declivity, provided lower vertical percolation of water, obtaining smaller depth of moisture in the soil profile, which can be explained by the fact that water tends to move to the soil surface before begin the infiltration-percolation process.

Analyzing Figures 1A and 2A, it is observed that the bulb radius was smaller than its depth, similar situation was observed by Souza et al. (2007). In Figure 1A it is verified that the radial distance achieved by the wetted surface was 18 cm, wherein Rivera (2004) and Nogueira et al. (2000), applying water by surface drip, obtained radial values of 35 and 25 cm, respectively. This difference, regarding this study, may be due to the application volume (6 and 4.33 L) and standby time (24 h) for collecting samples which was 2.17 L and 1 h, respectively.

Also, in the same Figure 1A, the maximum depth reached was 30 cm, while Barros et al. (2009) applying the volume of 3 L of water by subsurface drip irrigation with a flow emitter of 4 L h^{-1}, in a red nitosol, the value obtained was 18 cm of depth, difference caused, probably, by a higher content of clay in this soil type.

Already, in Figure 3A, it verified a predominance of radial dispersion on the vertical, similar to that observed by Maia et al. (2010) and Souza & Matsura (2004). According to Maia et al. (2010), the application rate of some emitters may be larger than the water infiltration capacity on the soil, which, therefore, will tend to form bulbs with larger surface width and less depth. Another important factor was that in during the field test, it was observed the formation of a thin crust under the drip, possibly by dispersing particles during application of water, which can be related to larger flow of the emitter and a decrease the porosity and, consequently, the soil hydraulic conductivity, which is in accordance with the results obtained by Rivera (2004).

Maia et al. (2010), studying the dimensions of the wetted bulb by surface drip irrigation in four different application times (1, 2, 4 and 7 h) and four flows emitter (1, 2, 4 and 8 h L^{-1}) on a quartzarenic neosol, verified that the maximum bulb diameter on the surface was lower than 60 cm in the time 1 hour of application. Results opposed to those was obtained in this research, therefore, all the application time was lower than 1 h (16, 26 and 32 min), and in the declivity of 30%, for example, it was observed a maximum surface diameter larger than 60 cm. This difference can be explained by the local topography of the experiment while that the terrain was level, and in this study has the declivities, showing the importance of declivity in the dimensions of wet bulb.

The largest depth reached for water in applications occurred to the flow of 4 L h^{-1} and declivity of 0% (Figure 1A), whose value was of 30 cm. Wherein, according to Bernard et al. (2006), the effective depth of the root system of tomato cultivation is, generally, 40 cm. It was conclued that, even in the application that reached larger depth than 30 cm, there would be if the tomato crop was established, water loss by deep percolation.

CONCLUSION

According to the experimentals conditions, can be concluded that the different terrain declivities and flow drippers influenced the wet bulb geometry and moisture distribution in your area, evidencing the importance of relief in the placement of emitters in the surface drip irrigation.

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