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PRODUCTION OF PEPPER C*APSICUM CHINENSE* UNDER DIFFERENTS IRRIGATION DEPTHS IN GREENHOUSE

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ABSTRACT

The aim of this work it was to study differents irrigation drip depths in peppers (*Capsicum chinense*) grown in a greenhouse, according to the daily reference evapotranspiration, to obtain the ideal irrigation depth for better development of this crop in Jataí, Goiás, Brazil. The experimental design was a completely randomized design with 4 treatments and 4 replications. The treatments consisted of four differents irrigation depths, corresponding to (L1: 33%, L2: 66%, L3: 100% and L4: 133%) the daily reference evapotranspiration. Each experimental unit consisted of 4 plants. Agronomic traits were evaluated, such as: plant height, height of the first fork, stem diameter at the base, stem diameter after the third leaf, fresh and dry matter. The irrigation depths of the treatments 1 (33%) and 2 (66%) showed inferior performance to the treatments 3 (100%) and 4 (133%) for all traits evaluated in this study. The treatments 3 (100%) and 4 (133%) showed the same performance for all traits evaluated in this study. So, the irrigation depth of the treatment 3 could be recommended for the irrigation management on pepper, considering the higher water use efficiency.

Keywords: irrigation management, pepper goat, reference evapotranspiration, water deficit

PRODUÇÃO DE PIMENTA C*APSICUM CHINENSE* SOB DIFERENTES LÂMINAS DE IRRIGAÇÃO EM CASA DE VEGETAÇÃO

RESUMO

O objetivo deste trabalho foi estudar diferentes lâminas de irrigação por gotejamento, em pimentas (*Capsicum chinense)* produzidas em casa de vegetação, de acordo com a evapotranspiração de referência diária de Jataí, Goiás. O delineamento utilizado foi o

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inteiramente casualisado com 4 tratamentos e 4 repetições. Os tratamentos corresponderam a quatro diferentes lâminas de irrigação, correspondendo a (L1: 33%, L2: 66%, L3: 100% e L4: 133%) da evapotranspiração de referência diária. Cada unidade experimental constou de 4 plantas úteis. Foram avaliados caracteres agronômicos como altura de plantas, altura da primeira bifurcação, diâmetro de colmo na base, diâmetro de colmo após a terceira folha, matéria fresca e matéria seca. As lâminas dos tratamentos 1 (33%) e 2 (66%) mostraram desempenho inferior às lâminas dos tratamentos 3 (100%) e 4 (133%) para todas as características avaliadas neste estudo. Os tratamentos 3 (100%) e 4 (133%) apresentaram o mesmo desempenho para todas as características avaliadas neste estudo. Então, a lâmina de irrigação do tratamento 3 (100%) poderia ser recomendada para o melhor manejo da irrigação na pimenta.

Palavras-chave: manejo da irrigação, pimenta de bode, evapotranspiração de referência, déficit hídrico

INTRODUCTION

The Capsicum peppers are originated in the Americas, especially Central and South. They and the peppers were possibly the first food additives used by the ancient civilizations of Mexico and South America (Crisóstomo, 2006).

The vast majority of peppers produces fruits with a characteristic pungent taste due to the presence of the alkaloid capsicin, associated with the genus name. This substance is accumulated in the tissue of the placental surface, it can being released by cutting the fruit (Filgueira, 2003). According Lopes (2008), the capsicin content is higher in certain species, being known as pepper of goat characterized as spicy.

Water is the most limiting factor in agricultural productivity, as it acts in several metabolic processes that culminate in plant development.

Excess water in the soil can also compromise production. Irrigations in excess impair the aeration and favor the development of various diseases of soil. In addition to the water supply at the appropriate time and in the correct amount, the application form is crucial to the success of plant (Marouelli & Silva, 2008). In this context, drip irrigation can be a viable alternative because of the possibility of working with low water availability and less energy costs associated with pumping (Azevedo et al., 2005).

It is necessary to irrigation management, with the correct water use, cost-effectively and providing adequate amounts for growth and plant development (Mantovani et al., 2007). A key requirement for the adoption of irrigation management is the daily determination of crop evapotranspiration (Bezerra et al., 2010).

The objective of this study was to evaluate differents irrigation depths drip in peppers grown in greenhouse, according to the daily reference evapotranspiration calculated by the Penman-Monteith method, to obtain the ideal irrigation depth for best development of pepper in the region of the Jatahy, state of Goiás.

MATERIAL AND METHODS

The experiment was conducted from September 2012 to February 2013 in the greenhouse of Jatahy Campus of the Federal University of Goiás, Jataí-GO, located at $17^0$53'S and $52^0$43'W and 670 m altitude. The municipality is situated at the microregion of Southwest Goiás, with an average annual temperature of 22 ° C and an average annual rainfall ranging from 1650 to 1800 mm. The soil used was a dystrophic Oxisol.

Pepper of the genus Capsicum chinense was used, the goat pepper, which has spicy pungency and color varies from cream, yellow or red. The size and diameter are approximately 10 mm and the height of the plant ranges from 0.6 to 1.0 m. The sowing date was August 16, 2012, in polystyrene trays of 128 pyramidal cells, filled with coconut substrate.

The ground material was collected from an Oxisol from an area located at the Federal University of Goiás - Campus Jataí. The clods were broken and homogenized. After this procedure, the chemical analysis of soil and fertilizer were realized. 200 g of limestone, 200 g of fertilizer 14-20-18 and 6 L of soil were mixed. 64 containers were used, containing 4 pots in each plot.

The seedlings were transplanted when they had 6 leaves, putting up a plant per container. The irrigation system used was the type localized drip. Aiming at the uniform initial development, the depth irrigation used was referent to 100% of the daily ETo for all treatments for 27 days till the full development of the seedlings.

A completely randomized design (CRD) was used with four treatments and four replications. The four treatments correspond to four differents irrigation depths, L1, L2, L3 and L4, respectively corresponding to 33%, 66%, 100% and 133% of the daily reference evapotranspiration. The treatments were differentiated by the number of emitters per plant (L1: 1 emitter, L2: 2 emitters, L3: 3 emitters and L4: 4 emitters). The flow rate of each emitter was equivalent to 2 L h^{-1}.

Irrigations were performed according to the reference evapotranspiration the day prior to application of the depth irrigation, which was calculated daily by SMAI program of State University of São Paulo - UNESP, using the Penman-Monteith method.

Plant height (cm) and stem diameter (mm) to 50 and 82 days after transplanting were determined. The measuring the height of plants was performed using a millimeter ruler, starting the length of the main stem of the plants till the insertion site last couple of leaves. The stem diameter was determined from an centimeter at the stem base and till the third leaf, using a digital caliper. The fresh and dry weight of plants was determined at the end of the test, with weighing and drying of shoots and roots of all plants in the plot. The drying of the plants was performed in an oven at 70 °C for 72 h.

Data for plant height, height of the first fork, stem diameter at the base, stem diameter after the definitive third leaf, fresh weight of shoot, dry weight of shoot, root fresh weight, root dry mass, total mass fresh and total dry mass were subjected to analysis of variance (F test) and Tukey test at 5% probability.

RESULTS AND DISCUSSION

The daily water requirement, also known as crop evapotranspiration, includes the amount of water transpired by the plant and water evaporated from the soil, and varies from 3 mm day^{-1} to 10 mm day^{-1} at the peak demand of the plants (Marouelli & Silva, 2008). In this work, the reference evapotranspiration of pepper ranged from 2 mm day^{-1} to 6.5 mm day^{-1}, which was calculated in January and February.

By analysis of variance of the factors studied, there was no significant effect at the stem diameter after the definitive third leaf. For the other factors studied as stem diameter at the base, plant height, fresh and dry weight of shoot, fresh weight and dry of root and fresh weight and total dry was significant difference between treatments to application of differents irrigation depths (Table 1 and 2).

After transplanting the seedlings was observed that there was influence of the crop growing stages for the plant height and stem diameter at the base (Table 1 and 2). According Peixoto et al. (2006) it is interesting to understand the responses of plants to drought, and know the variation of water consumption of crop in its different stages of development, studying the physiological aspects involved in the process as well as its consequences.

Table 1. Plant height (PLTH) in cm, stem diameter at the base (SDB) in mm, stem diameter after third leaf (SDATL) in mm, height of the first fork (HFF) in cm, of the different applied irrigation depths in pepper goat at greenhouse, on 50 days after transplanting (50 DAT)

Irrigation depths	50 days after transplanting			
	PLTH	SDB	SDATL	HFF

L1 - 33%	36.405 B	4.705 B	5.355 ns	31.842 ns
L2 - 66%	46.437 A	5.632 AB	6.067 ns	36.030 ns
L3 - 100%	51.375 A	5.702 A	6.267 ns	37.250 ns
L4 - 133%	49.875 A	5.855 A	6.332 ns	34.095 ns
CV (%)	8.232	8.113	8.232	8.580

Means followed by the same letter don't differ statistically by Tukey test at 5% probability; n.s = no significant difference.

Table 2. Plant height (PLTH) in cm, stem diameter at the base (SDB) in mm, stem diameter after third leaf (SDATL) in mm, height of the first fork (HFF) in cm, of the different applied irrigation depths in pepper goat at greenhouse, on 82 days after transplanting (82 DAT)

Irrigation depths	82 days after transplanting			
	PLTH	SDB	SDATL	HFF
L1 - 33%	42.625 C	5.367 C	5.6731 C	33.562 ns
L2 - 66%	60.937 B	6.507 B	7.013 B	38.125 ns
L3 - 100%	70.562 A	6.993 AB	7.485 AB	37.687 ns
L4 - 133%	76.5417 A	7.764 A	7.966 A	36.062 ns
CV (%)	5.724	5.573	4.891	8.536

Means followed by the same letter don't differ statistically by Tukey test at 5% probability; n.s = no significant difference.

For Melo et al. (2010), growth analysis can be very useful in the study of plant behavior under different environmental conditions, can quantify the amount of water that promotes maximum yield of the crop In the present work, the larger irrigation depths (2, 3 and 4) favored the development of pepper, not statistically different from each other, when we assessed plant height at 50 DAT (Table 1). At 82 DAT, it was observed that only the treatments 3 and 4 were superior to the others (Table 2).

The lower irrigation depth (33%) reflected in plants with lower heights, corroborating with the observed by Marouelli & Silva (2008) that the occurrence of water deficit may generate drastic limitations on the vegetative growth of plants, especially during the initial phase of culture. Guang-Cheng et al. (2010) studied the effect of water deficit imposed during the reproductive stage of pepper Zao feng, they found that both application techniques of irrigation water by applying 50% of the reference irrigation, or water replacement when the soil reached moisture equivalent to 80 % of field capacity, caused significant reduction in productivity. Yordanov et al. (2000) report that plants subjected to drought can modify their morphological and phenological characteristics.

As for the stem diameter at the base, at 50 DAT, the treatments 3 (100%) and 4 (133%) had plants with stem diameter greater than the other. At 82 DAT, only treatment 4 (133%) had the highest stem diameter. These factors justify that the demand for water by crop is gradually increased to the same extent that develops. A similar result was obtained by Albuquerque et al. (2011), who studied the growth and yield of pepper fertigated under differents irrigation depths, in which it was possible to observe the behavior of the variables plant height and stem diameter over the days of the experiment. The authors found that for both variables there was an increasing trend according to increasing irrigation depth, with little variation over time.

By contrast Santana et al. (2004) studied the production of irrigated peppers under different soil water tensions and doses of calcium, observed that there was no difference between the water tensions in the soil for stem diameter at 30 days after transplanting. Lima et al. (2012) evaluating the water tensions in the vegetative and reproductive stages of cayenne pepper crop, cultivated in greenhouse and irrigated by drip environment, they found that crop productivity decreased with the increase of the water tensions applied during the vegetative and reproductive stages. In a study conducted with Japanese cucumber crop in a greenhouse, Oliveira et al. (2011) found that the number and weight of fruits per plant were reduced with increasing water stress on the soil used as a treatment (15, 30, 60 and 120 kPa).

There was no significant difference between treatments in the two stages evaluated for the height of the first fork and stem diameter measured after the third leaf.

Regarding the characteristics of fresh and dry weight of shoots, treatments involving larger irrigation depths (3 and 4) produced plants with higher fresh and dry weight and it didn't differ statistically among themselves. Treatment 1 (33%) showed plants with smaller masses (Table 3). Taiz & Zeiger (2009) reported that plants exposed to water deficit have developed smaller and thicker leaves with the goal of minimizing water loss through transpiration.

Table 3. Fresh Matter (FM) in kg, root fresh matter (RFM) in kg, dry matter (DM), root dry matter (RDM) in kg, total fresh matter (TFM) and total dry matter (TDM) in kg, of the differents irrigation depths applied in goat pepper in greenhouse

Treatments	FM	RFM	DM	RDM	TFM	TDM
L1 - 33%	0.0285 C	0.0256 C	0.0129 C	0.0101 B	0.0541 C	0.0230 C
L2 - 66%	0.0558 B	0.0429 B	0.0192 B	0.0136 A	0.0987 B	0.0329 B
L3 - 100%	0.0772 A	0.0528 AB	0.0255 A	0.0151 A	0.1301 A	0.0406 A
L4 - 133%	0.0857 A	0.0584 A	0.0256 A	0.0171 A	0.1442 A	0.0427 A
CV (%)	10.07	15.45	10	11.79	11.02	9.8

Means followed by the same letter don't differ statistically by Tukey test at 5% probability; n.s = no significant difference.

It was observed that larger plants are also more weighted. Soares et al. (2012), determining the dry weight of the shoot of tomato plants in the vegetative phase, observed that the irrigation depth of 97% ET_0 provided greater accumulation in terms of dry weight of shoots, getting dry mass of shoots higher in tomato plants that applied irrigation depth 60 and 120% of ET_0.

It is emphasized that the availability of water to the plants reflects the growth and accumulation of water in plant tissues, interfering with its development. Azevedo et al. (2005) evaluated the yield of pepper due to irrigation depths (120, 100, 80, 60 and 40%) of the evaporation of class tank "A" (ECA), found that the largest amount of fresh matter of shoots was obtained with irrigation depth 100% ECA. Alvarenga et al. (2012) found that the dry matter yield of alecrim pepper was also favored by the increase in water supply.

As for the root fresh mass variable, the treatment with highest weight was treatment 4 (133%), treatments 3 (100%) and 2 (66%) had intermediate mass and treatment 1 (33%) resulted in plants less fresh weight. Once for the root dry mass, treatments 2, 3 and 4 did not differ statistically and dry mass of treatment 1 (33%) was maintained lower than the other treatments. This fact can be explained by the greater capacity of water retention by root of treatment 4 (133%), promoted by the greater availability of water to the plant and not the bigger than development of the same, since the dry mass was similar for irrigation depths 2, 3 and 4 (Table 3).

By studying the characteristics of fresh weight and total dry weight, there was a gradual increase in treatments concomitantly the amount of water applied till irrigation depths 100% and 133%, that from this point do not differ statistically among themselves. The same study was performed with chili by Dias et al. (2008), in which observed an increase in fresh and dry weight of seedlings of pepper with the increased supply of irrigation depths. Barroca et al. (2015) studied the effect of irrigation depths in the components of production of two pepper species, they found that the irrigation depths showed effects only for the productivity and average weight of the fruits of pepper.

CONCLUSION

The irrigation depths of treatments 3 (100%) and 4 (133%) for all caracteristics evaluated in this study presented the same performance. To better irrigation management, the use of the treatment 3 (100%) is recommended for the production of goat pepper in greenhouse, seeking a lower spend of water and energy savings with pumping. Based on the data obtained in this experiment, it was found that the reference evapotranspiration calculated by the Penman - Monteith method accurately reflects the need of water required for the crop of goat pepper, since with adding more water, there was no significant increase in development of characteristics evaluated.

REFERENCES

ALBUQUERQUE, F. S.; SILVA, E. F. F.; ALBUQUERQUE FILHO, J. A. C.; NUNES, M. F. F. N. Crescimento e rendimento de pimentão fertirrigado sob diferentes lâminas de irrigação e doses de potássio. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.15, n.7, p.686–694, 2011.

ALVARENGA, I. C. A.; LOPEZ, O. D.; PACHECO, F. V.; OLIVEIRA, F. G.; MARTINS, E. R. Fator de resposta do alecrim-pimenta a diferentes lâminas de irrigação. **Pesquisa Agropecuária Tropical**, v.42, n.4, p.462-468, 2012.

AZEVEDO, B. M.; CHAVES, S. W. P.; MEDEIROS, J. F.; AQUINO, B. F.; BEZERRA, F. M. L.; VIANA, T. V. de A. Rendimento da pimenteira em função de lâminas de irrigação. **Revista Ciência Agronômica**, v.36, n.3, p.268-273, 2005.

BARROCA, M. V.; BONOMO, R.; FERNANDES, A. A.; SOUZA, J. M. Lâminas de irrigação nos componentes de produção das pimentas 'De cheiro' e 'Dedo-de-Moça'. **Revista Agro@mbiente On-line**, v.9, n.3, p.243-250, 2015.

BEZERRA, B. G.; SILVA, B. D.; BEZERRA, J.; BRANDÃO, Z. Evapotranspiração real obtida através da relação entre o coeficiente dual de cultura da FAO-56 e o NDVI. **Revista Brasileira de Meteorologia**, v.25, n.3, p.404-414, 2010.

CRISÓSTOMO, J. R. **Cultivo de pimenta tabasco no Ceará**. Embrapa Agroindústria Tropical. Sistema de Produção 3, 2006. 40p.

DIAS, M. A.; LOPES, J. C.; CORRÊA, N. B.; DIAS, D. C. F. S. Germinação de sementes e desenvolvimento de plantas de Pimenta Malagueta em função do substrato e da lâmina de água. **Revista Brasileira de Sementes**, v.30, n.3, p.115-121, 2008.

FILGUEIRA, F. A. R. **Solanáceas:** agrotecnologia moderna na produção de tomate, batata, pimentão, pimenta, berinjela e jiló. UFLA, Lavras, Brasil, 2003. 333p.

GUANG-CHENG, S.; NA, L.; ZHAN-YU, Z.; SHUANG-EN, Y.; CHANG-REN, C. Growth, yeld and water use efficiency response of greenhouse-grow hot pepper under timer-space deficit irrigation. **Scientia Horticulturae**, v.126, n.2, p.172-179, 2010.

LIMA, E. M. C.; CARVALHO, J. A.; REZENDE, F. C.; THEBALDI, M. C.; GATTO, R. F. Rendimento da pimenta cayenne em função de diferentes tensões de água no solo. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.17, n.11, p.1181–1187, 2013.

LOPES, C. A. Ardume, picância, pungência. In: RIBEIRO, C. S. C.; LOPES, C. A.; CARVALHO, S. I. C.; HENZ, G. P.; REIFSCHNEIDER, F. J. B. **Pimentas Capsicum**. Athalaia, Brasília, Brasil, 2008. p.25-31.

MANTOVANI, E. C.; BERNARDO, S.; PALARETTI, L. F. **Irrigação princípios e métodos**. 2. UFV, Viçosa, Brasil, 2007. 358p.

MAROUELLI, W. A.; SILVA, H. R. Irrigação. In: RIBEIRO, C. S. C.; LOPES, C. A.; CARVALHO, S. I. C.; HENZ, G. P.; REIFSCHNEIDER, F. J. B. **Pimentas Capsicum**. Brasília: A Athalaia, Brasília, Brasil, 2008. p.95-109.

MELO, A. S.; SUASSUNA, J. F.; FERNANDES, P. D.; BRITO, M. E. B.;

SUASSUNA, A. F., AGUIAR NETTO, A. O. Crescimento vegetativo, resistência estomática, eficiência fotossintética e rendimento do fruto da melancieira em diferentes níveis de água. **Acta Scientiarum Agronomy**, v.32, n.1, p.73-79, 2010.

OLIVEIRA, E. C.; CARVALHO, J. A.; SILVA, W. G.; REZENDE, F. C.; ALMEIDA, W. F. Effects of water deficit in two phenological stages on production of japonese cucumber cultived in greenhouse. **Engenharia Agrícola**, v.31, n.4, p.676-686, 2011.

PEIXOTO, C. P.; CERQUEIRA, E. C.; SOARES FILHO, W. S.; CASTRO NETO, M. T.; LEDO, C. A. S.; MATOS, F. S.; OLIVEIRA, J. G. Análise de crescimento de diferentes genótipos de citros cultivados sob déficit hídrico. **Revista Brasileira de Fruticultura**, v.28, n.3, p.439-443, 2006.

SANTANA, M. J.; CARVALHO, J. A.; FAQUIN, V.; QUEIROZ, T. M. Produção do pimentão (Capsicum annuum L.) irrigado sob diferentes tensões de água no solo e doses de cálcio. **Ciência e Agrotecnologia**, v.28, n.6, p.1385-1391, 2004.

SOARES, L. A. D. A.; LIMA, G. S. D.; BRITO, M. E. B.; SÁ, F. V. D. S.; SILVA, E. C. B. D.; ARAÚJO, T. T. D. Cultivo do tomateiro na fase vegetativa sobre diferentes lâminas de irrigação em ambiente protegido. **Agropecuária Científica no Semiárido**, v.8, n.2, p.38-45, 2012.

TAIZ, L.; ZEIGER, E. **Fisiologia vegetal**. 4ª ed. Artmed, Porto Alegre, Brasil, 2009. 819p.

YORDANOV, I.; VELIKOVA, V.; TSONEV, T. Plant response to drought, acclimation, and stress tolerance. **Photosynthetica**, v.38, n.1, p.71-186, 2000.