ISSN 1808-8546 (ONLINE) 1808-3765 (CD-ROM)

RESPOSTA DO CRISÂNTEMO DE VASO À DIFERENTES LÂMINAS DE ÁGUA

ANDERSON CRESTANI PEREIRA[1]; MARCIA XAVIER PEITER[2]; MARCELO ANTONIO RODRIGUES[3]; ADROALDO DIAS ROBAINA[4]; JESSICA DARIANE PIROLI[5] E JHOSEFE BRUNING[6]

[1] Eng. Agrônomo, Mestre, Doutorando no Programa de Pós-Graduação em Agronomia, UFSM, Avenida Roraima, n° 1000, bairro Camobi, CEP: 97105-900, Santa Maria, RS, Brasil. Email: acrestanipereira@gmail.com.
[2] Eng. Agrônoma, Doutora, Professora Associada do Departamento de Engenharia Rural, UFSM, Avenida Roraima, nº 1000, bairro Camobi, CEP: 97105-900, Santa Maria, RS, Brasil. Email: mpeiter@gmail.com.
[3] Eng. Agrônomo, Doutor, Professor do Colégio Politécnico da Universidade Federal de Santa Maria, UFSM, Avenida Roraima, nº 1000, bairro Camobi, CEP: 97105-900, Santa Maria, RS, Brasil. Email: marceloarodrigues2002@yahoo.com.br.
[4] Eng. Agrônomo, Doutor, Professor Titular do Departamento de Engenharia Rural, UFSM, Avenida Roraima, nº 1000, bairro Camobi, CEP: 97105-900, Santa Maria, RS, Brasil. Email: diasrobaina@gmail.com.
[5] Eng. Agrônoma, Mestra, Doutoranda no Programa de Pós-Graduação em Engenharia Agrícola, UFSM, Avenida Roraima, nº 1000, bairro Camobi, CEP: 97105-900, Santa Maria, RS, Brasil. Email: jehpiroli@hotmail.com.
[6] Eng. Agrícola, Mestre, Doutorando no Programa de Pós-Graduação em Engenharia Agrícola, UFSM, Avenida Roraima, n° 1000, bairro Camobi, CEP: 97105-900, Santa Maria, RS, Brasil. Email: jhosefe.b@gmail.com.

1 RESUMO

O crisântemo de vaso está entre as espécies ornamentais mais comercializadas no Brasil. Todavia, há poucas informações relacionadas ao correto manejo hídrico da cultura. Com isso, este trabalho objetivou determinar o comportamento da área foliar e massa seca da parte aérea, raiz e total, além de obter a máxima eficiência técnica para produção de vasos comerciais de crisântemo sob distintos manejos de irrigação. O experimento foi conduzido em ambiente protegido em Santa Maria (RS), em delineamento inteiramente casualizado, com cinco tratamentos e dezesseis repetições. Os tratamentos foram baseados na capacidade de retenção de água no vaso (40, 60, 80, 100 e 120%). A área foliar foi mensurada semanalmente e a massa seca com periodicidade de catorze dias. Quando a espécie se encontrava no ponto de comercialização, os vasos foram classificados conforme os padrões de qualidade do Instituto Brasileiro de Floricultura. As lâminas de água correspondentes às maiores disponibilidades hídricas (80%, 100% e 120%) proporcionaram os melhores resultados de área foliar e massa seca. O maior número de vasos comerciais foi obtido na disponibilidade hídrica de 80% e a máxima eficiência técnica para produção de vasos de crisântemo comerciais foi observada com a lâmina corresponde à disponibilidade de 92,25% (226,29 mm).

Palavras-chave: *Dendranthema grandiflora*, manejo da irrigação, qualidade comercial.

Recebido em 13/11/2020 e aprovado para publicação em 22/01/2021
DOI: http://dx.doi.org/10.15809/irriga.2021v1n2p237-247

PEREIRA, A. C.; PEITER, M. X.; RODRIGUES, M. A.; ROBAINA, A.D.; PIROLI, J. D.; BRUNING, J.

RESPONSE OF POTTED CHRYSANTHEMUM TO DIFFERENT IRRIGATION DEPTHS

2 ABSTRACT

The potted chrysanthemum is among the most commercially ornamental species in Brazil. However, there is little information related to the correct water management of the crop. Thus, this work aimed to determine the behavior of the leaf area and dry mass of area, root and total part, in addition to obtaining maximum technical efficiency for the production of commercial potted chrysanthemum under different irrigation managements**.** The experiment was conducted in a greenhouse in Santa Maria (RS), in a completely randomized design, with five treatments and sixteen replications. The treatments were based on the water retention capacity in the pot (40, 60, 80, 100 and 120%). The leaf area was measured weekly and the dry mass at fourteen-day intervals. When the species was at the point of sale, the pots were classified according to the quality standard of the Brazilian Institute of Floriculture. The water depths corresponding to the highest water availabilities (80%, 100% and 120%) provided the best results for leaf area and dry mass. The highest number of commercial pots was obtained at the water availability of 80% and the maximum technical efficiency for the commercial production of potted chrysanthemum was observed with the water depth corresponding to the water availability of 92.25% (226.29 mm).

Keywords: *Dendranthema grandiflora*, irrigation management, commercial quality.

3 INTRODUCTION

Rio Grande do Sul has the potential to grow in flower production because of its large consumer market (UHLMANN et al., 2020). For both cut flowers and potted flowers, chrysanthemum (*Dendranthema grandiflora* Tzelev) is one of the most commercialized ornamental plant species in Brazil (KELLING et al., 2015; MENEGAES et al., 2017).

Environment agriculture is growing steadily worldwide (BAUDOIN et al., 2017). In floriculture, protected environment cultivation is highly important because it enables artificial microclimate conditions and allows plants to be grown in an environment protected from pests and diseases (DAMASCENO et al., 2019).

Proper irrigation management is one of the most important factors to consider when improving flower production and quality, especially in protected environments where water is provided solely through irrigation (SOARES et al., 2012; GIRARDI et al., 2016). Improving quality is important because, in the flower sector, the aesthetics of plants influence product classification and maximize marketing profits.

However, irrigation management in floriculture has been characterized by empiricism, resulting in excessive or insufficient water application. To avoid the risk of water deficit, many florists irrigate several times a day (OLIVEIRA et al., 2018). Measuring crop water demand allows for the rational use of water and fertilizer, increasing production efficiency and ensuring greater profitability (OLIVEIRA et al., 2016a).

Soil water availability and atmospheric evaporative demand affect plant water status, affecting plant dry matter accumulation and crop vegetative growth (AMINIFAR et al., 2012; DOMINGUES et al., 2017). To adapt to low water availability, some plants reduce their leaf area to promote root growth (ARAÚJO JÚNIOR et al., 2019). Girardi et al. (2014) emphasized that determining leaf area is an important tool for assessing plant response to environmental factors and crop management techniques and is therefore considered an important indicator of correct crop water management.

Given the above, this study sought to determine the behavior of the variables leaf area and dry mass of the aerial parts, roots and total parts, in addition to obtaining the maximum technical efficiency for the commercial production of potted chrysanthemum under different irrigation management practices.

4 MATERIALS AND METHODS

The work was developed in the Floriculture Sector of the Polytechnic College of the Federal University of Santa Maria (UFSM), in the city of Santa Maria (29° 43' S and 49° 19'W and with an altitude of 95 m), located in the central region of the state of Rio Grande do Sul.

The potted chrysanthemum variety 'Cherry White', which has mini-daisy-like inflorescences with white coloration, was used. The vegetative cuttings were previously treated with the rooting hormone indole-butyric acid (IBA) at a concentration of 1500 ppm.

The cuttings, measuring 5 cm in size, were planted in black plastic pots with a volume of 1.2 liters (heights of 12 cm, upper and lower bases of 14 cm and 9.4 cm in diameter, respectively) with drains at the lower end, which were filled with the commercial substrate Multiplant 3010.

A completely randomized experimental design (CRD) was adopted, with five treatments (various pot water holding capacities) and sixteen replicates for each treatment, totaling eighty pots. Each pot represents an experimental unit (EU). The treatments consisted of five water replacement depths in relation to the pot water holding capacity (VWC): 40%, 60%, 80%, 100%, and 120% of the VWC. The water depths were calculated according to water consumption, which was determined by weight lysimetry. Irrigation was applied with a fixed three-day irrigation schedule.

The CRV was determined according to the methodology described by Kämpf, Takane and Siqueira (2006). Equation (1), described by Mello (2006) and adapted by Schwab (2013), was used to apply the treatments.

$$MV\% = (MVcrv - MVdry).\ CRV\% + MVdry \quad (1)$$

Where MV% is the mass of the pot for each of the treatments; MVcrv is the mass of water retention capacity; Mvseco is the mass of the pot filled with completely dry substrate; and CRV% is the percentage of CRV for each treatment.

The leaf area (LA) was estimated weekly according to Equation 2, which was proposed by Kelling et al. (2015) for the Cherry White variety:

$$AF = 0{,}19X^{2{,}08} \quad (2)$$

where AF is the leaf area in cm² and X is the leaf length in cm.

The dry matter of the plants was measured every fourteen days, and the plant samples were separated into aerial parts (MSPAs), roots (MSPRs) and total dry mass (MST), after which they were enveloped and dried in an oven for 72 hours at 65°C. Later, they were weighed on a precision digital scale.

When the species was ready for sale (50% of the inflorescences were open), which occurred approximately 90 days after the vegetative chrysanthemum cuttings were planted, the pots were graded, and their quality was assessed via standards established by the Brazilian Institute of Floriculture (IBRAFLOR). These standards consider parameters such as firm, spot-free inflorescence color, uniform plant opening, the presence of pests and diseases and their damage to the plant, and root quality. Compliance with these marketing standards is essential, as they establish a minimum acceptable quality for the marketing of potted chrysanthemums, unifying communication throughout the production chain. When a species meets all quality criteria, it is classified as extra quality (A1), having a higher added marketing value than other classes do, which may lead to some quality defects.

To determine the maximum technical efficiency for the production of commercial chrysanthemum pots, the production function was initially obtained through regression analysis between the production of chrysanthemum in marketable pots and the applied water depths, adjusted by a second-order polynomial model, according to Equation 3:

$$Y = a + bX + cX^2 \quad (3)$$

where Y is the number of marketable vessels; X is the applied water depth (mm); and a, b and c are the adjusted coefficients of the equation.

After the vessel production function was adjusted, the blade (mm) that corresponds to the maximum technical efficiency for the production of commercial vessels (X_{MET}) was determined according to Equation (4):

$$X_{MET} = -\frac{b}{2c} \quad (4)$$

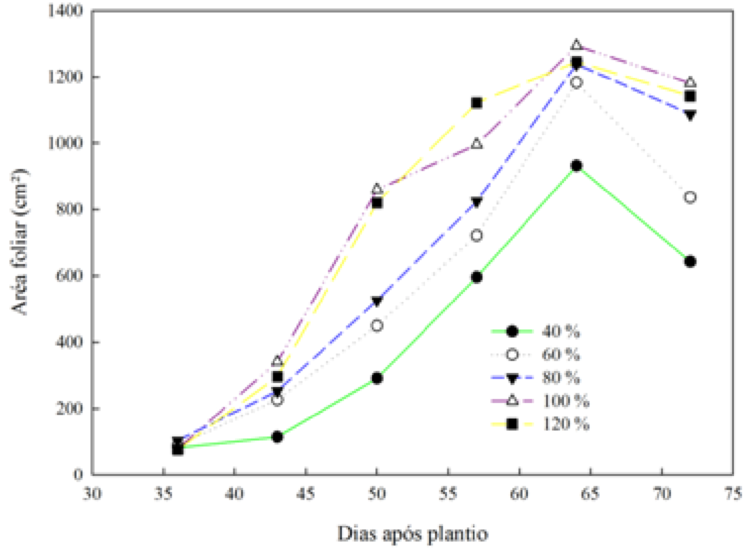
where X_{MET} is the blade (mm) corresponding to the maximum technical efficiency and b and c are the adjusted coefficients of equation 3.

Data on the leaf area (AF), aerial part dry mass (MSPA), root dry mass (MSPR), total dry mass (MST) and number of commercial pots of A1 quality were subjected to the Shapiro–Wilk normality test and homogeneity of variance through the Levene test. Finally, the data were subjected to analysis of variance at a 5% probability of error level via the statistical software Sisvar 5.6 (FERREIRA, 2011) and, subsequently, polynomial regression.

5 RESULTS AND DISCUSSION

The behavior of the leaf area under the different water availability conditions is shown in Figure 1.

Figure 1. Variation in leaf area throughout the cycle of potted chrysanthemum in different treatments according to the pot water retention capacity (VWC).



The leaf area fluctuated among the different treatments, with the highest values identified at the highest water availability. In turn, the lowest leaf area values throughout the cycle were observed at the lowest water availability studied (40% CRV), with an average leaf area 44% smaller than the leaf area of the 100% CRV treatment. As water availability decreased, the leaf area also decreased, possibly due to reduced biomass allocation to the shoots and increased biomass allocation to the roots (FASOLIN et al., 2019).

The reduction in leaf area and plant growth when subjected to low water availability can be considered an adaptive morphological process to reduce surface evaporation and decrease water consumption (ÁLVAREZ et al., 2011; BHARGAVA; SAWANT, 2013).

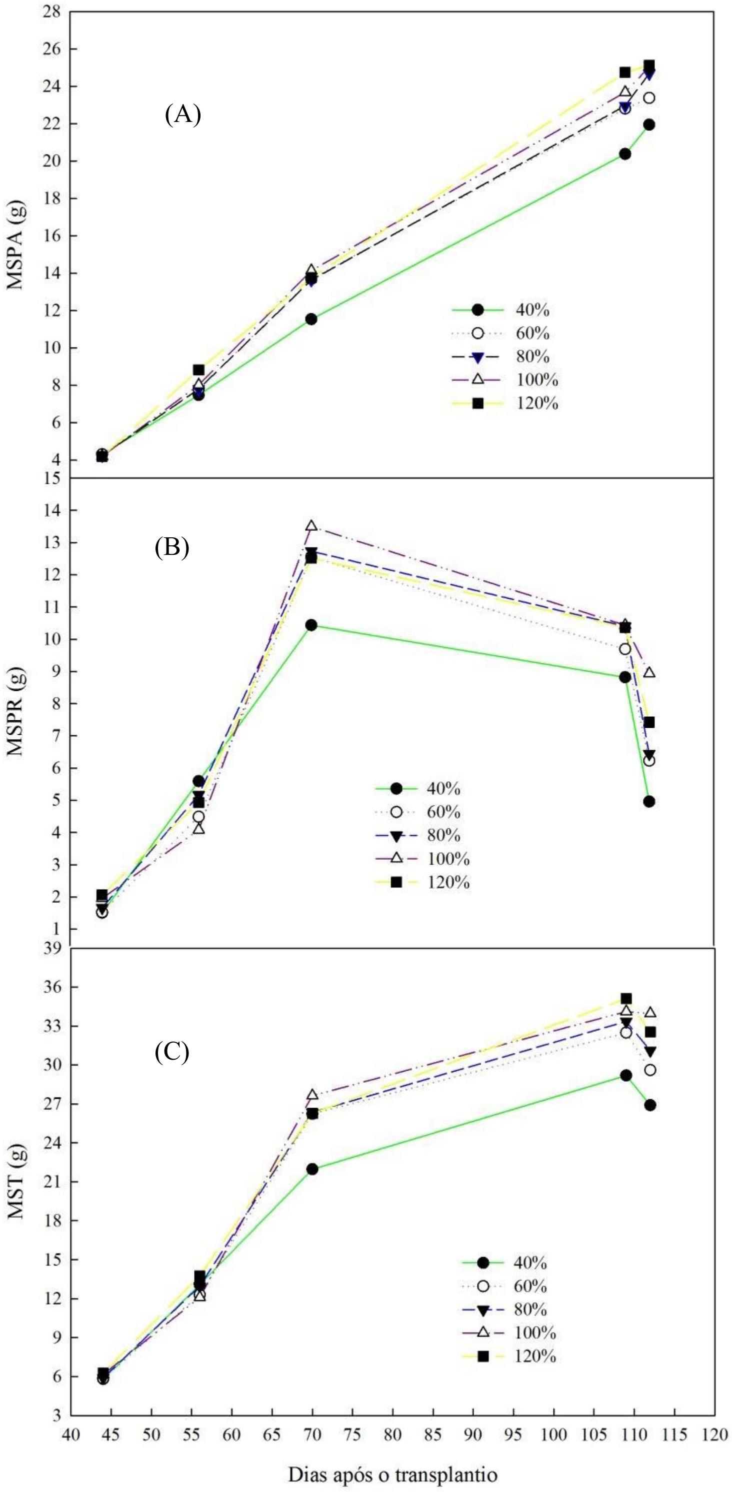
Farias and Saad (2011), evaluating the growth of the potted chrysanthemum cultivar Puritan under different water stresses in a protected environment, reported a reduction in leaf area under conditions of lower water availability (-30 kPa), highlighting the importance of water for plant growth. Under water stress conditions, leaves tend to expand less than they do under adequate water conditions.

When evaluating the response of transpiration and leaf growth in relation to the fractions of transpirable water in the substrate in four potted chrysanthemum cultivars, Kelling et al. (2015) reported an acceleration of senescence and leaf abscission with a decrease in the available water content in the substrate, validating the results of the present study, in which the lower water availability led to a reduction in the leaf area due to a possible water deficit in the potted chrysanthemum.

The largest leaf area was obtained in the treatments with greater water availability (100% and 120% CRV). Similar results were reported by Girardi et al. (2017), who, when verifying the effects of different levels of water retention capacity in the vase on the leaf area parameters and the number of stems and leaves of the *Alstroemeria x hybrida crop,* reported that the leaf area fluctuated significantly between treatments, resulting in the lowest water availability in this study.

The oscillations in the dry mass accumulation of aerial parts (MSPAs) and roots (MSPRs) and the total dry mass (MST) are shown in Figure 2.

Figure 2. Variation in the dry mass of the aerial part (MSPA), of the roots (MSPR) and total (MST) of the potted chrysanthemum culture in the different treatments of the water retention capacity in the pot (CRV).



As shown in Figure 2A, the MSPA grew as the crop developed, increasing its leaf area and subsequently emitting inflorescences, thus accumulating greater masses until the penultimate collection (fully open inflorescences). After this, there was a decrease in the dry mass curve of the aerial part, possibly due to the senescence of the inflorescences and leaves.

The highest values of dry mass of the aerial part were observed at the highest water availability (100%, 80% and 120% CRV), and the lowest values of dry mass of the aerial part were obtained for the lowest water availability studied (40% CRV).

Menegaes et al. (2019), aiming to evaluate the response of Chinese carnation plants grown under different irrigation levels and different concentrations of copper in the soil, reported an increase in the accumulation of phytomass in the aerial parts (leaves, stems and flowers) as the water supply to the crop increased. Full growth and development occurred in the treatment with 80% of the water retention capacity in the pot, regardless of the copper content added to the soil.

The MSPR (Figure 2B) increased in all the treatments up to 68 days after planting, after which the dry mass of the roots decreased for all the treatments studied, possibly in response to the advancement of the crop development cycle.

The highest MST values (Figure 2C) were obtained with the highest water availability (80%, 100%, and 120% CRV), whereas the lowest values were observed for the lowest water availability studied (40% CRV). These results are in agreement with those described by Spadeto (2016), who, working with the Faroe cutting chrysanthemum cultivar under different soil water deficits at different times after transplanting, obtained the highest values of dry mass of the shoot, root, and total crop when it was not subjected to water deficit.

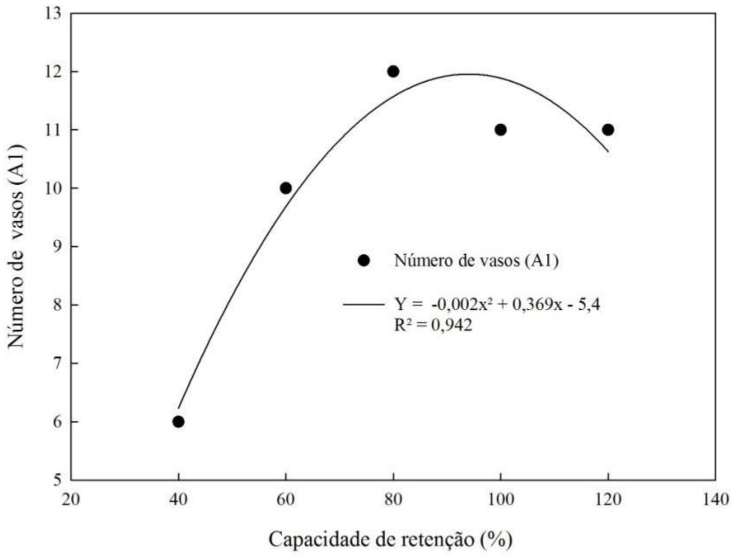
Similar results were reported by Govahi et al. (2015), who analyzed the growth and dry matter of sage and reported a decrease in dry matter due to water deficiency, with the highest dry matter values observed in treatments without water stress.

Farias and Saad (2011), studying the growth of the potted chrysanthemum cultivar Puritan, which was irrigated under different water tensions in a protected environment, did not find a significant difference in total plant dry mass between the different water tensions applied to the substrate.

Girardi et al. (2012), evaluating the influence of different water availability limits on the root development of gypsophila crops, reported that root growth and dry mass were affected as the water availability of the pot was reduced, and the highest values of root length and dry mass were obtained with 100% water retention capacity.

According to the IBRAFLOR classification, the best quality standard (A1) was obtained in treatments with greater water availability, and the lowest quality was obtained in the treatment with lower water availability (Figure 3).

Figure 3. Response of the commercial quality of the pots to the different treatments of the experiment.



In the treatments with greater water availability, the greatest number of A1-quality pots was observed, and the greatest number of commercial pots was obtained in the treatment with a water availability of 80% of the CRV. Piroli et al. (2019) reported a similar result for the gerbera crop. The authors described a reduction in the commercial quality of the crop, possibly due to a water deficit that interfered with the development of the aerial part, affecting the length and diameter and, consequently, influencing the stiffness of the stems, producing inflorescences outside the quality standard.

The maximum technical efficiency for the production of A1-quality pots was identified at 92.25% of the CRV, which corresponded to a 226.29 mm depth; this value represents the amount of water applied to achieve the highest technical productivity of the crop.

Farias and Saad (2011), working with the chrysanthemum cultivar Puritan grown in pots under different levels of water tension in the substrate (-2, -3, -4, -6, -10 and -30 kPa), described a strong correlation between plant quality and the applied water depth. The authors obtained the highest production of high-quality marketable pots (A1) in the treatment irrigated with a tension of -4 kPa. The treatment maintained at -30 kPa resulted in the lowest percentage of A1 pots. The results were similar to those identified in the present experiment, in which the lowest number of A1 pots was obtained in the treatment with lower water availability.

Piroli et al. (2019), who technically and economically evaluated the effect of irrigation on the production of cut gerbera in a protected environment, reported that the maximum technical efficiency for the production of gerbera stems in the blade corresponded to 79.3% of the water retention capacity in the vase.

technically and economically evaluated the effects of different irrigation depths and nitrogen doses on the productivity of rose bushes grown in a protected environment and reported greater production of commercial stems with a water replacement of 100% of the crop's water demand, with a difference of 35.7% in relation to the lowest replacement in the study (40%). The maximum technical efficiency was obtained with the replacement of 100.7% of the water in the soil.

6 CONCLUSION

Water availability interfered with the growth of the chrysanthemum crop, and greater water replacement levels resulted in greater values of leaf area and dry mass of aerial parts, roots and total dry mass of the crop in relation to the lower water availability of the experiment.

The highest number of high-quality commercial flower pots was observed when the potted chrysanthemums were grown at a water availability of 80% of the pot's WHC. However, the maximum technical efficiency for commercial pot production was achieved with a water replacement depth of 226.29 mm, corresponding to 92.25% of the pot's WHC.

7 REFERENCES

ÁLVAREZ, S.; NAVARROA, A.; NICOLÁS, E.; SÁNCHEZ-BLANCO, MJ Transpiration, photosynthetic responses, tissue water relations and dry mass partitioning in Callistemon plants during drought conditions. **Scientia Horticulturae** , Amsterdam, vol. 129 , n. 2 , p. 306-312, 2011.

AMINIFAR, J.; MOHSENABADI, GH; BIGLOUEI, MH; SAMIEZADEH, H. Effect of deficit irrigation on yield, yield components and phenology of soybean cultivars in Rasht region. **International Journal of AgriScience** , Rasht , v. 2, no. 2, p. 185-191, 2012.

ARAÚJO JUNIOR, GN; GOMES, FT; SILVA. MJ; JARDIM, AMFR; SIMÕES, VJLP; IZIDRO, JLPS; LEITE, MLMV; TEIXEIRA, VI; SILVA, TG F . Water stress in forage plants: A review. **PUBVET** , Maring á, v. 13, n. 1, p. 1-10, 2019.

BAUDOIN, W.; A. NERSISYAN, A.; SHAMILOV, A.; HODDER, D.; GUTIERREZ, S.; PASCALE, S.; NICOLA, N.; GRUDA, L.; URBAN E.J.T. **Good Agricultural Practices for Greenhouse Vegetable Production in the South East European Countries** . Principles for Sustainable Intensification of Smallholder Farms . Rome: FAO, 2017. v. 230.

BHARGAVA, S.; SAWANT, K. Drought stress adaptation: metabolic adjustment and regulation of gene expression. **Plant Breeding** , Berlin, v. 132, n. 1, p. 21-32, 2013.

DAMASCENO, FA; SILVA, E.; BALIEIRO, JID; NASCIMENTO, JAC; FERREIRA, MR Cooling efficiency of a moistened porous plate constructed with expanded clay . **Science ET Praxis** , Steps , v, 12, n. 23, p. 7-10, 2019.

DOMINGUES, R.; PEREIRA, AB; SCHIEBELBEIN, L.M.; ROSA, JA; BARBOSA, EAA; PIRES, LF Biological responsiveness of beans under different soil water regimes in a protected environment in Brazil . **Agricultural Engineering International** : CIGR Journal , Kissing , v . 19, no. 2, p. 22-33, 2017.

FARIAS, MF; SAAD, JCC Growth analysis of potted chrysanthemum, cultivar Puritan, irrigated at different water tensions in a protected environment. **Acta Scientiarum Agronomy** , Maringá, v. 33, n. 1, p. 75-79, 2011.

FASOLIN, JP; ZUCARELI, V.; CARBONIERI, J.; NAGASHIMA, GT; MORAIS, H.; CARAMORI, PH; MEDRI, ME Anatomical and physiological variation of peanut (cultivar IAPAR 25 Tição) grown under different water regimes. **Acta Iguazu** , Cascavel, v. 8, n. 3, p. 92-104, 2019.

FERREIRA, DF Sisvar: a computer statistical analysis system. **Science and Agrotechnology ,** Lavras, v. 35, n. 6, p. 1039-1042, 2011.

GIRARDI, LB; PEITER, MX; BELLÉ, RA; BACKES, FAA; SOARES, FC; VALMORBIDA, I. Water availability and its effects on root development and production of gypsophila potted in a protected environment. **Irriga** , Botucatu, v. 17, n. 1, p. 501-509, 2012.

GIRARDI, LB; PEITER, XP; BELLÉ, RA; ROBAINA AD; TORRES RR; KIRCHNER, JH; BEN, L. H B. Evapotranspiration and crop coefficient of alstroemeria (*Alstroemeria x hybrida)* grown in greenhouse. **Irriga** , Botucatu, v. 21, n. 4, p. 817-829, 2016.

GIRARDI, LB; PEITER, MX; PIMENTA, BD; BRUNING, J.; RODRIGUES, SA; KIRCHNER, JH Growth and development of *Alstroemeria x hybrida* when subjected to different vase retention capacities. **Brazilian Journal of Irrigated Agriculture** , Strength , v. 11, n. 1, p. 1191, 2017.

GIRARDI, LB; PEITER, MX; ROBAINA, AD; PEREIRA, AC; KOPP, LM; MEZZOMO, W. Analysis of the leaf area of *Alstroemeria* as a function of the irrigation depth. **Agricultural Science & Technology Journal** , João Pessoa, v. 8, n. 3, p. 21-25, 2014.

GOVAHI, M.; GHALAVAND, A.; NADJAFI, F.; SOROOSHZADEH, A. Comparing different soil fertility systems in Sage (Salvia officinalis) under water deficiency. **Industrial Crops and Products** , Fargo, vol. 74, n.1, p. 20-27, 2015.

KÄMPF, AN; TAKANE, RJ; SIQUEIRA, PTV **Floriculture** : substrate preparation techniques. Porto Alegre: LK, 2006.

KELLING, CRS; REICHARDT, K.; STRECK, N.A.; LAGO, I.; ZANON, AJ; RODRIGUES, M.A. Transpiration and leaf growth of chrysanthemum as a function of the fraction of transpirable water in the substrate. **Brazilian Agricultural Research** , Brasília, DF, v. 50, no. 9, p. 735-744, 2015.

MELLO, RP **Water consumption of Asiatic lily in pots with different substrates** . Dissertation (Master's in Agricultural Engineering) – Federal University of Santa Maria, Santa Maria, 2006.

MENEGAES, JF; BACKES, F.; BELLE, RA; SWAROWSKY, A.; SALAZAR, R. Evaluation of the phytoremediation potential of chrysanthemum in soil with excess copper. **Ornamental Horticulture** , Campinas , v. 23, n. 1, p. 63-71, 2017.

MENEGAES, JF; BELLÉ, RA; SWAROWSKY, A.; BACKES, FAAL; PADRÓN, RAR Water consumption and development of Chinese dianthus cultivated under different soil Cu contents. **Acta Iguazu** , Cascavel, v. 8, n. 1, p. 76-91, 2019.

OLIVEIRA, EC; ASSUNÇÂO, CJ; ALMEIDA, EFA; REZENDE, FC; REIS, SN; MIMURA, SN Yield of roses grown in a protected environment under different irrigation levels. **Irriga** . Botucatu, v. 21, no. 1, p. 14 -24 , 2018.

OLIVEIRA, EC; CARVALHO, JA; REZENDE, FC; ALMEIDA, EFA; REIS, SN; MIMURA, SN Irrigation levels and nitrogen doses in roses cultivated with integrated production techniques. **Irriga** , Botucatu, v. 21, no. 1, p. 14-24, 2016a.

OLIVEIRA, EC; CARVALHO, JA; REZENDE, FC; ALMEIDA, EFA; REIS, R. P . Production function for rose grown in an integrated production system. **Journal of Agricultural Engineering** , Viçosa, MG, v. 24, n. 6, p. 473-483, 2016b.

PIROLI, JD; PEITER, MX; ROBAINA, AD; RODRIGUES, MA; BOSCAINI, R.; RODRIGUES, PEC Technical and economic efficiency of irrigation in the production of cut gerbera in a protected environment. **Irriga** , Botucatu, v. 24, n. 3, p. 569-581, 2019.

SCHWAB, NT; PEITER, MX; BELLÉ, RA; BACKES, FAA; ROBAINA, AD; FERRAZ, RC Water consumption of carnation subjected to different irrigation strategies and pot sizes. **Irriga** , Botucatu, v. 18, n. 2, p. 328-336, 2013.

SOARES, FC; MELLO, RP; PEITER, MX; BELLÉ, RA; ROBAINA, AD; VIVAN, GA; PARIZI, AR Water consumption by lily crops grown in alternative substrates under protected environment conditions. **Revista Ciência Rural** , Santa Maria, v. 42, n. 6, p. 1001-1006, 2012.

SPADETO, MF **Development and production of chrysanthemum subjected to different levels of soil water deficit** . 2016. Dissertation (Master's in Plant Production) – Federal University of Espírito Santo, Alegre, 2016.

UHLMANN, LO; STRECK, NA; BECKER, CC; TOMIOZZO, R.; SCHWAB, NT; ORTIZ, VM Climate risk zoning for gladiolus in the state of Rio Grande do Sul, Brazil. **Brazilian Agricultural Research** , Brasília, DF, v. 55, n. 1094, p. l-14, 2020.