SCIENTIFIC NOTE

Population density of aphids in chrysanthemums grown under photoselective screens

Densidad poblacional de áfidos en crisantemos cultivados bajo pantallas fotoselectivas

Caio Henrique Binda de Assis[1], Ronilda Lana Aguiar[1], Anderson Mathias Holtz[1], Evandro Chaves de Oliveira[1], Julielson Oliveira Ataide[2]*, João Marcos Louzada[1], and Robson Prucoli Posse[1]

ABSTRACT

The chrysanthemum is one of the main ornamental species in the world. It has great relevance in the market. Aphids are the main pests that affect the chrysanthemum crop and cause various types of damage to this plant. The objective of this study was to evaluate the influence of different cropping systems using photoselective screens on the population density of aphids in cut chrysanthemum. The study was carried out in an experimental area of the Federal Institute of Espírito Santo – Campus Itapina (Brazil) in a randomized complete block design, according to the split-plot scheme over time. The experiment was established in 3 blocks of 12 m in length with plots of 3 m containing different photoselective screens (red, silver, and black) and the control treatment (open field). Repeated evaluations at different times were done at 0, 15, 30, 45, and 60 d. Data were checked for normality and homoscedasticity and submitted to the Tukey's test ($P<0.05$) and a non-parametric method of smoothing a dispersion graph with local weight (LOESS regression). Regardless of the color of the photoselective screen, there was a lower incidence of aphids compared to the open field treatment in the chrysanthemum culture with an average reduction of 84%. For the different sampling times, the Tukey test did not show significant differences between the means of aphid incidence in the evaluated period. Black, red, and silver photoselective screens promoted significant reductions in aphid populations in chrysanthemums of the variety *Zembla* in the environmental conditions of southeastern Brazil.

Key words: cut flowers, mechanical barrier, behavioral changes.

RESUMEN

El crisantemo es una de las principales especies ornamentales en el mundo con gran relevancia en el mercado. Los áfidos son la principal plaga que afecta al crisantemo, causando diferentes daños. El objetivo del presente trabajo fue evaluar la influencia de diferentes sistemas de cultivo bajo diferentes pantallas fotoselectivas sobre la densidad poblacional de áfidos en crisantemo. El estudio se realizó en un área experimental del Instituto Federal de Espírito Santo – Campus Itapina (Brasil); se empleó un diseño en bloques completamente al azar, con un arreglo de parcelas divididas a través del tiempo. El experimento se estableció en 3 bloques de 12 m de largo, con parcelas de 3 m de largo que contenían las diferentes pantallas fotoselectivas (roja, plateada y negra) y el tratamiento testigo (campo abierto). Las evaluaciones repetidas en el tiempo fueron a los 0, 15, 30, 45 y 60 d. Los datos fueron verificados por normalidad y homocedasticidad y sometidos a la prueba de Tukey ($P<0.05$) y un método no paramétrico de suavizado de un gráfico de dispersión con peso local (regresión LOESS). Independientemente del color de la pantalla fotoselectiva, hubo una menor incidencia de áfidos en comparación con el tratamiento de campo abierto en el cultivo de crisantemo, con una reducción promedio del 84%. Para las diferentes fechas de muestreo, la prueba de Tukey no mostró diferencias significativas entre medias de incidencia de áfidos durante el período evaluado. Las pantallas fotoselectivas negras, rojas y plateadas promovieron reducciones significativas en las poblaciones de áfidos en crisantemos de la variedad *Zembla* en las condiciones ambientales del sureste de Brasil.

Palabras clave: flores de corte, barrera mecánica, cambios de comportamiento.

Introduction

Chrysanthemum, *Chrysanthemum morifolium* Ramat., stands out as one of the main ornamental species in the world with great relevance in the cut flowers and potted plants market (Bhargavi *et al*., 2018). It is a common plant in the northern hemisphere, mainly Asia and Europe, and is one of the main flower species commercialized in countries like India, Colombia, and Brazil (Dhiman *et al*., 2018; Zandonadi *et al*., 2018; Parrado-Moreno *et al*., 2019; Sreedhar *et al*., 2020).

In Brazil, commercial floriculture has greatly expanded and become more competitive in recent years, proving to

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[1] Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo, ES (Brazil).
[2] Universidade Federal do Espírito Santo, ES (Brazil).
* Corresponding author: julielsonoliveira@hotmail.com

be a very promising commercial sector (Souza *et al*., 2020). Currently, the ornamental chain in the country has 8,000 producers of flowers and plants that together produce more than 2,500 species, including the chrysanthemum, which is among the main species cultivated for cut flowers and potted plants (Instituto Brasileiro de Floricultura, 2021).

Ease of cultivation, high return, great beauty and durability of inflorescences and especially great diversity are characteristics that contribute to the great worldwide popularity of chrysanthemums and make them suitable for various purposes, including interior and exterior decorations of houses, use in exhibitions, and production of garlands and bouquets (Heidemann & Barbosa, 2017; Dhiman *et al*., 2018; Thakur *et al*., 2018). However, the crop is affected by several factors, especially pest attacks, such as aphids, caterpillars, mites, white flies, and thrips (Saicharan *et al*., 2019).

Aphids are considered the most common pests that infest the crop with several species recorded such as *Macrosiphoniella sanborni* Gillette, *Myzus persicae* Sulzer, *Acyrthosiphon pisum* Harris, and *Aphis gossypii* Glover (Ali, 2017). These are small, sap-sucking insects that affect several plant species and can cause a wide range of damage, including weakening and yellowing, sprout deformation, honeydew secretion and consequent fungal development, and virus transmission that cause diseases (Singh & Singh, 2016).

Biotic factors, such as natural enemies and interspecific and intraspecific interactions, and abiotic factors, such as climatic conditions, presence of insecticides, and use of anti-insect and photoselective screens affect population dynamics and insect behavior (Nyamukondiwa *et al*., 2013).

Photoselective screens are tools that are being increasingly used in agricultural and ornamental crops. These screens function as a physical barrier for pests and act by modifying the spectrum and scattering light, a condition that directly influences pest behavior (Shahak *et al*., 2008). In addition, photoselective screens also impact the morphology and physiology of plants, promoting beneficial actions in the development and productivity of crops (Abbasnia *et al*., 2019; Bastías *et al*., 2021).

Researchers around the world have evaluated the influence of photoselective screens on populations of various pest species (Ngelenzi *et al*., 2019; Candian *et al*., 2020). However, in Brazil, studies with photoselective screens are focused on their impact on plants (Almeida *et al*., 2021; Sales *et al*., 2021). There is a gap in relation to the influence of these screens on agricultural pests in the conditions found in Brazil.

In this context, it is urgent to understand the impact of using photo-selective screens on pest populations and to assess their potential for use in ornamental crops under environmental conditions in Brazil. The objective of this study was to evaluate the influence of photoselective screens on the population density of aphids in the cut chrysanthemum variety *Zembla*.

Materials and methods

The study was carried out in the experimental area of the Federal Institute of Espírito Santo – Campus Itapina, located in the district of Itapina in Colatina – ES (Brazil). The region has a tropical climate according to the Köppen classification, characterized by seasonal rainfall and high temperatures (Köppen, 1936; Peel *et al*., 2007). The soil of the experimental area is classified as Dystrophic Red-Yellow Latosol (Santos *et al*., 2018).

Before installing the experiment, two simple samples were collected at a depth of 0 to 20 cm from each bed with a probe-type auger. The samples were homogenized in a clean container to form a composite sample, from which a sample was taken for chemical analysis at the Laboratory of Soil Analysis of IFES - Campus Itapina. This information was used to make fertilization recommendations for the cultivation of the variety *Zembla* chrysanthemum (white). The variety of chrysanthemum *Zembla* (white), acquired from the company Terra Viva located in the municipality of Holambra, São Paulo, was used in the experiment.

The experiment was conducted during the winter, between the months of July and September 2019 (July 24 to September 24). Maximum and minimum air temperature and relative air humidity were obtained from an automatic station of the National Institute of Meteorology (INMET), located in Marilândia - ES, 45 km away from the study (Fig. 1).

The experiment was conducted in a randomized block design, according to a split-plot scheme over time. The primary factor (plots) consisted of 4 different cropping systems: red, silver, and black photoselective shading screens and field conditions (control); and the secondary factor consisted of repeated evaluations over time (0, 15, 30, 45, and 60 d).

We established 3 blocks that consisted of beds 12 m long by 1.20 m wide and 7 planting lines covered by a 2.10 m

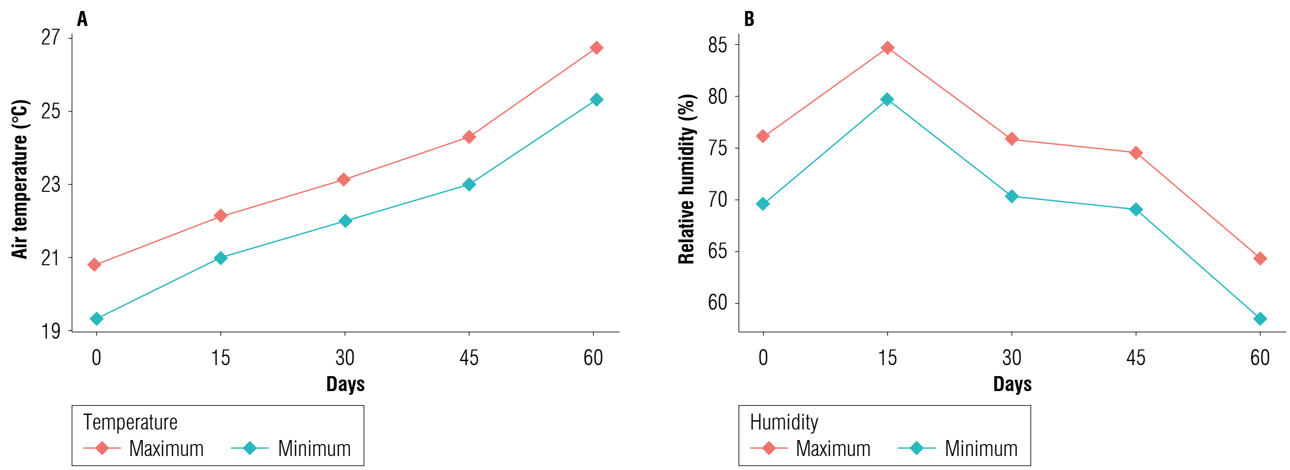

FIGURE 1. Maximum and minimum air temperature and relative air humidity during the experimental period (July 24 to September 24, 2019). INMET automatic station, Marilândia – ES (Brazil), 2019.

high cultivation tunnel (except for the areas related to the control treatment). These were established with a rotating hoe. The plots referring to the different treatments were 3 m long and consisted of 28 plants with a spacing of 15 x 15 cm between them. During the vegetative period, luminous supplementation was performed, supplied by 25 W lamps for 4 h until the plants reached a commercial stem height of 70 cm. Plants were irrigated using a micro sprinkler system. All screens used offered 35% shading.

The infestation of aphids on chrysanthemum plants was natural. To monitor the incidence and population density of this pest, one yellow checkered adhesive trap (10 x 19.5 cm) was used per plot, placed at a height of 10 cm from the plants. Each plot of the block received a trap distributed equidistantly and the evaluations for counting the aphids were carried out every two weeks.

Data were checked for normality and homoscedasticity and submitted to the Tukey's test ($P<0.05$) to compare treatment means. As for the time factor, the non-parametric method of smoothing a scatterplot with local weight (LOESS regression) was applied that estimates curves and surfaces through reference-free smoothing of an explicit mathematical model.

The data violated the assumption of normality and homogeneity of variance; and it was necessary to apply a logarithmic transformation (in base 10), mainly to stabilize the variance between treatments. Due to the fact that the data contains a lot of zeros, the formulation $z=\log(x+1)$ was used, where x represents the original data and z the transformed values. After processing the analyses, the data were returned to the original scale.

Results and discussion

From the analysis of variance, there was no significant interaction between the crop systems under photoselective screens and the evaluation period for the population density of chrysanthemum aphids. For this reason, the factors were analyzed independently (Figs. 2-3).

For the different cropping systems under photoselective screens ($F=13.11$, $P<0.01$), the results of the Tukey test at the 5% significance level showed that the mean incidence of aphids in the control or field treatment (47.3) differed statistically from the mean values of the other treatments. The data were as follow: 10.7 (black color screen), 7.27 (red color screen) and 5.4 (silver color screen) (Fig. 2).

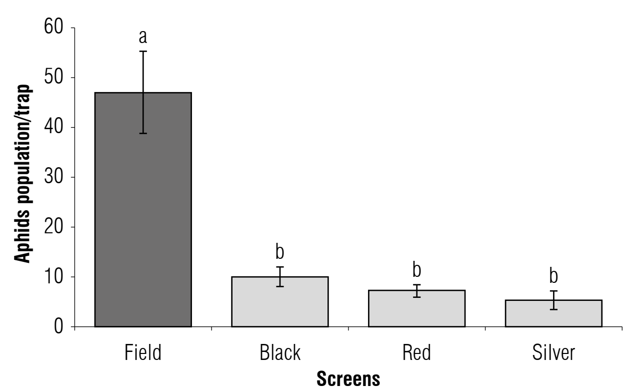

FIGURE 2. Effects of photoselective screens on aphid populations in a crop of *Chrysanthemum morifolium* variety *Zembla*. IFES, Colatina-ES (Brazil), 2019. Means followed by the same letter do not differ from each other by the Tukey test at 5% significance. Bars represent the standard error. Results obtained from the transformation of data into log10 and are presented in its original form.

Therefore, regardless of the color of the screen used, the cultivation of chrysanthemum under photoselective screens promoted a lower incidence of aphids compared to the open field treatment.

The adoption of cultivation techniques aimed at protecting plants and soil has been widely used in agriculture to improve production, yield, and product quality (Shahak, 2014). Photoselective screens or nets have been employed with the aim of protecting plants from adverse conditions such as excessive solar radiation, drought, wind and hail, in addition to their use in protecting against insect attack (Shahak *et al*., 2008; Silva *et al*., 2013; Shahak, 2014).

Although photoselective screens have holes large enough for pests such as aphids, thrips, and whiteflies to pass freely, several studies have demonstrated different responses of these insects to these screens (Shahak *et al*., 2004; Ben-Yakir *et al*., 2008; Shahak, 2014).

Chromatic additives and dispersive and reflective elements added to the composition of photoselective screens allow them to act as spectral modifiers and light disperses (Shahak *et al*., 2008). The fraction of light that passes through the screen holes remains unchanged in terms of its quality, while the light that reaches the wires has its spectrum modified and dispersed (Shahak *et al*., 2004).

Red photoselective screens absorb light in ultraviolet, blue, and green wavelengths of solar radiation and enrich the red and far-red spectral region. Gray screens absorb ultra violet, blue, green, yellow, far red, and infrared radiation and are not good light dispersants, while black ones only act on the amount of light, not altering its quality (Shahak, 2008).

They act as a mechanical barrier for insects as a plastic structure that is placed around the plants, preventing them from reaching the crops and consequently causing direct damage and virus transmission. They also act on the behavior of the aphids, since the perception of ultraviolet light is fundamental for insects for initial flight stimulation, in the location of hosts, in the dispersion within the cultures and in the orientation during the flight, all modified by the photoselective screens (Kigathi & Poehling, 2012). However, as highlighted previously, black screens do not modify the quality of light; and their action is limited to a physical barrier, a condition that may be associated with a higher incidence of aphids in them, although it does not differ statistically from the others (Fig. 2).

Insect vision is promoted by the presence of photoreceptors present in their ocelli and compound eyes. These have ocular photoreceptors capable of recognizing the spectrum of electromagnetic energy in the bandwidth of the ultraviolet (200-400 nm), visible or photosynthetically active radiation (400-700 nm), and far red light (700-800 nm). However, for spectral discrimination to occur, a minimum of two types of photoreceptors located in different parts of compound eyes is necessary (Diaz & Fereres, 2007). Thus, when artificial modifications are made to UV photons, as in the case of photoselective screens, the recognition of the host plant by herbivorous insects is compromised; and, consequently, there is a change in its orientation (Gulidov & Poehling, 2013).

Modifications in pest populational dynamics by using photoselective screens agree with results obtained by Ngelenzi *et al*. (2019) who observed reductions in aphid and whitefly populations in bean (*Phaseolus vulgaris* L.) plants grown under photoselective screens compared to open field treatment. Similarly, Candian *et al*. (2020) obtain significant reductions in the populations of *Halyomorpha halys* Stal and *Drosophila suzukii* Matsumura in apple plants (*Malus domestica* Borkh.) cultivated under photoselective screens.

As for the different epochs, the analysis of variance did not show a significant difference between the averages of aphid incidence in the period evaluated (F=0.8798, P=0.48) (Fig. 3).

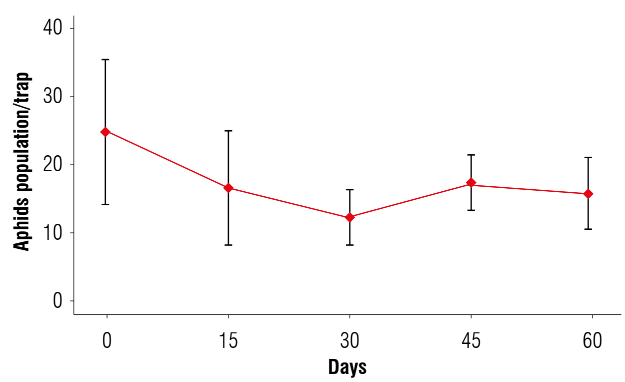

FIGURE 3. Populational fluctuation of aphids in *Chrysanthemum morifolium* variety *Zembla* cultivated between the months of July and September, 2019. IFES, Colatina-ES (Brazil). Bars represent the standard error. Results were obtained from the transformation of data into log10 and presented in its original form.

The local regression method (LOESS) was used to adjust the data considering the variation between epochs within the different levels of the crop system. It is possible to notice that the photoselective screens showed practically the same behavior around a constant value with mild oscillations where both curves remained within the confidence limits

(Fig. 4). However, the effect of different epochs in the control level (field) stood out; the data showed a well-defined non-linear trend. So, it was possible to establish a cubic polynomial model with an R^2=99.7% (Fig. 5).

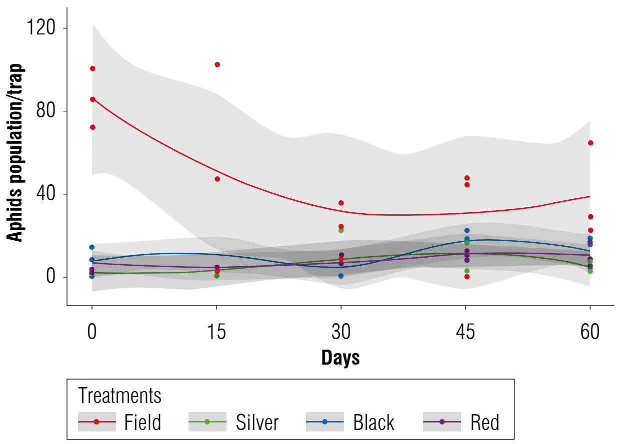

FIGURE 4. Overview of LOESS regression analysis across all treatments, disregarding screen effects over time (d). IFES, Colatina-ES (Brazil), 2019.

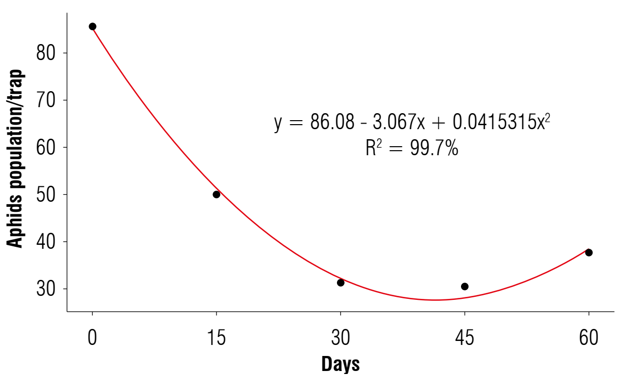

FIGURE 5. LOESS regression curve between the number of aphids and time (d) in open field treatment. IFES, Colatina-ES (Brazil), 2019.

Conclusion

Black, red, and silver photoselective screens promote significant reductions in aphid populations in chrysanthemums of the variety *Zembla* in the environmental conditions of southeastern Brazil.

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Conflict of interest statement

The authors declare that there is no conflict of interests regarding the publication of this article.

Author's contributions

CHBA carried out the experiments; RLA, AMH, ECO, and JOA carried out the laboratory and protected cultivation experiment, collected the data; JML, JOA, and RPP carried out the data analysis and writing. All authors reviewed the final version of the manuscript.

Literature cited

Abbasnia, S. K. Z., Sedaghathoor, S., Padasht Dahkaei, M. N., & Hashemabadi, D. (2019). The effect of light variations by photoselective shade nets on pigments, antioxidant capacity, and growth of two ornamental plant species: Marigold (*Calendula officinalis* L.) and violet (*Viola tricolor*). *Cogent Food & Agriculture, 5*(1), Article 1650415. https://doi.org/10.1080/23311932.2019.1650415

Ali, H. B. (2017). Seasonal population abundance of the chrysanthemum aphids (Homoptera, Aphididae) in the middle of Iraq with pictorial key to species. *Bulletin of the Iraq Natural History Museum, 14*(4), 315–328. https://doi.org/10.26842/binhm.7.2017.14.4.0315

Almeida, J. M., Calaboni, C., & Rodrigues, P. H. V. (2021). Pigments in flower stems of lisianthus under different photoselective shade nets. *Ornamental Horticulture, 27*(4), 535–543. https://doi.org/10.1590/2447-536X.v27i4.2389

Bastías, R. M., Losciale, P., Chieco, C., & Corelli-Grappadelli, L. (2021). Red and blue netting alters leaf morphological and physiological characteristics in apple trees. *Plants*, *10*(1), 127. https://doi.org/10.3390/plants10010127

Ben-Yakir, D., Hadar, M. D., Offir, Y., Chen, M., & Tregerman, M. (2008). Protecting crops from pests using OptiNet® screens and ChromatiNet® shading nets. *Acta Horticulturae*, *770*, 205–212. https://doi.org/10.17660/ActaHortic.2008.770.24

Bhargavi, S., Hemla, B. N., Chandrashekar, S., Ganapathi, M., & Kantharaj, Y. (2018). Efficacy of bio-stimulants on morphology, flowering and yield of chrysanthemum (*Dendranthema grandiflora*) cv Kolar local under fan and pad greenhouse. *International Journal of Chemical Studies*, *6*(5), 1831–1833.

Candian, V., Pansa, M. G., Santoro, K., Spadaro, D., Tavella, L., & Tedeschi, R. (2020). Photoselective exclusion netting in apple orchards: effectiveness against pests and impact on beneficial arthropods, fungal diseases and fruit quality. *Pest Management Science*, *76*(1), 179–187. https://doi.org/10.1002/ps.5491

Dhiman, S. R., Gupta, Y. C., Thakur, P.; Kashyap, B., Sharma, M., & Sharma, K. (2018). Effect of different black-out materials on off-season pot mum production of chrysanthemum (*Dendranthema grandiflora*). *Indian Journal of Agricultural Sciences*, *88*(4), 601–605.

Diaz, B. M., & Fereres, A. (2007). Ultraviolet-blocking materials as a physical barrier to control insect pests and plant pathogens in protected crops. *Pest Technology*, *1*(2), 85–95.

Gulidov, S., & Poehling, H. M. (2013). Control of aphids and whiteflies on brussels sprouts by means of UV-absorbing plastic films. *Journal of Plant Diseases and Protection*, *120*(3), 122–130. https://doi.org/10.1007/BF03356463

Heidemann, J. C., & Barbosa, J. G. (2017). Production and quality of three varieties of chrysanthemum grown in pots with different

NPK rates. *Ornamental Horticulture*, *23*(4), 426–431. https://doi.org/10.14295/oh.v23i4.1020

Instituto Brasileiro de Floricultura. (2021, November 5). O mercado de flores no Brasil. https://www.ibraflor.com.br/numeros-setor

Kigathi, R., & Poehling, H. M. (2012). UV-absorbing films and nets affect the dispersal of western flower thrips, *Frankliniella occidentalis* (Thysanoptera: Thripidae). *Journal of Applied Entomology*, *136*(10), 761–771. https://doi.org/10.1111/j.1439-0418.2012.01707.x

Köppen, W. (1936). Das geographische System der Klimate. In W. Köppen, & R. Geiger (Eds.), *Handbuch der Klimatologie*. Gebruder Borntrager. http://koeppen-geiger.vu-wien.ac.at/pdf/Koppen_1936.pdf

Ngelenzi, M. J., Otieno, O. J., & Mwanarusi, S. (2019). Improving water use efficiency and insect pest exclusion on French bean (*Phaseolus vulgaris* L.) using different colored agronet covers. *Journal of Agricultural Science*, *11*(3), 159–171. https://doi.org/10.5539/jas.v11n3p159

Nyamukondiwa, C., Weldon, C. W., Chown, S. L., le Roux, P. C., & Terblanche, J. S. (2013). Thermal biology, population fluctuations and implications of temperature extremes for the management of two globally significant insect pests. *Journal of Insect Physiology*, *59*(12), 1199–1211. https://doi.org/10.1016/j.jinsphys.2013.09.004

Parrado Moreno, C. A., Hernández Ricardo, R. E., Velásquez Arredondo, H. I., Lopera Castro, S. H., & Hasenstab, C. (2019). An environmental evaluation of the cut-flower supply chain (*Dendranthema grandiflora*) through a life cycle assessment. *Revista EIA*, *16*(31), 27–42. https://doi.org/10.24050/reia.v16i31.747

Peel, M. C., Finlayson, B. L., & McMahon, T. A. (2007). Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences*, *11*(5), 1633–1644. https://doi.org/10.5194/hess-11-1633-2007

Saicharan, M., Anitha, V., Sridevi, D., & Kameshwari, L. (2019). A brief review on chrysanthemum aphid: *Macrosiphoniella sanbornii* (Gillette) and its management. *International Journal of Current Microbiology and Applied Sciences*, *8*(4), 278–283. https://doi.org/10.20546/ijcmas.2019.804.031

Sales, R. A., Oliveira, E. C., Buzatto, E., Almeida, R. F., Lima, M. J. A., Berili, S. S., Aguiar, R. L., Lovo, M., Posse, R. P., Santos, J. C., Quartezani, W. Z., Salles, R. A., Siman, F., S., & Siman, F. C. (2021). Photo-selective shading screens as a cover for production of purple lettuce. *Scientific Reports*, *11*(1), Article 14972. https://doi.org/10.1038/s41598-021-94437-5

Santos, H. G., Jacomine, P. K. T., Anjos, L. H. C., Oliveira, V. A., Lumbreras, J. F., Coelho, M. R., Almeida, J. A., Filho, J. C. A., Oliveira, J. B., Cunha, T. J. F. (2018). *Sistema brasileiro de classificação de solos* (5th ed.). EMBRAPA. https://www.embrapa.br/solos/busca-de-publicacoes/-/publicacao/1094003/sistema-brasileiro-de-classificacao-de-solos

Shahak, Y. (2008). Photo-selective netting for improved performance of horticultural crops. A review of ornamental and vegetable studies carried out in Israel. *Acta Horticulturae*, *770*, 161–168. https://doi.org/10.17660/ActaHortic.2008.770.18

Shahak, Y., Gal, E., Offir, Y., & Ben-Yakir, D. (2008). Photoselective shade netting integrated with greenhouse technologies for improved performance of vegetable and ornamental crops. *Acta Horticulturae, 797*, 75–80. https://doi.org/10.17660/ActaHortic.2008.797.8

Shahak, Y., Gussakovsky, E. E., Gal, E., & Ganelevin, R. (2004). ColorNets: Crop protection and light-quality manipulation in one technology. *Acta Horticulturae*, *659*, 143–151. https://doi.org/10.17660/ActaHortic.2004.659.17

Shahak, Y. (2014). Photoselective netting: An overview of the concept, research and development and practical implementation in agriculture. *Acta Horticulturae*, *1015*, 155–162. https://doi.org/10.17660/ActaHortic.2014.1015.17

Silva, C. R., Vasconcelos, C. S., Silva, V. J., Sousa, L. B., & Sanches, M. C. (2013). Crescimento de mudas de tomateiro com diferentes telas de sombreamento. *Bioscience Journal*, *29*(S1), 1415–1420.

Singh, R., & Singh, G. (2016). Aphids and their biocontrol. In Omkar (Ed.), *Ecofriendly pest management for food security* (pp. 63–108). Academic Press. https://doi.org/10.1016/B978-0-12-803265-7.00003-8

Souza, J. N. C., Diniz, J. W. M., Silva, F. A. O. & Almeida, N. D. R. (2020). Economic overview of ornamental flowers and plants in Brazil. *Scientific Electronic Archives*, *13*(5), 96–102. https://doi.org/10.36560/1352020943

Sreedhar, M., Vasudha, A., & Syed khudus. (2020). Insect-pests complex studies on chrysanthemum in Pantnagar region. *Journal of Entomology and Zoology Studies*, *8*(2), 1644–1646.

Thakur, N., Nair, S. A., Kumar, R., Bharathi, T. U., Dhananjaya, M. V., & Venugopalan, R. (2018). Evaluation of chrysanthemum (*Dendranthema grandiflora* Tzvelev) for desirable horticultural traits. *International Journal of Current Microbiology and Applied Sciences*, *7*(8), 565–574. https://doi.org/10.20546/ijcmas.2018.708.062

Zandonadi, A. S., Maia, C., Barbosa, J. G., Finger, F. L., & Grossi, J. A. S. (2018). Influence of long days on the production of cut chrysanthemum cultivars. *Horticultura Brasileira*, *36*(1), 33–39. https://doi.org/10.1590/S0102-053620180106