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Science for strengthening family flower farms

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ABSTRACT

The region of La Plata, Argentina, has some 300 family farms producing flowers. The strongly perishable nature of products constitutes one of the biggest challenges that farmers must face. In this sense, an effective scientific intervention in the peri-urban productive environment can generate a positive impact on the settlement of the rural population. Based on demands gathered from a group of producers and a previous exploration of technologies, the present work aimed to find alternatives to extend the shelf life of cut flowers, using LED lighting sources and gibberellic acid on stems of Peruvian lily (*Alstroemeria* sp.) and lily (*Lilium* sp.), two regionally grown species highly susceptible to postharvest deterioration, which implies loss of turgor in leaves and tepals, as well as premature leaf yellowing and falling of tepals. Light treatment was the best option for postharvest conservation. After the results were shown at the regional flower market, the technologies were successfully adopted by a group of producers. However, the implementation of these technologies is still incipient, and, the postharvest storage of flowers still imposes many limitations on the development of regional flower producers. Developing public policies focusing on family farming will also be important to achieve this goal.

Societal impacts details

Impact of research on rural areas

As in other South American countries, flower production in Argentina is generally concentrated in the peri-urban areas of large cities, with La Plata region, an urban conglomerate that houses less than one million inhabitants, as one of the most important. Although there are other economic activities in the region such as the production of food and beverages, chemical and construction products, among others, the region stands out for being the most important production area of horticulture, and particularly of floriculture in the country [1,2]. In this region, there are about 300 flower establishments with an average area of 0.5–2 Ha, most of which employ intensive family labor, cultivating a wide variety of flower species. Wholesale commercialization is carried out by the producers through two cooperatives located in the region, where buyers from different parts of the country arrive. Floriculture in this region is a source of job creation since the technological system used requires significant contributions of manual labor. This workforce is made up of family members or hired employees. It is estimated that there are around 4000 workers in La Plata directly in primary production, to which should be added more than 2000 workers linked to the commercial and logistics activity. This leads to La Plata and its surroundings becoming an important hub for the production of flowers and related services that contributes to the development of the region (Fig. 1).

The strongly perishable nature of flowers is one of the biggest challenges facing growers. The high demand for cut flowers is usually concentrated on very specific days. Regarding supply, in times of extreme heat, the flowering occurs in a very short period of time, increasing the stock of flowers and saturating the market in certain periods with a noticeable drop in prices. In addition to these chronic structural problems, in the austral autumn of 2020, the commercial damage caused by the COVID-19 pandemic led several producers to bankruptcy and many others to reconversion. The problem of the loss of quality in flowers was raised by the regional Flower Cluster made up of Flower Markets, INTA (National Institute of Agricultural Technology), and producer organizations that indicated postharvest improvement as one of the priority issues for their economy [3]. Subsequently, meetings of groups of flower producers from La Plata highlighted the importance

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of developing technologies that improve the conservation of flowers, given the large number of flower stems discarded due to the loss of commercial quality while they were not commercialized in the short term. They argued that the reduction of losses would allow higher income with a synergistic effect on the productive communities of that area. Although cold storage rooms are sometimes used for the conservation of flowers, their installation and maintenance are expensive and not within the reach of all producers. Furthermore, the development and adoption of other technologies that allow a longer shelf life of floricultural products are incipient and insufficient. An effective scientific intervention that provides new practices to the rural or peri-urban productive environment can generate a high impact on the social fabric involved, by maintaining the social cohesion of these human groups and strengthening the roots of the rural population. The economic development of these rural populations also makes it possible to achieve better access to education and a better quality of life for men and women who dedicate daily to the activity. In this sense, the present work was presented as a means to intervene technologically in the problems of peri-urban flower producers in the city of La Plata, Argentina, to extend the shelf life of flowers by proposing the use of readily available technology. Within this framework, the application of low-cost technologies was proposed, such as lighting with LED sources, successfully tested previously in leafy and inflorescence vegetables [4,5], as well as the use of plant hormones, which have been used in flowers [6,7]. One motivation to test the effectiveness of these technologies was the low environmental impact, as opposed to other chemical technologies that, depending on the compounds used and the volume of waste generated, can cause environmental pollution in the rural environment where the producers live. Therefore, the objective of the work was to test technological alternative that allows improving the shelf life of cut flowers, and that these practices can be applied by local producers and marketers.

Methodology used

To carry out the work, first, sources such as *Diagnóstico Florícola* [8] were consulted to learn about the demand of the market chain players. Then, in 2018, a meeting with a group of 15 flower producers and marketers was held at the flower cooperative of La Plata (MERCOFLOR) to identify: 1) what were the biggest problems they encountered in the post-harvest of flowers, 2) what they intended to obtain/improve from a postharvest treatment, 3) which were the most relevant flower species for the application of technologies to preserve their quality, and 4) at what stage of the marketing chain their application would be most appropriate, namely, before leaving the field, during transportation, or at points of sale. Based on the producers' demands, LED illumination was proposed for fresh flowers of *Alstroemeria* sp., and *Lilium* sp., two species widely cultivated in the region that undergo postharvest yellowing of the leaves of the stem. This technology was not disseminated or adapted by flower producers in the region. Crops and merchandise processing facilities were visited to obtain information of how the producers carry out their work on their farms. The experimental conditions carried out in the tests are described in [9]. On the other hand, in contrast with light treatment, the effect of pulsing with plant hormones associated with the delay of plant senescence, such as gibberellins (AG3 type), was studied. A meeting was agreed upon with the producers once the tests were finished to take stock of the results obtained in the tests with the proposed technologies.

Research implications

The tested conservation conditions were effective to be proposed to the producers since the quality and postharvest life of the flowers were significantly improved. The leaves of the stems stored under the lighting regime were noticeably greener during storage, and the treated tepals were larger, had a more attractive color, and had less drop [9]. In the case of flowers treated with AG3 preservative solutions, it was possible to delay the deterioration of the leaves in both *Alstroemeria* sp. and *Lilium* sp. However, comparing the treatments, light treatment was the condition that best preserved postharvest quality, both in the quality of the flowers and in storage time, at 20 °C and 5 °C.

On the other hand, although cold technology is a relatively expensive alternative and accessible only to a limited group of producers, our assays showed that combining treatments was beneficial to maintaining the quality of the flowers. For producers that do not have a cold room, it is feasible to arrange the LED sources in a support structure that preferentially illuminates the flowers from above, using instruments such as a lux meter or PAR sensor to adjust the appropriate dose of light. Although this technology requires an adequate adaptation to each flower-producing or marketing establishment, which vary in their facilities and forms of organization, the present investigation allowed us to propose an alternative for producers at a low cost and with a low environmental impact. The mentioned results were socialized in the flower market (Fig. 2), and among other producers through brochures exposing the results.

After that, flower producers from La Plata, grouped into two

Fig. 1. Floriculture in La Plata is made up of various interconnected actors that imply an important source of jobs. The area of influence dedicated to floriculture is included within the horticultural belt of La Plata-Buenos Aires.

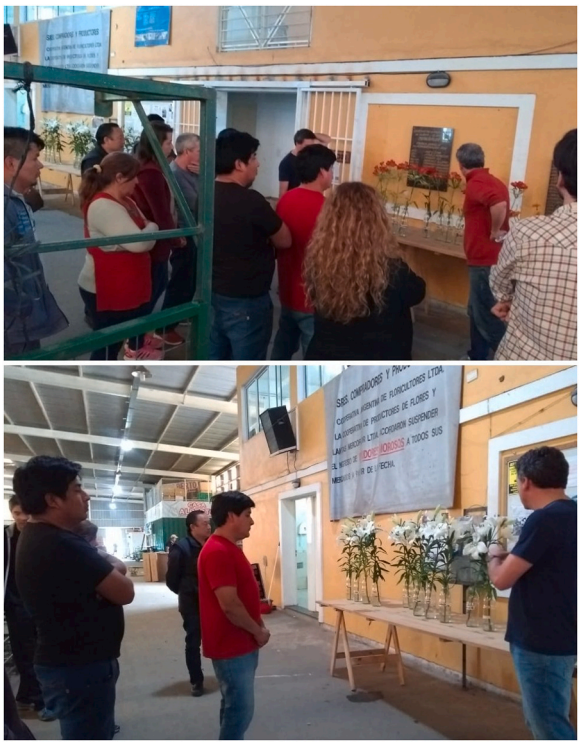

Fig. 2. Flower producers and marketers participating in the presentation of results of the tests carried out in the laboratory.

productive establishments, began to apply these technologies with excellent results. Regarding the impact of research on the economy of the producer in the short term, the delay in the loss of commercial quality of cut flowers in 7 days would bring an improvement in average income of 20%. This is due to the possibility of keeping the product for longer, without the need to discard it due to loss of cosmetic properties (color, turgor, etc) when they are not sold fresh after harvest. The economic benefit can also be explained since the producer can avoid discarding products at seasons of low prices due to the overproduction of flowers. On the other hand, we observed a better appearance of the treated flowers, which implies greater demand from consumers. About 170 producers could potentially use these conservation techniques in the mid-term. However, the application of these technologies has not been generalized yet in all the flower production units in the region. A greater dissemination of the results obtained in the research will likely be necessary, or a longer time until the producers decide to use and adapt new technologies/practices. In this sense, it is essential to expand the research to other floricultural species and study their response to these treatments, since producers also cultivate other flower species.

In the long term, the impact generated by the development of LED technology is the change in the concept of using chemical, expensive, and polluting methods for other physical methods with low environmental impact and reduced cost. Although it was not intended here to intervene in the different marketing channels that each involve a defined environmental impact (for example, transportation to the consumption destination), we consider this work as a contribution that can reduce the environmental impact in the first stage of the marketing chain that is the productive unit. On the other hand, other alternatives to traditional post-harvest treatments are incorporated, which implies having a broader battery of tools. Avoiding the use of chemical technologies allows the producers to enter into product differentiation processes by incorporating natural, agroecological, and/or organic products. Differentiation allows greater acceptance by certain types of consumers, premium payments, and specific marketing channels, being generally more valued in the market. The incorporation of flowers with a low environmental impact certification would be a potential benefit for producers, although it is currently not developed. The success obtained by expanding research into other products, adjusting the technology to the realities of each production unit, and its diffusion among producers can improve the income of flower producers in the region. Better income can contribute to development in rural areas and thus prevent traditional flower producers from leaving the activity. The relative easy reproducibility of the technology used in the experiments allows us to suggest that can be extrapolated to the conditions of other floricultural regions of Argentina and neighboring countries, as well as to other regions of the world where production still is of a microenterprise nature.

Conclusions

The technology used in the postharvest trials was effective in delaying the loss of quality and improving the appearance of the flowers during storage. Although incipient, the technological proposal developed in this work was used by some producers to maintain the quality of their stored flowers through a physical method with low environmental impact, which translates into fewer merchandise discards and lengthening the marketing time. The design of public policies involving professionals from different areas and focusing on family farming will allow all stakeholders to understand the contingencies that farmers go through and will also be essential to broaden their experiences. Given its broad approach, this type of intervention, together with tax benefits to promote the adoption of new environmentally friendly technologies, can be an effective tool for encouraging the adoption of new technologies that improve the sustainability of productive establishments and farmers' quality of life.

Ethics statements

The authors have written entirely this original work, and the experimental data from previous work has been appropriately cited. All authors have made substantial contributions from the interviews with the farmers, to the experimental design. The identity of the flower marketers and farmers participating in the study was completely anonymized.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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