

TECHNICAL ARTICLE

How to produce gladiolus corms?

Regina Tomiozzo*, Lilian Osmari Uhlmann, Camila Coelho Becker, Natalia Teixeira Schwab, Nereu Augusto Streck, Darlan Scapini Balest.

Abstract

Gladiolus (*Gladiolus x grandiflorus* Hort.), also called as Palma-de-Santa-Rita, is culturally known in Brazil as the All Soul's Day flower. In recent years, it has also become popular in other special dates due to its robustness, liveliness, and magnificence. However, there are challenges regarding the cut flower production, since the largest producer investment is the corm acquisition. Due to the insufficiency of technical information, there are no fully established corm production protocols for gladiolus. Therefore, this technical article has the objective of bringing information related to the gladiolus corms production technique, in view of the sustainability of the production.

Keywords: gladiolus, corms, propagation, postharvest.

Resumo

Como produzir cormos de gladiolo?

Gladiolo (*Gladiolus x grandiflorus* Hort.) também chamado como Palma-de-Santa-Rita, é conhecido no Brasil como flor de Finados e, nos últimos anos, têm se popularizado em outras datas especiais devido à sua robustez, vivacidade e imponência. Porém, existem desafios em relação à produção da espécie para flor de corte, visto que o maior investimento do produtor é com a aquisição de cormos. Devido à escassez de informação técnica, não existem protocolos de produção de cormos totalmente estabelecidos para o gladiolo. Logo, esse artigo técnico teve o propósito de trazer informações relacionadas à técnica de produção de cormos de gladiolo, tendo em vista a sustentabilidade da produção.

Palavras-chave: gladiolo, cormos, propagação, pós-colheita.

Introduction

Gladiolus (*Gladiolus x grandiflorus* Hort.), is culturally known in Brazil as the All Soul's Day flower, but in recent years, it has also become a popular flower in other special dates due to its robustness, liveliness, and magnificence. The production of flowers of gladiolus begins by planting the corm and its propagation is essentially vegetative. The corm is a solid bulb of rounded and flattened shape, swollen by the reserve accumulation with nodes and internodes and wrapped with dried leaf remains (Figure 1).

The main technique of gladiolus corms production is by harvesting new corms formed from the old-corm, which

loses its reserves and mummifies during plant growth. The formation of the new corm above the old corm occurs during the growth and development of the gladiolus plant, from V4 stage (four leaves) onwards and is structured as the leaves are emitted (Schwab et al., 2015) (Figure 2A). However, corm growth and development is limited before flowering, because the priority of the plant is the growth and development of the leaves and the floral stem, i.e., the photo-assimilates produced through photosynthesis are targeted for supply the needs of the above ground plant parts. It is only after harvesting the flower stems (the R2 stage) that the new corm becomes the main sink within the plant, and from then on its growth occurs more rapidly (Figure 2B).

Federal University of Santa Maria (UFSM), Crop Science Department, Santa Maria-RS, Brazil. *Corresponding author: re.tomiozzo@gmail.com.

Received Jun 03, 2019 | Accepted Aug 30, 2019

Licensed by CC BY 4.0

<https://doi.org/10.1590/2447-536X.v25i3.2048>

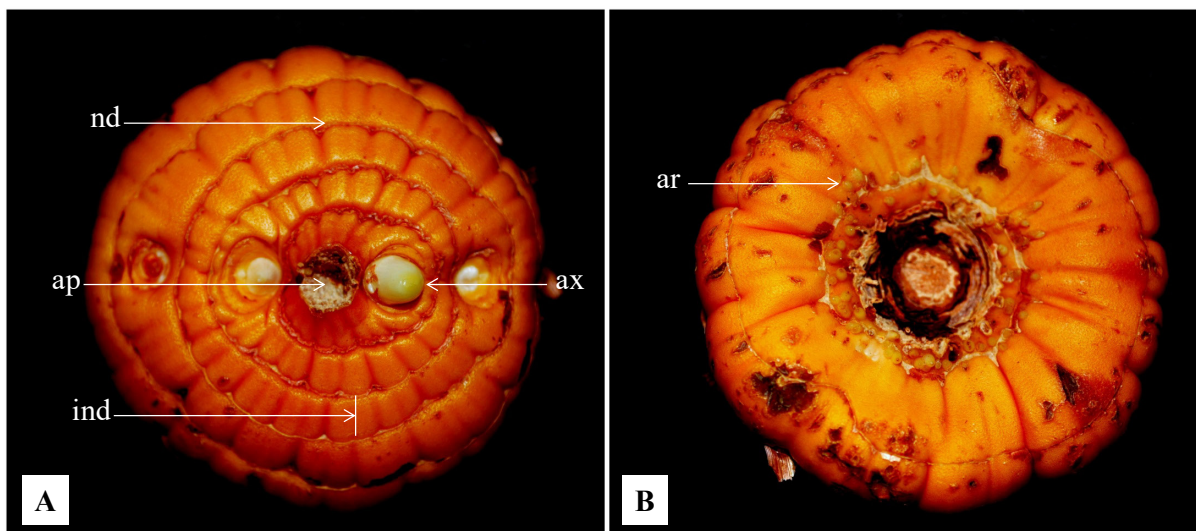


Figure 1. Morphological characterization of gladiolus corm, (A) upper side and (B) bottom side structure: nd - node, ax - axilar bud, ap - apical bud, ind - internodes, ar - adventitious roots.

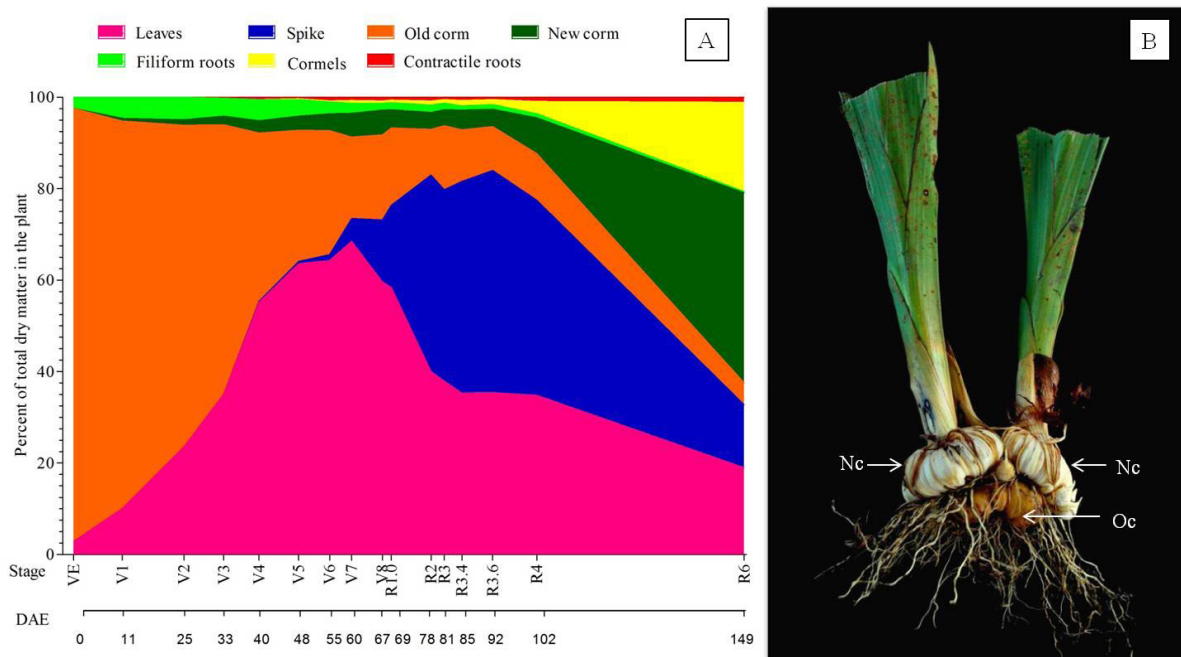


Figure 2. Dry matter partitioning (%) in a gladiolus plant of cv. Jester: (A) from VE to R6 (plant senescence). The image (B) shows the growth of the new corm (Nc) above old corm (Oc).

The production of gladiolus corms involves the field growth after removal the floral stem from the plant (R2 stage), harvesting and postharvesting. The obtaining of the gladiolus propagation material is one of the major problems in the productive chain of this flower crop, since few farmers have access to information on how to produce corms and, good management is essential to ensure uniformity and quality of the propagating material. In addition, the purchase of commercial corms (treated and

vernalized) each year makes the production of floral stems more expensive.

Gladiolus is an effective alternative for small farmers, who can offer an option for their customers along with fruits and vegetables at local markets. Because it is a flower easily produced, suitable for growing in open field and that demands low initial investment, gladiolus is attractive to producers. However, the acquisition of corms still represents the highest cost of gladiolus production,

about 60% of total cost, besides the difficulty of finding suppliers and propagating material identified with the name of the cultivar, which is important when it is desired to know the duration of the cultivar cycle to carry out production scheduling.

Therefore, it is important to understand the technology of gladiolus corms production to help farmers, mainly small farmers, to obtain propagative material of high quality, and for reducing the production costs. Few are the farmers who have access to information about postharvest corms management, and generating a technical material containing applied information on the corms production in a simple, clear and objective way can fill this gap. Thus, the present study aimed to describe the main aspects related to the commercial production of *Gladiolus x grandiflorus* Hort. corms in Brazil, such as growing conditions and post harvest.

Corms propagation

The period of corms production starts from the harvesting of the floral stem (R2 stage) and it is after the harvest of the floral stem that most of the photoassimilates are destined for the growth of the new corm. Therefore, it is important to cut the minimum number of leaves when harvesting the floral stem so that the plant remains with 5 to 6 leaves (Figure 3), on which the photoassimilates will be produced to nourish the new corm. The time required for the corm to reach the appropriate size vary according to the growing season, since the developmental cycle of the gladiolus is governed by air temperature (Streck et al., 2012; Schwab et al., 2015; Uhlmann et al., 2017). When the production of corms occurs in periods that the air temperature is high (summer), and in dry periods, the corm filling is faster and about 45 at 50 days are sufficient to obtain a maximum size.



Figure 3. Gladiolus plant after the harvest of the floral stem, with six healthy leaves for corm growth in growing season 2017-2018 in Santa Maria-RS, Brazil.

In periods which air temperature is low (winter), the corms filler is slowly and are required from 60 to 70 days after harvesting floral stems, to reach a maximum size of the corm. In general, the longer the corm stays in the growing field, the greater its size. Ideally, harvesting should be performed when the plant begins the process of senescence (natural drying of the plant), that is, the plant begins to present the leaves with yellowish coloration, the corm filling stops, and the maximum size is reached.

However, during the periods of high precipitation and humidity, the harvest anticipation is beneficial as regards phytosanitary, and the optimization of the production time of corms, reducing it and consequently, anticipating the next planting.

During the corm growing, the management of pests, diseases and weeds should continue to be performed to provide good conditions for corm growth. If the producer has an irrigation system, it is interesting to continue to

irrigate the plants when the soil presents low humidity, but it is necessary to suspend the irrigation about two to three weeks before harvesting to avoid rotting of the corms. The weeds control is an important management aiming the harvest moment of corms, because the presence of weeds can make it difficult the harvest besides competing with plants, reducing the size corms.

Harvest and postharvest

Harvest

Harvesting can be mechanical or manual. The mechanical harvest usually is more used for the productions in large scale, with the support of specialized machines. Manual harvest can be made with the aid of a hoe, losing the soil around the plants and pulling out the whole plant. At this stage, care must be taken for not causing lesions or cuts in the corms, because corms damaged become more susceptible to infection by diseases that can cause their rot. If any corm is damaged during harvest, it is suggested that it should be discarded. During the harvest it is important to pack them in identified boxes with the cultivar name and the production season. This identification is important to uniform batches mainly in relation to the ones of the flower color that will be produced in the next crop.

Postharvest

Cure and cleaning

After harvest, the gladiolus corms must undergo to the cure process. The cure is performed for different bulbs such as garlic, onion, lily and amaryllis, and is the most efficient way to standardize the humidity of the corm and ensure a good cure at the insertion point of the leaves.

Firstly, it is necessary to realize the quick cure, which consists in leaving the whole plants in the field, exposed indirectly to the sun of 2 to 3 days, for rapid loss of moisture. Plants should be rowed, and corms covered with leaves of plants from the bottom row, and so on until the last row, in which corms should be covered with soil to avoid direct exposure to solar radiation.

After rapid cure, the corms should be routed to the cleaning process, where they will be cleaned with water to remove soil excess. The old corm should be removed from the base of the new corm and it is recommended to make a cut in the leaves to two centimeters above the new corm (Figure 4A), to facilitate the drying of the leaves and the cauterization during the prolonged cure.

The drying of the corm is essential for forming the periderm (corm protective tissue), which replaces the epidermis when it dies or receives some mechanical damage, preventing the penetration of some pathogenic fungi (Monge, 1981). The optimal conditions for curing

and optimum corm periderm formation are the conditioning in a shaded and airy location, with circulation of hot air and relative air humidity (about 80%) during the period of approximately thirty days. In addition, the leaves around the corm will also dry to form protective husks for the corm, serving as protection during the planting-emergence stage.

The correct corm cure allows the good formation of the apical bud that will form and generate a new plant in the next crop. Figure 4 shows a cured corm (B) and an uncured corm (C). The uncured corm (Figure 4C) has a perforation, where in the previous crop there was the floral stem. This perforation can occur due to the incorrect separation between the leaves and the corm, that is, the cut is not performed 2 cm above the corm and therefore the drying of the leaves does not occur efficiently. This poor curing can impair the formation of the new bud or even delay the emergence of plants.

Classification

Grouping the corms into sizes is important to define the destination of the production and to guarantee the homogeneity of the lots and uniformity of the plants during the cultivation. Corms are classified according to their size and production destination and, in Brazil the corms are classified by perimeter (cm) following the European classification model. The American Model classifies the corms according to the diameter (cm). It is important to carry out the classification by forming lots with classes of close sizes, for example, class 14-16 contains corms between 14 and 16 cm in length. The uniformity of the corms ensures uniformity in the production, in the time of floral stems harvesting, in the floral stems quality and facilitates management practices.

Large corms (bigger than 8 cm) are intended for the cut flowers production, as they will produce uniform and vigorous plants with larger flowers. Small corms or even the cormels (less than 8 cm) that develop at the base of the new corm are destined to a new production cycle until they reach the appropriate size for the production of a floral stem.

The size of the corms will vary according to the cultivar and, with the time of growth in the field. Thus, the longer growth time, results in greater corms. However, within a same bed, there is variation in flowering period (Figure 5) from the first plant to reach the harvesting point of the floral stem until the last, and thus, the period of growth of the corms also varies. Thus, the first plants to bloom will form larger size corm and those that last bloom will form corms of smaller size, considering that the harvest of the corms will be realized in the same day. Therefore, corms harvested at the same production site will have a large variation of sizes, weight and quantity (Table 1).



Figure 4. Corms during the cure with the leaves cut two centimeters above the corm (A); Cured corm (B) and uncured corm (C), in Santa Maria-RS, Brazil

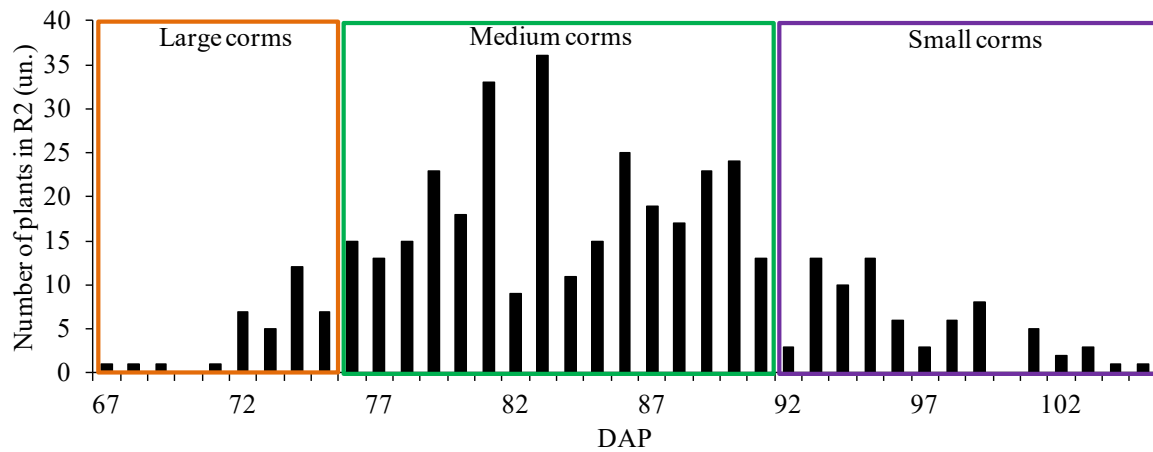


Figure 5. Flowering period and frequency of gladiolus plants in flowering (R2), cv. Jester, as function of days after planting (DAP) in Santa Maria-RS, Brazil, during the 2017/2018 growing season. Plants that flower earlier will produce large corms while plants flowering late will produce small corms.

Table 1. Corm size of Jester cultivar classified according to perimeter (cm) and their relation with average weight (g/corm) after the storage and number of corms harvested during the 2017-2018 growing season in Santa Maria-RS, Brazil.

Parameter	Corm size						
	Small		Medium			Large	
Perimeter corm (cm)	<10	10	12	14	16	18	20
Number of corms	120	71	103	145	76	11	4
Average weight (g/corm)	6.46	10.07	13.74	19.27	23.37	40.61	48.57

Vernalization and storage

The next step in postharvest is the vernalization of gladiolus corms. The vernalization is a process in which corms are exposed to low temperatures for a given period, to induce or accelerate the ability to bloom, not immediately, but as a later effect (Chouard, 1960; Michaels and Amasino, 2000).

The vernalization need is a problem for tropical countries such as Brazil, where only the states of Paraná, Santa Catarina and Rio Grande do Sul have climate to meet this demand for cold (due to the low winter temperatures). The vernalization can be supplied naturally or artificially. During the winter in southern Brazil, the corms vernalize naturally and after this period, the plants bloom in the spring. That is why many people of these regions believe that the gladiolus only flowering in the All Soul's day. The natural vernalization allows the gladiolus cultivation only once a year, which becomes an obstacle for producers who wish to cultivate in more times of the year.

Artificial vernalization becomes an alternative in these cases and, is carried out with the use of cold chambers, providing autonomy to the producers that can produce gladiolus flower stems at any time of the year. To perform this practice, the corms must be exposed during a period at low temperatures, enough for the corm to recognize that "winter is over" and thus acquire the signaling to start a new cycle. The recommendation for gladiolus is that the corms are stored at 5°C for approximately 30 days. This is enough for vernalization and subsequent uniformity in flowering and quality aspects of flower stems.

In addition to enabling corms vernalization, cold storage also controls the corms sprouting. Cold storage is an alternative for growers who do not plan to plant the corms immediately and want to delay the corms budding. According to Tombolato (2004), corms that do not present shoots during summer should be stored at temperatures between 17 to 20°C and relative humidity of 70 to 80%. The relative air humidity is an important factor to be considered during the storage of the corms, because in low humidity, the speed of growth is reduced, there is weight loss and vigor reduction, already in very high humidity occurs the root growth in advance and development of corms rot.

The corms storage is also important for the artificial induction of dormancy breaking. Corms dormancy occurs when there is absence of growth of the buds and roots and is broken when subjected to low temperatures and low light, which increases the production of gibberellin and reduces

the concentration of growth inhibitors such as abscisic acid (Tombolato, 2004).

After cold treatment, corms require a period of acclimatization before they are planted. It is therefore recommended to remove them from the cold chambers and leave them in an environment with a temperature of about 20 to 25°C for two weeks. This technique allows the proper development of roots and uniformity in sprouting.

Corms production schedule

In Brazil, the production of floral stem of gladiolus, occurs mainly in two special dates: Mother's Day and All Soul's Day. For the producer who wants to produce corms starting from these two dates, a simplified production schedule was elaborated (Figure 6).

After flowers harvest for Mother's Day (Figure 6A), in May, the plants staying in the field until the first fortnight of July, when the corms should be collected. In the Southern Brazil, where this period has high precipitation, care with the rotting corms due to high soil moisture and harvest can be earlier if necessary. The cure occurs in August and September and after this stage, the corms are taken to the artificial vernalization in October and November. In locations where winter is colder (with temperatures below 10°C), natural vernalization can occur, but even so is recommended that the corms are storage cold, to ensure that the vernalization process is satisfactory. Completed the vernalization period, the corms should be acclimated and from the December on the corms will be ready for the new planting.

For the All Soul's Day (Figure 6B), the flowers harvest is in November and the corms grow in the field until January. In this season, the corm size also can be larger due high summer temperatures and because of that, the others stages can be faster. After harvest, corms are ready for cure in February and March. During April, the vernalization is extremely necessary, because in this season the temperatures are still high and insufficient for supplying the vernalization needs. Therefore, from the second half of May, corms will be ready for a new planting.

In both special dates, the total period for corms production is six months. But, this time can vary according to the location, year, labor and amount of production. If the producer wishes, the production can be stepped to have available corms all year. Furthermore, it is recommended the renovation with commercial corms, every two years, at least.

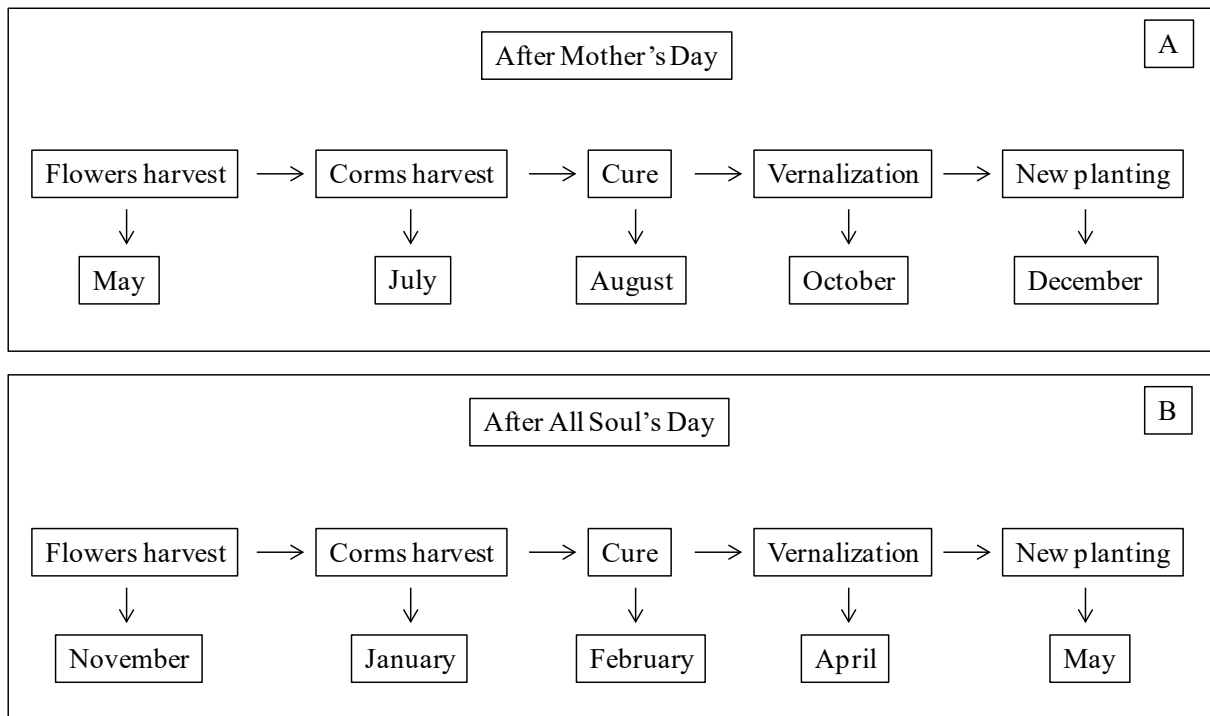


Figure 6. Gladiolus corms production schedule after harvesting floral stems for Mother's Day (A) and All Soul's Day (B).

Diseases

Several phytopathogenic fungi can infect gladiolus corms during their cultivation and during postharvest. To prevent infection, corms can be treated with chemical treatments (powder or solution) or to a set of complementary measures. Soil fungi such as *Fusarium oxysporum* f. sp. *gladioli* can infect corms by the roots or through the old corm and cause substantial crop losses due to the reduction of viable corms for flower production, plants death during the growing cycle and reduces the floral quality. A preventive measure for this disease is thermotherapy, which consists of immersing corms in hot water at 50 °C for 15 minutes (Ramos-García et al., 2009). During storage, fungi such as *Penicillium gladioli* can cause corms rot, so it is necessary to carry out a periodic inspection of stored corms, changing the corms position inside the box and eliminating diseased or damaged corms.

Final considerations

Corms production, as well as the production of flowers, is an alternative to diversify rural property and generate additional income for farmers. Furthermore, the corms production reduces the production costs of the gladiolus flower stems and the knowledge of the production techniques guarantees the obtaining of quality propagating material. Therefore, a new opportunity arises for Brazilian floriculture with the possibility of producing corms, filling

this market gap in several regions of Brazil, supplying local demand, shortening the chain and facilitating the gladiolus production chain.

Knowledge is as important as technology in modern production systems. Therefore, challenges are pitched for scientific research to enhance corm production, updating existing information, and making gladiola cropping systems more efficient and more sustainable, both economically and environmentally.

Author Contribution

R.T.⁰⁰⁰⁰⁻⁰⁰⁰¹⁻⁵⁴⁹⁸⁻³⁶⁴⁵: Creation of the idea, data collection, manuscript preparation and critical review of article. **L.O.U.**⁰⁰⁰⁰⁻⁰⁰⁰¹⁻⁹¹⁴²⁻⁴²⁰¹: Manuscript preparation and important suggestions incorporated to the work. **C.C.B.**⁰⁰⁰⁰⁻⁰⁰⁰¹⁻⁶¹⁵⁵⁻⁶⁴⁵⁷: Manuscript preparation and important suggestions incorporated to the work. **N.T.S.**⁰⁰⁰⁰⁻⁰⁰⁰³⁻⁴⁷⁶⁷⁻²⁹⁰⁷: Manuscript preparation and important suggestions incorporated to the work. **N.A.S.**⁰⁰⁰⁰⁻⁰⁰⁰²⁻²⁴⁹⁵⁻⁰⁸²³: Supervising of the work and manuscript revision. **D.S.B.**⁰⁰⁰⁰⁻⁰⁰⁰³⁻⁴²⁰¹⁻⁹⁸²⁹: Data collection and manuscript preparation.

References

CHOUARD, P. Vernalization and its relations to dormancy. **Annual Review of Plant Physiology**, v.11, p.191-238, 1960. DOI: doi.org/10.1146/annurev.pl.11.060160.001203

- MICHAEL, S.D.; AMASINO, R.M. Memories of winter: vernalization and the competence to flower. **Plant, Cell and Environment**, v.23, p.1145-1153, 2000. DOI: doi.org/10.1046/j.1365-3040.2000.00643.x
- MONGE, A.V. **Manejo de los bulbos de gladiolo**. Ministerio de Agricultura y Pesca del Chile, 1981, 20p.
- RAMOS-GARCÍA, M.; ORTEGA-CENTENO, S.; HERNÁNDEZ-LAUZARDO, A. N.; ALIA-TEJACAL, I.; BOSQUEZ-MOLINA, E.; BAUTISTA-BAÑOS, S. Response of gladiolus (*Gladiolus* spp.) plants after exposure corms to chitosan and hot water treatments. **Scientia Horticulturae**, v.121, p480-484, 2009. DOI: 10.1016/j.scienta.2009.03.002
- SCHWAB, N.T.; STRECK, N.A.; BECKER, C.C.; LANGNER, J.A.; UHLMANN, L.O.; RIBEIRO, B.S.M.R. A phenological scale for the development of Gladiolus. **Annals of Applied Biology**, v.166, n.3 p.496-507, 2015a. DOI: dx.doi.org/10.1111/aab.12198.
- STRECK, N.A.; BELLÉ, R.A.; BACKES, F.A.A.L.; GABRIEL, L.F.; UHLMANN, L.O.; BECKER, C.C. Desenvolvimento vegetativo e reprodutivo em gladiolo. **Ciência Rural**, v.42, n.11, p.1968-1974, 2012. DOI: dx.doi.org/10.1590/S0103-84782012001100010
- TOMBOLATO, A.F.C. **Cultivo comercial de plantas ornamentais**. Campinas: Instituto Agronômico, 2004. 221p.
- UHLMANN, L.O.; STRECK, N.A.; BECKER, C.C.; SCHWAB, N.T.; BENEDETTI, R.P.; CHARÃO, A.S.; RIBEIRO, B.S.M.R.; SILVEIRA, W.B.; BACKES, F.A.A.L.; ALBERTO, C.M., MUTTONI, M., PAULA, G.M., TOMIOZZO, R., BOSCO, L.C., BECKER, D. PhenoGlad: A model for simulating development in Gladiolus. **European Journal of Agronomy**, v.82, Part A, p.33-49, 2017. DOI: dx.doi.org/10.1016/j.eja.2016.10.001