SUMMARY OF THE THESIS

RESEARCHES REGARDING THE INCREASEMENT OF GENETIC VARIABILITY ON GLADIOLUS HYBRIDUS L. IN ORDER TO DIVERSIFY THE ASSORTMENT AND TO USE IT IN THE LANDSCAPING DESIGN
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SCIENTIFIC COORDINATOR:
Prof. univ. dr. MARIA CANTOR

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To, ____________________________________________________

We invite you to attend the public presentation of the thesis entitled:

“Researches regarding the increasement of genetic variability on *Gladiolus hybridus* L. in order to diversify the assortment and to use it in the landscaping design”

elaborated by Ing. Denisa Andreea Horț to obtain a doctoral degree in Horticulture.

The public presentation of the thesis will take place on September 26, 2014, at 11:00 in H58 laboratory in the building of Horticulture Faculty, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca.

Doctoral committee has been approved in the following composition:

**President:**
Prof. univ. dr. Radu SESTRAȘ - USAMV Cluj-Napoca

**Scientific coordinator:**
Prof. univ. dr. Maria CANTOR – USAMV Cluj-Napoca

**Official reviewers:**
Prof. univ. dr. Lucia DRĂGHIA – USAMV *Ion Ionescu de la Brad* Iași
Prof. univ. dr. Dumitru ZAHARIA – USAMV Cluj-Napoca
C.P. I. Dr. Cosmin SICORA – Grădina Botanică „Vasile Față”, Jibou

Appreciations comments and suggestions, please send them by e Doctoral School of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5, Mănăştur street, postal code 400372, Cluj-Napoca, or email: denisa.hort@gmail.com.
INTRODUCTION

Man, by nature, is seeking beautiful, is concerned with himself and the environment he lives. We are always trying to improve the home, the garden, or the community, so that the viewer is impressed by what he sees, by what he smels or by what he touches.

The economic importance of gladioli, the possibility of an easily cultivation according to the ecological conditions in Transylvania, and especially the beauty of flowers in varied colors and shapes are some of the reasons that led me to choose the topic of assortment study for the thesis.

The aim of the research was to improve the varietal range by introducing new varieties and to increase the genetic variability by obtaining hybrids that meet some superior decorative characters of their parents, but at the same time, to be suitable for landscaping design.

To achieve the goal were outlined four overall objectives of which were drawn more specific targets that describe concretely the action steps of the experiments to reach to achieve the goal. In this regard it should be noted that the experience was located in the Agrobotanical Garden of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, was conducted in 2010-2013, and was organized as two factors experience, the two factors being: the cultivar (or hybrid, during 2012 and 2013) and the year of experience. In the case the first factor, the number of graduations is 11, we used 11 genitors in 2010, but in subsequent years were analyzed seven hybrids derived from the 11 parents. As for the second experimental factor: the year of culture, the number of graduations is equal to four: in the first year were analyzed varieties and hybridization were performed, in the second year were monitored the hybrid combinations and in years 3 and 4, the subject of study was the selected hybrids.

The present thesis is structured into 14 chapters, to which the introduction, the bibliography and summary, both in Romanian and English, are added. The research was based on 153 bibliographical sources including books, scientific papers and specialty
Part 1. The current national and international knowledge on *Gladiolus* genus

The first part of the thesis has 3 chapters in which we present general knowledge on the cultivation of *Gladiolus* genus species, ecological requirements that are specific to the genus and different culture aspects as well as current research and improvement methods used on gladioli.

In the first chapter it is presented the origin and global distribution of *Gladiolus* genus. It is known that the name of the genus derives from Latin word „gladius”, which means sword, it being a reference to the shape of the leaves which is a characteristic for which the Iridaceae are known (CANTOR and TOLETY, 2011). Species of this genus were discovered in the South and Tropical Africa, Madagascar, as well as the Arabian Peninsula, in the Mediterranean area, Europe and Asia, Iran and Afghanistan (CANTOR and TOLETY, 2011); to this day 255 species belonging to this genus were identified (GOLDBLATT and MANNING, 1998). The gladiolus is not a traditional species in our country: only 3 species grow in the spontaneous flora: *G. imbricatus* (Fig 1.1), *G. palustris* (Fig 1.2) and *G. illyricus* (Fig 1.3) and were discovered in the areas with oak (CIOCÂRLAN, 2009).

It is said that the gladioli were cultivated since ancient Greece (CANTOR and TOLETY, 2011), and were used as well by Romans (GOLDBLATT and MANNING, 1998). The spread of *Gladiolus* culture started in the 19th century, when different and new methods of improvement were applied (NEAGU et al., 1976). Today a large scale production of gladioli is common on all continents, in countries as USA, Italy, France, Poland, Bulgaria, Brazil, Australia and Israel (RASHMI, 2006).

The species of *Gladiolus* genus are perennial geophytes semi-rustics, with the corms used for reproduction. The leaves are linear, with parallel and protuberant nerve lines and sharp at the end (DRAGHIA and CHELARIEU, 2011). All the species of this genus have an aerial stem which carries the inflorescence at the end and the leaves that are
attached along. The floral stem is generally unbranched (GOLDBLATT and MANNING, 1998). The flowers of Gladiolus genus are having one symmetrical plan, without stalk, and are arranged on both sides. The number of flowers in the inflorescence is different between varieties, varying from 5 to 30 or more, and can be of almost any color, with different spots at the base (CANTOR et al., 2007).

Regarding the environmental requirements of gladioli, presented in chapter two, it is known that these plants need for a good growth and development, to ensure at the optimal level, the main ecological factors.

The third chapter includes information on methods of obtaining seedlings and methods of improvement that are generally used for these plants, as well as different uses of the species. The seedlings can be obtained both sexually and asexually, each of these methods having advantages and disadvantages that need to be taken into consideration when the destination of the culture is set. In spite of a good asexual reproduction os these species, it is vital to use sexual reproduction through sowing in order to maintain a viable spontaneous populations and to establish new cultures (GOLDBLATT and MANNING, 1998).

The gladioli are considered a magic medicinal plant because of its capacity to cure dysentery, constipation and diarrhea at the same time. The bulb and the flower can also be used for cooking salads because they have a similar taste to lettuce (http://homecooking.about.com/library/weekly/blflowers.htm).

The main use of Gladiolus species is ornamental purposes, and they are very appreciated in the floral art. The plants are also popular for cut flowers and in landscaping (KAMO et al., 2005).

Because of a large assortment of species and varieties of Gladiolus genus, there are a lot of possibilities in creating different arrangements with gladioli, as well as paired with other floral and shrub species. Because they have a long decorative life (from June to September) with normal environmental requirements (CANTOR et al., 2007), the gladioli can easily be included in many garden designs. Unfortunately in Romania, these flowers are mostly used as cut flowers and less in landscaping design (HORT et al., 2013).
Out of the main improvement methods (cross-hybridization, individual selection, mutations and somaclonal variability) cross-hybridization is the one that is most often used. The variability obtained from crossings is more extended when using less genetically related genitors and a larger number of partners (SAVATTI et al., 2004; SESTRAŞ, 2010).

PART 2 – THE RESULTS OF THE EXPERIMENTAL RESEARCH

The second part starts with the motivation and the purpose of the present study. In order to reach our goal, three main objectives were outlined: the obtaining of hybrids that are better than their genitors both morphologically and esthetically (new colors, different flower shapes, a larger number of flowers in the inflorescence, a larger flower diameter and an increase in plant vigour; the diversity of varieties that can be used as cut flowers as well as in landscape design for the climatic conditions of Romania; the inclusion of new hybrids and the elaboration of new solutions for the use of gladioli in garden design.

The biological material that was used is part of a collection belonging to the department of Floriculture, at the UASVM Cluj-Napoca. The experiments were conducted on the field of the Agrobotanical Garden of the UASVM Cluj-Napoca and was spread on a surface of 300 square meters.

There were 27 varieties that were measured and were organised in randomized blocks, with 3 repetitions each, each of the varieties representing an experimental variant, with 10 plants per repetition (30 plants from each variety), with a total of 810 plants. Out of the 27 varieties, 11 varieties that have the traits that are needed in order to reach the proposed objective, were chosen as genitors for cross-hybridisation.

Several observations and determinations were made on the chosen hybrids, with the analysis of the main morphological traits: the height of the plant, the length of the floral stem, the length of the inflorescence, the number of leaves, the number of flowers in the inflorescence and the diameter of the flowers. The processing of the obtained data was made through a systematic observation of the biologic material used in the experiments, and were later interpreted using variance analysis and the Duncan test. The
work method that was used is presented in chapter 4 and the description of the area where the plants were grown is presented in chapter 5.

For the presentation of the results concerning morphological traits and fenotypical variability of the main quantitative traits of Gladiolus plants, 11 varieties were analyzed by measuring plant height, the length of the floral stem, the length of the inflorescence, the number of leaves and flowers in the inflorescence, flower diameter, all included in chapter 6.

The empirical data was comprised in tables, alongside with the results obtained from calculating the differences from the average of the experiment (used as control), the relative value and the value of the variability coefficient. For the statistical interpretation of the results the significance of the differences were included in the tables (with the help of variance analysis) and the Duncan test was applied.

Between 4 of the 6 quantitative traits that were observed, phenotypical corelations were used by calculating the corellation coefficient. The calculations were made using empirical data obtained from 10 plants out of each variety, and the results were compared to a probability of 5 and 1% of appearing by chance in an ideal statistical population, in which there are no real connections between variables (ARDELEAN et.al., 2007).

In chapter 7 were presented the results obtained from the interspecific cross-hybridization. In order to obtain the $F_1$ generation, the number of pollinated flowers varied from 20 (H7) to 38 (H9 and H19), according to the number of flowers in the inflorescence or the degree of their simultanious development.

Like in the case of the genitors, 6 quantitative traits of the obtained individuals from each of the 7 hybridizations were analysed. Once the data was centralized, the variability coefficient for each of the hybrid combination was calculated in order to be able to observe of a certain trait is stable or not, in the population. For a more clear understanding of the results, the traits were analyzed and presented in subchapters, in synthesis tables.

Depending on the total number of plants that have grown floral stems we calculated a percent in which the individuals from a hybrid population have a similar
color to the maternal and paternal genitor, intermediate colors or are totally different from the genitors.

In chapter 8 we start to present in separate subchapters the different results obtained from the measurements and calculations that were done on the hybrids belonging to \( F_1 \) generation.

The registered traits from the hybrids obtained through specific cross-hybridizations were compared to the ones from „Pink Lady” variety, which is well known and popular on the market.

In the case of the seven observed cross-hybridizations, the average height varies from 78,9 cm (H6/1) to 105,43 cm (H19/2), and the variability coefficient has low and medium values. The length of the floral stem varies from 59,64 cm (H6/1) to 97,33 cm (H19/2), both values having a difference from the control (66,67 cm) that are statistically ensured. Only in 1 case out of 7 a higher variability coefficient was obtained (hybrid H18/1 with 27,08%), which suggests that the length of the floral stem acn be influenced by the natural conditions.

H12/10, H18/1 and H19/2 hybrids registered longer inflorescences than the control (46 cm), but the differences were not statistically significant. Based on the variability coefficient that was registered, it can be stated that the length of the inflorescence is well stabylised trait and is very little influenced by the environmental conditions or the interaction of the genes with th environment.

Compared to the value registered by the control (6,7 leaves), the hybrids register higher distinctly significant difference (H3/1, H6/1, H12/10, H18/1, H19/2) and very significant differences (H7/4, H9/10).

The consistent values of this trait are reflected in the calculated value of the variability coefficient which is equal to 0.00 in the case of 6 hybrids that were obtained from the specific hybridizations: H3/1, H6/1, H9/10, H12/10, H18/1, H19/2

The number of flowers in the inflorescence that was registered among the analyzed hybrids varies from 10,1 (H9/10) and 16,33 (H18/1). Variability coefficient values are relatively small, including six of hybrid combinations are within 2.52% - 9.40%.
The flowers from the middle of the inflorescence were measured in order to correctly appreciate the flower diameter. The values that were obtained in the case of analyzed hybrid combinations are situated between 7,90 cm (H6/1) and 13,83 cm (H12/10).

The interaction between genotype and environment is given by the values that were registered from H6/1 (10,32%) and H7/4 (12,77%) combinations, which include 2 selections in the limits of a medium variability.

In chapter 9 we present the results that were obtained through correlations between the following traits: the total height of the plant and the length of the floral stem (a x b), the length of the floral stem and the flower diameter (b x d), the total plant height and the number of flower in the inflorescence (a x c), the number of flowers in the inflorescence and the diameter of the flower (c x d). In order to determine the intensity of the connection between 2 variables that form a normal bidimensional distribution the correlation coefficient was calculated (r).

The data that was obtained from F1 generation of hybrids were used to calculate the heterosis (Chaper 10) for the traits that can be used to estimate the degree to which the obtaining of commercial hybrids of *Gladiolus hybridus* can be a real solution for specific improvement. Thus we calculated the hybrid vigour, the difference from the genitors average and of the most valuable genitor, from each of the 6 quantitative traits that were followed: plant height, floral stem length, the length of the inflorescence, the number of leaves, the number of flowers from an inflorescence and flower diameter, results that were included in synthesis tables.

The calculation of the heritability of quantitative traits from F1 hybrids is justified in in the breeding work, by the knowledge of these traits that can be transmitted from the genitors to their descendents and the degree to which these can become stable.

In order to calculate the heritability coefficient in a larger as well as a narrow sense data obtained in 2012 and 2013 were used. The values of the coefficient will be presented in separate tables for each of the analyzed trait.

The values that were registered for each of the selected hybrids and their genitors where emphasized with the help of graphics for each of the quantitative trait and are
presented in chapter 12. This way can easily observe which of the hybrids registered higher values than its genitors.

Thereby in the case of the total plant height and the length of the inflorescence, the 7 hybrids did not exceed the values of the genitors, and in the case of floral stem length only H18/1 and H19/2 have higher values then the genitors. H9/10 hybrid exceeds the leaf number of the genitors and H18/1 hybrid has a higher number of flowers in the inflorescence than the paternal genitor and lower than the maternal one. Out of all the quantitative traits that were analysed, the flower diameter is the one that obtained the best results, when the values are compared to the genitors.

The possibility of using gladioli in garden design was discussed in chapter 12. Most of the gladioli can be planted anywhere, as long as their environmental necessities are taken into consideration; thereby, must avoid places with very little light and loamy soil.

The pallet of colors, the position of the floral stem and the long period of decoration recomend the inclusion of gladioli in almost any landscaping style.

Based on the data presented throughout the chapters, several conclusions and recommendations were made (Capitolul XIV):

1. The enriching and diversification of the varieties and genetic supply of *Gladyolus hybridus* with new genotypes is absolutely necessary because of the multiple uses and demands in Romanian market for these plants, as well as the creation of a selection base for the obtaining of new hybrids.

2. For the realization of controlled interspecific hybridizations, 201 flowers were pollinated from which 4181 seeds were obtained; the highest number have been obtained in the case of H9 combination (908 hybrid seeds), and the smallest number was reached in the case of the combination H3 (~21 hybrid seeds).

3. By comparing the values of the variability coefficient registered in hybrid combinations from the F1 generation, can observe that the variability is lower in selections, the lowest value for most of the traits is between 0,0 and 3,0.

4. In the observed selections, the most stable traits are: plant height, inflorescence length, the number of leaves (with a variability from 0 to 1,49) and flower diameter.
5. Regarding the transmission of the color of flowers to descendents, the experiments have proved that the chances of obtaining new colors even from the first generation by interspecific crossings are high, of 66.7%, the percent ensuring enough material for valuable selections.

6. Following comparisons between hybrids using Duncan test, it was observed that hybrid H19/1 had the best results in four out of six analysed traits: the biggest plant height, the longest floral stem and inflorescence, the highest number of flowers in inflorescence, and can be highly recommended to be used in floral art.

7. Hybrid H16/1 registered the lowest values in five out of six traits. Given the small size of the plant, hybrid H6 / 1 is suitable for ensuring green spaces decoration.

8. Out of the six quantitative traits that were analysed in hybrids from F1 generation, 4 were selected to study the existence or absence of a correlation. After calculating the results it was observed that there are positive significant and distinctly significant correlations for all of the traits. In genetics and plant breeding, some correlations, if they are statistically ensured, can be used as parameters for selection improving Gladiolus hybrids.

9. In the case of H19/2 hybrid, was obtained a positive heterosis, with floral stem longer than that of the best genitor. For all of the other traits, the registered values are lower compared to those of the genitors.

10. The hybrids that showed the highest degree of heritability are H3/1, H6/1, H7/4, H9/10 and H12/10. The influence of genotype of the phenotype is more pronounced in the case of total plant height, floral stem length and number of leaves and the number of flowers in the inflorescence (H7/4 – 0.991).

11. The influence of multiple genes is more visible on H18/1 and H19/2 hybrids, in the case plant height as well as inflorescence length and the number of flowers, the environment and the interaction of the genotype with the environment having influenced the genotype in variable degrees.

12. Based on the obtained results of the Gladiolus hybrids that were selected, we can conclude that these match the objectives of this thesis and are eligible for proceedings of homologation.
SELECTIVE BIBLIOGRAPHY


