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INFLUENCE OF COLD TREATMENTS ON FLOWER QUALITY OF BULBOUS ORNAMENTALS

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Abstract

Ornamental plants are among the most extensively grown plants worldwide. They main purpose is for different occasions, like Valentine Day, International women and Mother's Day and bulbous ornamental plants are one of the most important parts of these special moments. The aim of the present research was to find out for how long should be kept under cold conditions in order to produce cut and potted flowers. For this study it was selected the Tulipa gesneriana, Hyacinthus orientalis, and Muscari armeniacum. Different cold treatment types and times were applied to the bulbous plants. The results indicate that the bulbous plants under the influence of 7 weeks cold treatment under controlled temperature proved to be the best and suitable for cut flowers production at all three selected bulbous ornamental plants. In conclusion, the present work could be usefully for cultivation of different ornamental bulbous plants.

***Key words**: cold treatment, grape-hyacinth, hyacinth, tulip.*

INTRODUCTION

A lot of flower bulbs are purchased each year for their importance in outdoor and indoor decoration, moreover their flowering in periods when few other ornamental plants can do it (Cantor & Gheorghita, 2011). Bulbous ornamental plants are also called ornamental geophytes (Kamenetsky & Okubo, 2012) or are often referred as bulbs which means underground storage organs like rhizomes, corms, bulbs or tubers (Li et al., 2023). The ornamental geophytes include more than 800 different genera (Bryan, 1995), although the ornamental industry is mostly dominated by 7 genera's as: *Tulipa*, *Narcissus*, *Gladiolus*, *Iris*, *Crocus*, and *Hyacinthus* (Benschop et al., 2010). Their main utilization is commercial bulb production, growing as potted plants, forced fresh cut and potted flowers, and in landscaping (De Hertogh et al., 2012; Chawla et al., 2022). According to Gul et al. (2020) ornamental bulbous plants dominate the global flower market, and one of the main reasons is that they follow perfectly timed phenological period. The life cycle of the ornamental bulbous plants is actually connected with the temperature warm-cold-warm cycle which is a key factor leading to flower initiation (Khodorova & Boitel-Conti, 2013).

In the recent years the Romanian flower industry produced cut flowers and potted plants from a variety of different bulbous plants (Székely-Varga et al., 2019).

Hyacinthus orientalis L. beside is an excellent ornamental garden plant it could be also easily forced as cut or potted plant (Nazari et al., 2011). According to Sabo et al. (2018) in Europe firstly was introduced in the 16th century, and it was cultivated first by the Dutch. The hyacinth is a native species from southern Turkey to northern Israel, it is a tuberous earth plant that grows primarily in temperate biomes (POWO, 2023). Tulips are outstanding potted, cut or bedding flowers and can be grown in open or protected conditions (Nayeem & Qayoom, 2015). *Tulipa gesneriana* L. is an endemic plant to Turkey, it is mostly found in the temperate biome and is a bulbous geophyte (POWO, 2023b). The *Muscari armeniacum* Leichtlin species is endemic to Southeast Europe and the Caucasus, it is mostly found in the temperate biome and is a bulbous geophyte (POWO, 2023c). The grape-hyacinth is a perennial bulbous plant with simple basal leaves and short flower stalks (Bokov, 2019).

The aim of the present paper was to determine how long should *Hyacinthus orientalis*, *Muscari armeniacum*, and *Tulipa gesneriana* bulbs kept under cold treatments, as forced culture to produce cut or potted flowers. Also, an important aspect was to manage the flowering to be ready for 8th of March.

MATERIALS AND METHODS

The experiment was conducted at Sapientia Hungarian University of Transylvania, in Târgu Mureș, between December and March. As plant material were selected three bulbous ornamental plants as followed: *Hyacinthus orientalis* L. \`Miss Saigon\` (circumference 18/19 cm) - very compact hyacinth, leaves are light green, flowers are blue and one of its characteristics is that it can produce several flowers per bulb; *Tulipa gesneriana* L. \`Yellow Baby\` (circumference 10/11 cm) - strong, rigid tulip, characterized by grey-green leaves and wide yellow flowers; *Muscari armeniacum* Leichtlin \`Grandioso\` (circumference 10/11 cm) - with bright blue flowers. The bulbs were obtained from Agrosel (Câmpia Turzii, Romania) and were planted in 7×8 cm pots in a mixture of peat and sand 50:50 ratio. Before planting, each bulb was treated with fungicide (Captan 80 WDG), and after the planting the bulbs were irrigated. Two types of cold treatments were applied one in natural conditions, where the bulbs were kept under an unheated greenhouse covered with soil, the second when the bulbs were placed in artificial environment in a refrigerator (Kühlschrank 2 Türen aus Edelstahl). At the natural condition the temperature was between -4 and 6°C and the humidity 80-100%. In the case of the artificial conditions the temperature and the humidity were regulated with 5°C and 90%. For the experiment 180 *Hyacinthus orientalis*, 300 *Muscari armeniacum* and 300 *Tulipa gesneriana* bulbs were selected (Table 1), which were treated with three different cold treatments times 7, 8, and 9 weeks for both environmental conditions. Each cold cycle was repeated three times.
After the mentioned cold treatments, the bulbs were brought into an indoor place where the temperature was above 10°C, and were covered with a black foil for three days, to prevent the bulbs from a sudden strong light.

Table 1. Experimental schema

Time	Natural cold treatment			Artificial cold treatment		
	Hyacinthus orientalis	*Muscari armeniacum*	*Tulipa gesneriana*	*Hyacinthus orientalis*	*Muscari armeniacum*	*Tulipa gesneriana*
7 weeks	30 pcs	50 pcs	50 pcs	30 pcs	50 pcs	50 pcs
8 weeks	30 pcs	50 pcs	50 pcs	30 pcs	50 pcs	50 pcs
9 weeks	30 pcs	50 pcs	50 pcs	30 pcs	50 pcs	50 pcs

At the end of the cold treatments for each bulb the flowering stem of plant height was measured each third day until 8th of March.
The significance of the differences between the treatments was tested by applying two-way ANOVA, at a confidence level of 95%. When the ANOVA null hypothesis was rejected, Tukey's post hoc test was carried out to establish the statistically significant differences at $p < 0.05$.

RESULTS AND DISCUSSIONS

Considering the *Hyacinthus orientalis* could be clearly observed that the different cold treatments and cycles significantly influenced the stem length (Figure 1).

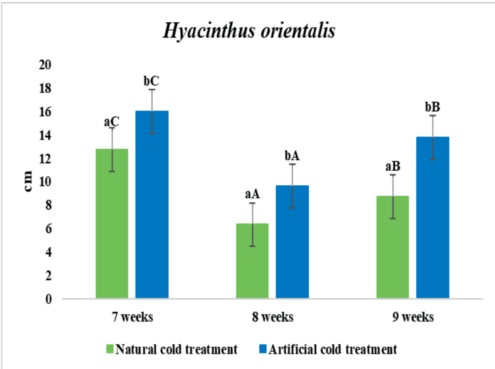

Figure 1. Stem length of *Hyacinthus orientalis* under the effect of different cold treatment and cycle. Bars represent the means ± SE ($n = 30$). Different lowercase letters above the bars indicate significant differences between cold treatments, and different uppercase letters indicate the significant differences between the cold cycle ($p < 0.05$)

Comparing the 7 weeks cold treatment under the effect of artificial cold the stem length reported a 16 cm significantly higher than the other treatment. In the case of 8 and 9 weeks the same significant differences were observed. Furthermore, when comparing the cold treatment time, distinctively the bulbs kept for 7 weeks treatment reported the highest stem length, which was significantly different compared to the other two treatments. Moreover, the smallest stem length was reported at the 8 weeks treatment.

Regarding the *Muscari armeniacum* in the case of the 7 weeks treatment the stem length of the bulbs kept in artificial conditionswas significantly greater compared to the other treatment (Figure 2). At the 8 and 9 weeks no significant differences were reported. The 8 and 9 weeks treatments recorded longer stems compared to the 7 weeks treatment, from which could be concluded that the 7 weeks treatment is more suitable for *Muscari armeniacum* cultivation.

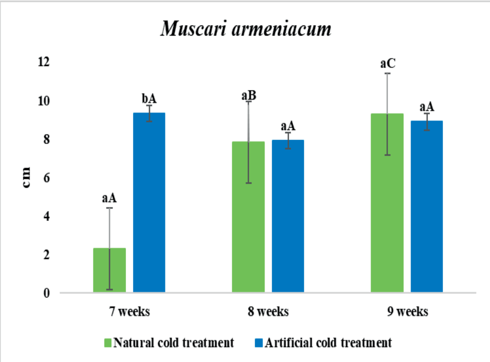

Figure 2. Stem length of *Muscari armeniacum* under the effect of different cold treatment and cycle. Bars represent the means ± SE ($n = 50$). Different lowercase letters above the bars indicate significant differences between cold treatments, and different uppercase letters indicate the significant differences between the cold cycle ($p < 0.05$)

At *Tulipa gesneriana* the longest stem length was determined at the 7 weeks cycle and natural cold treatment, approximately ~ 31 cm (Figure 3). In the case of 7 and 8 weeks cold treatment the bulbs under the natural conditions reported significant differences compared to the other treatment, however at 9 weeks it was contrary. When comparing the cold cycle, a significant higher change was recorded at 7 weeks treatment compared to the other two.

Regarding the growth dynamics of the plants at 7 weeks could be clearly observed that the tulips recorded the fastest growth, and at both type of cold treatments the growth dynamic was almost similar, however at the start of the growth the bulbs cultivated under the natural cold effects have had a slower growth compared to the other even so at the end of the experiment the stem length was longer (Figure 4). At hyacinth a stronger growth was recorded at the bulbs cultivated under artificial conditions. Also, the artificial conditions highly influenced the growth of the grape-hyacinth, in which case the growth have recorded a more pronounced start, and this advantage remained until the end of the experiment.

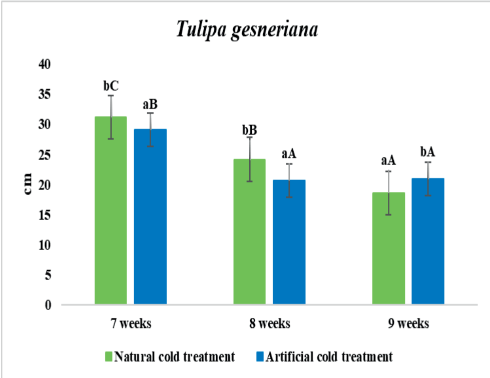

Figure 3. Stem length of *Tulipa gesneriana* under the effect of different cold treatment and cycle. Bars represent the means ± SE ($n = 50$). Different lowercase letters above the bars indicate significant differences between cold treatments, and different uppercase letters indicate the significant differences between the cold cycle ($p < 0.05$)

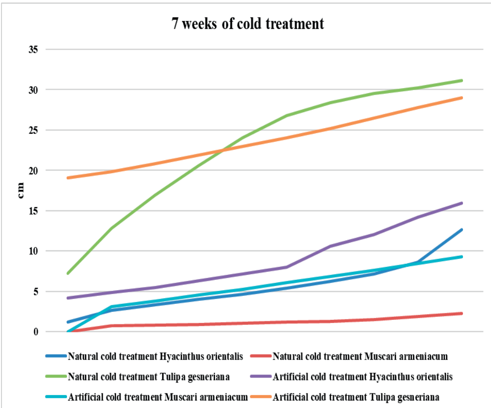

Figure 4. Growth dynamics of the plants under the effect of 7 weeks of cold treatments and cold cycles

As expected at the 8 weeks cold treatment similarly the highest growth was recorded at tulips (Figure 5). The tulip bulbs under natural conditions reached a higher growth. At the *M. armeniacum* the growth dynamics was similar. And again at *H. orientalis* the artificial conditions recorded the faster growth.

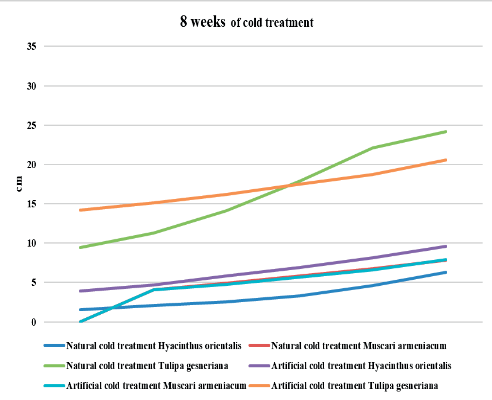

Figure 5. Growth dynamics of the plants under the effect of 8 weeks of cold treatments and cold cycles

Here again, at *T. gesneriana* a faster growth was observed at the bulbs under artificial conditions (Figure 6). Once more hyacinth bulbs under the influence of artificial conditions reported a faster growth dynamic, compared to the other. In the case of *Muscari armeniacum* in natural conditions bulbs achieved a better growth than the bulbs under the artificial conditions, however the difference is small.

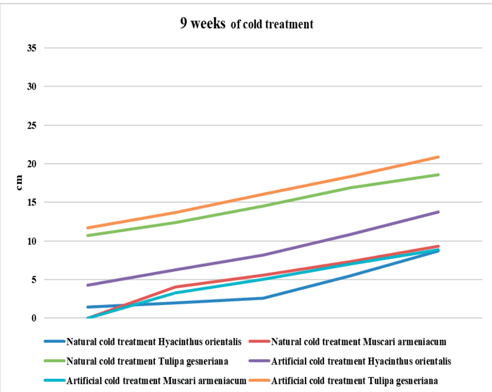

Figure 6. Growth dynamics of the plants under the effect of 9 weeks of cold treatments and cold cycles

According to Khodorova & Boitel-Conti, (2013) a several environmental factors that can affect bulb development (light, humidity, temperature), temperature has been shown to play a crucial role in controlling bulb growth and flowering The ideal cooling period would be 10 to 15 weeks, maybe even longer, during this period, plant roots form and the stem length increases (Graine & Scoggins, 2014).

In a study it was highlighted that at *Tulipa gesneriana* hybrids 'Royal Virgin' and 'Ad Rem' the low temperature and time treatment influenced positively the plants flowering (Carillo et al., 2022), moreover in another experiment it is also mentioned that the flowering time is mostly a genotype-specific response (Wang et al., 2019). According to Koçak & Çığ (2019), the 1st of December and 16th of December planting times are more suitable for hyacinths cultivation and also the planting substrate significantly influenced the bulbs. Additionally, is also determined that biostimulators can have a positive effect on the growth, floral characteristics and the yield of the volatile oil at hyacinths (Altaee, 2021). Furthermore, cold cycle can also have a positive effect on the seed's germination of *Muscari neglectum*, where the greatest results were obtained at the seeds under the treatment of mid-winter and natural conditions (Labbaf et al., 2023). In another study it was demonstrated that along cold cycle also the light colour could have influence on the bulbs, as it was determined that the yellow light colour recorded the greatest results (Smigielska et al., 2014).

CONCLUSIONS

From the present experiment could be concluded that the 7-week cold treatment proved to have the best growth dynamics, which means that the plants under this treatment are also suitable for cut flowers, because the stem length increased very quickly. The 8-week treatments were almost similar with 7-week but they did not show an equal or close trend in stem length growth. The results of the 8-week treatments indicated more pot use. The 9-week treatments did not achieve adequate stem by the time when their mostly sold on the market (8th of March). From this point of view, the 7-week treatments proved to be the most suitable, which could be also explain by the fact that this treatment had the most time to develop after the treatments.

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