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INFLUENCE OF CULTIVAR AND PLANTING MATERIAL REGARDING PHENOLOGICAL ASPECTS AT *DAHLIA HYBRIDA*

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Abstract
Dahlia is one of the most important cut flowers and it is used also for garden decor during the summer. Based on the researches conducted on seven cultivars of Dahlia hybrida cactus type: 'Kennemerland', 'Tsuki Yori No Sisha', 'Hayley Jane', 'Purple Gem', 'Star Favourite', 'Park Princess', 'Friquolet', it was analysed the influence of cultivar and planting material (forced and unforced tuberous roots) on some phenological aspects. Phenological observations conducted on the plants were the following: debut of growth, appearance of the first flower buds, opening of the first flower buds and decorative period. According to the data collected, it was calculated the duration between phenophases as number of days. After the interpretation of the results using Ducan test, it was found that forcing of the tuberous roots has a positive influence on the duration of decorative period, that took place in an interval of 58.11-112.55 days for the cultivars 'Park Princess' and 'Kennemerland' and by comparison, for the unforced tuberous roots, the decorative period was much shorter for cultivars 'Star Favourite' (29.77 days) and 'Kennemerland' (105.55 days). Studies reveal that forcing of the Dahlia tuberous roots is causing the decrease of number of days from planting to sprouting that also helps in extending the decorative period.

Keywords: cultivar, decorative period, phenological observations, tuberous roots

1. INTRODUCTION

Geophyte plants are important for commercial floriculture because the storage organs can be harvested, stored and forced to flower (Dole, 2003). Most ornamental geophytes are produced in open fields using large-scale farming systems. The specific agronomic requirements depend by crop. Geophytes culture can be done all year round if adequate environmental conditions are ensured. Summer-flowering geophytes may be planted in fall for example *Lilium longiflorum*, or in spring after controlled winter storage for *Dahlia* (Kamenetsky and Okubo, 2013). The *Dahlia* crop can be established towards the end of March in unheated greenhouse, using forced tuberous roots. By starting the *Dahlia* crop in greenhouse can be obtained an earliness of flowering with two months, and productions of 30-50 flower stems per plant. *Dahlia* is a feasible crop that can provide high yield during 5-7 months per year (Șelaru, 2007).
From the end of July until the first frost, dalia maintains colorful spots when many flowers have already wilted (Hessayon, 2007). Toma (2009) recommends the planting in the field at the beginning of May.

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The success of geophytic species depends on growing rapidly when environmental conditions are favorable. This rapid growth is ensured by the nutrients accumulated in the storage organ (Dole, 2003).

The forcing industry is based on two important concepts. The first one is that ornamental geophytes have distinct annual cycles of active growth and dormancy that are controlled by temperature, water and photoperiod. These cycles lead to periods of active growth and periods of dormancy. The active period consists of the growth of photosynthetic mass represented by leaves and stem, followed by flowering and flower senescence. The dormancy is represented by a period of time in which the plant survives the unfavorable conditions as a geophytic organ. The second concept relates to the specific duration of active photosynthetic growth for various geophytes before flowering (Kamenetsky and Okubo, 2013).

Regarding the response of *Dahlia* plants to environmental signals, the tuberous root formation is induced by photoperiods of 11-12 hours or less (Legnani and Miller, 2001; Dole, 2003). Also, *Dahlia hybrida* will not go dormant if grown under 12-14 hour daylengths. The dormant tubers stop to grow only after they have been exposed to temperatures from 0° to 10°C for six weeks (Dole, 2003).

De Hertogh (1996) cited by Kamenetsky and Okubo (2013) identified five stages of development in geophyte flowers. He says that regulation of the environmental factors (especially temperature) can accelerate or retard cell division, influencing leaf, shoot and flower formation. By understanding the annual cycle of the geophyte organ and by the application of proper temperature sequences, plants can be programmed to flower earlier.

The duration of the flowering process can be measured either the number of days to flowering (F) or the rate of progress toward flowering (1/F) (Goto et al., 1996).

Optimized forcing involves a good degree of control over the floricultural product, and is only possible with a complete understanding of the effects of temperature and other environmental factors on flower induction, initiation and development to anthesis (Kamenetsky and Okubo, 2013).

The aim of the present study was to determine the influence of cultivar and planting material (forced and unforced tuberous roots) on some phenological aspects for seven *Dahlia hybrida* cactus type cultivars.

2. MATERIALS AND METHODS

To meet the proposed objectives and to obtain relevant scientific results, the biologic material used to establish the experimental field was represented by seven *Dahlia hybrida* cultivars with cactus type flower: 'Kennemerland', 'Tsuki Yori No Sisha', 'Hayley Jane', 'Purple Gem', 'Star Favourite', 'Park Princess', 'Friquolet' (fig. 1).

The biological material comes from Holland and was purchased from Kertimag garden center located in Cluj-Napoca.

Forcing of the tuberous roots was conducted in the didactic greenhouse of the Faculty of Horticulture, USAMV Cluj-Napoca, starting with 19th March 2015.

Researches regarding the influence of planting material were conducted in a bifactorial experiment organized in randomized block design with three repetitions (Ardelean et al., 2007).

From the combination of the two experimental factors with two, respectively seven levels are resulted 14 experimental variants. There were used 9 tuberous roots per each variant.

Factor A – the planting material with two levels:

- a_1 – forced tuberous roots, planted in the field;
- a_2 – unforced tuberous roots, planted directly in the field.

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Factor B – the cultivar with seven levels:

- b_1 - 'Kennemerland';
- b_2 - 'Tsuki Yori No Sisha';
- b_3 - 'Hayley Jane';
- b_4 - 'Purple Gem';
- b_5 - 'Star Favourite';
- b_6 - 'Park Princess';
- b_7 - 'Friquolet'.

Figure 1: Dahlia hybrida cultivars used as biological material

The wounds of the tuberous roots were cleaned and dusted with charcoal powder before planting. The substrate was disinfected with Dithane 0.2%.

Regarding the phenological aspects, the observations conducted were: debut of growth, emergence of the flower buds, opening of the first flower buds, duration of decorative period.

The results obtained concerning the phenological aspects were assessed using Duncan test at 5% level of probability (Ardelean et al., 2007).

3. RESULTS AND DISCUSSIONS

The debut of growth of the forced tuberous roots belonging to seven *Dahlia hybrida* cultivars (V_1, V_2, V_3, V_4, V_5, V_6, V_7,) took place between 27.03–11.04.2015 while the debut of growth for the unforced tuberous roots (V_8, V_9, V_{10}, V_{11}, V_{12}, V_{13}, V_{14}) took place between 22.05–06.07 in 2015.

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According to table 1, between variants V_1 and V_8, V_2 and V_9, V_3 and V_{10}, V_4 and V_{11}, V_5 and V_{12}, V_6 and V_{13}, V_7 and V_{14} were registered differences in value, but were not ensured statistically.
The average number of days from planting to emergence of the plants was between 10.66–25.44 days for the forced tuberous roots (V_1 - 'Kennemerland' and V_5 - 'Star Favourite'). Compared with these, the average number of days for the unforced tuberous roots was between 12.66 days for V_8 - 'Kennemerland' and 32.22 days for V_{14} - 'Friquolet' (table 1).
It can be observed that the forced tuberous roots needed fewer days from planting for emergence.
Lubovsky and Ozeri (1990) examined the influence of the number of buds existing on the corms for *Ranunculus* sp. at the planting time and formed during the forcing treatment. They found that corms carrying several buds at planting had a better flower yield than those with single buds.
The flowers buds of the *Dahlia* forced tuberous roots (V_1, V_2, V_3, V_4, V_5, V_6, V_7, V_8) appeared during 11.06-20.07, while for the unforced tuberous roots the flowers buds appeared in 13.07–10.09.2015.
The variant V_4 - 'Purple Gem'/forced tuberous roots is statistically different from the variant V_{11} - 'Purple Gem'/unforced tuberous roots. The interval from debut of growth to emergence of the flower buds was larger for forced tuberous roots: 44.78 days for V_6 - 'Park Princess' and 97.11 days for V_2 - 'Tsuki Yori No Sisha'. Compared with these, the interval for unforced tuberous roots was 40.45 days for V_{12} - 'Park Princess' and 94.11 days for V_8 - 'Kennemerland'.
In *Zantedeschia rehmannii* tuber storage at 1-5°C for 30 days is recommanded for breaking dormancy, and a temperature of 10°C is suitable for flower bud initiation. The number of days was shorther until flowering for the plants stored at 10°C for 20 days followed by 1°C for 30 days. Flower production increased remarkably in plants stored at 1°C for 10 days followed by 10°C for 40 days and at 1°C for 20 days followed by 10°C for 30 days because secondary flowers were also harvested (Goto et al., 2005).
Similar results were obtained for other floricultural species as well. For example, forcing of two cultivars of *Pelargonium x domesticum* for 21 days at 16°C caused plants to flower earlier with 5-6 days, while forcing for 18 days at 13°C caused a continuous formation of buds, prolonging the duration of flowering (Evensen and Olson, 1992).
For the variants belonging to forced tuberous roots, the opening of the buds started during 29.06–13.08.2015, while for the unforced tuberous roots started during 23.07–21.09.2015. The number of days from the emergence of the flower buds to anthesis is different both for the type of planting material (forced/unforced tuberous roots) as well as for each cultivar. Regarding the planting material and these aspects, there are no significant differences among the 14 variants.
A study on forcing of *Lilium longiflorum x Lilium elegans*, revealed that the time range between shoot emergence, visible flower buds and flowering of the precooled plants varied between 80 to 110 days, dependent of plant clones, growth temperature and daylength, proving that they have potential to produce cut flower and mature bulb in less than a year by applying the described cultivation technology that involves forcing (Chen et al., 2008).
Studies on the controlled flowering of some herbaceous perennial plants like *Campanula carpatica, Coreopsis grandiflora* and *Lavandula angustifolia,* were conducted on ten mature plants from each species treated with 10 weeks of cold and then placed in greenhouse at 15-27°C. The number of days from the start of the forcing to visible bud and to flower was recorded, then it was calculated the number in days from visible bud to flower. It was concluded that as long as the plants are mature, there is little difference in time to flower between different-sized plants. Accurate prediction of flowering depends on plants starting at the same developmental stage. Plants already

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reproductive at the end of the cold treatment, will bloom in fewer days than those that are vegetative at the start of forcing (Goto et al., 1996).

Studying the forcing of *Watsonia laccata* Suh et al. (2011), determined that corm formation is favored by specific day/night temperatures, while the flowering was earliest for the corms produced at 24°–26°/18°–20 °C and then forced at 18°–20/15°–17 °C. Also, flowering was favored by 2–4 weeks of high temperatures (27°–29°/24°–26 °C) prior to forcing at low temperatures (18°–20°/15°–17 °C). The number of florets was not significantly affected by corm storage, forcing temperatures, or their interaction, but forcing at high temperatures is reducing the floret number in this species.

In the studied *Dahlia hybrida* cactus type cultivars the duration of decorative period lasted until the first frost from 22–29 October for both types of planting material.

In this study, significant differences regarding the two types of planting material (forced/unforced tuberous roots) were registered between variants V_4 - 'Purple Gem'/forced tuberous roots (110.66 days) and V_{11} - 'Purple Gem'/unforced tuberous roots (60.22 days).

Han et al. (1991) regarding the influence of environmental factors during forcing on some plant characteristics, identified that low night temperatures (5-10°C) during forcing of *Brodiaea* causes scape elongation with 250%, an important characteristic for this flower, and this increase was not accompanied by decrease in flower quality or increase in forcing time.

Analyzing table 1, it can be observed that forcing of the *Dahlia* tuberous roots had a positive influence on duration of decorative period that took place between 58.11–112.55 days for the cultivars 'Park Princess' and 'Kennemerland'. Compared with these, the duration of decorative period for the unforced tuberous roots was shorter, between 29.77–105.55 days, for the cultivars 'Star Favourite' and 'Kennemerland'.

In the case of the forced tuberous roots, the cultivar with longest duration of decorative period was 'Kennemerland' (112.55 days), followed by the cultivars 'Purple Gem' (110.66 days), 'Hayley Jane' (109.66 days), and 'Tsuki Yori No Sisha' (105.55 days.). For the unforced tuberous roots, the cultivar 'Kennemerland' had duration of decor of 105.55 days followed by 'Hayley Jane' (93.89 days), 'Tsuki Yori No Sisha' (75.66 days) and 'Friquolet' (64.11 days).

In an experiment conducted on *Dahlia* × *hybrida* cav. 'Figaro Mix', *Tagetes patula* 'Janie Flame' *Zinnia elegans* 'Magellan Pink' to evualuate the effects of constant and fluctuating temperatures on growth and flowering, Blanchard and Runkle (2011) found that all species grown at 20/14°C were 10% to 41% taller than those grown at 16/22 °C, but *Dahlia* plants cultivated at 18/18°C or 20/14°C had on average more inflorescences.

Table 1. Results regarding the influence of cultivar and planting material on some phenological aspects

Var. No.	Planting material	Cultivar	Phenologic observations			
			Average number of days from planting to emergence	Average number of days until buds development	Average number of days from the appearance of buds to opening	Average duration of decorative period (days)
V_1		'Kennemerland'	10.66 C	94.78 ABC	19.88 A	112.55 A
V_2		'Tsuki Yori No Sisha'	14.00 ABC	97.11 A	25.44 A	105.22 ABCD
V_3		'Hayley Jane'	14.44 ABC	91.45 ABCDE	17.00 AB	109.66 ABC

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V_4	Forced root	'Purple Gem'	16.66 AB	95.22 AB	17.22 AB	110.66 AB
V_5		'Star Favourite'	25.44 AB	61.78 BCDE	12.61 ABC	62.44 DE
V_6		'Park Princess'	14.77 ABC	44.78 DE	11.78 ABC	58.11 E
V_7		'Friquolet'	22.78 AB	63.89 ABCDE	13.44 ABC	71.55 BCDE
V_8	Unforced root	'Kennemerland'	12.66 BC	94.11 ABCD	14.54 AB	105.55 ABC
V_9		'Tsuki Yori No Sisha'	14.78 AB	72.22 ABCDE	14.55 AB	75.66 ABCDE
V_{10}		'Hayley Jane'	16.44 AB	84.00 ABCDE	15.44 AB	93.89 ABCD
V_{11}		'Purple Gem'	21.22 AB	60.67 CDE	9.90 ABC	60.22 DE
V_{12}		'Star Favourite'	20.11 AB	50.89 DE	11.00 ABC	29.77 E
V_{13}		'Park Princess'	15.11 AB	40.45 E	8.11 C	38.33 E
V_{14}		'Friquolet'	32.22 A	54.00 DE	8.22 BC	64.11 CDE
DS 5%			11.94-13.71	37.30-42.84	9.88-11.35	40.05-46.00

*Note: The difference between any two values followed by at least one common letter is insignificant

Studying the influence of photoperiod on potted plants of *Dahlia* 'Sunny Yellow' and *Dahlia* 'Sunny Rose' Legnani and Miller (2001) found that short days increased the tuberous root development at the expense of shoot growth, while the long days had the opposite effect. They suggested that the number of leaves may affect the time when the plant is capable to respond to photoperiod for flower induction and flowering. Previous studies indicated that in pinched *Dahlia* plants, only after the emergence of the 4th-6th true leaf pairs, the flower induction can occur under favorable photoperiod.

The summer-flowering geophyte plants require significant periods of photosynthesis for proper flowering and reserve organ development. Compared with these, the spring flowering geophytes have minimal requirement for photosynthesis for flowering (Kamenetsky and Okubo, 2013). It can be concluded that greenhouse forcing of the summer-flowering geophytes like *Dahlia*, before planting outdoor, relates to better flowering parameters, because the early entering in vegetation represents the extension of active photosynthetic period.

However, the positive results regarding the forcing were also found for many other flower species that were mentioned above.

4. CONCLUSIONS

Following the researchers conducted, it can be concluded that *Dahlia* forced tuberous roots start to grow earlier than the tuberous roots planted directly in the field, aspect that also has positive influence for the duration of decorative period.

The tuberous roots forced before planting in the field requires fewer number of days from planting to emergence (10.66 days for V_1 - 'Kennemerland' and 25.44 days for V_5 - 'Star Favourite'),

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compared with the unforced tuberous roots planted directly in the field in May that require a longer time start to grow (12.66 days for V_8 - 'Kennemerland' and 32.22 days for V_{14} - 'Friquolet').
It was determined that forcing of the tuberous roots extends the duration of decorative period of *Dahlia* cultivars.
The cultivars with the longest decorative period were: 'Kennemerland' (112.55 days), 'Purple Gem' (110.66 days), 'Hayley Jane' (109.66 days) and 'Tsuki Yori No Sisha' (105.22 days) belonging to the forced tuberous roots.

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