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EFFECT OF COLD NIGHT TEMPERATURE ON FLOWERING OF *Kalanchoë* SPECIES

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ABSTRACT

Control of flower induction is one of the most important aims in the floriculture industry as it determines the usefulness of plants for cross-pollination and production of flowering plants. The *Kalanchoë* genus contains around 140 species and numerous interspecific hybrids with a broad range of morphological traits, which makes this genus one of the most cultivated potted plants in the world. Commercial cultivars are easily induced to flowering by short days photoperiod, however, the number of species used for breeding is limited due to the lack of knowledge of flower inducing factors. Many studies suggested that cold night temperature can positively affect flowering in some *Kalanchoë* species. This study aimed to evaluate flowering in *K. prittwitzii*, *K. marmorata* and *K. longiflora* exposed to different night temperatures (6°C, 12°C and 18°C) combined with short day photoperiod (8 h). *K. prittwitzii* exhibited 100% flowering in all treatments, and flowering was enhanced by low night temperatures. *K. marmorata* had minimal flowering response to the treatments and *K. longiflora* did not flower in any of the treatments. The results support a postulate that interaction between different stimuli is required for flower induction in *Kalanchoë* species and demonstrate that night temperature can modify the flowering response. Therefore, the interaction between different factors during the plant life cycle requires further investigation.

Key words: cold night, flower induction, flowering time, ornamental plant, photoperiod, short day

INTRODUCTION

Kalanchoë is the second most commercialized genus of potted plants in Europe with a turnover of 62 million Euro in 2015 [Royal Flora Holland 2015]. It comprises around 140 species, which vary vastly regarding morphological traits such as growth habit and flower characteristics [Descoings 2003]. Most of the commercial *Kalanchoë* cultivars are induced to flowering under short day (SD) photoperiod. However, within the genus, several species are difficult to induce flowering as well as control the time of flowering [Currey and Erwin 2011]. These troublesome species are therefore not useful for cross-pollination when developing new hybrids or for commercial production. Several studies have reported that cold night temperature affects flowering of *Kalanchoë* species. It can act as a prerequisite to flower induction, promote early flowering or enhance flowering response [Sharma and Dunn 1970, Sharma 1973]. Kroon et al. [1989] reported that in some *Kalanchoë* species native to a desert-like climate, flowering is inhibited under SD when the night temperature is high. Spear and Thimann [1954] observed that high night temperature strongly decrease flowering in *K. blossfeldi-*

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ana. Sharma [1973] demonstrated that *K. velutina* only flowered when subjected to low night temperature, moreover Sharma and Dunn [1970] observed that low night temperature promoted earlier flowering in *K. fedtschenkoi.*

In order to program flowering and make more *Kalanchoë* species suitable for use in breeding programs, the flowering requirements of each species must be well understood. In the present study we investigated the influence of cold (6°C) and cool (12°C) night temperatures combined with short day photoperiod on flower initiation and flowering response in *Kalanchoë prittwitzii*, *Kalanchoë marmorata* and *Kalanchoë longiflora*, three *Kalanchoë* species with attractive traits to include in breeding programs.

MATERIALS AND METHODS

Plants of *K. prittwitzii* Engler, *K. marmorata* Baker and *K. longiflora* Marnier-Lapostolle were established from cuttings as described by Coelho et al. [2015]. Due to the growth rate of the species used, the establishment period was four, five and six weeks for *K. prittwitzii*, *K. marmorata* and *K. longiflora*, respectively. The plants with 2 to 4 leaf pairs were transferred to three climate chambers (VEPHQ 5/2000, Heraeus Vötsch GmbH, Balingen, Germany) and cultivated for 12 weeks under SDs (8 hours day length) with 22°C day temperature and three different night temperatures: 6°C, 12°C or 18°C, respectively. Daylight period was simulated by LED lamps (FL300 SUNLIGHT fixture from Fiona Lighting, Senmatic A/S, Søndersø, Denmark) with irradiance of approx. 250 μmol s^{-1} m^{-2}. After the SD treatment, the plants were transferred to the greenhouse and kept under LD for six weeks, or until the appearance of the first wilted flower. Plants were watered once a week. Plant growth was evaluated when the plants showed visible flower buds (*K. prittwitzii*) or at the end of the SD treatment (*K. marmorata* and *K. longiflora*). Flowering was monitored twice a week and numbers of inflorescences and flowers were counted when the first wilted flower appeared. The first open flower was defined as when the tips of the petals of at least one flower per plant were separated. The first wilted flower was evaluated when at least one flower per plant was wilted. A flower was considered wilted when the flower tube began to shrink. The data was collected in days after the start of the experiment. Two independent experiments (E1 and E2) separated in time were conducted with three treatments of different night temperatures (6°C, 12°C or 18°C) with 12 plants of each species. E1 was conducted from June to October, 2014, and E2 from September, 2014 to January, 2015. Percentage of flowering was analyzed by logistic regression, and Tuckey's HSD test ($P = 0.05$) was performed to compare the means of all other parameters, using the software R [RStudio Team 2015].

RESULTS AND DISCUSSION

The current study aimed to evaluate the effects of night temperature on flowering response in *K. prittwitzii*, *K. marmorata* and *K. longiflora*. *K. prittwitzii* flowered under SD regardless night temperature in both experiments (tab. 1). In contrast, *K. marmorata* exhibited minimal flowering (tab. 1) and *K. longiflora* did not flower under any treatment (tab. 1). Similarly to our results, Currey and Erwin [2011] did not succeed to induce flowering in either of the two last species under short days at 18°C.

The effect of night temperature on the flowering time could be observed in *K. prittwitzii* where plants subjected to higher night temperature had earlier flowering and, consequently, wilted first (fig. 1A). Independently of the night temperature, the time until flowering in our study was significantly reduced than in study by Kroon et al. [1989], which reported that in *K. prittwitzii* flowered after 159 days after the beginning of SD treatment. In our study we observed that flowering in *K. prittwitzii* varied from around 75 to 110 days, in the 18°C and 6°C treatments, respectively. However, other experimental conditions, such as the length of the SD and day temperature did differ between the studies. The night temperature had an effect on plant growth in all species, with shorter plants obtained at 6°C (tab.1). Since temperature is a primary stimulus to control plant development, earlier flowering could be attributed to faster growth and development observed in plants exposed to higher night temperature. Similarly, Mortensen (2014) and Eveleens-Clark et al. [2004] observed that time until flowering in *K. blossfeldiana* decreased when temperature increased. However, low temperature at night positively affected the number of inflorescences and flowers produced in *K. pritttwitzii* (fig. 1B and C). Plants induced at 12°C produced more inflorescences compared to the other treatments. Even though the effect of temperature differed on the number of open flowers between E1 and E2, both experiments showed that low night temperature increased the number of flowers compared to warm night temperature (i.e. 18°C) (fig. 1C). Similar to our results for *K. prittwitzii*, several studies suggested that low night temperature in the range of 11°C to 17°C, has a major positive impact on flower induction of *Kalanchoë*, and in some species it may be required for triggering flowering [Sharma and Dunn 1970, Sharma 1973, Kroon et al. 1989]. Koon et al. [1989] observed that among 163 species and cultivars studied, 48 did not flower, possibly due to the lack of low night temperature. Moreover, while low temperature at night was mandatory to trigger flowering in *K. velutina* [Sharma 1973], it was beneficial but not required in other species [Sharma and Dunn 1970].

The flower induction in *K. marmorata* did not depend upon night temperature and only minimal flowering was observed in this species (tab. 1) with few plants flowering at 6°C and 12°C in E1 and 12°C and 18°C in E2. The low percentage of flowering in *K. marmorata* and lack of flowering in *K. longiflora*, can be due to the juvenile state of the plants at the beginning of the inductive period. Khoury and White [1980] reported that different *Kalanchoë* cultivars differed in their juvenile period, and for occurrence of complete flowering, plants have to reach maturity around the start of SD inductive treatment. Thus, longer period of establishment before the inductive treatments for *K. marmorata* and *K. longiflora* could have been required to properly induce the plants to flower.

Table 1. Effect of different night temperatures on the percentage of plants flowering (%) and plant height (cm) in *K. prittwitzii*, *K. marmorata* and *K. longiflora* in experiment 1 (E1) and experiment 2 (E2)

Parameter	*K. prittwitzii*		*K. marmorata*		*K. longiflora*	
	E1	E2	E1	E2	E1	E2
Percent of population flowering†						
6°C	100	100	25 a	---	---	---
12°C	100	100	33 a	16 a	---	---
18°C	100	100	---#	8 a	---	---
Height§						
6°C	12.3 ±1.7c	8.9 ±1.6b	10.6 ±0.7 b	9.0 ± 0.5b	14.1 ±0.7b	12.5 ±0.5c
12°C	14.1 ±1.3b	9.24 ±0.8b	15.5 ± 0.9a	12.2 ± 0.8a	17.2 ±0.4a	14.5 ±0.8b
18°C	19.1 ±2.5a	11.0 ±0.5a	14.4 ± 0.4a	13.9 ±1.6a	18.3 ±0.6a	16.3 ±1.6a

Letters indicate means separations within night temperatures by Tuckey's HSD ($P = 0.05$) n = 12

Values are represented as means ± SE

† Data compared by logistic regression analysis

#---, Indicate treatments that did not promote flowering

§ Measured 4 weeks after the beginning of the treatments in *K. prittwitzii*, when the first treatment showed visible flower buds and 12 weeks in *K. marmorata* and *K. longiflora*

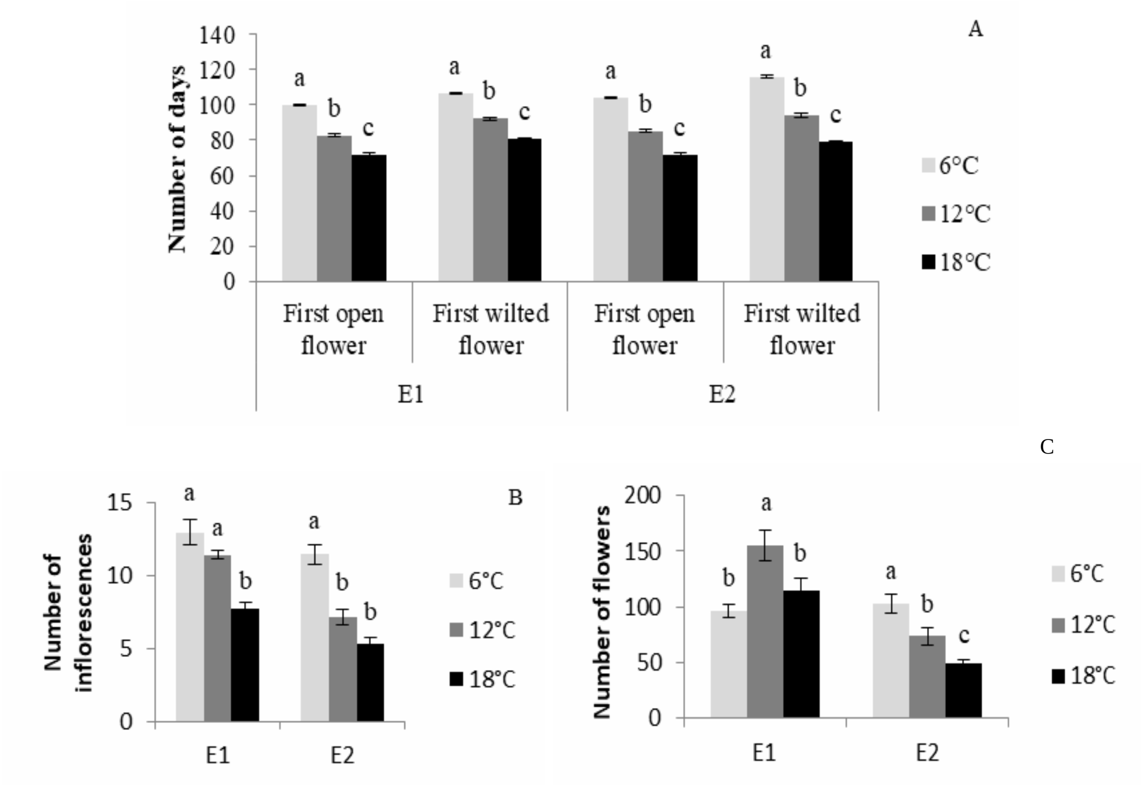

Fig. 1. Effect of night temperature on flowering of *Kalanchoë prittwitzii* observed in experiment 1 (E1) and 2 (E2). (A) Number of days after the beginning of the treatments until appearance of first open and first wilted flowers under different night temperatures. (B) Number of inflorescences produced under different night temperatures. (C) Number of flowers produced under each night temperature. Means were compared within the same experiment by Tukey's HSD (P = 0.05) and statistical differences are represented by different letters. Error bars represent the standard error. n = 12

In our study we observed differences in flowering response between two experiments. The plants may have been developmentally affected by the external natural light stimuli due to the time of year during establishment. In E1, plants were established during summer and had higher influence of external light in the greenhouse, while E2 established in autumn with less natural light, and thus exhibited lower quality of flowering. These observations from both experiments are consistent with the findings of Carvalho et al. [2006] who demonstrated that the height and number of flowers for *K. blossfeldiana* increased when the plants received more irradiation. These authors also showed that plants exposed to higher irradiance flowered earlier.

CONCLUSIONS

Our study confirmed previous reports showing that low night temperature has an impact on flowering response in *Kalanchoë*, but it is not a mandatory requirement for flowering to occur. Our experiments demonstrated that despite enhancing number of inflorescences and flowers in *K. prittwitzii*, low night temperature delays flowering time in this species. Moreover, low night temperature is not an efficient treatment to shorten juvenility in *K. marmorata* and *K. longiflora*.

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REFERENCES

Carvalho, S.M.P., Wuillai, S.E., Heuvelink, E. (2006). Combined effects of light and temperature on product quality of *Kalanchoe blossfeldiana*. Proc. Vth IS on artificial lighting, Moe, R. (ed.). Acta Hortic., 711, 121–126.

Coelho, L.L., Kuligowska, K., Lütken, H., Müller, R. (2015). Photoperiod and cold night temperature in control of flowering in *Kalanchoë*. Acta Hortic., 1087, 129–134. DOI: 10.17660/ActaHortic.2015.1087.14.

Currey, C.J., Erwin, J.E. (2011). Photoperiodic flower induction of several *Kalanchoe* species and ornamental characteristics of the flowering species. HortScience, 46, 35–39.

Descoings, B. (2003). Kalanchoe. In: Illustrated handbook of succulent plants. Crassulaceae, Eggli, U. (ed). Sukkulenten-Sammlung Zurich Mythenquai, Zurich, pp. 143–181.

Eveleens-Clark, B., Carvalho, S.M.P., Heuvelink, E. (2004). A conceptual dynamic model for external quality in *Kalanchoe*. Acta Hortic., 654, 263–269.

Khoury, N., White, J.W. (1980). Juvenility and response time in *Kalanchoë* cultivars. J. Am. Soc. Hort. Sci., 105, 724–726.

Kroon, G.H., De Jong, J., Van Raamsdonk, L.W.D. (1989). Evaluation of the genus *Kalanchoe* for breeding of new cutflowers and potplants. Acta Hortic., 252, 111–116.

Mortensen, L.M. (2014). The effect of wide-range photosynthetic active radiation on photosynthesis, growth and flowering of *Rosa* sp. and *Kalanchoë blossfeldiana*. Am. J. Plant Sci., 5, 1489–1498.

Royal Flora Holland. (2015). Annual report 2015. Available: file:///C:/Users/tdb733/Desktop/RoyalFloraHolland_Annual_Report_2015_ENG_facts_and_figures.pdf [date of access: 24.01.2017].

RStudio Team (2015). RStudio: Integrated Development for R. RStudio, Inc., Boston, MA. Available: http://www.rstudio.com/. [date of access: 24.01.2017].

Sharma, G.K. (1973). Flower formation in *Kalanchoë velutina* induced by low night temperature. Southwest. Nat., 18, 331–334.

Sharma, G.K., Dunn, D.B. (1970). Effects of cool nights on flowering of *Kalanchoë fedschenkoi*. Trans. Mo. Acad. Sci., 3, 22–28.

Spear, I, Thimann, K.V. (1954). The interrelation between CO_2 metabolism and photoperiodism in Kalanchoë. II. Effect of prolonged darkness and high temperatures. Plant Physiol., 29, 414–417.