アサガオの花成における温度とジベレリンA3の影響について

誌名	園藝學會雑誌
ISSN	00137626
著者	小川, 幸持
巻/号	57巻3号
掲載ページ	p. 475-480
発行年月	1988年12月

農林水産省 農林水産技術会議事務局筑波産学連携支援センター
Tsukuba Business-Academia Cooperation Support Center, Agriculture, Forestry and Fisheries Research Council Secretariat

J. Japan. Soc. Hort. Sci. 57(3): 475–480. 1988.

Effect of Temperature and Gibberellin A_3 on Flowering in *Pharbitis nil* Choisy

Yukiyoshi OGAWA
Faculty of Bioresources, Mie University, Tsu, Mie 514-22

Summary

Flowering of *Pharbitis nil* Choisy in response to exposure to a single inductive dark period was influenced by the temperature at which the plants were held after the dark period, with the optimum being 20°C. Promotion of flowering by gibberellin A_3 (GA_3) applied exogenously to the apex before or after the dark period was also influenced by temperature. In both instances, the higher temperature (25-35°C) inhibited the floral response.

There was no or little effect of high temperature on flowering for 24 h after the end of the dark period. However, high temperature for 96 h or more resulted in inhibition of flowering. When 48 h pulses of high temperature were employed, the most inhibitory period was from 48 to 96 h after the induction. The inhibitory effect decreased with delaying application of high temperature after the induction. These responses to temperature indicate that action is not directly against the short day stimulus to flowering but, rather, on events of floral evocation at the shoot apex and they also suggest that at low temperature (20°C) floral processes occur at the apex for 10 days after induction.

Introduction

There have been a number of reports for short day plants that flowering is strongly inhibited by high temperature, especially after floral induction and, hence, during floral development at the shoot apex(1, 2, 3, 7). This is also the case for *Pharbitis nil.* King and Evans(4) have shown that higher temperatures reduce flowering of *Pharbitis* during evocation at the apex. Ogawa(6) has shown that at a low temperature (15 or 20°C) exogenously applied GA_3 is effective for promotion of flowering for a longer period after induction than at a higher temperature (28°C). Direct effect of low temperature (15°C) for more than 25 days on floral evocation in *Pharbitis nil* has been also reported(5).

The present paper reports the effect of temperature after floral induction on the response of flowering of *Pharbitis nil*, in association with effects of applied GA_3. The timing of the temperature effect in relation to events of floral development at the apex is also discussed.

Received for publication May 27, 1987.

Materials and Methods

Seeds of *Pharbitis nil* Choisy, strain Kidachi, were treated with conc. H_2SO_4 for 40 min, then washed througly in running water for 20 h after which they were sprouted for 20 h in a petri dish at 20°C. The seeds that germinated were planted in a clay pot 15 cm in diameter filled with a garden soil. The seedlings were grown for 5 days in a glasshouse controlled at 28±2°C under sunlight during the day (800–1,200 $\mu Em^{-2}sec^{-1}$, photosynthetically active radiation, PAR) and under daylight fluorescent lamps at night (80 $\mu Em^{-2}sec^{-1}$, PAR), after which they were transferred to a dark room for exposure to an inductive dark period, usually 14 to 16 h at 28°C. Then the plants were held for different periods under daylight fluorescent lamps (80 μEm^{-2},sec^{-1}, PAR) in a growth cabinet controlled at different temperatures, after which they were grown in the same glasshouse or under the fluorescent lamps at 28°C for 3 weeks until the flowering response was determined by dissection. Approximately 5 μl of an aqueous solution of GA_3 (50 or 100 ppm) with 0.05 % (v/v)

Tween 80 was applied to the plumule of the seedlings by means of a glass capillary just before the beginning or just after the ending of an inductive dark period. The control plants were treated with water plus Tween-80. Two or three pots were used in each treatment with 7 seedlings per pot.

Results

Effect of length of dark period

The GA_3 was applied to the plumule prior to the dark period of different lengths (9–14 h). After the dark period the plants were held for 240 h either at 20 or 28°C. As shown in Fig. 1, the application of GA_3 or exposure to low temperature resulted in an enhanced flowering response and the combination of these treatments shortened by 2 h the minimum length of the dark period for floral induction.

Effect of different temperatures

The plants were held at different temperatures (15–35°C) for 240 h following an inductive dark period (15 h), GA_3 being applied before or after the dark period. As shown in Fig. 2, the floral response decreased at temperatures below or above 20°C, with a greater reduction at the high temperatures; at 30°C no promotion of flowering by GA_3 took place when the GA_3 was applied after the dark period, and at 35°C there was no longer promotion at any time of application. Marked increase in shoot elongation occurred in the plants treated with GA_3 at all the temperatures (Fig. 3); elongation was more striking at 30 and 35°C, at which some promotion of shoot elongation took place even in the plants without GA_3.

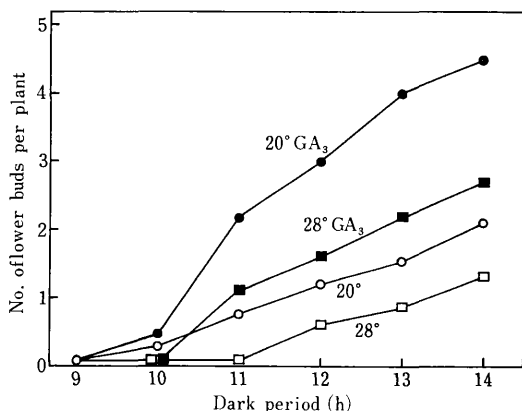

Fig. 1. Flowering response of *Pharbitis* to dark periods of different lengths before which GA_3 (0.5 μg/plant) was applied to the plumule and after which the plants were held at 20 or 28°C for 10 days.
With GA_3 20°C (●), 28°C (■); without GA_3 20°C (○), 28°C (□).

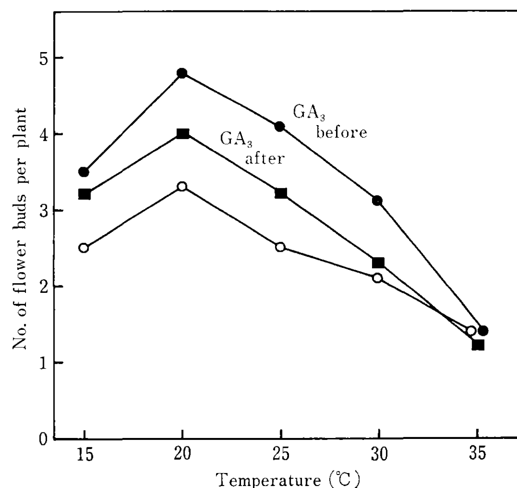

Fig. 2. Effect of different temperatures on the flowering response of *Pharbitis* following a 15 h dark period, before or after which GA_3 (0.25 μg/plant) was applied.
With GA_3 before (●) or after (■) the dark period; without GA_3 (○).

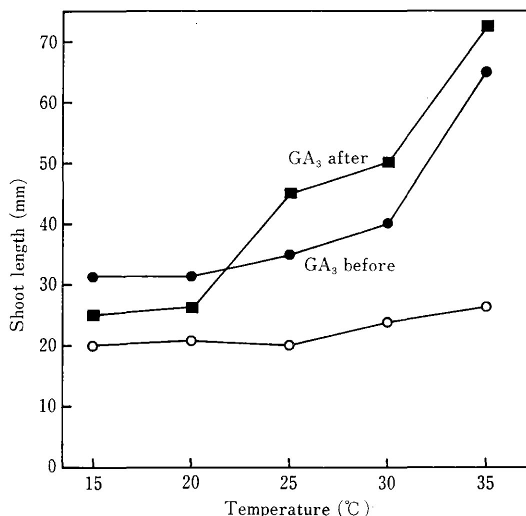

Fig. 3. Effect of different temperatures on the shoot elongation of *Pharbitis* following a 15 h dark period, before or after which GA_3 (0.25 μg/plant) was applied.
With GA_3 before (●) or after (■) the dark period; without GA_3 (○).

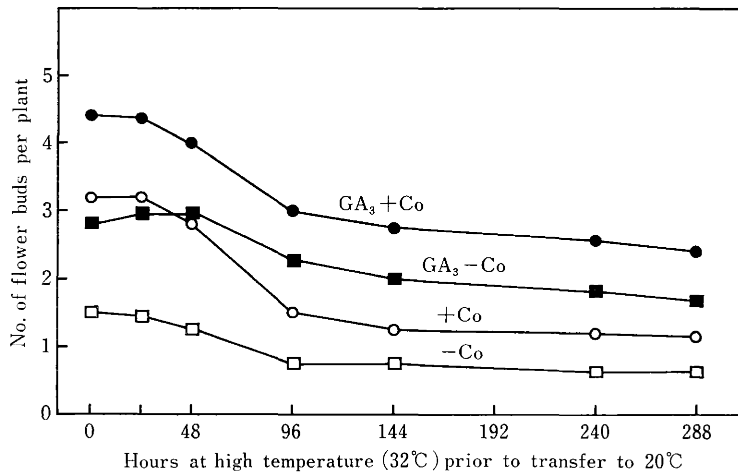

Fig. 4. Flowering response of *Pharbitis* to different lengths of high temperature at 32°C followed by low temperature at 20°C. The dark period was 16 h, before which GA_3 (0.25 μg/plant) was applied. Cotyledons were removed 8 h after the end of the dark period.
Intact plants with (●) or without GA_3 (○); plants with cotyledons removed, with (■) or without GA_3 (□).

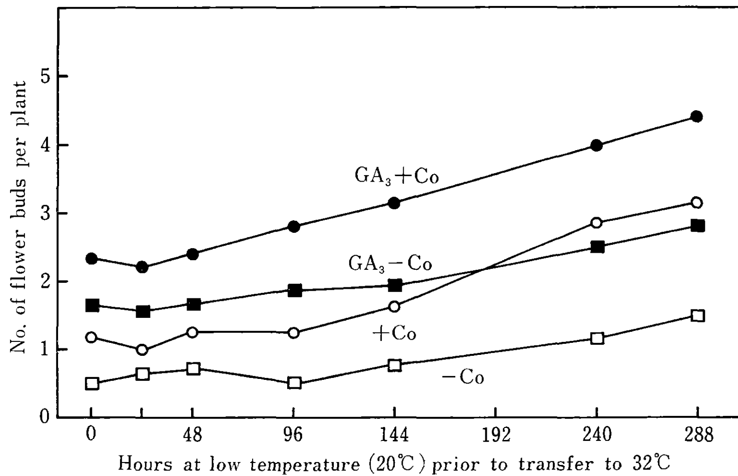

Fig. 5. Flowering response of *Pharbitis* to different lengths of low temperature at 20°C followed by high temperature at 32°C. The dark period was 16 h, before which GA_3 (0.25 μg/plant) was applied. Cotyledons were removed 8 h after the end of the dark period.
Intact plants with (●) or without GA_3 (○); plants with cotyledons removed, with (■) or without GA_3 (□).

Effect of length of the high-temperature period followed by low temperature or vice versa

To examine the effect of varying duration of the period at high temperature, the plants were first held at 32°C for different durations after the dark period (16 h) and were then transferred to 20°C for the remainder of 288 h. Conversely, seedlings were first held at 20°C and then transferred to high temperature (32°C). In one series GA_3 was also applied before the dark period or the cotyledons were removed 8 h after the end of the dark period when the floral stimulus appears to be exported out of the cotyledons(6, 8). Results are shown in Figs. 4 and 5, respectively.

Considerable floral-promotion was obtained

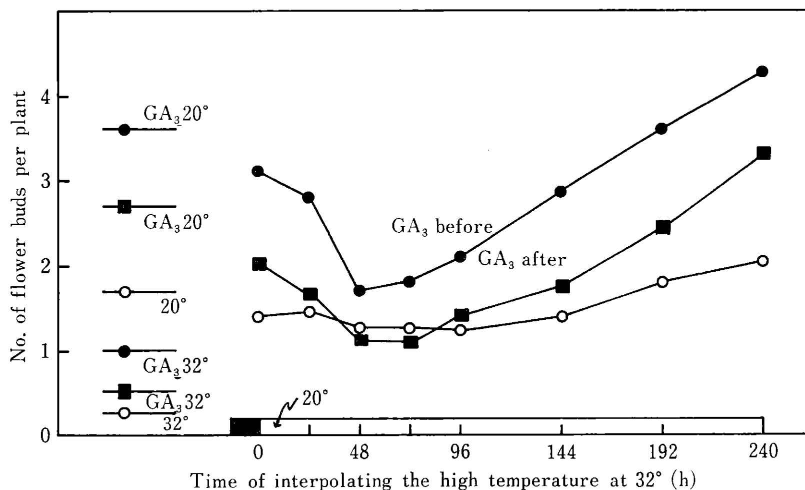

Fig. 6. Flowering response of *Pharbitis* to high temperature at 32°C for 48 h, interpolated at different times in the low temperature at 20°C for 240 h. The dark period was 14 h, before or after which GA_3 (0.25 μg/plant) was applied.
With GA_3 before (●) or after (■) the dark period; without GA_3 (○).

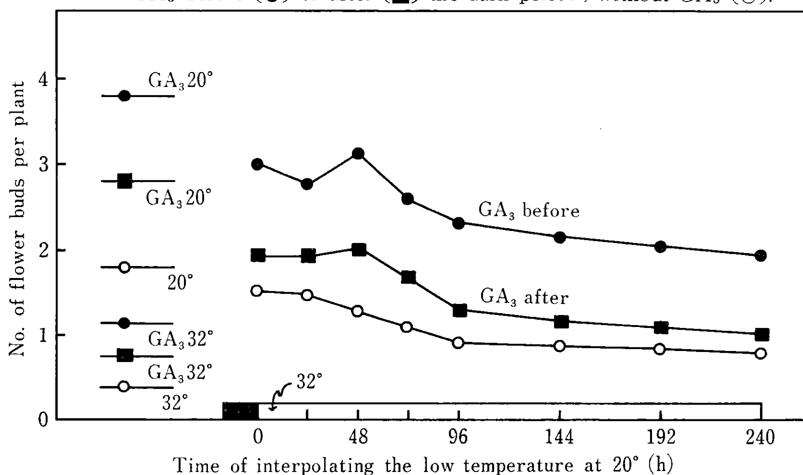

Fig. 7. Flowering response of *Pharbitis* to low temperature at 20°C for 48 h, interpolated at different times in the high temperature at 32°C for 240 h. The dark period was 16 h, before or after which GA_3 (0.25 μg/plant) was applied.
With GA_3 before (●) or after (■) the dark period; without GA_3 (○).

by the application of GA_3 even in the plants with cotyledons removed, the later treatment depressing flowering. Exposure to high temperature for 24 h following the dark period had no effect on flowering response and its promotion by GA_3. However, exposure to the high temperature for 96 h or more inhibited flowering of both intact plants and those without cotyledons. Conversely, exposure to the low temperature for 144 h and more was necessary to partly reduce the inhibition by the high temperature, and actually, the effect of low temperature exposure even for 240 h was reduced by subsequent high temperature. This evidence may suggest that, when the plants are held at low temperature (20°C) floral processes at the apex still occur 10 days after floral induction of the leaf.

Effect of high temperature interpolated in the low temperature period or vice versa

The effect of timing of exposure to high temperature was examined by transferring

plants to 32°C for 48 h at different times during 240 h at 20°C after the dark period. The reverse temperature transfer experiment, a short 48 h exposure to 20°C in the high temperature period after the dark period, was also carried out. The results are shown in Figs. 6 and 7, respectively. Flowering of the plants held for the whole period at low temperature was much promoted and the application of GA_3 resulted in much more flowering. Flowering was most affected when plants were exposed to the high temperature at 48 to 96 h after the dark period. This was most evident in association with GA_3 treatment and the flowering in plants without GA_3 was not much affected by temperature. In the reverse experiment, high temperature inhibition was partly reduced when the plants were exposed to low temperature from just after the dark period to 48 h.

Discussion

As indicated by King and Evans(4) with *Pharbitis* seedlings, the critical length of the inductive dark period was clearly shortened by low temperature after floral induction. Here, by using the strain, Kidachi, it has also been possible to obtain promotion of flowering by GA_3 which also shortened the critical dark period (Fig. 1). The higher the temperature after floral induction, the less the floral response (Fig. 2). It does not appear that the high temperature inhibition resulted from a competition between the reproductive phase of flowering and the vegetative phase of shoot elongation at the high temperature, as the promotion of flowering by GA_3 was always accompanied by promotion of shoot elongation. Also, the inhibition of flowering by high temperature occurred in the control plants without GA_3 which had short shoot (Figs. 2 and 3). The failure of GA_3 to promote the floral response at high temperature (30 and 35°C in Fig. 2) indicates a more thermolabile floral process enhanced by GA_3 as compared with "genuine floral processes" which proceed irrespective of GA_3. Inhibition of flowering by high temperature occurred in plants with cotyledons removed after the stimulus was sent out, as well as in the intact plants (Figs. 4 and 5). This finding clearly suggests that the high temperature inhibition is not due to a long-day inhibition of the cotyledons but to floral events at the shoot apex. A direct effect at the apex is favoured since greatest sensitivity to high temperature occurred over the period 48 to 96 h after induction (Fig. 6). Thus, the present evidence indicates that floral stimulus is thermostable at least when it has arrived at the apex, but subsequent floral processes at the apex are rather thermolabile. Further, the present results suggest that at low temperature (20°C) floral processes occur at the apex for 10 days after the stimulus is imported from the cotyledons.

Literature Cited

1. CATHY, H. M. 1954. Crysantheum temperature study. B. Thermal modification of photoperiods previous to and after flower bud initiation. J. Amer. Soc. Hort. Sci. 64: 492—498.
2. DARROW, G. M. 1937. Interrelation of temperature and photoperiodism in the production of fruit-bud and runners in the strawberry. Proc. Amer. Soc. Hort. Sci. 34: 360—363.
3. ITO, H. and T. SAITO. 1962. Studies on the flower formation in the strawberry plants I Effects of temperature and photoperiod on the flower formation. Tohoku J. Agr. Res. 13: 191—203.
4. KING, R. W. and L. T. Evans. 1969. Timing of evocation and development of flowers in *Pharbitis Nil*. Aust. J. Biol. Sci. 22: 559—572.
5. OGAWA, Y. 1980. Effect of chilling at germinating stage on the flowering response of *Pharbitis nil* Choisy. J. Japan Soc. Hort. Sci. 49: 102—106.
6. OGAWA, Y. 1981. Stimulation of the flowering of *Pharbitis nil* Chois. by gibberellin A_3: Time dependence action of the apex. Plant Cell Physiol. 22: 675—681.
7. RÜNGER, W. 1958. Über den Einfluss der Temperatur und der Lichtintensität auf die photoperiodische Reaction und die Blütenentwicklung von *Kalanchoe blossfeldiana* cv. Tom Thumb. (IV). Gartenbauwiss. 23: 419—432.
8. WADA, K. 1966. Studies of intiation and development of flower primordia of *Pharbitis nil*, with special reference to the time of arrival of flowering stimulus at plumule. Rep. Sci. Shizuoka Univ. 1: 83—89.

アサガオの花成における温度とジベレリン A_3 の影響について

小 川 幸 持
三重大学生物資源学部 514-22 津市高野尾町

摘 要

短日性のアサガオを用いて，花芽形成（花成）に対する誘導暗期後の育成温度の影響について調べた．

花成は暗期後の温度に著しく影響された．暗期の直前或は直後にジベレリン A_3 (GA_3) を茎頂に処理すると花成が促進されるが，この GA_3 の促進作用も温度に影響された．いずれの場合も，最適温度は 20℃ であり，高温（25—35℃）になるにしたがい強く抑制された．

暗期直後から 24 時間の高温（32℃）は花成に殆んど影響しないが，96 時間或はそれ以上の時間の高温は強く花成を抑制した．高温（32℃，98 時間）を与える時期を変えると，最も強い抑制が暗期後 48 時間から 96 時間に認められた．この抑制は高温を与える時期が遅れるにしたがい減少した．

アサガオの花成に対する温度の作用に関するこれらの実験結果から，温度は花成刺激それ自体の安定性に影響するのでなく，茎頂における花成誘導の過程に影響する事を示唆している．また，これらの実験結果から，低温下（20℃）では，葉での花成誘導後，或は茎項に花成刺激が移動した後 10 日間は茎項でなお花成誘導反応が進行していると推察される．