Promotion of flowering in sweet potato by gibberellin A₃ and A₇

Hiroshi SUGE

National Institute of Agricultural Sciences, Nishigahara, Kita-ku, Tokyo 114

Effect of exogenously applied gibberellin A₃(GA₃) and A₇(GA₇) on the flowering of Kanto No. 48, a dwarf strain of sweet potato, was tested. GA₃ and GA₇ were found to stimulate the flowering of the cuttings evidently. Cuttings with 15~20cm long were made using terminal tips of the stem from field grown plants and planted in 1/10,000 *are* pots or containers (28×24×11cm). Under those experimental conditions, untreated control plants flowered finally although the plants grown in the field remained strictly vegetative. GA₇ was much more effective than GA₃ to stimulate the stem growth and first flowering, whereas, total number of flowers was evidently increased by GA₃ application. However, neither control plants nor GA applied plants induced flowering under strictly non-inductive long photoperiod.

Introduction

Inducing flowering is an important first step in the sweet potato breeding since most varieties are known to produce no flowers under natural conditions of Japan proper. In Japan, however, this trouble has been eliminated by grafting sweet potato scions onto stocks of certain ornamental relatives of *Ipomoea* that do not produce storage roots. For this purpose a dwarf cultivar of Japanese morning glory, *Ipomoea nil* (L) Roth c.v. Kidachiasagao has been used efficiently as stocks. Another species, *Ipomoea alba* LINNE has also been used when the former species has no grafting affinity with sweet potato plants. However, some varieties are difficult to produce flowers even when the grafting method was employed (FUJISE 1964 and personal communication).

Chemical induction of flowering, if any, may provide great advantage on the sweet potato breeding. Foliar application of 2,4-dichlorophenoxy acetic acid was reported to induce flowering in two varieties of sweet potato (HOWELL and WITTWER 1954), whereas, certain hormone applications were ineffective, either for induction, or for retardation of floral primordia formation in sweet potatoes (MIKELL 1952).

I have conducted preliminary attempts to induce flowering in sweet potato plants using several growth regulators including GAs. GA₃ and GA₇ were found to promote flowering in a cultivar of sweet potato.

Materials and Methods

Cuttings were obtained from the terminal tip of sweet potato plants grown in the field of National Institute of Agricultural Sciences, Nishigahara, Kita-ku, Tokyo. Cuttings with 15~20cm long were planted in 1/10,000 *are* plastic pots or in containers (28×24×11 cm). Kanto No.48, a dwarf strain, was used throughout the experiments.

* Received December 9, 1976

Experiments were conducted 4 times under different conditions of natural daylength and under artificially controlled photoperiods as follows.

(1) **First experiment** : Cuttings were obtained in July 10, 1969 from field grown plants and planted in 1/10,000 *are* pots in the rate of one plant per a pot. Two μg of GA_3 was applied in 50 μl drop to the apex of 5 plants beginning August 1. This was done every other day for 10 days. Thus, total amount applied was 20 μg per plant. Plants were grown under out door conditions throughout the experiment.

(2) **Second experiment** : Cuttings were obtained in August 20, 1969 from field grown plants and planted in 1/10,000 *are* pots in a greenhouse in the rate of one plant per a pot. Application of the GAs was started when the plants had produced roots, 6 days after planting the cuttings. Four μg of GA_3 or GA_7 was applied in 50 μl drop to the apex of 5 plants in each respective treatment. This was done every day for 10 days. The total amount applied was 40 μg per plant.

(3) **Third experiment** : Cuttings were obtained from field grown plants and planted to plastic containers in the rate of 12 plants per a container in a growth cabinet on October 2, 1969. Ten μg of GA_3 or GA_7 was applied in 50 μl drop to the apex of 12 plants, beginning October 6. This was done every other day for 10 days. The total amount applied was 100 μg per a plant. The growth cabinet was maintained at 25°C. The light was obtained from 10 *Toshiba* FLR-60HD fluorescent lamps and 7 *Toshiba* 40 watt incandescent lamps, providing about 9,000 lux at the plant level. Light period was 16 hr. Plants were transferred into a greenhouse on November 8 since the plants grew over the capacity of the growth cabinet.

(4) **Fourth experiment** : Cuttings were obtained in July 6, 1973 from field grown plants and planted in 1/10,000 *are* pots in the rate of one plant per a pot. Plants were grown under either of 9 hr or 20 hr photoperiods. Five μg of GA_7 was applied in 50 μl drop to the apex of 5 plants beginning July 16. This was done every day for 18 days. Thus, total amounts applied was 90 μg per a plant. Fixed daylength was obtained using automatic devices that shortening the natural daylength by moving dark boxes controlled with time switches. Plants treated with 20 hr photoperiod have also been covered with a dark box at the same time as well as the plants subjected to short photoperiod but plants were illuminated by fluorescent tubes equipped within the dark box for adjusting the daylength. This was done for avoiding the temperature become different between 2 photoperiods.

Results

(1) **First experiment** : Number of buds and flowers is shown in Fig. 1 as well as change of natural daylength during the period of the experiment. Flower buds were differentiated by GA_3 treatment in mid August even when natural daylength is about 13.5 hr and then first anthesis observed in August 27. Flower buds differentiated also in nontreated control plants in late September although no anthesis was occurred probably due to low temperature of late fall. Flowering in GA_3 treated plant in late August is shown in Fig. 2.

Fig. 1. Effect of exogenously applied GA_3 on the induction of flower buds and anthesis. Dotted line indicates the change of natural day-length at Tokyo during the period of the experiment. Arrow indicates the time of last GA application.

Fig. 2. Photograph showing the effect of GA_3 on flowering. White arrows indicate the nodes that bearing flower buds. Photograph was taken on August 27. In this time no flower buds were seen in control plant.

Fig. 3. Increment of stem length affected by GA_3 treatment.

Fig. 4. Effect of exogenously applied GA_3 and GA_7 on flowering. Dotted line indicates the change of natural daylength at Tokyo during the period of the experiment.

No flower buds were seen in this time on nontreated control plants. Increment of stem length as affected by GA_3 is shown in Fig. 3.

(2) **Second experiment:** Number of total flowers is presented in Fig. 4. As shown in the figure, flowering was promoted by GA application but manners of plant responses are somewhat different between GA_3 and GA_7 . Date of first flower is faster in GA_7 treated plants than in GA_3 treated ones, whereas, total number of flowers was increased to about twice of nontreated control by GA_3 although GA_7 gave almost no effect in this respect. Promotion of flowering by GA application is shown in photographs (Fig. 5). GA_7

Fig. 5. Photographs showing the effect of GA_3 and GA_7 on stem growth and on flowering. Flower buds were formed also in control plants but no anthesis was seen in this time.

Fig. 6. Effect of exogenously applied GA_3 and GA_7 on flowering. Dotted line indicates the change of natural daylength at Tokyo during the period of the experiment.

is much more active than GA_3 to stimulate the stem growth as seen in the photograph.

(3) **Third experiment**: Flowering was evidently hastened by GA application as shown in Fig. 6. Difference of plant responses to GA_3 or GA_7 was again observed in this experiment. Experiment was stopped at December 27, 1969 in this case.

(4) **Fourth experiment**: Number of total flowers is presented in Fig. 7. As shown in the figure, flowering was evidently promoted by exogenously applied GA_7 under short photoperiod of 9 hr. Whereas, no flowering was induced under long photoperiod of 20 hr even when GA_7 was continuously applied during 18 days.

Discussion

GA can substitute for the cold requirement of certain vernalizable plants and for the long-day requirement of certain long-day plants, but not for the short-day requirement of short-day plant (SDP). However, when the photoperiodic treatment is suboptimal, applied GA_3 may enhance the flowering response of typical SDP, *Pharbitis nil* Chois (OGAWA 1961). While one long dark period is sufficient for photoperiodic induction of *Xanthium*, additional long dark periods increase the rate of reproductive development. GA could not induce flowering under non-

inductive conditions but can substitute for such additional inductive periods in promoting the reproductive development of *Xanthium* plants (GREULACH and HAESLOOP 1958). In a

Fig. 7. Effect of exogenously applied GA₇ on flowering under different photoperiods.

noticed that flower bud differentiation and even anthesis were occurred on non-treated plants under the present experimental conditions of natural daylength; the cuttings are raised in small pots or containers and grown in a greenhouse during from late fall to winter. In contrast to pot grown plants, no flowering was observed on field grown plants at all. However, neither control plants nor GA applied plants induced flowering under strictly non-inductive photoperiod even when they are grown in the same size of pots. Age of plants from which cuttings were obtained seems to affect flowering ability since cuttings obtained from field grown plants in early summer were difficult to flower even under short photoperiod (Fig. 7), whereas that obtained in early fall or mid fall bear flower buds easily even when they received no GAs (Figs. 5 and 6.).

Plant responses to GA₃ or to GA₇ were somewhat different each other is interesting. GA₇ was much more effective than GA₃ to promote first flowering, whereas total number of flowers was evidently increased by GA₃ treatment. It is not certain by what mechanisms applied GAs promote flowering of the sweet potato cultivar, but one possible explanation of promotive effect of applied GAs in SDP may be as that GAs promote cell division in the shoot apex through that floral stimulus works more effectively since it is reported that actively growing bud is essential for expression of the floral stimulus in *Pharbitis* plants (ZEEVAART 1962).

Effects of GAs on the flowering of other sweet potato varieties especially in the varieties that difficult to produce flowers even after the application of grafting method are not known. Interaction of chemical treatment and other methods, such like as grafting, is important problems to be solved for searching more effective way to induce flowering in such varieties of sweet potato. This, however, is a topic for future study.

photosensitive rice variety, GAs also reduce the number of inductive cycles requiring for flowering. In a photosensitive late variety Zuiho, for example, 6 cycles are necessary to induce flowering in 60 days old plants, whereas, GA₃ treated plant given 4 inductive cycles had differentiated inflorescence primordia (SUGI 1972).

In sweet potatoes, optimal daylength was reported to 8-10 hr (SHIGEMURA *et al* 1938). Flower promotion induced by GA₃ or GA₇ in this SDP is interesting with a view to utilize in the breeding. However, it must be

Acknowledgement

I express my sincere thanks to Dr. Yoshio Hozyo of our institute for original supply of sweet potato cuttings. I am also grateful to Dr. Kazuma FUJISE of Iwate University for his kind advices.

Literature cited

- FUJISE, K. 1964. Studies on flowering, seed setting and self-and cross incompatibility in the varieties of sweet potato. Bull. Kyushu Agric. Exp. Sta. **9** : 123~246 (in Japanese with English summary).
 GREULACH, V. A. and J. C. HAESLOOP 1958. Influence of gibberellin on *Xanthium* flowering as related to number of photoperiodic cycles. Science **127** : 646~647.
 HOWELL, M. J. and S. H. WITTWER 1952. Chemical induction of flowering in the sweetpotato. Science **120** : 717.
 MIKELL, J. J. 1952. The influence of chemical treatment on the growth and flowering of sweet potatoes. Proc. Amer. Hort. Sci. **60** : 695~298.
 OGAWA, Y. 1961. Über die Wirkung von gibberellin auf die Blütenbildung von *Pharbitis nil* Chois. Plant and Cell Physiol. **2** : 311~329.
 SHIGEMURA, T., T. TAKASAKI and K. KAKIHARA 1938. Sweet potato breeding by seeds, with artificial induction of blooming. Proc. Crop Sci. Soc. Japan **10** : 281~296 (in Japanese with English summary).
 SUGE, H. 1972. Physiology of flowering in rice plants V. Persistence of applied gibberellin A_3 and A_7 and their effect on the photoperiodic floral induction. Proc. Crop Sci. Soc. Japan **41** : 51~56.
 ZEEVAART, J. A. D. 1962. DNA multiplication as a requirement for expression of floral stimulus in *Pharbitis nil*. Plant Physiol. **37** : 296~304.

ジベレリン A_3 および A_7 によるサツマイモの開花促進

菅 洋

(農業技術研究所, 東京都)

サツマイモの矮性系統関東 48 号を用いて, 自然日長のことなる時期および制御した日長条件下における GA_3 または GA_7 の開花におよぼす影響をしらべた。圃場に挿苗して栽培し繁茂している植物体の先端より, 実験時に約 15~20 cm の苗を切りとり, 1/10,000 アールのプラスチックポットあるいは 28×24×11 cm のプラスチック容器に挿苗し完全に活着してから供試した。

自然日長条件下の実験では GA_7 は開花始期を著しく促進した。 GA_3 は開花始期は GA_7 よりおくれたが 1 個体当りの累積開花数を著しく増加させた。圃場で最後まで生育した個体では全く花蕾の着生はみとめられなかったが, 上記ポットあるいは容器に挿苗した個体は GA 処理しないものでも秋遅くなって着蕾がみとめられ更に温室において保温したものでは開花も認められた。

しかし, 初夏から秋にかけて戸外で上記と同サイズのポットに植えて日長を制御して行なった実験では短日下 (9 時間日長) では GA_7 により開花が著しく促進されたが, 長日下 (20 時間日長) では無処理区はもちろん開花しないが GA_7 処理によっても開花は誘起されなかった。