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Effect of Hot Water Treatment on Respiration, Endogenous Ethanol, and Ethylene Production from Gladiolus Corms and Easter Lily Bulbs

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Abstract. **A hot water (46° ± 1°C for 1 hr) treatment accelerated sprouting from gladiolus corms (*Gladiolus sp.*) and Easter lily bulbs (*Lilium longiflorum*). The respiration rate increased in both corms and bulbs after the hot water treatment. Ethanol was produced in corm and scale tissues immediately after the treatment, but no enhancement of ethylene production was observed.**

Hot water treatments have often been used as a method for interrupting dormancy of bulbs and ornamental trees (4, 6). Few studies have been conducted on mode of action. Tsukamoto et al. (8) reported that endogenous auxin increased in Easter lily bulbs after a hot water treatment.

In this report, changes of respiration rate, endogenous ethanol and ethylene in dormant Easter lily bulbs and gladiolus corms treated with hot water were studied in relation to sprouting.

Sprouting. Bulbs of Easter lily 'Hinomoto' and corms of gladiolus 'Traveler' were harvested on 12 July and on 9 Aug., 20 and 40 days after flowering, respectively. Fifty percent of them were immersed in hot water (46° ± 1°C) for one hr and the other half as a control, in cold water (23° ± 1°). No untreated control was given in this study. All treated bulbs and corms were planted in moist vermiculite, and the trays were kept at 23° ± 2° to determine the rate of sprouting. Watering was practiced every other day to maintain the moisture of the medium. Water temperature was 22° ± 3° during the sprouting period after planting. The hot water treatment caused both bulbs and corms to sprout at almost double the rate of the controls (Fig. 1 and 2).

Respiration. Dormant Easter lily bulbs and gladiolus corms were harvested on 12 July and 17 Aug., respectively. Five hundred fifty grams of bulbs and 750 g of corms were treated with hot and cold water in the same manner as sprouting test. They then were planted in moist perlite. For measuring respiration rates, the bulbs and corms were placed into 5 liter desiccators in which CO_2 released from the tissues was absorbed at 20°C in 2N-KOH solution for 2–4 hr (7). The absorbed CO_2 then was precipitated as $BaCO_3$ in 25% $BaCl_2$ solution. The amount of CO_2 respired by the tissues was calculated from the amount of 0.2N-HCl required to neutralize the unreacted KOH.

Respiration rate increased in both bulbs and corms immediately after hot water treatment, and the high rate continued for 6 days in Easter lily (Fig. 3). No marked increase was observed in the controls.

Endogenous ethanol. Dormant Easter lily bulbs and gladiolus corms were treated with hot and cold water in the same manner previously described. They then were planted in moist perlite and kept at 20°C. For ethanol detection, 10 g of scale and corm tissues were sliced to 1 mm in thickness, extracted with acetone, and 2 μl of the extract was subjected to a gas chromatography (Hitachi Co Ltd., FID). A stainless column was packed with 50/80 mesh Porapak Q. Column and detector were kept at 125° and 160°, respectively. The carrier gas was N_2 at a flow rate of 20 ml min^{-1}.

Ethanol was detected in both bulbs and corms immediately after hot water treatment. No ethanol, however, was detected 5 days after the treatment (Fig. 4), and ethanol did not appeared in control tissues either before or after the treatment.

Endogenous ethylene. Dormant Easter lily and gladiolus corms were treated with hot and cold water. For ethylene detection, 500 g of bulbs and corms were placed into 5 liter desiccators and the evolved ethylene was trapped at 20°C in ice-cold perchlorate overnight, using the method of Masuda and Asahira (5). The ethylene was released with 4 N

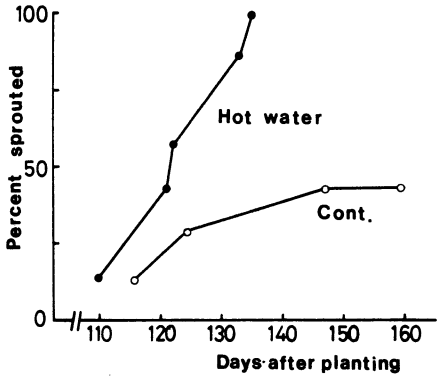

Fig. 2. Comparison of hot and cold water soaks on sprouting dormant gladiolus corms (8 corms per treatment).

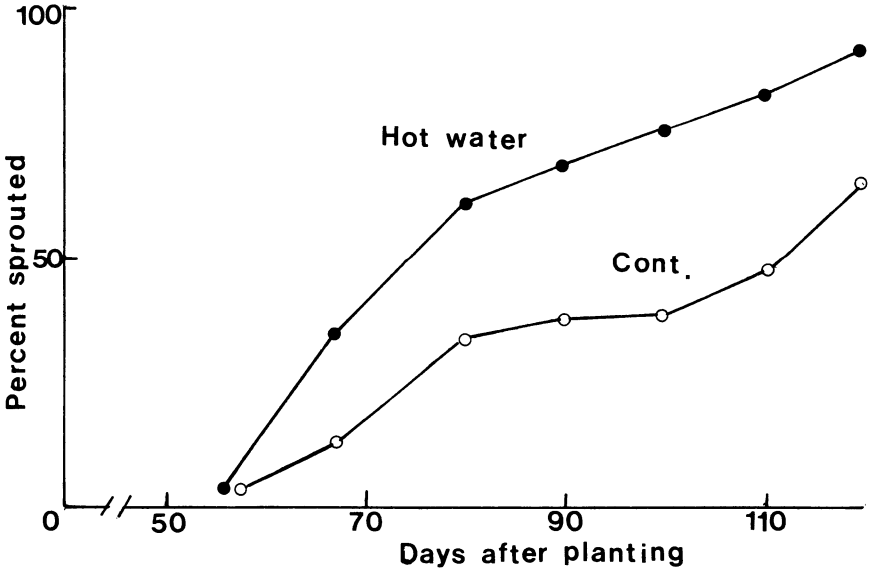

Fig. 1. Comparison of hot and cold water soaks on sprouting of dormant Easter lily bulbs (12 bulbs per treatment).

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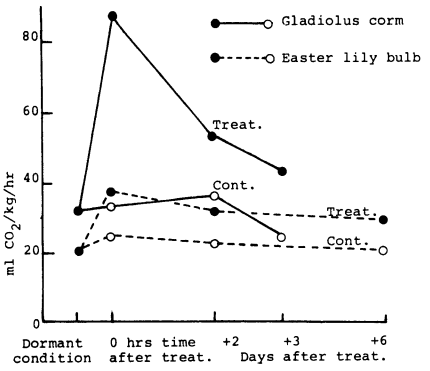

Fig. 3. Comparison of hot and cold water soaks on respiration rate of dormant Easter lily bulbs and gladiolus corms.

lithium chloride and determined by gas chromatography. The same type of column as in ethanol detection was used. Column and detector were kept at 85° and 150°, respectively. The carrier gas was N_2 at a flow of 35 ml min^{-1}.

No clear difference was noticed in the amount of ethylene production between hot water and control in both bulbs and corms (Fig. 5). As previous demonstrated (1), a hot water treatment enhanced the respiration rate in gladiolus corms and Easter lily bulbs. Ethanol was produced in bulbs and corms just after hot water treatment. It has been shown (2) that exogenously applied ethanol can enhance sprouting of dormant Easter lily bulbs and gladiolus corms. Therefore, ethanol produced concomitantly with respiration enhancement may become one of promotors for breaking dormancy by a hot water treatment. Exposure of Easter lily bulbs and gladiolus corms to ethylene gas accelerated sprouting (3). An appreciable increase of endogenous ethylene production however, was not observed in bulbs and corms treated with hot water. Since further study up to 30 days after treatment could not detect ethylene enhancement, hot water does not seem to promote ethylene production from dormant bulbs and corms.

Judging from the results, respiration enhancement and ethanol production seem to be involved in release from dormancy of bulbs and corms treated with hot water.

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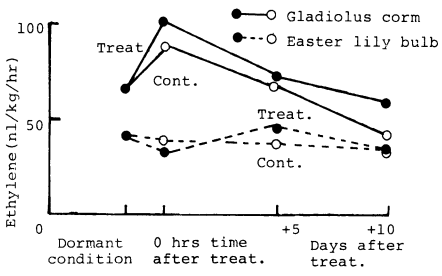

Fig. 5. Comparison of hot and cold water soaks on ethylene production from dormant Easter lily bulbs and gladiolus corms.

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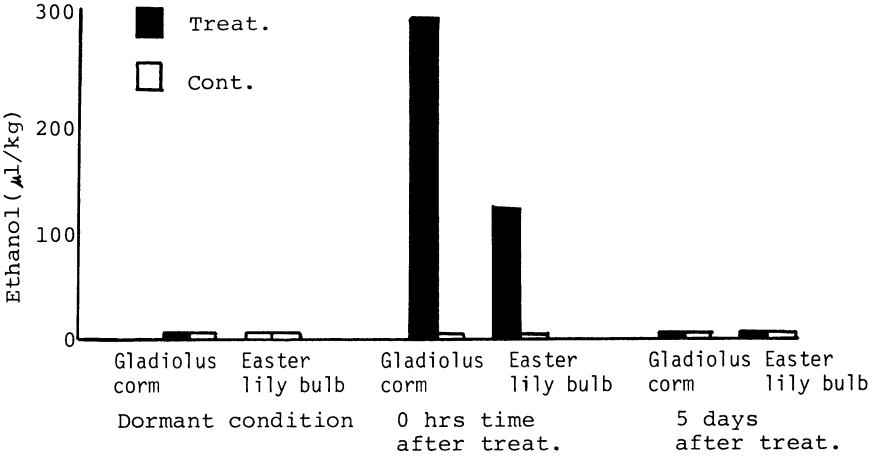

Fig. 4. Comparison of hot and cold water soaks on ethanol production in dormant Easter lily bulbs and gladiolus corms.