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Effect of Ethanol and Other Gaseous Compounds on Breaking Corm Dormancy of Spring-flowering Gladiolus and Accelerated Flowering

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エタノールおよび他のガス物質が春咲きグラジオラスの球茎の休眠打破および開花促進に及ぼす影響

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Dormancy of corms in spring-flowering gladiolus (*Gladiolus* X *Tubergenii* Hort.) cv Charm was broken by ethanol vapor, acetaldehyde vapor, 100% CO_2, 1% C_2H_4, 1% CO, 100% N_2, 1% $CaCN_2$ or corm-immersion into water with or without high temeprature corm-storage at 30°C for 15 or 30 days. The most accelerated flowering without adverse effect was observed in the 8 hr ethanol vapor treatment after 15 or 30 day storage at 30°C.

Introduction

Spring-flowering gladiolus which grows in winter and flowers in April-May is gaining popularity since miniature cut flowers are well matched to compact urban houses. This type of gladiolus has an advantage over the summer-flowering type as blindness seldom occurs under low irradiance of winter.[1)] Although forcing of spring-flowering gladiolus is possible if the growing structures are heated, rising of fuel cost obliges gladiolus-growers to grow them without heat. Hence, early sprouting of the corms is indispensable for completing flowering by the end of December. Previously, the author reported that ethanol broke corm dormancy of gladiolus and accelerated sprouting.[2)]

This report describes release from dormancy of spring-flowering gladiolus cv Charm with storage and chemicals including ethanol, and accelerated flowering for November and December in an unheated plastic house.

Materials and Methods

Corms of spring-flowering gladiolus (*Gladiolus* X *Tubergenii* Hort.) cv Charm which flowered in middle April were dug on May 22 and kept in the laboratory (20-25°C) for 6 days. The corms were treated at the start or after 15 or 30 day storage at 30°C. In the treatments of volatile substances, the corms were wrapped in excelsior soaked with ethanol or ace taldehyde without dilution, sealed in plastic bags and kept at 20°C for 8 or 16 hr and for

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0.5 or 2 hr, respectively, In the gas treatments, the corms were placed into 4.4 liter desiccators containing 1% CO, 1% C_2H_4 or 100% CO_2 and kept at 30°C for 3 days. In the second experiment, corms of cv Charm which flowered at the end of May were dug on July 15 and kept for 3 days in the laboratory. The corms were then treated on July 18 or after 15 day storage at 30°C. The treatments consisted of immersion of corms in 1% $CaCN_2$ at 20°C for 24 hr or in running water at room temperature (25-30°C) for 5 days (only for corms with storage), or exposure to 100% N_2 at 30°C for 5 days. Fifteen corms were used for each experiment. For the sprouting test, treated corms were planted in vermiculite, kept at 20°C and watered at 2-3 day intervals. All control corms with/without storage were planted immediately without any treatment. Sprouting was recorded when buds elongated to 5 mm in length.

In the flowering test, all corms of the first experiment were planled to pots (ϕ 30 cm) on Aug. 1 and grown in an unheated plastic house. On December 24, the experiment was terminated since freeze injury was noticed on the tip of florets. Date of 50% emergence of inflorescence, date of 50% flowering, percent of flowering by December 24, length of flower stalk at flowering, and floret number were recorded.

Results

Effect on sprouting. For the corms without storage, ethanol vapor for 8 and 16 hr was most effective, followed by CO_2, C_2H_4, CO gases, while the untreated corms remained dormant for 2 months (Fig. 1). Rot of corms due to phytotoxicity was observed in some of the treatments (27% of the 16 hr ethanol vapor and 100% of the 0.5 and 2 hr acetaldehyde treatments) ; rotted corms were excluded from calculation of sprouting rate. After 15 days of storage, the corms from the gas and volatile treatments sprouted about at the same order as those without storage. Untreated control corms remained dormant for 40 days. Multiple sprouting was observed in ethanol vapors and CO_2 gas treatments. Phytotoxic rot was 13% in the 16 hr ethanol vapor and 40% in the 1.5 hr acetaldehyde vapor treatment. No phytotoxicity was observed in the other treatments. After 30 days of storage, the effect of treatments was small except for the ethanol vapor treatments where sprouting was 7-10 days earlier than the untreated control.

In the second experiment, $CaCN_2$ and N_2 gas were also effective in promoting sprouting. The treatments had greater effects on the corms without storage (Fig. 2). Immersion of corms into running water was also effective. Phytotoxic rot was 53% in the $CaCN_2$ treatment without storage, but rot was not observed in the other treatments.

Effect on flowering. Emergence of the inflorescence from the leaf sheath was observed from the end of October to early December on the treated corms and from the end of November to the end of December on untreated corms with/without storage (Table 1). Fifty percent flowering was observed in middle to late November on the corms treated with ethanol vapors (8, 16 hr) after 15 or 30 day storage and with CO_2 gas after 15 day storage. In early December, 50% flowering was observed on the corms treated with 16 hr ethanol vapor without storage, 1.5 hr acetaldehyde vapor after 15 day storage, and with C_2H_4 gas after 30 day storage. In middle December, 50% flowering was observed on the corms treated with 8 hr

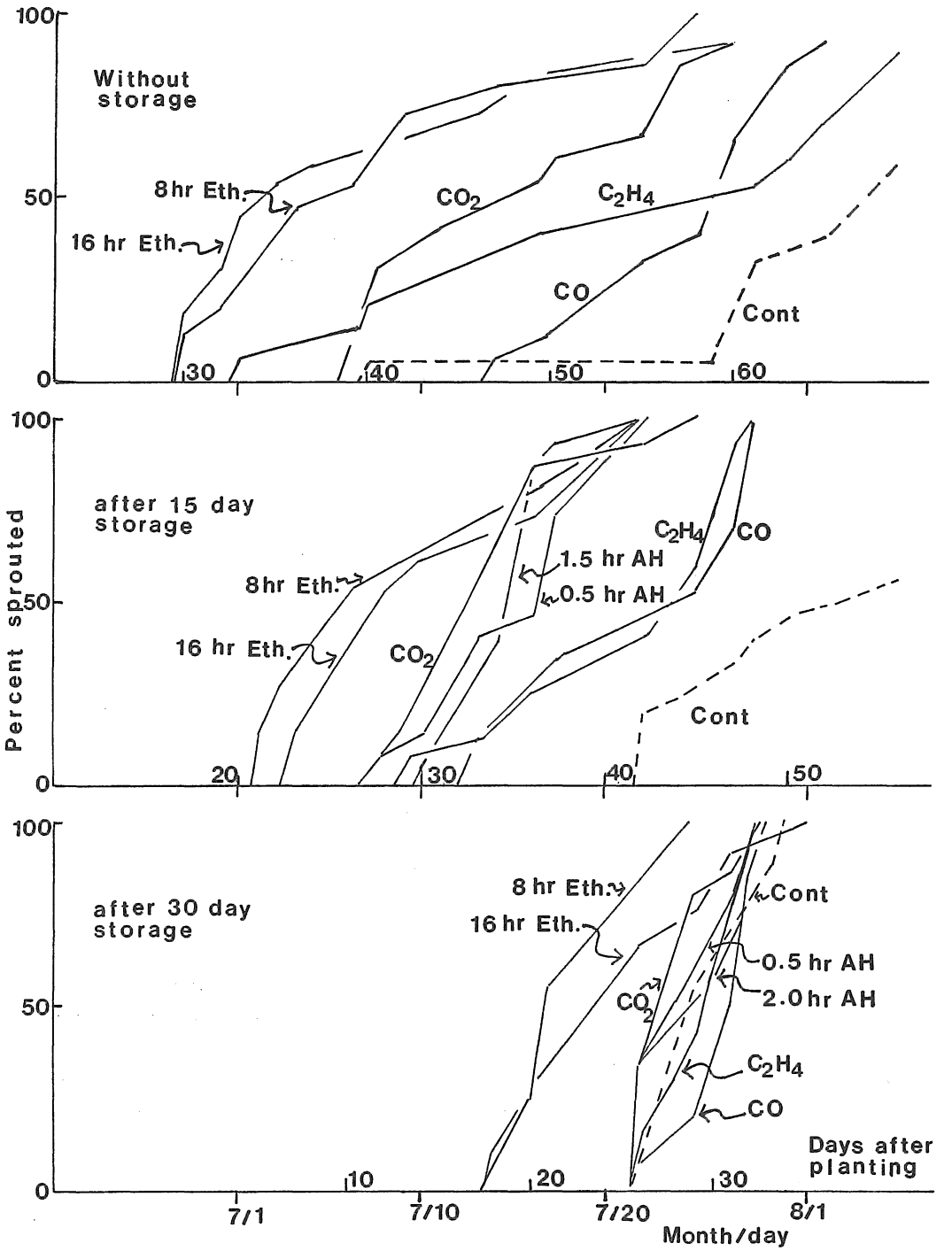

Fig. 1. Effect of ethanol (Eth.), acetaldehyde (AH) vapors and 1% CO, 100% CO_2, 1% C_2H_4 gases on sprouting from corms of spring-flowering gladiolus cv. Charm with/without storage at 30°C. Acetaldehyde vapor treatment without storage is not shown due to loss by phytotoxic rot.

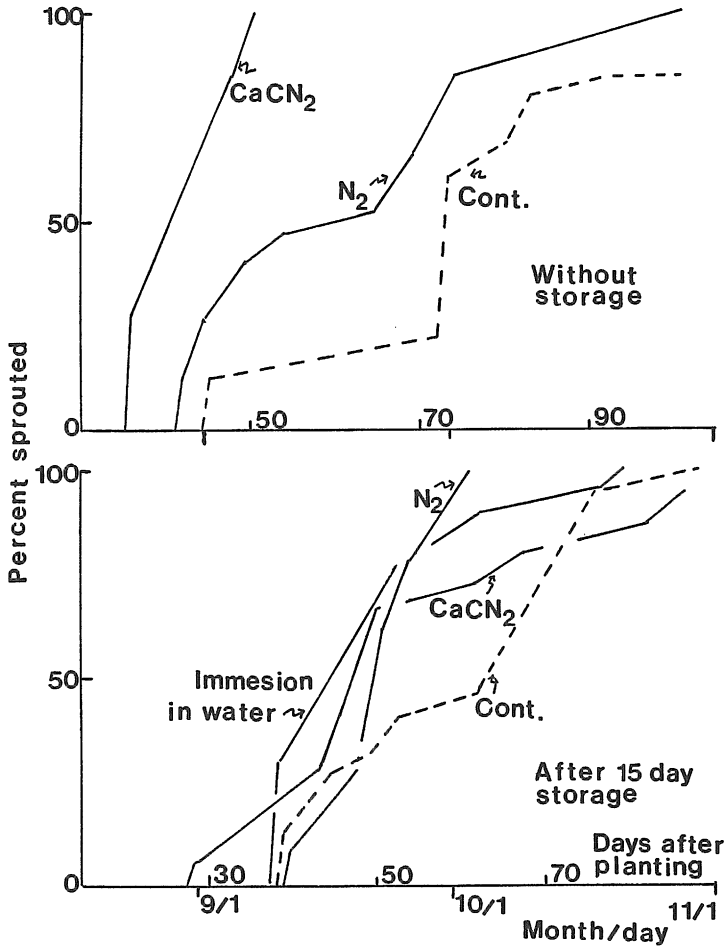

Fig. 2. Effect of 1% $CaCN_2$, 100% N_2 and immersion of corms in running water on sprouting from corms of spring-flowering gladiolus cv. Charm with/without storage at 30°C. Immersion was conducted only for corms with storage.

ethanol vapor and CO_2 gas without storage, 0.5 hr acetaldehyde vapor after 15 day storage, and with 0.5 hr acetaldehyde vapor and CO_2 gas after 30 day storage. The other treatments including untreated control did not reach 50% flowering by December 24. Flowering rates of most treatments by December 24 were higher than those of corresponding untreated controls. The high flowering rate over 73% was observed in ethanol vapors (8, 16 hr) after 15 and 30 day storage, acetaldehyde vapor for 1.5 hr and CO_2 gas after 15 day storage, and acetaldehyde vapor for 0.5 hr and C_2H_4 gas after 30 day storage. Flower stalk length was almost the same among treatments except ethanol vapor without storage which showed dwarfing of the stalks. Floret numbers were also the same in all the treatments although those in ethanol for 16 hr without storage were slightly less.

Table 1. Effect of ethanol, acetaldehyde vapors and CO, CO_2, C_2H_4 gases with/without storage on flowering

Days of storage at 30°C	Treatment	Date of 50% inflorescence emergence	Date of 50% flowering	Percent of flowering (Dec. 24)	Length (cm±SD) of flower stalk at flowering	Floret number (±SD)
0	Control	12/24	—[z]	0	—	8.7±0.5
	8 hrs ethanol	11/24	12/18	53	66±11.0	8.8±1.4
	16 hrs ethanol	11/12	12/6	71	56± 7.4	7.0±1.7
	1% CO	11/25	—	47	90± 6.7	8.3±1.1
	100% CO_2	11/22	12/12	53	74± 9.6	8.8±1.8
	1% C_2H_4	11/27	—	36	81± 5.9	8.4±1.7
15	Control	—[y]	—	13	91± 4.5	8.7±0.9
	8 hrs ethanol	11/3	11/19	79	80±10.1	8.3±1.8
	16 hrs ethanol	10/31	11/18	100	75± 8.5	7.7±1.4
	0.5 hr acetaldehyde	11/24	12/10	50	81±11.7	8.0±2.1
	1.5 hr acetaldehyde	11/16	12/1	100	80±13.1	9.6±1.2
	1% CO	12/1	—	27	71± 9.5	10.0±0.8
	100% CO_2	11/7	11/21	73	76± 8.9	9.0±1.8
	1% C_2H_4	12/5	—	0	—	9.3±0.5
30	Control	11/24	—	47	87±12.2	8.6±1.3
	8 hrs ethanol	11/7	11/27	79	80± 9.3	10.0±1.2
	16 hrs ethanol	10/30	11/18	89	77± 7.9	9.6±1.5
	0.5 hr acetaldehyde	11/20	12/15	73	94± 9.1	8.8±1.2
	2 hrs acetaldehyde	11/23	—	46	94± 4.2	9.2±1.8
	1% CO	11/25	—	40	93± 7.2	8.5±1.7
	100% CO_2	11/17	12/10	60	78±14.4	8.4±1.6
	1% C_2H_4	11/18	12/7	73	82±12.4	7.8±1.5

[z]Plants did not reach 50% flowering by December 24.
[y]Percent of inflorescence emergence was still 47% on December 24.

Discussion

Spring-flowering gladiolus flowers in April/May in the field and the corms become dormant. Exposure to high temperature in the summer breakes the dormancy and the corms sprout during September.[3] The shoots grow during winter and flower in spring. Although sprouting could be accelerated by breaking corm dormancy with high temperature storage,[4] flowering by the end of December is difficult unless a plastic house is heated. Therefore, reduction in the dormant period is indispensable to accomplish December flowering.

High temperature storage and chemical treatments ($CaCN_2$, C_2H_4) have been shown very useful for breaking bulb and corm dormancy of iris, summer-flowering gladiolus and freesia.[5,6,7] However, no detail reports on spring-flowering gladiolus have been published. In the present study, all the chemicals tested showed promotive effect on sprouting, ethanol vapor being the most effective. The flowering dates and percent were promoted by the chemical treatments and high temperature storage. However, induced sprouting with chemicals did not always lead to early flowering. The corms treated without storage showed slow shoot growth, which resulted in a delay of flowering. Moreover, the flower stalks from the corms without storage

were short as was observed in the ethanol vapor treatment, which had showed the earliest sprouting date of all the treatment. The corms treated after storage showed vigorous growth and reached flowering in November and December. Probably, the corms which experienced high temperature were less dormant and the subsequent chemical treatments completely broke corm dormancy. Although action mechanism of dormancy-breaking chemicals is under investigation, promotion of respiration was observed within 24 hr after the treatments, suggesting their involvement in the respiration system which precedes sprouting.[8)]

The ethanol or CO_2 treatment showed a beneficial effect of multiple sprouting, which resulted in harvest of a second or even third flower (data not shown).

Thus, the 8 hr ethanol vapor treatment at 20°C after 15 or 30 days of storage at 30°C seemed optimum for accelerated flowering of spring-flowering gladiolus cv Charm.

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摘　　要

春咲グラジオラス (*Gladiolus* X *Tubergenii*, Hort) 'チャーム' の球茎の休眠は，高温貯蔵0，15，30日後エタノール気浴，アセトアルデヒド気浴，100% CO_2, 1% C_2H_4, 1% CO, 100% N_2, 1% $CaCN_2$ または水浸漬処理により破れた．副作用なしに開花がもっとも促進された区は，15または30日高温貯蔵（30℃）後エタノール8時間気浴処理を行った区であった．