SOME FACTORS AFFECTING DORMANCY-BREAKING BY ETHYLENE IN FREESIA CORMS

H. Imanishi and J. Berghoef
Department of Horticulture
Agricultural University
P.O. Box 30
6700 AA Wageningen
The Netherlands
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Abstract

Ethylene applied at any time during storage at 30°C promoted sprouting. Earliest sprouting was obtained when ethylene was applied 2-4 weeks after storage at 30°C. Ethylene treatment for 3 or 6 hours was more effective than longer exposures. A single or repeated treatment with ethylene for 6 hours daily gave the same promotive effect, but repeated application for 23 hours daily diminished the promotive effect. Ethylene had maximum effect at concentrations of 0.75 $\mu l.l^{-1}$ or higher.

1. Introduction

High temperature treatment at 30°C for 12-16 weeks is necessary for breaking dormancy of freesia corms. Ethylene is known to be effective in reducing this high temperature requirement (Hayashi, 1974; Masuda and Asahira, 1980; Imanishi and Fortanier, 1983). The present experiment was carried out to investigate the effect of application time, length of exposure, and concentration of ethylene on dormancy breaking in freesia corms and consequently to find the optimum method of ethylene application.

2. Materials and methods

Corms of 'Ballerina' were harvested on 8 April, 1982, about 2 months after anthesis and dried at 20-25°C for 3 weeks. Corms with 7 or 8 cm size were selected and divided into 2 groups. One group was used immediately. Another group was stored at 2°C from 10 May to 15 November and then used.

Ethylene was administered in a sealed container of 70 l at 30°C, with concentration of 50 $\mu l.l^{-1}$ except when stated otherwise. Immediately after ethylene treatments, 40 corms per lot were planted in a mixture of sand and peatmoss at 17°C. Corms were recognized as sprouted, when sprouts were 2 cm long.

3. Results

3.1. Effects of ethylene applied at different times of storage at 30°C on sprouting

Storage at 30°C started on 10 May and continued for 2, 4, 6 or 8 weeks. After the various periods of storage at 30°C, corms were exposed to ethylene for 6 hours daily on each of 3 consecutive days.

Independent of ethylene application, time from planting till sprouting decreased with an increasing period of storage at 30°C (Table 1). Sprouting was promoted by ethylene when applied at any time during the storage period at 30°C, but the promotive effect of ethylene diminished as the storage period at 30°C increased. Earliest actual sprouting date

was obtained by ethylene treatment after 2-4 weeks storage at 30°C.

The same results were obtained with corms stored at 2°C for 6 months, although, ethylene applied just after transfer from 2°C to 30°C (0 weeks) did not promote sprouting.

3.2. Effects of the duration of ethylene exposure on sprouting

Corms were exposed to ethylene for various durations after 4 weeks storage at 30°C. Sprouting tests revealed that exposing corms to ethylene for 6 hours was sufficient to accelerate sprouting, whereas the promotive effect of ethylene diminished by extending the exposure from 6 hours to 72 hours (Table 2).

Corms, stored at 2°C for 6 months and treated with ethylene after 3 weeks storage at 30°C showed that an exposure of 3 hours was already sufficient (Table 3).

To determine the effect of the frequency of repeated exposures to ethylene on sprouting, corms stored at 30°C for 4 weeks were exposed to ethylene for 6 or 23 hours daily. A new dose of ethylene was applied after aeration. Ethylene applied 1, 2 or 4 times in a period of 6 hours per day had the same promotive effect. Repeated application in a period of 23 hours per day reduced the promotive effect on sprouting (Table 4).

3.3. Effects of concentrations of ethylene on sprouting

Corms which had been stored at 2°C for 6 months and then transferred to 30°C were exposed to ethylene for 6 hours with different concentrations of ethylene, 3 weeks after storage at 30°C. The actual concentrations of ethylene, determined on a gas chromatograph equipped with Alumina F1 column and flame ionization detector were 0.11, 0.24, 0.49, 0.72, 0.92 or 51.4 $\mu l.l^{-1}$.

Ethylene did not affect sprouting at 0.11 $\mu l.l^{-1}$ (Table 5). Higher levels promoted sprouting. At 0.72 $\mu l.l^{-1}$ the promotive effect of ethylene was almost at the maximum.

4. Discussion

From the present results, it is obvious that ethylene should be applied at an early stage of the high temperature treatment, as already pointed out by previous papers (Masuda and Asahira, 1980; Imanishi and Fortanier, 1983). The effect of ethylene on sprouting was most pronounced after 0 or 2 weeks of storage at 30°C and decreased after a longer storage period. For practical purposes, however, actual sprouting date and time from planting till sprouting are important. Considering these two preconditions, ethylene should be applied after 4 weeks at 30°C. The same was found by Hayashi (1974) who observed that smoke, which contains ethylene as an active component, applied after 4-5 weeks, storage at high temperature was effective in breaking dormancy of Freesia corms.

We demonstrated that exposure to ethylene for 3-6 hours was already sufficient to break dormancy of Freesia corms, whereas longer exposures diminished the positive effect. Masuda (1981) and Uyemura and Imanishi (1984) pointed out that there was no difference in effect between an exposure to ethylene of 5 and one of 72 hours. The latter authors used small containers, however, in which carbon dioxide accumulated to a concentration of more than 2% after 24 hours. In our experiments carbon dioxide concentrations were found to be 0.6, 1.2 and 1.6% after 24, 48 and 72 hours, respectively, which is considerably less than in the experiments of the latter authors. Carbon dioxide inhibits the action of

ethylene, although a number of exceptions have been found (Abeles, 1973). The contradictory effect of long exposures, therefore, may be a result of difference in carbon dioxide concentrations. This was confirmed by an other experimental result of Uyemura and Imahishi (1984), in which they found that long exposure to ethylene for 24-48 hours in a continuous flow of air, in which carbon dioxide concentration never exceeded 0.1%, also diminished the positive effect of ethylene.

Previous reports revealed that ethylene promoted sprouting at concentrations as low as 1 $\mu l.l^{-1}$ (Masuda and Asahira, 1980; Uyemura and Imanishi, 1983). The present experiment showed that at an even lower concentration of 0.24 $\mu l.l^{-1}$ ethylene was already effective and that at 0.72 $\mu l.l^{-1}$ or higher almost no further increase in effect was obtained. This result agrees well with those of De Munk (1984) with flowering of Dutch iris, although there effect of ethylene was at the maximum at 0.5 $\mu l.l^{-1}$.

In conclusion, to break dormancy of Freesia corms ethylene should be applied at concentrations above 0.72 $\mu l.l^{-1}$ for 6 hours, 4 weeks after storage at 30°C.

References

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Table 1 - Effects of storage at 30°C, followed by ethylene application, on sprouting of corms.

No. of weeks at 30°C before C_2H_4 application	No. of days from planting to sprouting		No. of days to sprouting from the start of experiment	
	$-C_2H_4$	$+C_2H_4$	$-C_2H_4$	$+C_2H_4$
0	137	77	144	84
2	117	49	135	67
4	50	34	82	66
6	35	29	80	74
8	27	23	86	82

Table 2 - Effects of various durations of ethylene exposure on sprouting of corms.

Exposure (hrs)	Days from planting to sprouting
0	57 ± 7
6	30 ± 3
12	34 ± 3
24	39 ± 3
48	42 ± 5
72	43 ± 4

Table 3 - Effects of various durations of ethylene exposure on sprouting of corms previously stored at $2^{o}C$ for 6 months.

Exposure (hrs)	Days from planting to sprouting
0	51 ± 5
3	35 ± 4
6	34 ± 4
9	37 ± 5
24	40 ± 5

Table 4 - Effects of repeated ethylene application for different durations on sprouting of corms.

Durations (hrs/day)	Times (days)	Days from planting to sprouting
6	1	31 ± 3
6	2	31 ± 3
6	4	32 ± 3
23	1	37 ± 3
23	2	41 ± 4
23	4	47 ± 5
control	(no ethylene)	50 ± 8

Table 5 - Effects of concentration of ethylene on sprouting of corms previously stored at $2^{o}C$ for 6 months.

Concentration ($\mu l.l^{-1}$)	Days from planting to sprouting
0	56 ± 7
0.11	57 ± 8
0.24	49 ± 8
0.49	43 ± 7
0.72	39 ± 3
0.92	39 ± 4
51.4	34 ± 4