INFLUENCE OF CONTROLLED ATMOSPHERES DURING CORM STORAGE ON SUBSEQUENT FLOWERING OF GLADIOLUS

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ABSTRACT

‘White Friendship’ gladiolus corms were stored in controlled atmospheres (CA) for 12 weeks at 45°F. Atmospheres used were air (control) and CA consisting of 20% oxygen (O₂) + 1% carbon dioxide (CO₂), 20% O₂ + 3% CO₂, 2% O₂ + CO₂, and 2% O₂ + 3% CO₂. Shoots from corms stored in air emerged and flowered earlier than shoots from corms stored in any CA. However, shoots from corms stored in 20% O₂ + 1% CO₂ emerged and flowered before shoots from corms stored in 2% O₂ + 3% CO₂. Corms stored in air yielded more flowers than corms stored in any CA. Corms stored in 2% O₂ + 3% CO₂ yielded the fewest flowers of any CA.

INTRODUCTION

Much has been published on the influence of storage temperatures and times, chemicals, and various cultural practices on dormancy in gladiolus corms. In a recent review, Apte (1) emphasizes the influence of storage temperature on dormancy in gladiolus corms. Little research data have been published on the effect of gaseous environment during corm storage and the subsequent influence on flowering. A standard commercial recommendation is to circulate air to all parts of storage room and through corm con-
Denny (2) showed that gladiolus corms stored in moist soil at room temperature retained deeper dormancy than corms stored in air. His findings suggest that the reduced oxygen ($O_2$) or the increased carbon dioxide ($CO_2$) found in the soil may prolong dormancy. Zimmerman and Hitchcock (14) aerated gladiolus corms with $O_2$ or $CO_2$ while corms were soaking in solutions of growth substances. They found that corms aerated with $O_2$ remained in good condition after planting, regardless of growth substance, while corms aerated with $CO_2$ rotted.

Much has been published on controlled atmosphere storage (CA) of fruits and vegetables, but limited information is available on CA storage of cut flowers (see Ref. 3 and 12 for reviews). Little information is available on CA storage of bulbs and corms. Stuart et al (11) reported that storage of lily bulbs in absence of or with low oxygen (0.25%) lessened the action of cool temperatures in accelerating flowering. No reports are available on CA storage of gladiolus corms.

This report summarizes the effects of gas environment during corm storage on subsequent growth and flowering of gladiolus.

**METHODS AND MATERIALS**

'White Friendship' gladiolus were dug from a commercial field on June 30, 1969. Corms were cleaned immediately after digging. Jumbo size corms were selected and dipped in Mertect 160 (1.5 lbs of 60% wettable powder per 100 gal water) for disease control (4). Corms were randomly divided into groups of 50 and placed in cloth bags. The corms were stored in air or in CA chambers at 45° F on July 2, 1969. The CA's consisted of 20% + 1% $CO_2$, 20% $O_2$ + 3% $CO_2$, 2% $O_2$ + 1% $CO_2$, and 2% $O_2$ + 3% $CO_2$. The balance of each CA was nitrogen. A total of 4 replications (bags) or 200 corms was used per treatment. The chambers for controlled atmospheres were 28 in. by 28 in. by 14 in. The chamber atmosphere were monitored daily and sufficient gases were added or released to maintain experimental levels. Gases were analyzed on a Microtex gas chromatograph (Model GC8000R) equipped with Silica gel and molecular sieve columns.

Corms were removed from storage on September 30, 1969. A random sample of 3 bulbs was taken from each bag. The corms were planted in randomized blocks in flats and placed in a controlled environmental chamber on October 1. The chamber was maintained at 78° F during the day and at 64° during the night. The light intensity was maintained at 750 ft-c with equal day and night periods. Shoot height was recorded on October 21.

The balance of the corms were held in a common storage shed at ambient temperatures from September 30 until October 28 when they were planted in the field at the Gulf Coast Experiment Station in randomized blocks. Corms were planted 3 inches apart in single rows. Row spacing was 4 1/2 feet. Routine commercial cultural practices (5) and fertilization procedures (13) were followed.

During late December and through January, a recording thermograph was placed in the field 4 inches above the soil line to determine minimum night temperatures.

Spike yield and quality data were collected beginning on January 26, 1970. Spikes were harvested when one-half inch of the lowest floret was visible. At harvest, spikes were cut just below the lowest floret. All leaves were retained on the plants. Flower heads were weighed, their length determined and the date of harvest recorded. Number of spikes harvested were totaled and percent spikes flowered on each date determined.

Corms were dug on April 15, 1970. The total number of corms and number of multiple crowns were determined. Multiple crown refers to a mother corm which produces more than one flowering size daughter corm. Four single crown mother corms were randomly selected per plot and the diameter of each daughter corm determined.

**RESULTS AND DISCUSSION**

 Shoots from corms held in the growth chamber had emerged in 3 weeks (Oct. 1-21). Shoots from corms held in air or 20% $O_2$ + 1% $CO_2$ emerged earlier and were taller than those from corms stored in 20% $O_2$ + 3% $CO_2$ (Table 1). Shoots from corms stored in 20% $O_2$ + 3% $CO_2$ emerged earlier and were taller than those from corms stored in 2% $O_2$ + 1 or 3% $CO_2$. Flowering in the field followed the same relative pattern as sprouting in the environmental chamber (Fig. 1). Shoots that emerged were the first to flower. Corms stored in air produced shoots that flowered earlier and yielded more flowers (Table 1) than corms in any CA. There were no differ-
Table 1. Mean height, yield, and per cent cold injury of gladiolus' spikes which developed from corms stored in air or in various controlled atmospheres.

<table>
<thead>
<tr>
<th>Storage atmospheres</th>
<th>Height 1</th>
<th>Spikes per plot 2</th>
<th>Cold injury 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>13.0</td>
<td>61.5</td>
<td>5.3</td>
</tr>
<tr>
<td>20% O2 + 1% CO2</td>
<td>13.0</td>
<td>52.8</td>
<td>3.3</td>
</tr>
<tr>
<td>20% O2 + 3% CO2</td>
<td>10.8</td>
<td>54.0</td>
<td>1.4</td>
</tr>
<tr>
<td>2% O2 + 1% CO2</td>
<td>5.3</td>
<td>54.3</td>
<td>0.9</td>
</tr>
<tr>
<td>2% O2 + 3% CO2</td>
<td>3.3</td>
<td>51.2</td>
<td>1.4</td>
</tr>
</tbody>
</table>

1Height 3 wks (Oct. 1-21) after corms were planted in environmental chamber.
2Includes spikes injured in field by cold, 47 jumbo corms planted per plot. High yield due to multiple sprouting.
3Per cent of total number of spikes injured by cold in the field.

ences in flower yield for corms stored in the CA's but corms stored at 2% O2 + 1 or 3% CO2 flowered later than corms stored in 20% O2 + 1 or 3% CO2. The flowering period for any group of corms was about 18 days but about 80% of each lot flowered in 10-12 days. These findings agree with Nakasone (7) who reported a significant correlation between the rate of sprouting and number of days to peak flowering. There were no differences in spike fresh weight or length relative to corm storage treatments (Table 2). The large yields are due to multiple sprouting per corm.

Spikes from corms stored in air had more cold injury than spikes from corms stored in CA (Table 1). On January 8-11, night temperatures in the field reached minimums of 33°, 30°, 29°, and 31° F respectively (Fig. 2). At that time corms stored in air had spikes just emerging from the leaf sheath while corms stored in CA had spikes which were well developed but were contained in the leaf sheath. Spikes which have emerged from the leaf sheath are very vulnerable to frost or cold injury. Florets injured by cold aborted and failed to develop normally. Spikes which were injured by low temperatures would have flowered earliest. The data presented in Figure 1 represent only flowering spikes not injured. Hence, if there were no cold injury, there would have been greater differences in the dates of flowering in response to CA stoppage.

Mother corms stored in CA produced fewer daughter corms than mother corms stored in air (Table 2); however, size of daughter corms was not affected. The difference in corm yield was due largely to the number of multiple crowns produced (Table 2).

Table 2. Mean spike length and weight, and subsequent daughter corm production from mother corms previously stored in air or controlled atmospheres.

<table>
<thead>
<tr>
<th>Storage atmospheres</th>
<th>Spike length</th>
<th>Spike weight</th>
<th>Corm diameter 1</th>
<th>Corm yield 2</th>
<th>Multiple crowns 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>43.1</td>
<td>31.5</td>
<td>7.6</td>
<td>65.5</td>
<td>21.5</td>
</tr>
<tr>
<td>20% O2 + 1% CO2</td>
<td>40.5</td>
<td>28.2</td>
<td>7.6</td>
<td>59.0</td>
<td>15.5</td>
</tr>
<tr>
<td>20% O2 + 3% CO2</td>
<td>43.7</td>
<td>31.6</td>
<td>7.8</td>
<td>57.0</td>
<td>15.5</td>
</tr>
<tr>
<td>2% O2 + 1% CO2</td>
<td>46.0</td>
<td>34.5</td>
<td>8.2</td>
<td>52.8</td>
<td>12.3</td>
</tr>
<tr>
<td>2% O2 + 3% CO2</td>
<td>44.2</td>
<td>30.0</td>
<td>7.9</td>
<td>52.0</td>
<td>13.0</td>
</tr>
</tbody>
</table>

1Mean diameter of 16 corms. Four daughter corms from single crown mother corms selected at random from each of 4 plots.
2Mean number corms produced per plot, 47 corms originally planted per plot.
3Mean number of multiple crowns per plot.

Figure 1.—Cumulative percent of gladiolus spikes harvested over a 13-day period from corms stored in air or various controlled atmospheres.
Magie et al. (6) reported that corms dug during warm weather usually have to be stored at 36-45° F for 1 to 3 months to overcome dormancy. In this experiment, CA storage of corms dug during warm weather (June) probably inhibited flowering and reduced flower yield.

Gladiolus flower growers in Florida usually complete all corm digging and curing operations by late June-early July. At this time the cold temperature storage areas are sealed and usually not aerated until planting begins in late August-early September. During this period, it is conceivable that CO₂ could build up to levels which would inhibit sprouting in the field.

Corms dug, cured and stored during the cold season (January-March) have little or no dormancy (8, 9). Corms are stored to prevent sprouting and root formation. High levels of CO₂ might be used to suppress sprouting.

Although CA storage might be used advantageously during certain periods of the year, the reduction in yield of corms stored in high levels of CO₂ would not warrant the general use of CA storage. The commercial practice for storing corms at low temperature to overcome dormancy is satisfactory but flower growers would do well to periodically aerate storage areas to prevent a build-up of high levels of CO₂. Flower growers would do well to follow established practices until new information becomes available.

**LITERATURE CITED**