# The Relation between the Time of Spike Removal and the Development of Corm and Cormel in Gladiolus

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# The Relation between the Time of Spike Removal and the Development of Corm and Cormel in Gladiolus

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## Abstract

The effect of time of spike removal on the development of corm and cormels in gladiolus plants raised from corms was investigated using cultivar Professor Goudriaan. The onset of corm thickening was correlated with time of spike removal; when the spike was removed early, the onset of corm thickening was hastened. Early removal of the spike advanced the start of corm growth but had little effect on the growth rate. Early spike removal increased the size of corms but differences were small at the normal time of harvesting. Failure to differentiate spikes or their removal just after emergence resulted in a marked increase in the number of cormels.

## Introduction

Effects of flower removal on growth of corms were formerly studied by Roberts and Milbrath[1]. They found that spike removal in the early stages of its development caused late flowering varieties to develop larger corms. However, spike removal had no effect on the size of corms produced in early flowering varieties. Further, Halevy and Monselise reported that spike removal, just after emergence, or at the beginning of flowering, did not significantly affect corm yield, but doubled the yield of cormels as compared with undisturbed plants[2].

One of the authors observed that 60 short days, given from the 20th or 60th after planting, increased the percentage of the plants with none or undeveloped spike and led to rapid thickening of corms[3]. Recently Shillo and Halevy obtained similar results[4, 5]. These observations suggest that corm thickening may be a consequence of the blindness of spike.

The present studies were made to investigate the process of the increase in corm diameter and in the number of cormels in plants whose spikes were removed at different stages of their development and to determine what relationship exists between time of spike removal and corm or cormel development in the gladiolus plant.

## Materials and Methods

Corms of cultivar Professor Goudriaan were used in all experiments.

*Experiment 1.* The experiment was repeated twice to compare growth and development behavior between the plants grown at two different seasons of the year under natural light and temperature conditions. Corms were planted in the field on April 19, and July 5, in Latin square design. Corms weighing 3-5 g and 5-7 g were selected for the former and latter planting respectively.

When plants raised from the corms and grown under usual management came into flowering, spikes were removed at the following stages of their development: A) as soon as they emerged from foliage leaves; B) when the first floret opened; C) after all florets withered.

An additional lot was set up: D) shading combined with a short day treatment, starting 4 weeks after planting and continued for different periods. Details of the treatment are given later and are also indicated in Tables 1 and 3. The purpose of the treatment was to induce abortion of inflorescence before its emergence from the foliage. This was only realized partially as will be indicated later.

The number of spike removed plants was recorded every day in order to estimate the average date of spike removal. In pursuit of the periodical development of the plants in each lot, 10 plants were dug up at weekly intervals from sprouting time till lifting day. All the remaining plants were harvested on August 30 and November 15, 19 weeks after planting, in April and July planting respectively.

*Experiment 2.* A and C treatments in Experiment 1 were repeated again in the next year. Corms of 7-10 g were planted in a randomized block design on June 5. Some plants were lifted on October 17, 19 weeks after planting while others lifted on November 7, 3 weeks later, when leaves began to wither. Other procedure and experimental conditions were the same as in Experiment 1.

## Results

*Experiment 1. A. April planting.*

Seven days were the average required from emergence of spike to opening of the first floret and 7 more days to withering of all florets.

In D lot, light was reduced by decreasing the intensity to a level between 25 and 40% with cheesecloth, and by shortening photoperiod to 8 hours from 9:00 till 17:00 with special plastic film. Plants in D lot did not differentiate spikes till the end of the treatment (Table 1). However, they differentiated and developed spikes normally when

Table 1. Effects of shading and short day treatment on development of spike and other organs (April planting).

| Lot | Period of shading | Light intensity | Period of short day | Development on June 7 | | | |
|---|---|---|---|---|---|---|---|
| | | | | Development of spike | Leaf length | Number of leaves | Corm diameter |
| A-C | | 100 % | | Spike-stamen differentiated | 47.2 cm | 4.2 | 11.6 mm |
| D | May 17-May 31 | 25 - 40 | May 17-June 7 | Spike not differentiated | 52.0 | 3.4 | 8.5 |

removed to natural conditions. Thus, they formed one more leaf and showed delay of flowering in D lot. Spikes were also removed after all florets withered in the same manner as in C lot. In this case, flowering time and in its turn date of spike removal showed delays of 10 days as compared with C lot (Table 2).

Growth of corm diameter hardly occurred from 11 weeks after planting to the time of spike removal. The onset of corm thickening was correlated with the time of spike

Table 2. Effects of time of spike removal on growth and development (April planting).

| Lot | Average date of spike removal* | Leaf length (cm) | Number of leaves | Fresh weight of | | | Number of cormels |
|---|---|---|---|---|---|---|---|
| | | | | tops (g) | corms (g) | cormels (g) | |
| A | July 14 | 81.6 | 9.1 | 67.8 | 41.8 | 4.3 | 31.4 |
| B | July 21 | 84.7 | 9.1 | 63.2 | 39.3 | 2.8 | 14.8 |
| C | July 28 | 85.8 | 9.1 | 58.3 | 32.7 | 2.3 | 14.4 |
| D | Aug. 7 | 94.7 | 10.2 | 73.8 | 32.3 | 2.2 | 11.7 |
| | LSD at 5% level | | | | 7.0 | – | 6.3 |
| | 1% level | | | | 9.8 | – | 8.9 |

* Spikes were removed: Lot A, when emerged from foliage leaves; Lot B, when the first floret opened; and Lots C and D, when all florets withered. Plants in Lot D showed delay of flowering due to shading and short day treatment.

removal. Namely, corms in A lot began to thicken first, followed by lots B and C, and then by D lot. Rapid thickening was shown in the course of about 5 weeks after spike removal, following gradual slowing down. But the rate of corm thickening as expressed in the gradient of growth curve was almost the same during the rapid thickening period irrespective of the time of spike removal (Fig. 1). At harvesting time, corm weight in A or B lot was significantly heavier than that in C or D lot (Table 2).

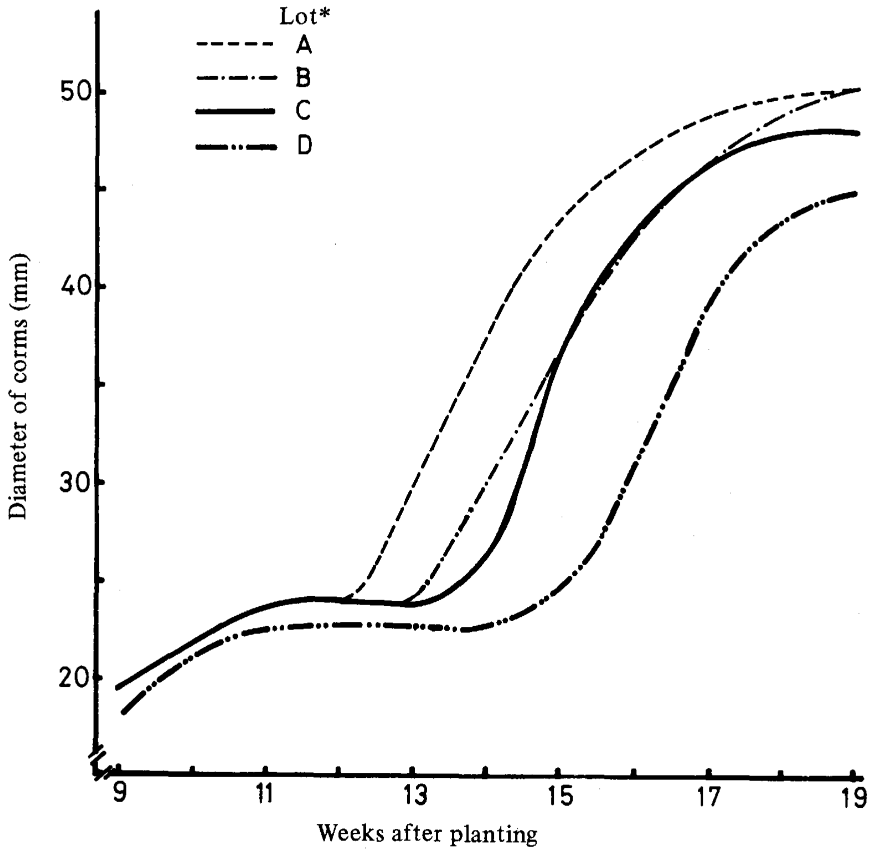


Fig. 1 Effects of time of spike removal on thickening of corms (April planting).
*: See Table 2.

In A lot a marked increase in the number of cormels was observed after spike removal, while such an increase was not seen in any other lots (Fig. 2). Although cormel

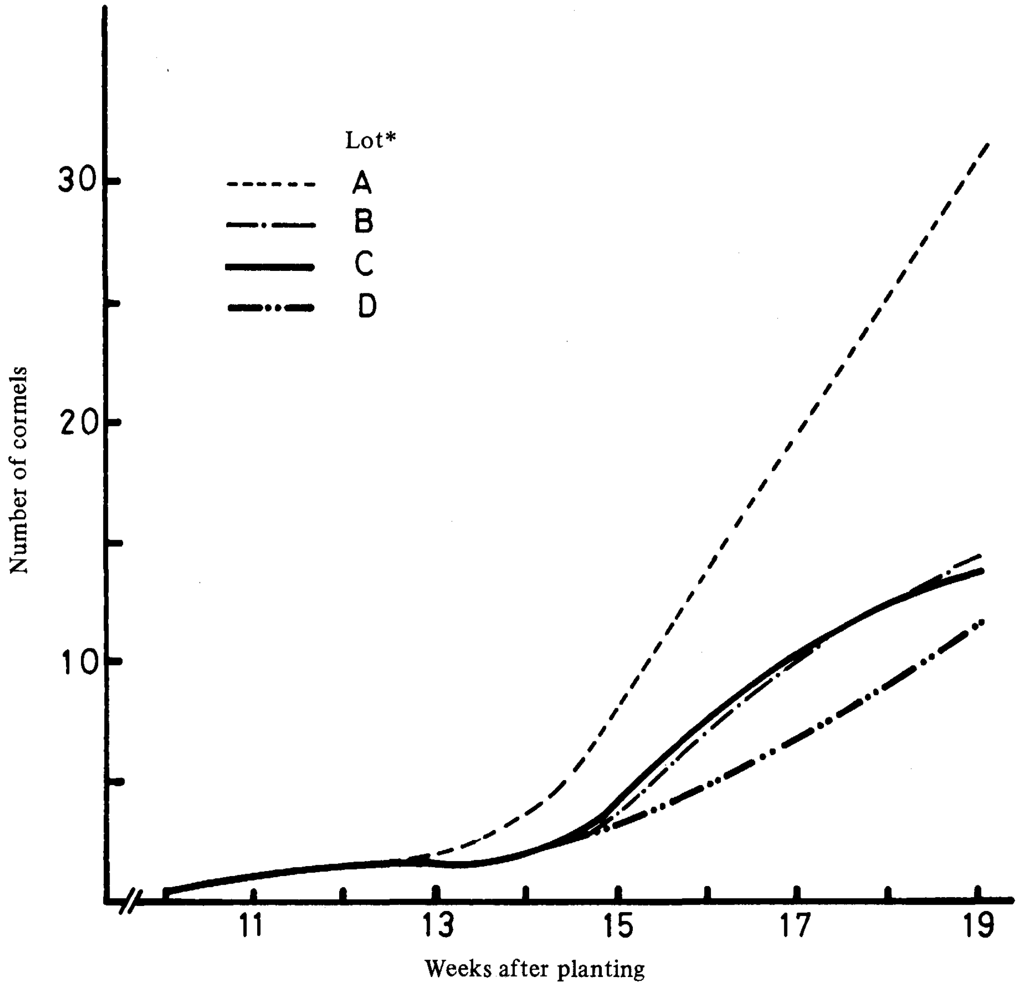


Fig. 2 Effects of time of spike removal on increase in number of cormels (April planting).
*: See Table 2.

formation in D lot started later than that in B and C lots, difference in the number of cormels was not significant among B, C and D lots at the time of harvest (Table 2). Results of grading of cormels showed that the number of cormels in all grades was larger in A lot than that in the other lots (Fig. 3).

*B. July planting*

All plants started in July were covered with one layer of cheesecloth from August 2. Then plants in D lot alone were given the short days of 10 hours. As a result, more than 80% of the plants in D lot did not differentiate spikes. In the experiment plants having developed spikes were excluded (Table 3).

The first floret opened 8 days after the spike had emerged from foliage leaves and all florets withered 15 days later than that (Table 4). The plants in July planting required an average of 8 days longer from opening of the first floret to withering of all florets than those in April planting. This may be ascribed to the fact that flowering time of the plants started in July met with cool temperature and reduced light intensity. Plants in D lot, which failed to differentiate spikes, showed a smaller number of leaves and much

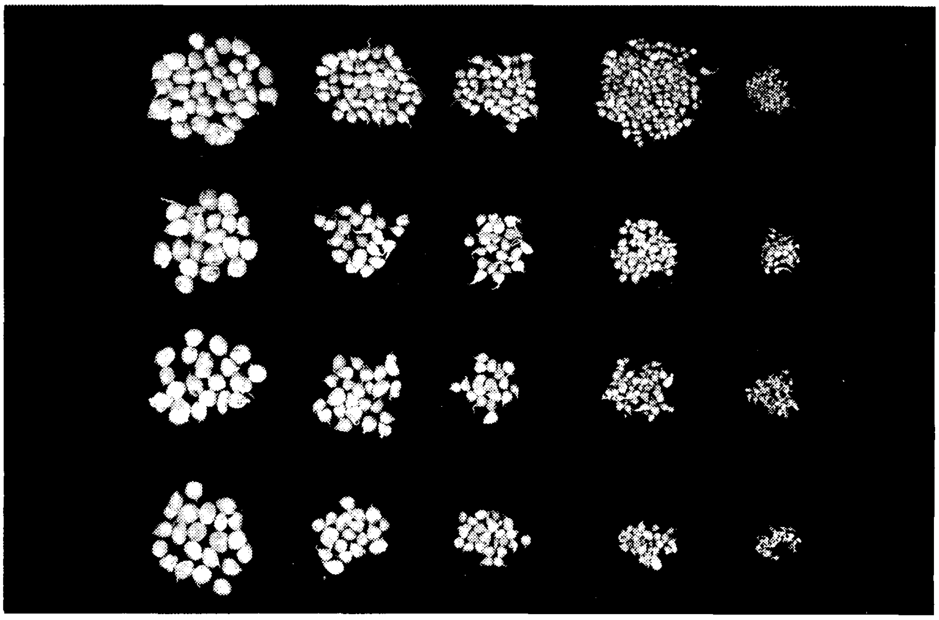

Fig. 3 The yield of cormels graded to their diameter (April planting).
Top to bottom: Lot, A, B, C, and D.
Left to right: Diameter of cormels, larger than 10 mm, 10-8 mm, 8-6 mm, 6-4 mm, and smaller than 4 mm.
Cormels taken from 10 plants in each lot are arranged.

Table 3. Effects of shading and short day treatment on development of spike and other organs (July planting).

| Lot | Period of shading | Light intensity* | Period of short day | Development on Sept. 14 | | | |
|---|---|---|---|---|---|---|---|
| | | | | Development of spike | Leaf length | Number of leaves | Corm diameter |
| A-C | Aug. 2-Sept. 2 | 40-55 % | – | Stamen-pistil formed | 87.5 cm | 8.2 | 20.3 mm |
| D | Aug. 2-Sept. 2 | 40-55 | Aug. 2-Sept. 14 | Spike not differentiated | 91.9 | 7.0 | 21.0 |

*: Light intensity under full sun light expressed as 100%.

less top weight than those with normal spikes (Table 4)

In A, B and C lots the growth curves of corm and cormels were the same as already described in the case of April planting. In D lot corm thickening and increase in the number of cormels commenced earlier than in any other lots. However, the rate of corm thickening was lower (Figs. 4 and 5).

The difference in corm weight between C and D lots was not significant on the lifting day, 19 weeks after planting. Corm weight in C or D lot was significantly lower than in A or B lot at lifting time. As far as cormels are concerned, the yield per plant was highest in D lot, followed by that in A lot, B lot and C lot in that order. The yield of A, B and C lots in July planting was about twice as high as that in April planting (Table 4). In all lots, a large proportion of cormels were small. Especially in A and D lots, the number of cormels below 6 mm was increased as shown in Fig. 6.

Table 4. Effects of time of spike removal on growth and development (July planting).

| Lot | Average date of spike removal* | Leaf length (cm) | Number of leaves | Fresh weight of tops (g) | Fresh weight of corms (g) | Fresh weight of cormels (g) | Number of cormels |
|---|---|---|---|---|---|---|---|
| A | Sept. 30 | 94.0 | 10.2 | 51.7 | 41.1 | 2.9 | 58.3 |
| B | Oct. 7 | 91.9 | 10.2 | 58.9 | 39.3 | 2.1 | 38.8 |
| C | Oct. 22 | 94.5 | 10.2 | 57.3 | 28.3 | 1.5 | 31.9 |
| D** | – | 96.2 | 8.6 | 35.8 | 31.2 | 4.5 | 72.2 |
| LSD at 5% level | | | | | 6.5 | – | 12.0 |
| 1% level | | | | | 9.9 | – | 22.0 |

*: See footnotes of Table 2.
**: Plants in D lot failed to differentiate spikes.

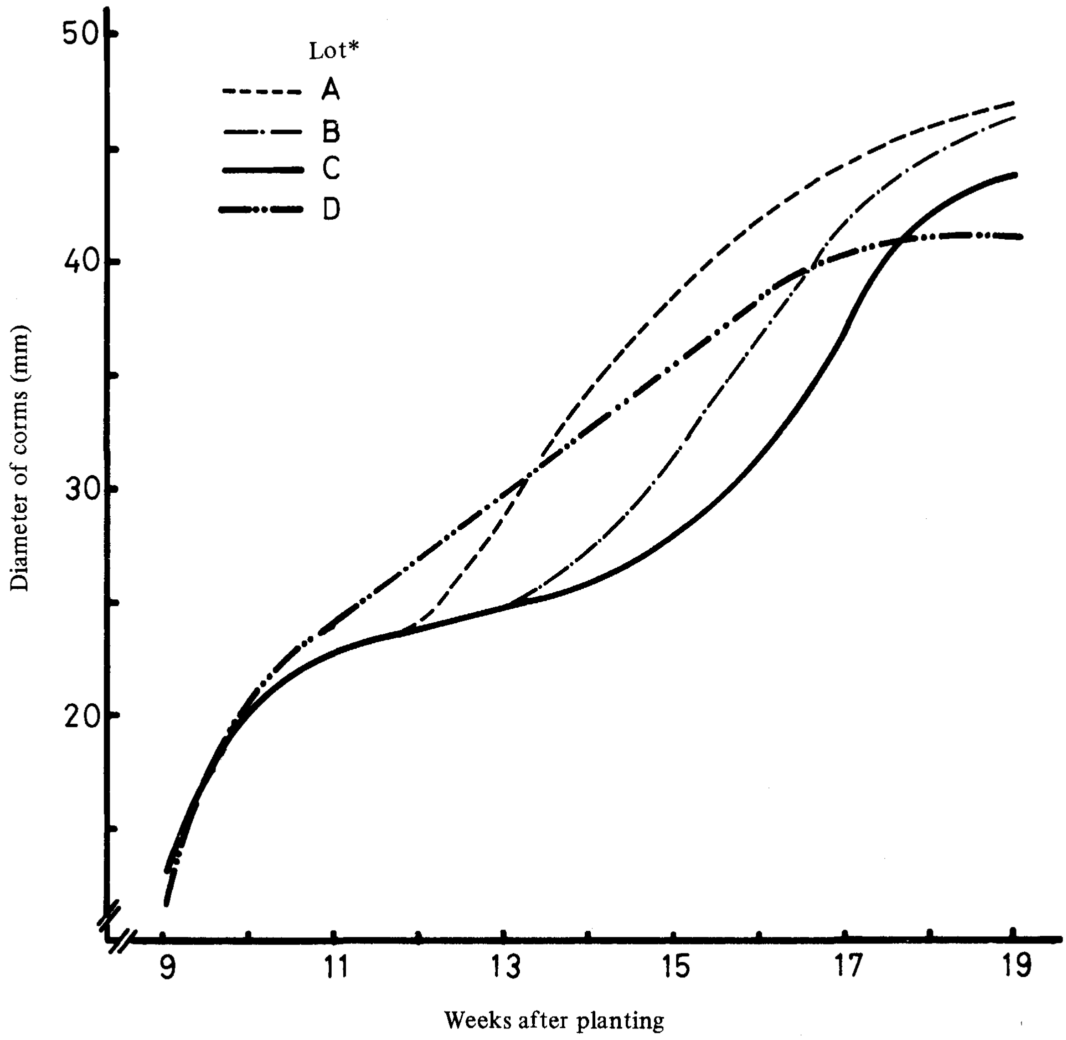


Fig. 4 Effects of time of spike removal on thickening of corms (July planting).
*: See Table 4.

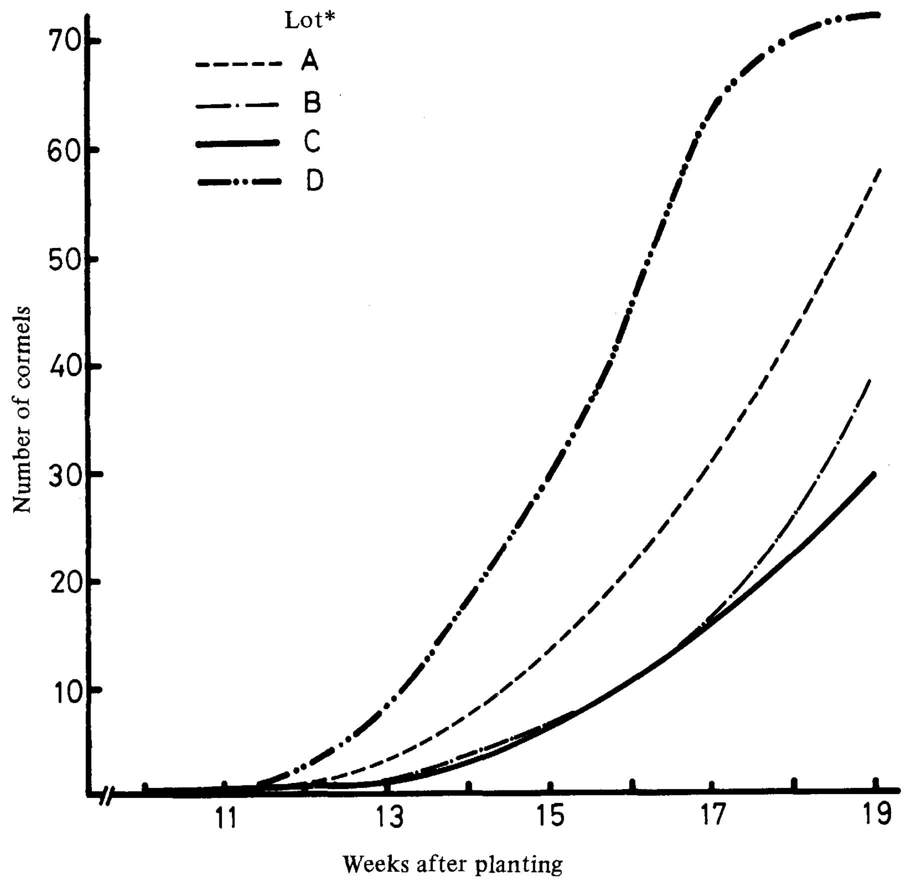


Fig. 5 Effects of time of spike removal on increase in number of cormels (July planting).
*: See Table 4.

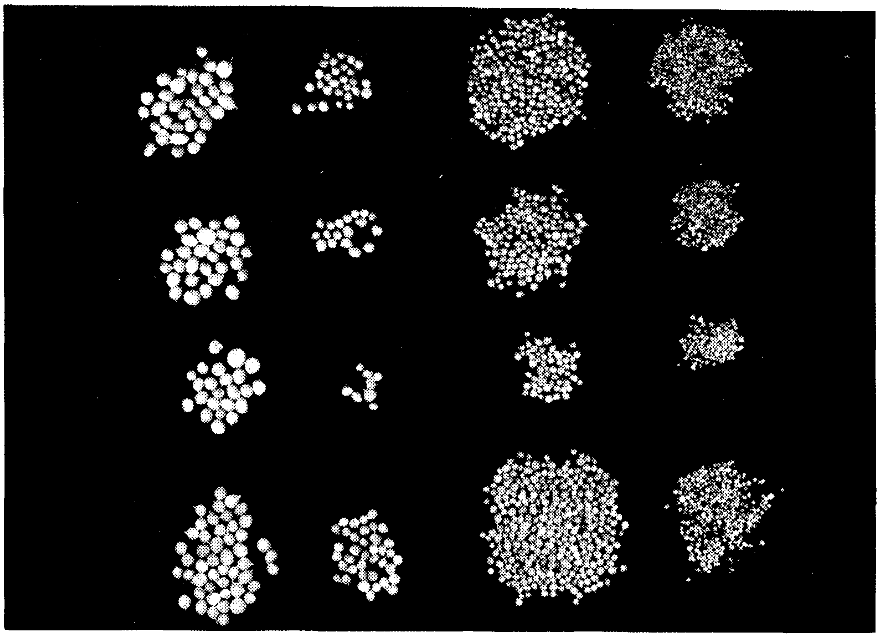

Fig. 6 The yield of cormels graded to their diameter (July planting).
Top to bottom: Lot, A, B, C, and D.
Left to right: Diameter of cormels, larger than 8 mm, 8-6 mm, 6-4 mm, and smaller than 4 mm.
Cormels taken from 10 plants in each lot are arranged.

*Experiment 2.*

Since the development of corm and cormels in A and C lots was the same as in Experiment 1 described above, only the results on the last two lifting times are shown in Table 5.

Table 5. Effects of time of spike removal on corm thickening and cormel yield at the last two lifting times.

| Time of lifting | Lot* | Corm diameter (mm) | Fresh weight of corms (g) | Number of cormels |
|---|---|---|---|---|
| Oct. 17 | A | 58.2 | 67.9 | 52.0 |
| (19 weeks after planting) | C | 55.5 | 55.7 | 24.0 |
| Nov. 7 | A | 59.7 | 71.2 | 75.9 |
| (22 weeks after planting) | C | 58.6 | 68.7 | 66.6 |

*: Same as in Tables 2 and 4.

Apparent differences in corm weight and in the number of cormels between A and C lots were observed on October 17, 19 weeks after planting, as being the same as in the Experiment 1. But there were no essential differences of corm and cormel growth between the two lots in the last lifting time when tops turned yellow. These results show that the effect on corm and cormel growth of spike removal just after its emergence became smaller and smaller in process of time.

## Discussion

Prevention of flowering or early removal of blooms was recommended as a better method of producing large bulbs or tubers in bulb or tuber production. In tulip, Tsukamoto observed that bulb storage for 15 days at 35°C resulted in inhibition of flower formation and increased yield of new bulbs[6]. Toyoda and Nishii[7,8,9] investigated this problem in detail, and obtained the following results. Completely non-flowering tulip plants were induced by keeping bulbs for 13 days at 35°C starting early in October, and this treatment resulted in an increased number and weight of new bulbs. Of the treated bulbs, those which developed flower stalks with no flower-buds or no open flowers produced the best yield of new bulbs. Lately Rees and Briggs observed that for optimum flower kill and yield increase the shoot should be about 1 cm high at the high-temperature treatment at 33°C for 1 week[10]. On the other hand Hartsema and Luyten pointed out that there were many reasons to advise against the practice of high-temperature treatment of tulip bulbs leading to blindness and large sized bulbs[11]. Kalin reported that snapping flower heads of narcissus produced bulbs with a greater individual weight[12, 13]. In the practice of bulb production, flower-buds of Easter lilies are snapped to hasten the thickening of bulbs when they reach 3-4 cm in length. Some experiments with chemical pruning have been made with success by Kunishige[14]. Also in dahlia[15, 16] and tuberous rooted begonia[17] it was confirmed that weight of tuberous roots was heavy at harvesting time when plants were prevented from flowering by removal of flower-buds.

In the present studies as well as the results in other bulbous or tuberous plants mentioned above, it was clarified that spike removal just after its emergence hastened corm thickening. New corms remained undeveloped for 3 weeks from pollen and ovule formation stage to flowering and then started to develop, showing the growth curve like a double sigmoid as pointed out by Halevy and Monselise[2]. This suggests that photosynthate from tops and nutrient from roots are exhausted for later spike development and their translocation to new corms are checked around flowering. Therefore, it seems likely that spike removal at an early stage allows photosynthate and nutrients to enter corms earlier and hasten their development.

Early removal of spikes has an effect only on advancing the start of corm growth and little effect on increasing the growth rate. Therefore, the later the lifting the smaller the difference in corm diameter and weight between the early spike removal lot and the late one. The results of Roberts and Milbrath[1] cited above may be ascribed to the following facts. The number of days from spike removal to lifting was smaller in late flowering varieties than in early flowering ones when spike was removed at its emergence and the plants in both groups were lifted on the same day. The present results in Experiment 2 give a satisfactory explanation to such a view.

It is true that the onset of corm thickening was hastened in plants which failed to differentiate spikes, but the rate of thickening in those was rather low. This may be attributed to reduced amounts of photosynthate translocated to the corms because the photosynthetic capacity was deemed small in those plants due to a small number of leaves. Similar results were also reported in tulip[9, 18] and dahlia[16]. In order to produce large sized corms in an early crop it is important that spikes are removed as early as possible without causing detrimental effects on leaves. In this regard successive experiments have shown that the abortion of spikes is successfully attained using plant growth regulators before they emerge from leaves. This aspect will be dealt with in a forthcoming paper.

When the yield of cormels is important, for example, when propagating gladioli rapidly from a few seed corms, it is effective to snap spikes as soon as they appear. This is in line with the results of Halevy and Monselise[2]. Moreover, it was clarified that undifferentiation of spike also results in a marked increase in the number of cormels.

Cormel production with July planting was over twice that of April planting. This may be due to the fact that the growing period with July planting falls in with natural short day and cool temperature conditions, favourable for cormel formation[19, 20].

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