was significantly greater at photoperiods $\geq$ 14 hr. (Fig. 3 and 4). The average no. of initial leaves in Expt. I was 8 and in Expt. II was 18, but the no. of leaves at stolon formation was nearly the same in both experiments. The no. of days to visible stolon was also about twice as great in Expt. I as in Expt. II which suggests a relationship between the no. of leaves and days to stolon formation as well as a possible relationship to previous photoperiod (Table 1). Also, the plants were under photoperiod treatment during the summer in Expt. I and during the winter in Expt. II. Although the greenhouse was pad-and-fan cooled, day temp often rose to 30–32°C during the summer as compared to 21–24° during the winter. Light intensity was also much higher during the summer as the house was not shaded.

Daylength had some effect on the days to visible stolon formation in the all-green *Chlorophytum* (Fig. 5) but much less than that seen with the variegated. The no. of leaves at stolon formation was not significantly affected by photoperiod in the all-green *Chlorophytum*. The plants had an average of 12 leaves at the start of the treatments and 18 at visible stolon.

The minimum number of 8-hr days required to reduce the time to visible stolon formation was 3 weeks (Fig. 6, Fig. 7). A comparison of the data from Expt. II and IV would indicate 1 or 2 weeks of 8-hr daylength gave about the same results as growing plants continuously under photoperiods $\geq$ 14 hr. The days to stolon formation and no. of leaves compare very well in these 2 experiments conducted during the same time of year. This suggests a need to look at temp and light intensity with photoperiod treatments given the results of Expt. I.

All of the present results relate only to stolon formation and not to flower or plantlet formation on the ends of the stolons. Our observations indicate that photoperiod affects plantlet formation on the ends of the stolon.

Fig. 7. Leaves at stolon formation (Expt. IV) for the variegated *Chlorophytum* grown at 1–10 wk of 8-hr photoperiod. Means of 5 plants.

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Sucrose Pulsing of Gladiolus Stems before Storage to Increase Spike Quality[1]

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Abstract. **Pulsing gladiolus stems at 21°C with 20% sucrose in combination with $AgNO_3$ before storage of 7 or 10 days resulted in greater floret opening and size than those not pulsed. A silver treatment alone was not effective. The sucrose fulfills the requirements for a carbohydrate source and osmoticum which are necessary for floret growth and development. This treatment with sucrose is recommended prior to shipping or storage of gladiolus for long periods.**

Recent studies (2, 4) have shown that pulsing (treating some cut flowers with high sucrose concn before shipment or sale) cut gladiolus spikes with high concentrations of sucrose resulted in the opening of many immature florets and increased longevity. Sucrose concn as high as 40% w/v were tolerated during a 20 hr pulse but there was no great advantage of using concn greater than 20% w/v (4). Pulsing gladiolus spikes with sucrose is now a commercial treatment for gladioli exported from Israel. The question of whether pusling spikes before cold storage benefits subsequent floret opening and longevity was raised. Experiments were conducted with 20% sucrose in combination with silver nitrate used in 2 different ways. These methods are described with the results of each experiment.

Impregnating stems with silver prior to a sucrose pulse. It has been demonstrated that when cut stems of carnations, chrysanthemums and gladioli were impregnated with high concn of $AgNO_3$ (1000 to 1200 ppm) flower longevity was enhanced (3). It was found, however, that a 10 min base immersion in 1200 ppm $AgNO_3$ of water stressed gladiolus allowed the Ag to rise only 3 mm in the conducting tissue (3). In the present experiment the intention was to impregnate the stems more thoroughly.

The experiment was conducted in August with Frazee's miniature pink 'M9-1258' gladiolus harvested when the 2 bottom florets were just showing color. Stem bases were immersed to a depth of 10 cm with 1000 ppm $AgNO_3$ soln for 1 hr, and the silver rose to a height of 3.5 cm. After this treatment some stems were pulsed at 21°C with 20% sucrose for 24 hr to a depth of 7.5 cm. The rationale was to obtain an adequate silver (Ag) coating in the conducting vessels to prevent possible contamination from microorganism growth which might have been promoted by the subsequent sucrose pulse. The spikes were wrapped after pulsing in tissue paper and then in several layers of newspaper before

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placing them in a fiberboard carton for storage at 2°C for 1 week. After storage some stems were recut by removing the bottom 2.5 cm and before placing them in deionized water (DI). Other stems were left uncut to determine whether the Ag might still be beneficial against microorganisms when placing in DI water a week after treatment.

Floral spikes were discarded when the 5th floret from the bottom wilted. Percentages of the fully opened and partially opened florets were calculated on the day the spikes were discarded.

Results of Table 1 show that a pulse of 20% sucrose following Ag treatment, significantly enhanced the longevity and the percentage of fully open florets when compared to impregnating with Ag alone. Recutting of the Ag treated stems after storage did not reduce the efficiency of the pulsing; however, recutting the stems after storage to create a fresh surface is not essential. The sucrose pulse in addition to increasing longevity also resulted in deep rich pink florets up to the time of senescence. Florets in the 2 other treatments had a bluish magenta hue before wilting.

In gladiolus, silver impregnation by itself had no effect on floret opening and longevity (Table 1). These results are unlike those obtained (unpublished) with carnations in which silver impregnation without a sugar pulse greatly enhanced longevity of stored flowers.

Pulsing with a soln containing Ag + sucrose. The experiment was conducted in May with the grandiflora 'Summer Queen'. Flowers were recut to a length of 100 cm before pulsing. Spikes were harvested when color was just beginning to show in the bottom 2 florets. A modified soln (4) was used containing: 20% sucrose w/v, 50 ppm $AgNO_3$ (Ag), 300 ppm $Al_2(SO_4)_3 \cdot 18 H_2O$ (Al) and 250 ppm 8 hydroxyquinoline citrate (HQC). A treatment often used by growers was the control, i.e. spikes were placed in water at 2°C for 20 hr. Three different soln temperatures were used for the 20 hr pulsing: starting with temperatures of 38° or 55°C and allowed to cool to room temperature (21°C), and using 21° throughout the pulsing period. This was found in earlier experiments (4) to be the optimal temperature for pulsing. Only the data of 21° pulsing throughout appear in Table 2 since the other 2 treatments were not significantly different from the former. Spikes were wrapped as in the first experiment but were stored for 10 days at 2°C. The bases were recut 2 cm after storage before placing them in DI water. The 21° observation room was lighted 24 hr. Spike longevity was terminated when 5 florets at the base wilted.

The % floret opening on the spikes was the greatest when they were pulsed with sucrose (Table 2). A greater number of florets opened and there were more florets open on any given day than those not pulsed. The diameter of the 8th floret of stored spikes and pulsed with sucrose was almost twice the size of unpulsed fresh flowers (unstored); however, the size difference in the 3rd floret was not significant between these treatments. The spike longevity was slightly better for the unstored and unpulsed control but this can be attributed to the slow and poor floret development (note the diameter and no. of florets open on the 8th day, Table 2).

Table 1. The effect of a silver impregnation, sucrose pulsing and stem section removal on the opening of florets and spike longevity of miniature 'M9-1258' gladioli. Spikes were stored dry for 1 week at 2°C after pulsing; following storage, spikes were placed in deionized water for observation.

Treatment	Floret opening (%)		Longevity (days)
	Fully	Partially	
No pretreatment before storage, stems recut 2.5 cm after storage	39b[z]	28a	7.0bc
No pretreatment before storage, stems not recut.	33b	29a	6.2c
Ag impregnation only, stems recut 2.5 cm after storage.	30b	28a	6.5c
Ag impregnation only, stems not recut.	36b	26a	6.9bc
Ag impregnation, followed with 20% sucrose pulse, stems recut 2.5 cm after storage.	71a	12b	7.8ab
Ag impregnation, followed with 20% sucrose pulse, stems not recut.	72a	5b	8.2a

[z]Mean separation within columns by Duncan's multiple range test, 1% level.

Table 2. Spike longevity, floret diam and no. opened on spikes pulsed with preservative soln or water for 20 hr followed by a 10 day storage period at 2°C. Each treatment had 10 spikes.

Treatment	Spike longevity (days)	Diameter (cm)		No. florets open on		Total no. florets opened	
		3rd floret on 6th day	8th floret on 8th day	4th day	8th day	per spike	% of maximum
Pulsed with sucrose at 21°C, 20 hr, then stored at 2°C.	9.3b[z]	9.9a	11.1a	4.8a	9.7a	14.8a	89a
Placed in water at 2°C, 20 hr, then stored at 2°C.	9.1b	5.4b	7.5b	1.3b	6.5b	11.4b	67b
Placed in water at 21°C at once, no storage.	10.5a	9.7a	6.2c	0.7b	5.7b	10.8c	61b

[z]Mean separation within column by Duncan's multiple range test, 1% level.

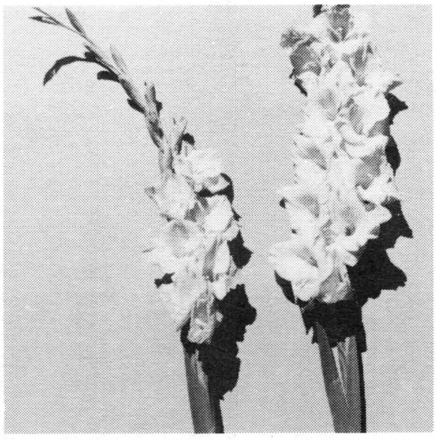

Fig. 1. Typical spikes of unpulsed (left) and pulsed (right) 'Summer Queen' gladiolus on the 8th keeping day following 10 days of storage at 2°C.

Floret opening is a growth process. Two of the basic requirements to maintain growth are a carbohydrate source and fully turgid tissues, and the sucrose pulse fulfills these two requirements. The first by supplying the tissue with carbohydrate and the second by decreasing the water potential (2) and thus improving the water uptake of the stem (1).

Our results demonstrate that a proper prestorage sucrose pulsing for gladioli enables one to obtain flowers that are equal or better than fresh flowers. This pretreatment should be of value for long term truck or boat shipment of gladiolus.

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