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HYBRID LILIES ADAPTABILITY TRIAL, ISLAND OF HAWAII

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INTRODUCTION

Hybrid lilies, genus *Lilium* (the true lilies), are fast becoming a major item in the U.S. flower market. They are sold either as cut flowers or as potted plants. Presently the major suppliers to the U.S. market are the European countries. Lilies as cut flowers or potted plants are packed in their flower bud stage and are shipped into New York or Chicago and marketed nationwide as far west as California. In recent years, handlers of flowering bulbs have been experimenting with lilies to learn more of their cultural requirements and adaptability in the mainland United States. Used as garden plants, hybrid lilies do well in both the northern and the southern states (*1, 5*). Several cultivars of garden hybrid lilies were grown successfully from precooled bulbs as potted plants for spring flowering in a greenhouse at 60–65° F day and 50° F night temperatures (*9*).

Hawaii, with its year-round subtropical climate, may present a natural potential location for cut lily flower production from precooled bulbs. Precooled bulbs of temperate flowers narcissi, hyacinths, and tulips were grown successfully at the Volcano Agricultural Experiment Station and found to have potential as pot plant crops (*3*). Hybrid lilies are divided into nine main groups, the most notable being the Longiflorum group, which includes the Easter lilies (*1*). Cultivars of the Asiatic group (the most adaptable and hardiest) and the Oriental group (more adapted to warmer climates) were selected for this trial to study the feasibility of forcing vernalized lily bulbs in Hawaii for the production of cut flowers (*7*).

MATERIALS AND METHODS

Vernalized bulbs of five Asiatic varieties, 'Firebrand' (red), 'Pollyanna' (yellow), 'Matchless' (orange), 'Zephyr' (pink), and 'Avalon' (white), and two Oriental clones, 'Jamboree' (magenta-rose) and 'Allegra' (white), were received from the Oregon Bulb Farms of Sandy, Oregon, on January 31, 1984. The bulbs were held at 45° F until they were potted on February 6, 1984. The medium was a 2:1:1 mix of fumigated soil:peat:volcanic cinder amended with 6 oz/cu ft hydrated lime. The bulbs were planted in 10-inch plastic pots with either three Asiatic lily bulbs per pot or two Oriental lily bulbs per pot. The potted bulbs were then distributed to fiberglass greenhouses at five University of Hawaii Agricultural Experiment Stations located on the Island of Hawaii, with four pots per Asiatic variety and six pots per Oriental variety per station. The five stations and their elevations and average minimum and maximum temperatures for February 1984 to June 1984 are shown in Table 1.

Plants were watered sparingly during the first few weeks and irrigation was increased after buds became visible. Once shoots emerged, weekly sprays of malathion and benomyl (Benlate) were applied as a preventive measure against aphids and botrytis blight, respectively. Slow-release fertilizer (Osmocote 14–14–14) was premixed with the medium at 4 lb/cu yd of medium, and foliar fertilizer (Peters 20–20–20) was applied at ½ T/gal (approximately ¼ oz/gal) water when flower buds first became visible and again 14 days after the first application. Data taken included date of shoot emergence, date of appearance of flower buds, date buds colored (marketability date), plant height (taken from medium surface to the top flower), percentage of plants that bloomed, flower rating, and foliage rating. Flower and foliage rating and stem length data were taken only on stems bloomed.

RESULTS AND DISCUSSION

The results of the trials are shown in Tables 2 and 3. In general, the lilies grew well on the Island of Hawaii, with each variety responding differently to each location. Very few insect or disease problems were observed with the pesticide regimen described earlier.

Forcing times differed among cultivars (with the Oriental lilies requiring more days) and also varied among stations for each cultivar (Table 3). Lilies grown at Volcano, the station with lowest temperatures, tended to require the longest forcing times.

The best overall results were obtained at the Volcano and Kona stations, with the only exceptions being lower foliage ratings for 'Pollyanna' at Volcano and for 'Zephyr' at Kona. Lower average temperatures were recorded for these two stations during the test period, probably accounting for the good performance of these temperate flowers. The temperatures given in Table 1 were mean ambient temperatures for the areas and not taken within each greenhouse used; thus the maximum tempera-

TABLE 1. Elevation and minimum and maximum Fahrenheit temperatures of the University of Hawaii Agricultural Experiment Stations

Station	Elevation		Temperature				
			Feb.	March	April	May	June
Beaumont	150'	min.	64	66	67	67	68
		max.	79	82	79	81	82
Waiakea	700'	min.	56	61	61	62	63
		max.	84	87	86	90	88
Kona	1700'	min.	59	61	61	61	62
		max.	77	78	77	74	71
Lalamilo	2400'	min.	54	54	57	58	59
		max.	71	73	71	73	73
Volcano	4000'	min.	50	52	55	55	56
		max.	69	70	66	69	68

TABLE 2. Performance of hybrid lilies, by station (percentage of stems bloomed, stem length, flower rating, foliage rating)

	FIREBRAND	POLLYANA	MATCHLESS	ZEPHYR	AVALON	JAMBOREE	ALLEGRA
Percentage of Stems Bloomed							
Beaumont	75%a*	58%b*	100%a	100%a	92%a	100%a	83%a
Waiakea	75%a	33%b	100%a	83%a	33%b	100%a	100%a
Kona	100%a	100%a	100%a	100%a	83%a	100%a	83%a
Lalamilo	83%a	58%b	100%a	67%a	83%a	100%a	83%a
Volcano	100%a	100%a	100%a	100%a	91%a	100%a	75%a
Stem Length (inches)							
Beaumont	15.4b	34.3a	23.8bc	37.3a	20.0b	40.2ab	39.1a
Waiakea	18.5a	43.4a	26.6ab	36.0a	22.9b	40.7ab	40.0a
Kona	20.6a	38.9a	26.0abc	37.0a	27.1a	40.3ab	38.8a
Lalamilo	13.8b	35.6a	23.5c	29.0b	22.6ab	35.9b	40.6a
Volcano	18.9a	37.9a	28.7a	37.7a	25.7a	43.2a	43.4a
Flower Rating**							
Beaumont	3.4a	3.9a	3.5b	4.0a	3.9a	4.0a	4.0a
Waiakea	3.7a	4.0a	3.9ab	3.8a	4.0a	4.0a	3.8a
Kona	3.5a	4.0a	3.8ab	4.0a	4.0a	4.0a	4.0a
Lalamilo	3.0a	4.0a	4.0a	3.7a	4.0a	3.9a	4.0a
Volcano	3.8a	4.0a	4.0a	4.0a	3.6a	4.0a	4.0a
Foliage Rating**							
Beaumont	3.5a	4.0a	3.8a	2.2ab	4.0a	4.0a	4.0a
Waiakea	3.9a	4.0a	4.0a	2.3ab	4.0a	3.5a	3.6a
Kona	3.6a	4.0a	4.0a	1.9b	4.0a	3.6a	4.0a
Lalamilo	3.8a	4.0a	4.0a	3.4a	4.0a	3.3a	3.7a
Volcano	3.9a	3.6b	4.0a	2.5ab	4.0a	3.8a	3.5a

*Mean separation by Waller-Duncan's Bayesian K-ratio t test, K=500. Means followed by the same letter are not significantly different.
**Rating: 1=poor, 2=fair, 3=good, 4=excellent.

tures within each greenhouse were probably higher than those indicated by Table 1. Although the Lalamilo station also recorded lower temperatures than other stations, the greenhouse used at this station was about half the size (30 × 50 ft) of other greenhouses used, and the difference between the actual temperature within the house and that indicated in Table 1 was probably much greater than at other stations. This may partially account for the poorer performance of lilies at Lalamilo than at Kona, which had higher recorded temperatures.

In general, of five Asiatic varieties, 'Matchless' seemed the best suited for forcing in Hawaii. The flowers were excellent with uniform flowering time (± 5 days) within each location. The stems were firm and straight with good height and excellent foliage. The overall rating as a cut flower was excellent.

Performance of the other Asiatic varieties varied among locations. 'Firebrand' blooming time was fairly uniform (± 5 days) within each location, but up to 25 percent bud abortion was observed on 'Firebrand' at the Beaumont and Waiakea stations. For plants that did bloom, the cut flower rating was excellent, with good to excellent foliage and firm stems. Stem lengths were good except at Beaumont and Lalamilo stations, where stems were significantly shorter.

'Pollyanna' did not perform well at Beaumont, Waiakea, and Lalamilo stations, where bud abortion or stunting was observed on up to 67 percent of the plants. Volcano and Kona stations had 100 percent blooms. On plants that did bloom, the flowers were excellent, stems were strong with excellent length, and foliage was good to excellent. The blooming time was uniform (± 3 days) within each location.

Performance of 'Avalon' also varied with location. Bud abortion was observed at all locations, with the most occurring at the Waiakea station (Fig. 1). Ratings of flowers that did bloom were good to excellent, stem lengths were good, and foliage was excellent, although leaves did seem a little small and out of proportion to the size of the flowers. Blooming time was not as uniform (± 7 days).

Although 'Zephyr' produced excellent flowers with 100 percent blooming at the Beaumont, Kona, and Volcano stations, the foliage was unattractive at all locations. Leaf tips and lower leaves turned brown, making the stems unmarketable (Fig. 2). Stems were also very long, except at Lalamilo, and tended to be weak. The leaf scorching and weak stems may have been the result of too high an application of nitrogen (*6*).

TABLE 3. Hybrid lily forcing days obtained, by station

	FIREBRAND	POLLYANA	MATCHLESS	ZEPHYR	AVALON	JAMBOREE	ALLEGRA
Average number of days from planting to shoot emergence							
Beaumont	11ab*	16a	7a	16bc	13b	19b	16a
Waiakea	13bc	14a	8b	14ab	12b	19b	14a
Kona	9a	13a	7a	12ab	6a	13a	13a
Lalamilo	13bc	15a	7a	14ab	13b	14a	14a
Volcano	15c	15a	10c	18c	12b	20b	14a
Average number of days from planting to first bud							
Beaumont	34a	39a	31b	35a	34a	63a	52a
Waiakea	46b	50c	37d	47c	42c	62a	58b
Kona	35a	43b	35c	43b	34a	60a	57b
Lalamilo	35a	37a	28a	35a	36b	NA	NA
Volcano	46b	59d	31b	56d	34a	93b	97c
Average number of days from planting to buds coloring							
Beaumont	49a	62a	49a	56a	54a	99a	101a
Waiakea	51ab	63a	46a	62a	58b	NAa	NA
Kona	55bc	64a	55b	60a	57ab	101a	107b
Lalamilo	59c	NA	55b	NA	59b	107a	NA
Volcano	NA	NA	NA	NA	NA	NA	NA

*Mean separation by Waller-Duncan's Bayesian K-ratio t test, K=500. Means followed by the same letter are not significantly different.

Figure 1. Bud abortion on 'Avalon'.

Figure 3. Fasciation of 'Allegra'.

Figure 2. Leaf scorch on 'Zephyr'.

The two Oriental clones tested were large, fragrant, and very attractive. 'Jamboree' performed very well, with 100 percent blooming at all locations. Flowers were excellent, but stems were very long and needed some support. There was some orange or brown discoloration of lower leaves; however, the overall foliage rating was good. Blooming time was not as uniform (± 3–12 days) as the Asiatic types, although the cut flowers were usable over a longer time since younger buds continued to open in succession.

'Allegra' produced excellent flowers, good to excellent foliage, and long stems that needed some support. However, only Waiakea produced 100 percent blooming plants. At other locations bud abortion or fasciation (a growth anomaly in which the tops of stems thickened into unattractive "heads" from which no buds developed) was observed on up to 25 percent of plants (Fig. 3). (This was apparently due to the use of a mutant "fasciation-prone" form of 'Allegra' that was produced in tissue culture.) As with the 'Jamboree', blooming time for 'Allegra' (± 3–12 days) was not as uniform as in the Asiatic types, with their shorter forcing times.

The main problems encountered in forcing the hybrid lilies were bud abortion, leaf scorch, and weak stems. A water deficit (e.g., caused by rapid transpiration or high air temperatures) or a deple-

tion of carbohydrates (e.g., caused by a period of darkness) in flower buds increased the incidence of bud blasting in Easter lilies (*4*). Bud blasting in Asiatic hybrid 'Enchantment' was produced by both darkness and ethylene production (*2*). Exposing lilies to stress, which stimulates ethylene production in flower buds, apparently will increase bud blasting. Hybrid lilies are temperate plants that normally are grown in cooler northern climates. Thus, high temperatures may have stressed the lily plants and led to bud blasting in this trial. Although average temperatures for all stations except Waiakea were within the recommended forcing temperature ranges of 50–55°F night minimum and 85°F day maximum (*8*), daily temperatures may have exceeded 85°F, especially at the lower-elevation stations and at Lalamilo, with its smaller greenhouse. The higher temperatures, then, may have contributed to the high incidence of bud abortion in 'Avalon' and 'Pollyanna' at Waiakea and that of 'Pollyanna' at Beaumont and Lalamilo. Shading and misting during the vulnerable soft growth stage when the flower buds first appear may help reduce these conditions. Leaf scorch can also be aggravated by rapid transpiration; providing cooler temperatures for a few days after potting of bulbs, for development of a more extensive root system, may also help reduce the incidence of leaf scorch and bud blast (*6*). A reduction in fertilizer levels, especially that of nitrogen, may aid in the production of stronger stems with less scorch-prone leaves.

In conclusion, hybrid lilies can be grown successfully as a cut flower crop in Hawaii. The location and the environmental conditions within each greenhouse will determine the varieties that can be grown, depending upon the flowering characteristics desired. The reader is directed to Tables 1 to 3 to obtain detailed information for specific locations with environmental conditions similar to any of the six stations.

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