Greenhouse Performance of Six Potted Anthurium Cultivars in a Subtropical Area

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SUMMARY. Vegetatively propagated liners of six hybrid anthurium cultivars (*Anthurium* Schott), 'Pink Aristocrat', 'Patty Anne', 'Purple Viking', 'Royal Pink', 'Royal Orange', and 'Royal Red', were planted in pots and grown under warm [maximum 30 °C (86 °F)] or hot [maximum 35 °C or (95 °F)] conditions with or without a single foliar application of 500 mg·L⁻¹ (ppm) GA₃ and evaluated after 7, 9, and 13 months. GA₃, when applied 7 months after planting, did not promote flower production or result in taller plants. Plants in warm and hot areas, except for 'Pink Aristocrat', had similar degrees of foliage injury in April, but those in the warm environment had better quality in July than those in the hothouse. Yellow leaves and necrosis on leaf margins were apparent on plants in the hot area. 'Pink Aristocrat' was the most (>20 flowers) and 'Royal Red' was the least (2 flowers) floriferous after 1 year. Flower color of 'Royal Red' was unaffected by high temperature, whereas flowers of the other cultivars faded under heat. Growing these anthurium cultivars at maximum 30 °C (86 °F) air temperatures is recommended for good quality and high flower count.

Anthurium plants have leathery, shiny leaves and flowers of various bright colors,

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making them very attractive to consumers. For many years, anthurium was produced almost strictly for cut flowers with limited use as a container plant because of its large size. 'Arabella' is a dwarf plant and does quite well in a greenhouse between October and March. However, it develops severe leaf injury when grown in south Texas during the summer, rendering plants unmarketable. In recent years, new cultivars suitable for pot production have been developed. These cultivars need to be tested for their possible commercial production as potted plants in warm production areas. Gibberellic acid has been found to promote flower initiation and production in several aroid genera, including *Anthurium* (Henny and Hamilton, 1992), *Caladium* (Harbaugh and Wilfret, 1979), and *Zantedeschia* (Corrand and Widmer, 1987). The effect of GA₃ on promoting flowering of six potted anthurium cultivars was also studied.

Materials and methods

Vegetatively propagated liners of six hybrid anthurium cultivars, 'Pink Aristocrat', 'Patty Anne', 'Purple Viking', 'Royal Pink', 'Royal Orange', and 'Royal Red', were received (Twyford Laboratories, Santa Paula, Calif.) and potted on 17 July 1993 in 11.4-cm (4.5-inch) round plastic pots (0.5 L or 0.13 gal in volume) using Sunshine No. 1 (Fisons Horticulture, Seattle, Wash.). Sixteen uniform plants of each cultivar were selected and separated into two groups of eight plants each with one group being placed in a warm greenhouse and the other in a hot house. Daytime maximum air temperature in the warm house remained at or below 30 °C (86 °F) in the summer and the minimum night temperature was at or above 17 °C (62.6 °F) in the winter. Daily high temperatures in the hot house were generally [2 °C (3.8 °F) in winter to 4 °C (7.2 °C) in summer] warmer

than the warm house (Fig. 1). Plants were transplanted to 15-cm pots (1.75 L or 0.46 gal in volume) on 3 Nov. 1993 in Sunshine No. 1.

All plants received a midday maximum photosynthetic photon flux (PPF) between 240 μmol·m⁻²·s⁻¹ (≈1200 f-c) in January and 370 μmol·m⁻²·s⁻¹ (≈1860 f-c) in July. They were given Peters 24N-3.4P-13.3K (24-8-16, W.R. Grace, Foglesville, Pa.) at the rate of 0.84 g·L⁻¹ (0.11 oz/gal) with every irrigation. Water from a reverse osmosis (RO) device [electrical conductivity (EC) <0.05 dS·m⁻¹ (mmho·cm⁻¹)] was used for irrigation until 1 Oct. when it became necessary to switch to municipal water (EC = 1.4 dS·m⁻¹ or mmho·cm⁻¹), and back to RO water on 18 Jan. the following year.

The experiment was a randomized complete block design within each cultivar. In each temperature treatment, there was one pair of plants in each of the four blocks. The first evaluation was conducted on 19 Feb. 1994. One plant in each of the four pairs was sprayed to incipient run off with GA₃ at 500 mg·L⁻¹ (ppm) on 24 Feb. 1994 to determine its effect on flower production. Data were collected again on 23 Apr. 1994, after 9 months of production. Final evaluation was performed on 24 Aug. 1994.

Each plant was evaluated for plant height (from pot rim to the highest point), flower height (from the base of a flowering stem to the tip of its flower), cumulative flower count, foliage injury, plant grade, and root vigor. In addition, plant characteristics, including shape and color of leaves and flowers, were recorded.

Results

The descriptions of plant characteristics are given in Table 1. Plants in the 'Royal' series had more basal shoots and substantially larger flowers than the other three cultivars. GA₃ neither promote flowering nor resulted in increased plant height; therefore, data were pooled to show the temperature effects only.

'Pink Aristocrat' is a very showy cultivar producing an abundance of flowers (Tables 2 and 3; 8 flowers in 9 months) rising well above the foliage (Tables 3 and 4). It was the earliest one to bloom and had less foliage injury under the warm environment (Tables 2, 3, and 4). When grown in the warm area, the plants' long triangular leaves had slight marginal yellowing, but no tip injury. Hot-grown plants had much

Fig. 1. Average monthly maximal air temperatures in the hot and warm greenhouses.

Table 1. The characteristics of six potted anthurium cultivars.

Cultivar	Leaf			Flower			Plant shape
	Size	Shape	Green	Size	Color	Shape	
Pink Aristocrat	Medium	Triangular	Medium	Medium	Pink	Drop	Open
Patty Anne	Large	Triangular	Medium	Medium	Lavender	Drop	Open
Purple Viking	Medium	Triangular	Medium	Medium	Purple	Drop	Open
Royal Orange	Large	Heart	Dark	Large	Orange	Heart	Dense
Royal Pink	Large	Heart	Dark	Large	Light red	Heart	Upright
Royal Red	Small	Heart	Dark	Large	Deep red	Heart	Compact

severe leaf yellowing and tip injury and a reduction in root vigor (Table 3). The flowers of 'Pink Aristocrat' plants grown in the hot house tended to fade early.

'Patty Anne' has spreading foliage and its teardrop shaped flowers are pale lavender. The flowers (2.8/plant in 9 months; Table 3) rose high above the foliage (Tables 3 and 4) and did not droop. In the warm area, this cultivar had long, slightly heart shaped leaves that developed slight injury on the margins. When grown under the hot condition, plants had long, wide leaves with extensive leaf edge burn, the foliage was sparse, and the flowers were pale.

'Purple Viking' has long, large dull-green leaves with open foliage. Plants have teardrop-shaped, lavender flowers that unfold at the foliage height and are sometimes blocked from view by the foliage (Table 3). When grown under hot conditions, leaf tip and margin injury was apparent. 'Purple Viking' grown in the hot area had extreme leaf yellowing with sparse, short foliage (Table 4). These plants had smaller spathes, which faded and were duller than those pro-

duced in the warm house. Flower count averaged only 2.5 per plant following 9 months of production.

All of the above cultivars had slightly droopy leaves when grown in the hot area. Plants were taller in the warm house. In general, flowers of these three cultivars were held above foliage that is highly desirable.

'Royal Pink' has large, heart-shaped leaves. The plant had dense foliage and young leaves had a slight red tint. The pinkish-red flowers (only 1.3/plant in Apr. 1994; Table 2) were large and brightly colored. Flowers opened at or just below the foliage (Tables 3 and 4) and remained upright. When exposed to the hot air, the foliage had a copper tint and was severely mottled, but the flowers remained bright pink-red.

'Royal Orange' has a dense upright growth habit with shiny, heart-shaped leaves and flowers. The flowers (1.7 per plant) opened at foliage level (Table 3 and 4), but some drooped down and were hidden by the dense foliage. Hot-grown plants had a reduction in average plant size, but retained the shiny leaves

and flowers. In addition, more leaf tip injury and leaf yellowing were present when grown under the hot conditions.

'Royal Red' has smaller heart-shaped leaves and denser, more compact foliage than 'Royal Pink' and 'Royal Orange'. Flowers are deep red and heart-shaped that opened at foliage height (Tables 3 and 4). The leaves were shiny with little or no injury in either the warm or the hot areas until the last evaluation, when leaf injury was apparent on plants in the hot area. Leaves were deep green and plants were vigorous. Only one plant of this cultivar flowered by the end of April 1994. Flower count was low when all plants had bloomed.

The 'Royal Pink', 'Royal Orange', and 'Royal Red' cultivars have numerous basal shoots, giving them dense foliage at the base. Again, plants produced in the hot area were shorter than those under the warm environment.

When evaluated in late August, 13 months following planting, plants that were grown in the warm house were taller and had more and/or taller flowers than those in the hot house, except

Table 2. Growth and flowering of six anthurium cultivars evaluated 7 months after planting of tissue-culture liners (2.54 cm = 1 inch).

Cultivar	Growing condition	Plant ht (cm)	Total flower count	Leaf tip injury (1-5) ^z	Plant grade (1-5) ^y	Root vigor (1-5) ^x
Pink Aristocrat	Warm	17.9	5.5	3.8**	4.5*	3.8*
	Hot	13.7	2.5	2.0	1.8	2.3
Patty Anne	Warm	19.2*	1.8	3.3	3.0	4.0**
	Hot	14.8	1.0	3.0	2.7	3.0
Purple Viking	Warm	18.4	1.3	2.5	3.0	3.3
	Hot	13.5	0.8	1.8	1.8	3.0
Royal Pink	Warm	28.8	0.3	4.8	5.0	4.0
	Hot	27.9	0.3	4.8	4.5	4.0
Royal Orange	Warm	27.1*	1.5	5.0*	5.0	3.8
	Hot	19.7	0.3	3.5	4.3	3.5
Royal Red	Warm	24.8	0	5.0	5.0	3.8
	Hot	19.3	0	4.8	5.0	3.5

^z5 = No injury to 1 = severe injury.

^y5 = Excellent, 4 = good, 3 = marketable, 2 = unmarketable, 1 = very poor.

^x5 = Healthy root system to 1 = no roots on the surface of the medium.

**Significant within a cultivar at $P = 0.05$ or 0.01 , respectively.

Table 3. Six potted anthurium cultivars evaluated on 24 Apr., 9 months after planting of tissue-culture liners (2.54 cm = 1 inch).

Cultivar	Growing condition	Plant ht (cm)	Flower ht (cm)	Cumulative flower count	Leaf injury (1-5) ^z	Root vigor (1-5) ^y
Pink Aristocrat	Warm	29.3*	38.0*	9.6	4.9*	5.0*
	Hot	18.9	28.3	7.9	3.6	2.0
Patty Anne	Warm	26.0*	43.9*	2.8	3.6	5.0*
	Hot	22.4	33.4	2.8	3.5	4.0
Purple Viking	Warm	26.9*	39.3*	3.0	3.0	5.0*
	Hot	20.4	24.5	2.1	2.6	3.9
Royal Pink	Warm	40.0*	36.6	1.6	5.0	5.0
	Hot	31.9	32.9	1.5	4.5	3.0
Royal Orange	Warm	32.2*	28.4	1.8	5.0	4.0*
	Hot	26.2	23.4	1.5	4.5	3.0
Royal Red	Warm	27.1	---	0.1	5.0	5.0
	Hot	24.0	---	0	4.6	4.0

^z5 = No injury to 1 = severe injury.

^y5 = Healthy root system to 1 = no roots on the surface of the medium.

*Significant within a cultivar at $P = 0.05$.

the 'Royal Pink'. Flower color of 'Pink Aristocrat' and 'Patty Anne' was similarly light under both environments. The deep red color of 'Royal Red' flowers did not fade with the high temperature (Table 4), whereas flowers of the above three cultivars had better color in the warm than the hot house. Overall plant grade was higher for those produced in the warm house, regardless of cultivar.

Discussion

Many of the new anthurium cultivars can be grown in a greenhouse in subtropical climates if certain cultural practices are followed. A warm environment with air temperature not to exceed

30 °C (86 °F) is desirable for plant vigor and high quality. Of the cultivars tested, 'Purple Viking' and 'Patty Anne' had leaf injury and yellowing in warm and hot areas, but the injury was considerably worse in the hot area.

The most impressive cultivar was 'Pink Aristocrat'. It had abundant flowers that rose above the foliage for a prominent display of color. This cultivar would still need the warm growing conditions to avoid leaf tip injury and loss of vigor. 'Pink Aristocrat' had a superior root system and larger flowers when grown in the warm than the hot environment (Table 3). Although it had five flowers after 7 months, these early flowers were small and inconspicuous.

Flowers of this cultivar lasted longer than 'Patty Anne' and 'Purple Viking'.

'Royal Orange' and 'Royal Pink' had large, shiny flowers and a desirable foliage appearance when grown in the warm area. These two cultivars did not have an apparent decline in flower production when grown in the hot area, but did show slight leaf tip injury and marginal yellowing. 'Royal Red' was a beautiful plant in both growing areas with smaller heart-shaped leaves than the other two cultivars in this series and dense foliage, but it took longer to produce a crop with only a few flowers. Failure of this cultivar to flower timely should be investigated further. The production of numerous basal shoots and the lack of a few

Table 4. Six anthurium cultivars evaluated on 24 Aug., 13 months after planting and grown in a warm or hot environment (2.54 cm = 1 inch).

Cultivar	Growing condition	Plant ht (cm)	Plant width (cm)	Flower ht (cm)	Total ^z flower count	No. of new buds	Leaf injury (1-5) ^y	Flower fade (1-5) ^y	Plant grade (1-5) ^x
Pink Aristocrat	Warm	37**	72**	51***	24.4	3.0**	4.7**	2.1	3.7**
	Hot	28	59	21	20.7	1.2	2.9	1.7	2.4
Patty Anne	Warm	42***	64	52***	9.7*	2.3	3.9**	2.3	3.7**
	Hot	31	59	41	6.6	1.3	2.9	2.1	2.6
Purple Viking	Warm	41**	65***	54**	7.2**	2.8*	3.9***	3.1***	4.1**
	Hot	32	49	36	4.1	1.3	2.4	2.0	1.9
Royal Orange	Warm	54***	64	57***	6.4**	1.1	4.9*	4.1***	4.8**
	Hot	42	56	40	4.0	0.4	3.6	3.3	3.3
Royal Pink	Warm	56**	63	58**	7.9	1.0	5.0**	3.7***	4.9**
	Hot	47	61	47	7.3	0.8	3.3	2.0	3.2
Royal Red	Warm	47***	58**	47*	2.2*	0.5	5.0**	4.7	5.0**
	Hot	35	54	33	0.8	0.4	2.4	4.7	2.3

^zCumulative.

^y5 = No injury or fade to 1 = severe injury or fade.

^x5 = Excellent, 4 = good, 3 = marketable, 2 = unmarketable, 1 = very poor.

***Significant at $P = 0.05$, 0.01, or 0.001, respectively.

strong lead shoots, possibly the result of tissue culture, might have contributed to the delayed flowering.

It was observed that once an anthurium shoot has started to bloom, a flower is produced in the axil of each successive, recently matured leaf of a few large lead shoots in each pot. Since the large shoots were capable of producing flowers and the small shoots were too small to bloom, GA₃ had no effect on promoting flower production. Henny and Hamilton (1992) reported, however, that *Anthurium scherzerianum* Schott 'Amazone' and 'Renate' responded to GA₃ application and produced more flowers under high but not low light.

The number of flowers present on a plant is dependent upon how many large, flowering shoots are present and how fast the leaves on these shoots are produced. 'Pink Aristocrat', 'Patty Anne', and 'Purple Viking' have more flowering shoots and fewer small lateral shoots than plants in the 'Royal' series, therefore, they produced more flowers. Under the conditions of this study, the former three cultivars should be grown in 15-cm (6-inch) pots and be marketable in 7 to 8 months. 'Royal Orange' and 'Royal Pink' require 9 to 10 months to be produced in 15-cm pots. It is not known at this time if the use of a lower nitrogen ratio fertilizer such as 10N-13P-16.6K would enhance flowering. Future studies should address the light and fertilizer requirements of these anthurium cultivars.

Literature cited

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