CLEMSON EXTENSION

HORTICULTURE

Hort. L 64 Rep. August 1995

Understanding and Producing Bromeliads

It seems appropriate, after the recent 500th Anniversary of Columbus's discovery of America, to talk about bromeliads. Few people realize his impact on this crop. In 1493, on his second voyage to "the New World," Christopher Columbus discovered the pineapple (*Ananas comosus*) already under cultivation in Guadeloupe, having been imported there from South America. A variegated one is pictured in Figure 1. He took plants back to Queen Isabella in Spain from where the demand for its fruit became widespread. The first picture of the pineapple appeared in the 1535 Spanish publication *The Universal History of India*. "India" was the name given to the New World. By the end of the 1500's, records indicate that the pineapple had been distributed to most parts of the world, including China and Africa. By 1816, Kew Gardens (England) reported a collection of six species of bromeliads, the first (*Guzmania lingulata*) introduced there in 1690. Nicolaus Jacquin of Holland was the first recorded bromeliad collector. In 1755, he explored the West Indies and Venezuela, collecting three new species for the Schonbrunn Botanical Garden in Vienna.

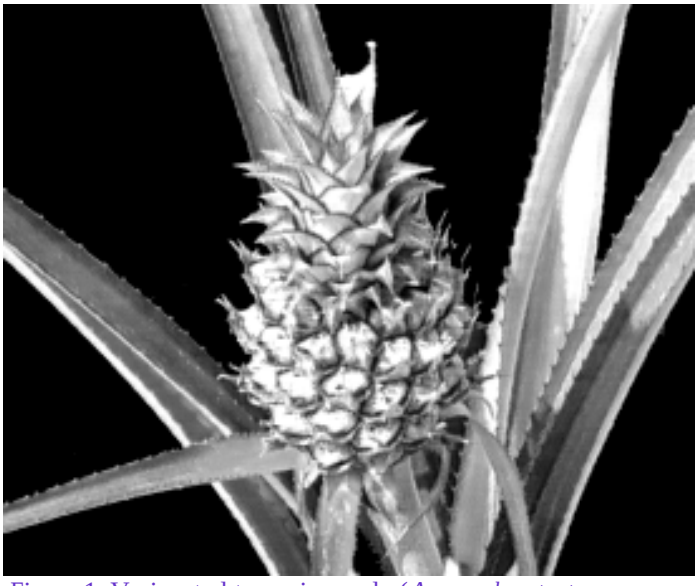

Figure 1. Variegated type pineapple (*Ananas bracteatus striatus*) in Clemson University greenhouse.

The popularity of bromeliads in the U.S. did not begin until the 1950's, their popularity due mainly to one individual -- Mulford Foster of Orlando, Fla. He did some plant exploring in the 1930's in Central and South America, Mexico, and the West Indies, introducing over 200 new bromeliads. He hybridized these very successfully and in 1950 helped to establish the Bromeliad Society, becoming its first president and journal editor.

About 2,000 species of 25 genera of bromeliads have been identified so far. Except for the genus *Pitcairnia*, which is native to West Africa, bromeliads are native to North, Central, and South America, with the greatest number of species found in the warm, humid Brazilian rain forests. Others, however, live on seashore sands, on desert cacti, and at relatively cold altitudes.

All bromeliads are in the Bromeliaceae family, but they also are divided into three subfamilies: Pitcairnioideae, Tillandsioideae, and Bromelioideae. Some recognize a third (i.e., a Navia subfamily, removing those "resembling" *Navia* spp. from the Pitcairnioideae subfamily), but most do not. Subfamily names end in "ioideae," which means "resembling." For example, those in the Tillandsioideae subfamily "resemble" *Tillandsia* spp.

Today, the bromeliad with which most people are familiar is still the pineapple, a terrestrial type (i.e., it roots deeply into the medium in which it's growing). Its roots are quite functional for water and nutrient absorption as well as for anchoring the plant. Here in the South, the bromeliad with which we also are familiar is Spanish moss (*Tillandsia usneoides*), the most widely distributed of all bromeliads. Like most bromeliads, Spanish moss is an epiphyte (i.e., it roots very shallowly into its growing medium), not a parasite. In many cases, a

bromeliad's roots have very little function other than anchoring the plant. All bromeliads have leaf scales which function somewhat like the roots of the terrestrial bromeliads. The scales are multicellular, plate-like-type trichomes attached into the epidermis (surface cells). On Spanish moss the scales are so numerous that they mask the plant's green color. If the plant is dipped in water and then observed, the green chlorophyll necessary for its food manufacture will become obvious. The scales collect moisture, which is absorbed by the leaves. On some bromeliads of a more tropical origin than *Til- landsia* (e.g., *Aechmea*), the scales are less abundant and, in the case of some *Aechmea* spp., the scales form attractive silver bands on its foliage.

Figure 2. Attractive, unusual foliage of *Vriesea guttata* grown in Clemson greenhouse.

Bromeliads manifest what is referred to as a rosette (i.e., like a rose flower) growth habit [i.e., stemless -- no stem (internode) is apparent between leaves]. Their strap-like leaves overlap, often increasing in width where they join the stem, forming a vase configuration where water contaminated with nutritious impurities collects for plant absorption.

Many bromeliads are grown primarily for their foliage (e.g., *Cryptanthus*, *Neoregelia*, *Nidularium*, etc.) which is often of unusual variegation and may be stiff (e.g., the pineapple) or pliable (e.g., *Guzmania*), relative to their native habitats. Those of more tropical origin are more pliable. The foliage of most bromeliads is basically green, but some have wine-colored or maroon foliage. Their basic color may be modified by a banded, lined, mottled, or spotted design of black, cream, gray, pink, purple, yellow, or white, or a combination thereof (Figure 2). Light intensity greatly influences not only leaf color but also leaf shape and size.

One can gauge the amount of light a bromeliad requires by observing its foliage. If the foliage is stiff with somewhat succulent leaves and the plant lacks a vase-like growth habit, it will do well at high light intensities (e.g., pineapple). If, however, the plant's leaves are soft in texture and it exhibits a vase-like growth habit, it will need shade.

At what light intensities should they be grown? If one remembers that the maximum light intensity at our beaches in the summer is about 12,000 ft-c and about 7,500 there in the winter, one can estimate the amount of shading required to produce the most popular bromeliad genera if one knows the recommended light intensities each prefers: *Aechmea*, *Cryptanthus*, *Guzmania*, *Neoregelia*, *Nidularium*, *Tillandsia*, and *Vriesea* prefer 1,000 to 3,000 ft-c, while *Ananas* and *Billbergia* prefer 4,000 to 8,000 ft-c. Remember, however, that plants of the same genera differ in variegation. As with all plants, the more variegation, the lower the light intensity required for optimum growth. Plants heavily covered with scales to preclude their drying out (e.g., Spanish moss), will not tolerate low light levels.

In addition to attractive foliage, many (e.g., *Aechmea*, *Billbergia*, *Guzmania*, *Vriesea*, etc., to name a few) produce a spectacular inflorescence. "Flowers" of bromeliads are extremely long lasting, often lasting for months. The inflorescence of bromeliads may consist of only one floret (e.g., Spanish moss) or thousands (e.g., *Puya raimondii*). Individual florets consist of three sepals, just to the outside of three petals (which always look different from the sepals), just to the outside of six stamens (which may fuse with the petals), just outside of one stigma (Figure 3). If not solitary, the inflorescence is an elongated type and may be a spike [i.e., each floret is connected directly to the main axis (peduncle or flower stem)

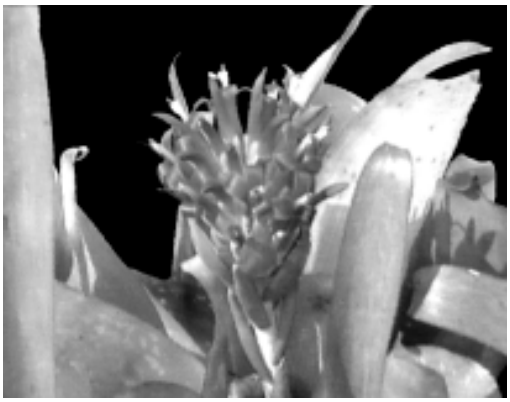

Figure 3. *Billbergia pyramidalis* var. *pyramidalis* grown in Clemson greenhouse.

with no obvious stem of its own], a raceme (i.e., the same as a spike, except each floret has an obvious stem), or a panicle (i.e., more than one axis -- the stem which connects the florets to the central axis of the stem is branched). Often, the colorful part of the inflorescence is produced by bracts, which are modified leaves at the base of several flowers. With some species of *Tillandsia*, *Vriesea*, etc., the florets may not be distributed all around the central axis, only in two opposite rows (i.e., a distichous inflorescence) -- as if it's been pressed firmly in a book.

Most bromeliads, particularly the variegated types, are propagated by offshoot division. The young shoots called "pups" will usually flower after a couple of years on their own. Bromeliads are monocarpic, which means "one life." A shoot "dies" after it flowers. What really happens is that the terminal growing point ceases to produce leaves once it has produced an inflorescence. The leaves below the inflorescence begin to die; however, the buds in the axils of the bottom leaves on the shoot start growing vegetatively, producing the "pups." Removing "pups" often induces the dying shoot to produce more "pups," which may also be removed. Too often, people throw out the plant when it appears to be dying. In time, one could get "pups," divide them, and get large plants again.

Bromeliads may be propagated by seeds, but genera vary greatly in the time required for the seed to mature in the capsule before the seed will germinate successfully -- with *Billbergia* (Figure 4), only about three weeks; with *Vriesea*, about five months. Seeds may be sown on the surface of fine, sterile peat, or, for that matter, on a moist paper towel if high humidity and ample light are provided. *Aechmea*, *Billbergia*, *Neoregelia*, and *Vriesea* can flower in three years if grown from seeds.

Some success in the tissue culture of *Vriesea hieroglyphica* and *Neoregelia carolinae* has been achieved. In tissue culture, a plant can eventually result from the division of a single cell. The problem is reproducing via tissue culture some of those bromeliads which are variegated (e.g., *Neoregelia carolinae* var. *tricolor*). The variegation in the leaves results from several cell layers, each layer contributing to the "overall picture." Because a single cell can not contribute all the colors of the entire original plant, the resulting plant cannot possibly look like the original. If, however, one induces an auxiliary bud to grow in tissue culture and produce auxiliary growth that subsequently produces auxiliary growth, etc., the plantlets that result will be identical to the original plant. This is because buds contain all the cell layers necessary to do this, and the plantlets produced in this fashion do not result from a single cell -- they result from a shoot (bud) of the plant which is composed of many cells.

Bromeliads are tough -- one must make a determined effort to kill one. At Clemson there are many bromeliad species in the greenhouse. They are grown at 60° F minimum nights, among other foliage plants, and receive no special attention. Over the years, there has been no problem doing this. Like other foliage plants, they are potted in a medium of 2 parts pine bark (soil conditioning grade), 1 part peat moss, 1 part sand (by volume). They grow best at acid pH's, as do foliage plants. All are watered on the same schedule -- the same as other foliage plants. Also, all are on the same fertilization program as other foliage plants -- about 300 ppm N in a liquid, complete fertilizer weekly. Do not keep water in "the cup;" in fact, try to avoid this because it would provide an ideal location for mosquitoes to multiply.

A bromeliad can be induced to flower by placing it for a few weeks in a clear poly bag with an apple or with a slice of apple. Apples are known to be strong

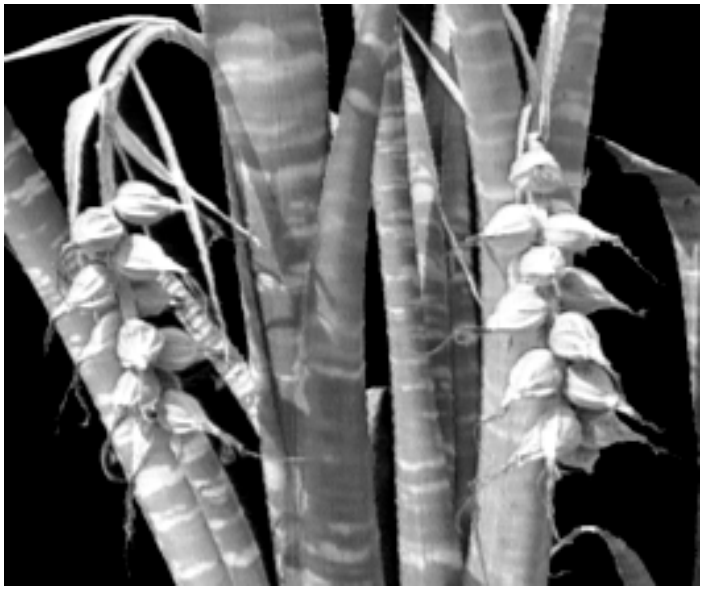

Figure 4. Attractive fruit (capsules) on *Billbergia zebrina* grown in Clemson greenhouse. It was one of the earliest bromeliads discovered (eastern Brazil).

producers of ethylene, a plant hormone that is increasingly produced by plants as they age or if they are injured. If a plant or its flowers is exposed to ethylene, aging can actually be speeded up. In the unique case of bromeliads, ethylene application results in floral initiation.

The case of pineapple: In years past, NAA (naphtha-lene acetic acid) was successfully applied to field plants to induce flower initiation. NAA is an auxin (i.e., a growth regulating chemical which induces cell elongation and cell division). Some auxins [e.g., IAA (indole acetic acid)] are produced naturally by the plant, and these are called hormones. By definition, hormones are produced in one location in the plant and translocated to another location in the plant where their effect is produced. The ability of auxins to induce flower initiation in bromeliads is unique among plants.

So, where does ethylene fit in? Ethylene is the most effective inducer of floral initiation of pineapple. Because ethylene is a gas, it was applied on activated charcoal "dust" to field plants. Research has shown that a plant's response to IAA (remember, this is naturally produced within the plant) is greatly enhanced by ethylene treatment. Ethylene, however, some say, should not be considered a growth hormone because the effect produced by its application is actually not directly due to ethylene; it's due to ethylene's enhancement of the effect of a growth hormone (i.e., IAA). Also, ethylene is not, in the true sense of the word, translocated; it diffuses. With pineapple, it could be that the ethylene effect is to enhance the effect of the auxin level present, the result being floral initiation. Ethephon [(2-chloroethyl) phosphonic acid] is not quite as effective on pineapple as ethylene, but it will induce floral initiation. The ethephon ("Ethrel" or "Florel") solution itself releases ethylene, so when ethephon is applied to a plant, the plant is exposed to the ethylene released by the ethephon solution. When flower initiation of bromeliads is induced via ethylene application, the time to "flower" varies from six (e.g., *Aechmea* spp.) to eight (e.g., *Vriesea* spp.) weeks.

Some growers in South Carolina have been successful in inducing flower initiation of several bromeliad species by using 2-hydroxyethyl hydrazine at the rate of 1.1 g per gal. of water. Thirty ml of this solution is applied twice, at a two-week interval, into the "cup" of each plant. Florel™ advertises the use of its product to induce floral initiation of *Ananas*, *Aechmea*, *Billbergia*, and *Vriesea*, pointing out that although it's almost 100% effective regardless of the application method, foliar sprays are more economical than crown treatments.

Some bromeliads (e.g., *Cryptanthus* spp.) are grown primarily for their foliage because their flowers are rather plain and small. With these, one would not be concerned with floral induction.

Some plants which are commercially popular, although sometimes "hard-to-get", are:

Aechmea fasciata. It's very popular -- green foliage with dense silver white scales. Its inflorescence of blue flowers within pink bracts is very attractive and extremely long lasting.

A. fasciata variegata. It's similar to the straight sp. but has a light yellow stripe in the center of leaves.

A. chantinii. Its olive leaves with pink-orange are very attractive. The inflorescence is red with yellow-tipped bracts.

A. 'Royal Wine'. This vigorous grower has maroon leaves with an orange/blue inflorescence without bracts.

A. 'Bey's Giant'. This attractive German hybrid is a rather large plant, compared to those above. Its green foliage has lime and dark green bands, and it produces a red flower.

Ananas bracteatus striatus. The variegated pineapple with its orange/pink fruit (Figure 1) is nice if you have space for it. Its sharp spines on its stiff foliage can be "mean."

Billbergia 'Fantasia'. It has a very upright habit of growth. Its foliage is olive (sometimes red-tinted) with ivory blotches. Its arched inflorescence of blue flowers with darker margins and rose bracts is most attractive but not long lasting, relatively speaking.

Cryptanthus spp. are smaller plants which are grown for their attractive foliage.

C. bivittatus minor. These small plants (about 4 in. diameter) have two black-green bands the length of their leaves. The copper foliage is intense in bright light, green in low light. It's suitable for terrariums.

C. bivittatus 'Pink Starlite'. Its medium green leaves are finely serrated at their wide, wavy, pink/red margins and have cream bands from end to end on both sides of the green center. It's very eye-catching.

C. fosterianus. It can get over a foot in diameter in a pot. It grows in a very flat rosette; its foliage very stiff, dark copper/green with lighter tan cross bands.

C. zonatus. It's similar to *C. fosterianus*, but its foliage is more wavy at leaf margins and not as stiff. Also, its foliage and crossbands are lighter in color.

C. x 'It'. It's similar to 'Pink Starlite,' except its green is darker and wider, and its leaf margins are not as wavy or light in color as 'Pink Starlite.'

Guzmania lingulata. Its leaves are light green, smooth, and not stiff. Its waxy inflorescence has bright red, yellow-tipped bracts. Its inflorescence life is moderate.

Neoregelia carolinae. This one is sometimes harder to find than the tricolor. Its strapped green, copper-tinted, serrated leaves with vivid red bases are striking. Its small purple flowers, which open just above the water level in the cup, are attractive but short lived.

N. carolinae 'Meyendorffii'. It's smaller than the above. Its leaf bases are maroon at flowering.

N. carolinae 'Tricolor'. Each leaf has yellow bands lengthwise, the central one the widest. Oth erwise, it's like the straight species.

N. 'Fireball'. This smaller plant has dark copper/maroon foliage. It freely produces offshoots on 3 to 5 inch stolons, making an attractive, unusual display when many connecting plants are produced.

Vriesea hieroglyphica. Its medium green leaves are cross-banded yellow, the bands not clearly defined (i.e., like they've been sprayed on). Its spikelike inflorescence produces yellow flowers. It's called "King of the Bromeliads."

V. splendens. Its medium green leaves are heavily cross-banded with dark purple. Its swordlike inflorescence of vivid red bracts and yellow flowers is eye-catching.

V. fenestralis. It's a very attractive one. Its broad light green leaves contain a "network" of spaced, dark green, fine lines in two directions (i.e., it looks like a dark green net has been placed over the light green foliage). It produces a bright yellow inflorescence, but it's the foliage that is so appealing.

Bromeliads seem to be an easy crop to produce, but time is involved. Some are well suited for the home environment and withstand as much abuse (i.e., neglect) as kalanchoe. Unlike many crops, some bromeliads can produce attractive foliage, flowers, and fruits. They probably will become more in demand but harder to acquire for some time as a result of the damage done to commercial production in south Florida by Hurricane Andrew.

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