Proc. Fla. State Hort. Soc. 96: 270-272. 1983.

PREMATURE WILT OF LEATHERLEAF FERN WITH DIFFERENT PINNAE MATURITIES FROM VARIOUS GROWING ENVIRONMENTS

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Additional index words. Fernery, frond curl *Rumohra adiantiformis.*

Abstract. **Leatherleaf fern [*Rumohra adiantiformis* (G. Forst.) Ching] with various pinnae maturities were sampled from a hammock and shadehouse environment to determine the incidence of postharvest wilt. The fronds were sampled from a single nursery with shadehouse and hammock growing areas. Fronds sampled from the shadehouse had a greater incidence of wilt than those sampled from the hammock. Fronds with mature pinnae had greater incidence of wilt then fronds with immature pinnae. Postharvest trimming of stripes greatly reduced but did not prevent premature wilt. Greatest amount of wilt (over 50%) occurred in mature fronds sampled from the shadehouse area without any postharvest stipe trimming. Fronds were sampled from different ferneries and evaluated for premature wilt. Incidence of wilt varied and depended on the grower source. Fronds from one fernery had a 50% wilt rate while fronds from other ferneries had no wilt. Fronds harvested from a heavily shaded greenhouse had fewer stomata than those harvested from shadehouses.**

The disorder commonly referred to as fern wilt has received much attention the last few years. Mathur et al. (7) described wilt by a partial or complete folding of the entire pinna starting as early as 1 day postharvest. Nell et al. (8) termed the syndrome frond curl to avoid confusion with common plant wilting due to drought stress. Mathur et al. (7) demonstrated that fronds grown in different commercial ferneries differed in wilt rates and was most prevalent in fronds harvested July through October.

Leatherleaf fern is grown under polypropylene shade fabric at shade levels of 63 to 73%, the latter being the preferred density (4). Stamps (9) reported no differences in wilt when ferns were grown in De Leon Springs under shade levels of 63 or 73%, but ferns grown in Pierson at 63% shade had more wilt than those grown at 73% shade.

Conover et al. (2) emphasized the importance of nutrition and irrigation as possible factors affecting wilt. They suggested that nutrition and watering could alter the physiology to produce weak stems with large thin walled cells and indicated wilt was not caused by a pathogen or stem blockage.

Nell et al. (8) reported that water potential of fern decreased rapidly shortly after harvest. The decrease in water potential was due to reduced water absorption but they found no occlusions at the base of stipes which would account for reduced uptake. They concluded that frond curl (wilt) was triggered by desiccation stress but other factors predesposed it.

This report summarizes the results of sampling of leatherleaf fern from various growing environments, different pinna maturities and postharvest stipe trimming on incidence of premature wilt.

[1]Research accomplished when the author was a member of the faculty at USDA-ARS and AREC, Bradenton.

Materials and Methods

General handling. Fronds used in these tests were harvested during September from ferneries located in the De Land area. The fronds were harvested midday to early afternoon and transported to AREC-Bradenton. During transit, the fronds were wrapped in moist newspaper and polyethylene sheeting. The fern was held overnight at 4-6°C. The following day, fronds were placed in quart jars (1 bunch/jar) containing deionized (DI) water and maintained at 23°C under cool-white fluorescent lights at 1.5 klux for 12 hr daily. Relative humidity varied from 50 to 70%. A frond was considered wilted when the margin of the pinna started to reflex inward (i.e. the point where the pinna margin reflexed at an angle of 10-15° above the frond plane). At this point the entire pinna usually reflexed inward.

Experiment 1. Fronds were harvested from a nursery (henceforth noted as Grower A) which had a history of premature wilt. This nursery had ferns growing under shadecloth (about 70% shade) and hammock areas. Fronds were harvested by an experienced harvester at 2 stages of maturity. For simplicity, the stages are designated mature and immature. Mature fronds refer to those which were dark green, fully expanded, and commercially acceptable for marketing. Immature fern refers to those which were light green and relatively soft. The latter group was judged to be about 2½ wk from stage for commercial harvest or mature stage. Twenty bunches of fern (10 mature and 10 immature) were harvested from each of the shadecloth and hammock growing environments. The fronds were transported to Bradenton and handled as outlined above. Five cm of the stipe ends of fronds from each growing environment-maturity group were trimmed before they were placed in water. Fronds from each growing environment-maturity group were also placed in water without any stipe trimming. The treatments of growing area, pinna maturity, and postharvest stipe trimming were arranged in a split-split plot arrangement with 5 replications (bunches) per treatment. There were 40 bunches or 1000 fronds in the sampling.

Experiment 2. Commercial grade, bunched fronds (about 25-30 cm long) were sampled from 4 ferneries. The fronds were transported and handled as outlined about. Fronds from Grower A (Experiment 1) were not used in this experiment. The morning after harvest the fronds from each fernery were divided into 2 lots. One lot was placed directly into jars of DI water. In the second lot, the stipe ends were retrimmed as outlined in Experiment 1 and placed in DI water. There were 4 replications (bunches) per treatment. There were 15 fronds per bunch. Number of wilted fronds were noted daily and water absorption was measured after 48 hr. Data were statistically analyzed for each fernery but not among the 4 ferneries.

Experiment 3. Fronds (25-30 cm long) were collected from 3 ferneries. Two of the ferneries were covered with shadecloth, (Growers F and G) while the third fernery was a heavily shaded greenhouse (Grower H). Fern from Grower G had a history of severe premature wilt (100% in 24-48 hr), while fern from F and H had no history of postharvest wilt. The fronds were brought to the laboratory and a silicone rubber imprint was made of the undersurface. A cellulose acetate positive imprint was made from the silicone mold. A light microscope was used to determine the number of stomata from the positive imprint. Data are expressed as numbers of stomata per cm² of frond.

Results and Discussion

Fronds sampled from the hammock environment had less wilt than those sampled from the shadehouse environment (Table 1). Fronds with mature pinnae had more wilt than those with immature pinnae. Fronds that had stipes trimmed before they were placed in water had less wilt than fronds without stipe trimming. Fronds with mature pinnae sampled from the shadehouse had more wilt than mature fronds sampled from the hammock environment (Table 2).

Table 1. Premature wilt of leatherleaf fern as influenced by sampling from different growing environments, pinna maturity and postharvest stipe trimming.

Growing environment	Pinna maturity	Postharvest stipe trimming	Wilted fronds/bunch after[z] 4 days	5 days
Hammock				
	immature	none	0.2[y]	0.2[y]
	immature	5 cm	0.6	0.6
	mature	none	1.8	2.2
	mature	5 cm	0.4	1.0
Shadehouse				
	immature	none	3.8	4.2
	immature	5 cm	0.2	0.6
	mature	none	13.8	15.6
	mature	5 cm	6.0	9.8

[z]25 fronds/bunch.
[y]Growing environment (GE), pinna maturity (PM), and stipe trimming main effects and GE x PM interaction are significant at the 1% level at 4 and 5 days.

Table 2. Premature wilt of leatherleaf fern after 4 and 5 days as influenced by sampling from different growing environments and pinna maturities.

Growing environment	Pinna maturity	Wilted fronds/bunch after[z] 4 days	5 days
Hammock	immature	0.4[y]	0.4[y]
	mature	1.1	1.6
Shadehouse	immature	2.0	2.4
	mature	9.9	12.7

[z]15 fronds/bunch.
[y]Growing environment x pinna maturity interactions are significant at the 1% level for each day. Data includes stipe trimming.

Most modern ferneries are covered with polypropylene to provide shade levels of 63 to 73% (4). The shadehouse used in this sampling reduced light about 70%, while the hammock environment reduced light about 90%. While the hammock growing area decreased light intensity, this growing area possibly had lower temperatures than those in shadehouses. Elevated temperatures may be the reason for the high incidence of wilt in shadehouses in July to October (7). The frond nutrient content is related to maturity. Fitts, et al. (3) found that nutrient content increased as frond matured. Possibly the different growing environments and grower fertilizer practices influence nutrient uptake and frond nutrient content and maturity.

Fern from hammock areas may have had fewer stomata than those in shadehouse areas, but stomatal density was not determined in this test (Experiment 1). In Experiment 3, fronds from a heavily shaded greenhouse had 23.3 x 10² stomata/cm², while those from the shadehouse had 32.0 x 10² and 39.4 x 10². Fern from Grower G had an unusually high incidence of wilting and also had the highest stomatal density. Fern from Growers F and H had low stomatal densities and no symptoms of wilt.

Fern from various growers had different wilt rates (Table 3). In some instances, fern from one grower showed symptoms of severe wilting (Grower C) while other growers had fern which did not wilt. Genetic variation may account for some of these differences. Chen and Read (1) showed that micropropagated leatherleaf fern expressed various phenotypes. Typically, clonal horticultural commodities respond uniformly to postharvest handling. For example, cut chrysanthemums subjected to harvesting procedures and floral preservatives responded uniformly to these treatments (5, 6). In the present study, only a portion of a given lot of fronds from any grower or environment wilted. Some of the variation in wilt may be due to a genetically mixed fern population among the various growers.

Table 3. Premature wilt of leatherleaf fern as influenced by sampling from different grower sources and postharvest stipe trimming.

Grower	Postharvest stipe trimming	Wilted fronds/bunch after[z] 1 day	2 days	Water absorbed in 2 days (ml/bunch)
B	none	2.0[y]	3.3	339
B	5 cm	0.3	2.0	469
C	none	7.8[y]	8.5	256
C	5 cm	3.3	6.0	374
D	none	0[x]	0	309
D	5 cm	0	0	449
E	none	0[x]	0.3	372
E	5 cm	0	0.2	499

[z]15 fronds/bunch.
[y]Statistical comparisons were made for samplings from individual growers. Trimming main effects are significant at the 1% level. Time main effects and time x trimming interaction are not significant.
[x]Not significant.

Stipe trimming improved water absorption and reduced but did not prevent wilting. I could not establish a relationship between water absorption and fern wilt. Fronds with trimmed stipes from Grower B absorbed 469 ml water and wilted, while fronds with untrimmed stipes from Grower D absorbed 309 ml but did not wilt.

I could not establish a cause for premature fern wilt but stomatal density and water retention may be important factors. Perhaps low light levels and/or other environmental factors produce fronds with low stomatal density, which transpire less than those with high stomatal density.

The season of the year, grower practices, genetic differences and other factors influence the incidence of rapid wilt, but the disorder still remains elusive.

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Proc. Fla. State Hort. Soc. 96: 272-273. 1983.

PRODUCTION AND POSTHARVEST CULTURE OF HELICONIA PSITTACORUM FLOWERS IN SOUTH FLORIDA[1]

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Additional index words. cut flowers, fertilization, light, temperature.

Abstract. Heliconia psittacorum **L.f. flowers, which superficially resemble those of bird-of-paradise** (Strelitzia reginae **Banks.), have brightly colored bracts and florets varying from pink, red, and orange, to yellow. Production in outdoor beds in south Florida begins in May and ends in November when minimum temperatures fall below 10° C. Flower production increased as fertilizer rate was increased and was substantially greater under full sun than under 63% shade. Bract size, peduncle length, total plant height, and postharvest life of cut heliconia flowers were comparable under the various fertilizer and light intensity regimes tested. Flowers must be cut at the desired stage of opening since further opening of the bracts does not occur after cutting, even if sucrose-containing solutions are used. Postharvest life averaged 14-15 days in deionized water, with or without floral preservatives. Flowers are damaged when stored at temperatures below 10° C.**

Heliconia psittacorum is one of several hundred species of tropical herbaceous plants which comprise the genus *Heliconia* (3). In general heliconias have banana-like foliage, spread by means of a fleshy underground rhizome, and have erect or pendulous terminal inflorescences composed of 2 or more boat-shaped bracts arising from a central floral axis. Within each bract are several florets which open sequentially, each lasting a day or 2 before abscissing (*H. psittacorum*) or senescing (most other species). The bracts of most species are brightly colored and many also retain their color and shape long after cutting. *H. psittacorum* flowers possess not only these characteristics, but also are borne on long clean peduncles and are produced throughout the year. Flower color in *H. psittacorum* ranges from pink, red, and orange to yellow. This paper discusses the production and postharvest culture of this promising new cut flower crop.

Heliconia psittacorum flowers are pollinated exclusively by several long-billed hummingbird species (2, 4), however, in the United States no such hummingbirds exist and viable seed is seldom produced. Dispersal of seeds in the tropics is also primarily by birds which eat the blue fruits. The main method of propagation, however, is by means of underground rhizomes. Single-eye rhizome pieces can be used to propagate heliconias, but the plants become established much more rapidly if rhizome clumps containing several eyes are planted. Clumps of rhizomes will fill in a bed in about 6-8 months if planted on 30-cm centers, but single eye rhizomes will require somewhat longer. In ground beds, 10 cm is a good planting depth for heliconia rhizomes.

Although heliconias can be grown in 35-cm or larger containers, the reduced drainage and restricted soil volume available for rhizome growth reduces the growth and flowering potential of these plants. They are best planted in ground beds bounded by a solid barrier 30 cm deep, which prevents the rhizomes from spreading into the aisles. A bed width of 90 cm is optimal for heliconia production. Narrower beds make inefficient use of space and wider beds not only make flower harvesting more difficult, but result in taller, more spindly plants in the center of such beds due to reduced light penetration through the dense foliage and subsequent plant stretching. Plant densities in 2-yr-old 120-cm wide beds grown in full sun exceeded 700 stems/m^2. Under these extremely crowded conditions, plant height exceeded 2.4 m and flower size was reduced. In narrower beds where fewer plants are subject to such dense shading, plant height can usually be kept under 1.2 m and flowers produced under these conditions are larger and stronger. Beds should be dug up, divided, and replanted after 2 yr if crowding is severe. To help alleviate the crowding problem, the vegetative stalk should also be removed along with the inflorscence at harvest by pulling or cutting at ground level. Since heliconia inflorescences are terminal, a stalk which has flowered serves no useful function, but competes with newly emerging shoots for light, water, and nutrients.

Fertilization rates strongly affect growth and flowering of heliconia under high light intensities (full sun). Under 63% shade, however, light is a limiting factor and increasing fertilization rate does not increase flower production (Table 1). In crowded second year beds in full sun, light reduction due to crowding again limited plant response to increased fertilization. If overcrowding can be prevented, a fertilizer rate of 650 g N/m^2/yr is excellent for heliconia production. Incorporation of dolomitic limestone and a complete micronutrient fertilizer blend is also essential to prevent deficiencies, particularly of Mg and Fe. Iron deficiency symptoms in heliconias may be induced by poor drainage, high soil pH (4.5-6.5 is excellent), root rot diseases, or by nematodes and will require treatment of the ultimate cause rather than just the Fe deficiency symptoms. Iron deficiency symptoms appear first on new foliage as uniformly yellow leaves. Magnesium deficiency symptoms appear first on older leaves as wide yellow bands along the leaf margins. Nitrogen deficient plants are light yellowish-green overall.

Light intensity appears to be one of the greatest limiting factors in heliconia production. Production under full sun was 2.5-3 times as great as under 63% shade (Table 1).

[1]Florida Agricultural Experiment Stations Journal Series No. 5165.