Keywords: cut flower, tropical floriculture, pre-breeding, inflorescence, morphology.

Abstract

Heliconia beautiful tropical flowers are helping to increase profits of cut flower industry worldwide. The inflorescence durability and vivid colors are supporting the commercialization on the international market. In Brazil, Pernambuco State is leading the research, production, and commercialization of heliconia inflorescences. The Federal Rural University of Pernambuco State (UFRPE) maintains its own Heliconia Germplasm Collection, which supplied the 10 genotypes evaluated in this study. The experimental design was randomized complete block design, with four replications. Cultivated in partial shade, the genotypes evaluated during 18 months were: Heliconia bihai; H. bihai ‘Nappi Yellow’; H. caribaea x H. bihai ‘Carib Flame’; H. collinsiana; H. episcopalis; H. pendula; H. psittacorum x H. spathocircinata ‘Golden Torch’; H. rostrata; H. stricta I; and H. stricta II. The flowering stems were collected at harvesting point, according to the genotype features. The evaluated variables were: fresh weight of stem (FWS); stem diameter (SD); stem length (SL); inflorescence length (IL); number of open bracts (NOB); bracts arrangement (BA) and wax on inflorescences (WAX). H. collinsiana and H. rostrata, which have pendant inflorescences, presented higher values of IL and NOB. The heaviest FWS was obtained with H. bihai (470 g) and H. collinsiana (410 g), which would have higher influence on transportation costs. SL varied from 71.60 cm (H. stricta II) to 121.51 cm (H. collinsiana). These results supply information for further studies on plant breeding programs and also show the potential of heliconia genotypes for tropical cut flower industry.

INTRODUCTION

Production and consumption of tropical flowers are increasing in many countries around the world. Tropical flowers are perceived by many flower consumers as exotic and unusual, with a potential market in temperate countries. Prices for Heliconia flowering stems can be over US$ 4 (Pizano, 2005).

Heliconia cut flower production is becoming an important agribusiness in Brazil. Pernambuco state, in Brazilian Northeast Region, produces heliconia flowers in the Atlantic Rainforest Zone. The extended blooming season, vivid colors, bigger flower size and higher quality are some of the advantages on growing these crops in this zone, which has great potential to become more competitive in the floriculture sector and an exponent of flower exportation (Loges et al., 2005a).

Despite the great potential, according to Pizano (2005), the commercialization of heliconia have not been as fast, simple and easy as expected, because of many reasons: availability of the product in quantity and quality; expected and historical price; variability of airfreight cost from one country to another; higher costs per commercialization box for larger and heavier flowering stems; necessity of better advertisement for office and home consumers.
Selection of genotypes for supporting the production of inflorescences in quality and quantity is strategic for this expanding industry in Brazil. Studies of pre-breeding parameters are necessary for defining commercial standards of stem fresh weight, number of leaves on stem at inflorescence emission, stem diameter and length, inflorescence length, wax presence and bract arrangement on inflorescence.

This study consisted of an evaluation of inflorescence morphological characters of genotypes from the Heliconia Germplasm Collection of the Federal Rural University of Pernambuco state (UFRPE). The main objective was to supply information to be considered for genotype selection for further breeding studies to support better quality production of heliconia for exportation as cut flower.

MATERIAL AND METHODS

The experiment was carried out from December 2003 to July 2005, at the Heliconia Germplasm Collection of Federal Rural University of Pernambuco state (UFRPE), located in the Atlantic Rainforest Zone, Northeast Region of Brazil (latitude S 8º19', longitude W 34º59'33'', and altitude 100 m). The local average temperature is 25.1°C and the monthly average precipitation is 171 mm, with maximum of 377 mm and minimum of 37 mm (ITEP, 2006). The irrigation was applied when needed by a microsprinkler irrigation system.

The evaluated genotypes were *H. bihai*; *H. bihai* ‘Nappi Yellow’; *H. caribaea* x *H. bihai* ‘Carib Flame’; *H. collinsiana*; *H. episcopalis*; *H. pendula*; *H. psittacorum* x *H. spathocircinata* ‘Golden Torch’; *H. rostrata*; *H. stricta* I; and *H. stricta* II. It was used the randomized complete block design, with four replications. The plant spacing was 1.5 m between plants in the row and 3.0 m between rows, at partial shade condition.

All the inflorescences were cut at 20 cm above ground level at the harvesting point according to the genotype characteristics (Loges et al., 2005b), and taken to the Floriculture Laboratory of UFRPE. The categories of the evaluated parameters were defined based on the classification used by growers for commercialization of these cut flowers. Using the methodology adapted from Castro (1993) inflorescence morphological characters were evaluated:

- Number of leaves in the stem at inflorescence emission (NLI).
- Fresh weight of stem (FWS): Light (less than 100 g); Medium (between 101 and 200 g); and Heavy (more than 201 g).
- Stem diameter 20 cm below the inflorescence (SD): Thin (less than 10.0 mm); Medium (between 10.1 and 30.0 mm); and Thick (more than 30.0 mm).
- Stem length (SL): Short (less than 50.0 cm); Medium (between 50.1 and 150.0 cm); and Long (more than 150.0 cm).
- Inflorescence length (IL): Short (less than 10.0 cm); Medium (between 10.1 and 30 cm); Long (between 30.1 and 50.0 cm); and Very Long (more than 50.0 cm).
- Number of open bracts at the harvest point (NOB).
- Bracts arrangement (BA): one plane or Spiraled.
- Wax on inflorescences (WAX): Presence or Absence.

The statistical analyses (ANOVA) were performed for all the data, except for those genotypes that produced less than 10 inflorescences per clump (NIC). The means were compared using the Scott-Knott test (Scott and Knott, 1974). Mean data of all evaluated traits of genotypes with less than 10 inflorescences per clump (NIC) are shown just for information purposes.

Considering some of the inflorescence morphological characters, the heliconia genotypes were classified for performance as cut flower crop: High Performance [fresh weight of stem less than 100 g, wax absence, and one plane arrangement of bracts]; Regular Performance [fresh weight of flowering stem between 101 to 200 g, wax absence]; and Low Performance [fresh weight of stem more than 200 g, spiraled arrangement of bracts]. The performance classification was defined taking in consideration transportation costs (the heavier the worse) and difficulty for handling and packing (plane arrangements accommodate better in the box). These aspects are directly
related to the product commercialization and the potential of certain heliconia genotypes for the cut flower industry.

RESULTS AND DISCUSSION

Mean data of the evaluated genotype characters are shown in Table 1. The genotypes with less than 10 flowering stems per clump were not statistically analyzed for these agronomic traits; however means are shown (Table 1). *H. pendula* did not begin its flowering stage during the 18 months of study, showing no precocity.

The number of leaves in the flowering stem at inflorescence emission (NLI) varied from 5.25 (*H. rostrata*) to 6.17 (*H. collinsiana*). According to Atehortua (1998), heliconia plants start flowering after emitting a number of leaves depending on species or variety. Criley and Kawabata (1986) observed inflorescence emission in *H. stricta* ‘Dwarf Jamaica’ when plants presented 6 or 7 leaves. Criley and Sakai (1998) reported that the heliconia flowering occurs with three expanded leaves. Castro (1995) reported that four to five leaves are needed for inflorescence emission. Criley (2000) stated that weather and environmental factors, such as light and humidity, have influence on timing of leaves and inflorescence emission.

Based on fresh weight of stem (FWS), the genotypes were classified as: Light (*H. psittacorum* x *H. spathocircinata* ‘Golden Torch’); Medium (*H. rostrata* and *H. stricta* I); Heavy (*H. bihai* and *H. collinsiana*). The FWS is directly related to transportation costs. Lighter heliconia stems are more adequate for commercialization as cut flowers (Criley et al., 2001; Pizano, 2005). Up to 120 flowering stems of *H. psittacorum* x *H. spathocircinata* ‘Golden Torch’ with 80 cm long, can be arranged in commercial boxes for 18 kg (dimensions: 1.15 m x 0.45 m x 0.20 m). For genotypes with heavy flowering stems, as *H. bihai*, the number is limited to 20 to 30 (Loges et al., 2005b).

Based on stem diameter (SD), the genotypes were classified as: Thin (*H. psittacorum* x *H. spathocircinata* ‘Golden Torch’); Medium (*H. rostrata*, *H. collinsiana* and *H. stricta* II); and Thick (*H. bihai*). The SD depends on the number of leaves that can not be removed during the post-harvesting process in order to keep stem firmness. Furthermore, genotypes with inflorescence pedicle far above the shoot apex, like *H. psittacorum* x *H. spathocircinata* ‘Golden Torch’, present smaller diameter and consequent lighter weight of flowering stem. Genotypes with short pedicle (some are not visible), like *H. bihai*, present larger diameter. However, according to Castro (2007), thinner and longer stems are more susceptible to rupture during handling procedures, resulting in quality losses up to 40%.

All the genotypes had stem length (SL) between 71.60 and 121.51 cm (medium length). The *H. bihai* genotypes presented SL values from 74.96 cm (*H. bihai* ‘Nappi Yellow’) to 95.42 cm (*H. bihai*). Lalrinawani and Talukdar (2000), in India, observed one-year old *H. psittacorum* plants with stem length varying from 116.90 cm to 91.77 cm. In Pernambuco state, stem length with 80 cm is the commercialization standard for heliconia (Loges et al., 2005b). Most the genotypes evaluated in this study fit to this standard for stem length, except for *H. bihai* ‘Nappi Yellow’ and *H. stricta* II. It may be possible that these two genotypes were not able to produce longer stems, since they may require stabilization periods longer than the 18 months considered in this study.

The larger values of inflorescence length (IL) were observed in *H. bihai* (classified as long length), *H. stricta* II (classified as medium length) and species with pendant inflorescences, like *H. collinsiana* (classified as long length) and *H. rostrata* (classified as long length). Minor value of IL was observed in *H. psittacorum* x *H. spathocircinata* ‘Golden Torch’ (classified as medium length). Lalrinawani and Talukdar (2000) observed inflorescences of *H. psittacorum* with maximum length of 18.56 cm.

The larger number of open bracts at harvesting point (NOB) was observed in genotypes with pendant inflorescences. The harvesting point of inflorescences based on NOB for each species is defined by the flower consumer market. The experience has been showing that inflorescences with smaller NOB present longer durability and are easier for handling and packing.
The bracts arrangement of the inflorescence has important influence on handling and packing and on the number of inflorescences per commercial box. Inflorescences with bracts arrangement in one plane allow easier handling and packing and also more stems per box. On the other hand, it is more difficult handling and packing inflorescences with bracts spirally arranged, taking more time and allowing less flowering stems per box. Some heliconia species present waxy bracts and should not be immersed in water during the washing procedure to avoiding stains on the bract surface (Loges et al., 2005b). Moreover, the post harvest handling and transportation may remove the wax from some portions of the bract surface causing quality losses.

Considering the bracts arrangement, wax on inflorescences and fresh weight of stem, the genotypes were classified as: High performance (H. rostrata, H. stricta II and H. psittacorum x H. spathocircinata ‘Golden Torch’); Regular performance (H. bihai, since it was classified as heavy inflorescence); Low performance (H. collinsiana). Only H. collinsiana presented bracts spirally arranged and wax. The other genotypes were not evaluated for this parameter due to the low number of flowering stems.

For heliconia cut flower industry the characteristics of interest are: production of inflorescences during the whole year; short flowering cycle; light flowering stems for lower transportation costs; stems longer than 80 cm; stems with diameter thick enough for better resistance to handling and for lighter total weight of inflorescence; inflorescences with no wax and no hair; and bracts arranged in one plane for easier handling and packing.

In addition, other characteristics must be observed: inflorescence width; length and rachis diameter mainly in erect inflorescences for reducing the possibility of rupture; firmness of bracts; bracts not too deep and with a few or no flower inside (which will reduce time and cost of cleaning and minimize occurrence of insects, odors from water accumulation and organic matter deterioration); and post-harvesting durability longer than seven days.

**CONCLUSIONS**

The genotypes H. rostrata, H. stricta II and H. psittacorum x H. spathocircinata ‘Golden Torch’ were classified as High Performance; H. bihai as Regular Performance; and H. collinsiana as Low Performance.

Many genotypes with regular or low performance are commercialized in local markets or exported only because of their beauty, which indicates the need for plant breeding, considering morphological and qualitative characters.

Since heliconia is a perennial crop, some species may require stabilization periods longer than the 18 months considered in this study. Some parameters and some estimates may differ from the ones presented in this paper if the plants are already well established for their production cycle. Therefore, evaluation studies longer than 18 months are highly recommended.

**ACKNOWLEDGEMENTS**

The authors are thankful to: CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), FACEPE (Fundação de Amparo à Ciência e Tecnologia de Pernambuco), BNB (Banco do Nordeste do Brasil), PROMATA (Programa de Apoio ao Desenvolvimento Sustentável da Zona da Mata de Pernambuco), FMFT (Fazenda Mumbecas Flores Tropicais), and the students of the floriculture lab of the UFRPE, for their support to this study.

**Literature Cited**


ITEP – Instituto de Tecnologia de Pernambuco. 2006, 09 de dezembro. Disponível em: http://www.itep.br/lamepe.ASP.
Table 1. Morphological characters of flowering stems evaluated for 18 months in genotypes from Heliconia Germplasm Collection of UFRPE, cultivated at partial shade condition.

<table>
<thead>
<tr>
<th>GENOTYPES</th>
<th>NIC</th>
<th>NLI</th>
<th>FWS</th>
<th>SD</th>
<th>SL</th>
<th>IL</th>
<th>NOB</th>
<th>BA</th>
<th>WAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>H. bihai</td>
<td>31.8</td>
<td>A</td>
<td>5.45</td>
<td>A</td>
<td>470</td>
<td>A</td>
<td>31.65</td>
<td>A</td>
<td>Thick</td>
</tr>
<tr>
<td>H. collinsiana</td>
<td>15.5</td>
<td>A</td>
<td>6.17</td>
<td>A</td>
<td>405</td>
<td>A</td>
<td>23.51</td>
<td>B</td>
<td>Medium</td>
</tr>
<tr>
<td>H. bihai ‘Nappi Yellow’</td>
<td>4.8</td>
<td>5.18</td>
<td>280</td>
<td>Heavy</td>
<td>26.30</td>
<td>Medium</td>
<td>74.96</td>
<td>31.39</td>
<td>2.97</td>
</tr>
<tr>
<td>H. caribaea x H. bihai ‘Carib Flame’</td>
<td>7.3</td>
<td>4.78</td>
<td>456</td>
<td>Heavy</td>
<td>31.99</td>
<td>Thick</td>
<td>91.96</td>
<td>35.76</td>
<td>3.23</td>
</tr>
<tr>
<td>H. episcopalis</td>
<td>6.0</td>
<td>5.48</td>
<td>135</td>
<td>Medium</td>
<td>10.75</td>
<td>Medium</td>
<td>87.4</td>
<td>12.14</td>
<td>5.02</td>
</tr>
<tr>
<td>H. stricta I</td>
<td>1.5</td>
<td>6.34</td>
<td>248</td>
<td>Heavy</td>
<td>30.55</td>
<td>Thick</td>
<td>88.9</td>
<td>33.05</td>
<td>3.04</td>
</tr>
</tbody>
</table>

Notes: NIC = Number of inflorescences per clump; NLI = Number of leaves in the stem at inflorescence emission; FWS = Fresh weight of stem: Light (less than 100 g); Medium (between 101 and 200 g); and Heavy (more than 200 g); SD = Stem diameter 20 cm below the inflorescence: Thin (less than 10.0 mm); Medium (between 10.1 and 30.0 mm); and Thick (more than 30.0 mm); SL = Stem length: Short (less than 50.0 cm), Medium (between 50.1 and 150.0 cm), Long (more than 150.0 cm); IL = Inflorescence length: Short (less than 10.0 cm); Medium (between 10.1 and 30 cm); Long (between 30.1 and 50.0 cm); and Too Long (more than 50.1 cm); NOB = Number of open bracts at the harvest point; BA = Bracts arrangement: Distichous or Spiraled; WAX = Wax on inflorescences: Presence or Absence.

*Means with same letter Scott-Knott, at 5%

Mean data of genotypes with less than 10 inflorescences per clump are shown but were not considered for statistical analysis.