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Feeding Preferences of *Agraulis vanillae* (Gulf Fritillary) for *Pentas lanceolata* cultivars[®]

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A study conducted in 2002 determined feeding preferences of *Agraulis vanillae* L. (gulf fritillary butterfly) for *Pentas lanceolata* (Forssk.) Deflers cultivars. *P. lanceolata* (pentas) are herbaceous annuals in the majority of the United States and commonly recommended nectar sources for attracting butterflies. Through hybridization *P. lanceolata* are produced in a wide range of flower colors and growth habits. One cultivar, 'Lilac Mist', attracted a greater number of total inflorescence visits, feeding visits, total plant trips, and longer visit duration by the gulf fritillary butterfly than the remaining five cultivars evaluated. Differences in morphology and color characteristics were found among cultivars. However, these differences did not correlate with the observed feeding preference.

INTRODUCTION

Butterfly gardening has become a popular niche in horticulture. Fueled by the popularity and increasing number of butterfly centers at public botanical gardens across the nation, the public has embraced the idea of attracting butterflies to their home landscapes. The horticultural industry has responded by marketing and producing plants that serve as nectar sources to attract butterflies to tap into this growing market. Considerable knowledge exists regarding the species of plants that are important nectar sources. However, over the years, extensive successful hybridization of these plants by the horticultural industry has produced many cultivars of the same species with a wide range of flower colors and growth habits. These additional cultivars meet consumers aesthetic needs, but their effectiveness for attracting butterflies is not known. Research has shown butterflies can be highly selective in their

choice of nectar plants, based on many factors, including color, nectar guides, and nectar sugar concentrations (Culin, 1997; Dafni et. al, 1998; Kandori and Naota, 1998; and Rusterholz and Erhardt, 1997). Additionally, previous research has shown that changes in corolla size and form during hybridization may disrupt or expand morphological matches between flower and insect, affecting nectar accessibility and changing the pollinator species composition (Comba et. al., 1999). The objective of this study was to evaluate feeding preferences of one butterfly species, *Agraulis vanillae* (Gulf Fritillary) for cultivars of one known nectar source, *Pentas lanceolata*. Plant characteristics investigated in this study were flower color characteristics, including light reflectance in the visible spectrum, and morphology.

MATERIALS AND METHODS

Pentas lanceolata liners were potted into 3.8 liter (#1) plastic containers on 15 Nov. 2001. Growing medium consisted of a pine bark and sand (7 : 1, v/v) substrate amended per cubic yard (cubic meter) with 13.8 lb (8.2 kg) Polyon 18-6-12 (Pursell Technologies), 1.5 lb (0.9 kg) Micromax (The Scotts Company), and 5.0 lb (3.0 kg) dolomitic limestone. Plants were grown in a double-poly greenhouse under natural light conditions with greenhouse vent and heat set points of 85° F (29°C) and 65°F (18°C). Gulf fritillary butterflies used in preference tests were reared in an indoor captive colony, without contact with flowering plants before the preference test, providing a 20% sugar solution for nourishment.

On 11 Feb. 2002 and 28 March 2002, six single plant replications of 'New Look Red', 'Lilac Mist', 'Butterfly Light Lavender', 'Red Butterfly', 'Butterfly Deep Pink', and 'Red' pentas were placed in a 12 ft × 8 ft × 7 ft (3.7 m × 2.4 m × 2.1 m) flight pen located within a glass greenhouse. Plants were placed on the flight pen floor in a completely randomized design. Six adult gulf fritillary butterflies were placed in the flight pen and observed. A different set of plants and butterflies were used on each test date. On 11 Feb. 2002 and 28 March 2002, the butterflies were observed for 1 h (Test #1) and 2 h (Test #2 and Test #3), respectively. On 28 March 2002, the 1st hour of observations (Test#2) were separated from the 2nd h of observations (Test #3) due to possible differences in the greenhouse environment including temperature, relative humidity, and light levels.

Data collected for butterfly visitation included:(1) number of total visits to individual inflorescences, (2) number of feeding visits and landing visits, (3) duration of each inflorescence visit in seconds, and (4) number of separate trips to each plant. Duration per visit was calculated by dividing the total visit duration in seconds by total number of visits. Temperature, relative humidity, and light levels within the flight pen were recorded at the beginning and end of each test. Flowering data collected immediately following the preference tests on 11 Feb. 2002 and 28 March 2002 included number of inflorescences, inflorescence width, and percent flowering.

Before conducting the preference tests, hue, lightness, chroma, and light reflectance in the visible spectrum wavelengths (400 to 700 nm) of flowers were quantified using the Minolta Spectrophotometer CM-2002 A (Minolta Camera Co., Ltd., Ramsey, New Jersey) using three to six single plant replications. Additionally, corolla width, corolla tube length, and nectar guide width were measured.

Table 1. Mean total visits, feeding visits, landing only visits, total trips, visit duration, and duration per visit observed for gulf fritillary butterfly visitation of *Penstemon* cultivars combining tests performed on 11 Feb. 2002 and 28 March 2002^z.

Cultivar	Total inflorescence visits ^y	Feeding visits	Landing only visits	Total plant trips	Total visit duration (seconds)	Duration per visit (seconds)
Lilac Mist	1.7 a ^x	1.3 a	0.7 a	1.6 a	9.7 a	4.7 a
Butterfly Deep Pink	1.0 b	0.7 b	0.5 ab	0.9 b	5.4 b	3.8 ab
Red	0.8 bc	0.2 bc	0.7 a	0.8 bc	3.4 bc	1.9 bc
Butterfly Light Lavender	0.8 bc	0.4 bc	0.5 ab	0.7 bc	2.6 bc	1.6 c
Red Butterfly	0.5 bc	0.3 bc	0.2 b	0.4 bc	1.7 bc	1.6 c
New Look Red	0.3 c	0.2 c	0.2 b	0.3 c	1.0 c	1.0 c

^zResults combined from three repeated tests. Tests #1 performed on 11 Feb. 2002 and Tests #2 and #3 performed on 28 March 2002.

^yData exhibited a Poisson distribution, a square root transformation was used to bring data closer to normality to meet ANOVA assumptions.

^xMeans within columns followed by different letters are significantly different according to Duncan's Multiple Range Test at the 5% level.

Table 2. Mean flower morphology characteristics including corolla widths, corolla tube lengths, and nectar guide widths of *Penstemon* cultivars collected in January 2002.

Cultivar	Corolla width (mm)	Corolla tube length (mm)	Nectar guide width (mm)
Lilac Mist	14.25 b ^x	18.98 a	4.39 b
Butterfly Deep Pink	17.20 a	19.13 a	5.16 a
Red	14.48 b	15.20 b	3.70 d
Butterfly Light Lavender	13.24 c	19.45 a	4.09 c
Red Butterfly	14.61 b	16.95 b	3.98 c
New Look Red	13.34 c	16.91 b	3.52 d

^xMeans followed by different letters are significantly different according to Duncan's Multiple Range Test at the 5% level.

RESULTS

Butterfly visitation data exhibited a Poisson distribution and a square root transformation was used to bring it closer to normality to meet ANOVA assumptions. Data collected from the three tests were statistically similar using ANOVA and the results were combined (Table 1). 'Lilac Mist' had the greatest number of total inflorescence visits (1.7), feeding visits (1.3), total plant trips (1.6), and visit duration (9.7 sec) compared to the remaining cultivars, while duration per visit for 'Lilac Mist' (4.7) and 'Butterfly Deep Pink' (3.8) was similar. The number of total inflorescence visits (1.0 to 0.3), feeding visits (0.7 to 0.2), total plant trips (0.9 to 0.3), and duration of visits (5.4 to 1.0 sec) were similar among the remaining cultivars with the exception of 'Butterfly Deep Pink' which was greater than 'New Look Red'. Mean duration per visit was similar for 'Butterfly Deep Pink' (3.9 sec) and 'Red' (1.9 sec), with the remaining cultivars and 'Red' being similar, ranging from 1.9 sec to 1.0 sec.

Morphological differences in corolla and nectar guide widths and corolla tube lengths were found among cultivars (Table 2.) The mean corolla and nectar guide widths of 'Butterfly Deep Pink' [0.7 in (17 mm) and 0.2 in (5.3 mm), respectively] were greater than the remaining cultivars. The mean corolla tube lengths of 'Butterfly Deep Pink', 'Lilac Mist', and 'Butterfly Light Lavender' were similar and greater than the remaining cultivars, ranging from 0.8 inches (19 mm) to 0.8 inches (19 mm).

Cultivar differences were also found in the remaining plant characteristics evaluated: inflorescence number and width, flowering percentage, and color characteristics such as hue, chroma, lightness, and light reflectance. However, correlations between butterfly visitation and these characteristics did not reveal correlation coefficients greater than 0.45 (N=108). Therefore, while gulf fritillary visitation and duration of visits were statistically greater for the cultivar 'Lilac Mist', no direct correlation was found in the plant characteristics investigated.

DISCUSSION

There has been few detailed studies conducted examining whether all cultivars or varieties of a certain plant species are equally effective in attracting butterflies. In these studies, visitation of the Gulf Fritillary butterfly to one *Pentas* cultivar 'Lilac Mist' was greater than visitation to the remaining cultivars in the tests. However, the various cultivar characteristics investigated did not reveal obvious correlations with the observed preference. Further studies on additional flowering characteristics of *P. lanceolata* cultivars, including nectar volumes and nectar sugar composition, along with thorough evaluations of other commonly used nectar sources, could provide information to the horticulture industry regarding which traits are most effective for butterfly attraction and should be targeted for hybridization and development.

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