Canna spp. Cultivar Response to the Lesser Canna Leafroller, *Geshna cannalis* (Quaintance), and the Japanese Beetle, *Popillia japonica* (Newman)[1]

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Abstract

Twenty-two cultivars of canna lilies, *Canna* × *generalis*, were evaluated for potential resistance to the lesser canna lily leafroller, *Geshna cannalis*, and the Japanese beetle, *Popillia japonica*. Both of these pests cause defoliation of the plants resulting in reduced plant fitness and aesthetic injury. Cultivars sustaining the most damage by leafrollers were 'Richard Wallace', 'Firebird', and 'Black Knight'. While Japanese beetle injury varied, cultivars most consistently damaged by beetles were 'Lenape', 'Scarlet Wave', 'Dawn Pink', and 'Crimson Beauty'. While all plants sustained at least some injury, cultivars that consistently had the least amount of damage by leafrollers were 'Maudie Malcolm', 'Striped Beauty', and 'Journey's End'. 'Maudie Malcolm' and 'Striped Beauty' were similarly avoided by Japanese beetles, while 'Journey's End' sustained moderate injury from this pest. Tall cultivars with red or orange flowers and some red in their foliage were especially vulnerable to infestation by the lesser canna leafroller.

Index words: hexapoda, lesser canna leafroller, Japanese beetle, ornamental pest, canna lily.

Species used in this study: *Canna* × *generalis* L.H. Bailey cultivars 'Wyoming', 'Firebird', 'Richard Wallace', 'City of Portland', 'Yellow King Humbert', 'Crimson Beauty', 'Orange Beauty', 'Red Dazzler', 'Dawn Pink', 'Journey's End', 'Cleopatra', 'President', 'Miss Oklahoma', 'Black Knight', 'Red King Humbert', 'Striped Beauty', 'Lenape', 'Maudie Malcom', 'Tropical Sunrise', 'Tangelo', 'Scarlet Wave', 'Pretoria', 'Wyoming', 'Firebird'.

Significance to the Nursery Industry

Cannas are popular ornamental plants prized for their tropical appearance and bright colors. Canna leafrollers and Japanese beetles can render the plants unsightly. We examined the tolerance of 22 cultivars to these two major pests for two years in two locations in field and in complementary greenhouse studies. Cultivars 'Maudie Malcolm', 'Striped Beauty', and 'Journey's End' consistently exhibited less severe signs of damage by these two pests, while cultivars like 'Richard Wallace' and 'Scarlet Wave' typically demonstrated greater injury. Tall cultivars with red or orange flowers and some red in their foliage were especially vulnerable to infestation by the lesser canna leafroller. Growers, landscape managers and homeowners can use this information to better understand management needs for popular cultivars and to provide pest-tolerant choices for varying sites.

Introduction

Cannas are tropical ornamental plants with large, colorful flowers and interesting foliage (2, 3). Cannas are commonly grown in landscapes within the southern United States and range in size from less than thirty inches to more than ten feet tall (3). The common ornamental canna lily is an interspecific hybrid, *Canna* × *generalis* L.H. Bailey, and is commercially available in hundreds of cultivars exhibiting dramatic differences in foliage and flower colors (8).

Three major pests of cannas are the lesser canna leafroller, *Geshna cannalis* (Quaintance), larger canna leaf roller, *Calpodes ethilus* (Stoll), and the Japanese beetle, *Popilla japonica* Newman (3, 8, and 9). Canna leafrollers can cause defoliation and lead to deformation of plant structures (5). Larvae roll leaves into long tubular structures around themselves using silken strands that serve as both protection and shelter for development (5). In addition to physically altering the leaves, larvae also chew distinctive rows of holes in the leaves while feeding (5, 8). The Japanese beetle, *Popillia japonica* Newman, a widespread pest throughout the United States, has over 300 recorded host plants (6). The adult beetle causes extensive defoliation resulting in a characteristic skeletonization pattern often leaving only the leaf veins. Larvae cause additional damage to ornamental plants and turf by feeding on roots and other plant structures found underground, which reduces the ability of the plant to take up enough water and nutrients.

While canna lily cultivars have been evaluated for resistance to *Calpodes ethlius* (7), the objective of our study was to determine whether resistance is found within commonly available canna lily cultivars to the Japanese beetle, the lesser canna leaf roller, or both.

Materials and Methods

Field choice study. Individual rhizomes of each of 22 cultivars (Table 1) were planted in a randomized complete block design in field plots on April 10, 2008, and April 30, 2008, respectively, at the University of Georgia Research and Education Garden (Griffin, GA), and the University of Georgia Mountain Research and Education Center (Blairsville, GA). Each replication included three bulbs of each cultivar within each of five blocks, totaling 330 plants at Griffin and 315 in Blairsville where 'Pretoria' was not represented. Bulbs were planted 0.3 m (1 ft) apart with an additional 0.3 m (1 ft) between each group of 3 bulbs of a single cultivar. Plots were irrigated with drip irrigation and mulched with pine bark wood chip mulch. Plot borders were maintained using

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Table 1. Canna cultivar physical characteristics.

Variety	Height	Color	
		Foliage	Flowers
'Wyoming'	Dwarf	Dark bronze-red	Orange
'Firebird'	Dwarf	Forest green	Crimson red
'Richard Wallace'	Medium	Apple green	Sunshine yellow
'City of Portland'	Medium	Green	Coral pink
'Yellow King Humbert'	Medium	Apple green	Yellow/orange splashes
'Crimson Beauty'	Medium	Green foliage	Dark fuchsia
'Orange Beauty'	Tall	Green	Bright orange
'Red Dazzler'	Tall	Green	Dark red
'Dawn Pink'	Dwarf	Dark burgundy	Coral pink
'Journey's End'	Dwarf	Green	Cream with pink streaks
'Cleopatra'	Medium	Green/red streaks	Yellow/red streaks
'President'	Dwarf	Forest green	Bright red
'Miss Oklahoma'	Dwarf	Green	Pink
'Black Knight'	Dwarf	Burgundy	Deep red
'Red King Humbert'	Tall	Bronze-red	Red
'Striped Beauty'	Dwarf	Green with light stripes	Clear yellow
'Lenape'	Dwarf	Dark green	Gold with red dots
'Maudie Malcom'	Dwarf	Dark green	Rose pink
'Tropical Sunrise'	Dwarf	Green	Pink and apricot
'Tangelo'	Dwarf	Green	Tangerine
'Scarlet Wave'	Dwarf	Green	Cherry Red
'Pretoria'	Tall	Yellow/green striped	Orange
'Wyoming'	Dwarf	Dark bronze-red	Orange
'Firebird'	Dwarf	Forest green	Crimson red

glyphosate with additional hand weeding as necessary. No insecticides were applied.

Plants were sampled on June 9, June 18, July 15, August 18, and September 26, 2008; May 19, June 16, July 22, and August 8, 2009, in Griffin. Data were collected in Blairsville on July 9 and August 7, 2008, and July 31, 2009. Plants were visually observed for intact larval *G. cannalis* rolls and Japanese beetle damage. Data collected on each date at each location included the number of inhabited intact larval leaf rolls per plant. Damage estimates from 0 to 100 were recorded for Japanese beetles and for leafrollers in Blairsville on July 31, 2009. Data were subjected to analysis of variance following arcsine square root transformation using the GLM procedure in SAS; mean separation was by LSD.

Greenhouse no-choice study. A no-choice greenhouse experiment was also conducted on July 29, 2008, using Japanese beetles individually caged onto potted canna plants. Individual rhizomes of canna cultivars were planted in one gallon containers using Sun Gro Metro-Mix 300 growing medium in April 2008. Fifteen canna cultivars were arranged in a randomized block design with ten individual plant repetitions. Plants were hand watered daily and received no chemical applications. Each plant received two females and two males confined in nylon screen cages. After five days, the overall percent damage inflicted on the plants was recorded. These data were analyzed as above.

Results and Discussion

Canna plots in Griffin and Blairsville became naturally infested with lesser canna leafroller and Japanese beetles over the course of the two year study. Leafrollers during the first year in Griffin were numerous enough to analyze by the August 2008 sample. They were present in sufficient numbers to analyze as early as May in Griffin in 2009. Cannas in Blairsville became infested with leafrollers late in 2009. Japanese beetles did not cause significant damage to cannas in Griffin during 2008, but were sufficiently numerous in Blairsville to rate during both years of the study. On all sample dates, infestation by leafrollers was significantly different ($P < 0.05$) among the cultivars (Table 2). Higher densities of both Japanese beetles and canna leafrollers were present during the 2009 sampling season.

In 2008 'Wyoming' and 'Firebird' were the most preferred canna leafroller host plants, although all cultivars sustained some level of infestation (Table 2). In the 2009 field experiments, 'Richard Wallace' was the most consistently preferred leafroller host in Griffin (Table 2). Damage caused by Japanese beetles was also significantly different among the cultivars. 'Lenape', 'Scarlet Wave', 'Crimson Beauty' and 'Dawn Pink' were among the most heavily damaged cultivars (Table 3).

Consistently throughout all studies conducted, 'Maudie Malcolm', 'Striped Beauty' and 'Journey's End' were the least preferred hosts of lesser canna leafrollers (Table 2). 'Maudie Malcolm', 'Striped Beauty' and 'Black Knight' sustained less damage than other cultivars exposed to Japanese beetles. 'Journey's End' which was less susceptible to leafrollers sustained moderate damage by Japanese beetles in field and greenhouse evaluations (Table 3). No single cultivar was completely resistant to either the canna lily leafroller or Japanese beetles.

Sadof and Sclar (8) found that the maximum percent damage caused by Japanese beetles tolerated by homeowners on canna lilies was less than 10%,and that this aesthetic injury level was consistent with other studies. Based on our field studies, 22% of the cultivars observed fell above the established 10% injury level accepted by consumers, indicating that those varieties would not be tolerated in a homeowner landscape setting.

Similar to a previous study on canna lily resistance to the larger canna leafroller, a hesperiid, found that leaf and

Table 2. Occurrence of lesser canna lily leafroller, *Geshna cannalis*, on 22 canna lily cultivars.

	Leafrollers and damage[x]						
Cultivar	**8/18/08[z]**	**9/26/08[z]**	**5/19/09[z]**	**6/16/09[z]**	**7/22/09[z]**	**7/31/09[y]**	**8/06/09[z]**
'Wyoming'	1.8bc	4.1a	1.8b–g	0.5f–j	1.2b–g	15.6b–e	4.7d–g
'Firebird'	3.7a	3.3ab	2.1b–g	1.8ab	1.5b–d	15.0b–e	5.1c–f
'Richard Wallace'	1.8bc	2.3b–f	4.8a	2.0a	2.9a	22.5b	5.4b–e
'City of Portland'	1.3b–f	1.6d–h	2.9bc	0.5f–j	1.1d–h	13.3b–f	4.3e–h
'Yellow King Humbert'	0.9c–g	2.5b–f	2.2b–g	0.8d–h	1.1d–h	8.7c–g	3.5g–i
'Crimson Beauty'	0.3fg	0.5ij	1.6c–h	0.2h–j	1.3b–f	5.0e–g	2.5ij
'Orange Beauty'	0.7d–g	2.2b–g	2.8b–d	1.5a–c	1.9bc	21.5b	4.7d–g
'Red Dazzler'	0.5e–g	1.7d–h	1.6d–h	1.1c–e	1.5b–e	18.3bc	3.7g–i
'Dawn Pink'	1.9b	3.0bc	0.9g–i	0.5e–j	0.7e–i	6.7d–g	5.1b–f
'Journey's End'	1.1b–g	1.3f–j	0.4hi	0.2h–j	0.1i	6.4d–g	2.5ij
'Cleopatra'	0.3fg	1.5d–h	1.7c–g	0.6e–j	0.6e–i	8.7c–g	4.4d–hi
'President'	1.1b–g	1.3e–j	1.8b–g	1.1c–f	0.5f–i	4.0fg	6.7b
'Miss Oklahoma'	0.9c–g	0.8h–j	1.6d–h	0.3h–j	0.5g–i	9.3c–g	5.4b–d
'Black Knight'	0.6d–g	2.4b–d	1.2f–i	1.3b–d	1.6b–d	50.0a	8.2a
'Red King Humbert'	1.6bcd	2.4b–d	3.1b	1.3b–d	2.1ab	16.4b–d	6.3bc
'Striped Beauty'	0.6d–g	1.3f–j	0.2i	0.2ij	0.1i	1.7g	5.6b–d
'Lenape'	1.5b–e	1.2g–j	1.8b–g	0.4g–j	0.8d–i	3.6fg	3.9f–h
'Maudie Malcom'	0.1g	0.4j	0.3hi	0.1j	0.3hi	0.9g	1.5j
'Tropical Sunrise'	0.9c–g	1.2g–j	1.9b–g	0.7d–i	0.8d–i	7.1d–g	3.3hi
'Tangelo'	0.7d–g	1.6d–i	2.4b–f	1.0c–g	1.5b–d	2.5fg	3.8f–i
'Scarlet Wave'	0.9c–g	1.9c–g	2.6b–e	1.5a–c	1.1c–g	15.0b–e	4.6d–h
'Pretoria'	0.2g	2.5b–d	1.4e–i	1.1c–e	1.5b–e	—	7.9a

[z]Average number of intact leaf rolls observed per plant, field plot choice study, Griffin.

[y]Observed percent damage (0–100%) to leaf surfaces, field plot choice study, Blairsville.

[x]Means in a column followed by the same letters are not significantly different ($P > 0.05$), LSD.

flower color influenced the amount of damage caused (7). We found plant height, flower color and foliage color to be a significant factor for lesser canna leafroller, a pyralid, and to lesser extent, Japanese beetles. Taller cultivars, darker foliage, and red and orange flowers were found to be more attractive to the lesser canna leafroller than cultivars possessing other traits (Table 4). Taller cultivars in this study possessed red or orange flowers (Table 1). However, even when dwarf cultivars alone are examined for influence of flower color (Table 5), orange and red were flowering culti-

Table 3. Japanese beetle, *Popillia japonica*, damage on 22 canna lily cultivars.

	Japanese beetle damage[x]				
Cultivar	**7/9/08[z] Blairsville**	**8/7/08[z] Blairsville**	**6/16/09[z] Griffin**	**7/31/09[z] Blairsville**	**7/29/08[y]**
'Wyoming'	2.5e–g	1.1e	0.0c	4.08a–c	6.5cd
'Firebird'	9.9a–e	7.8a–c	0.8c	0.0d	5.4cd
'Richard Wallace'	5.5d–g	3.0de	3.0a	0.0d	5.1cd
'City of Portland'	3.3d–g	3.6c–e	1.3abc	1.8a–d	5.3cd
'Yellow King Humbert'	1.4fg	0.9e	1.0bc	0.92cd	—
'Crimson Beauty'	13.9ab	5.5bd	0.8c	5.0a	16.0ab
'Orange Beauty'	1.8fg	1.4de	2.8ab	2.0a–d	3.1d
'Red Dazzler'	13.4a–c	3.6c–e	0.8c	0.67d	18.2a
'Dawn Pink'	11.4a–d	9.4ab	0.0c	4.33ab	7.5cd
'Journey's End'	6.1c–g	3.5de	0.0c	1.55b–d	10.9a–c
'Cleopatra'	5.3d–g	2.9de	0.0c	3.0a–d	8.2cd
'President'	6.0c–g	0.9e	0.0c	0.0d	10.0b–d
'Miss Oklahoma'	3.9d–g	2.4de	0.7c	0.0d	—
'Black Knight'	0.2g	0.1e	0.0c	0.0d	5.0cd
'Red King Humbert'	7.2b–g	1.2e	0.6c	0.39d	—
'Striped Beauty'	2.5e–g	0.9e	0.0c	0.47d	—
'Lenape'	16.7a	10.0a	0.0c	2.29a–d	—
'Maudie Malcom'	0.9g	0.2e	0.0c	0.18d	5.2cd
'Tropical Sunrise'	7.4b–g	3.9c–e	0.0c	0.0d	5.0cd
'Tangelo'	8.8b–f	2.7de	0.0c	0.0d	—
'Scarlet Wave'	16.4a	9.5a	0.0c	5.0a	10.3b–d
'Pretoria'	—	—	0.8c	—	—

[z]Observed percent damage (0–100%); field plot choice study.

[y]Observed percent damage (0–100%) to leaf surfaces; greenhouse no-choice study.

[x]Means in a column followed by the same letters are not significantly different ($P > 0.05$), LSD.

Table 4. Flower and foliage color and plant height influence on lesser canna lily leafroller, *Geshna cannalis*, on 22 canna lily cultivars.

	Leafrollers and damage[x]					
	9/26/08[z]	5/19/09[z]	6/16/09[z]	7/22/09[z]	7/31/09[y]	8/06/09[z]
Flower color						
Orange	2.6a	2.2a	1.5a	1.0a	16.2a	5.1ab
Red	2.2a	2.1a	1.4ab	1.0a	16.2a	5.7a
Yellow	1.6b	2.0a	1.0bc	1.0a	8.8b	4.6b
Pink	1.1b	1.3b	0.6c	0.4b	7.2b	3.5c
Foliage color						
Red	2.6a	NS	NS	NS	NS	2.4a
Green	1.6b					1.2b
Plant height						
Tall	2.2a	2.3a	1.7a	1.3a	18.2a	5.6a
Medium	1.6b	2.5a	1.3b	1.0ab	12.0b	4.0b
Dwarf	1.8ab	1.5b	0.8c	0.7b	7.2c	4.6b

[z]Average number of intact leaf rolls observed per plant, field plot choice study, Griffin.

[y]Observed percent damage (0–100%) to leaf surfaces, field plot choice study, Blairsville.

[x]Means in a column followed by the same letters are not significantly different ($P > 0.05$), LSD.

Table 5. Flower color influence on lesser canna lily leafroller, *Geshna cannalis*, among 15 dwarf canna lily cultivars.

	Leafrollers and damage[x]					
	9/26/08[z]	5/19/09[z]	6/16/09[z]	7/22/09[z]	7/31/09[y]	8/06/09[z]
Flower color						
Orange	2.9a	NS	1.2a	0.7b	13.6a	4.1bc
Red	2.2a		1.2a	1.4a	13.1a	6.0a
Yellow	1.2b		0.5b	0.3c	2.3b	4.7b
Pink	1.3b		0.5b	0.4c	5.3b	3.6c

[z]Average number of intact leaf rolls observed per plant, field plot choice study, Griffin.

[y]Observed percent damage (0–100%) to leaf surfaces, field plot choice study, Blairsville.

[x]Means in a column followed by the same letters are not significantly different ($P > 0.05$), LSD.

vars within this height category were most often preferred. Japanese beetles caused more damage to cultivars with red in the foliage on July 31, 2009, in Blairsville (red mean 2.4 vs green mean 1.2, $P < 0.05$). Flower color was significant for Japanese beetles only on July 9 where orange flowered cultivars were the least preferred ($P < 0.05$). Another study also found that Japanese beetles were attracted to lighter colored flowers (yellow and white) on hybrid tea roses as opposed to darker colored flower varieties (4). Height was not a significant factor influencing Japanese beetle preference in our study ($P > 0.05$ for all dates).

In addition to insect pests, canna lily cultivars have also been evaluated for resistance to canna rust, *Puccinia thaliae*, and Hippeastrum mosaic virus (HM) (1). Canna cultivars 'Wyoming' and 'Ambassador' were found to be highly resistant to canna rust and 'Louis Cayeaux' and 'La Boheme' were found to be moderately resistant to HM (1). Resistance to both diseases was not found in a single cultivar (1).

Our results and those of others suggest considerable variation in susceptibility to insect and disease pests among commonly available canna lily cultivars. Future studies identifying the specific mechanisms or attributes responsible for the varying levels of pest infestation on different canna lily cultivars could better inform plant breeding and selection efforts.

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