Preference of Twolined Spittlebug for *Ilex* Species, Hybrids and Cultivars[1]

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Abstract

Preference of twolined spittlebug, *Prosapia bicincta* (Say), for holly species and cultivars was evaluated in the laboratory using detached leaf assays. Field evaluations of spittlebug preference confirmed the high level of susceptibility of holly taxa with *Ilex cassine* L. or *I. opaca* Ait. parentage. Taxa observed in the field were rated as highly preferred (10 taxa), moderately (15 taxa), slightly (49), or not preferred (63) based on number of spittlebugs found infesting plants and degree of damage apparent during the two-year study. Increased production and use of pest-resistant plant material reduces the need for pesticide use and provides a good foundation for integrated pest management efforts.

Index words: pest-resistant plants, integrated pest management, twolined spittlebug, holly, nursery crops.

Significance to the Nursery Industry

Use of pest-resistant plants in the landscape can reduce the need for insecticide use in our landscapes. Identifying pest-resistant plant material provides an opportunity for incorporating pest-resistant plants in plant breeding programs. Knowing the pest resistance status of available cultivars assists in recommendations concerning their use in the landscape. The 137 *Ilex* L. selections evaluated in this study ranged from highly susceptible to completely resistant to feeding damage from the adult twolined spittlebug. *Ilex cassine* L. and *Ilex opaca* Ait., as well as the hybrids between the two parents (*I.* x *attenuata* Ashe) were very susceptible to damage. Species generally resistant to damage from twolined spittlebug were *Ilex cornuta* (Lindl. & Paxt.), *I. glabra* (L.) Gray, *I. verticillata* (L.) Gray, and *I. vomitoria* Ait. This information should be useful to nurserymen and landscapers, allowing them to make alternative selections or take appropriate control measures.

Introduction

The twolined spittlebug (TLS), *Prosapia bicincta* (Say), is a North American species with a wide geographic distribution (2, 6). It occurs from Maine to Florida and west to Iowa, Kansas, and Oklahoma. The TLS has been a sporadically severe pest of Coastal bermuda grass and other bermuda grass pastures in the southeast since the early 1950s (3, 5, 7). Recently damage to warm season grasses, especially centipede grass, and to a wide variety of woody landscape species, notably hollies, has focused attention on twolined spittlebug as a pest of ornamentals (2).

Two generations of the spittlebug have been shown to occur in Georgia and Florida (1, 3, 5), with a possible partial third generation present in some areas. Eggs overwinter in hollow stems of turfgrass, under leaf sheaths and in debris. Nymphs feed on herbaceous plants. Nymphs have been recorded on over 40 different plants, predominantly grasses. Once the mouthparts are inserted, nymphs produce their characteristic protective spittle mass.

In Georgia adults of the first generation are active in June. Second-generation adult activity peaks in August and September. The adult stage causes injury to woody ornamental plants, including hollies. Phytotoxemia induced by adults on turf has been noted (4). Damage associated with the second generation is usually most severe. Several woody and herbaceous hosts have been noted for adult and nymphal twolined spittlebugs (3, 7) including *Ilex opaca* and *I. cornuta* 'Burfordii'. Our objective was to determine the range in susceptibility among holly selections to TLS.

Materials and Methods

Laboratory evaluation. Cuttings from 23 holly accessions located at the Coastal Plain Experiment Station in Tifton, GA, were taken during 1994 and used to identify TLS preference under controlled laboratory conditions. Cuttings of different taxa were arranged in a randomized complete block design with five replicates inside large plastic arenas (38 cm x 34 cm x 15 cm) on August 22, 1994. Twenty spittlebugs were released into the center of the arena and location of spittlebugs on cuttings within these arenas was noted at 2, 4, 9, 21, and 24 hours post-introduction. After the 24-hour exposure period, three damage ratings per cutting were also taken using a scale of 0 (no damage) to 9 (severe damage) based on the blotchy discoloration typical of feeding on fully expanded foliage. Data were subjected to ANOVA and means were separated using Fisher's protected LSD.

Field evaluation. The *Ilex* collection (137 in-field accessions) at the Coastal Plain Experiment Station was evaluated for susceptibility to adult TLS infestation and damage. Levels of natural infestation and damage were assessed for the field-grown collection on three separate dates: August 19 and 26, 1994, and June 14, 1995. Sampling during 1994 corresponded with the occurrence of the second generation, while activity by the first generation was observed in 1995. Number of adult spittlebugs present per plant and number of damaged terminals per plant were recorded. Damaged terminals were evident as either possessing blotchy, irregular,

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interveinal discolored areas and/or distortion of new growth in response to feeding. A susceptibility rating was assigned to each plant selection based on the average number of spittlebugs or damaged terminals observed as follows: None = 0 TLS and 0 damaged terminals, Slight = 0–2 TLS or 0–10 damaged terminals, Moderate = 2–8 spittlebugs or 10–30 damaged terminals, and High = 9–15 TLS or 30+ damaged terminals.

Results and Discussion

Laboratory evaluation. Laboratory assays of 23 selections revealed a high level of susceptibility among cultivars with *I. cassine* or *I. opaca* parentage. Mean number of spittlebugs per cutting varied from 0–5 during the 24-hour assay. Significant ($P < 0.05$) differences in distribution occurred after 9 hours of exposure to plants in these arenas. After 24 hours a distinct pattern of preference was present (Table 1) that was also reflected in the average number of spittlebugs present per cutting.

Those plant taxa exhibiting most severe damage included 'Savannah', 'Carolina #2', 'Eagleston', 'East Palatka', 'Foster #2', 'W. J. Bean', *I. cassine*, and an *I. integra* Thunb. x *rugosa* Friedr. Schmidt. cross (Table 1). Cultivars in the laboratory assay exhibiting no damage included 'Shamrock', 'Winter Red', 'Burfordii', 'Wetumpka', 'Warren's Red', and 'Kathy Ann'. Damage as a result of feeding injury was more apparent on certain plant taxa than on others. *Ilex cassine*

Table 1. Laboratory evaluation of two-lined spittlebug (TLS) preference for holly taxa.

Plant species or cultivar[y]	Mean number of TLS per cutting		Mean damage rating[z]
	24 hrs	Avg/5 ratings	
'Carolina # 2'	2.6	1.4	3.2
'W. J. Bean'	1.6	1.0	3.2
'Rocket'	1.4	0.9	2.0
I. cassine (N5–10)	1.2	0.6	2.0
'Eagleston'	1.0	1.1	2.3
'Foster # 2'	1.0	0.6	1.9
'Nellie R. Stevens'	0.8	0.9	0.3
'China Boy'	0.8	0.6	0.7
'Lassie'	0.8	0.7	0.8
'Mary Nell'	0.6	0.5	0
I. cassine (N5–13)	0.6	0.6	2.9
'Wetumpka'	0.4	0.5	0
'Emily Bruner'	0.4	0.4	0
'Savannah'	0.4	0.5	2.3
'Shamrock'	0.2	0.1	0
'East Palatka'	0.2	0.2	1.8
I. cassine var. angustifolia	0.2	0.4	2.0
'Burfordii'	0	0.3	0
I. integra x *rugosa*	0	0.5	1.9
'Winter Red'	0	0.1	0
I. decidua (N7–8)	0	0.2	0.3
'Warren's Red'	0	0.1	0
'Kathy Ann'	0	0.2	0
P Value	0.0001	0.0001	0.0001
LSD	0.9	0.7	1.5

[z]Rating scale: damage was rated using a 0–9 scale from no damage to severely damaged.

[y]See table 2 for cultivar/species relationships.

Table 2. Relative resistance among holly taxa to two-lined spittlebug (TLS) in field evaluations.

TLS preference[z]	Damage rating[y]	Plant taxa
		Ilex x *altaclarensis* (Dallim.) Rehd. (*aquifolium* x *perado*)
S	S	'Wight Selection'
M	M	'W. J. Bean'
S	N	'Wilsonii'
		Ilex aquifolium (L.)
S	S	'Angustifolia'
H	S	'Golden Milkmaid'
		Ilex aquifolium x *cornuta* (Lindl. & Paxt.)
N	S	'Nellie R. Stevens'
		Ilex (*aquifolium* x *cornuta*) 'Nellie R.Stevens' x *leucoclada* (Maxim.)
S	N	'Clusterberry'
		Ilex (*aquifolium* x *ciliospinosa* Loes.) x *pernyi* Franch.
S	S	'September Gem'
		Ilex x *aquipernyi* Gable ex W. Clarke
S	M	'San Jose'
		+ *Ilex* x *aquipernyi*
S	N	'Dragon Lady' (on 'Nellie R. Stevens')
		Ilex x *attenuata* Ashe (cassine x opaca)
S	S	'Alagold'
M	N	'Bienville Gold'
M	S	'Blazer'
H	H	'Eagleston'
H	H	'East Palatka'
S	S	'Foster #2'
S	N	Accesssion N8–1
H	N	'Greenleaf'
M	M	'Nasa'
H	H	'Rocket'
H	H	'Savannah'
S	S	'Sunny Foster'
		Ilex buergeri Miq.
N	S	Accession N3–7
N	N	Accession N9–20
		Ilex cassine L.
H	H	Accession N5–11
H	H	Accession N5–10
H	H	Accession N5–13
S	N	var. myrtifolia (N7–6)
H	H	var. angustifolia (N7–7)
M	N	*Ilex cassine* var. angustifolia x *vomitoria* Ait.
S	S	*Ilex colchica* Franch.
		Ilex cornuta Lindl. & Paxt.
N	N	'Batwing'
N	N	'Berries Jubilee'
N	N	'Burfordii'
N	N	'Burford Nana'
N	N	'Burford Sport'
N	N	'Carissa'
N	N	'Casey'
S	S	Accession N4–6
S	S	'Dazzler'
N	S	'Femina Spreading'
N	N	'Fineline'
N	S	'Gable #76'
N	N	'Lottie Moon'
N	N	'Needlepoint'
N	N	'O'Spring'
N	N	'Rotunda'
N	N	Accession N4–4
N	N	'Shangri-La'
N	N	'Sizzler'
S	N	'Slack'
N	N	'Stoutmeyer'
		Ilex cornuta x *ciliospinosa* Loes
N	N	'William Cowgill'
		Ilex cornuta x *latifolia* Thunb.
N	N	'Emily Bruner'

Table 2. Relative resistance among holly taxa to two-lined spittlebug (TLS) in field evaluations, continued.

TLS preference[z]	Damage rating[y]	Plant taxa
S	N	'Ginny Bruner'
N	N	'James Swan'
		Ilex cornuta x *pernyi* Franch.
N	N	'Dr. Kassab'
N	S	'Hohman's Weeping'
		Ilex (*cornuta* x *pernyi*) x *latifolia*
N	N	'Mary Nell'
		Ilex crenata Thunb.
N	N	'Golden Gem'
N	N	'Helleri'
S	N	'Jersey Pinnacle'
S	N	'Snow Flake'
N	N	'Sky Pencil'
N	N	'Soft Touch'
		Ilex decidua Walt.
N	N	'Council Fire'
S	S	Accession N7–10
S	N	'Pocohontas'
S	S	'Warren's Red'
M	M	Accession N7–8
		Ilex glabra (L.) Gray
N	N	'Compacta'
N	N	'Georgia Wine'
N	N	'Ivory Queen'
N	N	'Nordic'
N	N	'Shamrock'
		Ilex integra Thunb.
N	S	Accession N5–18
N	N	Accession N9–19
		Ilex integra x *pernyi*
S	M	'Elegance'
H	H	*Ilex integra* x *rugosa* Friedr. Schmidt.
		Ilex x *koehneana* Loes. (aquifolium x latifolia)
N	S	'Hohman'
S	S	'Jade'
S	S	'Lassie'
S	N	'Wirt L. Winn'
N	N	*Ilex latifolia* Thunb.
		Ilex x *latifolia*
N	N	Accession N8–7
N	N	Accession N9–11
S	S	'Kurly-Koe'
		Ilex latifolia x *cornuta*
H	S	'Lib's Favorite'
		+ *Ilex* x *meserveae* S. Y. Hu.
S	S	'Blue Maid' (on Nellie R. Stevens)
S	N	'Blue Princess' (on Nellie R. Stevens)
		Ilex x *meserveae* (aquifolium x rugosa)
S	S	'Blue Prince'
M	N	'Blue Princess'
		Ilex opaca Ait.
M	S	'Canary'
M	S	'Carolina #2'
S	S	'Dan Fenton'
S	S	'George Hart'
S	S	'Jersey Knight'
M	S	'Jersey Princess'
M	S	'Maurice Rivers'
S	S	'Red Velvet'
S	N	'William Hawkins'
S	S	var. Arenicola
		Ilex perado Ait.
N	N	Accession N9–12
N	N	Accession N5–14
N	N	*Ilex pernyi* Franch.
		Ilex purpurea Hassk.= *I. chinensis* Sims
N	N	Accession N3–3
N	N	Accession N3–4
		Ilex rugosa x *cornuta*
S	S	'China Boy'
S	S	'China Girl'
S	N	*Ilex spinigera* Loes.
		Ilex verticillata (L.) Gray
N	N	'Afterglow'
N	N	'Aurantica'
S	S	'Earlibright'
N	N	'Southern Gentleman'
N	N	'Winter Red'
		Ilex verticillata x *serrata* Thunb.
N	N	'Autumn Glow'
N	N	'Harvest Red'
N	N	'Raritan Chief'
N	N	'Sparkleberry'
		Ilex vomitoria Ait.
N	N	'Big leaf'
N	N	'Bordeaux'
S	N	'Folsom's Weeping'
S	N	'Kathy Ann'
N	N	'Lynn Lowrey'
S	N	'Pendula'
N	N	'Saratoga Gold'
N	N	'Will Fleming'
N	N	Accession N7–14
N	N	'Dare County'
N	N	'Wiggin Yellow'
N	N	*Ilex* x *wandoensis* T. Dudley (cornuta x integra)
		Unknown Parentage
N	S	'Carolina Sentinel'
S	N	'Wetumpka'
N	N	'Festive'
N	N	'Oak Leaf'
N	N	'Cardinal'
N	N	'Little Red'

[z]TLS preference and damage ratings: N = none, S = slight, M = moderate, H = high.

[y]See text for further explanation of rating scale.

var. angustifolia, *I. integra* x *rugosa*, 'Savannah', 'East Palatka", and *I. cassine* expressed greater injury in relation to number of spittlebugs observed on the plants than did many other cultivars that had similar numbers of spittlebugs associated with them during the experiment. This may reflect a lower tolerance to the toxin injected by the adult spittlebug when feeding.

Field evaluation. Insect populations during the evaluation period were moderate to high at the site. Number of TLS on field grown plants observed on the three sampling dates ranged from 0 to 28 adult spittlebugs per plant. Number of damaged terminals ranged from 0 to 62.

Hollies in the collection ranged from highly susceptible to completely resistant (Table 2). In general, *I. cassine* and *I. opaca* were again observed to be highly susceptible to TLS. Crosses involving those species as parents (*I.* x *attenuata* Ashe) were also very susceptible. Species with only slight or no susceptibility to the spittlebug included *I. cornuta, I. vomitoria, I. verticillata, I. glabra* and others (Table 3). One selection, however, 'Lib's Favorite' (*I. latifolia* Thunb. x *cornuta)* was observed to be heavily infested with TLS during the second generation only. Very little foliar damage was

Table 3. Number of cultivars exhibiting various levels of susceptibility to twolined spittlebug.

Ilex spp. (no. cultivars)	None	Slight	Moderate	High
I. x *attenuata* Ashe (*cassine* x *opaca*) (12)		4	3	5
I. cassine L. (5)		1		4
I. cassine Ait. var. angustifolia x *vomitoria* (1)	1			
I. integra Thunb. x *rugosa* Friedr. Schmidt. (1)				1
I. opaca Ait. (10)		6	4	
I. aquifolium (L.) (2)		1	1	
I. x *altaclarensis* (Dallim.) Rehd. (*aquifolium* x *perado*) (3)	2	1		
I. aquifolium (Lindl. & Paxt.) x *cornuta* (1)	1			
I. (*aquifolium* x *cornuta*) x *leucoclada* (Maxim.) (1)		1		
I. (*aquifolium* x *ciliospinosa* Loes.) x *pernyi* Franch. (1)		1		
I. x *aquipernyi* Gable ex. W. Clarke (2)	1	1		
I. colchica Franch. (1)		1		
I. x *koehneana* Loes. (*aquifolium* x *latifolia*) (4)		4		
I. latifolia x *cornuta* (1)			1	
I. x *meserveae* S. Y. Hu (*aquifolium* x *rugosa*) (4)		3	1	
I. rugosa x *cornuta* (2)		2		
I. spinigera Loes. (1)		1		
I. buergeri Miq. (2)	1	1		
I. cornuta Lindl. & Paxt. (21)	16	5		
I. cornuta x *ciliospinosa* Loes. (1)	1			
I. cornuta x *latifolia* Thunb. (3)	2	1		
I. cornuta x *pernyi* Franch. (2)	1	1		
I. (*cornuta* x *pernyi*) x *latifolia* (1)	1			
I. crenata Thunb. (6)	4	2		
I. decidua Walt. (5)	1	3	1	
I. glabra (L.) Gray (5)	5			
I. integra Thunb. (2)	1	1		
I. integra x *pernyi* (1)	1			
I. latifolia Thunb. (3)	3			
I. x *latifolia* (1)	1			
I. perado Ait. (2)	2			
I. pernyi Franch. (1)	1			
I. purpurea Hassk. = *I. chinensis* Sims (2)	2			
I. verticillata (L.) Gray (5)	4	1		
I. verticillata x *serrata* Thunb. (4)	4			
I. vomitoria Ait. (11)	8	3		
I. x *wandoensis* T. Dudley (1)	1			
Unknown parentage (6)	4		2	

observed and the majority of the spittlebugs were concentrated on the fruit.

Additional insect or mite species that were observed on field grown plants included at least two species of scale insects, spider mites, and southern red mites. In addition sharpshooters, *Homaladisca* spp. (Homoptera: Cicadellidae) were regularly observed on 51 holly taxa of the total that were included in the study. Although present in moderate numbers, these leafhoppers inflicted no damage.

These experiments evaluated spittlebug preference under conditions involving choice among plant taxa. Those that were not observed to be infested under these conditions may prove suitable for the spittlebug under no-choice conditions. Cultural management such as irrigation and fertilization practices may also influence the degree of susceptibility of plant taxa to their insect and mite pests and may affect the relative ranking of resistance and insect abundance (e.g., 8). Overall, 10 taxa were determined to be highly preferred by TLS, 15 taxa were moderately preferred, 49 were only slightly preferred, and 63 taxa were not observed to be infested or damaged by the spittlebug under our conditions.

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