Evidence for Resistance of Deciduous Azaleas to Azalea Lace Bug[1]

S. Kristine Braman and Andrew F. Pendley[2]
Department of Entomology
University of Georgia
College of Agriculture Experiment Stations
Georgia Station
Griffin, GA 30223

Abstract

Five deciduous *Rhododendron* species (*R. albamense* Rehder, *R. austrinum* (Small) Rehder, *R. calendulaceum* (Michaux) Torrey, *R. canescens* (Michaux) Sweet, and *R. prunifolium* (Small) Millais) were tested for resistance to oviposition by the azalea lace bug (ALB), *Stephanitis pyrioides* (Scott). Control plants were *R. mucronatum* 'Delaware Valley White' (DVW), a susceptible evergreen variety. *Rhododendron canescens* and *R. prunifolium* were the least suitable for adult survival and the most resistant to oviposition in no-choice tests repeated six times during a two year study. All deciduous species were significantly less preferred than DVW early in the season corresponding with activity of first generation ALB adults. In late season assays corresponding to activity of second and third generation ALB adults, only *R. canescens* was consistently less preferred than DVW.

Index words: azalea lace bug, host plant resistance

Plant species used in this study: Alabama azalea (*Rhododendron albamense* Rehder); Florida azalea (*R. austrinum* (Small) Rehder); Flame azalea (*R. calendulaceum* (Michaux) Torrey); Piedmont azalea (*R. canescens* (Michaux) Sweet); Plumleaf azalea (*R. prunifolium* (Small) Millais); and 'Delaware Valley White' azalea (DVW) (*R. mucronatum* (Blume) G. Don 'Delaware Valley White')

Significance to the Nursery Industry

Native deciduous azaleas have potential for becoming increasingly valuable landscape plants for many urban and rural uses. Azalea lace bug (ALB) is a significant pest of azaleas in urban plantings. Although less susceptible to infestation and damage by ALB than evergreen varieties, the deciduous azaleas will support adult feeding and oviposition and nymphal development. The five azalea species studied varied in degree of susceptibility to ALB. *Rhododendron canescens* and *R. prunifolium* were considered the least susceptible. Production of insect resistant plants may be a consideration in increasing market acceptance.

Introduction

Azalea lace bug, *Stephanitis pyrioides* (Scott) a native of Asia, is one of the most serious pests attacking cultivated azaleas (5). Nymphs and adults feed on the underside of leaves where they pierce the plant and destroy the mesophyll. Infested leaves have a stippled appearance from above and are discolored with dark, varnish like excrement and exuviae (cast nymphal skins) from below. Both the evergreen and deciduous species, as well as greenhouse and hardy azaleas are susceptible to infestation (1). Infestations on deciduous azaleas are reportedly less severe, attributed, in part, to the fact that ALBs overwinter in the egg stage in the leaves of evergreen hosts and are therefore not harboured through the winter on deciduous plants (1).

Interest in native plants has resulted in wider commercial availability of seedling and cutting grown native azaleas (4). Susceptibility to known pests can be a consideration in the development of desirable hybrids and in long-term integrated pest management strategy. Indigenous plants may be quite sensitive to disease or insect pests, especially introduced pests. Here we present the results of a study designed to evaluate the relative susceptibility of five species of native azaleas to infestation by ALB.

Materials and Methods

Plant materials used in this study were obtained from Callaway Gardens, Pine Mountain, GA. One cutting from each of 12 plants of the previously mentioned deciduous *Rhododendron* spp. was collected three times per year for two years. Cuttings of azalea 'Delaware Valley White' used for comparative purposes were obtained from 12 container grown plants maintained in a screenhouse.

During 1990 cuttings were collected on May 8, June 26, and Aug 15. Cuttings were obtained during 1991 on May 7, July 3, and August 19. These dates corresponded with peak periods of oviposition activity of first, second, and third generation adults observed in the landscape (2). One 32 ml vial containing a cutting bearing two leaves of each entry was prepared on each date.

Two female ALBs collected locally from landscape azlaeas were confined to each of the 12 cuttings per cultivar using ventilated plastic cages. Adults were allowed to feed and oviposit for four days held in an environmental chamber at 24 ± 1°C (75.2°F) and a 15:9 hr light:dark photoperiod. Following the exposure period adults were removed and survivorship recorded. Leaves were backlighted and the number of eggs per cutting inserted into plant tissue was determined. Data were subjected to analysis of variance and

[1]Received for publication September 16, 1991; in revised form December 5, 1991. The research reported here was supported, in part, by a grant from the Horticultural Research Institute, Inc., 1250 I Street, NW, Suite 50, Washington, DC 20005. The authors gratefully acknowledge the cooperation of Callaway Gardens personnel for making the facilities and gardens available for research purposes. Appreciation is extended to Leon W. Hepner, Professor Emeritus, for identification of leafhopper specimens and Russell F. Mizell, III, University of Florida, for comments on the manuscript.

[2]Assistant Professor and Research Technician, respectively.

means were separated using Fisher's protected least significant difference test (LSD).

During 1990, cuttings with eggs were returned to the environmental chamber and maintained until eggs had hatched. Nymphs were supplied with additional cuttings of the appropriate plant material as needed. Developmental rates of azalea lace bug reared on cuttings in the laboratory compared closely with development in the landscape on intact plants (2). This suggests that excised plant material does not adversely affect azalea lace bug biology. Number of individuals surviving to the adult stage was recorded. Percentage data for eggs laid that survived to the adult stage were subjected to arcsine transformation prior to analysis of variance and mean separation using LSD.

In free-choice tests conducted during August, 1991, 18 ALBs were released in the center of 32 cm (12.6 in) high × 30 cm (11.8 in) diameter cages. Each cage served as a block, with six cages used in each test. In trial 1 the five deciduous spp. and DVW were arranged in a randomized complete block design. Cuttings were placed in a circle around the perimeter of each cage. During trial 2 procedures were identical except that DVW was excluded from the entries evaluated. After four days number of adult ALBs and number of eggs deposited per plant were recorded. Data were subjected to analysis of variance. Mean separation was by LSD.

Results and Discussion

Adult survival and oviposition varied with plant species and time of year the experiments were conducted (Table 1). Adult survivorship was always significantly lower on *R. canescens* than on DVW. Adult survivorship was also low on *R. prunifolium* (Table 1, generations 1 and 2, 1990 and 1, 2, & 3, 1991). Although adult survivorship on *R. calendulaceum, R. austrinum,* and *R. albamense* was never statistically lower than on DVW, mean number of eggs laid on those species was significantly lower during the May and June, 1990 assays, and the May and August, 1991 assays. *Rhododendron albamense* and *R. calendulaceum* especially appeared more susceptible to adult feeding and oviposition in later season assays. Although oviposition dur-

Table 1. Adult survival and oviposition preference of azalea lace bug (ALB) caged on cuttings for four days.

Plant species or cultivar	Date	ALB generation	Mean no. live females	Mean no. eggs
		1990		
Delaware Valley White	May 8–12	1	2.0 a[z]	22.2 a
R. albamense			1.6 a	12.2 b
R. austrinum			1.6 a	9.2 bc
R. calendulaceum			1.5 a	8.2 bc
R. canescens			0.6 b	2.4 d
R. prunifolium			0.7 b	6.2 cd
Delaware Valley White	June 26–30	2	1.9 a	37.6 a
R. albamense			1.8 a	20.0 b
R. austrinum			1.7 ab	11.3 bc
R. calendulaceum			1.9 a	17.2 bc
R. canescens			1.2 bc	10.7 bc
R. prunifolium			0.8 c	9.1 c
Delaware Valley White	Aug. 15–19	3	2.0 a	14.6 a
R. albamense			2.0 a	12.8 ab
R. austrinum			2.0 a	6.2 bc
R. calendulaceum			1.9 a	12.7 ab
R. canescens			1.1 b	5.3 c
R. prunifolium			1.9 a	9.7 abc
		1991		
Delaware Valley White	May 7–11	1	1.8 a	18.1 a
R. albamense			1.9 a	12.1 b
R. austrinum			1.8 a	8.3 b
R. calendulaceum			1.6 a	7.6 b
R. canescens			1.1 b	7.5 b
R. prunifolium			1.1 b	7.6 b
Delaware Valley White	July 3–7	2	1.9 a	16.1 a
R. albamense			1.7 a	13.7 a
R. austrinum			1.8 a	12.2 ab
R. calendulaceum			1.7 a	10.3 abc
R. canescens			1.0 b	7.0 bc
R. prunifolium			1.1 b	4.2 c
Delaware Valley White	Aug. 19–23	3	1.8 a	26.8 a
R. albamense			1.7 a	12.7 b
R. austrinum			1.4 ab	4.9 c
R. calendulaceum			1.6 ab	6.0 bc
R. canescens			0.7 c	0.7 c
R. prunifolium			1.2 b	3.7 c

[z]Means followed by the same letter within a date and column are not significantly different ($P > 0.05$). Mean separation was by LSD.

ing free-choice tests during 1991 was low (Table 2), the same trends revealed during no-choice tests were again apparent with *R. prunifolium* and *R. canescens* the least preferred.

Time of year that the assay was conducted did not affect percent nymphal survival and data for the three assays conducted during 1990 were combined. ALBs were able to hatch, feed, and develop to the adult stage on every species tested (Fig. 1). However, nymphal survival on all deciduous species was suppressed relative to that on DVW. *Rhododendron calendulaceum* was the most suitable for nymphal development among the deciduous species.

Degree of pubescence along the midvein, lateral veins, and remaining lower leaf surface may play a role in limiting ALB activity on the deciduous species (Table 3). ALB oviposit primarily along the midrib and occasionally along lateral veins of evergreen varieties (6). *Rhododendron canescens*, the least suitable species for ALB in our study, was the most densely pubescent especially along the veins. Foliar pubescence is known to negatively affect biology and or behavior of many insect species (8) including species infesting landscape plants (3, 7). *Rhododendron prunifolium*, however, also of low preference by ALB, is glabrous or nearly so. While phytochemical analysis was beyond the scope of the present study, factors in addition to leaf pubescence are apparently involved in the observed resistance to ALB.

Deciduous azaleas investigated in this study were less suitable for adult feeding, oviposition, and nymphal development than DVW azaleas. However, all five species supported adult activity, and oviposition in no-choice and free-choice tests. ALBs were also able to hatch and complete development on all five deciduous species. Nymphal survival was low in comparison with that which occurred on DVW azalea.

Rhododendron canescens and *R. prunifolium* were the least preferred by ALB in the various assays reported here, suggesting merit in future efforts to determine the mechanism of the observed antixenosis and antibiosis. Their deciduous habit and lower ability to support oviposition and nymphal development indicate the usefulness of these species in an integrated management program for ALB. Although less susceptible to damage by ALB, native azaleas are occasionally attacked by additional pests. During this study, for example, the leafhopper *Erythroneura (Eratoneura) claroides* Hepner was discovered reproducing on all but *R. prunifolium* (unpublished data) and imparts stippling damage similar to that caused by ALB on evergreen varieties. The damage potential of this species is not known and will be the subject of future study.

Table 2. Azalea lace bug oviposition preference in free-choice tests on azalea cuttings, August 1991.

Plant species or cultivar	Mean no. females per cutting	Mean no. eggs per cutting
	Trial 1	
Delaware Valley White	2.2	6.2
R. albamense	1.7	3.2
R. austrinum	0.8	2.3
R. calendulaceum	2.0	4.3
R. canescens	0.7	2.0
R. prunifolium	0.2	0
P-value	0.10	0.24
LSD .10, 25	1.4	—
	Trial 2	
R. albamense	1.8	3.2
R. austrinum	1.3	0.3
R. calendulaceum	0.5	1.5
R. canescens	0.3	1.8
R. prunifolium	0.8	0.7
P-value	0.13	0.32
LSD	—	—

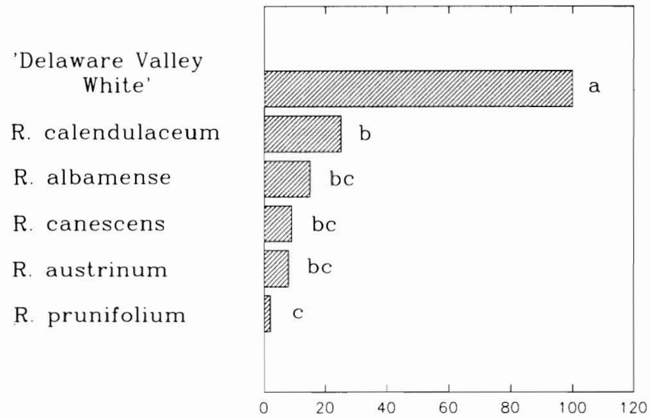

Fig. 1. Nymphal survival on five species of deciduous azaleas relative to that on the susceptible evergreen variety 'Delaware Valley White.'

Table 3. Leaf pubescense on the lower surface of azalea leaves.

Plant species	Average no. of hairs per 1.2 cm (0.5 in) midvein	Average no. of hairs per 1.2 cm (0.5 in) branch veins	Average no. of hairs per 0.6 cm^2 (0.25 in^2) interveinal
Delaware Valley White	60.5 d[z]	26.5 d	66.8 de
R. albamense	499.0 b	94.7 bc	203.7 bc
R. austrinum	497.9 b	123.8 bc	340.4 a
R. calendulaceum	307.0 c	65.9 c	144.8 cd
R. canescens	821.1 a	146.3 a	296.5 ab
R. prunifolium	16.5 d	1.8 d	0.4 e

[z]Means within a column followed by the same letter are not significantly different (P > 0.05). Mean separation was by LSD.

Literature Cited

1. Bailey, N.S. 1951. The Tingoidea of New England and their biology. Entomol. Amer. 31:1–140.

2. Braman, S.K., A.F. Pendley, B. Sparks, and W.G. Hudson. 1992. Thermal requirements for development, population trends, and parasitism of azalea lace bug (Heteroptera: Tingidae). J. Econ. Entomol. (*in press*).

3. Doss, R.P., C.H. Shanks, Jr., J.D. Chamberlain, and J.K.L. Garth. 1987. Role of leaf hairs in resistance of a clone of strawberry, *Fragaria chiloensis*, to feeding by adult black vine weevil, *Otiorhynchus sulcatus* (Coleoptera: Curculionidae). Environ. Entomol. 16:764–766.

4. Galle, F.C. 1987. Azaleas. Timber Press, Portland, OR, 486 pp.

5. Neal, J.W., Jr. and L.W. Douglass. 1988. Development, oviposition rate, longevity, and voltinism of *Stephanitis pyrioides* (Heteroptera: Tingidae), an adventive pest of azalea at three temperatures. Environ. Entomol. 17:827–831.

6. Neal, J.W., Jr. 1988. Unusual oviposition behavior on evergreen azalea by the andromeda lace bug *Stephanitis takeyai* (Drake and Maa) (Heteroptera: Tingidae). Proc. Entomol. Soc. Wash. 90:52–54.

7. Schultz, P.B. and M.A. Coffelt. 1987. Oviposition and nymphal survival of the hawthorn lace bug (Hemiptera: Tingidae) on selected species of *Cotoneaster* (Rosaceae). Environ. Entomol. 16:365–367.

8. Smith, C.M. 1989. Plant Resistance to Insects a Fundamental Approach. John Wiley & Sons, Inc., New York, NY, 286 pp.

Mulches: Durability, Aesthetic Value, Weed Control, and Temperature[1]

W.A. Skroch,[2] M.A. Powell,[2] T.E. Bilderback,[3] and P.H. Henry[4]
Department of Horticultural Science
North Carolina State University
Raleigh, NC 27695-7609

Abstract

Five organic mulches (pine bark, hardwood bark, cedar chips, longleaf pine needles, shortleaf pine needles), used alone or in combination with two inorganic mulches (black polyethylene, woven polypropylene), were evaluated over two years for weed control, durability, aesthetic value, and influence upon soil temperature. Organic mulches reduced total weed counts by 50% compared to control plots, and underlaying organic mulches with polyethylene resulted in complete control. Polypropylene, used in combination with organic mulch, was ineffective in controlling perennial weed species. Pine bark was the most durable organic mulch, requiring the least replenishment (70% initial volume) after 630 days. Durability of organic mulches increased when underlaid with polyethylene. Longleaf pine needles were rated most attractive, and underlying organic materials with either polyethylene or polypropylene enhanced appearance. Organic mulches reduced maximum daily temperatures at the soil surface by 2.2–3.3°C (4–6°F) and increased minimum daily temperatures by 1.1–2.2°C (2–4°F). However, the type of organic mulch did not affect temperatures at the soil surface.

Index words: Geotextiles, landscape fabrics, polyethylene, polypropylene, weed barriers

Significance to the Nursery Industry

Although both organic and inorganic mulches are commonly used within the landscaping and grounds maintenance industries, characteristics of specific mulches are poorly defined. Research within shows that optimal weed control is obtained when organic mulches are underlaid with a layer of polyethylene. Use of woven polypropylene as a foundation material is less effective, particularly in the control of perennial bermudagrass and yellow nutsedge.

Pine bark is the most durable organic mulch, and longleaf pine needles are significantly longer lasting than shortleaf. Durability of organic mulches increases when underlaid with polyethylene. Longleaf pine needles are the most attractive organic mulch, and pine bark rates higher than either hardwood bark or cedar chips. Underlying organic mulches with either polyethylene or polypropylene enhances appearance.

Introduction

Mulch application to landscape plantings is a common practice within the landscaping and grounds maintenance industries. Mulches enhance plant growth by reducing moisture evaporation from the soil and increasing water infiltration (2, 6). Additionally, mulches suppress weeds, thereby reducing costs of landscape maintenance.

Selection of a mulch depends on more than its potential to enhance plant growth. Mulches must also be durable and aesthetically pleasing since, when used over large areas to define turf interfaces or prevent soil compaction, they comprise a highly visible component of the landscape.

Mulches are classified as organic (naturally occurring) and inorganic (synthetic). Most common mulches are organic, with selection based upon cost, appearance, and local availability. Synthetic mulches, such as plastic (polyethylene) and more recently developed "fabrics" (woven polypropylene), reportedly restrict weed growth more effectively than organic mulches (1, 2, 3). However, these materials are unattractive in the landscape and are commonly overlaid with one of the more aesthetic organic mulches.

There is little information on characteristics of different organic mulches, or how characteristics are altered when organic mulches are used in conjunction with synthetic materials. Therefore, the objective of this study was to evaluate several organic mulches, used alone or with synthetic mulches, for durability, aesthetic value, weed control, and influence upon soil temperature.

Materials and Methods

A series of 1.2 × 1.2 m (4 × 4 ft) plots were established October 1, 1987 by tilling to a depth of 15 cm (6 in). The experimental design was a randomized complete block with

[1]Received for publication September 19, 1991; in revised form December 9, 1991. This research was funded by the North Carolina Agricultural Research Service (NCARS), Raleigh, NC 27695-7643. Use of trade names in this publication does not imply endorsement by the NCARS of products named nor criticism of similar ones not mentioned. Technical assistance of Mary R. Lorscheider is gratefully acknowledged.

[2]Professor.

[3]Associate Professor.

[4]Graduate Research Assistant.