Host Suitability of Three Asiatic Elms to the Elm Leaf Beetle *(Xanthogaleruca luteola)* (Coleoptera: Chrysomelidae)[1]

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Abstract

Larval and adult elm leaf beetle, *Xanthogaleruca luteola* (Muller) were fed leaves of *Ulmus pumila* L., *U. parvifolia* Jacq. and *U. wilsoniana* Schneid. to determine host suitability. *U. pumila* was a suitable host, while *U. parvifolia* and *U. wilsoniana* were found to be poor hosts. *U. parvifolia* and *U. wilsoniana* should be considered for urban plantings where elm leaf beetle defoliation is severe, and as sources of resistance in elm breeding programs.

Index words: Chinese elm, elm leaf beetle, host plant resistance, *Ulmus parvifolia, Ulmus pumila, Ulmus wilsoniana,* Siberian elm, *Xanthogaleruca luteola*

Introduction

The elm leaf beetle, *Xanthogaleruca luteola* (Muller), frequently defoliates elms in urban environments. European and Siberian (*Ulmus pumila* L.) elms appear to be preferred and frequently defoliated. The elm leaf beetle was imported from Europe to the U.S. in the 1830's (9). Since then its range has expanded to include most areas of the U.S. where elms are grown. It has recently been cited as a significant pest of urban trees in most parts of the U.S. (4, 8).

The Chinese elm, *U. parvifolia* Jacq., is reported to resist defoliation by elm leaf beetle (1, 6, 7, 10, 12). However, Chinese elm is cited by other authors as a host of elm leaf beetle in the southwestern U.S. (5, 11). Thus, there is reason to believe that Chinese elm clones may differ in susceptibility to elm leaf beetle or different biotypes of elm leaf beetle exist which differ in ability to utilize Chinese elm as a host.

We have observed that another Asiatic elm species, *U. wilsoniana* Schneid. is not defoliated by elm leaf beetle in the field; a similar observation was made in Italy (7). In laboratory preference experiments, Chinese elm and *U. wilsoniana* were less-preferred by adult elm leaf beetle than two other elm cultivars (3). Both Chinese elm and *U. wilsoniana* are resistant to Dutch elm disease and show considerable promise as trees for the urban landscape. Both may also be used by plant breeders as sources of resistance to Dutch elm disease and elm leaf beetle.

The experiments reported herein were designed to examine the suitability of *U. wilsoniana* and several cold-hearty cultivars of Chinese elm as hosts for elm leaf beetle.

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Materials and Methods

In May 1984, host suitability for elm leaf beetle larvae was determined by placing newly hatched, unfed, elm leaf beetle larvae on leaves from selected elms. Larvae were examined daily to determine mortality and date of pupation. Measures of suitability were % survival to pupal stage, and length of the larval stage.

Adults resulting from the experiment were placed in disposable plastic petri dishes on leaves from the larval host. Foliage was changed every 2-3 days. Beetles were examined daily to determine presence of feeding and oviposition and to determine longevity and number of eggs laid. Experiments were conducted at 26°C (80°F), 15 hour photophase. All experiments reported herein were conducted in environmental chambers under full-spectrum, high-intensity light at ca. 1200 foot-candles.

Additional host suitability experiments were conducted in June and August, 1984. Pairs (male + female) of newly emerged, unfed, adult elm leaf beetles were placed on foliage from selected elms. Beetles and foliage were placed in plastic petri dishes and held at 26°C (80°F) in the first replicate and 25°C (77°F) in the second replicate. Both experiments were run under long day conditions (15h photophase). Beetles used in the first study were obtained by collecting eggs from field-collected overwintered adults, rearing the larvae in the laboratory at 26°C (80°F) on greenhouse-grown *U. pumila,* and holding the pupae until adult emergence. In the second study, beetles were field collected from *U. procera* Salisb. as wandering 3rd instars and held in the laboratory at 25°C (77°F) for pupation and adult emergence. Five or 10 pairs of beetles were used on each elm tested. Foliage was changed at 2-3 day intervals. Containers were examined daily to detect feeding and oviposition and to determine longevity and number of eggs laid.

All elms utilized in experiments were in plantings at the U.S.D.A., A.R.S. Nursery Crops Research Laboratory at Delaware, Ohio. Leaves were removed from trees weekly, and held in the laboratory, under refrigeration until used in experiments. Elms examined were *U. pumila, U. parvifolia* and *U. wilsoniana. U.*

Table 1. Survivorship and development of Elm leaf beetle (*Xanthogaleruca luteola*) in the larval suitability experiment.[z]

Host Species	n	% surviving to pupal stage	mean days to pupal stage[y]
U. pumila	29	82.3	14.1 (0.6)a
U. parvifolia-M	30	94.1	14.2 (0.8)ab
U. parvifolia-S	31	100.0	14.4 (0.8)ab
U. parvifolia-C1	25	94.1	14.6 (1.1)ab
U. parvifolia-C2	24	82.3	14.2 (0.8)ab
U. parvifolia-P	28	100.0	14.8 (1.0)b
U. parvifolia-D	18	50.0	15.4 (1.0)c

[z]Standard deviations are given in parentheses following each mean. Means followed by the same letter or letters are not significantly different at the 0.05 level according to a Student-Newman-Keuls multiple comparison test.

[y]$F(6,178) = 5.9$; $P < 0.01$.

pumila was included in the study as a reference because it is frequently defoliated by elm leaf beetle. Different *U. parvifolia* were chosen to represent a broad selection of growth forms from geographically separate plots. *U. wilsoniana* was a single tree of selection 3-14. All leaves were randomly selected from the lower half of the crown of the larger trees and from the entirety of the smaller trees. Leaf samples were taken in this manner in an attempt to compensate for differences in leaf quality within trees.

Results and Discussion

In the larval suitability experiment, larvae developed to the pupal stage on all elms tested (Table 1). Significant differences existed in the developmental time of larvae fed on the different *U. parvifolia.*

Feeding by surviving pairs (male and female) of adults occurred in: all 13 petri dishes containing *U. pumila,* 15 of 19 on *U. parvifolia*-M, 8 of 13 on *U. parvifolia*-S, 11 of 11 on *U. parvifolia*-C1, 13 of 15 on *U. parvifolia*-C2, 5 of 13 on *U. parvifolia*-P and 2 of 8 on *U. parvifolia*-D. Both males and females reared on *U. pumila* lived significantly longer than those reared on any of the *U. parvifolia* (Table 2).

Females reared on *U. pumila* oviposited and had the shortest pre-oviposition periods. On *U. parvifolia,* only females reared on *U. parvifolia*-M and C2 oviposited.

In the June adult suitability experiment, feeding occurred in: all 10 petri dishes containing *U. pumila,* 4 of 5 on *U. parvifolia*-M, 1 of 5 on *U. parvifolia*-S, 4 of 5 on *U. parvifolia*-C1, 0 of 5 on *U. parvifolia*-P, 1 of 10 on *U. parvifolia*-D and 3 of 10 on *U. wilsoniana.* Female longevity was significantly greater on *U. pumila* than on *U. parvifolia* or *U. wilsoniana* (Table 3). Males lived significantly longer on *U. pumila* than on *U. parvifolia*-D.

In June, 6 of 10 females fed *U. pumila* oviposited. Pre-oviposition period was 7.8 (±4.5) days, 916 eggs were laid with 152.7 (± 182.5) eggs/ovipositing female. No females fed *U. parvifolia* oviposited.

In the August adult suitability experiment, feeding occurred in: all 10 petri dishes containing *U. pumila,* 10 of 10 on *U. parvifolia*-M, 10 of 10 on *U. parvifolia*-S, 10 of 10 on *U. parvifolia*-C1, 9 of 10 on *U. parvifolia*-P, 7 of 10 on *U. parvifolia*-D and 0 of 10 on *U. wilsoniana.* Female longevity was not significantly different on *U. pumila* than on the other elms (Table 3). Six females feeding on *U. pumila* apparently entered diapause and thus were excluded from the experiment. However, differences in longevity existed within *U. parvifolia* and between *U. parvifolia* and *U. wilsoniana.* Males lived significantly longer on *U. pumila* than on *U. parvifolia*-D.

In August, beetles fed on *U. pumila* and on *U. parvifolia* oviposited. Significantly more eggs were laid by females fed on *U. pumila* (Table 4). No eggs were laid by females fed *U. parvifolia*-P or *U. wilsoniana.*

Chinese elm and *U. wilsoniana* appear to be much less suitable than *U. pumila* as hosts for elm leaf beetle. On Chinese elm, decreased suitability was expressed as longer larval developmental time, reduced adult feeding, decreased adult longevity and lower fecundity. On *U. wilsoniana,* adults fed less, exhibited reduced longevity and did not oviposit. Differences were found among Chinese elms in feeding, longevity and oviposition.

Our results suggest that differences may occur in suitability of Chinese elm over the season. Adult feeding, longevity, and oviposition rates were higher in August than in June. This finding seems to conflict with findings of Wene (11) who suggested that new foliage rather than senescent Chinese elm foliage was more suitable as a host for elm leaf beetle. However, comparisons

Table 2. Longevity (days) of adult *Xanthogaleruca luteola* reared in the larval suitability experiment.[z]

Host Species	Male Longevity[y]	n	Female Longevity[x]	n	No. Females Ovipositing	Preoviposition Period[w]	No. Eggs/ Female[v]	No. Eggs/Ovipositing Female
U. pumila	17.3 (2.7)a	15	15.6 (3.5)a	13	13	4.5 (0.5)	435.4 (186.6)a	435.4 (186.6)
U. parvifolia-M	9.8 (6.8)b	11	7.1 (4.7)b	19	2	12.0 (5.6)	0.6 (2.1)b	5.5 (5.0)
U. parvifolia-S	6.2 (4.9)b	15	4.2 (1.1)b	13	0	—	0.0b	—
U. parvifolia-C1	6.3 (5.0)b	12	5.6 (3.5)b	11	0	—	0.0b	—
U. parvifolia-C2	8.0 (3.8)b	7	6.2 (4.2)b	15	1	14.0 (—)	0.1 (0.2)b	1.0 (—)
U. parvifolia-P	6.1 (4.6)b	15	4.0 (0.8)b	13	0	—	0.0b	—
U. parvifolia-D	4.1 (0.6)b	10	4.3 (0.7)b	8	0	—	0.0b	—

[z]Standard deviations are given in parentheses following each mean. Means followed by the same letter or letters are not significantly different at the 0.05 level according to a Student-Newman-Keuls multiple comparison test.

[y]$F(6,78) = 13.3$; $P < 0.01$.

[x]$F(6,85) = 18.9$; $P < 0.01$.

[w]$F(1,13) = 35.6$; $P < 0.01$.

[v]$F(6,85) = 71.6$; $P < 0.01$.

Table 3. Longevity (days) of adult *Xanthogaleruca luteola* in the adult suitability experiments.[z]

Host Species	June				August			
	Male Longevity[y]	n	Female Longevity[x]	n	Male Longevity[w]	n	Female Longevity[v]	n
U. pumila	9.9 (9.1)a	10	16.7 (8.4)a	10	23.2 (12.4)ab	4	16.8 (10.1)ab	4
U. parvifolia-M	7.2 (7.8)ab	5	7.0 (7.3)b	5	19.3 (7.9)a	10	17.7 (10.0)ac	10
U. parvifolia-S	3.6 (0.9)ab	5	3.4 (0.9)b	5	21.0 (11.9)a	10	15.6 (9.4)ac	10
U. parvifolia-C1	5.8 (4.1)ab	5	3.6 (0.6)b	5	21.4 (6.8)a	10	22.9 (12.3)a	10
U. parvifolia-P	2.0 (0.0)ab	5	2.4 (0.9)b	5	8.1 (4.7)b	10	5.3 (1.2)b	10
U. parvifolia-D	2.9 (1.1)b	10	3.2 (1.5)b	10	9.4 (5.7)b	10	8.4 (6.1)bc	10
U. wilsoniana	5.1 (3.6)ab	10	4.2 (1.3)b	10	4.1 (0.6)b	10	4.6 (0.5)b	10

[z]Standard deviations are given in parentheses following each mean. Means followed by the same letter or letters are not significantly different at the 0.05 level according to a Student-Newman-Keuls multiple comparison test.

[y]$F(6,43) = 2.5; P < 0.05$.

[x]$F(6,43) = 9.9; P < 0.01$.

[w]$F(6,57) = 9.4; P < 0.01$.

[v]$F(6,57) = 7.2; P < 0.01$.

Table 4. Oviposition of adult *Xanthogaleruca luteola* in the August 1984 adult suitability experiment.

Host Species	n	no. ovipos.	pre-oviposition period	eggs/ female[z]	eggs/ovipositing female[y]
U. pumila	4	3	8.3 (3.2)	134.0 (125.2)a	178.7 (107.5)a
U. parvifolia-M	10	5	12.4 (3.5)	11.1 (12.1)b	22.2 (4.6)b
U. parvifolia-S	10	3	8.3 (1.2)	10.9 (18.7)b	36.3 (13.6)b
U. parvifolia-C1	10	2	13.0 (1.4)	2.0 (5.1)b	10.0 (8.5)b
U. parvifolia-P	10	0	—	0.0 (0.0)b	—
U. parvifolia-D	10	1	14.0 (—)	2.7 (8.5)b	27 (—)
U. wilsoniana 3-14	10	0	—	0.0 (0.0)b	—

[z]Standard deviations are given in parentheses following each mean. Means in columns followed by the same letter or letters are not significantly different at the 0.05 level according to a Student-Newman-Keuls multiple comparison test. $F(6,57) = 11.65; P < 0.01$.

[y]$F(3,9) = 7.11; P < 0.01$.

must be made with caution as elm leaf beetles used in June and August were from different sources.

Our results confirm that Chinese elm is a poor host for elm leaf beetle. However, there may be clones or selections of Chinese elm that are suitable hosts for elm leaf beetle or there may be biotypes of elm leaf beetle that can use Chinese elm effectively as a host.

Significance to the Nursery Industry

Chinese elm and *U. wilsoniana* resist feeding by elm leaf beetle. Both elm species should be considered as suitable in urban plantings where elm leaf beetle causes significant defoliation. Siberian elm is susceptible to elm leaf beetle defoliation and should not be planted where elm leaf beetle is a recognized pest. Both Chinese elm and *U. wilsoniana* should be considered as sources of elm leaf beetle resistance for elm breeding programs.

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