JAPANESE BEETLE PREFERENCES AMONG LINDEN CULTIVARS[1]

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ABSTRACT.--Defoliation of four linden cultivars by Japanese beetles (Popillia japonica) was compared on three dates. Tilia cordata 'Greenspire' was damaged much more than T. cordata 'June Bride'. T. americana 'Redmond' was fed upon nearly as much-as the 'Greenspire' lindens, but T. tomentosa (Princeton strain) was damaged very little. 'Greenspire' lindens growing along city streets about one mile away were not defoliated at all. Differences in beetle preferences seem to be important only if lindens are to be planted near lawns, where beetles can multiply in the sod. Metro. Tree Impr. Alliance (METRIA) Proc. 1:44-48, 1978.

INTRODUCTION

The Japanese beetle, Popillia japonica Newman, has spread through most of the eastern United States since its introduction to New Jersey in 1916. In the Northeast, partially developed grubs overwinter in the soil (Johnson and Lyon, 1976); in the spring they start feeding on fibrous roots and organic matter until about an inch long (Becker, 1938). The mature grub then pupates and adults emerge a few days later - about the third week in May in North Carolina to early July in New England. The adult lives for 30-45 days and each female lays 40-60 eggs. Eggs hatch in about two weeks and the small grubs feed on rootlets until winter (Johnson and Lyon, 1976).

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Adult beetles feed on about 300 species of plants, chewing out the tissue between veins. They prefer plants in direct sunlight and usually start at the top and work downward. The amount of damage to a plant depends on its attractiveness to the beetle, the number of beetles in the area, and local conditions (Fleming, 1962). Adult beetles can completely defoliate a tree, which impairs the tree's health and seriously reduces its aesthetic value.

In places where Japanese beetles could cause serious damage it would be advantageous to plant trees that are resistant. This paper reports the relative preferences of Japanese beetles for four linden cultivars.

MATERIALS AND METHODS

During the summers of 1975 and 1976 Japanese beetles were observed feeding in a small plantation of ash and linden cultivars located on the Blue Golf Course at The Pennsylvania State University. The plantation was established in 1973 to study effects of air pollutants, and consists of three randomized blocks, each with 7 ramets of each of the following clones:

Fraxinus americana 'Rosehill' -- Rosehill Ash
F. excelsior 'Hessei' -- Singleleaf European Ash
F. pennsylvanica 'Marshall's Seedless' -- Marshall Seedless Ash
F. pennsylvanica 'Summit' -- Summitt Ash
Tilia americana 'Redmond' -- Redmond Linden
T. cordata 'Greenspire' -- Greenspire Linden
T. cordata 'June Bride' -- June Bride Linden
T. tomentosa 'Silver Linden', grafted Princeton Strain

All the trees were about the same size (approximately 10' tall), except the silver lindens, which had died back after planting and were mostly basal sprouts (approximately 3' tall).

In June it was noticed that the Greenspire lindens were being severely damaged by Japanese beetles, but the ash were untouched. The other lindens were being attacked less than the Greenspires. The beetles were defoliating the tops of the trees and working their way downward.

On July 10, 19'75, the damage to each linden was recorded. For each tree the percent of leaves attacked and the percent of area removed from an average leaf was estimated, both to the nearest 10%. These two figures were multiplied to give a total percentage of foliage removed. That afternoon all trees were sprayed by golf course employees with insecticide. This treatment protected the trees for a few days, but within several days more beetles resumed feeding on the lindens.

On August 20 the amount of foliage subsequently removed was recorded by subtracting the percentage of foliage removed on July 10 from the total percentage of foliage removed by August 20. Data were taken again on July 16, 1976.

RESULTS

An analysis of variance was performed on each set of data. All three analyses showed the clones as a significant source of variation (Table 1). There was a significant replicate effect in data from July 16, 1976 and a small replicate x clone interaction on the data of August 20, 1975.

Cultivar means are shown in Table 2. The Greenspire lindens received the most damage followed closely by the Redmond lindens. June Bride lindens consistently ranked third, followed by the silver lindens with the least amount of damage. Duncan's Modified Least Significant Difference test showed most of the cultivar means significantly different from each other; but on August 20, 1975, and July 16, 1976, Greenspires were not significantly different from the Redmonds.

DISCUSSION

Fleming (1962) reported that Japanese beetles feed extensively on American linden (Tilia americana) and littleleaf linden (T. cordata) but only lightly to moderately on silver linden (T. tomentosa), and not at all on either green or white ash. This is totally consistent with our observations. Near Wooster, Ohio, T. americana 'Redmond' has been observed as the cultivar of Tilia first attacked and most severely damaged.[1] In contrast, our Greenspires were damaged significantly more than the Redmonds in the beginning of the summer of 1975, but received the same amount of damage in the latter part of that year and in 1976. This difference may be due to our method of observation. Redmonds seemed to retain the brown skeletons of consumed leaves longer than Greenspires, which makes a tree appear worse than when these leaves fall off. In collecting our data the differences in retention of dead leaves was ignored.

Under our conditions T. cordata 'Greenspire' and T. americana *Redmond' were highly preferred by Japanese

[1] Personal communication, April 6, 1976, T. L. Ladd, Jr., Research Leader, Japanese Beetle Research Laboratory, Ohio Agriculture Research and Development Center, ARS, USDA, Wooster, Ohio.

Table 1. Mean squares from analyses of variance of percent foliage removed from linden cultivars by Japanese beetles.

Source	D.F.	July 10, 1975	August 20, 1975	July 16, 1975
Replicates	2	4.9 n.s. [a]	260.7 n.s.	664.4"
Clones	3	7547.0*	6376.6*	2530.5*
R x C	6	48.9 n.s.	416.2*	145.4 n.s.
Error	72	37.6	176.6	125.5

[a] n.s. not significant

* significant at 95% level

Table 2. Percent of foliage removed from linden cultivars by Japanese beetles.[a]

Cultivar	July 10, 1975	August 20, 1975	July 16, 1975
Greenspire	44.0	44.6	28.2 b
Redmond	11.8	41.1	23.0 b
June Bride	7.3	22.0	18.5
Silver	1.9	7.3	4.4

[a] Values within dates were significantly different from each other at the 95% level except those followed by the same letter. Values between dates were not compared statistically.

beetles, T. cordata 'June Bride' was preferred much less, and T. tomentosa was preferred the least. These rankings depend on the local conditions and vegetation. Had there been an abundant source of a more preferred food (roses, for instance) the lindens may have been attacked much less. Also, beetles usually fly only short distances to find food (Fleming, 1962), and less than a mile away Greenspire lindens growing along city streets were not defoliated at all. It seems that these differences in preferences may only be important if the lindens are planted near areas such as lawns, where the beetles can multiply in the sod.

Japanese beetles may be controlled successfully by insecticides such as Sevin (Carbaryl), but repeated spraying is often necessary and costly. Biological control methods have been investigated, and a disease-causing bacterium is commercially available (Johnson and Lyon, 1976). The best method of "control" is to avoid planting preferred trees where Japanese beetles are a problem.

The large difference in damage between the two cultivars 'Greenspire' and 'June Bride' indicates that intraspecific variation in attractiveness to Japanese beetles exists in Tilia cordata. Schreiner (1949) reported large variations in Japanese beetle damage among individual Populus hybrids of the same parentage. This supports the idea that attractiveness to Japanese beetles is genetically controlled and that it would be possible to exploit natural variation, or variation among hybrids, and breed beetle-resistant cultivars.

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