

SUSCEPTIBILITY OF HONEYLOCUST (GLEDITSIA) SPECIES
TO MIMOSA WEBWORM

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ABSTRACT .--Seedlings of 13 taxa of Gleditsia were deliberately exposed to high natural populations of mimosa webworm during 1974 and 1975. The only species exhibiting high resistance (bordering on immunity) was G. fera from Hong Kong, which is of doubtful hardiness over much of the United States. G. amorphoides, the only South American species, also appeared to be somewhat resistant. No meaningful levels of resistance were found among hardy species. Thus, interspecific hybridization may not be very useful in developing webworm-resistant cultivars. It is suggested that mass-screening of thornless seedlings of G. triacanthos may be the most feasible method of early selection for resistance to webworm in any long-term improvement program. Metro. Tree Impr. Alliance (METRIA) Proc. 1: 49-56, 1978.

INTRODUCTION

Honeylocust (Gleditsia triacanthos L.) has become, in recent years, one of the most extensively grown, vegetatively-propagated landscape trees in the United States. The thornless types (G. triacanthos f. inermis Schneid.¹) have, of course, been preferred for environmental planting. Most of the selections have also been essentially fruitless, producing mostly male flowers. The cultivar 'Stephens', in 1940, was the first American-named thornless cultivar, 'Moraine', in 1949, was the first patented cultivar (Wagenknecht, 1961). Since then, nearly 20 cultivars have been named or patented. Thousands of thornless honeylocust trees, including a high percentage of selected cultivars, are planted annually in urban and suburban areas.

¹ Botanical authority according to Isley (1975)

The increase in popularity of honeylocust has, unfortunately, been paralleled by the spread of a destructive insect pest, the mimosa webworm. This insect was first discovered in 1940 in the United States infesting leaves of "mimosa" (Albizia julibrissin Duraz.) in Washington, D. C. Clarke (1943) named the insect Homadaula albizziae and suspected that it was of Indo-Australian origin. Subsequent study (Clarke, 1968) has revealed that the webworm is identical to an insect described from China in 1935. Thus, the correct name for the mimosa webworm is Homadaula anisocentra Meyr. (Caradja and Meyrick, 1935).

Wester and St. George (1947) were the first to report honeylocust as a host plant for the mimosa webworm, and their work remains the authoritative study of the life cycle of this insect. They also reported that from 1940 to 1946 the insect had spread 100 miles south and some 50-65 miles north of the District of Columbia. A distribution map presented by Clarke (1968) and a recent updating (USDA, 1975) show that continuing infestations have been reported from 28 states. This area runs roughly from the Massachusetts-Rhode Island border west to central Nebraska, south to northern Texas, and east through the Gulf States to Florida. Several counties in northern California also have severe infestations.

Because of climatic control of population development, the present distribution is likely to remain relatively static over the next decade or so, except for "border" movement. However, the distribution does indicate that an origin in China is far more likely than, as once suspected, an Indo-Australian origin.

Opinions vary from person to person and region to region as to whether the webworm is of sufficient importance to justify chemical control methods or the development of resistant trees. The necessity of three spray applications per year for complete control of the insect normally is a deterrent to an effective control program. Trees growing in lawns are especially prone to late summer defoliation, because the ground cover affords good protection for the overwintering pupae. Insect populations may not be sustained in planting areas surrounded by concrete and asphalt because of the lack of overwintering sites. Under optimum conditions, however, the webworm can be a destructive pest.

Honeylocust cultivars vary in apparent resistance to the mimosa webworm. Schuder (1973) reported that 'Moraine*' was significantly more resistant than four other cultivars when statistically tested under natural infestation conditions over a 10-year period. Our observations of these same cultivars (nonreplicated) at the National Arboretum are in agreement with Schuder's results. Certainly, the most effective long-

term control method would be the development of more highly resistant trees with varied growth habits and growth rates.

One approach to the creation of webworm-resistant trees might be hybridization between the best forms of G. triacanthos and some other species that had high resistance or immunity. However, we have very little knowledge concerning the potential resistance or susceptibility in exotic Gleditsia species. Even though there are about 13 species of Gleditsia besides G. triacanthos (Gordon, 1966), they are seldom planted, even in arboreta or botanical gardens.

The other native American species of honeylocust is G. aquatica Marsh. (water locust), a native of South-Central United States. Natural hybrids between this species and G. triacanthos have been recognized as G. x texana Sarg. and have been reported from Texas, Louisiana, Mississippi, and Indiana. No species are native to Europe, but G. caspica Desf. (Caspian locust) occurs south and southwest of the Caspian Sea in the Transcaucasus and Northern Iran. G. japonica Miq. may occur in Japan and China, and var. koraiensis Nakai has been described from Korea. G. assamica Bor is a little-known species from Northern India, and G. rolfei Vid. is found in Taiwan, Viet Nam, the Philippines, and the Celebes. The remainder of the Asiatic species are native to China, including G. australis Hemsl., G. delavayi Franch., G. fera (Lour.) Merr., G. microphylla Gordon (= G. heterophylla Bunge), G. macracantha Desf., and G. sinensis Lam., all of which are listed by Gordon (1966). Another Chinese species, G. melanacantha Tang & Wang, has recently been described in a Chinese "Flora" (Institute of Botany of the Chinese Academy of Sciences, 1972), and we have identified an unknown tree growing at the U. S. plant Introduction Station in Glenn Dale, Maryland, as that species. One species, G. amorphoides (Griseb.) Taub., is found in Argentina, Uruguay, and Paraguay in South America. Although Rehder (1940) mentioned a species from tropical Africa (G. africana Welw. ex Bentham from Angola), this species has been re-assigned to another genus.

The exotic species are seldom planted because of their poor or unknown adaptability and ornamental inferiority, and no thornless forms have been widely propagated. At least three of the Chinese species were originally described from cultivated specimens in Europe, and data on their native habitats are sketchy. In addition, the taxonomic confusion in botanical gardens and nurseries has led to many errors of identification (Bean, 1973).

Nevertheless, we have attempted to obtain seed, grow plants, and determine the webworm susceptibility of all available species of Gleditsia. The present study is part of an over-all investigation on the taxonomy, biochemistry, and genetics of this genus currently underway at the U. S. National Arboretum.

MATERIALS AND METHODS

Table 1 lists the primary seed sources for the species tested in this study. Seed was obtained from arboreta and botanic gardens throughout the world, either from their regular seed lists or through personal communication. Some 47 seedlots were received, and in most cases we obtained seed of a given species from two or more sources. Sources other than those in the table included gardens in France, Germany, Portugal, and Tunisia.

Because of the probable errors in identification mentioned previously, the seeds of each accession were weighed, measured, and color-coded, and a sample was saved for inclusion with herbarium specimens.

Seeds were soaked in concentrated sulfuric acid for one hour before sowing in the greenhouse in January-February, 1974. Data on germination, seedling growth habit, time of thorn production, time of production of bipinnate leaves, and other morphological and physiological traits were taken during the seedling stage. Seedlings were potted in 10-inch fiber pots and acclimated outdoors in a lathouse for two weeks before being placed in test locations prior to the period of emergence of adult webworm moths in the spring.

Seedlings of all species except G. amorphoides, G. fera, and G. microphylla were included in replicated tests at two locations on the Arboretum grounds in 1974 and 1975. One location was in a permanent open coldframe, where established trees of Albizia julibrissin and G. triacanthos in the vicinity were infested annually by the webworm. A temporary coldframe was erected at the second test location, where surrounding trees of A. julibrissin and A. kalkora Prain. were infested. After the potted seedlings were placed in the coldframe, a heavy mulch of wood chips was applied over the containers.

A single seedlot of each species was chosen for the major test. Each of these seedlots was represented by a two-tree plot in each of three replications at each location. The other seedlots were represented by at least one four-tree row at each location. Some 380 seedlings of 10 species were tested in this manner.

Seedlings of the aforementioned three species (G. amorphoides, G. fera, and G. microphylla) were judged to be too small in the spring of 1974 for inclusion in the major tests. Instead, a smaller test consisting of six two-tree plots of each species was set up in only one location.

Webworm infestation was checked every two weeks in 1974 using two rather subjective criteria: (1) percentage of compound leaves that were webbed, and (2) percentage of foliage destroyed. The webworm has two complete generations and a partial third in the Washington, D. C. area. The damage from the second-and-third-generation larvae is normally far worse than that caused by first-generation larvae. Therefore, observations were made at monthly intervals, only from June 15 to October 15, during 1975.

Because of suspected lack of cold hardiness in G. amorphoides, G. fera, and G. microphylla, six plants of each species were left in the outdoor coldframe during the winter of 1974-75 and six plants were taken up and overwintered in a cool greenhouse. A few surplus plants of G. macracantha and G. sinensis were also overwintered under glass. The plants that had spent the winter in the greenhouse were placed in the coldframe again at the beginning of the 1975 growing season

RESULTS AND DISCUSSION

Webworm infestation during 1974, the first season of testing, was somewhat confounded by plant size and growth rate. In addition, there was a significant difference in infestation intensity between locations, with 78 percent of the plants in the temporary coldframe being colonized as opposed to 31 percent in the permanent coldframe. However, no seedlots of the hardy species were completely free from insect damage.

No infestation was noted in 1974 in the three slow-growing, potentially tender species (G. amorphoides, G. fera, G. microphylla) in the permanent coldframe. All plants of these species that were left outdoors over winter were killed back to the root collar. Most of these plants resprouted during 1975'

There were no "location" differences in webworm damage among hardy species in 1975. Nearly 100 percent of the seedlings of these species were infested at each location. Comparisons among species were based on the percentage of foliage infested on September 15, 1975. G. delavayi and G. japonica var. koraiensis showed less damage than the other species, but even in those seedlots the amount of infestation could be detrimental to the landscape value of larger trees. Most of the seedlings of G. japonica var. koraiensis were thornless, and could be referred to f. inarmata Nakai.

Plants of G. amorphoides, G. fera, G. macracantha, G. microphylla, and G. sinensis, which had been overwintered in the cool greenhouse, were tested in only the permanent

coldframe during 1975. On September 15, 1975, the G. macracantha and G. sinensis seedlings were heavily defoliated; G. amorphoides had more than 75 percent of its foliage intact; and G. fera was completely free of webworm damage. The poor growth and development of G. microphylla did not allow any reasonable assessments of potential insect susceptibility.

Table 2 gives the overall rankings of webworm susceptibility among the species and seedlots tested. A few individual seedlings appeared to be significantly less susceptible to webworm infestation than other plants of the same seedlots or species. This was especially evident in G. delavayi and G. x texana.

CONCLUSIONS

The results of this preliminary survey of resistance to mimosa webworm among Gleditsia species do not offer much hope for the development of superior, webworm-resistant cultivars through interspecific hybridization. The only species with apparently high and potentially transmissible resistance is G. fera, and this species is not winter-hardy in Washington, D.C.

The goals of a honeylocust improvement program must include insect resistance, rapid growth rate, thornlessness, and fruitlessness. Only G. aquatica, G. triacanthos, and G. x texana have exhibited the qualities of adaptability and growth required in a successful cultivar. Thornless individuals are well known in these species.

It is suggested that the most feasible technique for the production of improved cultivars of honeylocust would be the mass-screening of thornless seedlings under conditions allowing for constant high populations of the webworm. Initial selections after the second year of growth could be outplanted for long-term testing in areas where Albizia julibrissin and highly susceptible plants of Gleditsia species serve as webworm "reservoirs." During this testing period, observations could also be made on the incidence of mites, various plant bugs, gall midges, and the few fungal diseases known to occur on Gleditsia species. Finally, after flowering at age 10 or older, male trees or male-flowering branches could be isolated for further propagation of desirable material.

Table 1. Primary seed sources of Gleditsia species.

<u>Species</u>	<u>Aboretum</u>	<u>Country</u>
<u>amorphoides</u>	Buenos Aries	Argentina
<u>aquatica</u>	Morris Arboretum	Philadelphia, Pa., USA
<u>casgica</u>	Taschkent	USSR
<u>delavayi</u>	Taschkent	USSR
<u>fera</u>	Agric. & Fish. Dept.	Hong Kong
<u>japonica</u>	Aritaki Arboretum	Japan
<u>japonica</u> var. <u>koraiensis</u>	Forest Expt. Sta.	Korea
<u>macracantha</u>	Univ. Athens	Greece
<u>melanacantha</u>	U.S. Plant Intr.Sta.	Glenn Dale, Md., USA
<u>microphylla</u> (<u>heterophylla</u>)	Taschkent	USSR
<u>sinensis</u>	U.S. Plant Intr.Sta.	Chico, Calif., USA
x <u>texana</u>	Taschkent	USSR
<u>triacanthos</u>	various	U.S. and Foreign

Table 2. Susceptibility of Gleditsia species to mimosa webworm infestation in 1975.

<u>Percent Foliage Destroyed</u>	<u>Species</u>
None	G. <u>fera</u>
25%	G. <u>amorphoides</u>
25-50%	G. <u>delavayi</u> , G. <u>japonica</u> var. <u>koraiensis</u>
50%	G. <u>aquatica</u> , G. <u>casgica</u> , G. <u>japonica</u> , G. <u>macracantha</u> , G. <u>melanacantha</u> , G. <u>sinensis</u> , G. x <u>texana</u> , G. <u>triacanthos</u>
Unknown	G. <u>microphylla</u>

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