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IDENTIFICATION AND CONTROL OF CANKERS CAUSED BY *NECTRIA CINNABARINA* OF HONEY LOCUST

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Cultivars of thornless honey locust (*Gleditsia triacanthos* var. *inermis*) are popular shade trees because of their fast growth, attractive foliage, spreading shape, and diffuse shade. These cultivars are also favored by the horticultural industry because they propagate well and transplant easily. In recent years honey locusts have been planted in increasingly large numbers. Between 1976 and 1981, nearly 17,000 honey locusts were planted in public areas in Minnesota (Minnesota Dept. of Agric. 1981). As honey locusts become more important components of our urban forests, disease problems that occur on this species infrequently will undoubtedly become more prevalent.

Honey locusts are susceptible to several canker-causing fungi (Bedker and Wingfield 1983, Schoeneweiss 1966). *Thyronectria austro-americana* (Speg.) Seeler is the most widely reported cause of cankers on this species with reports from Alabama, Colorado, Kansas, Illinois, Massachusetts, Mississippi, Oklahoma, and Tennessee (Crandell 1942, Hudler and Oshima 1976, Crowe *et al.* 1982, Stim and Himelick 1981, Seeler 1940, Conway and Morrison 1983). In Minnesota, however, *Nectria cinnabarina* (Tode:Fr.) Fr. is an important cause of cankers on honey locust (Bedker *et al.* 1982). *Nectria cinnabarina* has an extremely large host range (Jorgensen 1952) and a global distribution, especially throughout the northern hemisphere (Booth 1977). These two canker-causing fungi of honey locust cause very similar symptoms (Bedker *et al.* 1982, Seeler 1940), and may only be differentiated with certainty by microscopic examination of the fungi involved (Bedker and Wingfield 1983).

Cankers caused by *N. cinnabarina* can result in serious damage. In Syracuse, New York, pruning wounds on 53% of young Norway maples (*Acer platanoides*) were found to be infected with *N. cinnabarina* (Manion 1981). Branches were occasionally girdled by developing cankers; however, most of the trees recovered. In Minneapolis, Minnesota, 12.2% of the honey locusts surveyed were found to have cankers caused by *N. cinnabarina* (Bedker *et al.* 1982). In one nursery 24% of the honey locusts were found to have cankers, and had an average of two cankers per tree.

Further planting of this species in urban areas requires that control procedures be implemented. Perhaps the most essential portion of a control program is identification of the problem. Reducing the impact of this disease on honey locust can be achieved by various cultural practices, using resistant cultivars, and possibly through the use of chemical wound treatments.

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Identification of *Nectria cinnabarina* Cankers

The first symptoms of infection by *N. cinnabarina* are the appearance of slightly sunken, brown to reddish brown areas associated with wounds (Fig. 1). *Nectria cinnabarina* requires a wound before infection can occur (Jorgensen 1952). The first signs of infection are the formation of asexual fruiting structures (sporodochia). These sporodochia are cushion-shaped structures (Fig. 2) that range in color from coral pink to dark brown or black. They grow through the lenticels of the bark on the canker surface. During wet weather abundant conidia are exuded to the surface of the sporodochium in a gelatinous matrix (Fig. 3), and are readily disseminated by rainsplash (Gregory *et al.* 1959) and by flow of water across the surface of the canker. During dry weather the matrix, in which the spores are produced, dehydrates preventing dispersal of the conidia.

Figure 1. Early symptoms of infection of honey locust by *Nectria cinnabarina*. The two cankers on this tree (arrows) demonstrate the sunken discolored areas associated with infected pruning wounds.

Cankers caused by *N. cinnabarina* on honey locust are primarily annual cankers. The fungus invades the host and actively kills the cambium for one season. The host responds to this infection and the fungus is compartmentalized by the formation of callus. If the host does not respond to the infection, the fungus may continue to enlarge the canker for a longer period of time. One or two years after the compartmentalization of the fungus, the necrotic bark will be sloughed off exposing the wood below (Fig. 4). Cankers provide excellent avenues of entry for decay fungi (Fig. 5). These wood destroying fungi weaken the structural integrity of the trees, resulting in unsightly and potentially hazardous trees.

Not all cankers caused by *N. cinnabarina* on honey locust are annual. Occasionally the fungus remains active for several years, continually killing the cambium and enlarging the canker. Depending on the location of the canker, the entire tree or a portion of it may be girdled (Fig. 6).

Nectria cinnabarina also produces sexual fruiting bodies (perithecia, Fig. 7). They are bright cinnabar red and are formed in clusters on infected material. Perithecia rarely form on standing trees. However, in moist shaded areas, they are readily produced on infected material that is in contact with the ground.

Control of *Nectria cinnabarina* Cankers

Control of cankers located on small branches can be achieved simply by pruning off infected branches along with some healthy tissue. Often, however, cankers caused by *N. cinnabarina* occur on the main bole of the tree and cannot be removed without destroying the tree. An accepted technique for control of *Nectria* cankers (Tattar 1978) is to excise and remove infected tissue (Figs. 8 a,b). When scribing around cankers or removing infected tissue, great care should be taken to avoid injury to existing callus. New, unnecessary wounds provide the opportunity for reinfection by the fungus. Since it takes approximately two years for infected tissue to be sloughed off once the infection has been compartmentalized, it may be desirable to remove the infected tissue because the tissue only serves as a source of inoculum for other wounds.

Cultural practices can reduce the incidence of cankers, caused by *N. cinnabarina,* on honey locusts. Since wounds are required for infection by *N. cinnabarina,* canker incidence on honey locust may be reduced by avoiding excessive pruning wounds. Timely pruning of honey locusts is also important. Honey locusts should not be pruned during damp weather when spores of *N. cinnabarina* are present. Jorgensen (1952) states that it is possible to transmit the spores of *N. cinnabarina* to fresh wounds on pruning tools. In a tree nursery surveyed by the authors (unpublished data), located west of Minneapolis, Minnesota, honey locusts with cankers were more likely to be grouped within the rows, in the direction taken by nursery workers when pruning, whereas trees with cankers occurred at random across the rows. This provides only circumstantial evidence for transmission of *N. cinnabarina* by pruning tools, and we have not been able to confirm this experimentally. Precautionary steps for reducing canker incidence include avoidance of pruning honey locusts in wet weather and sterilization of pruning tools (Jorgensen 1952).

Nectria cinnabarina is usually a saprophyte living on dead organic matter but occasionally it can become parasitic. Like any other canker-causing fungi, the severity of cankers caused by *N. cinnabarina* can be enhanced when the hosts are under stress (Bedker and Blanchette 1983a). This may explain why *N. cinnabarina* is capable of causing two types of cankers on honey locust. Healthy, vigorously growing trees are able to respond quickly to infection by *N. cinnabarina* and compartmentalize the infection (Bedker and Blanchette 1983a). Honey locusts under stress are less able to respond to wounding (Neely 1970) and subsequent infection resulting in canker enlargement. Thus it may be possible to reduce the severity of cankers caused by *N. cinnabarina* on honey locusts by maintaining tree vigor.

In maintenance of vigor of urban trees, it is important to consider two periods of time during tree establishment. The first is the period from the time of transplanting until the trees are established on their new site, and the second is the time after establishment. Trees are often under severe stress during transplanting and until they become established. In a recent study, Watson and Himelick (1982) showed that tree spades may reduce the root system of nursery trees by 98% during transplanting. These investigators demonstrated the need for re-establishment of a favorable root-shoot ratio to maximize the survival of newly transplanted trees. When transplanting honey locusts it may be possible to reduce the impact of stress and subsequent attack by *N. cinnabarina* by using larger ball sizes, effectively moving a larger portion of the root systems, or by transplanting younger trees. After transplanting, supplemental watering and fertilization may be desirable. This would aid in the establishment of a favorable root-shoot ratio and promote rapid establishment of the trees. It may be desirable to continue supplemental watering even after the trees are established. Established honey locusts in urban environment have been shown to be under water stress much of the growing season (Halverson and Potts 1981), thus it may be possible to improve tree vigor and reduce the effects of *N. cinnabarina* by providing supplemental water to these trees.

Two additional methods that are potentially useful for the control of this canker disease, are the use of wound dressings and planting resistant cultivars. Honey locusts wounded on 29 June 1982 and inoculated with *N. cinnabarina* at various times after wounding were shown to remain susceptible to infection for one week or less (Fig. 9) (Bedker and Blanchette 1983b). Since wounds remain susceptible to infection for such a short period of time, the use of an effective wound treatment could have great potential for reducing the incidence of cankers. The most common materials used in the treatment of wounds are asphalt-based. The usefullness of these materials has been seriously questioned (Marshall 1932, Shigo and Wilson 1977). Benomyl, a systemic fungicide, has been used as a wound treatment for the control of many canker-causing fungi (English *et al.* 1979, Carter and Moller 1970, Moller and Kasimatis 1980). Moller and Kasimatis (1980) showed that benomyl, at high concentrations (10,000 μ g/ml), when applied to fresh pruning wounds on grape prevented colonization by *Eutypa armeniacae.* However, fairly low concentrations of benomyl did not prevent colonization of wounds on honey locust by *N. cinnabarina*

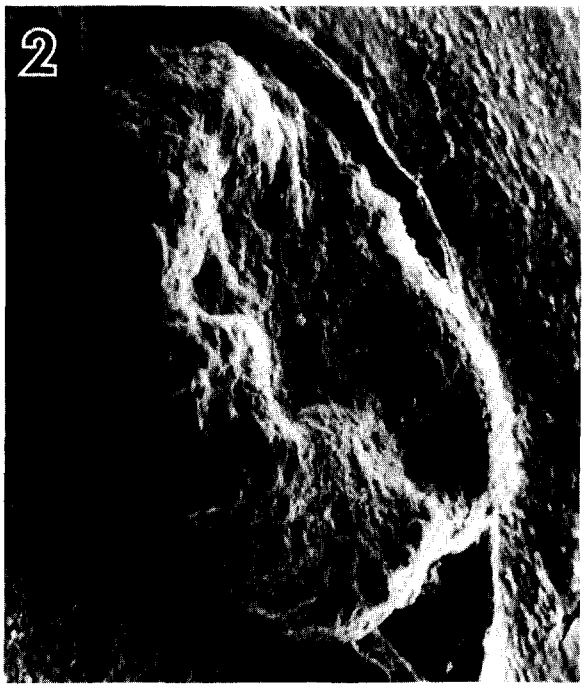

Figure 2. Cushion-shaped sporodochium of *Nectria cinnabarina* erupting through a lenticel on the canker surface.

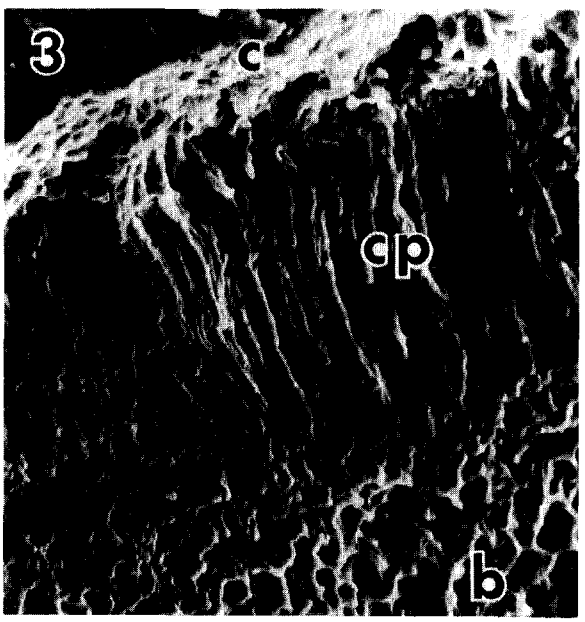

Figure 3. Vertical section through a sporodochium showing the conidia (c) that were exuded to the surface to form a crust-like layer over the sporodochium, the conidiophores (cp) (the structures that produce the conidia), and the stromatic base (b) of the sporodochium.

Figure 4. Large canker located on the main stem of a honey locust. Note the callus around the wound. Much of the infected bark has been sloughed off exposing the wood below.

Figure 5. Canker caused by *Nectria cinnabarina* colonized by *Schizophyllum commune*, a wood decay fungus.

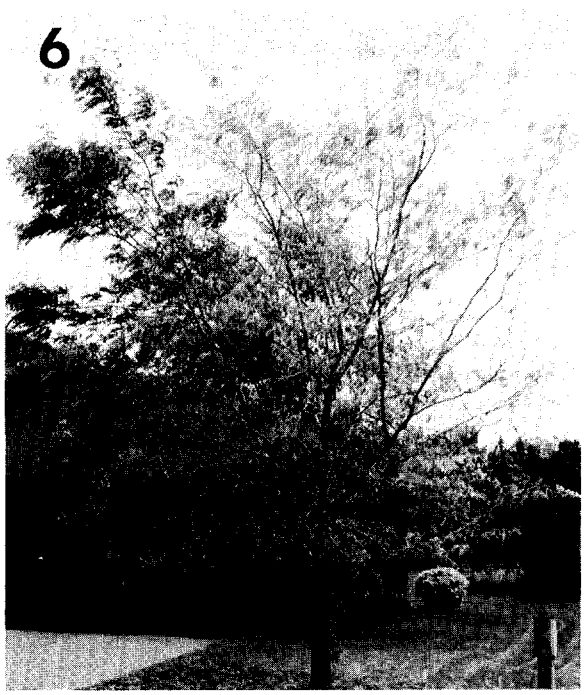

Figure 6. A girdling canker located in the branch axil three feet above the ground that has resulted in the death of over half the crown of the tree.

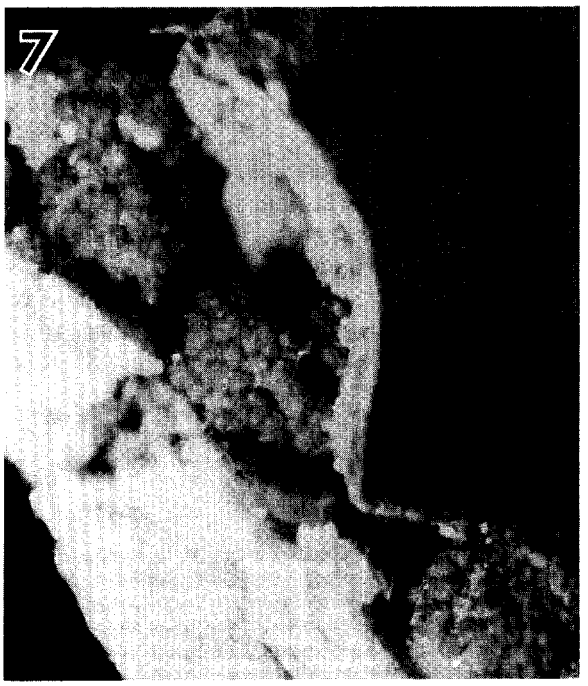

Figure 7. Perithecia of *Nectria cinnabarina* produced in clusters on a common stromatic base.

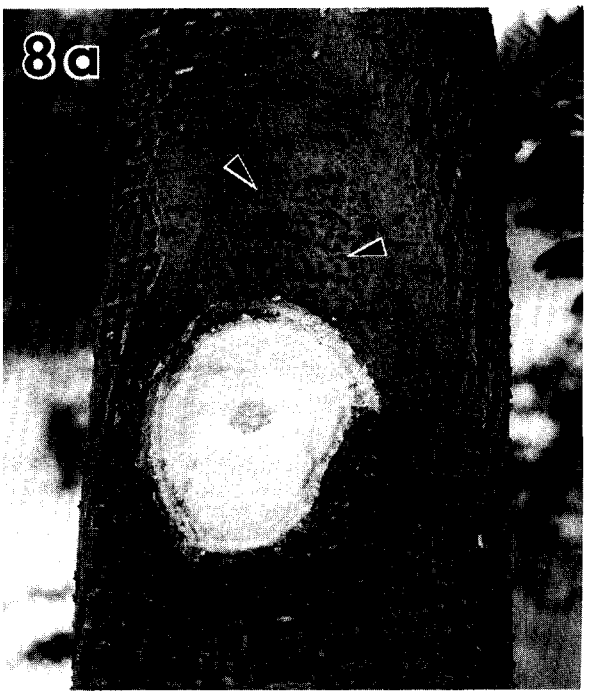

Figure 8a. Canker caused by *Nectria cinnabarina* on the stem of a honey locust. Note the numerous sporodochia (arrows) on the sunken canker surface.

Figure 8b. Canker has been scribed around and infected tissue has been removed. Notice some additional healthy tissue has been removed beyond the area of discoloration.

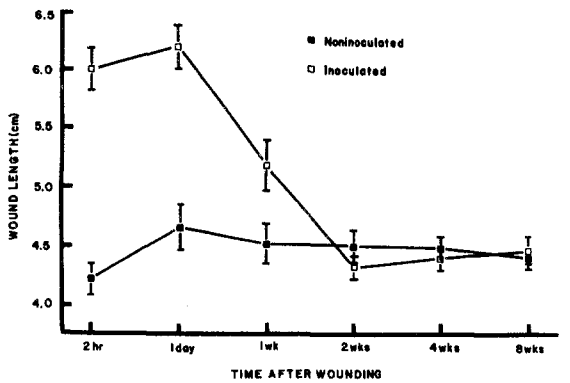

Figure 9. Comparison of lesion length for noninoculated wounds and wounds inoculated with *Nectria cinnabarina* on honey locust fourteen weeks after inoculation. Wounds were produced on 29 June 1982 and inoculated at various intervals after wounding. The bars represent the standard errors of the mean values for 10 replicates of each treatment.

Table 1. Comparison of lesion length of four cultivars of honey locust inoculated with *Nectria cinnabarina* on 28 June 1982.

	Lesion length (cm)[x]	
Cultivar	*Inoculated*[y]	*Noninoculated*[z]
Sunburst	4.22 a	1.15*
Skyline	3.91 a	1.01*
Imperial	3.47 a	1.40*
Thornless	1.99 b	1.41

[x] Average values of ten replicates.
[y] Values followed by the same letter within a column were not significantly different (P = 0.05) using Bonferroni's method of multiple comparisons (BSD = 1.26 cm).
[z] An asterisk denotes the average values within a row were significantly different (P = 0.01) using Bonferroni's method of multiple comparisons (BSD = 1.26 cm).

(Bedker and Blanchette 1983b). There is a need for further research to develop and evaluate different wound treatments for their effectiveness in preventing infections of wounds by *N. cinnabarina*.

Perhaps the most promising control method for cankers caused by *N. cinnabarina* is the use of resistant cultivars. In one experiment four cultivars of honey locust (Skyline, Imperial, Sunburst, and Thornless) were evaluated for their susceptibility (Bedker and Blanchette 1983b). When inoculated in the early summer (28 June 1982), the cultivar Thornless was found to be least susceptible (Table 1). The inoculated wounds were not statistically larger than the control wounds (Table 1). Skyline, Imperial, and Sunburst were equally susceptible to *N. cinnabarina* (Table 1). For these three cultivars the average length of the cankers (3.87 cm) was significantly greater (P .05) 11 weeks after inoculation than the noninoculated wounds (1.19 cm). The use of resistant cultivars has great potential for the control of *N. cinnabarina* cankers. Successful control of this canker-causing fungus on elm was achieved through selection of resistant clones (Heybroek 1964). Further research is needed to develop and evaluate additional cultivars of honey locust for resistance to this fungus. Also the development of local cultivars, where possible, should be investigated. Trees that are native to an area are often much less suceptible to the stresses of the local environment and thus better able to respond to infection.

The incidence and severity of cankers caused by *N. cinnabarina* on honey locust may be reduced by proper cultural procedures, which include: 1) not pruning during wet weather, 2) avoiding excessive wounds, and 3) enhancing tree vigor when possible; chemical control (i.e. the use of effective wound treatment); and the use of resistant cultivars.

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Literature Cited

Bedker, P.J., and R.A. Blanchette. 1983a. *Development of cankers caused by Nectria cinnabarina on honey locusts after root pruning.* Plant Dis. (In press)

Bedker, P.J., and R.A. Blanchette. 1983b. *Control of Nectria cinnabarina cankers of honey locust.* Plant Dis. (In press)

Bedker, P.J., R.A. Blanchette, and D.W. French. 1982. *Nectria cinnabarina: The cause of a canker disease of honey locust in Minnesota.* Plant Dis. 66: 1066-1067.

Bedker, P.J., and M.J. Wingfield. 1983. *Taxonomy of three canker-causing fungi of honey locust in the United States.* Tran. Brit. Mycol. Soc. (In press)

Booth, C. 1977. Nectria cinnabarina. Descriptions of Pathogenic Fungi and Bacteria. No. 531. Commonw. Mycol. Inst., Kew, Surrey, England.

Carter, M.V., and W.J. Moller. 1970. *Duration of susceptibility of apricot pruning wounds to infection by Eutypa armeniacae.* Aust. J. Agric. Res. 21: 915-920.

Crandell, B.S. 1942. *Thyronectria disease of honey locusts in the South.* Plant Dis. Rep. 26: 376.

Crowe, F., D. Starkey, and V. Lengkeek. 1982. *Honey locust canker in Kansas caused by Thyronectria austro-americana.* Plant Dis. 66: 155-158.

Conway, K.E., and L.S. Morrison. 1983. *Diseases and decay fungi in windbreaks in Oklahoma.* Plant Dis. 67: 289-291.

English, H., H.J. Dudin, and F.J. Schick. 1979. *Chemical control of European canker of apple.* Plant Dis. Rep. 63: 998-1002.

Gregory, P.H., E.J. Guthrie, and M.E. Bunce. 1959. *Experiments on splash dispersal of fungus spores.* J. Gen. Microbiol. 20: 328-354.

Halverson, H.G., and D.F. Potts. 1981. Water requirements of honey locust (*Gleditsia triacanthos* f. *inermis*) in the urban forest. U.S. For. Ser. Res. Pap. NE-487. 4 pp.

Heybroek, H.M., translated by F.W. Holmes. 1964. *De iep 'Groeneveld' — the 'Groeneveld' elm.* Plant Dis. Rep. 48: 187-189.

Hudler, G.W., and N. Oshima. 1976. *The occurrence and distribution of Thyronectria austro-americana on honey locust in Colorado.* Plant Dis. Rep. 60: 920-922.

Jorgensen, H.A. 1952. *Studies on Nectria cinnabarina hosts and variation.* R. Agric. College Contrib. Dept. Plant Pathol. Copenhagen. 35: 57-120.

Manion, P.D. 1981. *Norway maple decline.* J. Arboric. 7:38-42.

Marshall, R.P. 1932. Some experimental treatments of shade tree wounds. N.J. Fed. Shade Tree Comm., Shade Tree 5: 3p.

Minnesota Department of Agriculture. Shade Tree Program. 1980 Report to the Legislature. 77 pp.

Moller, W.J., and A.N. Kasimatis. 1980. *Protection of grapevine pruning wounds from Eutypa dieback.* Plant Dis. 64: 278-280.

Neely, D. 1970. *Healing of wounds on trees.* J. Amer. Soc. Hort. Sci. 95: 536-540.

Schoeneweiss, D.F. 1966. *Cytospora canker on thornless honey locust trees.* Plant Dis. Rep. 50: 13-14.

Seeler, E.V., Jr., 1940. *Two diseases of Thyronectria.* J. Arnold Arbor. Harv. Univ. 21: 405-427.

Shigo, A.L., and C.L. Wilson. 1977. *Wound dressings on red maple and American elm: Effectiveness after five years.* J. Arboric. 3: 81-87.

Stim, J.A., and E.B. Himelick. 1981. *Honey locust decline in urban areas.* Phytopathology 71: 906 (Abstr.)

Tatter, T.A. 1978. Diseases of shade trees. Academic Press Inc. New York. 361p.

Watson, G.W., and E.B. Himelick. 1982. *Root distribution of nursery trees and its relationship to transplanting success.* J. Arboric. 8: 225-229.

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