Development of Cankers Caused by *Nectria cinnabarina* on Honey Locusts After Root Pruning

P. J. BEDKER, Graduate Research Assistant, and R. A. BLANCHETTE, Assistant Professor, Department of Plant Pathology, University of Minnesota, St. Paul 55108

ABSTRACT

Bedker, P. J., and Blanchette, R. A. 1983. Development of cankers caused by *Nectria cinnabarina* on honey locusts after root pruning. Plant Disease 67: 1010-1013.

Nectria cinnabarina can cause damaging cankers on honey locusts, especially on newly transplanted trees. Root pruning was used to simulate transplanting stress on honey locusts. Trees that were root-pruned had significantly lower ($P < 0.05$) water potentials than unpruned trees. Cankers caused by *N. cinnabarina* after inoculation to twigs, branches, and stems were larger on trees that were root-pruned than on unpruned trees. Uninoculated wounds closed more slowly on trees that were root-pruned than those that were not root-pruned.

Nursery and landscape industry practices subject trees to stress caused by root damage during transplanting. Root damage, water or nutrient shortage, temperature extremes, and other stress factors affect the susceptibility of trees to disease (8). This is especially true for canker diseases (2,3,9,10). Many canker-causing fungi are facultative parasites that easily invade a weakened host but rarely affect vigorous trees. Other canker pathogens attack both stressed and unstressed hosts but their development is enhanced when the host is stressed.

Thornless varieties of honey locust (*Gleditsia triacanthos* L.) are popular urban shade trees. This species, once thought to be tolerant to drought, has been used extensively for windbreak and shelterbelt plantings throughout the Great Plains (5). Halverson and Potts (6) demonstrated that water requirements of urban honey locusts were significantly higher than those of nonurban trees. The excessive water demands of urban honey locusts could result in those trees being under stress for much of the growing season.

Recently, *Nectria cinnabarina* (Tode: Fr.) Fr. was identified as a cause of damaging cankers on honey locust in Minnesota (1). The purpose of these studies was to determine the effects of root pruning as a method of inducing water and transplanting stress on canker development on *G. triacanthos* var. *inermis* Willd. inoculated with *N. cinnabarina*.

MATERIALS AND METHODS

Eight thornless honey locusts (cultivar Skyline), each 5–8 cm in diameter at 1.4 m above the ground, received 36–48 wounds divided among the trunk (>4 cm), branches (4–1.6 cm), and twigs (≤1.5 cm) on 11 August 1981. The wounds, extending 1 cm longitudinally and 1–3 cm circumferentially (Fig. 1) depending on the diameter of the stem at the inoculation point (1 cm on twigs, 2 cm on branches, and 3 cm on trunks), were made with a sterile scalpel through the outer bark and phloem. Two isolates of *N. cinnabarina* (IMI 262936 and 262937), obtained from the margins of active cankers on honey locust, were grown on sterile oats for 4 wk before inoculation. One colonized oat kernel was placed in each of about half of the wounds on each tree. A sterile kernel was placed in each of the remaining wounds as a control. All wounds were covered with Parafilm.

Two days after inoculation, four of the eight trees were root-pruned with a mechanical trencher. A trench 90 cm deep and 15 cm wide was made 60 cm from the base of the tree on all four sides. A pressure bomb (11,12) was used to monitor water potentials of the honey locusts in the field on several occasions before and after root pruning. For determination of water potential, five bipinnately compound leaves were removed from the lower crown of each tree and placed in the pressure bomb. For each tree at the time of measurement, the time, temperature, relative humidity, and sky condition were noted. Accurate measurements of nonosmotic xylem water potentials of leaves can be obtained with a pressure bomb (4,7).

Forty-six weeks after inoculation, the trees were cut and the length and width of dead cambium measured after removing the outer bark and phloem from around the wounds with a scalpel. No attempt was made to determine maximal lesion

Portion of a thesis submitted by the first author in partial fulfillment of the requirements for the M.S. degree, University of Minnesota.

Paper 13,204, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul 55108.

Accepted for publication 19 March 1983.

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "*advertisement*" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

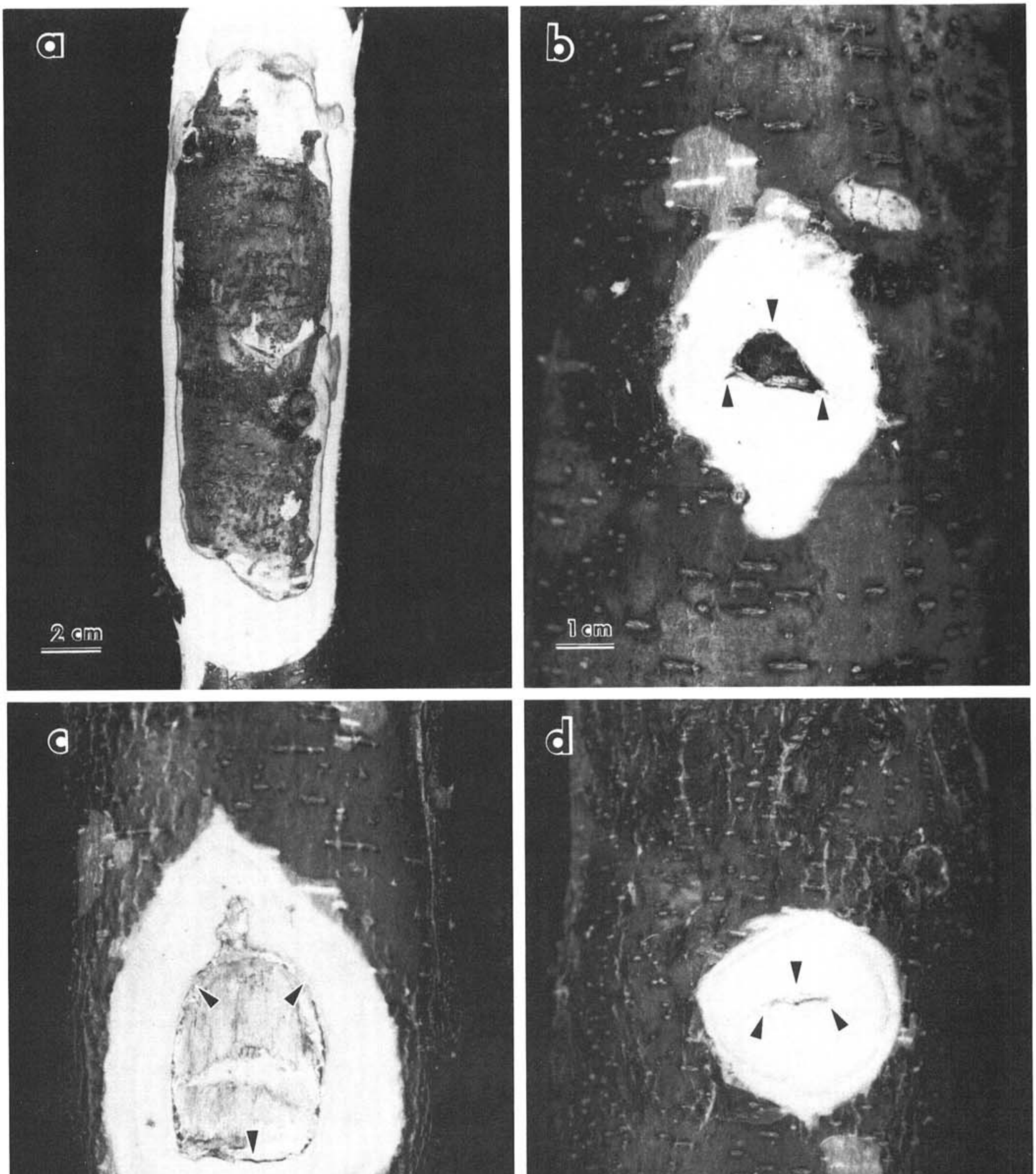

Fig. 1. Comparison of wounds on honey locusts with various treatments. The outer bark and phloem have been removed, exposing the xylem. **(A)** Canker caused by *Nectria cinnabarina* on a tree that was root-pruned. **(B)** Uninoculated wound on a root-pruned tree. Callus tissue has formed (arrowheads) around the wound. **(C)** Canker caused by *N. cinnabarina* on a non-root-pruned tree with callus tissue (arrowheads) completely around the lesion. **(D)** Uninoculated wound completely closed on an unpruned tree (arrowheads denote position of wound).

Table 1. Lesion dimensions on root-pruned and unpruned honey locusts as related to inoculation of wounds with *Nectria cinnabarina*

	Lesion dimensions (cm)[a]					
	Inoculated		Uninoculated		Average	
Treatment	Length	Width	Length	Width	Length	Width
Root-pruned	6.24	1.86	1.23	0.94	3.73	1.40
Unpruned	3.77	1.58	0.74	0.71	2.25	1.14
Average	5.00	1.72	0.99	0.83		

[a] For lesion length, an *F*-test indicated the effect of root pruning was significant at $P<0.05$ and the effect of inoculation was significant at $P<0.01$, but the interaction of treatments was not significant ($P>0.05$). Data used in the statistical analysis were transformed by natural logarithms so that the assumption of analysis of variance (that treatment and environmental effects are additive) was met. For lesion width, similar transformation and analysis indicated significant effect only of inoculation ($P<0.01$).

Table 2. Average midday water potentials (-1×10^8 mPa) of honey locusts in 1981 before and after root pruning compared with unpruned trees

Root-pruned (13 August)			Unpruned		
31 July and 4 August[a]	17 August[b]	Difference	31 July and 4 August[a]	17 August[b]	Difference
5.70[c]	27.00	−21.30	7.45[c]	6.20	1.25
7.65	13.10	− 5.75	8.00	11.50	−3.50
7.75	18.50	−10.75	7.40	6.90	0.50
7.20	23.90	−16.70	9.75	10.20	−0.45
Average		−13.55[d]	Average		−0.55
Standard deviation		6.915	Standard deviation		2.086

[a] Mean value of measurements taken on two dates before root pruning.
[b] Measurements taken after root pruning.
[c] Mean value of five samples per tree for each measurement time.
[d] Average difference for root-pruned trees was significantly lower ($P<0.05$) than for unpruned trees according to a *t* test for independent samples with unequal variances.

length by excising callus that had formed. Isolations to recover *N. cinnabarina* were made from margins of inoculated wounds by removing small amounts of xylem and phloem. These samples were placed in petri dishes containing 22 ml of Difco potato-dextrose agar (PDA) amended with 20 μg/ml streptomycin sulfate and incubated at 25 C for 3–5 days. Isolations were also made from uninoculated wounds if a large amount of cambial dieback was evident.

RESULTS

Root-pruned honey locusts had significantly ($P<0.05$) less wound closure than unpruned trees. Average lengths of lesions at inoculated wounds on root-pruned and unpruned trees were 6.24 and 3.77 cm, respectively (Table 1), compared with 1.23 and 0.74 cm, respectively, at uninoculated wounds. Root pruning as well as inoculation with *N. cinnabarina* had significant effects on lesion length ($P<0.05$ and $P<0.01$, respectively) but there was no interaction between them ($P>0.05$). In comparisons of wound widths, only the effect of inoculation was significant ($P<0.01$) (Table 1). Figure 1A demonstrates the extensive canker development at inoculated wounds on trees that were root-pruned compared with uninoculated wounds on trees of the same treatment (Fig. 1B). Inoculated wounds on unpruned trees also had large areas of dead cambium (Fig. 1C), but callus surrounded the lesions (arrowheads). The uninoculated wounds on unpruned trees were often completely closed by callus (Fig. 1D).

Nonosmotic xylem water potentials for the eight trees taken 31 July and 4 and 17 August 1981 are presented in Table 2. On all three days, measurements were made between 1000 and 1300 hours under similar ambient temperatures, relative humidities, and sky conditions. Measurements on 31 July and 4 August 1981 were taken before the trees were root-pruned, whereas those from 17 August 1981 were taken 4 days after root pruning. The mean difference in water potentials before and after root pruning for the four root-pruned trees was significantly greater ($P<0.05$) than for the unpruned trees (Table 2). The four root-pruned trees also began to senesce about 2 wk before the unpruned trees in autumn of 1981.

N. cinnabarina was isolated from 59% of the inoculated wounds and from one uninoculated wound that showed excessive cambial dieback.

DISCUSSION

Disruption of the root system by pruning resulted in significantly larger cankers and slower wound closure on inoculated and uninoculated stems, respectively. Root pruning removes the portion of the root system most active in water and nutrient uptake and places trees under stress. Because honey locusts have a well-developed lateral root system with a weakly developed taproot, the root-pruning methods used in this study simulated transplanting stress.

N. cinnabarina is often referred to as a weak parasite, causing only annual cankers on honey locust. Once callus tissue has formed around a canker, compartmentalization prevents expansion by *N. cinnabarina*. Trees under stress respond poorly to wounding and subsequent infection. Delayed callus formation and compartmentalization result in a diffuse canker that may rapidly girdle the tree. Results in this paper indicate that severity of *N. cinnabarina* cankers can be greatly enhanced when the host is under stress.

A recent investigation (6) indicated that honey locusts may be under stress in urban environments. The added stress that occurs after transplanting indicates that precautions need to be observed if honey locusts are to be planted in urban environments. Recently, Watson and Himelick (13) demonstrated that using tree spades may reduce the root system of trees as much as 98%; they suggest that to maximize survival, a favorable root-shoot ratio must be reestablished after transplanting. A supplemental watering program may also be essential (6).

Stress plays a definite role in development of *N. cinnabarina* cankers of honey locust. Transplanting smaller trees or moving a larger portion of the root system with the trees will subject honey locusts to less stress and will enhance reestablishment of a favorable root-shoot ratio. Efforts should be made to reduce stress on honey locust during transplanting and the initial establishment period. If stress on these trees can be alleviated effectively, the problems associated with this canker disease could be reduced.

ACKNOWLEDGMENTS

We wish to thank David French and Edward Sucoff for comments and suggestions and Dave Devoto, Jim Herman, and the Minneapolis Park and Recreation Board for providing trees and an area in which to conduct our experiments. This research is supported in part by the nursery industry through contributions to the Horticultural Research Institute, a nonprofit organization devoted to progress through research.

LITERATURE CITED

1. Bedker, P. J., Blanchette, R. A., and French, D. W. 1982. *Nectria cinnabarina*: The cause of a canker disease of honey locust in Minnesota. Plant Dis. 66:1067-1070.
2. Bier, J. E. 1959. The relation of bark moisture to the development of canker diseases caused by native, facultative parasites. I. *Cryptodiaporthe* canker on willow. Can. J. Bot. 37:229-238.
3. Bier, J. E. 1959. The relation of bark moisture to the development of canker diseases caused by native, facultative parasites 2. *Fusarium* canker on black cottonwood. Can. J. Bot. 37:781-788.
4. Boyer, J. S. 1967. Leaf water potentials measured with a pressure bomb. Plant Physiol. 42:133-137.
5. Fowells, H. A., ed. 1965. Silvics of forest trees of the United States. U.S. Dep. Agric. Handb. 271. 762 pp.
6. Halverson, H. G., and Potts, D. F. 1981. Water requirements of honey locust (*Gleditsia triacanthos* f. *inermis*) in the urban forest. U.S.

For. Serv. Res. Pap. NE-487. 4 pp.
7. Kaufmann, M. R. 1968. Evaluation of the pressure chamber technique for estimating plant water potential of forest tree species. For. Sci. 14:369-374.
8. Schoeneweiss, D. F. 1975. Predisposition, stress, and plant disease. Annu. Rev. Phytopathol. 13:193-211.
9. Schoeneweiss, D. F., and Crist, C. R. 1975. The influence of controlled stresses on susceptibility of European white birch stems to attack by *Botryosphaeria dothidea*. Phytopathology 65:369-373.
10. Schoeneweiss, D. F., and Wene, E. G. 1977. Freezing stress predisposes *Euonymus alatus* stems to attack by *Nectria cinnabarina*. Plant Dis. Rep. 61:921-925.
11. Sholander, P. F., Hammel, H. T., Bradstreet, E. D., and Hemmingsen, E. A. 1965. Sap pressure in vascular plants. Science 148:339-346.
12. Tyree, M. T., and Hammel, H. T. 1972. The measurement of turgor pressure and the water relations of plants by the pressure bomb technique. J. Exp. Bot. 23:267-282.
13. Watson, G. W., and Himelick, E. B. 1982. Root distribution of nursery trees and its relationship to transplanting success. J. Arboric. 8:225-229.