Thousand Cankers Disease Management in Urban Forestry

Active infestations of thousand cankers disease (TCD) of walnut are present in several pockets within Colorado and to date have caused the loss of scores, if not hundreds, of black walnut (*Juglans nigra*) in the short time since it has been recognized and described (2008). Infestations have involved eastern Colorado communities within Adams, Arapahoe, Boulder, Broomfield, Crowley, Denver, El Paso, Jefferson, Larimer, and Otero counties; infestations have been confirmed from Delta county and are thought to have occurred in other West Slope areas where black walnut was planted.

Arborists have made attempts to manage this disease, primarily involving use of various bark applied sprays (e.g., permethrin, bifenthrin) or soil drench systemic insecticides (e.g., imidacloprid) to kill the walnut twig beetle (*Pityophthorus juglandis*). The walnut twig beetle is the vector of *Geosmithia morbida*, the fungal associate that produces bark cankers that most define the course of TCD infections. These beetle-targeted insecticide applications have apparently had only limited effectiveness and, at best, have been able only to slow the TCD progress.

Sanitation has also been considered for TCD management. The effectiveness of sanitation for managing some shade tree diseases is well illustrated with Dutch elm disease (DED), a devastating disease of American elm (*Ulmus americana*) that similarly involves a pathogenic fungus (*Ophiostoma novo-ulmi*) and a bark beetle vector (*Scolytus multistriatus*; probably *Scolytus schevyrewii*). Indeed, the adoption of sanitation and other management practices for DED was a key event in the development modern urban forestry.

However, the epidemiology of thousand cankers disease differs in many respects from that of Dutch Elm Disease. It is important to recognize these differences to understand how management, including sanitation, may differ for these two urban tree problems.

Epidemiology-Dutch Elm Disease vs. Thousand Cankers Disease

Involvement of the pathogen

DED. *Ophiostoma novo-ulmi* develops within the vascular system of the plant and can move quickly throughout a tree, including into roots.

TCD. *Geosmithia morbida* is restricted to the phloem and outer tree bark (and later the cambium) producing localized cankers.

Role of Root Grafts

DED. Root graft transmission can be a very important means of DED-spread.

TCD. Root graft transmission does not occur.

Association of the Pathogen with the Beetle Vector

DED. *Ophiostoma novo-ulmi* is only incidentally associated with the *Scolytus* spp. vectors, via attachment of spores when beetles develop within a DED-infected wood. The bark beetles will develop in damaged limbs and dying trees or recently felled logs, regardless of whether DED is present. In areas where DED is well managed, essentially no beetles carry the *O. nova-ulmi* pathogen.

TCD. *Geosmithia morbida* is consistently associated with the walnut twig beetle. It is a very common and perhaps invariable fungal associate of walnut twig beetles. It is possible that the two organisms have a mutualistic association, as occurs with some bark beetles.

Speed of Symptom Development

DED. Infections resulting from twig-feeding by infective bark beetles initially produce a limited area of crown flagging. As the fungus moves within the plant symptoms progress and trees will usually die within 1-2 years following initial infection. Infection via root grafts may result in more rapid tree death.

TCD. Symptoms develop from the cumulative effects of multiple canker production, resulting from very large numbers of individual inoculations by *G. morbida*-carrying walnut twig beetles. External symptoms of infection, e.g., flagging, will not occur until sufficient numbers of cankers have been present to produce girdling.

The speed at which walnut trees are killed is still unknown and will depend on many factors, notably the number of infective beetles initiating infections as well as host susceptibility to *G. morbida*. However, if planting are originally colonized by only small numbers of walnut twig beetles, it may take a very long time (i.e., more than 3-4 years), before sufficient numbers of cankers have developed to produce external symptoms. However, trees usually are dead within 2-3 years after symptoms such as branch wilting or dieback are observed.

Overwintering of Beetle Vectors

DED. The *Scolytus* spp. of elm overwinter as a developing larvae under the bark.

TCD. The overwintering habits of the walnut twig beetle need more attention. Presently, we believe beetles overwinter primarily as adults in cavities excavated in outer bark. These overwintering chambers may be in the same tree within which the beetle developed or may be a nearby walnut tree.

Survival in Cut Wood

DED. Freshly cut wood is highly attractive to and can support development of elm *Scolytus* spp. bark beetles. However, logs will dry out fairly quickly after cutting and are unlikely to be able to support beetle development after a year.

Debarking will kill stages of beetles that are developing in wood and adults do not winter in bark. Chipping should kill all stages of the beetles as the beetles are relatively large (compared to walnut twig beetles) and pieces of wood following chipping are unsuitable for further larval development.

TCD. Freshly cut wood is highly attractive to and can support development of walnut twig beetles. Successful larval development will require wood of sufficient moisture and drying ultimately will make wood unsuitable. However, because of the small size of the beetles development may occur in small pockets within drying logs. It is possible that under conditions where drying is slow, logs may remain suitable for breeding for 2 or even 3 years after felling.

Debarking may kill some developing larvae. However, bark may contain live adult beetles. Chipping likely will kill most beetles, but some small pieces of wood with bark intact remain after chipping that can support surviving walnut twig beetles and allow successful development of some larvae.

Role of Bark-Sprayed Insecticides

DED. Drenching sprays of persistent insecticides (e.g., carbaryl, permethrin, bifenthrin) directed at the crown of the tree prior to beetle feeding in spring are generally thought to be useful in further reducing DED-spread in areas where a strong sanitation program is present.

TCD. Trunk/branch sprays applied in a manner typically used for bark beetle control do not appear to be effective in preventing TCD-progress. The large number of walnut twig beetles present over an extended period (May-September) and the large areas of the tree that may be attacked are all significant impediments to effective coverage.

It is possible that late summer trunk sprays directed at beetles seeking overwintering shelter in the trunk may be useful in reducing populations. This may have some value in slowing TCD development and spread. However, this method has not been demonstrated.

Role of Systemic Insecticides

DED. Systemic insecticides have no value in managing DED. Infections by beetles during twig feeding occur before beetles have sufficient exposure to the insecticide.

TCD. The value of systemic insecticides in TCD management has not been well evaluated. Limited observations indicate that imidacloprid (i.e., Merit, Marathon, Touchstone, etc.) is ineffective after symptoms have developed. Anecdotal accounts suggest that disease progress may be slowed by imidacloprid if applications are made before extensive cankers have been formed.
However, it is unlikely that systemic insecticides can prevent TCD. Successful inoculations of *G. morbida* likely can occur even if the walnut twig beetle is subsequently killed. Cankers resulting from infection will produce pockets within the tree where future movement of systemic insecticides will be limited, allowing some successful development of twig beetles at these sites.

These areas under the bark where beetles will be protected from systemic insecticides will increase with time as cankers expand and new cankers are initiated.

It is possible that the more water soluble insecticide dinotefuran (Safari) may provide improved coverage. However, it has not been evaluated.

Pesticide labeling restrictions will be an important limitation to the use of systemic insecticides in most walnuts. Although these trees are almost exclusively grown in Colorado as a shade tree, they do produce consumable nuts. Therefore, any pesticide (insecticide, fungicide) considered in TCD management may need to comply with use restrictions of walnuts grown for nut-crops.

At present, there are food crop tolerances for imidacloprid in walnut meat, as this insecticide (Provado formulation) is used in commercial nut production. Dinotefuran has no established tolerance for walnut meat and no formulations are labeled for this crop.

The Role of Sanitation in TCD Management

For urban forestry, sanitation will have a substantially more modest role in management of thousand cankers disease than does management of Dutch elm disease. This is largely due to two factors: 1) the long lag time between tree infestation and TCD symptom expression, allowing undetected local spread; and 2) the consistent association of the pathogen with essentially all bark beetles. Because of this, once TCD has become established in a city, eradication is unlikely; some slowing of spread is the best potential outcome.

Where black walnut trees within a city occur in contiguous plantings, elimination of TCD-symptomatic trees will have minimal effects. Nearby non-symptomatic trees can be assumed to very likely also be infested whenever a TCD-symptomatic tree is detected. Although tree removal will result in some removal of infective walnut twig beetles within the cut tree, these will constitute only a portion of those already present among the plantings, perhaps only a small portion. Elimination of these beetles through tree removal will likely only modestly slow the course of disease development in remaining nearby trees, probably by only a couple of years at most.

Sanitation may be most effective if plantings of black walnut within the city are widely separated, by several city blocks at a minimum. If it is assumed that normally the beetles disperse short distances, then removal of all TCD infected trees, symptomatic or not, *may* provide local TCD-eradication within an isolated pocket of black walnuts. If infective walnut twig beetles have not already spread beyond this area, TCD spread to more distant uninfected plantings of walnut may be substantially slowed.

Also extremely important in TCD-containment is the proper handling of TCD-infective wood. Recently cut trees that showed TCD symptoms likely will contain many thousands of walnut twig beetles. If this infective wood is moved in a manner that these beetles can invade new, healthy stands of walnut, new pockets of TCD will develop and ultimately destroy these plantings.

As walnut wood may support development of walnut twig beetles until thoroughly dried, beetle-containing wood must be either destroyed or isolated. Chipping will largely achieved beetle destruction, but not completely so that chipped TCD-infected wood should also be handled with care.

(During warm periods, active beetles potentially may even disperse from cut wood as it is moved from the site. Therefore, care should be given in routing trucks hauling TCD-infective wood to avoid areas of healthy, uninfected walnut.)

Because of the very high value of black walnut logs, salvage often will be attempted. If logs cut from TCD-infective trees are recovered, they should be handled in a manner that prevents beetle dispersal until the wood no long supports further walnut twig beetle development. Until sufficiently dried (2, perhaps 3 years under normal conditions) they should be isolated.

Isolation can be achieved largely by stockpiling wood in a site that is distant from healthy walnuts, particularly walnuts located down wind. Storage of logs in buildings can achieve beetle containment. Tarping logs with clear plastic also may contain beetles within logs. Tarping to achieve solarization also would likely be a means to kill developing beetles.

A Proposed Action Plan for TCD Management in Urban Forests

Where TCD is present in Colorado the following action plan is proposed:

1. Identify the location of all *Juglans* species within the area.

2. Identify the location of all TCD-symptomatic trees. Trees suspected of TCD should be confirmed by examining limbs for presence of the cankers and/or beetle presence. Culture of *Geosmithia morbida* or the presence of walnut twig beetle can be used for positive identification. Note: verification of the disease by culturing is not necessary if the walnut twig beetle is observed in the wood. The assumption is that all beetles are infested with *Geosmithia*; therefore beetle infested bark will contain the fungus. . Remember that flagging on walnut, the earliest diagnostic symptom of TCD, may be caused by squirrel damage or other limb injuries.

3. Inform all owners of *Juglans* sp. trees of the nature of thousand cankers disease. In particular, educate tree owners of the importance of handling infective wood to prevent spread to new locations.

4. Establish a means to properly handle and store/destroy infective wood.

5. Decide on an action plan.

If the disease is widespread and *Juglans* plantings occur throughout the municipality, there is little opportunity to affect the course of the disease via directed tree removals. Education and proper handling of TCD-infective wood should be the primary focus.

If TCD is present in isolated pockets within a community then containment can be considered as

having potential value in slowing spread. Tree removal should focus on these sites, eliminating all *Juglans* that can reasonably be suspected of containing infective walnut twig beetles. Establishment of a *Juglans*-free barrier between the TCD site and areas of healthy trees not already colonized by walnut twig beetle may substantially retard spread. Education and proper handling of TCD-infective wood should be emphasized.

TCD-Prevention: The Best Strategy

Prevention of TCD establishment in a community is the only means to effectively manage this disease. This no longer is an option where TCD is already present. However, many areas of Colorado (e.g., Fort Collins, Pueblo) do not appear to be presently infected. If the disease can be contained, most importantly by restricting beetle-containing wood or bark, then the ultimate course of Thousand Cankers Disease in the state may be limited to the destruction of walnut trees within communities were the disease has already become established.

More importantly, the present eastern edge of thousand cankers disease appears to be in eastern Colorado (Adams, Crowley, Otero counties). These areas are separated by hundreds of miles - and the largely *Juglans*-free High Plains - from areas of the eastern US where black walnut is a native tree.

Should Thousand Cankers Disease become established within the native range of this tree the results could be a catastrophic - possibly even leading to the functional extermination of this species in the manner that Chestnut blight or Dutch elm disease destroyed American chestnut and American elm, respectively. Prevention of spread by preventing the movement of TCD-infective walnut wood is critical to the protection and future survival of *Juglans nigra* (black walnut) in North America.

Whitney Cranshaw
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