

Questions and Answers about Thousand Cankers Disease of Walnut

What is thousand cankers disease of walnut? This is a newly recognized disease (2008) of certain walnut species (*Juglans*) caused by a fungus (*Geosmithia 'morbida'*) that is vectored by a bark beetle (walnut twig beetle). Thousand cankers disease has produced widespread death of walnuts in many western states during the past decade. Recently (July 2010) it was discovered to have also been killing black walnut in the Knoxville, TN area.

Is thousand cankers disease a problem confined to the western United States? No. Observations of the recently discovered infestation in Tennessee demonstrate that this disease will be a serious problem in urban and natural forests of the eastern US. There may be some regional differences in the progress of the disease and in symptoms development but the walnut twig beetle and *Geosmithia 'morbida'* appear to be well adapted to colonizing black walnuts (*Juglans nigra*) in the eastern United States. It appears that ultimately thousand cankers disease can be lethal to susceptible host trees where ever it becomes established.

What are symptoms of the disease? A recently identified *Geosmithia* fungus kills an area under the bark in the twigs and branches where it is introduced when the walnut twig beetle tunnels into the limb. These dead areas are called cankers and numerous cankers are formed when the walnut twig beetles are abundant. These cankers coalesce to girdle twigs and branches, restricting movement of nutrients and interfering with production and storage of energy.

(The cankers rarely show any of the external symptoms that are associated with most canker-producing fungi that affect trees. The affected area is shallow and confined to the phloem of the tree so that it can easily be missed if inspection cuts are made too deeply into the sapwood. Minor weeping may occur at points where walnut twig beetles enter the bark but often no symptoms area associated with the beetle attacks aside from minute entry wounds or star shaped cracks.)

Early symptoms are yellowing of leaves and foliage thinning of the upper crown of the tree. As the disease progresses larger limbs are killed which may have dead, flagging leaves associated with them. In end stages the fungus may be introduced into the trunk and large cankered areas develop in the trunk. In susceptible hosts, such as black walnut (*Juglans nigra*), trees in the Rocky Mountain states have almost invariably died within three years after initial symptoms are observed in the crown of the tree.

Symptoms progression may vary. For example, many black walnut trees affected by thousand cankers disease in the Knoxville area currently show broad crown dieback but have a lush growing lower canopy during the end stages of the disease. In the western states dieback may be more scattered through the canopy throughout the progress of external symptoms expression. Furthermore, there is often very little, if any, sprouting from black walnut that die from thousand cankers in Colorado; somewhat more sprouting appears to occur in Tennessee. These may be due to differences in growing conditions and overall tree health. However, in all susceptible hosts thousand cankers is ultimately lethal.

What is the insect vector? The walnut twig beetle, *Pityophthorus juglandis*, is the only insect

presently known to transmit the fungus from tree to tree. Investigations are currently underway to see if other species that tunnel into walnut (e.g., various borers, ambrosia beetles) may also be incidental vectors.

The walnut twig beetle is a native species to North America. It was first described in 1928 from western New Mexico, where the presumed host was Arizona walnut (*Juglans major*). Prior to 1992 it was reported from Arizona, New Mexico, and northern Mexico (Chihuahua); presumably it is likely found throughout the native range of Arizona walnut. Also, there were two 1959 California reports of the beetle from walnut collected in Los Angeles County. The latter may indicate that the insect also was native to southern California where the native host would be *Juglans californica* (southern California walnut).

Within the past couple of decades, the walnut twig beetle has substantially expanded its range. New state records for the insect have recently been determined from Colorado, Utah, Idaho, Oregon, and Washington. Within California the beetle is widespread throughout central areas of the state and in some coastal counties. In July 2010 the walnut twig beetle was found in Knox County, TN in association with a detected outbreak of thousand cankers disease that appears to have originated from an introduction that occurred at least a decade earlier.

What is the fungus? The fungus identified in 2008 that is capable of producing thousand cankers is a previously undescribed species of *Geosmithia*. (The name *Geosmithia morbida* has been proposed but is not formally accepted at present.) The fungus is consistently recovered from the walnut twig beetles and cankers that form around the beetle galleries in the bark.

Research into the genetics and biology of this fungus are underway. The origin of the fungus is not yet known but is likely also native to the same *Juglans* that serve as native hosts of the walnut twig beetle. Limited data indicate the population of the fungus in the West is complex and diverse. This type of diversity would be expected from a long established species (e.g., one established on a native population of Arizona walnut in the Southwest) rather than a recent introduction from Asia or Europe.

Are the twig beetle and the fungus always associated? The *Geosmithia* fungus can consistently be recovered from the body of beetles, from their galleries and their frass. It appears that the fungus is essentially always found in association with the walnut twig beetle. This includes its occurrence in native hosts (*Juglans major* in AZ and NM, *J. californica* in CA) as well as all other *Juglans* in all other sites where walnut twig beetle has been observed.

Because of this consistent association of the beetle with *Geosmithia 'morbida'*, the detection of the walnut twig beetle in a walnut tree can be considered equivalent to detection of thousand cankers (walnut twig beetle = *Geosmithia 'morbida'* = thousand cankers disease).

Whether there is some mutualistic association of the two species remains a subject for further study. The walnut twig beetle apparently does not possess mycangia for transport of the fungus but beetles are heavily contaminated externally by *Geosmithia* spores when they emerge from trees.

What species of trees are susceptible to this disease? This disease was first recognized on black walnut (*Juglans nigra*), a common woodland species distributed throughout much of the eastern US. Black walnut is extremely susceptible to thousand cankers, is the most commercially valuable *Juglans* species, and is the species of greatest concern.

Evaluating other species is a major focus of ongoing research. Arizona walnut (*Juglans major*), the native host of the walnut twig beetle, apparently is quite resistant. The insect is commonly found associated with this species in New Mexico and Arizona yet in Arizona walnut beetle attacks are limited largely to small diameter branches that are overshadowed or injured. Galleries typically occur at leaf scars. The *Geosmithia* fungus colonizes around these galleries, but does not progress aggressively as in black walnut and does not result in tree mortality.

Interestingly, walnut twig beetle has never been found in native stands of little walnut (*Juglans microcarpa*), a species that occurs between the native range of Arizona walnut and black walnut and overlaps both at the extremes of its range. Further surveys for walnut twig beetle and its *Geosmithia* associate in little walnut is a current research priority. Some tree colonization was noted in little walnut grown in a *Juglans* research planting in Davis, CA.

Tentatively, it appears that northern California walnut (*Juglans hindsii*) and southern California walnut (*Juglans californica*) show degrees of intermediate susceptibility to thousand cankers disease. Dieback and even some tree mortality (particularly in *J. hindsii*) have recently been observed in California, although more limited die-back has been more commonly noted. It is also likely that there is a range in resistance to thousand cankers in different populations of the trees.

It is unknown whether the walnut twig beetle can develop in the other species of *Juglans* native to North America, butternut (*J. cinerea*). No butternut trees have yet been found to occur for observation in areas where this beetle is present.

The commercial nut-producing Persian (English) walnut (*Juglans regia*) appears to have fairly high resistance to thousand cankers, although it has been observed to be attacked in sites where large numbers of walnut twig beetles are present. However, most Persian walnut is grafted onto rootstock of other *Juglans* that may be more susceptible.

Walnut twig beetle and *Geosmithia 'morbida'* do not colonize pecan and other hickories (*Carya*) are similarly immune.

Are other fungi involved? A fungus called *Fusarium solani* (as well as other *Fusarium* species) is associated with long, vertical trunk cankers in advanced stages of the disease. *Fusarium solani* is widespread in North America and has previously been reported to cause cankers on drought-stressed or freeze-damaged walnut trees. However, this fungus has not been found in cankers surrounding walnut twig beetle galleries and is likely associated with thousand cankers only very late in its development.

As thousand cankers causes a depletion of energy reserves, other secondary pathogens may invade trees weakened by this disease. Armillaria root rot, an organism well know to be favored

in trees with reduced root starch reserves, has been noted to develop in thousand cankers-affected trees in Oregon.

In the advanced stages of the disease, the bark on the main trunk becomes macerated by walnut twig beetle attacks and subsequent colonization and canker formation by the *Geosmithia* fungus. This macerated bark and surrounding weakened tissue may serve as a food source for a number of opportunistic microorganisms.

Are other insect vectors important in Thousand Cankers? It is unlikely that any insect aside from the walnut twig beetle is important in the course of this disease. Other species of insects, notably various longhorned beetles and ambrosia beetles, are frequently recovered from declining walnut, including thousand cankers-affected walnut. These species may incidentally carry spores and possibly could initiate a point of infection with the *Geosmithia* fungus. However, thousand cankers requires sustained attacks by a vector that can produce thousands of entry courts for *Geosmithia* infection and lives within the cambium of the tree. The habits of the walnut twig beetle, but not the other wood boring insects, are particularly suited for this type of spread.

Can trees survive this disease? Thousand cankers kills trees from the cumulative effects of numerous coalescing cankers that develop around individual entry wounds made by walnut twig beetles. Although the fungus does grow within the tree, the area infected is limited; it *does not* move systemically in the plant as do some other insect vectored fungi, such as the species involved in Dutch elm disease (*Ophiostoma novo-ulmi*). Instead, tree death results from disruption of phloem tissues transporting nutrients resulting in a progressive depletion of energy.

It is unknown how long it takes to kill a tree once it has been initially colonized by *Geosmithia*-bearing walnut twig beetles and the subject is one of considerable debate. It is possible it may take many years – possibly sometimes a decade or more – to kill even a highly susceptible black walnut (*Juglans nigra*) following the colonization event. Symptoms only appear after there has been considerable amounts of canker formation produced by large numbers of walnut twig beetle entry wounds. Whether sufficient colonization to produce external symptoms can require 5 years, 10 years, or even 20 years is not known and will vary due to many factors. However, observations of black walnut (*Juglans nigra*) in the western states indicate that thousand cankers is ultimately fatal to essentially all trees of this species.

Trees that are well-sited, provided adequate water and have been able to produce vigorous growth may show substantially slower progress of thousand cankers than in trees growing more slowly. Thousand cankers disease appears to be a disease of energy depletion caused by disruption of the tree's ability to produce and store energy due to canker formation. Trees with large energy reserves will thus likely survive longer than more stressed trees.

Furthermore, some *Juglans* species and hybrids appear to be more resistant to thousand cankers than is *Juglans nigra* (black walnut). The course of disease may be substantially slowed in such trees or even halted. In highly resistant hosts (e.g., Arizona walnut) thousand cankers disease will rarely, if ever, progress to kill trees or even major limbs. In species or hybrids with more intermediate resistance the effects of thousand cankers may ultimately be limited to scattered

dieback rather than death of the tree.

Theoretically, thousand cankers disease progress could be arrested if colonization of *Geosmithia*-bearing walnut twig beetles were prevented from producing new tunnels in trees. No methods that can adequately achieve this have been identified. In susceptible hosts, such as black walnut, trees can always be expected to die within a few years after external symptoms have been observed.

Where does thousand cankers presently occur? Die-offs of walnuts suspected or confirmed to have been caused by this insect/fungal complex have been recorded from northern New Mexico, Colorado, Utah, Idaho, Oregon, California and Washington. The walnut twig beetle is also present at all of these sites, indicates a broad range extension of this insect within the past decade or so.

The discovery of walnut twig beetle and thousand cankers disease in Tennessee is the first east of the Mississippi. Unfortunately, this infestation is also located near the geographic center of the native range of its most susceptible host, black walnut (*Juglans nigra*). Now that the all geographic/ecological barriers to spread of thousand cankers disease have been breached it can be expected to ultimately work its way throughout most if not all of the native range of black walnut over the next century.

Does thousand cankers disease harm walnut wood? No. Beetle tunneling is primarily limited to the tree bark and extends very shallowly into sapwood causing no injury to marketed wood. Similarly the *Geosmithia* fungus grows phloem and does not produce any deep staining. Neither of the two species associated with thousand cankers will affect the quality of the wood in any manner.

Where did this disease come from? The origin of the disease is currently in debate and further research will be needed to better develop and test hypotheses on this subject.

The leading hypothesis is that the disease resulted from the movement of the walnut twig beetle and its associated *Geosmithia* fungus from native hosts (Arizona walnut, southern California walnut) into other *Juglans* species that are more susceptible to thousand cankers disease. Somehow infective beetles dispersed throughout much of the western US during the past couple of decades where they found and colonized susceptible black walnut and other *Juglans* that had been introduced and planted by humans within the past century. No *Juglans* species are native to the most of the states where thousand cankers was first recognized (e.g., Colorado, Utah, Idaho, Washington, Oregon) and black walnut and some hybrid walnuts are the *Juglans* species that have been most often planted in these areas over the past century.

If the above scenario is correct, dispersal may have occurred by natural dispersal event or by human transfer. The former would have involved a wind-blown dispersal event where an immense flight of walnut twig beetles was pushed northward on favorable weather patterns at some period in the past few decades. Human transfer, through movement of walnut wood pieces that contain living walnut twig beetles is also, always, a means of further spread. The isolated infestation in Tennessee is clearly due to human transfer, likely either on a piece of wood carried

for woodworking or in walnut firewood collected in the southwestern US.

Regardless, once established there is a lag time for the beetle populations and *Geosmithia* canker production to build to the point where symptoms of the disease became evident. The earliest known suspected cluster of black walnut die-off from this disease probably occurred in Utah and western Colorado in the early to mid-1990s. Often, early black walnut die-offs associated with this disease were diagnosed as being drought related or of unknown cause and thousand cankers disease was present for a great many years before it was recognized and described.

There are some other alternative hypotheses on the origin of the disease. The fungus may have been introduced into North America from Central America or some other exotic location. Or there may somehow been a shift in the pathogenicity of the fungus and this new strain was acquired by walnut twig beetles where it was widely spread.

Studies of the genetics of *Geosmithia 'morbida'* and its present distribution in various *Juglans* populations should provide information that will resolve this question. Preliminary information on the genetics of fungal strains collected across the western US indicates that it is genetically diverse. This argues against a single event introduction in to the West; there is no evidence of a “genetic bottleneck” that might be expected to occur following an introduction. Genetics studies on the various populations of walnut twig beetles will also be illustrative of how this disease originated and spread.

Are there any traps for this insect? Walnut twig beetle can be trapped in Lindgren funnels and yellow sticky panels. However, there is no evidence that either of these designs are particularly attractive and it is likely that captures in these traps are just incidental. Attempts to increase capture by use of walnut wood, ptyol and other compounds useful in trapping some bark beetle do not increase capture of walnut twig beetle in these traps.

Sex pheromones produced by the walnut twig beetle appear to be present, based on observations of beetle behavior by USDA Forest Service researchers in California. Most active are male produced compounds released when beetles first colonize a walnut tree; evidence of a female-produced compound also has observed.

These pheromones may prove to effective attractants that will be useful in detecting and monitoring this insect. Work is in progress to identify these pheromone and test them in future field studies. However, substantial research problems need to be solved regarding identification of the exact chemical blends that constitute walnut twig beetle pheromones, development of methods for their synthesis, and production.

Does drought have an effect on this disease? The effects of drought on thousand cankers disease is probably minimal and indirect. Well watered and well maintained black walnut have been killed by the disease almost as rapidly as trees in poorer condition. Drought stress perhaps could have some effect on progression of canker development and the relative ability of the twig beetle to successfully reproduce in trees. These effects have not been documented but drought is probably of minor importance in the overall epidemiology of this disease.

What is the life cycle of the walnut twig beetle? Recent observations can provide the broad outlines for the life history of this insect, but even basic life history information is presently lacking. This insect has previously received no study because of its negligible importance in native hosts.

In areas of cold winters, the adult stage appears to be the primary overwintering stage. Furthermore, adult beetles are seen to move into the thick outer bark of trunks in fall where they appear to produce overwintering chambers. (*Geosmithia morbida* may be incidentally introduced into the trunk during this period.) In late April and early May the beetles emerge and fly to limbs where they initiate tunneling under the bark. Initial colonization of trees is done by males, who excavate a small chamber under the bark and release pheromones attractive to females. One or two females typically join the male and they create egg galleries under the bark, along which eggs are laid.

Larvae develop in the living phloem and bark tissues, excavating shallow tunnels that branch from the egg gallery. Pupation occurs at the end of the tunnels and adults cut their way out through the bark, producing a minute exit hole. Most galleries are formed in the phloem and bark and do not extend to the cambium and sapwood until very late in disease development. Therefore, the larval galleries do not score the sapwood as is found with beetles such as the emerald ash borer or mountain pine beetle.

A generation can be completed in about 6-7 weeks. Two, possibly three, generations will be produced during a growing season. Distinct peaks of adult activity are not very clear and adults can be initiating new attacks over a continuous period throughout most of the season. Adults produced late in the season, in late summer and early fall, appear to move into trunks where they excavate overwintering chambers. Most, if not all, survive winter in the adult stage; some larvae have been observed in late fall and a small portion of the population may survive between seasons as late stage larvae

This life history may be considerably different in warmer climates. For example, in California overwintering stages include larvae in various stages of development and adult flights may begin in March.

What treatments are available for thousand cankers disease? Currently there are no known means of reliably controlling this disease. Some techniques directed at the vector ultimately may prove to be useful in suppressing the rate of disease spread. However, it may be unlikely that effective treatments will be found that can control walnut twig beetles once tree attacks have begun.

Theoretically, methods that can prevent tunneling by walnut twig beetles (e.g., certain insecticides) can prevent further spread of this disease. However, to date, effective techniques to control the walnut twig beetle have not been identified. Control of walnut twig beetle by use of drenching trunk/branch sprays of insecticides (permethrin, bifenthrin) is a technique used successfully against some other bark beetles (e.g., mountain pine beetle, *Ips* beetles). However, infested black walnut trees that have received repeated insecticide spray treatments by arborists in Colorado are observed to continue to decline and die. This method appears to have only

limited effectiveness, at most.

The use of soil applied systemic neonicotinoid insecticides (e.g., imidacloprid, dinotefuran, clothianidin) is a possibility for bark beetle control and there has been some attempts to use these products for this purpose. Anecdotally these treatments seem to have had negligible effectiveness, at most. Some informal observations suggest that the disease may be suppressed for a few years by soil applications of imidacloprid if they are applied before the disease has become well established in the tree; treatments made after symptoms begin to appear are ineffective.

However, complicating the issue of pesticide use on black walnut are significant regulatory issues. Black walnut is a plant material that produces edible nuts that sometimes are collected and eaten. As a result, these trees may be considered to be “nut crops” and thus pesticide uses made to black walnut need to comply with those used on edible nut crops. This currently greatly restricts available insecticide (and fungicide) options. Insecticides that appear to have adequate labeling for use on black walnut appear to include certain brands containing imidacloprid, clothianidin, permethrin, and carbaryl. However, pesticide uses often are interpreted differently by different state regulatory agencies and any pesticide application must conform to local laws.

Trunk injected pesticides have not been evaluated for managing this disease. Macrocytic lactones (e.g., abamectin, emamectin benzoate) and possibly certain fungicides may be useful materials for further testing. Opportunities for such evaluations may become available in the future. However, there are similar regulatory and pesticide registration issues with all trunk injection systemic pesticides that can be considered for possible use on black walnut.

Can the walnut twig beetle and thousand cankers be spread on nuts or nut meat? There is no evidence that the walnut twig beetle is attracted to or spends any time in association with walnut fruit and does not tunnel into hulls. Furthermore it is very unlikely that the *Geosmithia* fungus would colonize the hull or meat of any walnut species. Even if this were the case, the fungus would be unable to effectively colonize the tree without the presence of the beetle.

Can the walnut twig beetle survive in bark mulch? In a recent test some developing bark beetles were observed to survive in relatively large diameter chips that were collected following the chipping of a diseased tree. Therefore, it is likely that beetles could be spread on freshly chipped bark mulch.

On the other hand chipping is likely one of the best ways to disinfest wood material from TCD-affected trees. Although some walnut twig beetles and the *Geosmithia* fungus can survive normal chipping and later emergence, chips will likely unsuitable host material in a much shorter time (i.e., months) than are whole logs (i.e., years).

If I have a tree that has thousand cankers how should I handle the wood? Most important is all wood from a TCD-affected tree should be retained locally to prevent further spread of the disease. Whether the wood is consumed (e.g., firewood, woodworking) or whether it is destroyed (e.g., chipped, landfilled) is a decision that will be determined locally, but no wood

material from TCD-killed trees should ever be moved to a location where the disease is not already present.

Logs and standing trees affected with thousand cankers can support development of tremendous numbers of walnut twig beetles. As long as live beetles remain associated with this wood it remains extremely infectious and can easily allow the disease to spread. Because of this it is critically important that logs or pieces of wood with bark intact from walnut harvested in any area where TCD is known to be present (e.g., all western states and Knox County, TN) never be allowed to move outside the area where thousand cankers currently is present. Movement of a single log with live beetles can be the initial source of an outbreak that could ultimately devastate black walnut in uninfested areas.

Walnut twig beetles will readily reinvade fresh logs with any bark remaining. These reinvasion cycles may continue until the bark is completely consumed and/or becomes so dry that larval development can no longer be completed. It is unknown how long this process will take if logs are stored under normal conditions outdoors. Logs are known to remain extremely infectious (i.e., support live beetles) for at least 15 months after being cut. Possibly, logs that have been stored for 3 or more years will no longer support beetles – but this has not been conclusively established. Furthermore the suitability of wood for continued walnut twig beetle breeding will also be affected by storage conditions such as humidity, temperature and whether cut ends are sealed.

Milled wood that produces bark-free lumber will not support walnut twig beetles. Kiln drying undoubtedly will kill beetles and likely accelerate drying so that wood becomes less suitable for development. However, it is still unknown if kiln dried logs or slabs with bark intact can be reinfested for some period.

Treatment of logs with insecticide sprays (e.g., permethrin, bifenthrin, dinotefuran) will not kill all beetles. Insecticide spray applications are ineffective for eliminating walnut twig beetles.

Research into methods that can reliably disinfest walnut products are a high priority of research and better answers should be available within a year or two. In the interim it is strongly recommended that all walnut wood from thousand cankers affect trees be milled and used locally to prevent accidental spread of walnut twig beetles that can move the disease into new areas.

Are there regulations affecting thousand cankers disease and movement of walnut wood?

Several states have enacted state quarantines that prohibit the movement of any walnut item that may harbor live walnut twig beetles and that originate from a state/region where thousand cankers disease is known to be present. Missouri led the way with a state quarantine in spring 2010. Since then several states have followed their lead. As of August 2010 state quarantines have been enacted or are in advanced development in Kansas, Nebraska, Iowa, Indiana, Michigan, Wisconsin and Ohio. Other states likely will soon have quarantines and regulations restricting introduction of walnut products that may allow spread of thousand cankers disease.

At present there are no national quarantines, such as exist for emerald ash borer, Asian longhorned beetle, gypsy moth, sudden oak death and other pest problems that originated from

outside the borders of the United States.

How should one go about surveying for thousand cankers disease? Surveys should be done in a manner that allows detection of symptomatic trees with follow-up examination to determine if walnut twig beetles and/or *Geosmithia morbida* is present in samples from suspect trees.

In initial surveys, detection of walnut trees with crown dieback or abnormally thin crowns may be indicators of thousand cankers disease. However, crown dieback may have many other causes (e.g., freeze injury, root damage, colonization by tree rotting fungi). Similarly, various biotic (e.g., aphids, mites) and abiotic causes (e.g., drought) may cause premature leaf shed broadly across a walnut canopy.

In closer inspection look for individual limbs that show flagging, either in the form of branches with clumps of yellowing leaves, or branches with leaves that have wilted and remained on the branch. These limbs are often sites where new cankers and current activity of walnut twig beetles can be most readily found.

For confirmation cut and exam dying or recently dead limbs. The most easily observed symptom of thousand cankers presence is the occurrence of minute exit holes in the bark made by walnut twig beetles. In areas where these are present the galleries of the bark beetles can usually be exposed easily when the bark is peeled away with a knife. These exit holes are most easily found in limbs with relatively smooth bark that are at least ¾-inch diameter. Despite the name “twig beetle”, walnut twig beetles are not found in the smallest diameter twigs. Branches of 1-2 inch diameter are probably easiest to exam for the presence of the beetle.

Also indicative of thousand cankers is the occurrence of multiple trees at a site with potential symptoms.

Surveys of thousand cankers are most productively done during July and August. Early in the season symptoms of flagging may not yet express and will go undetected. Late in the season flagging may occur on limbs due to many causes (e.g., mechanical injuries, overshadowing) and normal senescence, making detection of symptomatic limbs more difficult.

If I am growing black walnut in an area where thousand cankers does not occur yet do I need to change any growing practices or marketing plans? No. Despite the Tennessee infestation it remains reasonable to expect that spread of thousand cankers will only slowly move through the native range of black walnut, if spread is not accelerated by human transfers of infected wood.

Consider the following theoretical example. Assume that, unaided by humans, the walnut twig beetle is capable of spreading about 2 miles/year. (The ability of the beetles to move is unknown, but they are small and likely dispersal flights are normally of short distance, particularly through forested areas.) If that is the case, then it will take about 240 years to move from Knoxville to Columbia, MO; 145 years to get to Indianapolis. Even if it moves twice as quickly natural spread may take 120 years to move deep into Missouri and 70 years into Indiana, the major US producers of black walnut wood products.

Furthermore, once established at a site there will be a lag time before it destroys all the black walnut trees. Depending on what assumptions one makes it may take 15-30 years before black walnuts will be largely destroyed in a city following its initial introduction. (Assumption based on the first detected symptoms in a tree appearing 5-15 years after initial infestation and 10-20 years for TCD to fully progress across a municipality following the appearance of the first symptomatic tree.)

This potentially gives the United States a very long time to help prepare for and absorb the effects of thousand cankers and the premature cutting of black walnut that it entails. Furthermore, over time improved means of management and development of TCD-resistant black walnut can be expected to be developed.

However, the distance between a location where thousand cankers occurs and any uninfested site is only a day trip away via pick-up load of walnut wood. The extent that humans move TCD-infected walnut wood will determine the progress and ultimate economic and ecological effects of thousand cankers disease in the US.

The establishment of effective regulations to prevent further spread of walnut twig beetle infested material can have tremendous effect in reducing risk of thousand cankers spread in the upcoming decades. Furthermore, as public awareness of thousand cankers increases it is hoped that movement of infested walnut wood originating from western states will largely cease. Woodworkers, lumber yards, tree removal services and firewood distributors are among the key groups that need to be provided information on this new disease.

At this point in time there is no need for walnut producers in the eastern US to alter any production practices or marketing plans. However, they should be engaged in the public relations work needed to restrict movement of walnut products that can support live walnut twig beetles and thus reduce the possibility of its spread into eastern production areas.

On the other hand, in areas where thousand cankers disease is known to already be present further planting of black walnut is not currently recommended. If future research and breeding allow identification of thousand cankers resistant cultivars production may prove viable. However, at this point in time the absence of effective controls and the extreme susceptibility of *Juglans nigra* to thousand cankers makes its further culture in the western US and eastern Tennessee to be highly problematic.

What should be done to help prevent further damage by Thousand Cankers disease? *It is extremely important that from this point on that no infective walnut twig beetles are ever allowed to move beyond the current known range of thousand cankers disease. Salvaged trees with bark intact will very likely contain these beetles. A recent observation indicated that over 30 beetles could develop under a square inch of bark, making recently killed trees potentially highly infectious.*

Due to the high value of black walnut for woodworking purposes, the movement of such wood is most likely to occur by wood workers and wood turners; walnut originating from the western US

is rarely used as firewood. Therefore it is very important that woodworkers, mills and companies involved in lumber movement, foresters and arborists understand the serious nature of this threat and never allow movement of infective walnut wood into areas where this disease does not occur.

Where can I get more information on this situation? A fact sheet on this disease has been developed by Colorado State University and will be regularly updated as new information is learned. It and other materials related to detection and diagnosis of thousand cankers disease is located at the web site established within the Department of Bioagricultural Sciences and Pest Management at:

<http://www.colostate.edu/Depts/bspm/extension%20and%20outreach/thousand%20cankers.html>

Departments of Agriculture in Missouri and Tennessee currently have web sites related to this disease and fact sheets are available through the US Forest Service. In the near future it can be expected that many sources of information will be provided by reliable government and University sources.

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