

## 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* sp.) 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.

**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 water and nutrients.

(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 are 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 usually die within three years after initial symptoms are observed in the crown of the tree.

**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; alternately these reports may reflect early introductions of the beetle into that state.

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.

**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. 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) as well as all other *Juglans* in all other sites where walnut twig beetle has been observed. Because of this the detection of the walnut twig beetle in a walnut tree can be considered equivalent to detection of thousand cankers.

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 and is the species of greatest concern.

Evaluating other species is a major focus of ongoing research. Tentatively, it appears that northern California walnut (*Juglans hindsii*) and southern California walnut (*Juglans californica*) are moderately susceptible. Die-offs of these species from thousand cankers disease 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.

Arizona walnut (*Juglans major*), a 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 overshaded 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 not been recovered from 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.

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. Pecan and other hickories (*Carya*) are 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 very 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. 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.

We do not currently know how long it takes to kill a tree once it has been initially colonized by walnut twig beetles and the *Geosmithia* associate. It is possible it may take many years – possibly sometimes a decade or more – to kill even a highly susceptible black walnut (*Juglans nigra*). However, observations of black walnut in the western states indicate that thousand cankers is ultimately fatal to essentially all trees of this species.

Trees that are well-sited and grow vigorously may resist, in part, the effects of thousand cankers

disease. 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.

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.

**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.

We hope, based on surveys completed in Colorado in 2009, that the eastern edge of this disease in the US is in eastern Colorado, where it has caused widespread death of black walnut in the last five years in Front Range communities that include Boulder, Colorado Springs and several towns in the western Metro Denver area. Other positive confirmations of thousand cankers include certain eastern Colorado communities within Adams, Arapahoe, Boulder, Broomfield, Crowley, Denver, El Paso, Jefferson, Larimer, and Otero counties. Presently the furthest east known infestations are in Rocky Ford, along the Arkansas River Valley in Otero County.

**Does this disease concern walnut grown outside the western states?** *Absolutely.* Thousand cankers is presently having devastating effects on black walnut and some other *Juglans* in most western states. However, in most areas these involve the widely dispersed plantings made by humans (i.e., street tree, farmstead plantings). Most areas where damage by thousand cankers disease has occurred are sites where *Juglans* are not native. Parts of California are an exception, where native *Juglans* species (*J. hindsii*, *J. californica*) appear to be affected in the present outbreak.

This serious situation could become catastrophic if infective walnut twig beetles were allowed to colonize areas where black walnut grows as a native tree. Based on the patterns seen in the West, such a colonization could very possibly develop into an uncontrollable outbreak. This may ultimately have the potential to destroy black walnut in its native range in a manner previously demonstrated by introduced species such the emerald ash borer (affecting NA *Fraxinus* spp.) and pathogens that produce Dutch elm disease (affecting American elm) and chestnut blight (affecting American chestnut).

**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 shallowly in the cambium 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.

One hypothesis is that the disease resulted from the movement of the walnut twig beetle and its associated *Geosmithia* fungus from Arizona walnut into *Juglans* species that were planted across the western states. Both the beetle and the fungus occur in Arizona walnut and in this species they do negligible damage. Somehow infective beetles dispersed throughout much of the western US during the past 20-25 years or so and found and colonized susceptible black walnut and other *Juglans* that have been planted by humans within the past century.

If the above scenario is correct, dispersal may have occurred by natural dispersal event or by human transfer. Regardless, once established there would have been a lag time for the beetle populations 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.

There are many 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. Studies of the genetics of the *Geosmithia* sp. and its present distribution in native and introduced host *Juglans* 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.

**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, pityol 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 been observed.

These pheromones may prove to be effective attractants that will be useful in detecting and monitoring this insect. Work is in progress to identify these pheromones 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. Drought stress perhaps could have some effect on progression of canker development and the ability of the twig beetle to successfully colonize trees. These effects have not been documented and 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. This insect has previously received no study because of its negligible importance in native hosts and much remains to be learned about its basic biology.

The great majority of adult beetles cut small chambers in the thick outer bark of walnut trunks during autumn and overwinter in these protected sites. (The *Geosmithia* fungus 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

**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.

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 imidacloprid (e.g., Merit) for this purpose. Anecdotally these treatments seem to have had negligible effectiveness. Some people report that the disease may be suppressed 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.

Trials are planned to look at the value of these treatments in a preventive vs. curative manner. These may also involve alternative neonicotinoid insecticides (e.g., dinotefuran/Safari, clothianidin/Arena).

However, there are also significant regulatory problems with most any insecticide use on black walnut as it 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 may need to comply with those used on edible nut crops. This could greatly restrict available insecticide options. The regulatory status of black walnut grown as shade trees in Colorado is under discussion.

The overwintering habit of this beetle to move into the trunk bark may provide a means to manage populations. This could involve trunk sprays of effective insecticides prior to when beetles enter the trunk (e.g., late August/early September). Such targeted treatments of the trunk have been used to help manage some other bark beetles with similar habit (e.g., native elm bark beetle, ash bark beetles) and may reduce beetle populations so that the disease is slowed. Trials to evaluate this technique are planned for 2009.

Trunk injected fungicides have not been evaluated for managing this disease. Macrocytic lactones (e.g., abamectin, emamectin benzoate) and possibly certain fungicide 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 systemic fungicide 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 develops galleries in walnut 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.

**If I have a tree that has Thousand Cankers how should I handle the wood?** 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 fresh cut logs from walnut harvested in the western states 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. We don't know how long this process will take if logs are stored under normal conditions outdoors. It is likely logs that have been stored for 3 or more years will not support beetles – but this has not been conclusively established.

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.

**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. It is still reasonable to expect that spread of thousand cankers can be contained to prevent its spread into the eastern US where black walnut is native. Effective regulations to prevent further spread of walnut twig beetle infested material are being considered and their adoption will 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.

Furthermore, if thousand cankers disease is introduced into the midwest its subsequent spread may be relatively slow – although likely impossible to stop. Walnut plantings near points where walnut twig beetles are introduced will succumb first; more distant areas may not see declines for decades.

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 states 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 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 east of 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 36 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.

Walnut logs with bark intact and walnut bark both may be sources of infective beetles. Milled wood without bark and logs without bark that have been dried for three years or more likely will not be a source of risk. However, we strongly recommend that no untreated walnut logs originating from any state west of Colorado ever moves east of Colorado.

**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 is located on the Colorado State Extension publications web site and can be accessed at: [http://www.ext.colostate.edu/pubs/insect/0812\\_alert.pdf](http://www.ext.colostate.edu/pubs/insect/0812_alert.pdf)

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