TREE PATHOGEN SURVIVAL IN CHIPPED WOOD MULCH

by Ronda Koski[1] and William R. Jacobi[2]

Abstract. Uncomposted wood chips are often used as landscape mulches. Chips are commonly derived from landscape trees removed because they were in poor health and often contained plant pests. Chips are also derived from pallets and other wood packing materials that may harbor indigenous and exotic plant pathogens. A study was initiated to determine how long a fungal plant pathogen could survive in uncomposted wood chip mulch in an urban landscape. *Thyronectria austroamericana*, the causal agent of Thyronectria canker in honeylocust (*Gleditsia triacanthos)* trees, was used to inoculate branches of honeylocust trees. Cankered branch pieces were placed into mulched areas surrounding honeylocust trees growing under two irrigation regimes. *Thyronectria austroamericana* recovered from cankered wood pieces after 98 weeks produced cankers when inoculated into branches of honeylocust trees. Irrigation regimes did not affect recovery of the fungus. Cankered wood pieces remained a source of inoculum for 143 weeks after placement in the mulched areas. Due to the longevity of pathogen survival, uncomposted mulch derived from honeylocust trees infected with *T. austroamericana* should not be placed around honeylocust trees in urban landscapes. Using uncomposted wood chips derived from wood packing materials could increase the risk of introducing exotic plant pathogens to urban landscapes.

Key Words. Disease spread; fungus; *Gleditsia triacanthos*; honeylocust; mulch; plant health care; plant pathogens; *Thyronectria austroamericana*; urban forestry; urban landscapes; wood chips.

Wood-based mulches are commonly used in landscapes to improve appearances. Additional benefits provided to landscape plants by wood-based mulches include conservation of soil moisture, reduction of invasion of weedy plant species, and reduction of soil temperature fluctuations (Watson 1988; Ellefson et al. 1992; Greenly and Rakow 1995; Herms et al. 2001). Compared to nonmulched soils, soils mulched with chipped conifer and shredded hardwood had lower temperatures, reduced weed cover, and increased moisture content (Greenly and Rakow 1995). In a minimal maintenance landscape, mulching enhanced the establishment of trees (Green and Watson 1989). However, mulch piled high against a tree's trunk often retains moisture for prolonged periods of time, resulting in an environment that may actually harm the tree. Prolonged moist conditions immediately around the trunks of trees can favor infection by canker-causing and root-rot fungal plant pathogens and infestation of insect pests, especially if there are trunk wounds under the mulch (Herms et al. 2001). In addition, mulch placed too close to the trunk of a tree can interfere with respiration of cambium, phloem, and other living cells in the trunk by limiting their exchange of oxygen and carbon dioxide with the surrounding atmosphere. To minimize these problems, mulch should be kept about 15 cm (6 in.) away from the trunks of woody plants (Green and Watson 1989; Ellefson et al.1992; Feucht 1997; Herms et al. 2001).

A common arboriculture practice is to chip pruned tree branches, as well as to grind entire trees that are removed from urban landscapes. The trees removed are often in poor health and exhibit dead and dying branches. Diseased trees are commonly disposed of by grinding the entire tree into small wood chips; these wood chips are often later used as mulch in landscapes. While fresh organic matter in wood chips can provide a food source to support the growth of numerous microorganisms and pests, there is limited information pertaining to the survival of plant parasites and plant pathogens in wood chip mulch. Pinewood nematodes (*Bursaphelenchus xylophilus* (Steiner & Buhrer) Nickle) survived in infested mixed-conifer mulch for 14 to 20 months, depending upon the temperature at which the mulch was stored and the size of wood chips. Survival rates and longevity of pinewood nematodes in the wood chips varied widely; this variation in survival was attributed to differences in wood chip size, wood chip moisture content, and the experimental method employed (Panesar et al. 1994). Only a few studies have focused on the survival of plant pathogenic organisms in mulch. In a study investigating the ecology of *Verticillium dahliae* Klebahn in *Fraxinus* and *Acer* species, there was no evidence that fresh wood chips from a *V. dahliae*–infected sugar maple (*Acer saccharum* Marsh.) were able to transmit the Verticillium wilt disease fungus to either amur maple *(Acer ginnala* Maxim.) or green ash (*Fraxinus pennsylvanica* Marsh.) seedlings. However, when *V. dahliae*–infected sugar maple wood chips were incorporated into the potting mix of transplants of eggplant (*Solanum melongena* L.), many of the eggplants became infected. Likewise, when *V. dahliae*–infected sugar maple wood chips were used as garden mulch, many of the eggplants developed symptoms typical of Verticillium wilt. Storing *V. dahliae*–infected sugar maple wood chips in a pile for 1 week greatly reduced the viability of *V. dahliae* (Ash

1999). In a later study, *V. dahliae* grew from uncomposted *V. dahliae*–infested sugar maple wood chips after 122 days in a simulated mulch layer. The *V. dahliae*–infested sugar maple wood chips initiated wilt in approximately 90% of young eggplants within 14 days of transplanting into infested potting mix (Foreman et al. 2002).

Chipping of wood palettes, dunnage, and other wood-based packing materials is a common practice in North America. Several reports from a recent symposium that addressed the issue of international trade of wood and wood products focused on the increased risk of importation of exotic pathogens and other pests (Allen and Humble 2002; Mireku and Simpson 2002; Tkacz 2002). Solid-wood packing materials can be pathways of entry for nonindigenous organisms, prompting the development of international quarantine standards to reduce the risk associated with movement of these packing materials (Allen and Humble 2002). In Australia, the international trade in untreated wood and wood products, including dunnage, has increased the likelihood of the introduction of exotic plant pathogens and decay fungi (Mireku and Simpson 2002). In the United States, risks associated with the introduction of exotic plant pathogens and other pests from imported wood-based packing materials are not completely known. To date, there has been limited research pertaining to the types of pathogens associated with wood-based packing materials. Several studies have been conducted by the United States Department of Agriculture assessing the risk of importation of "unmanufactured wood," wood usually in the form of tree logs (USDA 1991a, 1991b, 1998, 2001; Tkacz 2002).

This study was initiated to determine the length of time that a common canker-causing fungus could survive in uncomposted wood chip mulch under various irrigation regimes, and whether the surviving fungus could produce viable infection propagules. The three specific objectives of this study were to determine (1) the length of time that *Thyronectria austroamericana* (Speg.) Seeler, the causal agent of Thyronectria canker of honeylocust, remains viable in honeylocust (*Gleditsia triacanthos* L.) wood pieces when these wood pieces are placed on the surface of a mulch layer or buried under the surface of a mulch layer; and (2) the effect of irrigation amounts of survival of *T. austroamericana*; and (3) whether the fungus is able to cause cankers after surviving in wood chip mulch for over a year.

MATERIALS AND METHODS

Three experiments were conducted between 1998 and 2002 to determine the viability of *Thyronectria austroamericana* in uncomposted wood chip mulch. Experiments one and two were initiated in August 1998 for 9 and 10 weeks of exposure, respectively; experiment three was initiated in August 1999 and was completed in May 2002 after 143 weeks of exposure.

To produce cankered wood pieces, honeylocust branches [2 to 4 cm (0.8 to 1.6 in.) in diameter] were inoculated at a former plant pathology research facility in Fort Collins, Colorado, U.S., and at a tree nursery in Miliken, Colorado. Two isolates (T82-23 and T82-24) of *T. austroamericana* were cultured for 7 to 14 days on potato dextrose agar (PDA) at room temperature before inoculation. Branch surfaces were disinfected with 95% ethyl alcohol (EtOH) prior to wounding. Bark was removed using a sterile 8 mm (0.3 in.) diameter cork borer to produce wounds spaced at least 15 cm (6 in.) apart. A 6 mm (0.2 in.) plug of the fungus was placed in each wound and wrapped with PARAFILM® wax film. After 14 days, branches were collected and cut into 6.5 cm (2.6 in.) sections in such a way that each piece contained one-half of an inoculation site. Successful inoculations resulted in development of slightly depressed elongated cankers typical of Thyronectria canker of honeylocust (Seeler 1940; Sinclair et al. 1987).

Experimental Procedures

Cankered wood pieces were placed in mulch around 'Skyline' honeylocust trees at a university research farm in Fort Collins, Colorado. The study area consists of nine treatment blocks that measure 43.9 m × 31.7 m (144 ft × 104 ft). The study area was designed with a typical turf-type irrigation system with pop-up heads, and controls that allow each of the nine treatment blocks to be controlled independently. Within each block are plots that contain three rows with nine 'Skyline' honeylocust trees planted in 1996, spaced at 4.9 m (16 ft) within row and 3.7 m (12 ft) between rows. 'Livingston' Kentucky bluegrass grows throughout the study area.

The nine blocks are arranged in a split-plot design, with three irrigation treatments based on levels of measured evapotranspiration (ET) for alfalfa based on a meteorological station 800 m (880 yd) away. The irrigation treatments were low (40% of ET), medium (80% of ET), and high (160% ET). Each block was irrigated twice a week during the growing season from mid May to mid September. Approximately 230 mm (9.2 in.) of water was applied to each of the "low" treatment blocks and approximately 969 mm (38.8 in.) of water was applied to each of the "high" treatment blocks by the end of each growing season.

Cankered wood pieces were placed around trees in only the "low" and "high" irrigation blocks. Honeylocust trees growing in the middle row of two "low" irrigation blocks and two "high" irrigation blocks were randomly selected for use in this study. The turfgrass was removed from around the base of the selected trees and a ring of plastic landscape edging material, 0.75 m (2.5 ft) in diameter, was placed around the base of each tree. Within each ring, uncomposted

cottonwood wood chips (derived from *Populus deltoides* Bartr. ex Marsh. ssp. *monilifera* (Ait.) Eckenwalder) were placed to a depth of 10 cm (4 in.). Cottonwood wood chips were used because species of *Populus* are not hosts of *T. austroamericana*. Cankered wood pieces were placed around either two (experiments one and two) or four (experiment three) of the selected honeylocust trees. Ten to twenty cankered wood pieces per isolate were attached to a 20 cm (8 in.) landscape staple using acrylic yarn. Wood pieces were secured to hold the pieces in place and to prevent the pieces from being blown away or removed by animals. Half of the wood pieces attached to each landscape staple were positioned so that they remained in contact with the soil; that is, buried under 10 cm (4 in.) of mulch; and the remaining half of the wood pieces were positioned so that they rested 10 cm above the soil, on the surface of the mulch layer.

Analysis of Cankered Wood Pieces

At various times after the placement, cankered wood pieces were collected from the mulch layer and assessed for moisture percentage and fungal viability. On each collection date, a surface and buried piece for each isolate were removed from the mulch layer around each tree. Thus, for experiments one and two, eight cankered wood pieces were collected per irrigation ("low" and "high") and position ("surface" and "buried") treatment combination. In experiment three, 16 cankered wood pieces were collected per irrigation and position combination. Depending on the experiment, 32 to 64 cankered mulch pieces were collected on each collection date. Each cankered wood piece was sealed in a small plastic bag and kept cool until processed.

Using a band saw, a 2.5 cm (1 in.) portion was cut from each piece and immediately weighed for fresh weight. These portions were then oven dried at 100°C (212°F) for 2 to 3 days and weighed again to calculate the percentage of moisture. The remaining 4 cm (1.6 in.) portion of each cankered wood piece was used to assess fungal viability. Each 4 cm portion was surface disinfected using a 10% bleach solution for 5 minutes and rinsed four times in sterile distilled water. Using a scalpel, bark was removed and eight wood chips were cut from each cankered wood piece. Four wood chips were placed on each of two Petri dishes containing PDA amended with 10 ppm streptomycin to inhibit bacterial development. Petri dishes were wrapped with PARAFILM and incubated at 23°C (73.4°F) and exposed to overhead fluorescent lighting. Over a period of 14 days, each plate was examined periodically and the presence of the imperfect state of *T. austroamericana* recorded. The imperfect state of *T. austroamericana* is *Gyrostroma austroamericanum* Seeler. When grown on PDA, *G. austroamericanum* produces a mycelium that appears wet and pinkish orange in color (the appearance is due to the presence of abundant microconidia); the mycelium is actually hyaline and later gives rise to dark-colored pycnidial stromata (Seeler 1940; Sinclair et al. 1987).

Collection Dates

Experiment one was placed in the field August 3, 1998, and wood pieces collected after 1, 3, 5, 7, and 9 weeks ending on October 5, 1998. Experiment two was initiated August 31, 1998, and sampled at 2, 4, 6, 8, and 10 weeks ending November 9, 1998. Experiment three started August 10, 1999, with collections at 2, 5, 23, 31, 40, 59, 98 and 143 weeks, ending May 9, 2002.

Pathogenicity

Thyronectria austroamericana isolates recovered from cankered wood pieces after 98 weeks in the mulch layer (M82-23 and M82-24) were used to inoculate branches of honeylocust trees. Representatives of the recovered isolates were grown in Petri dishes containing PDA. In early September 2001, six honeylocust trees from two blocks of trees receiving low amounts of irrigation water (40% ET); six honeylocust trees from two blocks of trees receiving medium amounts of irrigation water (80% ET); and six honeylocust trees from two blocks of trees receiving high amounts of irrigation water (160% ET) were inoculated with the recovered isolates. At the same time, but on a different branch of each tree, inoculations were made using the original two fungal isolates from the culture collection. Three wounds were made on branches using an 8 mm (0.3 in.) cork borer—one each for the PDA control, isolate T82-23, and isolate T82-24. A 6 mm (0.2 in.) plug of PDA was placed in the distal wound as a control and an infested PDA plug was placed in each of the other two wounds. Each wound was then wrapped with PARAFILM. Two weeks later, the PARAFILM was removed and cankers measured. Canker development was monitored periodically through July 2002.

RESULTS

Thyronectria austroamericana survived in wood pieces placed on the surface, as well as in pieces buried in the mulch, for 9 and 10 weeks in the first two experiments. The fungus was found viable in 17% to 94% of the collected wood pieces after 9 and 10 weeks in the field (Table 1). By the end of the first two experiments, recovery of the fungus was significantly less in cankered wood pieces on the surface of mulch compared to cankered wood pieces buried in the mulch. The percentage of moisture in the surface pieces averaged 11% and was significantly less when compared to the percentage of moisture in the buried cankered wood pieces, which averaged 38% (Table 2). Irrigation amounts had no impact on experiments one and two because these experiments were primarily run at the end of the irrigation season.

Table 1. Percentage of *Thyronectria austroamericana* recovered from uncomposted infested honeylocust wood pieces.

Length of time on/in mulch layer (weeks)	Collection date	Percentage recovered					
		Position[z]		Irrigation treatment[y]			
				High		Low	
		Surface	Buried	Surface	Buried	Surface	Buried
Experiment One							
1	08/10/98	92.9 a[x]	96.1 a	96.9 a	100.0 a	89.1 b	92.2 a
3	08/24/98	68.8 a	86.7 a	79.7 a	92.2 a	57.8 b	81.3 a
5	09/07/98	46.8 b	85.1 a	37.5 b	85.9 a	56.2 a	84.4 a
7	09/21/98	63.3 a	66.4 a	79.7 a	78.1 a	46.9 a	54.7 a
9	10/05/98	30.5 b	85.2 a	35.9 b	78.1 a	25.0 b	92.2 a
Experiment Two							
2	09/14/98	38.3 b	91.4 a	45.3 b	92.2 a	31.2 b	90.6 a
4	09/28/98	10.2 b	94.5 a	7.8 b	92.2 a	12.5 b	96.9 a
6	10/12/98	9.4 b	88.3 a	14.1 b	89.1 a	4.7 b	87.5 a
8	10/26/98	10.9 b	80.5 a	21.9 b	81.2 a	0.0 b	79.7 a
10	11/09/98	24.2 b	93.8 a	31.2 b	93.8 a	17.2 b	93.8 a
Experiment Three							
2	08/24/99	88.7 a	80.5 a	87.5 a	75.8 a	89.8 a	85.2 a
5	09/14/99	68.0 b	83.6 a	80.5 a	80.5 a	86.7 a	52.3 b
23	01/19/00	89.8 a	53.1 b	89.1 a	48.4 b	90.6 a	57.8 b
31	03/13/00	82.0 a	51.2 b	86.7 a	54.7 b	77.3 a	47.7 b
40	05/15/00	73.8 a	48.4 b	78.9 a	44.5 bc	68.8 ab	52.3 b
59	09/26/00	58.9 a	58.9 a	64.8 a	53.1 a	53.1 a	64.8 a
98	06/19/01	15.6 b	31.2 a	25.0 a	39.8 a	6.2 b	22.7 ab
143	05/09/02	23.4 a	24.2 a	30.5 a	22.6 a	16.4 a	25.8 a

[z]Position: Surface wood pieces were placed on mulch layer surface, and buried wood pieces were buried 10 cm (4 in.) in mulch. In experiments one and two, N =16; in experiment three, N = 32.

[y]Irrigation: Low irrigation sites received 40% ET, and high irrigation sites received 160% ET. In experiments one and two, N = 8; in experiment three, N = 16.

[x]Means followed by the same letter are not significantly different at the P = 0.05 level at a particular date for position or irrigation treatment.

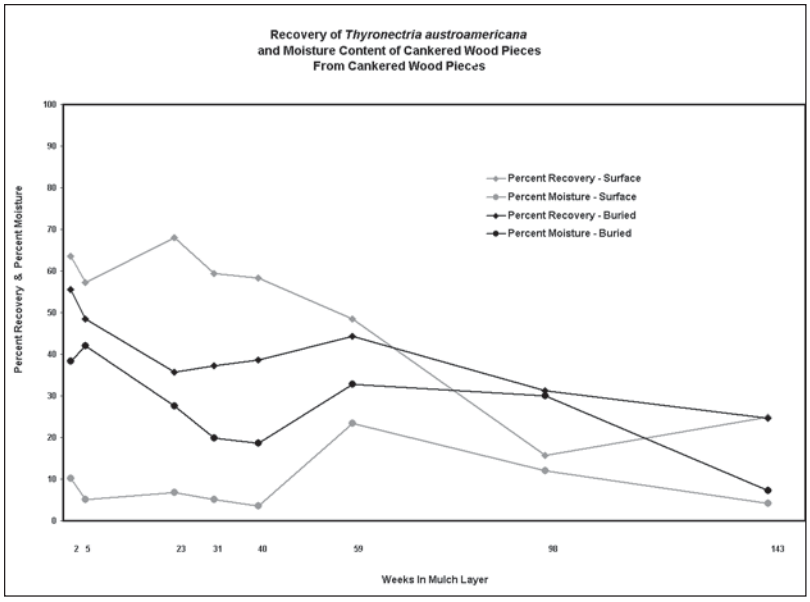

Figure 1. Percentage of fungal pathogen recovered and percentage of moisture from infested wood pieces in a landscape mulch layer (experiment three).

Table 2. Moisture percentage of wood pieces inoculated with *Thyronectria austroamericana* and placed in landscape wood chip mulch.

	Percentage of moisture			
	Position[z]		Irrigation treatment[y]	
Date	Surface	Buried	High	Low
Experiment One				
08/10/98	—[x]	—[x]	—[x]	—[x]
08/24/98	10.8 a[w]	36.8 b	24.2 a	23.3 a
09/07/98	7.0 a	42.0 b	24.1 a	24.9 a
09/21/98	18.7 a	38.4 b	25.6 b	31.4 a
10/05/98	17.8 a	44.3 b	31.0 a	31.0 a
Average	**13.6**	**40.4**	**26.2**	**27.6**
Experiment Two				
09/14/98	7.8 a	32.3 b	18.4 a	21.7 a
09/28/98	5.2 a	36.7 b	19.9 b	21.9 a
10/12/98	3.9 a	34.8 b	8.4 b	20.3 a
10/26/98	5.5 a	37.5 a	21.2 a	21.9 a
11/09/98	18.9 a	35.0 b	25.4 b	28.6 a
Average	**8.3**	**35.2**	**20.7**	**22.9**
Experiment Three				
08/24/99	11.5 a	30.9 b	19.6 a	22.8 a
09/14/99	15.6 a	31.2 b	14.4 b	32.4 a
01/19/00	7.0 a	27.7 b	16.6 a	18.1 a
03/13/00	5.1 a	18.8 b	11.4 a	12.5 a
05/15/00	3.6 a	16.8 b	10.0 a	10.4 a
09/26/00	24.9 a	32.8 b	26.0 b	31.7 a
06/19/01	11.5 a	30.9 b	19.6 a	22.8 a
05/09/02	3.9 a	7.7 b	5.0 a	6.7 a
Average	**10.4**	**24.6**	**15.3**	**19.7**

[z]Position: Surface wood pieces were placed on mulch layer surface, and buried wood pieces were buried 10 cm (4 in.) in mulch. In experiments one and two, $N = 16$; in experiment three, $N = 32$.
[y]Irrigation: Low irrigation sites received 40% ET, and high irrigation sites received 160% ET. In experiments one and two, $N = 16$; in experiment three, $N = 32$.
[x]Data not collected.
[w]Means followed by the same letter are not significantly different at the $P = 0.05$ level at a particular date for position or irrigation treatment.

Thyronectria austroamericana survived in wood pieces placed on the surface, as well as in pieces buried in the mulch, for over 2 years in experiment three. Experiment three began in the fall with no differences in recovery between surface and buried pieces. (Figure 1). During the winter and early spring of the first year (January through May), surface pieces provided significantly greater recovery than buried pieces. For the remaining years, there were no differences in recovery between surface and buried pieces (Figure 1). Percentages of moisture were significantly different, with the surface pieces averaging 10% and the buried pieces averaging 24% over the 143 weeks (Table 2). The percentage of moisture, however, explained position effects only at 98 weeks. In experiment three, irrigation treatments had little impact on recovery of *T. austroamericana* except by 98 weeks when the fungus was isolated from 32% of cankered wood pieces from high irrigation blocks and from only 14% of cankered wood pieces from low irrigation blocks (Table 1).

In the test for pathogenicity, cankers typical of those caused by *T. austroamericana* developed at sites inoculated with the recovered (M82-23 and M82-24) and original (T82-23 and T82-24) isolates of *T. austroamericana*. Canker size did not differ significantly between recovered or original isolates nor did irrigation treatments affect canker size.

DISCUSSION

The recovery data for *T. austroamericana* from cankered wood pieces was variable among the three experiments (Table 1). In spite of the variability, the recovery data suggest the following:

- Recovery of *T. austroamericana* was not affected by the irrigation regimes utilized in these experiments.
- Recovery of *T. austroamericana* was affected by the position of cankered wood pieces in the mulch layer for a few months after placement in the landscape.
- Recovery of *T. austroamericana* decreases over time, suggesting that it may not compete well as a saprophyte with other microorganisms.
- Recovery of *T. austroamericana* from cankered wood pieces collected during the winter indicates that the pathogen can withstand freezing temperatures even when not in association with living host tissue.

In our study, species of *Fusarium, Rhizopus*, and *Trichoderma* were common contaminants in culture plates, which often made detection of *T. austroamericana* more difficult. These rapidly growing fungi may have masked the presence of *T. austroamericana* when small wood chips were plated on PDA. Panesar et al. (1994) also reported unexplainable variability in their survival rate and longevity data of pinewood nematodes in the wood chips. The authors attributed these variations to differences in wood chip size, moisture content, and/or to the experimental method employed.

The results from the three experiments suggest that moisture content of the cankered wood pieces was affected by the position of the cankered wood pieces on or in the mulch layer (Table 2). Surface pieces had lower moisture values compared to buried pieces, suggesting that conditions on the mulch surface caused the exposed cankered wood pieces to dry out more than those pieces buried under the mulch. This may be due to the fact that some of the buried pieces were closer to the surface than others. Recovery from surface pieces was significantly greater than buried pieces in experiment three only during the first winter, but not throughout the remaining 2 years (Table 1).

Thyronectria austroamericana isolated from cankered wood pieces that had been on or in mulch layers for 98 weeks produced typical Thyronectria canker lesions on honeylocust tree branches after these branches had been inoculated with the recovered isolates. The fact that recovered *T. austroamericana* resulted in canker development on inoculated branches indicates that chipped, diseased honeylocust trees may remain a source of inoculum of *T. austroamericana* for well over 2 years after placement as mulch in landscape plantings. This finding reinforces the earlier supposition that wood chips from diseased trees may harbor plant pathogens and therefore should not be used as a mulch material for healthy trees of the same species.

CONCLUSIONS

The results of this study suggest that infested wood chip mulch can be a source of inoculum for plant pathogens. However, just because a plant pathogen can be isolated from infested wood chips does not mean that the pathogen in these wood chips can infect and incite disease in nearby healthy trees. A specific plant pathogen, a susceptible plant host, and delimited environmental conditions are necessary for disease development. Infested mulch may allow some fungal pathogens to survive for prolonged periods until environmental conditions and horticultural practices favor infection.

Thyronectria austroamericana, a plant pathogenic fungus, can remain viable for well over 2 years after infected plant parts are removed from the host plant. Thus, the risk of introducing exotic plant pathogens via the importation of wood-based packing material originating outside of the United States or secondary movement within the United States can be increased by the use of this material for landscape mulch. The findings from this research suggest that the risk of introducing exotic plant pathogens and other pests is real and may justify stricter regulations on wood packing materials.

LITERATURE CITED

Allen, E.A., and L.M. Humble. 2002. Nonindigenous species introductions: A threat to Canada's forests and forest economy. Can. J. Plant Pathol. 24:103–110.

Ash, C. 1999. The ecology of *Verticillium dahliae* in *Fraxinus* and *Acer* species. Ph.D. thesis. University of Minnesota, St. Paul, MN. 112 pp.

Ellefson, C.L., T.L. Stephens, and D. Welsh. 1992. Xeriscape Gardening—Water Conservation for the American Landscape. MacMillian, New York, NY. 323 pp.

Feucht, J.R. 1997. Mulches for Home Grounds. Colorado State University Cooperative Extension Fact Sheet No. 7.214. Colorado State University, Fort Collins, CO. 2 pp.

Foreman, G.L., D.I. Rouse, and B.D. Hudelson. 2002. Wood chip mulch as a source of *Verticillium dahliae* (abstract). Phytopathology 92(6):S26.

Green, T.L., and G.W. Watson. 1989. Effects of turfgrass and mulch on the establishment and growth of bare-root sugar maples. J. Arboric.15:268–273.

Greenly, K.M., and D.A. Rakow. 1995. The effect of wood mulch type and depth on weed and tree growth and certain soil parameters. J. Arboric. 21:225–232.

Herms, D., M. Gleason J. Iles, D. Lewis, H. Hoitink, and J. Hartman. 2001. Using mulches in managed landscapes. University Extension SUL 12. Iowa State University, Ames, IA. 12 pp.

Mireku, E., and Simpson, J.A. 2002. Fungal and nematode threats to Australian forests and amenity trees from importation of wood and wood products. Can. J. Plant Pathol. 24:117–124.

Panesar, T.S., F.G. Peet, J.R. Sutherland, and T.S. Sahota. 1994. Effects of temperature, relative humidity and time on survival of pinewood nematodes in wood chips. Eur. For. Pathol. 24:287–299.

Seeler, E.V., Jr. 1940. Two diseases of *Gleditsia* caused by a species of *Thyronectria*. J. Arnold Arboretum 21:405–427.

Sinclair, W.A., H.H. Lyon, and W.T. Johnson. 1987. Diseases of Trees and Shrubs. Cornell University Press, Ithaca, NY. 512 pp

Tkacz, B.M. 2002. Pest risks associated with importing wood to the United States. Can. J. Plant Pathol. 24:111–116.

United States Department of Agriculture (USDA). 1991a. Pest Risk Assessment of the Importation of Larch from Siberia and the Soviet Far East. USDA For. Serv., Misc. Pub. No.1495.

———. 1991b. An Efficacy Review of Control Measures for Potential Pests of Imported Soviet timber. USDA For. Serv., Misc. Pub. No. 1496. 28 pp.

———. 1998. Pest Risk Assessment of the Importation into the United States of Unprocessed *Pinus* and *Abies* Logs from Mexico. USDA For. Serv., Forest Products Laboratory. FPL-GTR-104. 116 pp.

———. 2001. Pest Risk Assessment of the Importation into the United States of Unprocessed Eucalyptus Logs and Chips from South America. USDA For. Serv., Forest Products Laboratory. FPL-GTR-124. 134 pp.

Watson, G.W. 1988. Organic mulch and grass competition influence tree root development. J. Arboric. 14:200–203.

[1]*Research Associate*
[2*]*Professor*
Department of Bioagricultural Sciences & Pest Management
Colorado State University
Fort Collins, CO 80523-1177, U.S.

**Corresponding author.*

Résumé. Des copeaux de bois non compostés sont souvent employés comme paillis. Les copeaux proviennent régulièrement de résidus d'abattage d'arbres qui étaient en mauvaise santé ou qui étaient affectés par des maladies. Les copeaux proviennent aussi de résidus de palettes de bois et d'autres matériaux ligneux d'emballage qui peuvent abriter des maladies pathogènes indigènes ou exotiques. Une étude a été entreprise afin de déterminer combien de temps une maladie fongique peut survivre dans un paillis de copeaux de bois non composté dans les aménagements paysagers en milieu urbain. Le *Thyronectria austroamericana*, l'agent causal du chancre thyronectrien chez le févier inerme, a été utilisé pour inoculer des branches de févier inerme. Des pièces de bois chancrées ont été placées dans le paillis entourant des féviers qui poussaient dans deux milieux irrigués de manière différente. *T. austroamericana* s'est rétabli à partir de pièces de bois chancrées après une période 98 semaines en produisant de nouveaux chancres lorsqu'il était inoculé sur des branches de févier inerme. Le régime d'irrigation n'a pas affecté la capacité de rétablissement du chancre. Les pièces de bois chancrées demeuraient une source d'inoculation jusqu'à 143 semaines après leur dépôt au travers du paillis. En raison de la durée de survie du pathogène, des paillis non compostés provenant de résidus de féviers infectés avec le *T. austroamericana* ne devraient pas être utilisés autours de féviers dans les aménagements paysagers en milieu urbain. L'emploi de copeaux non compostés dérivés de matériaux ligneux d'emballages pourrait augmenter le risque d'introduction de maladies exotiques chez les végétaux en milieu urbain.

Zusammenfassung. Unkompostierte Holzschnitzel werden oft als Landschaftsmulch verwendet. Die Schnitzel kommen gewöhnlich von entfernten Gehölzen mit schlechtem Gesundheitszustand bzw. bereits mit Krankheitsbefall. Die Schnitzel kommen auch von Paletten und anderen holzigen Verpackungen, die möglicherweise einheimische oder exotische Krankheitskeime bergen. Hier wurde eine Studie initiiert, um zu bestimmen, wie lang ein pilzlicher Pflanzenerreger in einer unkompostierten Mulchdecke im innerstädtischen Bereich überleben kann. *Thyronectria austroamericana*, der kausale Überträger von Thyronectria-Krebs bei Gleditsien wurde verwendet, um Äste von Gleditsien zu infizieren. Die Krebsbefallenen Aststücke wurden in den gemulchten Flächen bei zwei verschiedenen Bewässerungsregimen platziert. *T. austroamericana* aus befallenen Holzschnitzeln erholte sich 98 Wochen später und produzierte Krebs, als der Erreger in Äste von Gleditsien inokuliert wurde. Die Bewässerung hatte keinen Einfluss auf die Entwicklung des Erregers. Die befallenen Holzschnitzel blieben als eine Quelle für Inokulate für 143 Wochen in den gemulchten Flächen. Wegen der Langlebigkeit des Erregers sollte der Mulch von befallenen Gleditsien nicht bei gesunden Gleditsien verwendet werden. Die Verwendung von unkompostierten Holzschnitzeln aus Verpackungsmaterialien könnte das Risiko der Einführung exotischer Pflanzenkrankheiten in unsere Pflanzengesellschaften begünstigen.

Resumen. Las astillas no composteadas de madera son usadas con frecuencia como mulches. Las astillas son comúnmente obtenidas de árboles removidos por su pobre condición de salud y porque con frecuencia estaban plagados. Las astillas también se obtienen de tabletas y otros materiales de empaque que pueden albergar patógenos nativos y exóticos para las plantas. Se realizó un estudio para determinar cuánto tiempo puede sobrevivir un patógeno fungal en astillas no composteadas en un paisaje urbano. *Thyronectria austroamericana*, el agente causal del cancro Thyronectria en acacias de tres espinas (*Gleditsia triacanthos*), fue usado para inocular ramas de acacias. Partes de ramas infestadas fueron ubicadas en áreas mulcheadas de acacias que crecen en dos regímenes de riego. *T. austroamericana*, recobrado de la madera infestada, produjo cancros después de 98 semanas, cuando se inoculó en ramas de acacias. Los regímenes de riego no afectaron los tratamientos. Las partes infectadas mantuvieron la fuente del inóculo por 143 semanas después de colocarse en áreas mulcheadas. Debido a la longevidad del patógeno, el mulch no composteado derivado árboles infectados con T. austroamericana, no debería ser colocado alrededor de las acacias en paisajes urbanos. El uso astillas de madera no composteada derivada de materiales de empaque, podría incrementar el riesgo de introducir patógenos exóticos de las plantas en paisajes urbanos.