POLYETHYLENE PLASTIC WRAP FOR TREE WOUNDS: A PROMOTER OF WOUND CLOSURE ON FRESH WOUNDS

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Abstract. Tree wounds are often accompanied by the dieback of uninjured cambium at the edges of the wound. Dieback increases wound size and lengthens the time that xylem is exposed and susceptible to colonization by decay fungi. Wrapping new wounds with polyethylene plastic sheeting (PEP) can reduce dieback and promote the formation of callus tissue. Fresh wounds on aspen and maple wrapped with PEP had significantly less dieback than unwrapped wounds after 14 weeks. When PEP treatment was delayed 1 week or longer after wounding, there was no difference in wound size. Fresh wounds of aspen wrapped with PEP for 1 week were significantly smaller than unwrapped wounds after 15 weeks. In maple, 2 weeks of wrapping with PEP was required to improve wound closure. The use of PEP on wounds of birch did not affect wound size. Wounds of aspen continuously wrapped for 2 years with PEP did not have more colonization by decay fungi than untreated control wounds.

Key words. Tree, wound dressings, discoloration, decay, basidiomycetes.

Treatment of tree wounds has long been a common but controversial arboricultural practice. Modern research has shown that many commercial and traditional treatments provide no benefit to the tree, and some may even promote wood decay (16,19,20). General recommendations advise arborists to either not treat wounds or to apply a black wound dressing for aesthetic purposes only. There are, however, specific cases for which wound treatments are recommended, such as painting wounds on oak trees to prevent insect transmission of *Ceratocystis fagacearum* in areas where oak wilt is prevalent (6,7,8,18).

The use of polyethylene plastic (PEP) as a covering for tree wounds was first suggested nearly 4 decades ago (10). Since then, however, only a few researchers have conducted further investigations with this potentially useful wound treatment (2,21). These studies have shown that wrapping wounds with PEP reduces tissue desiccation and promotes callus formation. When wounds of greenhouse and field-grown yellow birch seedlings were wrapped with PEP, a 4- to 5-fold increase in wound closure was observed after 30 and 45 days, respectively (2). When mature red maple trees were wrapped with either black or clear PEP, wounds were also significantly smaller than controls after 1 growing season (21). In spite of these encouraging results, further research using PEP to treat tree wounds has not been pursued.

The objectives of this study were to determine 1) whether a PEP wrap applied to wounds of different tree species can enhance wound closure, 2) the most appropriate time after wounding to apply PEP to achieve the greatest wound closure, 3) how long the PEP needs to remain on the tree to stimulate wound response, and 4) the effect of PEP treatment on the colonization of wounds by wood decay fungi.

Materials and Methods

Two wounding experiments were initiated in an uneven-aged northern hardwood stand in northwestern Wisconsin. A total of 60 trees, 20 each of quaking aspen (*Populus tremuloides*), paper birch (*Betuta papyrifera*), and red maple (*Acer rubrum*) were wounded by driving a 5 by 8 cm ellipsoidally shaped template cutter into the tree and removing a corresponding section of bark. The resulting wounds measured 26.5 cm^2. Wound severity was increased by driving a 13 mm wide chisel 15 mm deep into the exposed xylem at 3 points within the wound. Wounding began approximately 0.3 m above the ground and proceeded in a spiral pattern up the trunk with a vertical distance of 0.3 m between each of 6 wounds per tree. Treatments were systematically distributed at different heights on trees to avoid any impact that wound position might have on wound size.

At the end of each experiment, the bark surrounding each wound was removed and the perimeter of living cambium encircling the wound was traced onto acetate sheets. The area of all wounds was determined from the acetate tracings using a Delta-T Devices Area Meter (Delta T Devices, Cambridge, England).

Experiment 1. PEP applied at various times after wounding. On June 15, 1995, 10 trees of each species received 6 wounds, as described above. Wounds were wrapped with 2 mil PEP around the stem and secured above and below with duct tape. One wound per tree was wrapped with PEP the day of wounding, and again at intervals of 1, 2, 3, and 4 weeks after wounding. One wound per tree remained unwrapped to serve as a control. After 14 weeks, the area of each wound was measured.

Experiment 2. PEP removed from wounds at various times. On June 22, 1995, a second set of 10 trees per species were wounded at the same location. Five of 6 wounds per tree were wrapped with PEP the day of wounding, with 1 wound left unwrapped as a control. The PEP was removed from 1 wound per tree at intervals of 1, 2, 3, 4, and 15 weeks after wounding, or left untreated. Fifteen weeks after wounding, the area of all wounds was determined as previously described.

Experiment 3. PEP and colonization of wounds by decay fungi. In June of 1994, 18 aspen trees received 2 wounds as described above at the Cloquet Forestry Center, Cloquet, Minnesota. One wound was wrapped with PEP, and the other remained untreated. Nine trees were cut after 16 weeks (1 growing season) and 9 cut after 61 weeks (2 growing seasons). Wounds were dissected and wood chips were aseptically removed and placed in a semi-selective media for basidiomycetes (15 gm malt extract, 15 g agar, 2 g yeast extract, 0.06 g Benlate, 0.01 g streptomycin sulfate, and 2 mL lactic acid per 1000 mL distilled water) and observed for fungal growth.

Table 1. Size after 14 weeks of wounds wrapped with polyethylene plastic at various times after wounding.

	Mean wound size[y], cm^2		
Application time	Aspen	Birch	Maple
Same day	38.7 b[z]	43.0 a	33.3 b
1 week	55.4 a	47.6 a	45.3 a
2 weeks	60.5 a	48.8 a	48.5 a
3 weeks	58.4 a	47.3 a	49.7 a
4 weeks	59.6 a	42.2 a	43.0 a
Untreated	56.6 a	45.1 a	44.4 a

[y]Mean of 10 replications.
[z]Numbers in a column followed by the same letter are not significantly different (P = 0.05), Duncan's Multiple Range Test.

Table 2. Size after 15 weeks of wounds wrapped with polyethylene plastic at wounding and removed at various times.

	Mean wound size[y], cm^2		
Removal time	Aspen	Birch	Maple
1 week	53.6 b[z]	46.4 a	43.9 b
2 weeks	46.8 b	50.5 a	38.1 b
3 weeks	52.7 b	55.3 a	36.5 b
4 weeks	40.7 b	47.0 a	38.3 b
Not removed	43.5 b	43.1 a	37.5 b
Untreated	69.3 a	46.8 a	46.0 a

[y]Mean of 10 replications.
[z]Numbers in a column followed by the same letter are not significantly different (P = 0.05), Duncan's Multiple Range Test.

Results

Experiment 1. Wrapping wounds with PEP the day of wounding resulted in significantly smaller wounds (P = 0.05) compared to controls for aspen and maple, but not for birch after 14 weeks (Table 1). Applying PEP 1 week or longer after wounding resulted in wounds that were not significantly different in size than untreated controls for aspen and maple. Applying PEP any time after wounding resulted in no significant differences in wound size compared to controls for birch.

Experiment 2. Wounds wrapped for as little as 1 week were significantly smaller after 15 weeks than unwrapped control wounds on aspen (Table 2). Leaving wounds wrapped longer than 1 week did not significantly reduce wound size compared to wounds wrapped for only 1 week on aspen. Wounds wrapped for 2 weeks or longer were significantly smaller than unwrapped wounds on maple. Wrapping wounds with PEP did not produce wounds significantly different than unwrapped control wounds on birch.

Experiment 3. After 16 and 61 weeks, decay fungi could be isolated from a small number of

Table 3. Number of wood chips[y] yielding decay fungi from aspen wounds either wrapped with polyethylene plastic or not wrapped for 16 and 61 weeks.

Treatment	16 weeks	61 weeks
PEP	4 a[z]	9 a
Unwrapped	1 a	16 a

[y]Value is the total of 9 replications, 9 chips per replication.
[z]Values in a column followed by the same letter are not significantly different, (P = 0.05) LSD.

wounds regardless of treatment (Table 3). There was no significant difference in the amount of colonization between treatments at either 16 or 61 weeks. Colonization of wounds by decay fungi was greater the second year for both PEP wrapped wounds and unwrapped wounds.

Discussion

Dieback around wounds is of concern because it can greatly increase wound size and subsequently prolong the time needed for wound closure (Figure 1). Wounds that close quickly are less likely to have decay associated with them because of decreased exposure to decay fungi and reduced time available for wood degradation to develop. Research has shown that decay organisms are limited spatially within trees after wound closure (15). A successful wound treatment, therefore, should be able to minimize wound size by reducing dieback and at the same time stimulate the formation of callus tissue. Our research clearly shows that dieback can be reduced and wound closure enhanced by wrapping wounds with PEP promptly after wounding for both aspen and maple (Figure 1).

Dieback is generally attributed to desiccation of cambial cells (5,9,15), and the effects of moisture loss on tree defense mechanisms are extremely important (3). Wrapping fresh wounds with PEP apparently prevents desiccation of the newly exposed cambium and subsequent death of cambial cells by reducing the rate of evaporation from vulnerable tissue. The moist environment created under the PEP wrap promotes rapid formation of callus tissue at or near the point where the cambium was severed. When wounds are unprotected, however, initiation of callus may be delayed until the tree is able to form its own protective barrier to

Figure 1. Wounds on aspen after 1 year covered with plastic wrap or left unwrapped. Extensive dieback (arrows) can be seen on the unwrapped wound.

prevent desiccation. The use of a material that minimizes desiccation, such as PEP, may enhance the tree's natural wound response, promoting barrier zone formation and the formation of callus tissue.

Additionally, a PEP wrap would trap wound-related gases, such as ethylene, that are produced at the site of the wound as part of the tree's natural wounding response. Ethylene has been shown to be of importance to wound closure in wounds of cottonwood (17). By preventing such gases from dispersing into the atmosphere and concentrating them at the wound site, their function may be enhanced.

Also, PEP wrap may provide some thermal protection, which might enhance callus formation and wound closure. The warming of tissues through the "greenhouse effect" from the clear PEP wrap may increase cellular activity and promote more rapid formation of callus tissue. It should be noted that these studies were carried out in a shaded forest situation. Open grown street or yard trees that receive direct sunlight, however, might experience dangerously high temperatures underneath a PEP wrap. In this situation, a white or reflective PEP wrap may be more appropriate (10).

Our research shows that wounds must be treated early to realize optimum wound closure benefits. Similarly, Shortle and Shigo (21) found that wounds of red maple, wrapped with either black or clear plastic 2 weeks after wounding, were not significantly different than unwrapped controls. But wounds wrapped the day of wounding were significantly smaller than unwrapped controls after both 1 and 2 growing seasons. Therefore, prompt treatment of wounds seems essential.

After an initial critical period of time, extending the length of time the PEP wrap remains covering the wound does not appear to provide further benefit. A short treatment period is desirable because of the deleterious aesthetic impact of the plastic wrap on high visibility specimen trees. This would also minimize any negative effects that a long PEP treatment period might have on the tree, such as constricting the cambium, enlarging lenticles, or encouraging adventitious root growth.

There is a concern that some wound treatments can create conditions favorable to the growth of decay organisms (19,20). Our preliminary results have shown that this may not be the case with PEP. Shortle and Shigo (21) also found that wounds wrapped with PEP had less decay than unwrapped wounds of red maple after 2 years. Since PEP wrap apparently needs to remain on wounds only a few weeks, the conditions should not be beneficial for decay—indeed, the stimulated xylary responses may help to inhibit decay (1).

The use of PEP did not influence callus formation and wound closure on wounds of paper birch used in this study. Growth rate of callus tissue varies by tree species (11,12,14). When comparing the closure rates on 10 different tree species, Neely (11) found paper birch to be one of the slowest to close. The inability of birch to form callus quickly may be due to its naturally slow rate of wound closure or because of desiccation, due to the unique characteristics of birch bark. Additionally, it has been reported that callus production is directly correlated with radial stem growth (13). It is possible that the radial growth was lower for these older birch trees than it was for maple or aspen on these sites and, therefore, callus growth was subsequently much less.

Although wound closure is only one of several issues to consider when dealing with tree wounds, wrapping fresh wounds with PEP can clearly reduce marginal dieback and promote callus formation in some tree species. Additional long-term studies need to be done, however, to monitor results over extended periods of time. Nonetheless, this technique seems to be an easy, inexpensive, and effective way of reducing the impact of some tree injuries.

Nearly 2 decades ago Shigo and Wilson (19) reiterated the words of Collins (4) who said, "the ideal dressing for a wound is yet to be discovered." Although PEP is not the ideal wound treatment, it is a technique that can be useful to arborists or homeowners for reducing dieback and promoting wound closure on freshly made tree wounds.

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Literature Cited

1. Blanchette, R.A. 1992. Anatomical responses of xylem to injury and invasion. **In:** Blanchette, R.A., and A.R. Biggs (eds.). Defense Mechanisms of Woody Plants Against Fungi. Springer-Verlag. Heidelberg, New York, pp. 76–95.
2. Blanchette, R.A., and E.M. Sharon. 1975. *Agrobacterium tumefaciens, a promoter of wound healing in Betuta alleghaniensis*. Can. J. For. Res. 5: 722–730.
3. Boddy, L. 1992. Microenvironmental aspects of xylem defenses to wood decay fungi. **In:** Blanchette, R.A., and A.R. Biggs (eds.). *Defense Mechanisms* of Woody Plants Against Fungi. Springer-Verlag. Heidelberg, New York, pp. 96–132.

4. Collins, J.F. 1934. Treatment and care of tree wounds. U.S. Dept. of Agric. Farmers' Bull. 1726. 33 pp.
5. Fenner, C. 1942. Shade method of direct cambium-to-bark development. 18th National Shade Tree Conference. Collier Printing, Wooster, OH, pp. 131–138.
6. French, D.W., and T.G. Eiber. 1990. Oak wilt in Minnesota. Minnesota Dept. of Resources, St. Paul, MN. 28 pp.
7. James, N.D.G. 1990. (2nd ed.) The Arboriculturalist's Companion: A Guide to the Care of Trees. Basil Blackwell Ltd. Oxford, UK. 244 pp.
8. Lawrence, T., P. Norquay, and K. Liffman. 1993. Practical Tree Management: An Arborist's Handbook. Inkata Press, Melbourne. 122 pp.
9. Leben, C. 1985. *Wound occlusion and discoloration columns in red maple.* New Phytol. 99: 485–490.
10. Leiser, A.T. 1958. *Polyethylene treatment for tree bark wounds.* Amer. Nurseryman 107(9): 13,49.
11. Neely, D. 1988. *Wound closure rates on trees.* J. Arboric. 14(10): 250–254.
12. Neely, D. 1973. *Tree wound healing and radial growth correlations.* HortScience 8(5): 384–385.
13. Neely, D. 1970. *Healing of wounds on trees.* J. Amer. Soc. Hort. Sci. 95(5): 135–140.
14. Martin, J.M., and T.D. Sydnor. 1987. *Differences in wound closure rates in 12 tree species.* HortScience 22(3): 442–444.
15. Mercer, P.C. 1982. *Tree wounds and their treatment.* Arboric. J. 6: 131–137.
16. Mercer, P.C., S.A. Kirk, P. Gendle, and D.R. Clifford. 1983. *Chemical treatments for control of decay in pruning wounds.* Ann. Appl. Biol. 102: 435–453.
17. Shain, L., and J.B. Miller. 1988. *Ethylene production by excised sapwood of clonal eastern cottonwood and the compartmentalization and closure of seasonal wounds.* Phytopathology 78: 1261–1265.
18. Shigo, A.L. 1986. A New Tree Biology. Shigo and Trees, Durham, NC. 595 pp.
19. Shigo, A.L., and C.L. Wilson. 1977. *Wound dressings on red maple and American elm: Effectiveness after five years.* J. Arboric. 3(5): 81–87.
20. Shigo, A.L., and C.L. Wilson. 1971. *Are tree wound dressings beneficial?* Arborist's News 36: 85–88.
21. Shortle, W.C., and A.L. Shigo. 1978. *Effect of plastic wrap on wound closure and internal compartmentalization of discolored and decayed wood in red maple.* Plant Dis. Rep. 62(11): 999–1002.

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Résumé. Les blessures sur un arbre sont souvent accompagnées du dépérissement du cambium demeuré intact en bordure de la zone blessée. Le dépérissement accroît les dimensions de la blessure et augmente la période d'exposition du xylème à son environnement ainsi que sa colonisation par des champignons de carie. Envelopper les blessures fraîches avec un film plastique de polyéthylène peut diminuer la propension au dépérissement et favoriser la formation de tissu cicatriciel. Des blessures fraîches, sur des peupliers et des érables, ont présenté des degrés de dépérissement significativement moins élevés, après 14 semaines, si elles étaient enveloppées avec un film plastique contrairement à celles non enveloppées. Lorsque l'enveloppe de plastique était installée une semaine ou plus après le moment où la blessure avait été effectuée, il n'y avait alors pas de différence dans les dimensions de la blessure. Les blessures fraîches sur le peuplier enveloppées d'un film plastique durant une semaine étaient significativement plus petites que celles qui ne l'étaient pas, 15 semaines plus tard. Chez l'érable, deux semaines de traitement avec le film plastique étaient nécessaires afin d'améliorer le processus de cicatrisation de la blessure. L'emploi d'un film plastique de polyéthylène sur les blessures des bouleaux n'a affecté en rien les dimensions des blessures. Chez le peuplier, les blessures continuellement enveloppées durant deux années n'étaient pas plus envahies par les champignons de carie que les blessures non traitées des arbres-contrôle.

Zussammenfassung. Baumwunden werden oftmals durch ein Zurücksterben von unverletztem Kambium am Wundrand begleitet. Das Zurücksterben vergrößert die Wunde und verlängert die Zeit, in der das Xylem offenliegt und von Fäulepilzen kolonisiert werden kann. DasEinwickeln frischer Wunden mit Polyäthylen-Folie (PEP) kann das Absterben reduzieren und begünstigt due Formation von Kallusgewebe. Frische Wunden an Espen und Ahorn, die mit PEP umhüllt wurden, zeigten nach 14 Wochen deutlich weniger Absterbeerscheinungen als unbehandelte Wunden. Wenn die PEP-Behandlung eine Woche nach der Verletzung durchgefüht wurde, zeigte sich kein Unterschied in der Wundgroße. Frische Wunden an Espen, die eine Woche mit PEP-Folie eingewickelt wurdern, waren deutlich kleiner als unbehandelte Wunden nach 15 Wochen. Bei Ahorn waren 2 Wochen Behandlung mit PEP efforderlich, um den Wundverschluß zu verbessern. Die Anwendung von PEP bei Birkenwunden hatte keinen Einfluß auf die Wundgröße. Espenwunden, die kontinuierlich über einen Zeitraum von 2 Jahren eingewickelt waaren, zeigten nicht mehr Befall mit Fäulepilzen als unbehandelte Kontrollwunden.