Mulch affects on trees

Jim Downer

THERE ARE SEVERAL REASONS to apply mulch. Mulches prevent weeds from germinating, reduce evaporative loss from soil surfaces, add organic matter to soils thereby increasing their mineral content and increase soil-borne disease suppression, and finally as shown in some studies (but not others), increase the growth of trees planted under them. Mulches allow space in the landscape for the deposition of organic matter from the trees growing over them (litterfall) **(Figure 1)**. Mulching effectively controls weeds and conserves moisture—these are perhaps the most consistent effects of mulch layers (Robinson, 1988). There can also be mulch-associated problems. Mulches can exacerbate planting problems, increase root disease, increase frost injury, introduce pests and trash into tree planting areas and can be costly to apply and maintain at working depths. In many cases these negatives associated with mulch can be resolved or prevented by careful management and knowledge.

Figure 1. Litterfall is essential to trees for nutrient recycling and all the changes to soil that organic matter contribute to.
Image by Chris Webb.

Benefits of mulching

The benefit most desired from mulch applications is for more growth or better growth of trees. Increased growth of trees has been associated with organic mulches in several studies (Downer and Faber, 2005; Greenly and Rakow, 1995; Foshee et al., 1996) Mulch effects on growth depend on the age of the tree, whether newly planted or an established specimen, tree species and site factors such as water applications, soil types and their mineral nutrient content as well as the presence or absence of pathogenic fungi in soil.

Since edaphic (soil) conditions are so variable in western landscapes, the response of trees to mulch presence is also variable. In essence, the effects of mulching depend on the qualities of the soil under the mulch. Mulch can accomplish many things but may not be necessary in all sites, or conversely, may correct problems that significantly improve tree vigor and response to moisture or applied nutrients. Many studies of mulched trees measure growth benefits, but as mentioned above the reason for the benefit may vary. Gillman and Grabosky (2004) note that mulched oaks grew better not because mulch was present, but due to lack of competition from turfgrass. Downer and Hodel (2001) found that the presence of turfgrass in lieu of mulches or bare soil slowed growth of landscape palms. Thus by having mulch and not having other competitive landscape elements such as turfgrasss, groundcovers or shrubs, trees have more available resources and will grow more, especially if water or nutrients are in poor supply. Ferini and others (2008) suggest that mulches do not affect basic tree physiological factors such as gas exchange or chlorophyll fluorescence. Mulches can also have distinct effects on some species of trees but not others. Downer (1998) found that avocado partitions roots into mulch layers making a separate and distinct root system and that root length of mulched avocado trees is greater than unmulched trees **(Figure 2)**. However, this is not the case with citrus (Menge et al., 1999). Iles and Dosmann (1999) suggest that benefits of mulching are not entirely generated by organic substrates; they found various stone mulches had the same levels of growth promotion as bark and wood chip mulches. This implies that biological effects of mulches are less significant than temperature and moisture effects but I would assert that the soil under the mulch is what really determines what effects mulch will have on trees growing in that soil.

The benefit most desired from mulch applications is for more growth or better growth of trees.

Mulching with organic materials derived from trees increases the mineral content of underlying soils, and many positively charged nutrients contained in plants (including toxic ions) tend to accumulate in fine textured soils under organic mulches (Downer, 1998). When soil minerals are not limiting to plant growth, or-

Figure 2. Avocado roots proliferate in the interface of mulch and soil. Old roots can be seen growing in lower soil layers, these roots are less vigorous and more susceptible to avocado root rot than those growing in or near mulch layers.

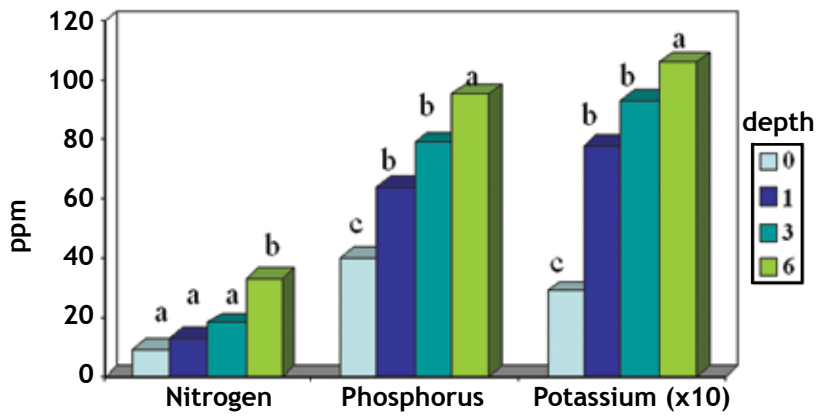

Chart 1. Nutrient accumulation in soils under various depths of yardwaste mulches. As mulch thickness increases so does soil mineral nutrient content under the mulch.

ganic mulches still seem to stimulate growth increases (Foshee et. al., 1999), again suggesting that nutrient additions are less important to growth response than other possible mulch benefits. While Faber et al. (2000) found that nutrients accumulated in soils underlying yard waste-mulched avocado and citrus (Chart 1), tissue nutrient contents were not increased—probably because nutrients were in adequate supply from the soil and fertilization practices in the groves. They associated mulch treatment growth increases with increases in rooting.

Many horticulturists believe that application of fresh, woody, (not composted mulches of high carbon nitrogen ratio) will deplete nitrogen from soils under them. Borland (1998) asserts that this is not supported in the literature. This is still not shown to be true in any valid study, but is a common and widely held belief by many horticultural professionals (Downer, 2007).

In my own studies (Downer, 1998, Downer and Hodel, 2001; Downer and Faber, 2005) use of freshly chopped eucalyptus tree branches did not cause any nitrogen draft from soils or symptoms of nutrient deficiency in trees growing under them. Indeed just the opposite was true, avocado trees mulched with fresh eucalyptus had higher nitrogen content in their tissue than unmulched trees (Table 1).

Table 1. Effect of fresh eucalyptus mulches on soil and tissue nitrogen content in an avocado grove.

	1995		1996		1997		1998	
Mulch treatment	soil	tissue	soil	tissue	soil	tissue	soil	tissue
Mulched	--	2.53	0.16	2.43	0.166	2.54	0.159	--
Not mulched	--	2.55	0.123	2.37	0.121	2.5	0.112	--
Significance	--	ns	***	***	***	*	*	--

*** and * indicate that the numbers are different (mulched vs. unmulched) according to ANOVA at P<0.001 or 0.05 respectively. Trees initially mulched in 1994 and mulched once per year thereafter with freshly chipped *Eucalyptus globulus*.

Taken from Downer, 1998.

Figure 3. Fungi grow through mulch with mycelium and rhizomorphs that secrete enzymes (cellulases) which have been shown to control root diseases.

Figure 4. *Ceraciomyces tessulatus* is a potent cellulase producer. The fruiting body looks like paint on the wood surface it is decaying.

A coarse mulch layer cuts evaporative water loss from soils thus preserving moisture for root absorption. This source of moisture is especially useful to shallow rooted trees such as avocado. I have found in various studies that mulched trees can skip every other irrigation compared to non-mulched trees and maintain the same soil matric potential (Downer, 1998; Downer and Hodel, 2001; Downer and Faber, 2005). The caveat here is that the mulch must be coarser than the underlying soil. Mulches texturally finer than the soil underneath them can lead to increased moisture loss and drying (Svenson and Witte, 1989). Moisture savings by mulches is greatest when there is maximum exposure of soil to the sun, before complete canopy cover occurs. As soils become shaded, moisture savings from mulches will decrease.

Mulching has been associated with root rot disease control for many years and was notably documented by Broadbent and Baker in Australia back in 1974. They observed that mulched avocado orchards could become suppressive to the avocado root rot organism *Phytophthora cinnamomi*. Later work in California avocado orchards established that enzymes produced by fungi growing in mulches plays a role in control of diseases caused by *Phytophthora cinnamomi* (Downer et al. 2001a&b). Mulch based enzyme systems require copious quantities of cellulose (wood) to support the growth of saprophytic fungi that live in the mulch (**Figure 4**). Mulches made of chipped tree branches and leaves provide good substrate for wood decay fungi that colonize them and then release the enzymes that are toxic to root rot pathogens. It is common to observe the rhizomorphs and mycelium of these organisms in mulch layers. When you see rhizomorphs of mulch fungi growing on wood chips, (**Figure 3**) you know that the mulch is well colonized and has the potential to control pathgens in the underlying soil.

Deleterious effects of mulch

Mulches can have negative effects on trees growing under them. Mulching does not allow observation of

Natural mulch layers develop when trees have room for litterfall. (Photos courtesy of Bruce Hagen)

the soil surface and thus awareness of underlying surface moisture is reduced. Not recognizing soil saturation and attempting to alleviate it can predispose plants to root disease. Mulch can interfere with moisture penetration to underlying soil layers. In landscapes with frequent light irrigations, mulch may be wetted and dry but underlying soils may not obtain enough water for plants growing on these mulched soils. This is most likely to happen with texturally fine mulches not coarse ones. Gilman and Grabosky (2004) found that mulching increased tree stress in lightly irrigated landscape trees—likely this was a result of mulch interception of shallow irrigations.

Mulching can accentuate the ill effects of improper planting. Arnold and others (2007), showed that green ash planted with its root collars below grade were less likely to survive when mulched than when non-mulched.

Mulches change the way that radiation is absorbed and radiated around trees thus having potential positive or negative effects on trees growing around them. Mulched trees are generally cooler and have cooler stem temperatures (Downer and Faber, 2007). Organic mulches better insulate landscape soils from intense solar radiation than decomposed granite or soil (Singer and Martin, 2008) and thus dissipate heat faster in warm climates than stone gravel or bare soil. . The insulation properties of mulch help plants resist intense soil heating in arid climates; however, these same properties reduce night time radiation from soil and tend to cool orchards at night, increasing the number of nights that trees are exposed to freezing temperatures during winter months in subtropical climates (Ben Faber personnel communication).

Mulching is an obvious way to spread pests and pathogens. The main concern is that diseased trees or parts of them when chipped and freshly applied may transfer disease propagues to soils or trees elsewhere. *Verticillium dahlieae* was found to survive several weeks outside in wood chips (Foreman and others, 2002). The canker fungus *Thyronectria austroamericana* remained viable outside in mulch for over two years after removal from an infected host (Koski and Jacobi, 2004). Survival of pests and pathogens in chips does not imply that the infection process will continue, only that they can remain viable for a time. Jacobs (2005) showed that mulch infested with *Sphaeropteris sapinea* caused blight in Austrian pine, yet mulches with *Armillaria gallica* and *Botryosphaeria ribis* failed to initiate disease from their presence in mulch. When mulches are composted before use, it is generally accepted that most pests are destroyed. However, pathogens, weeds, and insect pests can escape the yardwaste processing systems used by municipalities and survive the holding process in stockpiles (Daugovish et al., 2006; Crohn et al, 2007; Downer et al., 2008). And while Downer et al. (2008) found that *Phytophthora cinnamomi, Armillaria mellea* and *Meloidogyne incognita* were short lived in yardwaste piles, *Sclerotinia sclerotiorum* a common rot fungus survived the entire test period in many pile locations.

Mulches are useful tools for horticulturists but their best use is by informed and observant gardeners and landscape professionals that can monitor their plants, understand soil moisture relations, and are alert to the development of diseases and other pests. If used in an informed way, mulches can add benefits to plantings, retard diseases and other pests while stimulating growth.

Jim Downer
University of California Cooperative Extension, Ventura CA.
ajdowner@ucdavis.edu
Photos courtesy of Jim Downer.

Literature cited

Arnold, M.A. G. V, McDonald, and D. L. Bryan. 2007. Planting Depth and mulch thickness affect establishment of green ash (*Fraxinus pennsylvatica* and Bougainvillea Goldenraintree (*Koelreuteria bipinnata*). J. Arboriculture 33:64-69.

Borland, J. 1988. Mulches in ornamental Plantings (letter) HortScience 23:956-957.

Broadbent, P. and K.F. Baker. 1974. of *Phytophthora cinnamomi* in soils suppressive and conducive to root rot. Aust. J. Agric. Res. 25:121-137.

Crohn, D.M., Faber, B., A.J. Downer and O. Daugovish. 2007. Probabilities for Survival of Glassy-winged sharpshooter and Olive Fruit Fly pests in urban yard waste piles. Bioresource Technology 99: 1425-1432.

Daugovish, O., Downer, J., Faber, B. and M. McGiffin. 2006. Weed Survival in Yardwaste Mulch. Weed Technology 21: 59-65

Downer, A.J. 1998. Control of Avocado Root Rot and *Phytophthora cinnamomi* Rands in mulched soils. University of California, PhD. Dissertation, Riverside, CA. 212pp.

Downer, J. 2007. Snake oil, horticultural myths, horticultural urban legends, and persuaders in our industry. Arborist News 16:30-34

Downer, A.J., J.A. Menge, and, E. Pond, 2001a. Effects of cellulytic enzymes on *Phytophthora cinnamomi* Rands. Phytopathology: 91: 839-846

Downer, A.J., J.A. Menge, and E Pond. 2001b. Association of cellulytic enzyme activities in eucalyptus mulches with biological control of *Phytophthora cinnamomi* Rands. Phytopathology: 91 847-855

Downer, J. and D. Hodel. 2001. The effect of mulching and turfgrass on growth and establishment of *Syagrus romanzoffiana* (Cham.) Becc., *Washingtonia robusta* H.Wendl. and *Archontophoenix cunninhamiana* (H.Wendl.)H. Wendl. & Drude in the landscape. Scientia Horticulturae: 87:85-92

Literature cited (continued)

Downer, A.J. and B. Faber. 2005. Effect of *Eucalyptus cladocalyx* mulch on establishment of California sycamore (*Platanus racemosa*). J. Applied Hort. 7:90-94.

Downer, A.J., D. Crohn, B. Faber, O. Daugovish, J.O. Becker, J.A. Menge, and M. J. Mochizuki. 2008. Survival of Plant Pathogens in Static Piles of Ground Green Waste. Phytopathology 98: 574-554

Baber, B.A., A.J. Downer and J.A. Menge. 2000. Differential Effects of mulch on citrus and avocado. Acta Horticulturae 557: 303-308.

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

Foshee, W.G., W.D. Goff, M.G. Patterson, K.M. Tilt, W.A. Dozler, L.S. Tucker and J.S. Bannon. 1999. J. Arboriculture 25:81-84.

Foshee, W.G. and W.D. Goff, K.M. Tilt, J.D. Williams, J.S. Bannon and J.B. Witt. 1996 Organic mulches increase growth of young pecan trees. HortScience 31:811-812.

Ferrini, F. A. Fini, P. Frangi, and G. Amoroso. 2008. Mulching of Ornamental Trees: Effects on Growth and Physiology. J. Arboriculture 34:157-162.

Gilman, E.F and J. Grabosky. 2004. Mulch and Planting depth affect live oak (Quercus virginiana Mill) establishment. J. Arboriculture. 30:311-317.

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. Arboriculture 21:225-232.

Iles, J.K. and M.S. Dosmann. 1999. Effect of organic and mineral mulches on soil properties and growth of Fairview Flame red maple trees. J. Arboriculture 25: 163167.

Jacobs, K.A. 2005. The potential of mulch to transmit three tree pathogens. J. Arboriculture 31:235-242.

Koski, R. and W.R. Jacobi. 2004. Tree Pathogen survival in chipped wood muolch. J. Arboriculture 30:165-171.

Menge, J.A., B. Faber, J. Downer, and D. Crohn. 1999. Compost demonstration project Southern California. Use of yard trimmings and compost on citrus and avocado. Integrated Waste Management Board Pub. #443-99-010. pp.36.

Robinson, D.W. Mulches and Herbicides in Ornamental Plantings. 1988. HortScience 23: 537-552.

Singer, C.K. and C.A. Martin. 2008. Effect of Landscape Mulches on Desert Landscape Microclimates. J. Arboriculture 34: 230-237.

Svenson.S.E., and W.T. Witte. Mulch Toxicity: prevent plant damage by carefully processing and storing organic mulch. American Nurseryman 169:45-46.

Tejedor, M., C. Jimenez and F. Diaz. 2003. Volcanic materials as mulches for water conservation. Geoderma 117:283-295