Tweaking the Benefits of Organic Mulch

Is organic mulch from any one tree species better for transplant survival and soil-borne disease suppression?

Photo 1: The mulched hawthorn trees used for experimental purposes. All photos and images courtesy of Glynn Percival.

By Dr. Glynn Percival and Evangelos Gklavakis

Plant moisture stress is widely recognized as a leading cause of tree decline within urban landscapes. In the United Kingdom soil moisture deficits were especially damaging during the 2003, 2004 and 2006 growing seasons, where prolonged periods of no rainfall and temperatures frequently above 85 degrees resulted in substantial tree deaths, especially of newly transplanted trees. A subsequent watering ban in the south of England during 2006 meant techniques to prevent or reduce moisture stress of landscape trees have become of fundamental importance.

Mulching as a means of reducing soil moisture stress, weed control and improving soil fertility has been used in arboricultural, agricultural, fruit and farming systems for decades. Many benefits of mulches exist to include minimizing soil temperature and soil moisture fluctuations, encouraging tree root growth, suppressing weeds and enhancing soil nutrient status. In addition, mulches can prevent mower and string-trimmer damage to the tree trunk and act as a buffer in preventing excess de-icing salts from percolating into the soil around the root zone.

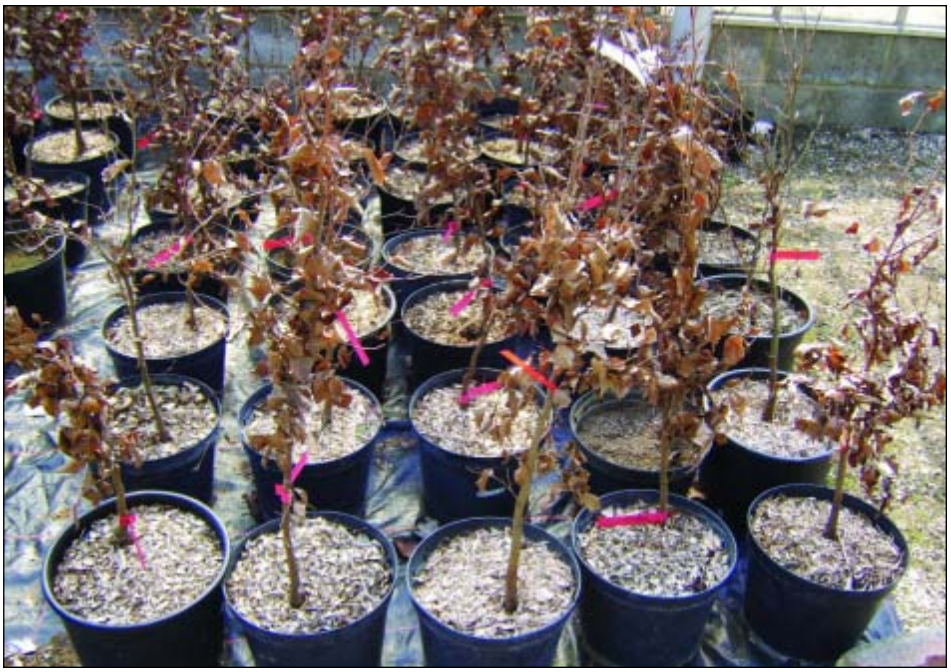


Photo 2: The mulched beech trees used for experimental purposes.

Landscape mulches can be composed of inorganic (e.g. crushed stone, crushed brick, gravel, polyethylene films) and organic matter (shredded branches and leaves, softwood and hardwood tree bark, wood chips, sawdust, pine straw, recycled pallets and mixes of the above). The use of organic rather than inorganic mulches in urban landscapes is more widely recommended for improved growth of establishing and established trees.

Pure mulches

Although organic mulches derived from wood chips are widely applied to trees, few studies have investigated the effectiveness of organic mulches derived solely from one tree species (defined in this instance as a pure mulch) on transplant survival and soil-borne disease suppression. For example, are mulches derived purely from English oak (*Quercus robur*), better than ones derived solely from common ash (*Fraxinus excelsior*), horse chestnut

Photo 3: The only surviving beech control tree, which was not mulched, at the end of the growing season.

(*Aesculus hippocastanum*) or birch (*Betula pendula*)? Likewise would an English oak perform better when a pure mulch derived from English oak is used compared to a mulch from another tree species? Or is there one species of tree from which a pure mulch is ideal for all tree species? To answer these questions and provide further information regarding the use of mulches, a number of mulching trials were instigated at the R.A. Bartlett Tree Laboratory based at the University of Reading in the United Kingdom.

Container experiments

Initial experiments used bare-rooted stock of beech (*Fagus sylvatica*, Photo 2), a species regarded as notoriously transplant sensitive, and hawthorn (*Crataegus monogyna*, Photo 1), a species regarded as highly transplant tolerant. Each bare rooted tree was planted into two-gallon pots containing a general tree compost mix. Six pure mulches were then prepared from beech (*Fagus sylvatica*), hawthorn (*Crataegus monogyna*), silver birch (*Betula pendula*), cherry (*Prunus avium*), evergreen oak (*Quercus ilex*) and English oak (*Q. robur*). All mulches were made when trees were fully dormant in early February when, with the exception of evergreen oak, no leaves were present on the tree. Mulches were applied to a depth of 4 inches. Ten beech and 10 hawthorn per pure mulch were used. It was important to record the date when pure mulches were made as chemical and physical variations will exist within mulches made during spring and summer when foliage and flowers will be present. This in turn would affect mulch chemical composition, rate of decomposition and particle size. Effects on tree survival and growth were recorded at the end of the growing season (late September).

Results showed that pure mulches had a substantial effect on tree survival rate and growth at the end of the growing season. In the case of beech, survival rates of control (non-mulched trees) was only 10 percent. Application of a pure mulch increased survival rates to 20 percent to 70 percent. The pure mulch providing the highest survival rate was that derived from hawthorn (Figure 1). Not only were survival rates improved, but there was a marked difference in the appearance of the surviving control beech tree (Photo 3) compared to a hawthorn-mulched beech tree (Photo 4).

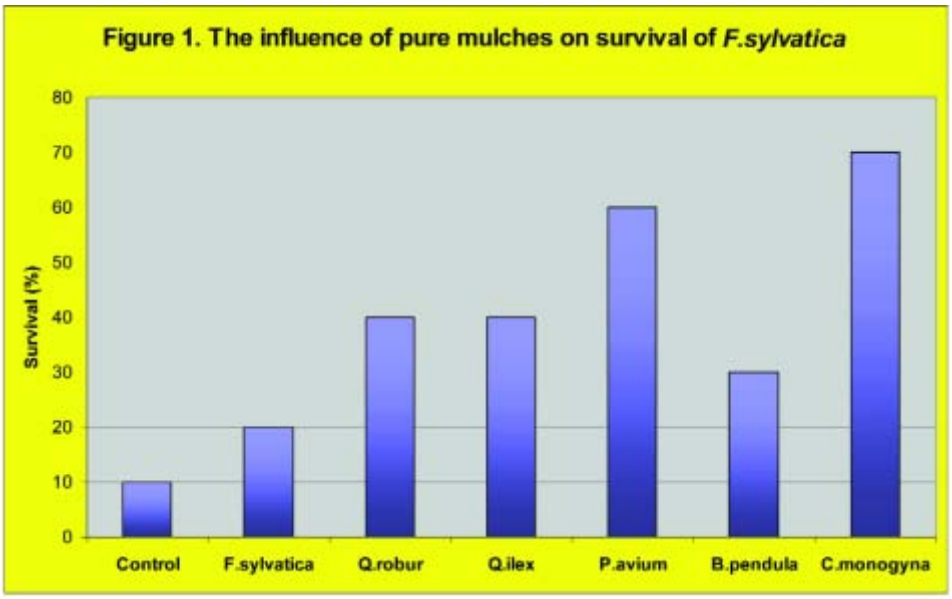


Photo 4: A mulched beech tree at the end of the growing season.

A similar response was shown when hawthorns were treated with a range of pure mulches. As hawthorn is a transplant tolerant tree, a 100 percent survival was recorded in all cases. However, at the end of the growing year, hawthorn trees treated with pure hawthorn mulches had 20 percent to 30 percent higher dry weights than non-mulched control trees. Overall, results constantly indicated that pure mulches derived from hawthorn and cherry increased survival rates and resulted in larger, healthier trees compared to pure mulches derived from silver birch, beech, evergreen oak and English oak.

Field trials

Based on the results of the container experiments, a number of field trials were instigated using larger 3.3- to 4.95-foot trees of conference pear and apple, cultivar Gala (Photo 5). At the time of planting all trees were root pruned by removal of about 55 percent (conference pear) and 45 percent (apple) total root volume to produce a

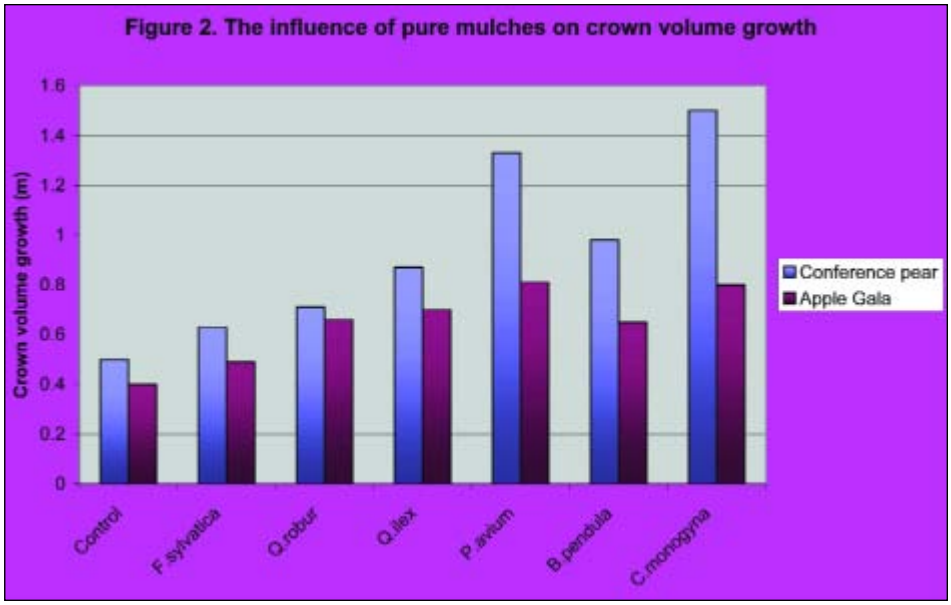
Photo 5: Based on the results of the container experiments, a number of field trials were instigated using larger 3.3- to 4.95-foot trees of conference pear and apple, cultivar Gala.

root:shoot ratio of 0:33 – a ratio associated with transplant stress in trees. Trees were planted in late January and mulched to a depth of 4 inches using one of the six pure mulches mentioned above. Ten trees per pure mulch were used and all mulches were applied at the time of planting. During the growing season, no irrigation was used and no fertilizers applied. The effects of pure mulches on growth (i.e. crown volume) and fruit yield were recorded at the end of the growing season. Pure mulches derived from hawthorn and cherry were again the best type of pure mulch, increasing crown volume growth by 100 percent to 150 percent (Figure 2) and fruit yields by 400 percent to 600 percent. Even the poorest pure mulch, a mulch derived from beech, still increased crown volume growth by 20 percent and fruit yields by 50 percent. The importance of this result: any mulch is better than no mulch.

Why the differences between mulches?

This then begs the question, why did pear and apple trees grow more slowly when a beech mulch was used compared to an hawthorn mulch? Published literature points to an important influence of the breakdown chemicals released by each mulch type. A pure mulch derived from cypress, for example, has been shown to slow down the growth of a range of woody plants (hydrangea, spirea, viburnum) compared to conventional garden center pine bark mulches. As cypress trees are noted for their resistance to decay fungi that is associated with the presence of phenolic compounds in the wood, it was suggested these phenolics would be leached into the soil and inhibit root growth. Likewise pure mulches derived from *Eucalyptus grandis* have been found to contain phytotoxic residues (organic oils and acids) that were toxic to germinating seedlings of a range of plants. One of the most famous allelopathic trees is black walnut (*Juglans nigra*) with reported effects of allelopathic chemicals produced by the roots of this tree inhibiting growth or even killing surrounding trees. The chemical responsible for the toxicity in black walnut is known as Juglone. When plants are exposed to juglone, they exhibit wilting, foliar chlorosis, and eventually death. The Tree-Of-Heaven, or *Ailanthus altissima*, is a recent addition to the list of allelopathic trees. Ailanthone, an allelotoxin extracted from the root bark of Ailanthus, is known for its herbicidal activity on other plants.

Other wood breakdown products, however, have been shown to be effective at stimulating rather than inhibiting root growth. Both hawthorn and cherry wood are high in sugars such as sucrose and sorbital, respectively. Applications of sugars to transplanted trees have been shown to be effective at enhancing root vigor and in turn alleviating transplant stress and promoting survival rates of newly planted English oak, birch and beech. Similarly, extracts of box elder have been shown to stimulate the growth of a range of grasses, while recent studies demonstrated that fresh and composted mulch derived solely from *Eucalyptus cladocalyx* was found to have a positive effect in transplant performance of *Platanus racemosa*. Furthermore, fresh pine



bark mulch has been shown to positively affect establishment of English oak (*Quercus robur*). Possibly beech wood is higher in chemicals associated with inhibiting root growth compared to hawthorn wood, which is higher in chemicals with root-promoting properties?

Can mulches be used to suppress or control soil-borne disease?

Phytophthora cinnamomi is a destructive and widespread soil-borne pathogen that has been associated with the decline of several forestry (oak, chestnut, eucalyptus), ornamental (rhododendron, azalea, camellia) and fruit (avocado, cranberry, blueberry) plants. Primary symptoms caused by this pathogen in trees include fine root lesions that can extend into larger roots, collar and trunks causing bleeding cankers (Photo 6). Control of *P. cinnamomi* is primarily through the use of agrochemicals. Disadvantages of chemical control include the build up of fungicide tolerance, failure of chemicals to control *P. cinnamomi* once a tree is infected, and increased government restrictions regarding chemical use and application. For these reasons, research at the R.A. Bartlett Tree Research Laboratory has been evaluating pure mulches for their potential in suppressing or controlling *P. cinnamomi*. Preliminary data has been promising. Trials using container grown trees have shown that plants grown under pure mulches of hawthorn had higher concentrations of enzymes (catalase, superoxide dismutase) in the root and leaves related to host defense mechanisms, which in turn resulted in a 40 percent to 60 percent

Photo 6: Primary symptoms caused by Phytophthora cinnamomi *in trees include fine root lesions that can extend into larger roots, collar and trunks causing bleeding cankers.*

reduction in disease severity (Figure 3). The discovery that mulches are useful in suppressing specific soil-borne diseases was made about 40 years ago. According to researchers at the University of California, *Phytophthora*, for example, is "eaten," dissolved and starved at the soil/mulch interface. Further research undertaken at the University of California has shown that mulches with copious quantities of under-composed wood are also effective in suppressing *Phytophthora* root rot. The addition of lime (calcium carbonate) to the mulch promoted the suppressive conditions necessary for *Phytophthora* suppression. Interestingly it was not the increase in soil pH that suppressed *Phytophthora* but the fact that biocontrol bacteria were stimulated by the increased pH levels. Research has also shown that economically important agricultural soil-borne diseases such as rhizoctonia, fusarium and pythium can be usefully suppressed by mulch application.

Guidelines for applying mulches

1. Mulch should be applied from the drip line to the trunk. If this is not practical, minimum mulch circles should be 1.1 feet for small trees, 3.3 feet for medium trees and 9.9 feet for large trees.

2. When applying mulch it is best to kill or remove existing ground cover or at least mow the grass very short and remove clippings. Mulch should be applied directly to the soil surface. Do not use landscape fabric to separate the mulch from the soil.

3. A mulch layer should be 2 to 4 inches thick, depending on the tree species and type of mulch applied.

4. To avoid root disruption for most species, mulch should not be removed. Additional mulch should be added to maintain 2 to 4 inches on an annual basis.

5. Mulch should not be placed against the trunk. Mulch will retain too much moisture against the trunk that may result in disease.

Conclusion

Initial results of our trials and that of others show that pure mulches can provide many beneficial effects. A useful degree of control of *P cinnamomi* in containerized stock is achievable without the use of chemicals, while research elsewhere strongly suggests pure mulches offer potential to suppress diseases at the landscape level.

In addition, establishment rates of difficult-to-transplant trees such as beech can be increased from 10 percent to 70 percent by the use of appropriate pure mulches. Fruit yields of young trees be increased by 400 percent to 600 percent. Such benefits have a positive impact not only for those involved in the care and maintenance of urban trees, but also agricultural, forestry, orchard and horticultural crop production. Importantly the use of pure mulches requires no capital investment and only small adjustments to standard management aftercare procedures.

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Selected References:

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