THE EFFECT OF VARIOUS LANDSCAPE WEED CONTROL MEASURES ON SOIL MOISTURE AND TEMPERATURE, AND TREE ROOT GROWTH

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Abstract. Seven landscape weed control measures (five landscape fabrics/films, black plastic, and a preemergence herbicide, each with and without mulch) were compared with bare soil to determine their affect on soil moisture and temperature. When mulched, there were no differences during any season. When unmulched, landscape fabrics/films varied in their effects. Soil moisture in unmulched plots decreased as weed growth increased. Mulching affected plant growth more than type of soil covering beneath the mulch. Mulched plants were generally larger than unmulched plants.

Résumé. Sept méthodes de contrôle des mauvaises herbes sur le terrain (cinq films synthétiques, un plastique noir et un herbicide de préémergence) étaient comparées à un sol dénudé afin de déterminer leur effet sur l'humidité et la température su sol. Quand le sol était paillé, il y avait aucune différence durant aucune saison. Quand il n'était pas paillé, les filmes synthétiques variaient dans leurs effets. L'humidité du sol dans les parcelles non paillées décrossait avec l'accroissement des mauvaises herbes. Le paillage affecte la croissance des plantes de manière plus importante que le type de sol recouvert par le paillis. Les plantes paillées étaient généralement de plus grandes dimensions que les plantes non paillées.

Weed control around trees and shrubs is very important, especially in the first year after transplanting (4, 8, 17, 18) because of competition for water and nutrients essential for plant establishment. Beneficial effects from control of competing vegetation can even be seen for some older trees (15), though these effects are less pronounced as trees become established (18), or for more drought tolerant species (17).

Several measures to control weeds are utilized in landscapes including handweeding, herbicides, mulches, and physical barriers such as plastic and landscape fabrics (geotextiles) and films. Mulches are generally the preferred landscape weed control measure when soil environment modification, cost, labor, and appearance are considered. A good review of mulching practices has been provided by Robinson (13) and by Watson (16).

Various fabrics (mainly polypropylene and polyester) and perforated films (polyethylene) are being marketed as alternatives to conventional solid black plastic (polyethylene) as mulch underliners. Their weed control success in large landscape screening trials has varied depending upon weed species, and the types and depths of mulches used (1, 2, 5, 11, 12).

One of the major advantages cited for the use of fabrics/films over plastic is their porous nature. Water and air apparently can move freely through the fabric/film barrier between the mulch and the soil, preventing detrimental moisture extremes, oxygen deficiencies, and carbon dioxide buildup attributed to plastic (6, 10, 12, 14, 17). However, Davies (3) and Davison (4) reported better tree growth when impermeable mulches (black polyethylene) were used. Watson (16) suggests that reduction of soil oxygen by black plastic kills deep roots, leaving only shallow roots. He further suggests that mulch itself does not cause roots to move to the surface but simply increases shallow root development.

Readily available moisture and a favorable soil temperature are required for root growth of landscape plants. The objectives of this study were to compare soil moisture and temperature conditions as a result of different landscape weed control measures, and to determine whether the landscape fabrics and films might have any detrimental influences on the growth of landscape plants.

Methods and Materials

The landscape site was a well drained, fertile Tetotum loam soil covered with a heavy stand of bermudagrass *(Cynodon dactylon)*. Glyphosate was applied twice in August, 1987, to kill all existing vegetation. In November, 1987, individual plots (1.8 m by 6.0 m each) were planted with three each of Japanese holly *(Ilex crenata* 'Roundleaf') and azaleas *(Rhododendron obtusum*

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'Orange Beauty'), and one red maple *(Acer rubrum).* Holes were dug with an auger, and no amendments were added to the backfill soil. All plants were fertilized with slow-release fertilizers at planting: the azaleas and hollies with 40 g of Osmocote 18-6-12 (Sierra Chemical Co., Milpitas, CA), and the red maple with five (5) 17 g 14-3-3 Woodace briquettes (Vigoro Industries, Fairview Heights, IL. (Ammonium nitrate was applied at the rate of 770 g per plot one year after planting. No supplemental irrigation was provided.

Once planted, plots were covered with one of eight soil coverings, then half of all plots were covered with mulch (8 by 2 factorial). The soil coverings were: bare ground; the herbicide oryzalin at 2.2 kg/ha; black plastic (polyethylene); the landscape fabrics Typar (gray spunbonded), Duon (gray spunbonded), DeWitt (black woven), and Exxon (white spunbonded); and the landscape film VisQueen (black embossed). VisQueen film is polyethylene; all other landscape fabrics used are polypropylene.

The mulch, partially-composted, chipped hardwood and softwood bark and wood, was applied 7.6 cm deep, and replenished to that depth after the first year. Treatments were replicated four times in a randomized complete block design.

No weeds were seeded. Natural weed growth was allowed to establish. The time required to hand weed each plot and weed weights were recorded in July, 1988, and reported elsewhere (5). After the summer weeding, weeds were allowed to regrow.

One concentric electrode gypsum block for soil moisture determination, and one thermocouple for soil temperature monitoring were installed at a 15.5 cm soil depth in the center of each plot. Soil temperature readings (Model TH-65 Thermocouple Thermometer, Wescor, Inc., Logan, UT) were taken biweekly from December, 1987, through November, 1988, at 9 am and 2 pm. Temperatures were averaged over the four seasons (winter-Dec. to Feb.; spring-March to May; summer—June and July (no Aug. due to malfunctioning termometer); fall—Sept. to Nov.). Electrical resistance readings (Model 5910A Soilmoisture Meter, Soilmoisture Equipment Corp., Santa Barbara, CA) were taken on the same interval and averaged as described above (Aug. included for summer average), but only at 2 pm. Electrical resistance readings were converted to soil moisture tension and subjected, along with all temperature measurements, to analysis of variance. After two years of growth the mulches and coverings were removed and the tree and shrub root systems observed.

Table 1. Average seasonal temperatures (°C.) under different soil coverings with or without mulch.

Soil covering	*Winter*^{z}	*Spring*	*Summer*	*Fall*
Morning (9 am)				
Bare soil	5.4	12.5	25.6	15.9
with mulch	6.8	12.5	23.8	17.1
Herbicide	5.2	12.3	24.8	15.4
with mulch	6.7	12.4	23.7	16.8
Plastic	6.4	13.7	26.8	16.8
with mulch	7.0	12.7	24.0	17.0
DeWitt	5.6	13.3	25.6	15.9
with mulch	6.8	12.4	23.6	16.5
Exxon	6.6	13.4	24.6	16.3
with mulch	6.9	12.5	23.9	17.0
Duon	5.1	12.9	24.5	15.3
with mulch	6.7	12.4	23.6	16.5
Typar	5.7	12.8	23.9	15.6
with mulch	6.8	12.5	23.7	17.0
VisQueen	5.1	12.4	24.4	15.3
with mulch	6.8	12.4	23.6	16.3
LSD^y (0.05)	0.4	0.3	0.8	0.7
Afternoon (2 pm)				
Bare soil	7.9	16.8	28.4	17.1
with mulch	7.3	13.1	24.5	17.0
Herbicide	8.4	16.8	27.9	17.4
with mulch	7.4	13.0	24.4	17.3
Plastic	8.8	17.3	29.4	19.5
with mulch	7.5	13.1	24.5	17.5
DeWitt	8.1	16.2	28.0	18.4
with mulch	7.4	13.0	24.3	17.4
Exxon	8.1	15.6	27.2	17.2
with mulch	7.3	13.0	24.4	17.4
Duon	7.7	15.7	27.6	17.2
with mulch	7.4	13.1	24.3	17.2
Typar	7.3	15.3	26.0	16.7
with mulch	7.4	13.1	24.4	17.2
VisQueen	7.5	15.4	26.6	17.2
with mulch	7.3	13.2	24.3	17.1
LSD^y (0.05)	0.4	0.6	0.9	0.4

^{z}Seasons: Winter = Dec., Jan., Feb.; Spring = March, April, May; Summer = June, July (no Aug.); Fall = Sep., Oct., Nov.
^{y}Least Significant Difference for comparing means within rows or columns within a season

Results and Discussion

Soil Temperature. A significant interaction occurred between soil coverings and the presence or absence of mulch. In agreement with Powell, et al. (11, 12), when mulched, there were no significant differences in am or pm soil temperatures among the five landscape fabrics/film during any season (Tables 1). The only significant differences among any of the eight soil coverings when mulched occurred in the fall between bare soil and VisQueen (am) and bare soil and black plastic (pm). When unmulched, significant differences occurred among all the soil coverings for both am and pm soil temperatures during all seasons.

Mulching bare ground buffered temperature fluctuations, increasing fall am and winter am and pm soil temperatures, and decreasing spring pm and summer am and pm temperatures (Table 1). As reported by Powell, et al. (12), bare ground was warmer (pm) in summer than any of the mulch treatments. When unmulched, higher am and pm soil temperatures were recorded in the black plastic-covered plots than in bare ground for all seasons except spring pm.

Soil Moisture. A significant interaction occurred between soil coverings and the presence or absence of mulch. In agreement with Powell, et al. (12), when mulched, there were no differences in soil moisture among the eight soil coverings during any season (Table 2). Though the manufacturers' technical data for the various fabrics/films show differences in water flow rates, these differences did not significantly alter the soil moisture content under any of the fabrics/films when they were covered with mulch. Furthermore, independent testing has shown little effect on water flow rates with single layers of fabric (9).

During winter and spring, when rainfall was adequate, no significant differences among unmulched soil coverings occurred except for Exxon in winter (white with weeds actively growing beneath), and VisQueen in spring. During summer and fall, when a severe drought occurred, significant differences occurred with the unmulched bare soil, herbicide, Exxon and Typar soil coverings. Light going through the Exxon and Typar supported weed growth beneath them, and large numbers of weeds grew in the bare soil plots (Figure 1). This demonstrates the impact of weed growth on water available for landscape plants.

Plant Growth. Plant growth data are not presented due to root rot damage to the azaleas, and excessive death of the red maples, which were bareroot nursery stock. Mulching helped increase plant growth for most soil coverings. The use of black plastic was neither consistently beneficial nor detrimental, although in other studies, detrimental effects, especially oxygen deficiencies, became more apparent with time (17).

Root Distribution. Roots of all species were found growing on the soil surface in the mulch, herbicide plus mulch, plastic, plastic plus mulch, and all fabric/film plus mulch treatments (Figure 2). This was not unexpected because not only are most tree and shrub roots naturally shallow, but also because roots were probably responding either to a limited oxygen supply (plastic alone—soil oxygen content not measured), or to the moist, yet well-aerated, conditions created atop the soil by the mulches. Gilman, et al. (7),

Table 2. Soil moisture tension (bars) by season under different soil coverings with or without mulch.

Soil Covering	*Winter*[z]	*Spring*	*Summer*	*Fall*
Bare soil	0.26[y]	0.24	1.02	0.40
with mulch	0.25	0.23	0.21	0.26
Herbicide	0.21	0.23	0.76	0.41
with mulch	0.25	0.25	0.21	0.23
Plastic	0.27	0.22	0.14	0.23
with mulch	0.25	0.25	0.15	0.22
DeWitt	0.26	0.23	0.26	0.24
with mulch	0.24	0.23	0.19	0.22
Exxon	0.45	0.27	0.76	0.47
with mulch	0.22	0.24	0.18	0.28
Duon	0.24	0.24	0.33	0.27
with mulch	0.27	0.25	0.18	0.24
Typar	0.22	0.25	0.77	0.33
with mulch	0.24	0.24	0.16	0.22
VisQueen	0.33	0.28	0.30	0.29
with mulch	0.23	0.23	0.19	0.22
LSD[x] (0.05)	0.11	0.04	0.17	0.08

[z]Seasons: Winter = Dec., Jan., Feb.; Spring = March, April, May; Summer = June, July, Aug; Fall = Sep., Oct., Nov.
[y]Plant available water (PAW): 0.05 bar (field capacity) = 100% PAW; 0.20 bar = 86.5% PAW; 0.40 bar = 76% PAW; 0.60 bar = 68% PAW; 0.80 bar = 62% PAW; 1.00 bar = 51.4% PAW; 15 bars = 8.5% PAW (permanent wilting point)
[x]Least Significant Difference for comparing means within rows or columns with a season

reported shallower root growth where compaction limited soil oxygen.

In addition, roots of all species were found growing in the mulch layer in mulch alone and herbicide plus mulch treatments, as expected due to reasons listed above. Watson (15) reported similar surface and in-mulch root growth for several tree species.

Though fabric/film penetration by weed roots has been reported by Derr and Appleton (5) and others, what was not anticipated was red maple and Japanese holly root growth into, through, and often atop certain of the fabric/film coverings (Figure 3). The greatest amount of penetration was observed for Duon, Typar and VisQueen.

While fabric or film/mulch combinations create moist, well-aerated media conducive to root growth, this root growth pattern raises a concern about damage that might be inflicted on plant roots if the fabrics or films must be removed or lifted for additional planting or other maintenance practices. No roots grew into, through or atop the plastic or black woven fabric. This phenomenon needs to be further studied, in particular comparing inorganic (rock) vs. organic mulches atop the fabrics.

Miscellaneous. Runs of voles were more prevalent under plastic and the fabrics/film than under the bare ground, herbicide or mulch-alone coverings (Figure 4). Since voles are vegeterians, their increased presence under the fabrics/films could potentially increase tree and shrub injury via their feeding on roots. Davies (3) noted an increase in field vole nesting under polyethylene

Figure 1. The greatest decrease in soil moisture occurred in bare soil plots where red maple and azaleas were wilting and dying due to weed competition.

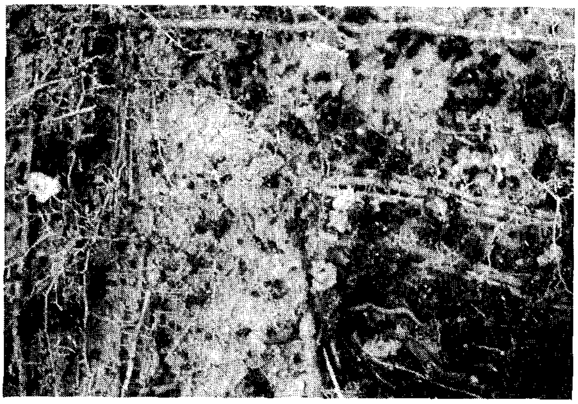

Figure 2. Surface roots were found under many soil coverings. These roots even followed the weave pattern of one of the coverings.

Figure 3. Red maple roots growing in, through and atop a spunbonded fabric.

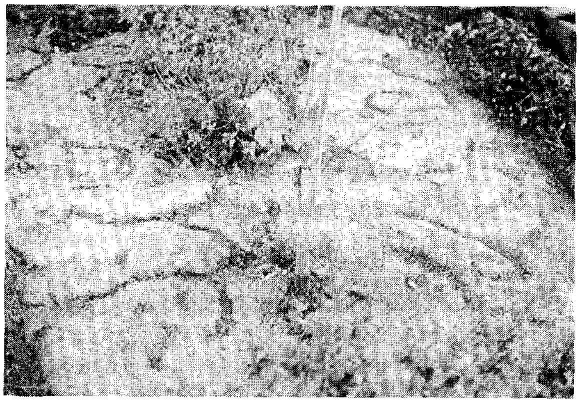

Figure 4. Mole runs increased under the plastic and fabric coverings.

mulches, with severe damage caused by gnawing of root collar bark which, in some cases, felled small trees.

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ABSTRACT

CODER, KIM D. 1989. **Should you or shouldn't you fill tree hollows?** Grounds Maintenance 24(9):68, 70, 72-73, 100.

Tree cavity filling, as a standard procedure, is misguided tree care. Recent research shows that hollow filling rarely benefits trees, and that it generally damages them. The biological reasons for leaving hollows alone is a complex story involving tree defenses, wood structure, wood-decaying organisms and tree vigor. The managerial reasons for leaving hollows alone are economic. Learn how to identify which hollows are hazardous and remove the tree or branch. Leave non-hazardous tree hollows alone. Not all wounds lead to decay and hollow formation. Many organisms colonize freshly wounded wood, but most of these organisms are not wood-decaying. Wood-decaying fungi break up the cellulose in wood, and derive the energy they need to live, grow and reproduce from this process. The tree's structure and defense mechanisms keep the decay fungi from randomly destroying the entire inside of the tree. This is why the tree is simply hollowed out rather than completely destroyed.