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*Proc. Fla. State Hort. Soc.* 103:372-377. 1990.

# EVALUATION OF LANDSCAPE MULCHES

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*Additional index words.* mulch, yard trash

*Abstract.* **Fifteen organic materials including commercially available mulches were evaluated during the 6 month period of June to November 1990 to determine their potential value as landscape mulch. The materials evaluated included cypress mulch, pine bark, pine straw, grass clippings, hardwood chips, ground yard trash,, cypress mulch on oak leaves, hardwood chips on oak leaves, ground yard trash on oak leaves, cypress mulch on ground yard trash, hardwood chips on ground yard trash, oak leaves, chipped branches, Pinellas mulch, and Tampa mulch.**

**Particle size of the mulches were determined. During the evaluation period, soil pH, soil moisture, soil temperature, and rate of subsidence were measured. Color differences were determined. Weeds were collected monthly, and dry weights were recorded. Trials to determine water infiltration rate and effect of flooding and wind were conducted. Significant differences were detected in soil moisture, soil temperature, weed control, and subsidence. Subjective evaluations were ascertained by written survey. Cypress mulch and wood chips ranked highest and grass clippings and Pinellas mulch ranked lowest.**

Mulch can be defined as any organic or inorganic material placed on the soil surface "to modify the soil environment and enhance plant growth" (4). Landscape contractors and home gardeners utilize mulch for functional and aesthetic purposes. Mulch has been reported to conserve soil moisture, moderate soil temperature, and reduce weed numbers (1,2,5,7).

As soil moisture moves to the surface by capillary action, the effects of sun, wind, or low-relative humidity promote evaporation (3). A mulch cover may reduce soil moisture evaporation by lengthening water flowage between soil capillaries and air (1). Mulch may keep soil temperature cooler in summer and warmer in winter. Ashworth and Harrison (1) noted diurnal soil temperatures recorded under two organic mulches (bark and straw) fluctuated less when compared to 6 other synthetic mulches. The use of various mulches to suppress weed populations was documented by Powell *et al.* (5). All mulches reduced weed numbers but differed in their effect on specific weed species.

Organic material such as branches, leaves, or grass clippings obtained from landscape maintenance practices may be considered yard trash. After 1991, according to Florida's Solid Waste Management Act of 1988 (Florida Statute, Chapter 88-130), yard trash may no longer be disposed of in municipal landfills. Utilization of yard trash as a landscape mulch may be one of several alternative uses for this material.

The objective of the current investigation was to determine the suitability of 15 organic materials, including municipal yard trash and commercially available mulches, for use as a landscape mulch. The results presented and discussed in this paper report findings obtained from the 6 month period June to November 1990.

## Materials and Methods

Research plots were installed in a field which was rototilled to a depth of 6 inches and leveled. Plots were delineated using 8" x 4" landscape timbers as borders. Timbers were placed such that 3 randomized complete blocks, each consisting of sixteen 8' x 3'4" plots, comprised the study area.

Any weeds remaining in the plots were removed by hand. Then each plot was filled to a 3" depth with one of the 15 mulch materials. The plots were 1) bare soil, 2) cypress mulch, 3) pine bark, 4) pine straw, 5) grass clippings, 6) hardwood chips, 7) ground yard trash, 8) cypress mulch on oak leaves, 9) hardwood chips on oak leaves, 10) ground yard trash on oak leaves, 11) cypress mulch on

Florida Agricultural Experiment Station Journal Series No. 0-00343. I acknowledge with thanks John Tucker for his dedicated assistance in preparing the tables.
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ground yard trash, 12) hardwood chips on ground yard trash, 13) oak leaves, 14) chipped branches, 15) Pinellas mulch, and 16) Tampa mulch. Plots containing combinations of mulches consisted of 1½" of one mulch on top of 1½" of another material.

The ground yard trash and hardwood chips utilized in this experiment were obtained from Wood Resource Recovery, Inc., Gainesville, Florida. For a fee, Wood Resource Recovery accepts vegetative waste materials from landscape maintenance operations, grinds the materials, and sieves out the larger pieces. Resulting material is sold as ground yard trash to be used in composting operations or as a landscape mulch. Large pieces, like tree limbs and trunks, are chipped and sold as hardwood landscape chips.

The Pinellas mulch was produced from municipal yard trash which had been ground and then composted for 90 days. Since the writing of this paper, Pinellas county has modified its composting procedures. The results presented in this paper represent material obtained prior to the modifications.

The Tampa mulch was obtained from Recycled Wood Products, Tampa, Florida. The Tampa mulch was produced from ground yard trash which was composted for 90 days and screened to contain particles between 3/8 and 5/8 inch.

Chipped branches were obtained by processing small twigs and branches in a Lascka chipper/shredder. Live oak leaves, pine needles, and fresh grass clippings were obtained from local sources. Cypress mulch and pine bark were purchased.

Percent soil moisture was determined by sampling the soil in each plot at a 6" depth, drying the soil at 110°F, and calculating wet soil minus dry soil/dry soil multiplied by 100. Soil temperature readings were taken at a 3" depth using an analog dial thermometer (0-180°F). Soil moisture and temperature were recorded biweekly.

Mulch subsidence was determined monthly by delineating the plot into 1/3 and 2/3 sections and placing a 2" x 4" board across the landscape timbers at these marks. Three subsidence measurements were taken at each section across the plot at points 1/4, 1/2, and 3/4 the length of the board. Subsidence was determined by averaging all measurements taken.

Plots were hand weeded monthly. Weeds were collected, washed, and dried for 24 hours at 110°F. Dry weed weight was recorded in ounces.

Mulch color differences were determined monthly. Color determinations were made using a Munsell Color Chart. Munsell color notations were then translated into descriptive language using the same charts.

Four soil samples taken at a 6" depth were collected from each plot and mixed together. Determinations for pH were made using the 1:1 volume procedure. Samples for pH were taken at the beginning of the investigation and 3 months later.

A notable amount of fungal growth in the mulch was detected once, 5 months after experiment initiation. Plots were ranked according to the percentage of the mulch surface covered by mushroom canopy. Rankings were based on a scale of 0 to 4. The rankings were 0 = none; 1 = <25%; 2 = 25-50%; 3 = 50-75%; and 4 = 75-100% coverage.

A 3.53 oz. sample of each of the original materials was analyzed to determine particle size. Samples were oven dried at 110F° to a constant weight. Particle size was determined by passing the sample through the following U.S. alternate designated sieve series: 5/16, 1/4, 3½, 5, 10, and 12. Weight of material in each sieve and in the base was recorded. Particle size distribution procedure was repeated twice and an average was calculated.

A 4" length of 6" diameter polyvinyl (PVC) column supported by a 6" diameter, 32 oz. capacity catchment basin was used to measure water infiltration. A screen was placed between the column and the basin. Three inches of each mulch was added to the column, brought to field capacity, and allowed to equilibrate for 24 hours. Then a volume of water which simulated a 1" rain (15.8 oz.) was applied to each column, using a watering can. After 24 hours the amount of water in the basin was measured. The procedure was repeated 3 times, and an average was calculated.

A mulch may be affected by pressures from rain or wind. A very light mulch may easily float away in an area where flooding is likely. Strong breezes tend to displace light mulch materials. The mulches were subjected to tests to determine the effect of flooding and wind. Flood and wind tests were repeated twice. Tests were not performed on combined mulches.

In the flood test, a container 2" deep and 9.2" square was filled with the mulch to be tested. The container was set at a 15% slope. Water was directly applied to the container for 1 minute at a rate of 254 gal/hr, using a modified irrigation device.

In the wind test, a 3" layer of mulch was placed inside a 1' x 1' frame. The frame was removed. A 1-DC engine blower was placed 25" in front of the mulch and operated for 1 minute in an oscillating pattern to maximize effect. Wind speed was mesured with a Omega HH-30 Digital Anemometer at 18 mph.

The amount of material remaining after the wind and flood tests was measured. Mulches were ranked on a relative scale of 1 to 5. Scale was based on 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; and 5 = 80-100% of the original material remaining after the flood or wind test.

Individuals involved in landscape practices are concerned with attractiveness, durability, and cost of a mulch. Visitors to the mulch plots were asked to complete a written survey to subjectively evaluate the mulches for texture and color preferences. Responses were ranked on a scale of 1 (least desirable) to 5 (most desirable). Visitors were also asked to verify if they would use or buy the mulch by a 1 (yes) or 2 (no) response. Surveys were compiled by month. A total of 58 surveys were completed.

All data obtained from the soil moisture, soil temperature, weed dry weight, mulch subsidence, fungal growth, and pH analysis procedures were subjected to analysis of variance based on a complete randomized block design. If a particular analysis resulted in significance at $P < 0.05$, means were separated using a Waller-Duncan K-ratio test.

## Results and Discussion

*Soil temperature.* Overall, temperatures were significantly lower in the mulched plots compared to bare soil (Table 1). Differences in soil temperatures in mulched plots versus bare soil ranged from 3 to 10°F. Although there were significant differences in soil temperatures between some mulches, the differences were not consistent during the 6 month period.

Table 1. Soil temperature (°F)[z,y] readings taken at 3" depth.

| Mulch | July | August | Sept. | Oct. | Nov.[x] |
|---|---|---|---|---|---|
| Bare Soil | 83.3 a | 92.7 a | 84.0 a | NS | 77.7 a |
| Cypress Mulch | 80.0 b | 83.3 bc | 79.0 cde | NS | 67.7 de |
| Pine Bark | 78.0 c | 82.7 c | 79.3 cde | NS | 70.0 bcd |
| Pine Straw | 80.0 b | 84.0 bc | 78.7 de | NS | 69.0 bcde |
| Grass Clippings | 80.0 b | 86.7 b | 80.7 bc | NS | 70.3 bc |
| Hardwood Chips | 79.3 bc | 83.7 bc | 78.7 de | NS | 69.0 bcde |
| Ground Yard Trash | 79.3 bc | 84.3 bc | 79.7 cd | NS | 69.3 bcde |
| Cypress on Oak Lvs. | 79.3 bc | 83.7 bc | 78.7 de | NS | 69.7 bcd |
| Woodchips on Oak Lvs. | 80.0 bc | 84.7 bc | 77.7 e | NS | 67.0 e |
| Yard Trash on Oak Lvs. | 79.3 bc | 84.3 bc | 79.0 cde | NS | 68.0 cde |
| Cypress on Yard Trash | 78.7 bc | 84.0 bc | 79.7 cd | NS | 68.7 bcde |
| Chips on Yard Trash | 78.7 bc | 83.7 bc | 79.7 cd | NS | 69.7 bcd |
| Oak Leaves | 79.3 bc | 84.3 bc | 81.7 b | NS | 69.3 bcde |
| Chipped Branches | 78.7 bc | 84.7 bc | 79.3 cde | NS | 71.0 b |
| Pinellas Mulch | 79.3 bc | 84.0 bc | 80.3 bcd | NS | 70.7 bc |
| Tampa Mulch | 79.3 bc | 85.3 bc | 79.3 cde | NS | 69.0 bcde |

[z]Data represent temperature mean of 3 replications.
[y]Mean separation within columns and treatment by Waller-Duncan's K-ratio T-test, $P < 0.05$.
[x]Nonsignificant or significant at $P < 0.05$.

Table 2. Mean of subsidence measurements (inches)[z,y] taken at 1/3 and 2/3 sections in the mulched plots.

| Mulch | July | August | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|
| Bare Soil | 0.00 e | 0.00 c | 0.00 e | 0.00 f | 0.00 e |
| Cypress Mulch | 0.58 bcd | 0.79 b | 0.89 bcd | 0.71 bcde | 0.85 bcd |
| Pine Bark | 0.51 bcd | 0.57 b | 0.85 bcd | 0.61 cde | 0.78 bcd |
| Pine Straw | 0.60 bc | 0.72 b | 1.00 bcd | 0.99 bc | 1.01 bcd |
| Grass Clippings | 1.43 a | 1.77 a | 1.58 a | 1.67 a | 1.51 a |
| Hardwood Chips | 0.42 bcde | 0.56 b | 0.68 cd | 0.53 de | 0.61 d |
| Ground Yard Trash | 0.65 bc | 0.88 b | 0.78 bcd | 0.75 bcde | 0.96 bcd |
| Cypress on Oak Lvs. | 0.54 bcd | 0.67 b | 0.85 bcd | 0.65 cde | 0.72 cd |
| Woodchips on Oak Lvs. | 0.32 cde | 0.68 b | 0.72 bcd | 0.7 bcde | 0.76 bcd |
| Yard Trash on Oak Lvs. | 0.4 bcde | 0.82 b | 0.93 bcd | 0.71 bcde | 0.74 bcd |
| Cypress on Yard Trash | 0.78 b | 0.79 b | 0.85 bcd | 0.58 de | 0.80 bcd |
| Chips on Yard Trash | 0.17 de | 0.58 b | 0.64 d | 0.43 e | 0.67 cd |
| Oak Leaves | 0.68 bc | 0.83 b | 1.11 b | 1.05 b | 1.15 ab |
| Chipped Branches | 0.64 bc | 0.82 b | 0.90 bcd | 0.76 bcde | 0.89 bcd |
| Pinellas Mulch | 0.58 bcd | 0.81 b | 1.04 bcd | 0.90 bcd | 1.01 bcd |
| Tampa Mulch | 0.54 bcd | 0.76 b | 1.07 bc | 0.88 bcd | 1.06 bc |

[z]Data represent means for the 3 replications of the 1/3 and 2/3 delineation mark averages for each mulch.
[y]Mean separation within columns by Waller-Duncan's K-ratio T-test, $P < 0.05$.

*Soil moisture.* Soil moisture readings were only significantly different in August. Apparently, enough rainfall occurred during the other months to keep the soil moist and minimize differences. Soil moisture was significantly higher in cypress mulch, pine straw, grass clippings, hardwood chips, ground yard trash, cypress on ground trash, hardwood chips on ground yard trash, chipped branches, and Pinellas mulch compared to bare soil. Although significant differences in soil moisture were not detected in other months, the mulched plots consistently had higher moisture contents than bare soil.

*Subsidence.* There were significant differences in the amount of subsidence between the mulches (Table 2). In every data set, grass clippings subsided more than any other mulch. Grass clippings dried and decomposed rapidly. Consequently, grass clippings are not a good mulch in terms of longevity.

Each mulch appeared to subside gradually. In August, significant differences between some mulches occurred. The differences, however, were not consistent in subsequent months. Typically, mulches seem to expand and contract due to factors such as change in moisture content and disturbances associated with human or animal activity.

*Color.* Mulch color differences and changes were documented using terminology obtained from Munsell Color Charts (Table 3). Noticeable changes from original color to a more weathered or gray color were detected in grass clippings. Less obvious changes were detected in hardwood chips, pine straw, cypress mulch, and chipped branches. The aesthetic value of a mulch may be primarily based on the mulches' ability to retain original color.

*Weed dry weight.* Weed populations on the bare soil were always higher when compared to the mulched plots. Significant differences in weed dry weight between the bare soil and mulched plots occurred only twice (Figure 1). There were no significant differences in weed dry weight between mulches. However, grass clippings, hardwood chips, ground yard trash, oak leaves, chipped branches, and Tampa mulch had slightly higher weed dry weights than the other mulches.

*pH change.* Oak leaves and pine needles may decrease soil pH, while hardwood bark may increase soil pH values (6). Plants requiring a specific soil pH could be adversely

Table 3. Munsell color notation readings[z,y] translated into descriptive language using same charts.

| Mulch | June | July | August | Sept. | Nov. |
|---|---|---|---|---|---|
| Bare Soil | Lt. Gray | Gray | Gray | Gray | Lt. Gray |
| Cypress Mulch | Strong Brn. | Strong Brn. | Red. Yellow | Yel. Brn. | Lt. Brn. |
| Pine Bark | Dark Red | Dark Brn. | Dusky Red | Dark Red. Brn. | Red. Brn. |
| Pine Straw | Yel. Red | Strong Brn. | Brn. | Brn. | Dark Red. Brn. |
| Grass Clippings | Olive | Gray Brn. | Dark Gray. Brn. | Brn. | Lt. Brn. |
| Hardwood Chips | Pale Yellow | Yellow | Reddish Brn. | Pale Brn. | Lt. Brn. |
| Ground Yard Trash | Red. Brn. | Dark Brn. | Dark Brn. | Dark Brn. | Red. Brn. |
| Cypress on Oak Lvs. | Strong Brn. | Strong Brn. | Red. Yellow | Dark Yel. Brn. | Lt. Brn. |
| Woodchips on Oak Lvs. | Pale Yellow | Lt. Yellow Brn. | Lt. Red. Brn. | Pale Brn. | Lt. Brn. |
| Yard Trash on Oak Lvs. | Weak Red | Dark Brn. | Red. Brn. | Gray. Brn. | Lt. Brn. |
| Cypress on Yard Trash | Strong Brn. | Strong Brn. | Red. Yellow | Yel Brn. | Lt. Brn. |
| Chips on Yard Trash | Pale Yellow | Lt. Yellow Brn. | Red. Brn. | Lt. Brwn. Gray | Lt. Brn. |
| Oak Leaves | Yel. Red | Yel. Red | Red. Brn. | Brn. | Red. Brn. |
| Chipped Branches | Red. Brn. | Strong Brn. | Strong Brn. | Yel Brn. | Pinkish Gray |
| Pinellas Mulch | Black | Dark Gray. Brn. | Olive Gray | Gray. Brn. | Lt. Gray |
| Tampa Mulch | Very Dark Gray | Dark Gray. Brn. | Gray | Gray. Brn. | Lt. Gray |

[z]Data represents Munsell Color Chart notation translated into words.
[y]Abbreviations represent the following: Lt. = light; Yel. = Yellowish; Red. = yellowish; Brn. = brown; Brwn. = brownish; Gray. = grayish.

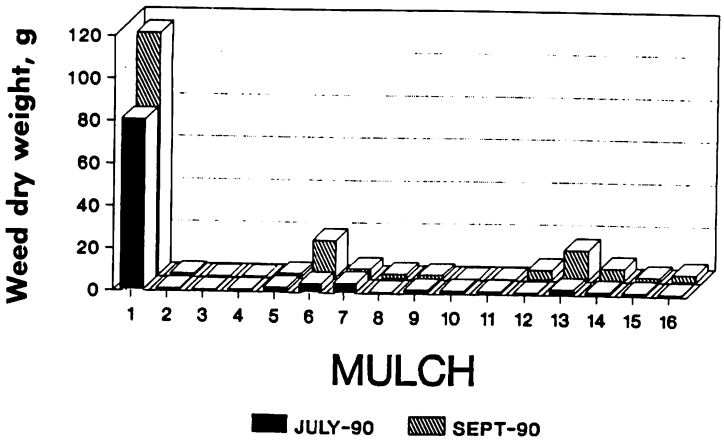


Fig. 1. Dry weight of weeds sampled from 16 mulch plots. Each indicated value is the mean of 3 replications. Plots are as follows: 1 = check; 2 = cypress mulch; 3 = pine bark; 4 = pine straw; 5 = grass clippings; 6 = hardwood chips; 7 = ground yard trash; 8 = cypress on oak leaves; 9 = woodchips on oak leaves; 10 = yard trash on oak leaves; 11 = cypress on yard trash; 12 = woodchips on yard trash; 13 = oak leaves; 14 = chipped branches; 15 = Pinellas mulch; 16 = Tampa mulch.

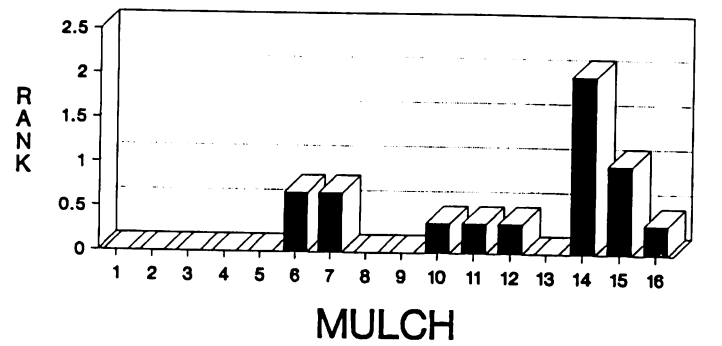


Fig. 2. Mushroom canopy cover measured in October 1990 as influenced by landscape mulch. Rank 0 = no mushrooms; rank 1 = 25% mushroom cover; rank 2 = 25-50% mushroom cover; rank 3 = 50-75% mushroom cover; rank 4 = 75-100% mushroom cover. Each indicated value is the mean of 3 replications. Mulch plots are as follows: 1 = check; 2 = cypress mulch; 3 = pine bark; 4 = pine straw; 5 = grass clippings; 6 = hardwood chips; 7 = ground yard trash; 8 = cypress on oak leaves; 9 = woodchips on oak leaves; 10 = yard trash on oak leaves; 11 = cypress on yard trash; 12 = woodchips on yard trash; 13 = oak leaves; 14 = chipped branches; 15 = Pinellas mulch; 16 = Tampa mulch.

affected. In our plots, significant differences in soil pH were not detected. However, cypress on oak leaves, ground yard trash on oak leaves, and oak leaf mulches all had reduced soil pH values in each replication. Perhaps, this was due to the acidifying effect of the oak leaves.

*Mushroom growth.* One concern of utilizing yard trash materials as a landscape mulch is fungal contamination. Presence of fungal fruiting bodies, i.e., mushrooms, are not aesthetically pleasing. Furthermore, fungal matting may restrict water penetration.

Significant differences in the occurrence of substantial mushroom growth was observed once in October (Figure 2). No growth was detected on the bare soil. Mushroom growth in the chipped branches plot was significantly different than all other plots. Some degree of mushroom growth occurred in at least 2 of 3 replications in hardwood chips, ground yard trash, and Pinellas mulch plots. This finding may substantiate the concern of utilizing these yard waste materials as mulches.

*Other tests.* The particle size distribution of the mulches indicated the texture of the material (Table 4). The particle size of most of the mulch particles was in the range of 8 to 5.6mm, indicating a course texture; while ground yard trash, Pinellas, and Tampa mulches ranged from 1.7 to 4mm, indicating a fine texture.

Water infiltration rates (oz/24 hour) did not differ greatly between the mulches except for cypress and Pinellas mulches. Cypress mulch appears to have high water holding capacity which may reduce the amount of water reaching the plant root zone. However, moist cypress mulch may also buffer the soil against soil-water evaporative losses.

Even less water infiltrated the Pinellas mulch. This mulch, for the most part, had practically composted into a fine soil like material. After water was added, the mulch became very saturated or muddy.

Most of the mulches performed well in the flood test (Table 5). However, oak leaves and Pinellas mulch were highly susceptible to the effects of flooding. Oak leaves floated away while Pinellas mulch washed away.

At the conclusion of the wind test, the following percentages of the original material tested remained intact: 80-100% of cypress, pine bark, pine straw, and hardwood chip mulches; 60-80% of ground yard trash, chipped branches, Pinellas and Tampa mulches; 20-40% of grass

Table 4. Particle size distribution analysis of mulches[z,y]

| Mulch | U.S. sieve designation no.[x] | | | | | | |
|---|---|---|---|---|---|---|---|
| | 5/16 | 1/4 | 31/2 | 5 | 10 | 12 | Base |
| Chipped Branches | 0.41 | 0.51 | 0.30 | 0.77 | 1.02 | 0.12 | 0.41 |
| Cypress Mulch | 0.81 | 0.37 | 0.32 | 0.53 | 0.68 | 0.10 | 0.73 |
| Grass Clippings | 2.38 | 0.04 | 0.05 | 0.11 | 0.26 | 0.13 | 0.55 |
| Oak Leaves | 2.73 | 0.20 | 0.10 | 0.19 | 0.20 | 0.04 | 0.14 |
| Pine Bark | 3.33 | 0.05 | 0.01 | 0.02 | 0.04 | 0.01 | 0.08 |
| Pine Straw | 0.98 | 0.13 | 0.12 | 0.29 | 0.71 | 0.54 | 0.78 |
| Pinellas Mulch | 0.18 | 0.07 | 0.07 | 0.14 | 0.30 | 0.08 | 2.67 |
| Tampa Mulch | 0.25 | 0.41 | 0.30 | 0.70 | 1.03 | 0.14 | 0.71 |
| Hardwood Chips | 2.62 | 0.24 | 0.12 | 0.19 | 0.16 | 0.02 | 0.18 |
| Ground Yard Trash | 0.56 | 0.19 | 0.11 | 0.31 | 0.55 | 0.16 | 1.66 |

[z]Values represent the mean of two repetitions using a 3.53 oz. (100 gram) sample.
[y]Particle size distribution analysis was not performed on combined mulches.
[x]U.S. Series sieve designation no. 5/16 = 8mm; 1/4 = 6.3mm; 3½ = 5.6mm; 5 = 4mm; 10 = 2mm; 12 = 1.7mm. Base = material remaining after passing through sieves.

Table 5. Results of water infiltration rate, flood, and wind tests performed on mulches. Tests were not replicated. Flood and wind tests were not performed on combined mulches.

| Mulch | Infiltration (oz/24hr)[z] | Flood Test[y] | Wind Test[y] |
|---|---|---|---|
| Bare Soil | NA[x] | NA | NA |
| Cypress Mulch | 13.81 | 5 | 5 |
| Pine Bark | 14.77 | 5 | 5 |
| Pine Straw | 14.99 | 5 | 5 |
| Grass Clippings | 14.26 | 5 | 3 |
| Hardwood Chips | 14.09 | 5 | 5 |
| Ground Yard Trash | 14.31 | 5 | 4 |
| Cypress on Oak Lvs. | 14.54 | NA | NA |
| Woodchips on Oak Lvs. | 14.37 | NA | NA |
| Yard Trash on Oak Lvs. | 14.93 | NA | NA |
| Cypress on Yard Trash | 14.37 | NA | NA |
| Chips on Yard Trash | 14.20 | NA | NA |
| Oak Leaves | 14.88 | 4 | 1 |
| Chipped Branches | 14.82 | 5 | 4 |
| Pinellas Mulch | 12.34 | 1 | 4 |
| Tampa Mulch | 14.71 | 5 | 4 |

[z]Values represent the mean for 3 repetitions of tests on each mulch.
[y]Flood and wind tests were performed twice. Values represent relative ranking of means on scale of 1 to 5. 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; and 5 = 80-100% of the original material remaining after the test.
[x]NA = material was not tested.

clippings; and 0-20% of oak leaves (Table 5). More than 1/2 of oak leaves and grass clippings were blown away. The ease at which these materials are transported by wind may present a problem when utilizing these materials as a mulch.

*Surveys.* For each month, a mean was calculated of the ranking numbers given in response to questions asked about each mulch. Means from the June and November surveys were compared to determine if individual's preferences for a mulch changed as the mulch aged (Table 6). In June, cypress mulch, hardwood chips, and combinations of cypress and woodchips with other materials were ranked as having most desirable texture. Pine bark and pine straw were considered slightly less desirable. Pinellas mulch, chipped branches, ground yard trash, and combinations containing ground yard trash were ranked as least desirable.

By October, grass clippings had almost completely decomposed; while, Pinellas mulch had aged such that it lost distinguishable particle differences becoming even more soil-like. Individuals ranked cypress mulch and cypress in combinations with other materials as having the most desirable texture. Grass clippings and Pinellas mulch were ranked least desirable.

In June, cypress mulch, hardwood chips, and combinations of cypress and woodchips with other materials were ranked as having most desirable color. Pine bark, pine straw, oak leaves, and chipped branches were considered slightly less desirable. Grass clippings and ground yard trash were ranked least desirable.

By October, most of the mulches had aged to a weathered gray color. Cypress mulch and combinations of cypress with other materials were ranked as having most desirable color. Grass clippings and Pinellas mulch were ranked as having least desirable color.

In June, the majority indicated they would use all of the mulches. By October, rankings indicated that most

Table 6. Mean of ranking numbers given corresponding to questions asked about each mulch in the June and October surveys.[z,y,x]

| | Text | | Color | | Use? | | Buy? | |
|---|---|---|---|---|---|---|---|---|
| Mulch | June | Oct. | June | Oct. | June | Oct. | June | Oct. |
| Bare Soil | 3.0 | 1.0 | 2.6 | 1.0 | 1.0 | 2.0 | * | 2.0 |
| Cypress Mulch | 4.5 | 4.0 | 4.6 | 4.1 | 1.0 | 1.2 | * | 1.4 |
| Pine Bark | 3.7 | 2.8 | 4.3 | 3.6 | 1.0 | 1.4 | * | 1.6 |
| Pine Straw | 3.8 | 3.6 | 3.9 | 3.5 | 1.0 | 1.2 | * | 1.5 |
| Grass | 3.0 | 2.0 | 2.6 | 1.9 | 1.0 | 1.6 | * | 1.9 |
| Woodchips | 3.8 | 2.9 | 4.4 | 2.9 | 1.0 | 1.3 | * | 1.6 |
| G. Yard Trash | 2.3 | 2.7 | 2.8 | 2.8 | 1.0 | 1.4 | * | 1.7 |
| Cyp/Oak Lvs. | 4.2 | 4.0 | 4.5 | 3.8 | 1.0 | 1.2 | * | 1.3 |
| Wood/Oak Lvs. | 4.2 | 2.9 | 4.6 | 3.1 | 1.0 | 1.2 | * | 1.6 |
| Yard/Oak Lvs. | 2.7 | 2.8 | 2.8 | 2.8 | 1.0 | 1.4 | * | 1.7 |
| Cyp/Yd Trash | 4.4 | 4.1 | 4.8 | 4.2 | 1.0 | 1.2 | * | 1.5 |
| Wood/Yd Trash | 4.0 | 2.9 | 4.4 | 2.8 | 1.0 | 1.5 | * | 1.8 |
| Oak Leaves | 3.3 | 3.2 | 3.5 | 3.5 | 1.0 | 1.2 | * | 1.6 |
| Chip. Branches | 2.8 | 2.6 | 3.8 | 2.6 | 1.0 | 1.4 | * | 1.5 |
| Pinellas Mch. | 2.7 | 1.9 | 3.1 | 1.9 | 1.0 | 1.6 | * | 1.9 |
| Tampa Mulch | 3.4 | 3.3 | 3.2 | 2.6 | 1.0 | 1.4 | * | 1.7 |

[z]Values represent mean of the rankings. Ranking scale for texture and color was 1 to 5: 1 = least desirable and 5 = most desirable. For the questions, "Would you use?" or "Would you buy?", yes responses were denoted as a 1 and no responses as a 2.
[y]*represents no data. Question was not on June survey form.
[x]Chip. Branches = chipped branches; Cyp/Oak Lvs. = cypress on oak leaves; Cyp/Yd Trash = cypress on yard trash; G. Yard Trash = ground yard trash; Pinellas Mch = Pinellas mulch; Wood/Oak Lvs. = woodchips on oak leaves; Wood/Yd Trash = wood on ground yard trash.

people would still use the materials. Yet, Pinellas mulch and grass clippings were less preferred.

The question "would you buy?" was not included on the June survey, but was added in July. Most individuals indicated they would buy cypress, pine straw, chipped branches, and combinations of cypress with other materials. Purchase of grass clippings and Pinellas mulch were almost unanimously rejected.

The surveys indicated a majority of individuals surveyed did not object to utilizing yard trash material as mulch with the exception of grass clippings and Pinellas mulch. Respondents seemed to accept the use of combinations of more expensive material like cypress on a yard trash material. Combining materials helps to reduce costs and provides a solution to disposal of these yard waste materials.

The results presented indicate all materials evaluated, except grass clippings and Pinellas mulch, had qualities which make them potentially valuable as landscape mulches. The mulches moderated soil temperature, reduced soil moisture losses, and suppressed weed populations, when compared to bare soil. Survey results showed individuals preferred cypress mulch and woodchips and felt grass clippings and Pinellas mulch were least desirable for landscape use.

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*Proc. Fla. State Hort. Soc.* 103:377-379. 1990.

# RECLAIMED WATER AND FLORIDA NATIVES

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*Abstract.* **A demonstration landscape area using Florida native plant species mulched with St. Petersburg's recycled mulch and irrigated with St. Petersburg's reclaimed water was laid out around the Water Quality Assessment Laboratory at 1635 3rd Avenue North, St. Petersburg, FL 33713, in June 1989. The species included: American Beautyberry (*Callicarpa americana*), Blackhaw (*Viburnum obovatum*), Blazing Star (*Liatris* spp.), Blue-eyed Grass (*Sisyrinchium atlanticum*), Coral Honey Suckle (*Lonicera sempervirens*), Fahkahatchee grass (*Tripsacum dactyloides*), Rain Lily (*Zephyranthes simpsoni*), Red Anise (*Illicium floridanum*), River Birch, (*Betule nigra*), Rusty Blackhaw (*Viburnum rufidulum*), Rusty Lyonia (*Lyonia ferruginea*), Salvia (*Salvia coccineus*), Saw Palmetto (*Serenoa repens*), Simpsons' Stopper (*Myricanthes fragrans* var. simpsonii), Winged Elm, (*Ulmus alata*), Yellow Anise (*Illicium parviflora*) and Yellow Jessamine (*Gelsemium sempervirens*).**

**Reclaimed water quality application rates and mean rainfall levels were regularly monitored from June 1989 to November 1990. The growth and maturation of selected plant species was measured and the vegetative condition of all species was observed and recorded throughout the same time period.**

**The growth responses to reclaimed irrigation water and the salt tolerance of selected species was evaluated and recommendations for the selection and suitability of salt tolerant species for inclusion in xeriscapes are included.**

The ever expanding need for the reuse of treated wastewater to conserve potable water supplies and protect groundwater sources is evidenced by the fact that there are now over 200 sites recycling treated wastewater in Florida alone. Fifteen of these sites supply reclaimed water to domestic households for irrigation purposes. St. Petersburg still has the largest reclaimed water distribution system with over 6000 domestic customers and a total of 6000 acres under irrigation.

Previous studies on the effects of St. Petersburg's reclaimed water on the growth and maturation of commonly occurring ornamental plants in Central Florida have been published by Parnell, (1), (2) and Robinson and Parnell, (3). The expanded use of reclaimed water in natural systems and wetlands restoration projects and the increasing use of indigenous species in creative and xeriscape landscaping requires that further studies be implemented on the effects of this new resource on locally occurring plant species. This paper represents a preliminary review of 18 months of observations on 17 species of Florida native plants.

## Materials and Methods

Seventeen species of Florida native plants were planted in an area 15 feet wide and 100 feet long on the eastern and southern sides of the Water Quality Assessment Laboratory. The area was enclosed by a retaining wall and the soil surface was raised approximately 2 feet above ground level. Top soil was used to build up the level and one 40 lb bag of Lesco sulfur coated 24-5-11 fertilizer was applied to the area before planting. The surface of the soil was covered with a 4 inch layer of St. Petersburg's yard waste recycled mulch.

An underground irrigation system was installed to cover the whole area as uniformly as possible. The system was calibrated to deliver 0.5 inches of irrigation water in a 30 minute irrigation period. Throughout the investigation from June 1989 to November 1990 the irrigation system was automatically activated every other day at 5:00 a.m. and delivered approximately 8 inches of supplemental irrigation per month.

Reclaimed water was sampled and analyzed for chloride concentration monthly. Rainfall levels were obtained from the records at the nearby Albert Whitted Water Reclamation Facility.

The initial size of 10 native plant species was measured in June 1989 by calculating the sum of plant height and mean width (Table 1). All plants within a single species were selected so that they were of similar size at the outset of the investigation. Final sizes were calculated by a similar method in November 1990. Growth indices were obtained by dividing final size by initial size. In addition to the measurements, observations on the growth and condition of the plants were monitored throughout the investigation.

## Results and Discussion

The chloride concentration of the reclaimed water applied to the landscape area varied between 100 and 500 parts per million (Fig. 1). Lowest concentrations occurred in the winter months. Figure 1 includes the mean monthly rainfall added to the monthly 8 inches of supplemental reclaimed water irrigation data for the period under inves-