

Mulch Ado about Something

John Colwill - Plantsman

While everybody seems to agree that mulching the soil is good practice, not all agree on which mulch is the best at saving water or on how thick a mulch should be spread. The results from this independent pilot trial clearly show that to be 'Waterwise' a mulch should consist of large, irregularly shaped particles that hold little if any water. It also shows that 'Waterwise' mulches only need to be 50 to 75mm thick

Abstract

The trial was in two parts. Part 1 to compare moisture loss to the atmosphere through various mulches applied to the surface at 75 mm thick and Part 2 to compare the effects of applying mulches at different thicknesses.

In part 1 of the trial containers were filled to 75 mm below the top with a standard potting mix. Five different treatments (A, B, C, D & E) were then applied at 75mm thick to the surface in sets of 3. Another set (F) was filled to the brim with potting mix.

In part 2 of the trial the same process was followed except that two different mulches (G & H), were used at three different thicknesses, 50 mm, 75 mm and 100 mm. Once again set (F) was filled to the brim with potting mix.

In both parts of the trial the containers were initially watered to beyond field capacity, allowed to drain and then weighed at regular intervals and the weight loss compared. Each gramme (g) of weight loss is equivalent to a millilitre (mL) of water.

In part 1, two of the six treatments lost more water than the comparator (standard potting mix) and three lost less. All three that lost less were composed of large and irregular particles that held little, if any, water.

In part 2 Treatment G lost less water than H at all thicknesses. Treatment H lost most water when it was applied at the thinnest rate while treatment G lost most water when applied at the thickest rate.

Introduction

The trials were conducted to assess what properties are desirable in a surface mulch to minimise evaporative loss, and what effect varying thicknesses of mulch will have upon the extent of evaporative loss.

The trial was necessary because there were conflicting opinions about these matters.

Evaporative loss through various mulches was assessed by weight loss over time from a uniform surface area. The results indicate that the current definition of a Waterwise mulch I.e. "A mulch consisting of large, irregularly shaped particles that hold little, if any, water" is correct. They also indicate there is little advantage in spreading Waterwise mulches at greater than 75 mm thick.

Materials

Containers

Square tapered pots (Reko Patio Tub) 233 mm high by 233 mm by 233 mm with a surface area at 10 mm below the rim of 225mm by 225mm.

Containers weight approx 385 gm, capacity when full to brim approx 9.250L.

Soil mix

Amgrow Nu-erth general purpose potting mix made to AS 3743. It was chosen because it contained some sand.



Surface treatments (Mulches)

A Screened pine bark mulch. Large, coarse, brown irregularly shaped particles with low to moderate moisture holding capacity.

Labeled as: Pine bark Mulch

Instructions: Apply at 25mm to 50 mm or until area appears neat and well covered.

Claims made on packaging: Reduces weed growth, retains moisture and regulates soil temperature.

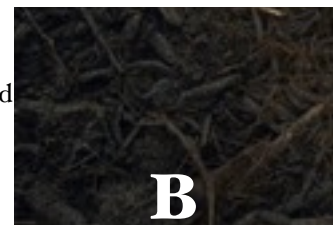


B Composted organic mix 1. Some larger particles but predominantly smaller particles and fines. The material had been treated with a wetting agent and displayed a high moisture holding capacity. Black in colour.

Labeled as: Organic Water Saving Mulch

Instructions: Spread at 75mm to 100 mm thick

Claims made on packaging: Saves 45% water, Smart Approved Watermark.



C Screened crushed granite with a particle size of 12-35 mm.

Labeled as: Not applicable

Instructions: None

Claims made on packaging: None



D Composted sugar cane mulch. Apart from a few foreign objects, almost entirely composed of fine fibrous material less than 1 mm in diameter and 5 mm long. The material had compacted in the bag and had to be broken up before application. It displayed a high moisture holding capacity. Black in colour.

Labeled as: Composted mulch

Instructions: Spread 2cm thick on established gardens, 5 cm thick on new gardens. Keep 2 cm from plants

Claims made on packaging: Suppresses weeds. Superior water retention.



E Aged tree prunings taken from a pile that had been standing for approximately 6 months. Mostly large coarse, brown, irregularly shaped particles with a small proportion of finer particles. Displayed low to moderate water holding capacity.

Labeled as: Not applicable

Instructions: None

Claims made on packaging: None



F Soil mix. These containers were filled to the brim with potting mix as a benchmark for comparison.



G Chipped Red Gum. Large, coarse particles with a low to moderate water holding capacity and very low proportion of fines. Colour brown and reddish orange indicating fresh material.

Labeled as: Red Gum Mulch

Instructions: Apply to a depth of 25 to 50mm or until area appears neat and well covered.

Claims made on packaging: Reduces weed growth, retains moisture and regulates soil temperature.



H Composted organic mix 2. Displayed a high moisture holding capacity. Dark brown to black in colour. Some large particles and a high proportion of fines.

Labeled as: Moisture Mulch

Instructions: Flower beds 10mm thick, Landscaping 100mm thick.

Claims made on packaging: Waterwise, Reduces evaporation. Smart Approved Watermark



Particle Size

Each treatment was hand sieved through an 8mm and 3.5mm sieve to gauge the proportions of fine, medium and coarse particles.

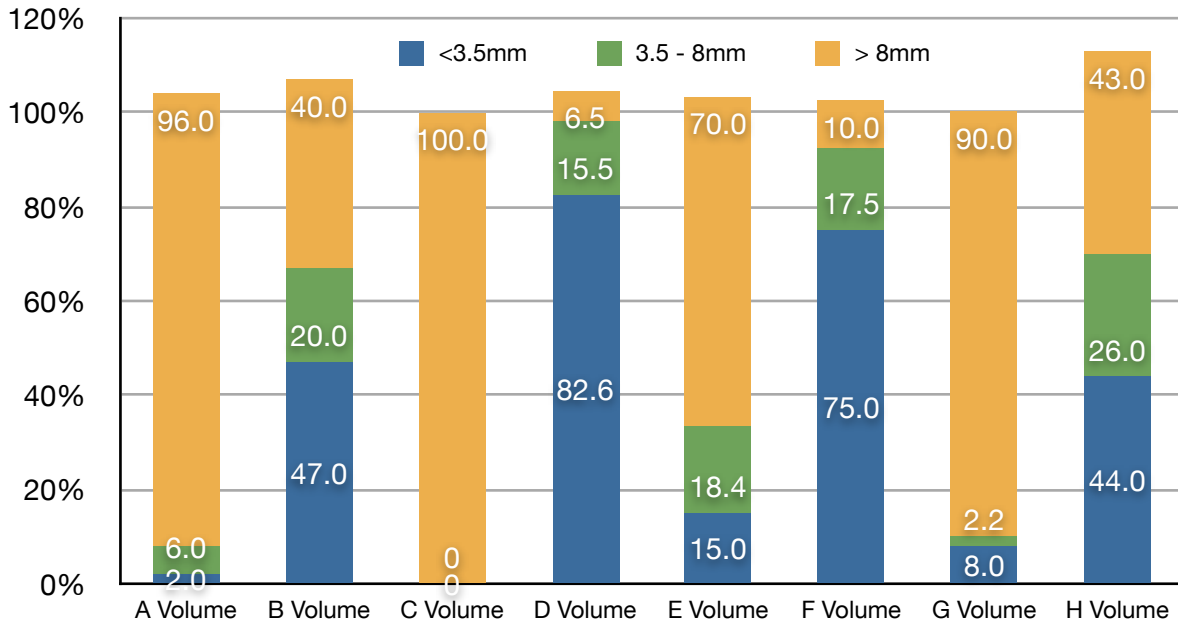


Figure 1 Approximate proportions by volume of size group

Method

Extra holes were drilled at the base of the containers to ensure adequate drainage before the first weighing. Bags of potting mix were mixed together to ensure uniformity.

Filling Part 1

Containers A to E were filled to a gross weight of 5,320g and dropped three times on to a hard surface from a height of 3cm to consolidate the mix to approx 5L, leveled off at 75mm below the rim. Containers F were filled to a gross weight of 7,215g and dropped three times on to a hard surface from a height of 3cm to consolidate the mix to level full, approx 9.250L.

Filling Part 2

Containers G11, G12, G13, H11, H12 & H13 were filled to a gross weight of 4,780g and dropped three times on to a hard surface from a height of 3cm to consolidate the mix to 50mm below the rim. Containers G21, G22, G23, H21, H22 & H23 were filled to a gross weight of 3,790g and dropped three times on to a hard surface from a height of 3cm to consolidate the mix to 75mm below the rim. Containers G31, G32, G33, H31, H32 & H33 were filled to a gross weight of 3,450g and dropped three times on to a hard surface from a height of 3cm to consolidate the mix to 100mm below the rim.

Parts 1 and 2

Buffer containers were filled to the rim with aged tree prunings but not weighed. Treatments were applied loose and leveled off to the top of the container. A wire mesh (1.3mm galvanized wire at 25mm spacing) was attached to cover the upper surface of the container to prevent wind dislodgment. Containers were placed out on a mesh frame in full sun in 3 rows, positioned as follows

Part 1

Buffer E3 F3 A3 B3 C3 D3 Buffer
 Buffer C2 D2 E2 F2 A2 B2 Buffer
 Buffer A1 B1 C1 D1 E1 F1 Buffer

Part 2

Buffer G11 H21 G31 F1 H11 G21 H31 Buffer
 Buffer H12 G22 H32 G12 H22 G32 F2 Buffer
 Buffer G13 H23 G33 F3 H13 G23 H33 Buffer



All were thoroughly watered by hand to beyond field capacity of mulch and soil combined at 0630 on Day 1
 All containers settled by approx. 10mm after the initial watering.
 The containers were first weighed at 0800 and then at regular intervals and the weight loss recorded.
 Scales weighed to the nearest 5g and were checked for accuracy before and after every weighing session against a known weight of 2,000g.

Observations

Elapsed Hours	0	5	10	24	29	34	48	53	58
Container									
A1	5255	5125	5055	5040	5010	4975	4980	4940	4910
A2	5250	5125	5080	5070	5040	5020	5025	4985	4965
A3	5430	5300	5240	5225	5195	5170	5170	5120	5085
Ave A	5312	5183	5125	5112	5082	5055	5058	5015	4987
B1	6415	6190	6095	6060	6020	5975	5965	5910	5865
B2	6240	6025	5945	5910	5880	5830	5825	5770	5735
B3	6225	6025	5945	5910	5875	5830	5825	5770	5725
Ave B	6293	6080	5995	5960	5925	5878	5872	5817	5775
C1	9565	9490	9460	9445	9435	9415	9405	9395	9370
C2	9525	9440	9420	9405	9400	9385	9375	9365	9340
C3	9385	9320	9290	9275	9265	9250	9240	9225	9200
Ave C	9492	9417	9390	9375	9367	9350	9340	9328	9303
D1	6335	6085	5940	5880	5810	5740	5720	5645	5580
D2	6220	5955	5820	5770	5705	5640	5620	5550	5495
D3	6365	6095	5950	5895	5830	5750	5735	5655	5595
Ave D	6307	6045	5903	5848	5782	5710	5692	5617	5557
E1	5275	5195	5150	5135	5115	5085	5090	5055	5025
E2	5105	4985	4950	4935	4915	4900	4900	4870	4855
E3	5395	5280	5220	5210	5185	5165	5170	5125	5095
Ave E	5258	5153	5107	5093	5072	5050	5053	5017	4992
F1	6730	6600	6530	6495	6465	6425	6415	6370	6325
F2	6770	6595	6530	6495	6465	6430	6420	6375	6340
F3	6785	6590	6510	6475	6445	6410	6400	6350	6320
Ave F	6762	6595	6523	6488	6458	6422	6412	6365	6328

Table 1: Observations (g) from Part 1 - Five different treatments at 75mm thick

Legend

- A1, A2 & A3 - Treatment A at 75mm depth
- B1, B2 & B3 - Treatment B at 75mm depth
- C1, C2 & C3 - Treatment C at 75mm depth
- D1, D2 & D3 - Treatment D at 75mm depth
- E1, E2 & E3 - Treatment E at 75mm depth
- F1, F2 & F3 - Soil mix no mulch

Elapsed Hours	0	5	10	24	29	34	48	53	58	72	82	106	130	154	168
Container															
G11	5915	5785	5725	5725	5685	5655	5655	5615	5585	5575	5510	5430	5360	5300	5285
G12	5880	5740	5690	5685	5655	5630	5635	5595	5575	5565	5510	5435	5370	5320	5305
G13	5795	5665	5620	5615	5580	5550	5545	5500	5480	5460	5385	5275	5190	5120	5105
Av G 50mm	5863	5730	5678	5675	5640	5612	5612	5570	5547	5533	5468	5380	5307	5247	5232
G21	5355	5230	5160	5155	5110	5075	5085	5035	4995	4990	4920	4850	4785	4735	4725
G22	5390	5280	5220	5220	5185	5155	5155	5110	5080	5070	5005	4910	4845	4795	4790
G23	5495	5375	5315	5310	5260	5235	5255	5165	5130	5110	5020	4900	4810	4755	4745
Av G 75mm	5413	5295	5232	5228	5185	5155	5165	5103	5068	5057	4982	4887	4813	4762	4753
G31	5275	5150	5060	5060	5010	4960	4965	4925	4880	4875	4805	4725	4665	4610	4600
G32	5230	5115	5050	5045	5005	4975	4970	4925	4895	4880	4805	4705	4635	4590	4585
G33	5310	5190	5120	5120	5075	5035	5030	4965	4930	4910	4805	4680	4595	4530	4530
Av G 100mm	5272	5152	5077	5075	5030	4990	4988	4938	4902	4888	4805	4703	4632	4577	4572
H11	6315	6085	5985	5970	5920	5880	5870	5815	5770	5755	5670	5570	5490	5410	5395
H12	6175	5945	5865	5850	5805	5765	5755	5705	5670	5650	5570	5470	5385	5315	5295
H13	6240	6030	5935	5920	5870	5825	5815	5760	5720	5700	5610	5495	5405	5325	5305
Av H 50mm	6243	6020	5928	5913	5865	5823	5813	5760	5720	5702	5617	5512	5427	5350	5332
H21	6145	5940	5845	5835	5785	5740	5730	5680	5640	5625	5540	5440	5360	5280	5260
H22	6175	5975	5890	5875	5825	5790	5780	5725	5690	5675	5595	5505	5425	5355	5340
H23	6465	6255	6165	6155	6105	6060	6055	5995	5960	5940	5850	5735	5640	5560	5545
Av H 75mm	6262	6057	5967	5955	5905	5863	5855	5800	5763	5747	5662	5560	5475	5398	5382
H31	6,195	5985	5895	5880	5830	5785	5755	5730	5695	5670	5595	5490	5410	5335	5315
H32	6,195	5985	5905	5890	5845	5800	5790	5745	5710	5690	5615	5525	5445	5380	5365
H33	6,270	6070	5985	5970	5925	5880	5875	5820	5785	5765	5685	5570	5480	5395	5390
Av H 100mm	6220	6013	5928	5913	5867	5822	5807	5765	5730	5708	5632	5528	5445	5370	5357
F1	6580	6345	6265	6250	6205	6165	6160	6110	6075	6060	5980	5885	5810	5740	5715
F2	6580	6340	6240	6230	6195	6155	6150	6105	6075	6060	5995	5905	5835	5770	5755
F3	6545	6315	6235	6220	6175	6135	6130	6080	6045	6025	5950	5885	5780	5710	5690
Av F	6568	6333	6247	6233	6192	6152	6147	6098	6065	6048	5975	5892	5808	5740	5720

Table 2: Observations from Part 2 - Two further mulches and three different thicknesses

Legend

- G11, G12 & G13 - Treatment G at 50mm depth
- G21, G22 & G23 - Treatment G at 75mm depth
- G31, G32 & G33 - Treatment G at 100mm depth
- H11, H12 & H13 - Treatment H at 50mm depth
- H21, H22 & H23 - Treatment H at 75mm depth
- H31, H32 & H33 - Treatment H at 100mm depth
- F1, F2 & F3 - Soil mix no mulch

	Min	Max T	Evap	Sun	Max Wind gus		Time	Observations at trial site
	°C	°C	mm	hrs	Dir	Spd	Local	
02/01/2011	18.7	40.3	12	12.5	E	50	830	Hot sunny windy day
03/01/2011	25.4	36.4	10.4	6.3	WSW	35	1533	Humid night. Humid partly cloudy and hot afternoon
04/01/2011	21.7	38.0	8.4	13.2	SSW	44	1541	Very humid night and a hot day

Table 3: Weather data from Perth Airport during Part 1

	Min	Max T	Evap	Sun	Max Wind gus		Time	Observations at trial site
	°C	°C	mm	hours	Dir	Spd	Local	
06/01/2011	18.5	25.9	5.4	11.8	WSW	39	1653	Rain overnight. partly cloudy morning clearing to a mostly sunny afternoon
07/01/2011	17.3	26.2	7.8	11.1	SW	46	1702	Cloudy still, humid night clearing to a fine day
08/01/2011	16.7	32.2	8.4	13	E	56	646	Sunny and hot day
09/01/2011	18.4	37.4	10.6	13.2	E	54	2355	Sunny and hot day
10/01/2011	22.5	36.5	13.8	13.2	E	63	206	Sunny and hot day
11/01/2011	18.3	35.2	13.2	13	E	65	632	Sunny and hot day
12/01/2011	19.4	37.2	14	13	E	54	453	Sunny and hot day
13/01/2011	20							Partly cloudy morning

Table 4: Weather data from Perth Airport during Part 2

* Evaporation is for the 24 hrs to 0900. The amount is therefore more relevant to the previous day's weight loss

Results

Do different mulches lose different amounts of water?

Figure 2 shows the accumulated total moisture loss in g over 58 hours from five different mulches applied at 75mm thick. There is a very significant difference between the mulches.

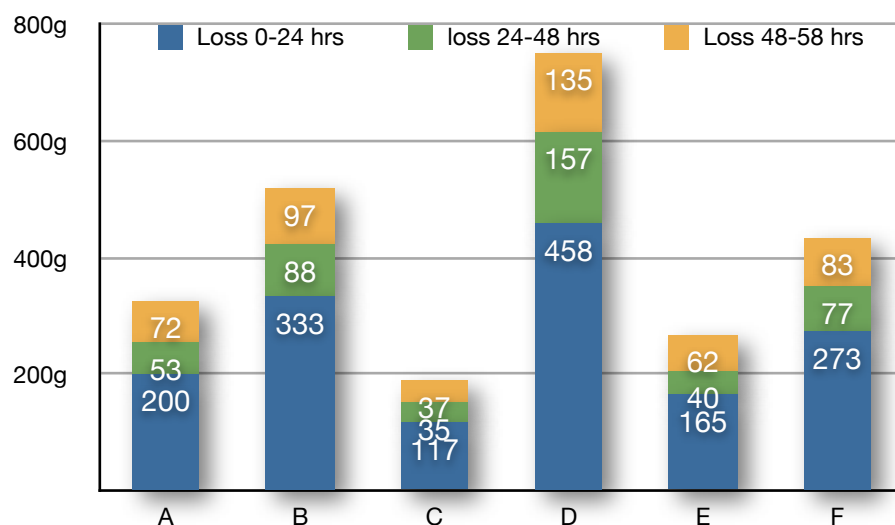


Figure 2 Accumulated weight loss (g) from 75mm thick mulch over 58 hrs Part 1

Range 433g to 750g

Figure 3 shows the same data presented as a %age of the moisture lost from F which was the unmulched surface. The worst mulch lost 73% more than the bare potting mix and the best lost 57% less.

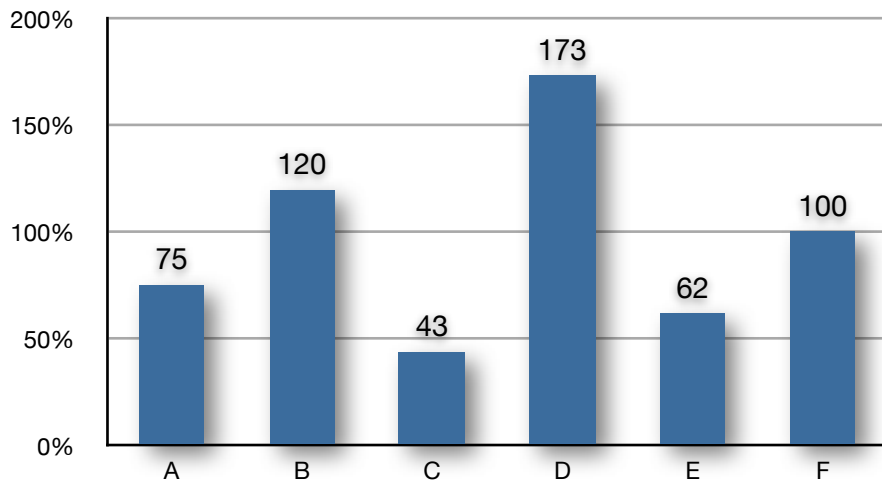


Figure 3 Average weight loss (g) over 58 hrs as a %age of F (unmulched) Part 1
Range 43% to 173%

Figure 4 presents the same information shown as mm of water using a conversion factor of 0.0178 to convert g of weight loss into mm depth of water. The worst mulch lost the equivalent of 13.4mm. The recommended Standard Drink (SD) for improved sandy soil in Perth is 10mm indicating that this mulch would absorb all 10mm and then lose it all again. None would have reached the root zone in the soil. The best performing mulch lost only 3.4mm leaving the remainder of the SD available to plants for transpiration.

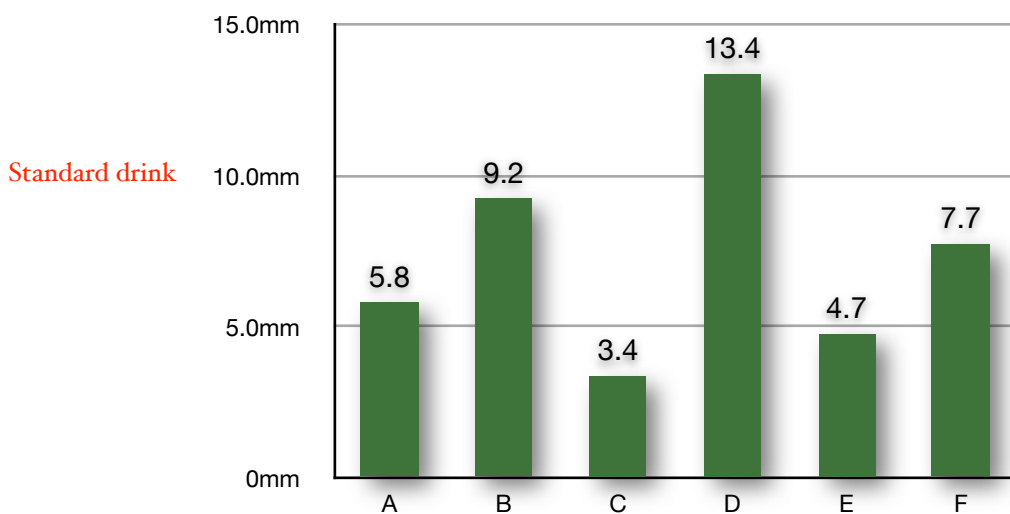


Figure 4 Average weight loss over 58 hours expressed as mm of water Part 1
Range 3.4mm to 13.4mm

Figure 5 compares moisture loss from seven treatments as a %age of the unmulched potting mix. Even though treatment F was a common factor, bearing in mind the varying weather conditions between Part 1 and 2, the comparison between mulches A B C D & E and mulches G & H may not be too reliable.

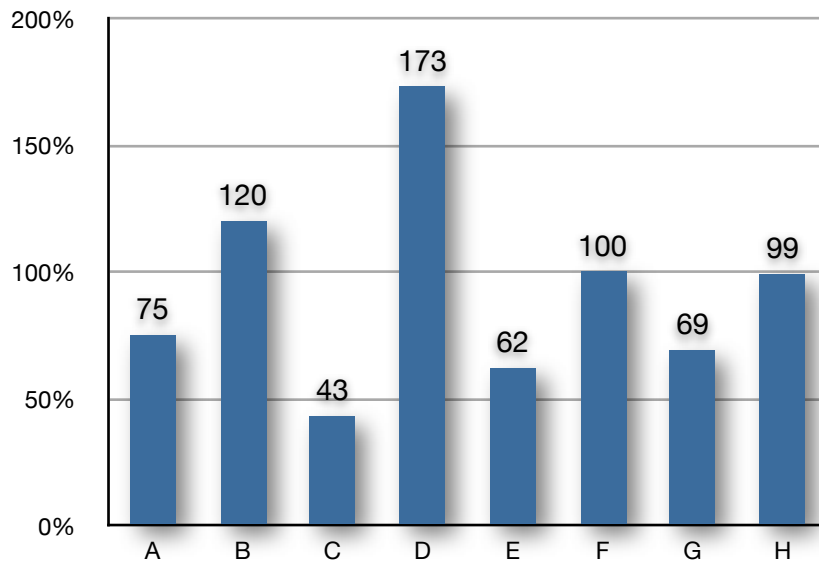


Figure 5 Average weight loss (g) over 58 hrs as a %age of F (unmulched) Parts 1 & 2
Range 43% to 173%

Does the texture of the material affect moisture loss?

Figure 6 compares the weight loss against the proportion of fine particles. A strong correlation between particle size and weight loss is evident.

Factors that determine the extent of weight (moisture) loss are

- 1 Prevailing weather conditions summarised in Tables 3 & 4
- 2 The moisture holding capacity of the mulch material. This was assessed by eye but not measured and should be tested in future trials.
- 3 The ability of the material to re-wet and take up moisture once it has dried out. This was not measured in this trial.
- 4 The capillarity of the material. Capillarity redistributes moisture already absorbed by the material. When the surface dries, materials with a high or strong capillarity will bring more moisture to the surface. A high capillarity is desirable in potting mixes but not in water saving mulches. Capillarity was not measured in this trial.

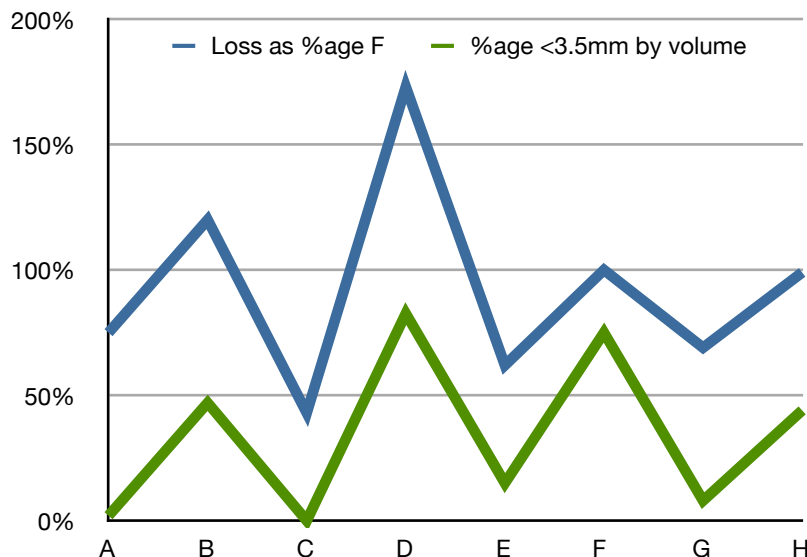


Figure 6 Relationship between particle size and weight loss Parts 1 & 2

What effect does the frequency of watering have?

Figures 2 and 7 show that the highest rate of moisture loss occurs immediately after watering. Therefore, the shorter the watering interval, the greater the proportion of water lost. It was intended to run part 1 of this trial over 96 hours to allow calculations to be made on twice a week watering. Unfortunately it had to be concluded after 58 hours due to rain. Part 2 was run over 168 hours (a week).

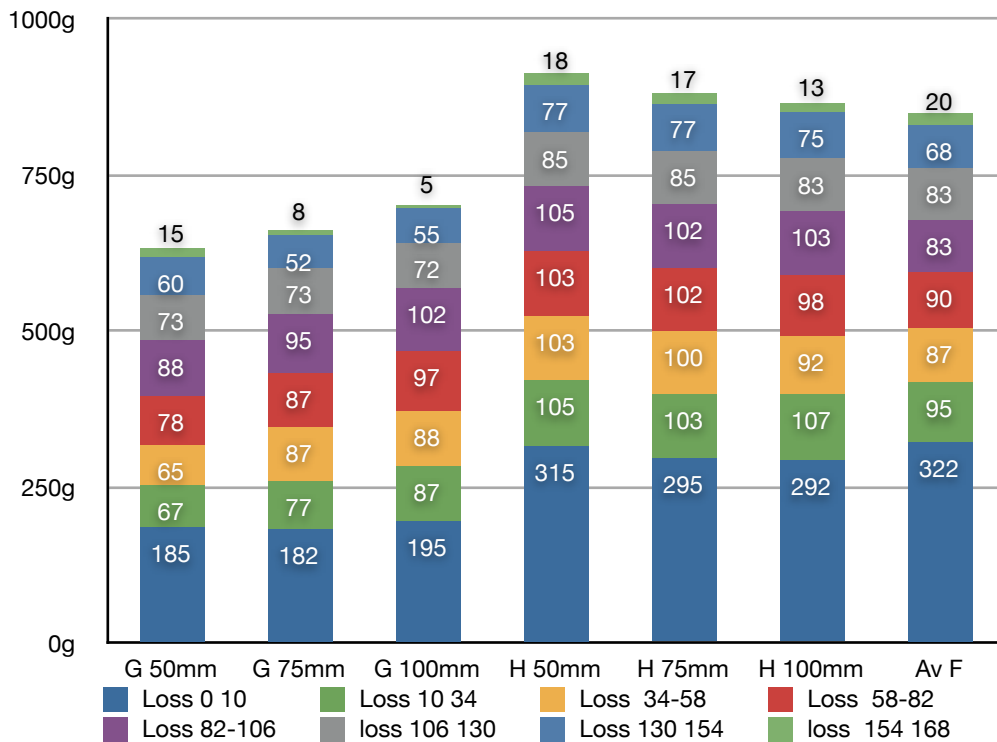


Figure 7 Accumulated weight loss (g) from three different depths of two mulch treatments over 168 hours Part 2

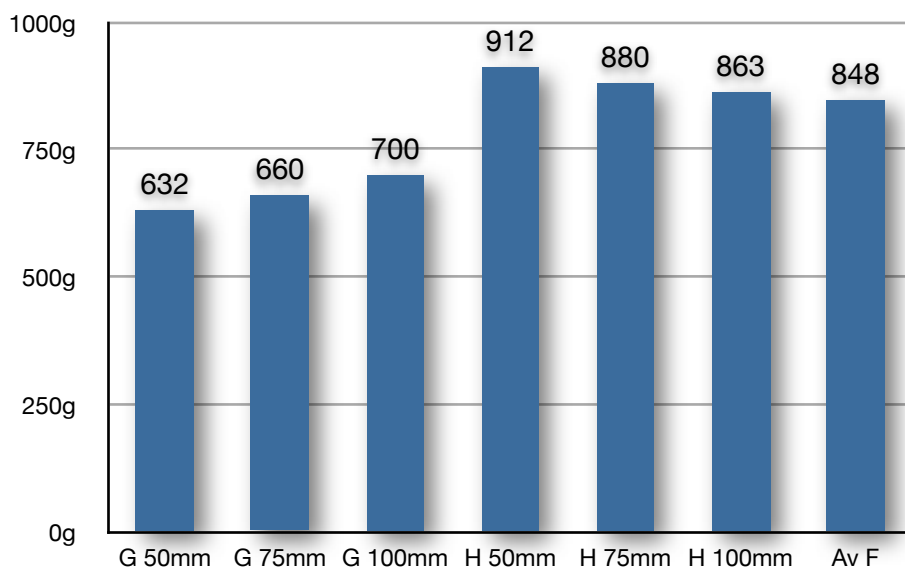


Figure 8 Total weight loss (g) from three different depths of two mulch treatments over 168 hours Part 2

What effect does the thickness of mulch have?

Figures 7 and 8 show an interesting pattern that makes it difficult to reach a clear conclusion on the data. However, the following consistent trends can be observed.

- 1 Loss in treatment G is less at all thicknesses than treatment H
- 2 All thicknesses of treatment H lose more water than the treatment F (unmulched).
- 3 Loss in Treatment G is greatest when the mulch is thickest.
- 4 Loss in treatment H shows a slight reduction when it is applied at the thicker level

While this variation in moisture loss between the different depths of mulch may be interesting and worthy of further research, it does not affect the significant overall differences between the two mulches (Figure 5). Since mulch G loses less moisture at the thinner rates, and is the more 'Waterwise' of the two, it seems reasonable to continue to recommend that 'Waterwise' mulches should be spread at 50-75mm thick.

Discussion

Results of this trial show considerable variation in performance between mulches and highlight the significant differences between the properties required for a Waterwise mulch and a soil improver. It should be noted that even though AS 4454 is applied to both composts and mulches, it does not have relevance to water saving ability when the material is used as a mulch.

Factors that appear to determine the potential for moisture loss through a mulch are

- Depth of mulch
- Water absorbing capacity
- Capillarity and
- Watering regime

Factors that appear to determine the rate of moisture loss through a mulch are

- Moisture level
- Capillarity and
- Prevailing weather conditions

What effect will the amount of applied water have?

Since mulches with very low absorption allow most of the water to pass through to the soil, changing the amount of applied water is likely to make little difference.

However, mulches with a high absorption rate will not allow water to enter the soil until the mulch itself is saturated. If it takes more than 10 mm of water (the standard drink for an improved sandy soil) to saturate the mulch, none will enter the root zone. In essence the thicker the mulch, the more water will be absorbed.

What effects will the method of watering have?

This trial was based on an imitation of overhead watering. It is known that water loss is reduced when water is delivered at the soil surface through an integrated dripper system. Integrated dripper pipe is usually laid on the soil surface and covered with a mulch. It is reasonable to assume that if the mulch has a high capillarity and absorption, then some water will be drawn towards the surface and lost through evaporation. The greatest savings using an integrated dripper system are likely to occur when the covering mulch has very low capillarity and absorption.

What effects will wetting agents have?

Wetting agents are likely to have different effects according to the type of mulch material.

When used on mulches with a high level of organic fines (B, D & H) it is most likely that wetting agents will allow the mulch material to absorb a greater quantity of water and thus increase the potential for moisture loss. When used on mulches with a low proportion of fines (A, E & G), wetting agents are likely to mostly pass through and increase the ability of the soil to absorb water. When used on mulches that hold no water at all (C), wetting agents will provide maximum benefit to the soil below.

Conclusion

- 1 Not all mulches save water. The difference between the best performing mulch and the worst is very significant.
- 2 In order for a mulch to save water it should consist of large, irregularly shaped particles that hold little, if any, water.
- 3 Labeling of mulch products needs to be improved. Many mulches claim or hint at an ability to save water, even though some hardly save any at all, and others actually waste more water than bare soil.
- 4 'Waterwise' mulches should be applied at 50-75mm thick.
- 5 Non waterwise mulches should not be promoted.
- 6 Further research needs to be conducted.

Recommendations

- 1 That a formal independent research project be carried out by a Post Doctoral Researcher, Masters by Research or PhD student as appropriate to the final scope, budget and time frame. Further investigation is needed into
 - a wider range of mulches over a longer period,
 - moisture holding capacities,
 - the abilities of mulches to re-wet or become hydrophobic,
 - capillarity and
 - the effect of colour on surface temperature and evaporative loss.
- 2 That Australian Standards be encouraged to develop a protocol/standard that can be applied to ensure a product sold as a Waterwise or water saving mulch does save a significant amount of water.

John Colwill
January 2011 Perth, Western Australia
john@plantsman.com.au
www.plantsman.com.au

This pilot trial was not sponsored by any product or manufacturer. It was carried out by, and at the expense of, John Colwill in the interests of providing accurate and reliable information to support sustainable gardening in Western Australia. This report may be freely reproduced providing the author's rights are acknowledged. Queries should be directed to john@plantsman.com.au

