



# **ENVIRONMENTAL SCIENCE AND TECHNOLOGY**

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## **PROCEEDINGS**

## MULCHING IMPACT ON SOIL MOISTURE CONSERVATION IN URBAN SOIL



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**Abstract:** Applying mulch to soil has several benefits including soil moisture conservation, fertility and health improvement of the soil, reducing weed growth and enhancing the visual appeal of the area. In this study, four mulch (organic mulch - straw, leaf; inorganic mulch - sand, gravel) treatments were tested for their ability to control moisture on Technosol. We have measured soil moisture at 5cm, 10cm, 20cm and 25cm depths for 3 months. Soil moisture content determined by the gravimetric method in the laboratory. Soil moisture was significantly higher in soil with organic mulch than those with inorganic mulch for the same positions. The most significant soil moisture loss occurred in the soil with sand mulch. On the contrary, leaf mulch has the highest soil moisture storage capacity compare to other 3 mulches. Under the leaf mulch, average soil moisture was 8.9%, 8.1%, and 12.7% at 5 cm, 10 cm, and 20 cm, respectively during experiment time.

**Keywords:** Mulch, soil moisture, conservation moisture, organic mulch, inorganic mulch,

### Introduction

Soil moisture is an important component of the Earth system (Koster et al., 2004) and strongly impacts water, carbon and energy exchange between the atmosphere and land surface (Gallego-Elvira et al., 2016). The main source of water for ecosystem evapotranspiration, and compared with precipitation, it is more closely associated with vegetation growth and ecosystem carbon dynamics (Chen et al., 2014). Soil moisture is biologically important and greatly influences biogeochemical cycles (Seneviratne et al., 2010). Moisture in soils is a key factor in decomposing soil organic carbon by soil microorganisms (Christ and David, 1996), and carbon sequestration is moisture dependent (Lamparter et al., 2009). The availability of soil water is one of the main factors affecting plant growth and development. Conversely, plant cover influences soil water conditions by affecting the evapotranspiration component of the soil water balance (Baumgartner, 1967). Reasons for applying mulch include conser-

vation of soil moisture, improving fertility and health of the soil, reducing weed growth and enhancing the visual appeal of the area. In horticulture plantation, both organic mulch and inorganic mulch have been into common use (George Hochmuth et al, 2002). Use of gravel-sand mulch changes the hydrological process and improves soil productivity, which is effective in reducing evaporation and runoff, improving infiltration and soil temperature, checking wind and water erosion as well as enhancing biological activity and soil fertility (Xiao Yang Li, 2003) Specifically, in this unstable climate and global warming condition, mulch is utilized to help plants adapt to climate change by modifying microclimate around the growing plants (Dvořák et al, 2001). Some previous studies have found that mulch usage increases plant productivity (Siwek et al, 2007). According to the Colorado State University, using mulch reduces evaporation of water from the soil, and can reduce irrigation needs by up to 50% (Neibauer & Waskom, 2004). The application of mulch can be classified as an ef-

-fective soil conservation practice (Smets et al., 2007).

Many materials are used as mulches, which are used to retain soil moisture, regulate soil temperature, suppress weed growth, and for aesthetics. They are applied at various times of the year depending on the purpose. Mulch forms a layer between the soil and the atmosphere preventing sunlight from reaching the soil surface, thus reducing evaporation. However, mulch can also prevent water from reaching the soil by absorbing or blocking water from light rains. The main aim of this research was to investigate the effectiveness of various mulch types in conserving soil moisture.

### Method

We used inorganic mulch (sand and stone), organic mulch (straw and leaf) cover for the soil. This study was established in gravelly, sandy urban soil (*Technosol*) in Ulaanbaatar Mongolia. The study was conducted in to choose 1m<sup>2</sup> area in different land cover types and to covered by sand, straw, gravel, and leaf. Also, uncovered area was chosen as control site. We used gravimetric method to determine soil moisture.

Gravimetric method: One of the most common methods of soil water content determination is a gravimetric method with oven drying (Black, 1965). This method covers the laboratory of the moisture content of the soil as a percentage of its oven-dried weight in Equation 1.

$$S_{water} = \frac{S_{wet} - S_{dry}}{S_{dry}} * 100 \quad (1)$$

S water - Soil water content (%), S wet - Weight of wet soil (g), S dry - Weight of dry soil (g)

The criterion for a dry soil sample is the difference that has been dried to constant weight in the oven at a temperature between 105°C.

The measurement was installed at different depth of each study site at 5cm, 10cm, 20cm and 25cm in every 10 days for 3 months.

### Result

Results from this research show that the moisture infiltration was higher at leaf mulched soil, compared to other mulch and uncovered field. In addition, organic mulches, specifically dry leaf was the most effective type of mulch for soil moisture conservation in hot summer conditions. The maximum soil moisture was 18.4-22.0% at 0-25 cm of mulched soil in July, when had the highest precipitation. The maximum soil moisture was 25.8% at 0-25 cm at the control site (Figure 1).

#### Control site

Soil moisture dynamic is a lot of dependent on precipitation. After precipitation, soil moisture of control site was higher than mulched soil. However, soil moisture evaporated quickly for short term. After many days rain, moisture infiltrates to 25 cm depth. But, in short term rain, moisture could not infiltrate to the depth because it was evaporated quickly. The average content of soil moisture ranges of from 7.6 to 8.9% at 0-25cm of soil in July. The maximum soil moisture content of control site soil was 25.8% in the depth of 5 cm, in the depth of 10 cm was 21.5% and in the depth of 25 cm was 17.6%. But minimum soil moisture content was 0.1-4.1% in August.

#### Leaf mulch

Tree leaf conserves moisture, modifies temperatures and prevents soil erosion and crusting. In time bacteria, fungi and other naturally occurring organisms

decompose or compost the leaf and other organic material, supplying the existing plants with a natural, slow-release form of nutrients. Conservation of soil moisture of leaf mulching was 23.1% higher in the depth of 5cm, in the depth of 10cm was 22.2 % higher, and in the depth of 20 cm was 60.6 % higher than compared with the control site.

**Straw mulch**

Straw mulch is typically made from the stems of grains. The mulch helps to hold in moisture and it composts into nutrient and amendments for the soil. Soil moisture infiltrated deep into the soil and evaporate slowly influence of straw mulch. For example, it did not rain and during 14 sunny days (from 19th August to 3rd September). Straw mulch keeps soil moisture more than inorganic soil mulches. Soil mulched by straw was 2-4% moisture in 5 cm, but control site soil was 2%. Also, soil mulched by straw was 8% moisture in 10 cm, but control site soil was 4%.

**Sand mulch**

The arid climate of some country use of the traditional farming practices for soil and water conservation, including the use of sand mulch. The soil moisture content ranges from 3.4 to 20.1% at 0-25 cm of soil. Conservation of soil moisture of sand mulching was 10.7 % higher in the depth of 5cm, in the depth of 10cm was 13.1 % higher, and in the depth of 20 cm was 27.7 % higher than compared with the control site.

**Gravel mulch**

It helps to reduce erosion and prevents water loss also provide a more balanced soil temperature. The soil covered with gravel mulch is able to adsorb the rainwater into the deep of the soil. Gravel mulch soil was conserved 14.1-32.5% more than the control site.

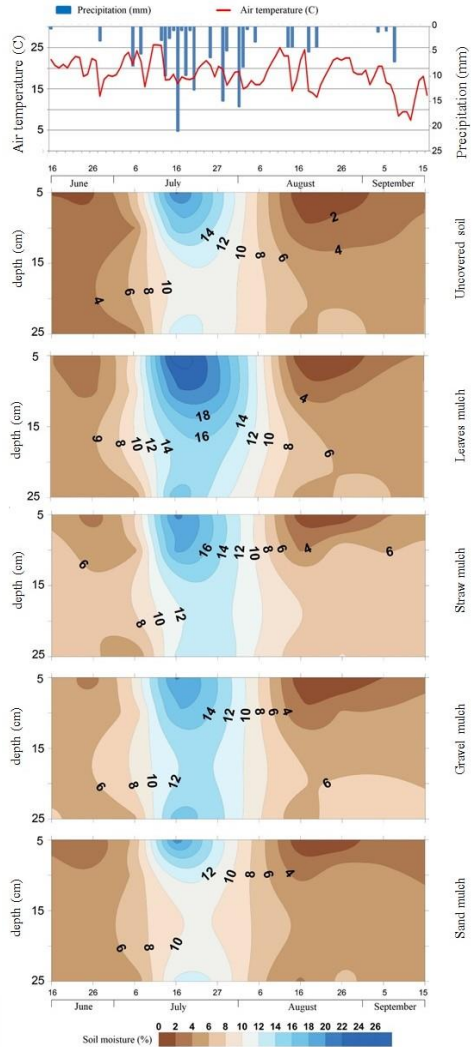


Figure 1. Each mulch moisture dynamic during summer time

Average soil moisture was 7.9%, 9.9%, 6.3%, 8.1% and 8.2% at every depth under straw mulch, leaf mulch, sand mulch, gravel mulch and control site, respectively between June and September. Soil moisture fluctuated greatly (SD= 6.5%) at every site, also the greatest soil moisture was measured in July because of high precipitation.

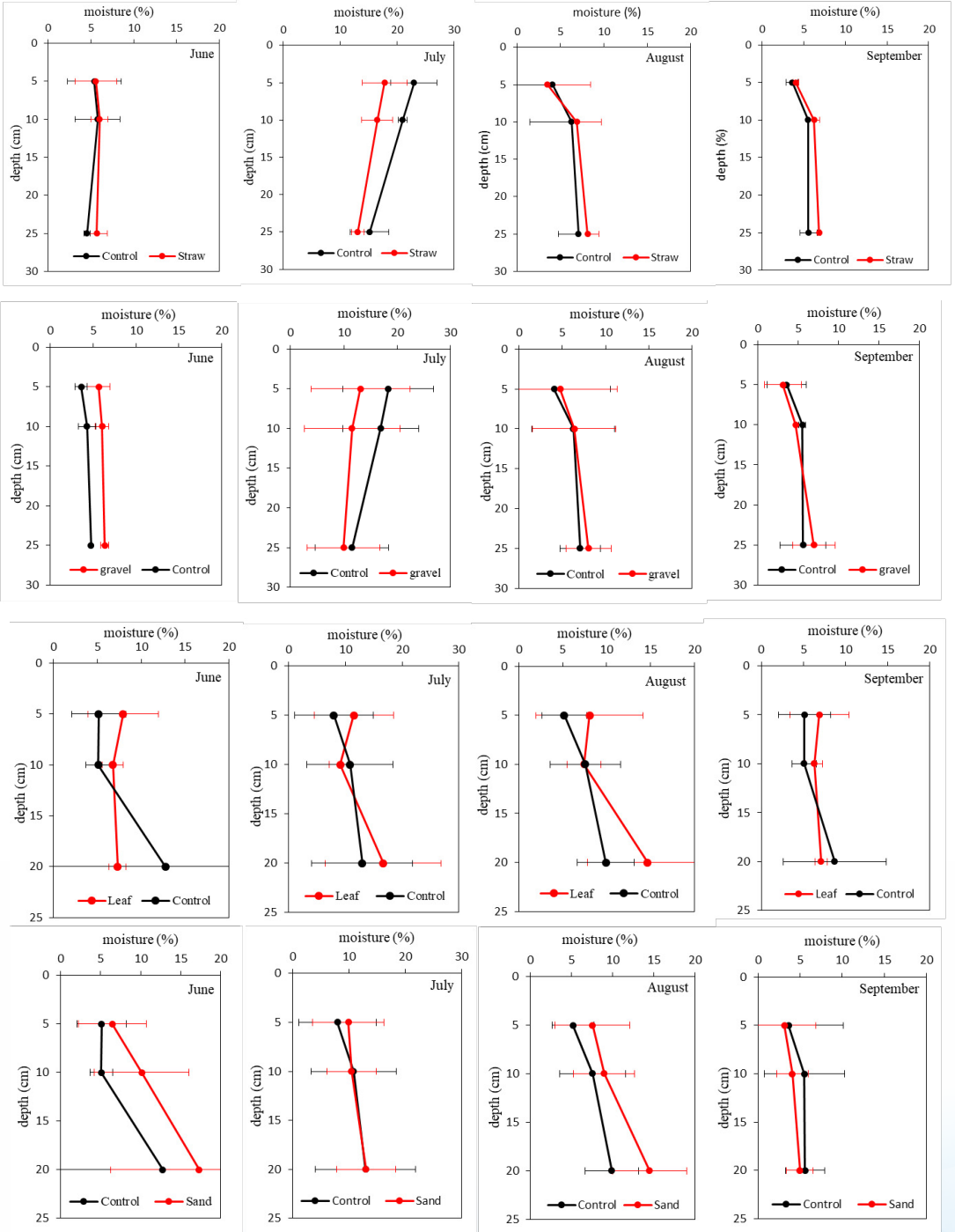


Figure 2. The average soil moisture content and standard deviation each months in summer time. b). comparison of straw mulch and control site-uncovered b). Comparison of leaf mulch and control site-uncovered c). Comparison of gravel and control site-uncovered d). Comparison of sand mulch and control site-uncovered The highest moisture of both 5 cm and 10 cm occurred at control site (8.1 and 8.9%, respectively), but at 25 cm depth, the highest moisture measured under leaf mulch (12.7%) in July. This shows that moisture can penetrate deeper under leaf mulch than other types of mulches. Whereas, in September, all sites had the least soil moisture ranging from 3.2-7.5% at every depth (Figure 2).

### Discussion

These 4 different mulches are strongly affected soil moisture dynamic and leaf mulch and straw mulch can be saved moisture in the long term. Also soil protection cover can be reducing soil redistribution rate. Soil protection cover have been affecting soil temperature and soil temperature dynamics was stable under the residual and other cover types (Brady & Weil, 2000).

There are methods has been developed to improve the soil moisture content and to use sand to make mulch is more used in the field. Our previous result has shown the sand mulch impact has lower than other mulch on moisture in the soil profile. But sand mulch has useful in rehabilitation and gardening in the city has been reduced the weeds by 50% in a field experiment (Bolormaa & Byambaa, 2016). It's also to affect the soil temperature and soil temperature in 10 cm depth has warmer than control soil and its suitable condition to seeding.

Our result has been suggested that do not remove the leaf in street and in other hands to use the cover of soil until the spring with snowing. This cover has more affected soil quality and environment and such us to increase soil moisture content, to reduce soil particle removed by wind and decrease the air pollution in the dry period of spring.

### Conclusion

Our experiment has shown to use organic and inorganic mulch for soil, which is

more useful to reduce soil erosion, land degradation, and reclamation. The soil protections mulch has directly affected to decrease runoff for soil erosion and it was directly connected with vegetation cover. This research confirmed the effectiveness of the organic and inorganic mulch as a conservation practice.

Results from field studies and laboratory experiments showed that conservation of soil moisture in mulched soils was higher (sand mulch was 1.2 times higher, gravel mulch was 1.5 times higher, straw mulch was 2 times higher, leaf mulch was 3 times higher ) when compared to uncovered soils. According to the research, this organic mulch sheet is cheaper in price more practical and effective in usage, using simpler technology, environmentally friendly, and in long-term increases soil fertility and soil moisture.

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