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"The Art of Mulching" Nature's Natural Water Saver

Use of Mulch for Controlling Evaporation and Conservation of Irrigation Water

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ABSTRACT

Agriculture is strongly influenced by weather and climate. Due to high temperatures and dry weather conditions for nearly eight months in a year, the annual evaporation rate in Kuwait is in excess of 4,000 mm as against the annual precipitation of 110 mm. In arid regions like Kuwait, where water resources are limited and regulated, there should be continuous efforts to conserve water and improve irrigation efficiency in agriculture. Soil of Kuwait is sandy in texture with high amounts of calcareous materials, little organic matter, insufficient plant nutrients and poor moisture holding capacity to support plant growth and development. Therefore, the surface mulch which is known to regulate soil temperature, prevent water loss by evaporation, improve soil fertility reduce salinity and improve soil health will have several functions under arid climate of Kuwait. Thus, two experiments were conducted to examine the use of mulch to control evaporation and reduce moisture loss from the soil. The results of the first study indicated that use of mulch reduced the evaporation rate of soil by **26.91%.**The results of the second study indicated that all the examined mulches were effective in conserving soil water, compared to control. Date palm residue mulch reduced the soil temperature by (**8.84%)**, whereas the gravel mulch increased the temperatureby**4.01%.** This study clearly demonstrated the benefits of locally available organic mulches in controlling evaporation and conserving irrigation water.

Keywords: soil moisture, soil temperature, water conservation, arid, agriculture

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INTRODUCTION

Kuwait is a hyper-arid country with extremely hot dry summer (average daily maximum temperature and relative humidity during June - August around 46^0C and <15%, respectively) and moderate winter (average daily maximum temperature and relative humidity during January is 8^0C and 60%, respectively) seasons. The rainfall is scarce, averaging about 115mm/y, unevenly distributed between October and April. In contrast, the annual evaporation of over 4,000 mm which is increasing @ 13.6 mm/year (Roderick et al. 2009). In recent years, Kuwait has experienced increased intensity and frequency of extreme weather events such as prolonged drought, severe dust storms and heat waves (Ramadan, 2010). The country has witnessed below average total amount of precipitation received in the past five years (average ≈ 40 $mm.yr^{-1}$)has been below the normal range. Under these conditions, plant production is not possible without adopting measures that will conserve water and other resources (Bhat et al., 2006; 2011; O'Connel and Snyder, 1999; Bhatt and Khera, 2006). These measures include minimizing the evaporation from soil surface, transpiration from plants, surface run-off or deep percolation of applied water or rain. The most effective way to reduce evaporation is to reduce exposure of wet soil to the atmosphere by covering the soil with a suitable material. Mulch is any material placed on the soil surface to conserve moisture, lower soil temperatures around plant roots, prevent erosion and reduce weed growth. Mulches can be derived from either organic (straw, conocarpus trimmings, grass, wood chips, compost) or inorganic materials (gravels, plastic) (Terasaki et al., 2008; McMillen, 2013). Natural mulch consists of dead leaves, twigs, fallen branches and other plant debris used to cover the earth's surface. Bacteria, fungi and other living organisms use these raw organic materials for food and release valuable nutrients into the soil solution. In the natural scheme of things, decay is nature's way of returning to the earth the raw materials borrowed by previous generations of plants. Organic mulches not only conserve moisture, they also feed plants, earth worms, microbes and other beneficial soil life by composting at the moist earth surface.

Our team conducted site visits to the farms in Wafra area located to the south of Kuwait city. Objective of the visit was to understand the methods of cultivation used, preparation of land for cultivation, methods adopted for protection of plants, irrigation methods used, the sources of water, fertilizers used, the seasonal crops which are cultivated. It was observed that crops are grown in green houses, as well as in open areas using drip irrigation. Mulching is not practiced in agricultural activities of Kuwait. We could understand that the most valuable resource required for cultivation is water and the need is met by expensive desalinated water. Bore wells cater to the additional need of water for irrigation. The bore well is salty and cannot be directly used for irrigation. A Reverse Osmosis (RO) unit is installed to desalinate water before using it in irrigation. The plants are watered frequently, fertilizers are added and appropriate pest control measures are carried out. The main crops that are cultivated in the greenhouses are cucumber, string beans, eggplant, sweet and tomatoes. Bitter gourd, snake gourd, cauliflower, cabbage,

pumpkin, mint, etc. are grown in open areas. Hence we decided to minimize the consumption of water by using the practice of mulching. Additionally, the green waste remained after cultivation can be recycled as mulching material, thereby putting it to good use. Experiments were conducted to determine the effects of different mulches on the evaporation rate, soil moisture and soil temperature.

OBJECTIVES

1. To determine the influence of mulch on evaporation loss from the soil.

2. To assess the influence of different mulches on soil moisture & soil temperature.

NULL HYPOTHESIS

Practice of mulching will not have any effects on the rate of evaporation, leading to reduction in water loss from soil surface.

STATEMENT AND RELEVANCE

The purpose of this experiment was to show the use of mulch in arid areas for reducing water consumption, decreasing soil temperature and enhancing water retention capacity of the soil.

SCIENTIFIC CONCEPTS AND PRINCIPLES RELATED TO THE PROJECT

1) **Mulch-** It is a layer of material which is applied to the surface of the soil as a covering to retain moisture in the soil e.g. Crop waste, grass clippings, leaves, saw dust, straw, date palm chips), usedpaper, gravel, plastic film etc.

2) **Evaporation-*(E)*** The process of changing water into vapor.

3) **Container capacity-** It is the amount of water the soil in a pot can hold after excess water has drained out.

4) **Gravimetric method-**. Determination of moisture content of soil by weighing.

METHODOLOGY

I. Evaporation study

Materials used:

1) Weighing scale
2) Pots with uniform weight of soil
3) Date palm residue
4) Same amount of water

Procedure:

1. Take 6 pots of same size with the same amount of soil.
2. Label the 3 pots as, M_1, M_2 and M_3 (M - Mulched).
3. Label the 3 remaining pots as C_1, C_2 and C_3(C- Control/un-mulched pot).
4. Place a 5 cm layer of date palm mulch (produced from ground leaves, trunks and roots of date palm) on the soil surface of pots M_1, M_2 and M_3.
5. Water each plant at 6.00 am every day for a week.
6. Allow the excess water to drain from the pots for 10 minutes. This makes the soil in each Pot reach "container capacity"
7. Weigh the pots and record the initial weight (W_1grams).
8. Place the pots outdoors.
9. Weigh the pots daily for a week and record the final weight (W_2 grams).
10. Calculate the percentage change in the daily evaporation (D.E) due to mulch, using the formula:

$$\frac{(\textbf{Average D.E for Control pots} - \textbf{Average D.E for Mulched pot}) \times 100}{(\textbf{Average D.E for Controlled pots})} = \%\textbf{changeinD.Edue to Mulch}$$

II.Soil water retention study

Materials used:

1. Soil collected from farm
2. Mulches

Organic mulches	**Inorganic mulches**
Date Palm residue (D.P)	Gravel (G.R)
Conocarpus trimmings (C)	Recycled glass (R.G)

3. Laboratory Balance
4. Thermometer
5. Measuring cylinder
6. Distilled water &desalinated water
7. Artificial Sun Lamp

Procedure:

1. Add the same weight of soil to all 16 pots.
2. For first replication of each treatment, add mulch to 5cm depth.
3. Remove the mulch layer, weigh and replace it.
4. Fill the other 2 replications with a mulch layer of equal weight and depth.
5. Add the same amount of water to all pots.
6. Allow the water to percolate through the soil.
7. Place all pots under an artificial sun lamp.
8. Record the soil temperature daily with the help of a thermometer.
9. Determine the soil moisture in laboratory on the 2^{nd}, 4^{th} and 6^{th} day.
10. Tabulate the results.

DATA ANALYSIS

After all data was collected, the water loss for each experimental unit at each sampling was divided by the weight of the saturated soil to obtain percentage water loss. The data was tabulated and analyzed using Microsoft Excel to observe the gradation.

RESULTS AND DISCUSSION

According to **Experiment I,** the mulched soil showed less evaporation rate than unmulched soil. Average Daily evaporation for mulched pots was observed to be **26.91%** less than that 0f control pots (Fig1).All the Mulches used improved the water retention capacity of the soil (Fig2).Organic mulches reduced soil temperature. The maximum decrease was observed in date palm residue (**8.84%**). (Fig.3). Inorganic mulch (gravel)increased the soil temperature by **4.04%.**

Table 1: Average Daily evaporation of Mulched Soil and Unmulched Soil.

	Average Daily Evaporation (ml)	
Pot no	**Control Pot (C)**	**Mulched Pot(M)**
1	17.86	13.29
2	18.86	14.14
3	20.14	14.14
Average	**18.95 ml**	**13.85 ml**
Percentage of Change= 26.91%		

Figure 1. Shows the daily evaporation of Mulched soil and Unmulched soil.

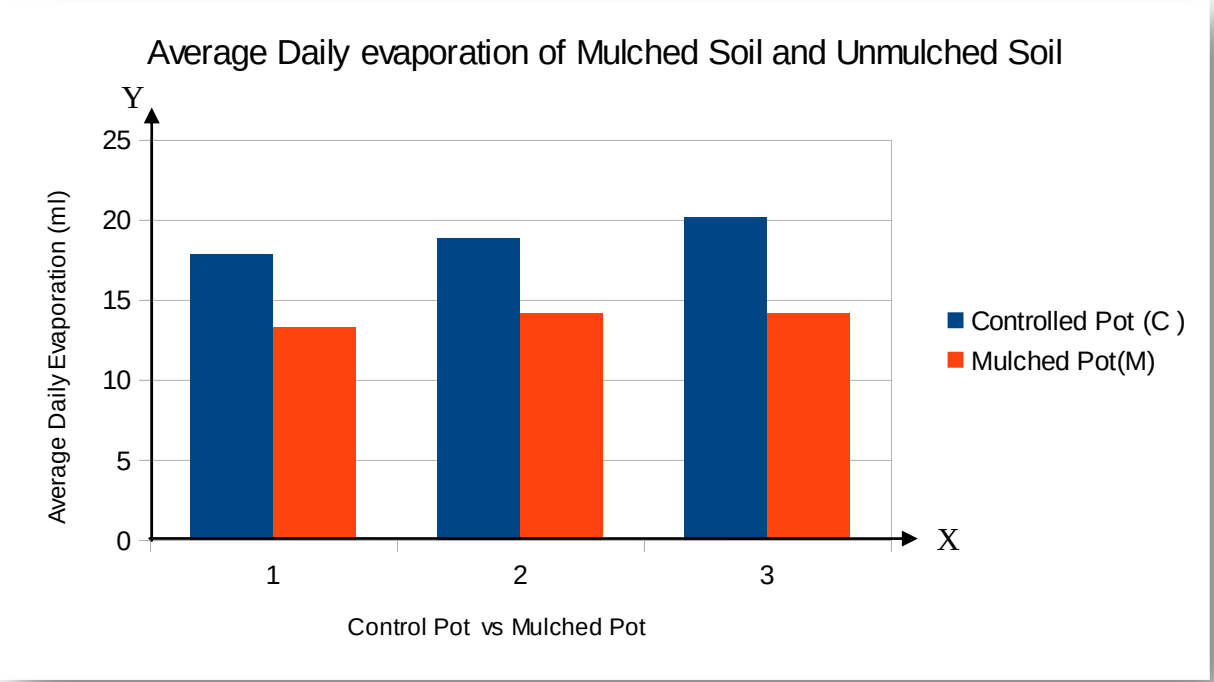

Table 2: Soil moisture % and Soil temperature using various mulches

Mulch	**Average of Moisture (%)**			**Temperature (^{o} C)**		
	Day 2	Day 4	Day 6	Day 2	Day 4	Day 6
Date Palm(D.P)	16.4	14.3	11.2	22.8	22.7	22.7
***Conocarpus* (C)**	14.9	12.3	9.2	23.1	23.8	23.4
Gravel (G)	15.6	13.7	11.0	25.7	25.5	25.9

Recycled Glass(R.G)	14.3	12.6	9.7	25.4	25.3	25.6
Control Pot(C.P)	11.9	9.3	6.4	24.8	24.9	24.9

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Fig 2 the influence of Different mulches on Soil Moisture

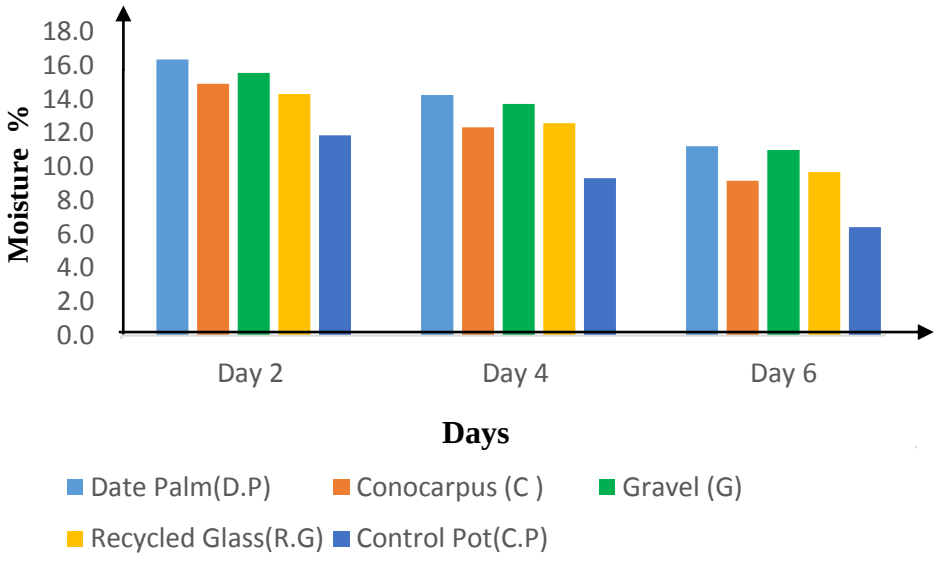
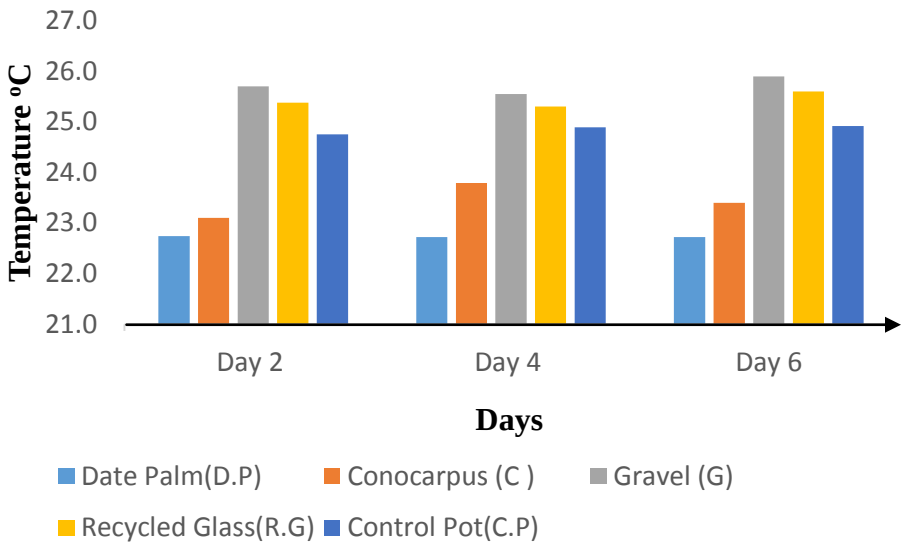


Fig 3 the influence of different mulches on Soil temperature



CONCLUSIONS

Through these experiments, we reject the 'Null Hypothesis' which states that the practice of mulching will not have any effects on the rate of evaporation and water loss from soil surface Based on the results obtained, we would like to draw the following conclusions:

- Mulching *reduces water loss* through evaporation from the soil surface**.**
- Mulching *reduces water consumption and regulates the soil temperature*.

Thus the practice of organic mulching in Kuwait, using readily available crop residues will significantly control evaporation and conserve irrigation water, thereby reducing the dependence on high cost desalinated water resource. Additionally, the green waste from cultivated crops can be recycled and reused as 'Mulch'.

SOLUTION TO THE PROBLEM

Mulching of soil with organic matter will control evaporation and regulate soil temperature. It will reduce the dependence on expensive and scarce water resources. Finally, it is suggested that using surface mulch is a scientific method to improve quality of sandy soils in arid areas. Arid regions like Kuwait, where water is scarce and needs to be desalinated, farmers should adopt the practice of Mulching which will help in the production of usual crops as well as aid in experimenting with new vegetation or crops.

Mulching will also lead to improvement in crop yields in arid and semi-arid environments and will minimize the use of irrigation water substantially.

FUTURE PLAN

In future studies, more experiments using different mulching materials with different thickness should be conducted in the agricultural farms. More studies can be done on the effect of different mulches on crop plants such as vegetables and fruits. Recommendations and follow up with the authorities and agriculturists should be carried out to encourage and adopt the practice of mulching. It is highly recommended to adopt the practice of Mulching to make cultivation of crops economically feasible and increase the yield of agricultural produce significantly.

Rightfully, Mulching is "**Nature's Natural Water Saver**"

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