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Water Saver a Natural Product for Saving Irrigation Water in Date palm Trees and Golf Courses Plantations in UAE

Mohamed A. Badawi

Professor of Soil Science, SWERI, ARC, Giza, Egypt
Emirates Biofertilizers Factory, Al Ain UAE, P.O. Box: 17786

Abstract: Water saver, is a natural soil mix has been developed and used to reduce the amount of water needed in irrigation to maintain vigorous plants and other trees. When mixed in the soil, the material can retain 25 liters of water per kg of product, as water is added and absorbed. When the potting system dries, the product will release its water to the plant. Water saver acts as a water reservoir--even during periods of drought the stored water is released to the plant. The expansion and retraction of the product during the watering cycle helps soil aeration, which is important to all plants. Using water saver not only save water but also, improve the soil physical properties e.g. water holding capacity (WHC) and cation exchange capacity (CEC) of the treated soil. Water saver product has been tested on sandy soils in United Arab Emirate (UAE) for several years. The plants tested were, Date palm trees and grass for landscaping turf grass in golf courses. After two years of testing, we found that water saver can save more than 40% of irrigation water. Our results recommended that, addition of 1.5 kg/m^2, for turf grass and 14-15 kg/date palm tree can reduce the water needed for irrigation by 40%.

Key words: Water Saver · Irrigation · Date palm trees · Grass

INTRODUCTION

Today, some 2.8 billion people live in water-scarce areas, but by 2030, it is expected that about half of the world's population will live in water stressed areas. World agriculture faces an enormous challenge over the next 40 years: to produce almost 50% more food up to 2030 and double production by 2050. This will probably have to be achieved with less water, mainly because of pressure from growing urbanization, industrialization and the negative impact of climate change, [1, 2]

Groundwater has provided great benefits to agriculture irrigation in semi-arid countries, but its intensive use beyond recharge in certain regions has depleted resources and generated significant negative environmental externalities.

The agricultural industry is the United Arab Emirates' largest consumer of water, accounting for 70-80% of the nation's consumptive water usage. Water is an incredibly valuable national resource and should be given the attention that it deserves. During seasons of drought and water scarcity, the other inefficiencies of irrigation and soil management make already difficult times for farmers even worse, [2].

A leading concern facing the future of agricultural production is the availability of water. It is expected that climate change will cause more extreme climate events including droughts and floods and shifts in plant growing zones. As populations grow, more efficient use of water in growing food will be of key importance.

Since water is essential to grow food, a drought situation can pose major problems for agriculture. Hence, farmers often face extreme poverty in drought-prone areas. Efficient water use techniques are very important in the face of climate change, [3, 4, 5, 6]

Date Palm Trees: In this research paper, we focused mainly on introducing a natural means of managing irrigation water through soil conditioning, using water saver to be incorporated in soil to prevent water losses by evaporation and infiltration.

Corresponding Author: Mohamed A. Badawi, Professor of Soil Science, SWERI, ARC, Giza, Egypt
Emirates Biofertilizers Factory, Al Ain UAE, P.O. Box: 17786.
E-mail: info@ebff.ae, dr_badawi22@hotmail.com.

Many technologies, such as irrigation scheduling, advanced irrigation systems, limited irrigation methods, soil moisture management, wastewater irrigation, can be used to reduce the problems attributed to date palm irrigation [7]. Improvement of water management is required at all levels of irrigation including planning and design, project implementation and operation and maintenance. In The Saudi Arabia , KSA, [7} studied the irrigation water requirements for date palm trees in several locations selected for studying determination of date palm water requirements in areas located in regions of the Medina (Al Ula), Tabuk (Teimaa), Makkah (Al Jumum), Al Jouf (Sakakah), Riyadh (Sodos), Qassim (Riyad Al Khabra, Hail (AL Kaedh) and East Region (Al Ahsa). Irrigation water requirements (m^3 /ha) after taking into account the proportion of cultivated area of date palm for each year were found to be 9495.24, 7340.18, 7298.93, 8913.59, 8614.96, 8568.68, 7996.99, 8510.72 m 3 /ha, respectively, per 100 Date Palm trees/ha. The annual total irrigation water requirements (m 3 /tree) in these regions is 95, 73.4, 73, 89, 86, 85.7, 80, 85 m^3 , respectively as the radius of shaded area per tree is 3.5 m. The decrease of the crop water requirement CRW in all sites of study to around 8000 m^3 /ha from previously reported by many researchers is mainly attributed to percentage of shaded area of date palm tree. Therefore, it is recommended that the practice of a distance between trees to 10m x10m should be changed to 7mx7m in order to reduce the estimation of CRW of date palm trees.[7, 8].

Each soil type has a different capability to hold moisture based on soil depth, soil texture (ratios of various soil particle sizes), soil structure (soil porosity) and soil water tension. A combination of these elements determines the amount of water available to the plant. Soil type may vary within the root zone, so it is important to know crop root depth and the soil type throughout the root zone. [9, 10, 11, 12].

Proper soil management is a key to conserving water. It is the soil that absorbs, transmits and holds the water for crops to use and there is much a farmer can do to manipulate the nature of soil and is especially helpful if the soil quality is compromised. [13, 14].

Various techniques farmers may consider include conservation tillage, using compost and utilizing cover for crops. Again, what works the best to conserve water will depend on what kind of soil is being managed, [12].

Water Saving in Golf Courses: The actual amount of water a golf course needs to sustain healthy turf growth depends on many variables including the species of turf and the prevailing climate in a given area. Scientific studies have determined that various turf grasses require a specific percentage of the water that naturally evaporates from the soil and through the plants, also known as evapotranspiration (ETo). This reference number is typically measured by a weather station and models the inches of water that evaporates from a large, deep pan of water that is exposed to environmental conditions. Cool-season grasses, such as Kentucky bluegrass, creeping bentgrass, perennial ryegrass and tall fescue generally require only 80% of the total evaporative demand. Warm-season grasses such as Bermuda grass, zoysia grass, seashore paspalum and buffalo grass use even less at 70% of ETo. Golf courses in cooler climates and high rainfall can use less than 1 acre-foot of water per acre each year. (One acre-foot of water is the amount of water covering a one-acre area - roughly one football field - to a depth of one foot, which is equal to 325, 851 gallons.) Golf courses in hot, dry climates may require as much as 6 acre-feet of water per acre per year, [15, 16].

Compost, or decomposed organic matter used as fertilizer has been found to enhance water-holding capacity and improve soil structure. Mulch is a material spread on top of the soil to retain soil moisture. Mulch can be made from organic materials like wood chips or straw which can break down into compost. It further enhances the soil's water-holding capacity. Compost and mulch can help to retain more water in the soil during dry season. Farmers may also use black plastic mulch as soil cover to suppress weeds and reduce evaporation, [10].

Many of the methods known to conserve water and use it efficiently have been practiced for thousands of years in some very arid regions of the world with great success. The best systems require little maintenance while yielding maximum results. The ability to add water during crucial growth periods can greatly increase crop yields, [17].

Soil Capacity: Soil acts as a water reservoir between irrigations or rains. Soil is also a nutrient reservoir and it mechanically supports and stabilizes plants. Each soil type has a different capability to hold moisture based on soil depth, soil texture (ratios of various soil particle sizes), soil structure (soil porosity) and soil water tension. A combination of these elements determines the amount of water available to the plant. Soil type may vary within the root zone, so it is important to know crop root depth and the soil type throughout the root zone.

The table below estimates available water for various soil textures, including a margin of error of up to 25%.

Table 1: Soil Texture and Inches of Water Available per Foot of Soil

Soil Texture	Available water (inch/foot of soil)
Coarse Sand	0.50
Fine Sand	0.75
Loamy Sand	1.00
Sandy loam	1.25
Clay or silt loam	1.50-2.0
Clay	2.0-2.4

Source: Ag-Irrigation Management (Irrigation Training and Research Center, 2000), [18].

MATERIALS AND METHODS

- Soils, sandy soil used in this study, located in Al Ain, Abu Dhabi – UAE. Irrigation water used was underground water wells analysis of soil and irrigation water, are presented in Table (2).

2- Water Saver was produced at Emirate Bio Fertilizer Factory from natural materials e.g. clay minerals, organic matter, Gypsum and Amorphous Silica. The following table (3) shows analysis of water saver used.

Methods: Water Saver Product was added at different rates to sandy soil e.g. 1.5kg/m^2 and 3kg/m^2 of Paspalum grass of 16m^2 Blots. Irrigation was scheduled for 10 minutes daily for grass irrigation in winter season and 20 minutes in summer season.

For date palm trees of 7 years old, received 15kg was mixed in the tree bits 20 trees used as control and 20 trees treated with water saver

Irrigation was scheduled every 6 days in summer months and every 16 days in winter months and every 8 days in moderate months.

- Irrigation water was monitored and water consumption was recorded.
- Soil samples were taking for analysis of water retained and water losses and samples dried at 105ºC for 24 hours.
- Chemical of soil and water analysis followed the standard methods protocol as per [19, 20]

Also, water saver capability for retention of water was measured in a separate experiment under lab condition, e.g. 100gm of sandy soil was mixed with water saver at different ratios, e.g. control (0 water saver), 0.5gm water saver, 1.0gm water saver, 2.0gm water saver and 10gm water saver per 100gm soil.

Soil was saturated with water and incubated for 5 days, then weight of water losses and water retained are recorded.

Table 2: Soil and irrigation water analysis used in experiment

				Cations (ppm)				Anions (ppm)			
Sample	pH	EC	CaCO3	Ca	Mg	Na	K	Cl	CO3	HCO3	SO4
Soil	7.30	21.2	26.95	27.6	58.3	124	3.8	146	0.0	2.5	42.9
Water	7.50	13.6	---	490	462	1393	46	3053	0.0	91.5	2640

Analysis of water saver used

Table 3: Analysis of water saver product used in experiment.

Parameter	Values
Moisture (%)	10
Organic matter (%)	40
pH value	7
EC mmoh/cm	4.5
Total nitrogen (%)	1.0
Total phosphorus (%)	0.5
Total potassium (%)	0.5
Total sulfur (%)	5.0
Water holding capacity L/Kg	25.0
Specific gravity (kg / m^3)	750
Cation Exchange capacity (meq / 100 gm)	120

RESULTS AND DISCUSSION

Evaluation of water losses and water retained in soil over time as affected by addition of water saver product are depicted in table (4). After five days of incubation the control lost its water content faster than treated samples, control lose 92.3% of its water content while treatment received 0.5%, 1.0%, 2.0% and 10% were 83%, 77.5% 72% and 37% respectively, While water retention in sandy soil after 5 days of incubation with water saver were as follow, only 7.4% for control and 17%, 22.5%, 28% and 63% respectively, [17].

Increasing the ratio of water saver reduced the water losses and increased the water retention. It is very clear that cultivating sandy soil consume huge amounts of irrigation water, due to its physical properties e.g. open structure and les organic matter content. [10, 21]. The results recommend that for better management of irrigation water, farmers have to add soil amendments to reduce water losses and to improve the soil water retention and plant growth, [21].

The reason for soil amendment is to provide a better environment for roots and plant growth: this includes the improvement of the soil structure and water holding capacity, the availability of nutrients and the living conditions for soil organisms, which are important for the plants to grow, [22, 5, 13]

Irrigation water requirements (m^3 /ha) after taking into account the proportion of cultivated area of date palm for each year were found to be 7044 m^3 considering

Table 4: Evaluation of water losses and water retained with time as affected by water saver product after five days incubation in sandy soils at room temperature

	Water losses		Water retained	
Treatment	(Volume)	(%)	(Volume)	(%)
O% ws (control)	32.41	92.3	2.59	7.4
0.5% ws	49.8	83.0	10.2	17.0
1% ws	54.38	77.5	15.62	22.5
2% ws	56.86	72.0	23.14	28.0
10% ws	56.15	37.0	93.85	63.0

WS= Water saver

Table 5: Average irrigation water per date palm tree of 7 years old, during different seasons and water saved percent in Al Ain

Treatment	Summer months (L)	Winter months (L)	Moderate Months (L)	Average Per year (L)	Annual Requirement (L)
Control	279.0	99.0	202.0	193.0	70440
Treated (ws)	151.0	51, 0	115.0	105.6	38540
Percent saving	44.9	48.5	43.0	44.3	44.3

Table 6: Effect of water saver on water retention in grass grown in sandy soil and biomass yield in plots (16m each).

	Control	1.5 kg/m^2	3 kg/m^2
Soil moisture (%)	4.56	9.99	13.58
Biomass (kg/plot)	16.0	26.0	30.0

100 trees per ha which mean, date palm tree consumed 70.44 m^3/tree under control while the percent water saved is 44.3%. The annual total irrigation water requirements (m^3 /tree) in different regions in KSA were, 95, 73.4, 73, 89, 86, 85.7, 80, 85 m ^{3}, respectively as the radius of shaded area per tree is 3.5 m. The decrease of the crop water requirement CRW in all sites of study to around 8000 m^3/ha from previously reported by many researchers is mainly attributed to percentage of shaded area of date palm tree, While Gafar (2010) in UAE stated that mature trees require 69.7 m^3 .[23, 24, 6, 7]. Effect of water saver on the growth of Paspalum grass grown in sandy soil are presented in Table (6).

The plots showed different quality and biomass yield of grass in the plots. Control showed less biomass growth and however, with increasing water saver showed better growth, due to the moisture level in the soil which was 4.56%, 9.99% and 13.58% for control, 1.5kg/m^2 and 3kg/m^2 respectively, which means that water saver maintain more water in the root zone of treated plots than control, [25, 16].

CONCLUSION

Proper water management in sandy soil should use available organic matter in their farms to be serving as soil conditioner and to act for saving water for better plant growth and soil microbial activities in the soils.

Addition of water saver improved water retention and contribute to:

- improved crop yields, produces uniform moisture at the root zone, reduces irrigation requirement by up to 50%, saving both water and money, reduces evapotranspiration, holding water and nutrients at the roots to produce strong, healthy plants and lawns Allows sandy soils to retain water and nutrients.

We can save more than 40% of irrigation water requested for date palm plantation and golf courses. This water saving can be used for other eventual needs of water e.g. industry and other purposes.

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