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MATHEMATICAL MODEL TO PREDICT THE DISTRIBUTION OF SOIL MOISTURE IN THE ROOT ZONE OF TURF LANDSCAPE

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ABSTRACT

Field experiment was carried out on one of the turf (lawn) , category

(Passpalm 10) to study the effect of irrigation systems on soil moisture distribution in the root zone. Experimental plot area was (4.5*4.5m^2), soil media used was sandy soil and three treatments (spray, sub surface drib irrigation (SDI) , hydrogel) irrigation and every treatment replicated three times .

Results of this research could be summarized as follows:

- Annual water consumption was less by 77.3%, 71.3% when using hydrogel material, compared with other irrigation systems (spray, and SDI) resp. , this is due to the quantity of loss water from evaporation in spray irrigation treatment , where evaporation parameters are more effective than the others (SDI, hydrogel) irrigation treatments.
- The hydrogel treatment has highest water saving by 170% ,300% compared with (SDI and spray) irrigation treatments , because the hydrogel's ability to hold water and has a large period between irrigation when using hydrogel in the soil .
- The SDI treatment has highest electrical saving by 520% ,55% compared with (spray and hydrogel) irrigation treatments resp.
- The turf quality index (color, density, ground cover) give high degree at hydrogel treatment compared with others, this is due to the hydrogel has many materials , both naturally occurring and synthetic and ability of water saving around root zone of turf .
- The average of soil moisture contents at (10cm and 15cm) depth of soil under hydrogel treatment was highest compared with (Spray and SDI) irrigation systems resp.

Keywords: Irrigation, Spray, Hydrogel, Sub Surface Drip irrigation, Turf, Distribution of Soil moisture.

INTRODUCTION

Water scarcity is a growing global problem in some parts of the world , and Egypt is one of those countries facing such challenges. It receives about 98% of its fresh water from outside, the population of Egypt is the main cause of its problem. Since 1959, Egypt's share of Nile water has been estimated at about 55.5 billion cubic meters per year , this was when the population of Egypt was about 25 million , Egypt now has four times peoples, than year of 1959 .

In Egypt, there are a lot of residential compounds, touristic villages and municipalities' landscape and all of these require a big amount of irrigation water per day, the majority of these turfs are grown on highly permeable sandy soils. Careful management is therefore required to achieve an acceptable balance between maintaining turf quality and reducing water use and minimizing water and nutrient loss beyond the root zone (**Del, Marco, 1990).**

Water scarcity in turf areas and increased water losses by using improper irrigation systems for narrow turf, or steep slopes make cause design problems.

So, Proper irrigation system selection for strips, islands, areas near buildings, sidewalk, and steep areas is very important to obtain good turf quality, minimum operation, costs and water losses **(Bedair, 2018).**

Kjlgren et al (2000) stated that, with increasing seasonal water use most of them goes to landscape, because the high water requirement, increasing use of irrigation for landscape is causing new demands for efficient irrigation systems.

There is a problem of loss of water due to the use of uni-spray in the turf areas where this loss is in several forms: evaporation of water from the surface, the volatilization of water droplets with the change of the prevailing weather, the emergence of some salts on the surface of the soil requiring an additional amount of water to wash these salts and covers Small spaces require more sprinklers **(Irrisoft, 2014).**

Toro (2006) reported that narrow or irregularly shaped areas, including turf , less than 8 feet in width in any direction, shall be irrigated with subsurface drip irrigation or low volume water irrigation system , sub-surface drip irrigation saves water with minimal water loss due to mist, evaporation, runoff or wind drift , There have been some investigations of the viability of using sub-surface drip irrigation (SDI) to irrigate turf grass **(Johnson and Leinauer, 2004, Devitt and Miller, 1988 and Ferguson, 1994**), some of the benefits of SDI over conventional irrigation are that it operates at lower volumes and flow rates, puts water directly into the root zone, and is thus less susceptible to lessees from wind and evapotranspiration

El-Gindy et al (2001) mentioned that, sandy soil has low holding capacity, so using soil conditioners especially polymers can increase the water holding capacity of the soil. The use of polymer is not restricted to only sandy soils but also use to clay ones however it can improve soil hydraulic conductivity, seed emergence and eliminate crust problems. They also reported that incorporated polymer into the soil will improve soil structure and water retention, thus reducing leaching, reducing water losses due to percolation and evaporation, protecting the plant against water stress and increasing both the nutrient and water supply to the roots.

Objectives of this study are

1- Predicting the distribution of moisture levels below the root zone turf area as a result of the addition of hydrogel.
2- Determine the best application rates of water for hydrogel treatment compared with using different irrigation systems (spray and SDI).
3- Determine the best quality index (color – density and ground cover %) under three treatments (hydrogel – SDI and Spray).

MATERIALS AND METHODS

A field experiment was carried out on one of the landscape plants at the landscape area of Faculty of Agriculture , Ain shams university , Shoubra El-Kheima with coordinates N = 30° 06' 46.9" , E = 31° 4' 47.3"

This experiment was carried out on one of the turf (lawn) , Category: PassPalm 10 .

The experimental plot has a square shape (4.5 * 4.5m^2), while at the center of these experimental areas there are the samples spot with dimensions of (1 * 1 * 0.2 m –L*W*D) . The media soil used was sandy soil , three treatments (spray , SDI and hydrogel material) and every treatment will be around three replicates , irrigation interval day (50 % allowable water depletion) in the root zone .

Specification of irrigation source

1- Type of water source: Domestic water , (discharge of water source was 6m^3/hr and 2.5 bar pressure)
2- Specifications of pump (Q= 2.1m^3/hr , 3.5bar , 0.33K.W (0.45 HP) , 220V , 50 HZ , 2850 rpm)
3- Description of main lines : (50mm diameter , made of P.V.C. and working pressure 6 bar).
4- Description of sub main lines : (50mm diameter , made of P.V.C. and working pressure 6 bar)
5- Description manifold : (32mm diameter , P.V.C. and working pressure 6 bar)

Fixed spray sprinkler

Fixed spray heads have traditionally been used for small and irregularly shaped landscape areas **(Irrigation Association, 2004)**. Fixed spray heads produce a static spray distributing water over their entire arc of coverage (1/4, 1/2, full variable arc, etc.) . These may be installed on fixed risers, or in “pop-up” heads, which rise when the water is turned on **(Hunter, 2012; Rain Bird, 2012; Toro, 2012)** illustrates fixed spray pop-up heads.

Type of sprinklers used in the experiment: Spray type under pressure 2 bar, with discharge 0.8 m^3/ hr , Nozzle 15, average precipitation rate = 40 mm / hr , radius = 4.5 m

Subsurface drip irrigation system (SDi)

Type of hoses used is 16 mm in diameter made of P.E. having drippers (built in). Distance between laterals is 0.5 m and the distance between the drippers is 30 cm . Dripper discharge is 2 liters / hour at 1 bar operating pressure. Laterals is placed at 10 cm depth from the soil surface.

Description of Hydrogel

Hydrogel is very unique water-absorbing and water-holding materials. It is a solid, granular or powder cross linked polymers that rapidly absorb and retain large volumes of aqueous solutions. The material is weighed on the scale. Then soak it in the amount of water you need to become saturated and increase in size and then filtered using a filter to get rid of excess water , The material can be used after two hours of soaking it in water and can be left for longer and in both cases we will get the same result. The material is placed at a depth of 10 cm and is a very suitable depth because the root hairs that the water in the upper two thirds of the root area and is about 8 cm , was mixed with sand and put it Sandwich , Each 1 kilogram of sand needs 7 grams of material, and the amount of sand contained 15.5 kg . soil consumed 108.5 grams of material , Every 20 grams of material needs almost a liter of water to soak . The amount of water required to settle 108.5 grams of material was 5 liters of water , for tested volume from soil about (1 * 1 * 0.2 m) .

Irrigation scheduling

The irrigation water is calculated according to the weather data under area of Faculty of Ag.Eng., Ain Shams University by using different irrigation systems (spray and SDI), while to get the best irrigation schedule for turf , then determine irrigation period depends on field capacity (F.C)= 22% , and wilting point (W.P) = 9% for this soil under investigation.

Management Allowable Depletion

Management allowable depletion (MAD) is the maximum percentage of plant available water (PAW), that the irrigation manager allows to be extracted (depleted) from the soil before irrigation is applied . MAD is used in this investigation was 60% from available water.

Allowable depletion (AD) is the desired amount of plant available water (PAW) to be depleted from the root zone before applying irrigation:

AD= PAW x (MAD/100) …….(1)

Where:

AD = Allowable depletion of water from the root zone (in.)

PAW = Plant available water in the root zone when at field capacity (in.)

= (F.C –WP)

MAD, Management allowable depletion (%) =60% from available water.

Distribution Uniformity

The distribution uniformity is measured by conducting a catch-can test and comparing the average of the lower quarter of the samples with the overall average of samples **(The Irrigation Association, 2001)** , good distribution uniformity is indicated by the average values of the lower quarter being similar to the overall average according to rating of emission uniformity **(Table 1)**

Table 1. Rating of emission uniformity (EU) for drip/micro-irrigation zones.

Type of zone	Excellent (%)	Very Good (%)	Good (%)	Fair (%)	Poor (%)
Micro Spray	80	70	60	50	40
Drip- standard	80	70	65	55	50
Pressure drip compensating	95	90	85	80	70

(IA, 2005)

The lower quarter distribution uniformity (DULQ) is calculated with the following method:

Step 1: Order the catch-can volumes in a list from smallest to largest.

Step 2: Separate out the catchment values for the quarter of the cans containing the least amount of water. Calculate the average catchment volume of these cans (VLQ).

Calculate the lower quarter distribution uniformity (DULQ) as a percentage:

DULQ = 100 x (VLQ/Vavg) ……. (2)

DULQ = Lower-quarter distribution uniformity (%)
VLQ = Average low quarter (ml)
Vavg = Total average (ml)

Quality Index

Values of quality index for lawn plant (Paspalm 10) such as color , density and ground cover are presented in **Table (2).**

Table 2. Turf quality index.

Type of turf	color	Density (pcs/m^2)	Ground cover%
Paspalum 10	0-9	0-9	1-9

- Color: a 0-to-9 scale, where 0 = brown, (dead turf); 6 =Acceptable quality for home lawn; and 9 = optimum color (dark green)
- Density (pcs/m^2): summer density (1=low, 9=high), turf density was measured instrumentally and expressed in number of tillers per unit area (pcs/m^2), high ratings (> 10000 shoots per sq. m), equal9 provided moderate density (6000 to 10000 shoots per sq. m), while 4 and demonstrated low ratings (<6000 shoots per sq.m), 2.
- Ground cover%: ground cover (1=0% and 9= 100% cover).

Irrigation Run Time for the Interval

Irrigation run time is the amount of time that a station/zone valve is activated (turned on) as required to fulfill the irrigation water requirement for an irrigation interval. Irrigation run time is usually defined in minutes. The base run time for the interval (RTbase) depends on the base irrigation water requirement for the interval (IWRbase) and the precipitation rate (PR) of the station/zone in applying the water:

RT= IWR x (60/PR) …….. (3)

where:
RT= Base run time (minutes) for the interval
IWR= Base irrigation water requirement (in.) for the interval
PR = Precipitation rate of station/zone (in./hr)

Plant Water Requirement

The landscape coefficient KL is used to adjust ETo to determine the plant water requirement (PWR) of a specific plant species:

PWR = ETo × KL……. (4)

where:
PWR = Plant water requirement (in./period)
ETo = Reference ET based on cool-season grass (in./period)
KL = Landscape coefficient (dimensionless)

If ETo is expressed in inches per month, then the plant water requirement of the hydrozone will be the monthly amount of water, in inches, required to maintain a healthy plant. If ETo is reported in inches per day, then the PWR will be the daily plant water requirement (in inches) of the hydro zone.

KL = K s× K mc× Kd……….(5)

where:
KL = Landscape coefficient (dimensionless)
Ks = Adjustment factor representing characteristics for a particular plant species (dimensionless)
Kmc = Adjustment factor for microclimate influences upon the planting (dimensionless)
Kd = Adjustment factor for plant density (dimensionless)

W.R(L/day)= PWR (mm/day)* Area/$\eta_{for\ (irrigation\ system)}$ **……………………..…..(6)**

W.R (L/Season)= W.R (L/day) * (number of days per season) ………………….…………..……..(7)

W.R (L/Year)= W.R (autumn) + W.R (winter) + W.R (spring)+W.R (summer) ………………….(8)

Available Water Holding Capacity(AWHC)

Available water holding capacity relates to the ability of a particular soil texture to retain water. Refer to the following table for approximate values of available water holding capacity for different soil textures. AWHC expressed in units of inches of water held per inch of soil , **(Irrigation Training and research Center, 1999)**.

Plant Available Water

Plant available water (PAW) is the amount of water within the root zone that is available to the plants when at field capacity. For landscape purposes, PAW is expressed in inches and is based on the available water holding capacity (AWHC) and the effective root zone depth (RZ) as per the following equation:

PAW = AWHC × RZ …….. (9)

Where:

PAW = Plant available water in the root zone when at field capacity (in.)

AWHC =Available water holding capacity (in./in.).

RZ = Average depth of effective root zone for the hydrozone (in.)

The root depth for a hydrozone can be established by observing several soil cores and determining the average depth of root penetration into the soil profile. **(Irrigation Training and research Center, 1999).**

Cost analysis

Cost of operation was calculated according to the equation given by

Davies and Richards (2002) in the following form:

Costs per year = Pumping cost + Labour cost + Depreciation +Interest + Repairs

where,

Pumping costs, L.E./year = [a] × [b] × [c]

i.e., irrigated area, m^2 [a] × pumping cost, L.E./m^3 [b] × water used, m^3/m^2/year [c]

Labour costs, L.E./year = [h] × [i]

i.e., yearly labour in hours [h] × labour cost in L.E/h [i] Depreciation, L.E./year = ([d] – [g]) ÷ [f]

i.e., (capital cost, L.E. [d] – resale value, L.E. [g]) ÷ years of working life, year [f]

Average capital value = (capital cost, L.E. [d] + resale value, L.E. [g]) ÷ 2

Interest, L.E./year = average capital value × interest rate [e] ÷ 100

Repairs, L.E./year = yearly repair cost [j]

RESULTS AND DISCUSSION

Effect of different treatments on water consumption for Different Seasons

Fig. (1) shows that the hydrogel treatment consumed less water in four seasons compared with the other irrigation treatments (sprays and SDI)**.**

It is clear that the average water consumption in the presence of hydrogel was lower by 75.6% and 69% compared with (spray and SDI) treatments resp. , in the winter season , it was lower by 75.6% and 69.4% compared with (spray and SDI) treatments resp. , in the spring season , it was lower by 21% , 69% compared with (spray and SDI) irrigation treatments resp. , in the summer season , and it was lower by 81.7% and 76.8% compared with (spray and SDI) irrigation treatments resp. , in the autumn season. This is due to the hydrogel's ability to hold water and a large period between irrigation when using hydrogel in the soil.

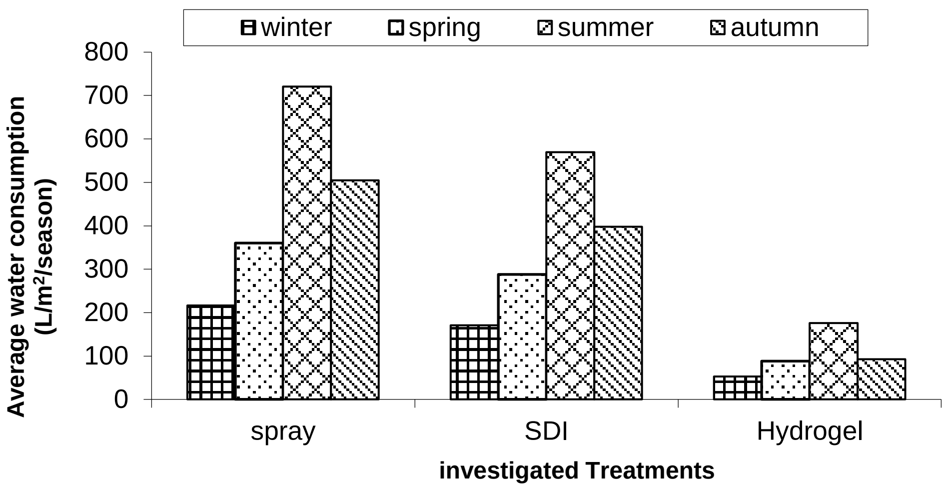

Fig. 1: Effect of different treatments on water consumption at different seasons .

Effect of Different Treatments on Total Annual Water Consumption (L/m^2/year)

Fig. (2), indicates that total annual water consumption less by 77.3% and 71.3% when using hydrogel compared with (spray and SDI) treatments resp. This is due to the loss of water in spray irrigation treatment due to evaporation, sun exposure more than (SDI and hydrogel) treatments**.**

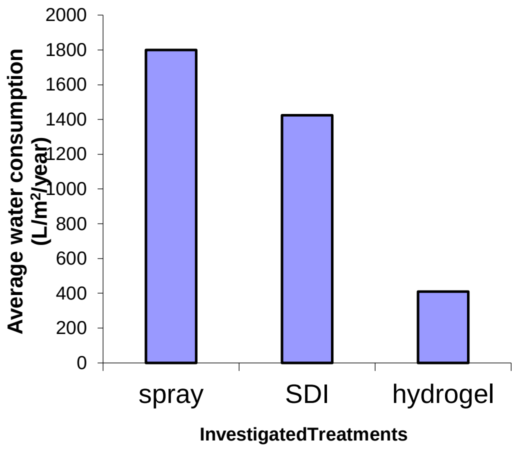

Fig. 2. Effect of different irrigation systems on annual total water consumption (L/m^2/year) .

Appropriate Interval Irrigation Time for Different Irrigation Treatments:

Fig. (3), illustrates that, in spray irrigation and SDI irrigation treatments, the depletion soil limit (MAD,%) was reached on the second day, so, we must irrigated in second day, while when used hydrogel, the depletion soil limit (MAD,%) was reached on the fourth day , so , it must be irrigated after fourth day. According to the most suitable period between irrigation under spray irrigation was daily for a quarter of an hour. In the SDI irrigation was daily for half an hour , and in the presence of hydrogel irrigation was done every four days because the wilt point of soil was 9% , field capacity of soil was 22% , and the depletion soil limit was 13% (MAD = 60 % from field capacity) , so , when using hydrogel treatment give higher water saving compared with another irrigation treatments (SDI and spray) .

Effect of Different Treatments (spray , SDI and hydrogel) on Annual Water Consumption (m$^{3/}$m^2/year)

Table (3) and Fig.(4) , the hydrogel treatment has highest water saving by 166% and 69% compared with (SDI and hydrogel) irrigation treatments resp. , because the hydrogel's ability to hold water and a large period between irrigation when using hydrogel in the soil .

Table 3. Annual water and electrical consumption .

	Q m^3/hr	Operation time {h}	Pa {KW}	Motor load %	E, KWh	Water consumption m^3/60.75 m^2/Year
Spray	0.8 m^3/hr	90	0.186	0.6	66.96	216
SDI	2 L/hr	180	0.03	0.6	10.8	145.8
hydrogel	0.8 m^3/hr	22.5	0.180	0.6	16.74	54

Effect of Different Irrigation on Annual Electrical Consumption

Table (3) and Fig. (5), the results shows that , the SDI treatment has highest electrical saving by 35.7% and 293% compared with (spray and hydrogel) irrigation treatments resp., because the working pressure at SDI lower than spray , so give electrical consumption less than other treatments (spray and hydrogel).

Effect of Different Treatments on Turf Quality Index

Fig. (6), the results shows that , the turf quality index (color, density, ground cover) give high degree at hydrogel treatment compared with other irrigation treatments (SDI, spray). This is due to the hydrogel have many materials , both naturally occurring and synthetic and ability of water saving around root zone of turf .

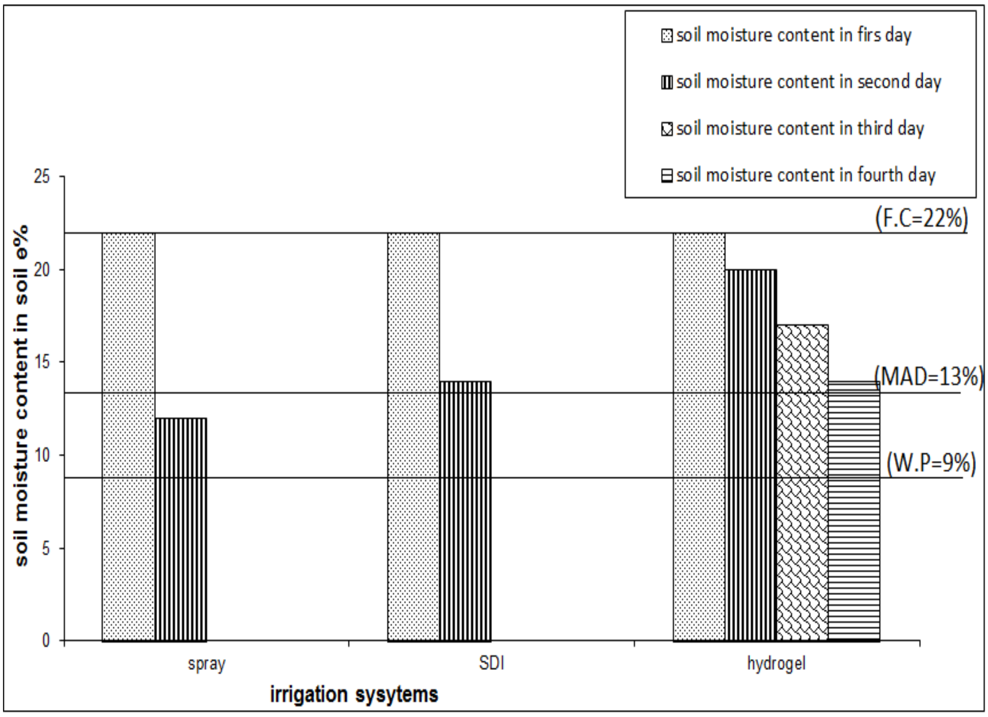

Fig. 3, Appropriate interval irrigation time by using different irrigation systems (hydrogel, spray and SDI) depend on depletion soil limit (MAD,%) .

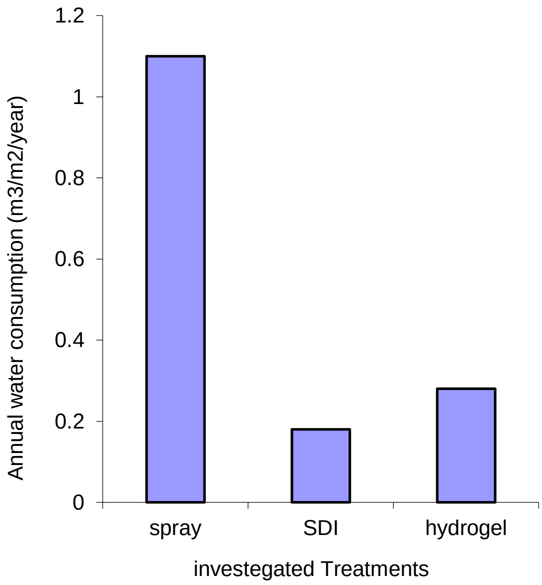

Fig. 4. Effect of different treatments (spray m SDI m hydrogel) on annual water consumption ($m^{3/}m^2$/year) .

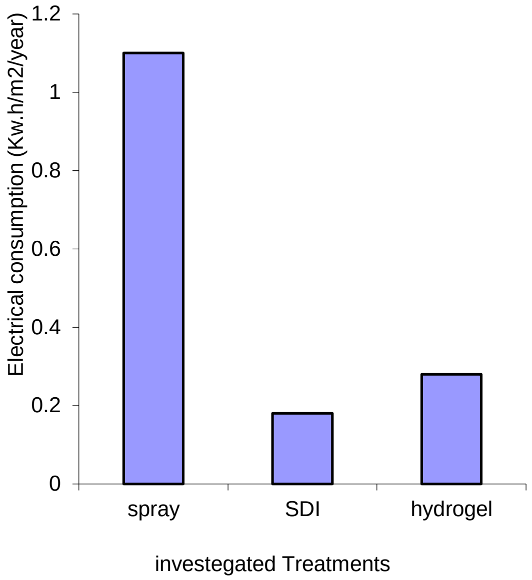

Fig. 5. Effect of different treatments (spray , SDI , hydrogel) on annual Electrical consumptive (Kw.h)

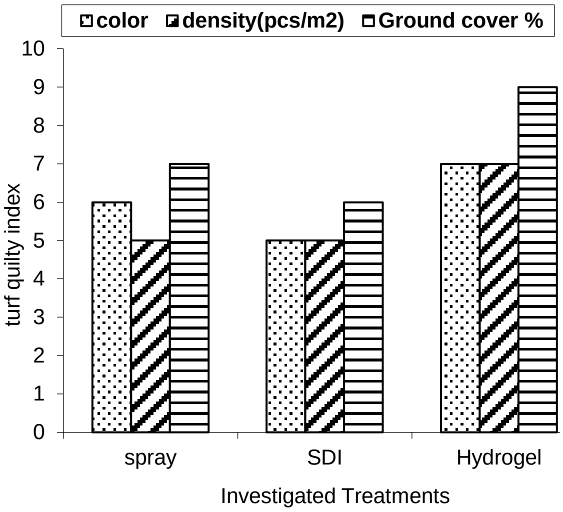

Fig. 6: Effect of different Treatments systems on turf quality index .

CONCLUSION

Field experiment was carried out on one of the turf (lawn), category (Passpalm 10) to study the effect of irrigation systems on soil moisture distribution in the root zone . Experimental plot area was (4.5*4.5m^2) , soil media used was sandy soil and three treatments (spray , sub surface drib irrigation (SDI), hydrogel) irrigation and every treatment replicated three times .

Hydrogel reduced deep percolation of irrigation water at 15 cm soil depth around root zone turf , the amount of water retained to the lower layer in the presence of hydrogel is lower compared to the spraying and subsurface dosing a large amount of moisture content is present at a depth of 15 cm in the spray irrigation system followed by drip irrigation and hydrogel

This means the hydrogel treatment retained most of the water in the layer (10-15cm) and prevented the water leakage to a depth greater than the depth of the spread of root zone, and this is a conservation of water and reduce loss by deep perecolation, it is also noted that the relatively high rate of addition under the spraying conditions led to the rapid passage of water in the deepest layer (15cm) away from the root zone spreading layer.

The obtained results can be summarized as follow

- The average water consumption in the presence of hydrogel was lower by 21% , 69% compared with (spray irrigation treatment , SDI irrigation treatment) resp. in the summer season , it was lower by 75.6%, 69% compare with (spray irrigation treatment , SDI irrigation treatment) resp. in the winter , it was lower by 81.7%, 76.8% compare with (spray irrigation treatment , SDI irrigation treatment) resp. in the autumn , it was lower by 75.6%, 69.4% compare with (spray irrigation treatment , SDI irrigation treatment) resp. in the spring**.**
- Annual water consumption less by 77.3%, 71.3% when using hydrogel , compared with other irrigation systems (spray, and SDI) resp. , This is due to the Loss of water in spray irrigation treatment due to evaporation , sun exposure more than (SDI, hydrogel) treatments .
- In spray irrigation treatment and SDI irrigation treatment the depletion soil limit (MAD%) was reached on the second day, so, we must irrigated in second day , while when used hydrogel the depletion soil limit (MAD%) was reached on the fourth day , so , it must irrigated after fourth day , according to the most suitable period between irrigation under spray irrigation was daily for a quarter of an hour ,In the SDI irrigation was daily for half an hour , In the presence of hydrogel irrigation was done every four days because the wilt point of soil was 9% , field capacity of soil was 22% , and the depletion soil limit was 13% (MAD = 60 % from field capacity), so , when using hydrogel treatment give higher water saving compared with another irrigation systems (SDI , spray).
- The hydrogel treatment has highest water saving by 166% , 69% compared with (SDI - hydrogel) irrigation treatments , because the high ability of hydrogel to hold water and that , resulted to a large period between irrigation when adding hydrogel to the soil.
- the SDI treatment has highest electrical saving by 35.7% ,293% compared with (spray - hydrogel) irrigation treatments resp.
- The turf quality index (color , density , ground cover) give high degree at hydrogel treatment compared with other irrigation treatments (SDI, spray), This is due to the hydrogel have many materials, both naturally occurring and synthetic and ability of water saving around root zone of turf .
- the average of soil moisture contents at (10cm,15cm) depth of soil in hydrogel treatment was highest compared with (Spray, SDI) systems resp.

- The average of soil water holding capacity at different depth in (SDI, spray) irrigation treatments was highest compared with hydrogel treatments, this is due to the hydrogel's ability to hold water and a large period between irrigation when using hydrogel in the soil.

REFERENCES

Bedair, O.M. 2018, Narrowly- bounded turf irrigation system selection using "Expert System" approach WP 1 in landscaping, **14th. International Water Technology Conference, IWTC Cairo, Egypt, pp. 114-125.**

Davies, L. and Richards, A., 2002. Costing an irrigation system (net margin calculator), **State of New South Wales, Department of Primary Industries Agriculture, pp. 112-115.**

Del Marco, A. 1990. Turf Management in Perth: A Review of Species, maintaining requirements and opportunities for water conservation, edited by Wykes B. ed. WAWA Water resources Planning Branch Report No WP 88. **(Cited from El-Zakaziky, M.M.O., 2012) Modeling of integrated water management for landscape irrigation, Ph.D. Thesis, Fac. of Agric., Ain Shams Univ., Cairo, Egypt,**

Devitt, D.A. and Miller, W.W. 1988. Subsurface drip irrigation of bermuda grass with saline water. **Appl. Agr. Res., 3(4), 133-143.**

El-Gindy, A.M., Abdel Mageed, H.N.M.A. Adl and Mohamed E.M.K., 2001. Management of pressurize, **Misr. J. Ag. Eng., 18(1), 29-44.**

Ferguson, K.R. 1994. Subsurface drip Irrigation for Turf. **Proc. Int. Irrig. Show. Nov. 5-8,** Atlanta, U.S. State of Georgia

Hunter, 2012. Product Catalog. San Marcos, Calif.: Hunter Industries Incorporated. **Cited from Mona M. El-Diba, 2017, Expert system for turf irigation management. Ph.D. Thesis, Fac. Agric., Ain Shams Univ. Cairo, Egypt.**

IA., 2005. Landscape irrigation scheduling and water management. **The Irrigation Assoc., Water Manag. Com. USA, 190p.**

IA. 2004. Certified landscape irrigation auditor training manual. Falls Church, Va:IA., **Cited from Mona M. El-Diba, 2017, Expert system for turf irigation management. Ph.D. Thesis, Fac. Agric., Ain Shams Univ., Cairo, Egypt.**

IA, 2001. Predicting and estimating landscape water use. **Cited from El-Zakaziky, M.M.O., 2012) Modeling of integrated water management for landscape irrigation, Ph.D. Thesis, Fac. of Agric., Ain Shams Univ., Cairo, Egypt,**

Irrisoft, 2004. Landscape Water Management Weather Reach. **North Long, UT., 66p.**

ITRC, 1999. Landscape water management auditing, California polytechnic state university, San Luis Obispo. **Cited from El-Zakaziky, M.M.O., 2012) Modeling of integrated water management for landscape irrigation, Ph.D. Thesis, Fac. of Agric., Ain Shams Univ., Cairo, Egypt,**

Johnson, C. and Leinauer, B. 2004. Effect of salinity level and irrigation type on the establishment rate and winter survival of turfgrass. **Fragmenta Agronomica, 30(1), 54-61.**

Kjelgren R., Larry R. and Doug K., 2000, Water Conservation in Urban Landscape. **Hort. Science, 18(4), 238-246.**

Rain Bird. 2012. Rain Bird landscape irrigation Products 2011-2012 Catalog. Azusa, Calif.: Rain Bird Corporation. **Cited from Mona M. El-Diba, 2017, Expert system for turf irigation management. Ph.D. Thesis, Fac. Agric., Ain Shams Univ. Cairo, Egypt.**

Toro, 2006. Toro Company. Bloomington, MN. http://toro.com/watermgmt/brochures/solutions.pdf. (Accessed October 17, 2009).

Toro. 2012. Residential/Commercial irrigation products specification Catalog. The Toro Company, Irrigation Division, Riverside, Calif. . **Cited from Mona M. El-Diba, 2017, Expert system for turf irigation management. Ph.D. Thesis, Fac. Agric., Ain Shams Univ., Cairo, Egypt.**

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نموذج رياضي للتنبأ بتوزيع الرطوبة الارضية في منطقة الجذور للمسطحات الخضراء [10]

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الموجـــــــز

تم إجراء تجربة حقلية على أحد نباتات المسطحات الخضراء بمنطقة المسطحات الخضراء بكلية الزراعة ، جامعة عين شمس، باحداثيات N = 30 ° 06 '46.9"، E = 31 ° 4' 47.3"، تم دراسة معاملات للري (الرش– التنقيط تحت السطحي – تحت ظروف استخدام الهيدروجيل)، ولكل معاملة ثلاثة مكررات على العشب، لتحديد أفضل فترة بين الريات، وأفضل توزيع المياه لمنطقة الجذور لكل معاملة .

كانت اهم النتائج المتحصل عليها :

- كان متوسط كمية المياه في التربة على اعماق مختلفة في معاملات الري (بالتنقيط تحت السطحي، الرش) اعلى مقارنة بمعاملة الهيدروجيل.
- استخدام الهيدروجيل في المسطحات الخضراء وفر كميات كبيرة من المياه المستهلكة بالمقارنة باستخدام (نظام الري بالرش– التنقيط التحت سطحي) لتحسين تواجد المحتوى الرطوبي حول منطقة الجذور نتيجة استخدام الهيدروجيل واعطاء مظهر جيد للمسطح الاخضر من حيث اللون، الكثافة، التغطية للنجيلة.
- أعطت معاملة الهيدروجيل أعلى نسبة توفير للمياه بنسبة 170٪، 300٪ مقارنة مع معاملات الري (التنقيط تحت السطح، الرش) خلال السنة، وذلك بسبب قدرة الهيدروجيل على الاحتفاظ بالماء ووجود فترة كبيرة بين الريات عند استخدام معاملة الهيدروجيل في التربة.
- اعطت معاملة الري بالتنقيط تحت السطحي أعلي توفير لاستهلاك الكهرباء بنسبة 520٪، 55٪ بالمقارنة مع معاملات الري (الرش–ال هيدروجيل).
- جودة العشب للمسطح الاخضر (النجيلة) عالية من حيث (اللون والكثافة والغطاء الأرضي) له في معاملة الهيدروجيل مقارنة مع معاملات الري الأخرى (التنقيط تحت السطحي، الرش)، وهذا يرجع إلى أن الهيدروجيل يحتوي على العديد من المواد، سواء الطبيعية أو الاصطناعية، وقدرته على توفير المياه حول منطقة الجذور في النجيلة.
- كان متوسط المحتوى الرطوبي للتربة على عمق (10 سم، 15 سم) في معاملة الهيدروجيل أعلى مقارنة مع أنظمة الري (الرش، بالتنقيط تحت السطحي).
- اعطت معاملة الهيدروجيل افضل توزيع رطوبي حول منطقة الجذور وذلك على عمق (15,10سم) من التربة بالمقارنة مع معاملات الري الاخرى (التنقيط تحت السطحي، الرش).
- ساهم استخدام معاملة الهيدروجيل تحت سطح التربة في إعطاء افضل درجة للمظهر العام للمسطح الاخضر من حيث (اللون، الكثافة، نسبة التغطية) وذلك بالمقارنة مع معاملات الري الاخرى (التنقيط تحت السطحي، الرش).

الكلمات الدالة: الري، الري بالرش، الري بالتنقيط تحت السطحي، الهيدروجيل، المسطحات الخضراء – توزيع الرطوبة الارضية

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