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Effect of Sprinkler Type and Pump Operating Pressure in a Stationary Sprinkler Pump

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Abstract:-

The modern irrigation method using small local sprinklers (fog spraying) is one of the methods that is recommended to be followed. Evaluate the performance of the sprinkler irrigation system in terms of water distribution over the irrigated area, where several different standards must be adopted to control the irrigation regularity. This study was conducted on agricultural land located in the region. The desert in Karbala Governorate, 100 km south of the capital, Baghdad, in the month of April 2023, to determine the effect of two factors, namely the type of sprinkler, where two types of short-range and more widely used sprinklers were used; The operating pressure of the pump has two levels (2 and 4) Bar, and their interactions in the coefficient of uniformity of water distribution, uniformity of distribution, and efficiency of water addition. The averages were tested and the results showed that there were differences in water distribution at the pillar sprinkler for both the water distribution coefficient and distribution efficiency, as it gave the best result for the water distribution uniformity coefficient of 75.951% and the water addition efficiency of 74.865%, while the (Al-Khairat) sprinkler was the best morally. The consistency of water distribution 68.716%. The results also showed that the pump's operating pressure was superior at 2 bar in all the characteristics studied at the operating pressure of 4 bar. In the three-way interaction between the treatments, the best value for the water distribution uniformity coefficient and water addition efficiency was when using the sprinkler with a pressure of 2 bar, where the distribution uniformity coefficient was 77.245% and the water addition efficiency was 70.985%, while the consistency of distribution was its best value. With the sprayer (Al-Khairat) and the pressure of 2 bar, this value reached 69.426%.

Key words; Sprinkler, irrigation, pump, distribution, uniformity, Efficiency

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Introduction:

There are increasing calls for the use of modern irrigation techniques, such as sprinkler and drip irrigation, and other techniques that save irrigation water due to the decline in fresh water levels in Iraq due to the low level of the Tigris and Euphrates rivers, in addition to the drying or receding water in most of the rivers and their tributaries. These calls come in light of what these methods provide high irrigation efficiency and the resulting water savings. This in turn gives the possibility of horizontal expansion of irrigated areas to meet the growing need to provide food supplies due to the large population increase and the scarcity of irrigation water sources. It was necessary to shift from traditional irrigation systems to economic irrigation systems. Sprinkler irrigation is considered one of the main methods of field irrigation, in which water is supplied to the surface of the soil in the form of rain, by adopting the nozzle principle in converting the pressure inside the pipes into kinetic energy when the water runs out at high speed from the sprinkler nozzle, where it is separated and dispersed from the sprinkler nozzle into drops that fall on Soil or plant at a certain consistency and rate. There are many factors that affect the distribution of water when using sprinkler irrigation. Regular water distribution is the main goal of the sprinkler irrigation process.

As stated by (Al-Amin Agha 2001),the coefficient of uniformity of water distribution generally increases when pressure increases. As (Abo-Ghobar and Al-Amoud, 1992) adued that the evaluating of the performance of the sprinkler irrigation system depends on measuring the regularity of water distribution, operational pressures, and finding losses resulting from evaporation. Thus, the efficiency of irrigation regularity can be known in terms of water distribution over the irrigated area (Al-Ghobari, 2005).

(Nuzzled،2009) motioned that the efficiency of quenching is a function of the rate of depth of addition and the consistency of the mixture. Distribution, and there is a direct relationship between the depth of addition and the consistency of distribution. The deeper the addition, the greater the efficiency of quenching, while the efficiency of The addition decreases with the increase in the depth of the added water as a result of the increase in both Evaporation and small water droplets drifting.

Kara et.al (2009) explained that distributing water equally in the barrage irrigation system What depends on many factors, including: The type of sprinkler, the number and size of the sprinkler nozzles, the arrangement of the sprinklers, and Operational pressure. The design and investment of sprinkler networks requires knowing the appropriate pressure in the spray nozzle. The appropriate pressure is the pressure that ensures the largest possible spray radius with the lowest energy consumption. It must also ensure the water is spread and distributed well over the designated area. Previous studies show that the spray radius increases. The pressure increases until it reaches a limit value, and then it decreases as a result of the decrease in the kinetic energy of the water droplets, as the increase in pressure leads to the scattering of the water droplets into small spray droplets (Al-Amoud et al., 1991).

Al- Chanatis. 1992) mentioned that the water hydraulics in the sprinkler irrigation system depends on the Sprinkler nozzle diameter, height, operating pressure, and separation distance A connection between the sprinklers to achieve consistency and control the distribution of water.

(Both Haman and Yeager indicated). (2001) indicated that knowing the consistency of sprinkler water distribution is important because it reflects the tide of The water reaches most of the plants throughout

the field, and thus He foretold the intended benefit of the water used, and stressed that he is envious. Chapter: The decrease in distribution uniformity of the sprinkler irrigation system results from oscillation Operational pressure.

2- Materials and Mythology:

The experiment was conducted on agricultural land located in the desert of Karbala Governorate, which relies on well water for irrigation, in the month of April 2023, during times of calm winds, where the effect of wind on the sprinkler radius was excluded in order to obtain a comparable standard condition, and the readings were recorded to evaluate the performance of the sprinkler irrigation system by calculating the water distribution uniformity coefficient, distribution uniformity, and water distribution efficiency.

Two types of rotary reciprocating agricultural sprinklers were used, one of which is made of plastic and the other of metal. The two are highly resistant to salinity, long lasting, and have dual-extruded heads with a spray diameter of 20 meters. They are placed on a 90-cm-high pipe stand attached to the sub-water pipe, and the spray nozzle discharge volume is 50 cm. (1.0 cubic meters/hour). The second factor is the pump's operating pressure at two levels (2 and 4) bar.

The experiment was carried out with a randomized complete block design (RCBD), with a split-plot system, and with three replications, to demonstrate the significance of the differences between the averages of the coefficients.

Collection containers made of painted pottery were used to collect the water coming out of the sprinklers. They were placed on a stand 10 cm above ground level. These containers had a diameter of 12 cm and a height of 7 cm to collect the water distributed around the sprinklers. The time taken for each reading was 40 minutes. A graduated laboratory vessel with a volume of 250 ml was also used. Liter to measure the amount of water in the containers, and the characteristics of the uniformity of water distribution, the consistency of water distribution, and the efficiency of water addition were studied.

2-1: Studied attributes:

2-1-1) (UC) Uniformity coefficient;

This characteristic gives an indication of the homogeneity and regularity of the distribution of the added water over the irrigated area.To calculate the water distribution uniformity coefficient, the following equation was used (Ascough et al. 2002).

$$CU=\left[1-\frac{\sum_{0}^{1}(xi-\bar{x})}{nx-}\right]\times 100$$

CU: donate water distribution uniformity coefficient (%)

xi : represent height of water in different measuring vessels (mm)

$\bar{x}$The average height of the water collected in the vessels (mm).

$n\bar{x}$ is the number of measuring vessels in the studied area.

2-1-2) -1-2 (DU) Distribution Uniformity;

This relationship indicates consistency of distribution, which is one of the criteria by which the operational performance of the sprinkler irrigation system is evaluated (Merriam and Keller 1978).

The uniformity of water distribution was calculated by the following equation:

Du = d/(x) × 100

Where,

whereas:

DU: donate Uniformity of water distribution (%)

d : represent the average depths of water collected in the lowest quarter (mm)

X: is the average height of the water collected in the vessels (mm).

-1-3 Calculating the Efficiency of Water Addition (Ea

The efficiency of adding water was measured with the following equation (Mahdi et al., 2011):

Ea = (Ds/Da) x 100

whereas:

Ea = water addition efficiency.

Ds = average height of water in measuring vessels (mm).

Da = average absolute water height (mm).

The average absolute water height was calculated by the following equation:

$$\mathbf{Da} = \frac{(\mathbf{q}\times\mathbf{Ta}\times\mathbf{100})}{(\mathbf{si}\times\mathbf{sm}\times\mathbf{60})}\times\mathbf{1000}$$

whereas:

Da = average absolute water height (mm)

q= Sprayer discharge (L.h-1)

Ta= addition time (h)

Si = distance between sprays (m)

Sm = distance between lines (m)

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3- Results and iscussion

3-1 Type of influence on the organization of distribution, coordination and coordination in addition to:

Table (1) indicates that the sprinkler (column) had a significantly better effect than the sprinkler (Al-Khayrat) in the function of better water distribution agreement, where the value is 75.951%, in addition to water 74.865%, while the sprinkler (2) was morally better in Adjective. 68.716% Strange Talk with (Abo-Ghobar and Al-Amoud, 1992)

Which shows that choosing the type of sprinkler has a major impact on determining the amount of water sprayed and the various sprinklers from type to finish eliminating the manufacturers**.**

Table1: The effect of the type of sprinkler on the uniformity of water distribution, the uniformity of distribution, and the efficiency of adding water around the sprinkler

Efficiency of % adding water	*Uniform distribution of water around the % sprinkler*	*Coefficient of uniformity of water distribution around % the sprinkler*	*Type of sprinkler*
74.865	*51.127*	*75.951*	*Piltar*
69.726	*68.716*	*60.234*	*Al-Khairat*

3-2 The effect of water pressure on the uniformity of water distribution, the uniformity of distribution, and the recipe for adding water

It appears from Table (2) that the first pressure of 2 bar was significantly superior in the coefficient of uniformity of water distribution, reaching 69.090%. It also excelled in the consistency of water distribution, reaching 65.234%, as well as in the efficiency of adding water, reaching 70.157%. The reason may be due to the increase in pressure to 4 bar leads to the scattering of water droplets, depending on the type of sprinkler, into small spray droplets, which affects the characteristics mentioned above (Al-Amoud et al., 1991).

Table 2: The effect of water pressure on the uniformity of water distribution, uniformity of distribution, and efficiency of adding water around the sprinkler.

Efficiency of % adding water	Uniform distribution of water around the % sprinkler	Coefficient of uniformity of water distribution around % the sprinkler	Pressure of water (Bar)
70.157	65.234	69.090	2
62.893	54.608	67.094	4

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3-3 The effect of the interaction of sprinkler type and water pressure on the uniformity of water distribution, the uniformity of distribution around the sprinkler, and the efficiency of adding water.

It is clear from Table (3) that the type of sprinkler and water pressure have a significant effect on the coefficient of regularity and consistency of water distribution and the efficiency of addition, as the best value for the coefficient of uniformity of water distribution was 77.245% when the sprinkler (piltar) and the pressure were 2 bar. Likewise, the best value was for the efficiency of adding water When using the piltar with a pressure of 2 bar, it reached 70.985%, while the uniformity of distribution was its best value with the sprinkler (Al-Khairat) and a pressure of 2 bar, where this value reached 69.426%. The reason for this is because increasing the pressure reduces the coefficient of uniformity and coordination. Water distribution for both types of sprinklers.

Table 3:- The effect of the interaction of sprinkler type and water pressure on the uniformity of water distribution, uniformity of distribution, and the efficiency of adding water around the sprinkler.

Efficiency of adding water%	Uniformity of water distribution around the % sprinkler	Coefficient of uniformity of water distribution around % the sprinkler	Pressure of water (bar)	Spray type
70.985	69.426	60.935	2	Piltar
61.724	68.006	59.533	4	
69.075	61.043	77.245	2	Al-Khairat
63.158	41.211	74.657	4	

Fig1: The effect of the type of sprinkler on the uniformity of water distribution, the uniformity of distribution, and the efficiency of adding water around the sprinkler.

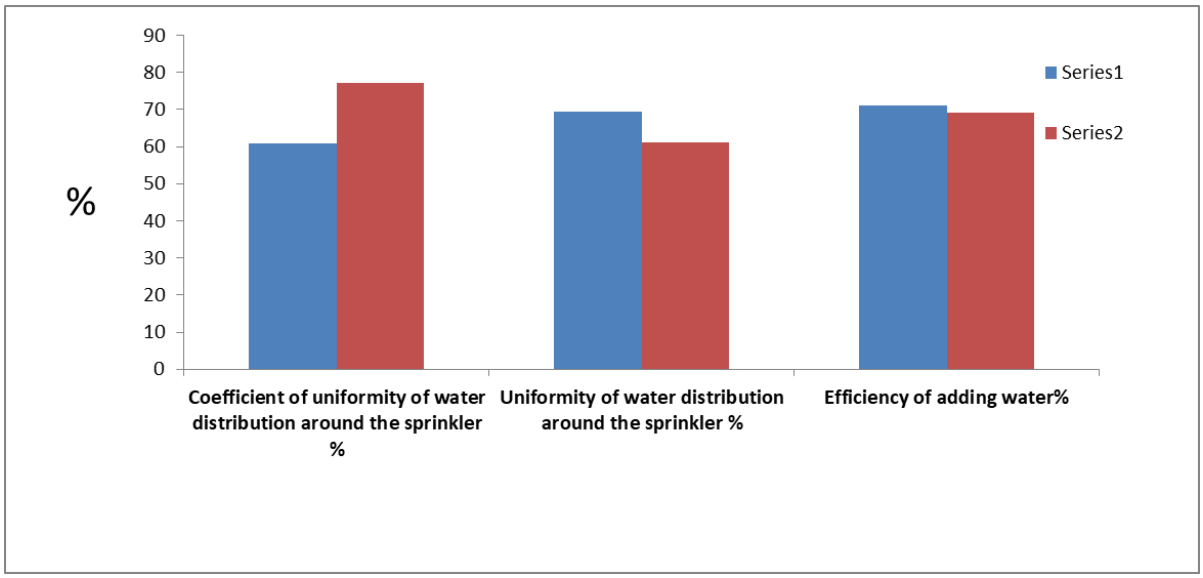
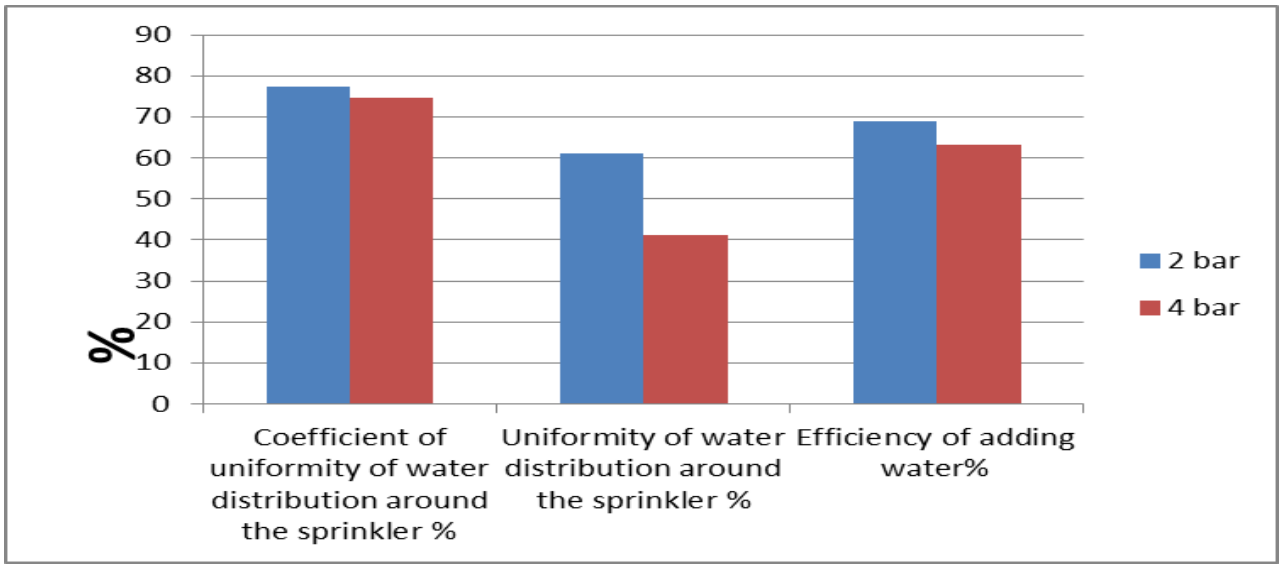


Fig 2: The effect of water pressure on the uniformity of water distribution, uniformity of distribution, and efficiency of adding water around the sprinkler.



Conclusion:-

As shown above, the most important findings of this research can be summarized as follows; The appropriate pressure value for the studied sprinklers is 2 bar. Piltar type sprinklers gave the best results in terms of water distribution coefficient and water addition efficiency. Al-Khairat type sprinklers gave the best results in terms of consistency of water distribution around the sprinkler. It is recommended to use an irrigation system with local sprinklers because of its importance in saving irrigation water. Use piltar sprinklers because they have high irrigation efficiency.

Farther study can be done using different distribution systems for vertical sprinklers. Also, the evaluation of the efficiency of sprinkler irrigation should be investigated to obtain the best irrigation efficiency by using appropriate design systems for irrigation networks.

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