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Effect Of Floppy Sprinkler And Irrigation Regime On Wheat Productivity Under New Land Conditions

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ABSTRACT

Background: This study examined the effects of various irrigation schedules and operating pressures on water uniformity, water relations, wheat yield, and yield components when using a 3 m-height overhead floppy sprinkler. During the winter of 2022-2023 the experiments and measurements were planned and carried out at the experimental farm of El Salhia, El Sharkia Governorate, Egypt, under new land conditions. The CU and DU were calculated under five different pressure levels (100, 150, 200, 250 and 300 kPa and irrigation regimes (100, 75, and 50% of evapotranspiration (ETc). According to the results the highest CU and DU values 82.37 and 72.23% respectively were achieved with an overhead floppy sprinkler at a height of 3 meters and a pressure of 200 kPa. Additionally the results demonstrated that in order to achieve high wheat yield an irrigation regime ranging from 50 to 100% ETc under ideal operating circumstances was implemented. Treatment 100% ETc produced the highest yield production and components whereas 50% ETc produced the highest water use efficiency (WUE rating. Ultimately the optimum system for producing a high wheat yield under the given testing conditions was the use of irrigation water 100% ETc at a pressure of 200 kPa at a height of 3 m above the ground with high CU and DU for an overhead floppy sprinkler. However it can be recommended to use 75% ETc for irrigation water in order to achieve high yield output and conserve 25% of water which will help address future water scarcity.

Keywords*:* Wheat productivity, Floppy sprinkler, Irrigation regime, Water uniformity

1. INTRODUCTION

Water scarcity is defined as a shortage in water moisture content due to a lack in precipitation that causes increased transportation and evaporation from the soil[1].

The world is facing significant challenges in meeting the increasing demand for food production to feed a growing global population, projected to reach 9.7 billion by 2050. Agriculture is a critical sector that plays a vital role in ensuring food security, and wheat is one of the most important staple crops globally. However the increasing pressure on water resources and the degradation of arable land pose significant threats to wheat productivity and food security. The

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increasing demand for food production to meet the needs of a growing global population has led to the expansion of agricultural land into new areas. However these new lands often face challenges such as limited water resources and poor soil quality which can negatively impact crop productivity. Wheat is a staple crop in many parts of the world and its productivity is crucial for ensuring food security. The floppy sprinkler irrigation system has emerged as a promising technology for improving water use efficiency and crop productivity in water-scarce areas.

In many parts of the world, agricultural production is being expanded into new lands, often characterized by poor soil quality limited water resources and harsh climatic conditions. These new lands present unique challenges for agricultural production and innovative solutions are needed to improve crop productivity and water use efficiency. Irrigation is one of the most critical factors affecting wheat productivity. In recent years various modern irrigation systems have been developed to improve irrigation efficiency and reduce water loss. The floppy sprinkler irrigation system is one such system that has proven effective in improving wheat productivity.

The floppy sprinkler irrigation system has emerged as a promising technology for improving water use efficiency and crop productivity in water-scarce areas. This system uses a flexible hose with sprinklers that can be easily moved across the field, providing uniform water distribution and reducing evaporation and runoff. Irrigation systems (center pivot and solid sit are widely used in many countries due to they allow applying a small amount of water the Solidset irrigation system can be more adjustable than center pivots in irrigation control easily allowing selecting the irrigation time (day or night and repetitions[2,3]. Studded the relationship and modeling between irrigation system, tillage depth, tillage system, and soil water moisture through the growing season in Iraqi semi-arid areas it is crucial to make a simplified methodology to determine SMC in different stages of the growing season[4,5]. The researcher recommends the necessity of providing material and moral support to vegetable farmers by the Ministry of Agriculture and the General Company for Agricultural Supplies so that they can acquire drip irrigation systems. Working to increase the material and moral support for vegetable farmers from the Ministry of Agriculture and the General Company for Agricultural Supplies. The need to work on finding scientific and practical solutions to the problems that accompany the application of drip irrigation technology[6].

Wheat is a water intensive crop that requires adequate water supply throughout its growth stages. However, water scarcity is a major constraint to wheat production in many parts of the

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world. The use of efficient irrigation systems such as the floppy sprinkler system can help to improve water use efficiency and reduce the environmental impact of agriculture[7],conducted a comprehensive study evaluating the performance of two types of floppy sprinkler irrigation systems imported and indigenous with the goal of improving water efficiency in agricultural irrigation. The research focused on three key parameters: Application Efficiency of the Low Quarter (AELQ, Distribution Uniformity (DU and Coefficient of Uniformity (CU tested under varying operating pressures (1.5 to 4 bar and riser heights (10 ft, 12 ft, and 15 ft. Some studies detected apparent deficiency in a number of large pores in unplowed soils compared with conventionally plowed soil[8]. The statistical results illustrated the effect of drip irrigation system on all parameters which included; superlative of the modified system significantly on all parameters than the normal system. The modified system generally is superlative on the normal system by recorded lowest (q_c values from the normal system. From this modification an increased stationary force of roots in the soil and be achieved by increasing wetted area and easily cultivation for weed protect that will effect on trees breeding, as a result production increased.[9].

The water content in the soil is affected by how water is added to the soil (water irrigation systems irrigates soil by adding water with the smallest particles to soil than this made water penetrate deeper in soil layers on other hand plowing method have big role in facilitating water penetration through soil layer by making holes and crakes through soil layers choosing plowing method without soil layer revers and keeping soil construction and aggregate play an effective roll in soil water conserve. [10,11] reported water application efficiencies for different irrigation systems: 68% for solid set sprinklers 95% for subsurface drip 74% for floppy sprinklers and 82% for center pivot systems. These results guide selection based on system efficiency. The sprinkler performance helps to differentiate the selection of a method for cropping system. In a highly efficient irrigation system evaporation losses, distribution uniformity and wind drift are the primary factors that measure the sprinkler system's performance [12]. Careful selection of nozzle diameters, operating pressure, riser height and sprinkler spacing in sprinkler irrigation can be used to apply the ideal amount of irrigation water needed to refill the crop root zone that can neither cause runoff nor harm the crop and also provide the best uniformity possible under the prevailing wind and management conditions. [13] conducted a comprehensive experimental study to investigate how pressure loss affects water distribution uniformity (CU application rate and spray velocity using a dynamic fluidic sprinkler under varying working conditions, the experiments tested four operating pressures (0.15, 0.2, 0.25, and 0.3 MPa and sprinkler spacing

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based on different layouts (square and triangular with ratios of 1R, 1.2R and 1.4R [14] investigated how the riser height affects the rotation uniformity and application rate of dynamic fluidic sprinklers under various operating conditions. The study involved experimental trials with different riser heights to observe changes in sprinkler rotation speed water distribution uniformity and application rates. The results demonstrated that riser height significantly influences sprinkler performance. Specifically increasing the riser height improved rotation uniformity up to an optimal point by reducing hydraulic disturbances and enabling a more stable flow regime. However excessively high risers caused instability in rotation leading to decreased uniformity. [15] examined the influence of riser height on sprinkler irrigation performance under constant pressure. Using three riser heights (0.5 m, 1.0 m and 1.5 m they assessed water distribution based on Christiansen's Uniformity Coefficient (CU and Distribution Uniformity (DU. Results indicated that a 1.0 m riser achieved the most uniform water application balancing spray coverage with minimal losses. Short risers led to under-irrigation while taller ones increased wind drift and evaporation. The study concludes that optimizing riser height is essential for improving irrigation efficiency in pressurized systems. [16] evaluated the effects of operating pressure, nozzle diameter and riser height on sprinkler irrigation uniformity using both experimental data and Artificial Neural Networks (ANN. Results identified pressure and nozzle diameter as the dominant factors influencing Christiansen's Uniformity Coefficient (CU with minimal impact from riser height. The ANN model yielded accurate predictions, demonstrating the potential of machine learning in optimizing irrigation system design and performance. Water stress affects nearly in the plant. The total of wheat yield reduction as a result of water stress is affected by the stage of crop development where early grain development stage is more vulnerable to water stress than latter grain development stage [17] . Water use efficiency is defined as the relation between grain yield and total evapotranspiration (ET_c during the growing season. Maize (*Zea mays L.* can be classified as one of the most important cereal crops in the world, can be used as food for humans and animals and many populations in developing countries use as a source of revenue [18].

The current study set out to investigate the effects of various irrigation regimes and operating pressures on the water uniformity, growth, yield components, wheat productivity and water use efficiency when employing overhead floppy sprinklers in new land conditions.

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2. Materials and Methods

During the winter of 2022–2023 the experimental field was conducted in sandy soil in the experimental farm of El Salhia 30° 36′ *N*, 31° 47′ *E*, ElSharkia Governorate, Egypt, under new land conditions. A pump with 25 Hp, head control unit, pipe lines and sprinkler device that up the experimental overhead floppy sprinkler system. Pipe lines were designed with a 75 mm PVC main line a 63 mm PVC submain line and an overhead lateral line with 50 mm PE. An overhead floppy system that was three meters high was attached as a fixed system. A variety of crops were used with the overhead floppy design. A plastic pipe with a flexible silicon tube installed within the sprinkler body made up a floppy sprinkler. Water snakes through the tube as it rotate slowly in a 360-degree circle creating droplets. To collect water plastic catch cans of 175 mm in diameter and 135 mm in height were placed beneath the floppy sprinkler in the whole sprinklers circle. The test lasted for half an hour. A measurement of the collected water's area in millimeters per hour was made. To ascertain high uniformity the floppy sprinkler was tested at five operating pressure levels (100, 150, 200, 250, and 300 kPa at a height of three meters above the ground are shown in Figure (1).

Fig.1.Experimental field for evaluating overhead floppy sprinkler.

Wheat grains of the Misr-2 variety (*Triticum aestivum L*. were planted in rows 0.15 meters apart on November 20, 2022 and harvested on April 15, 2023 during the winter season of 2022-2023. Wheat plants were harvested 142 days after they were planted the generated floppy sprinkler was using at 200 kPa of pressure 3.0 m of overhead height and 100, 75 and 50% of evapotranspiration (ETc which was determined using the Penman-Monteith equation [19]. All agricultural procedures were followed as they are typically used to cultivate wheat, and fertilizer was used in accordance with the Egyptian Agriculture Ministry's recommendations.

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Fertilization rates at the experimental site were expressed as percentages of the Ministry of Agriculture's recommended rates: Ammonium nitrate or NH_4NO_3 was injected into the irrigation network in three doses over the growth season as a nitrogen supply with a rate of N (225 kg/fed. Prior to cultivation the soil was supplemented with super phosphate (P_2O_5 a source of phosphorus with a rate of P (100 kg/fed. When the land was being prepared for planting, potassium sulfate (K_2O a source of potassium with a rate of K (50 kg/fed was supplied.

2.1.Soil characteristics

The soil has a sandy texture. Prior to cultivation the experimental site's soil's physical and chemical characteristics were examined. The methodological processes were based on those outlined by [20.21]. and the results are shown in Tables (1 and 2. The sandy soil in the tested depth levels is uniform.

Table 1: Physical characteristics of the experimental soil.

Soil depth (cm)	Particle size distribution %			Tex. Class	ρb (g/cm^3)	FC (%)	WP (%)	AW (%)
	Sand	Silt	Clay					
0 -25	90.50	5.51	3.99	Sandy	1.57	9.93	3.36	6.57
25-50	90.75	6.01	3.24	Sandy	1.58	9.35	3.94	5.51

Table 2: Chemical characteristics of the experimental soil.

Soil depth (cm)	C.E.C mol/kg	pH 1:2.5	EC (dS/m) at 25□C	Soluble anions (meq/l)				Soluble cations (meq/l)			
				CO_3□□	HCO_3□	Cl□	SO_4□□	Ca^{++}	Mq^{++}	Na^{+}	K^{+}
0 -25	3.31	7.45	2.41	□	2.86	9.67	11.62	7.08	4.66	10.97	1.42
25-50	3.59	7.33	2.51	□	3.00	10.16	11.88	7.31	4.89	11.34	1.51

2.2.Irrigation water analyses

The irrigation water's chemical analyses which are shown in Table (3 were carried out using the procedures outlined by [22].

Table 3 : Chemical characteristics of irrigation water.

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SAR	PH	EC (dS/m) at 25°C	Soluble anions (meq/l)				Soluble cations (meq/l)			
			CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mq^{++}	Na^+	K^+
1.83	8.04	1.06	−	2.83	3.50	4.54	6.87	0.55	2.68	0.77

The floppy sprinkler's discharge was measured by gathering water in a container over the course of four minutes. The following formula was used to determine the floppy sprinkler's rate of application (Ra, mm/h) [23]:

$$Ra = k\frac{Q}{A}$$

Where: Q is discharge of floppy sprinkler (*ℓ /min*, A is wetted area of floppy sprinkler (m^2 and k: unit constant (Q in *ℓ /min*, A in m^2 and k = 60 for Ra in *mm /h*.

Water uniformity, wheat productivity, and water use efficiency are all significantly impacted by distribution consistency. In order to determine the distribution uniformity the sprinkler system unit was estimated under various pressures (100, 150, 200, 250 and 300 kPa with an overhead floppy measuring 3 meters (Bilalis *et al.,* 2009. Water uniformity, wheat productivity and water use efficiency are all significantly impacted by distribution consistency:

$$DU = 100\frac{D_{lq}}{\overline{D}}$$

Where: *DU is* distribution uniformity (% $\overline{D_{lq}}$ is average can depth in the lowest quarter of the field (*mm* and $\overline{D}$ is average can depth (*mm*.

The quantity of water collected in each catch can was noted and measured by equation coefficient of uniformity according to [24] as follows:

$$CU = 100\left(1 - \frac{\sum\left|D_i - \overline{D}\right|}{n\overline{D}}\right)$$

Where: *CU is* coefficient of uniformity (% $\sum\left|D_i - \overline{D}\right|$ is the summation of absolute values of

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deviation from the average can depth, D_i is can measurement (*mm*, D is average of can measurements (*mm* and n is the number of cans collector.

The Penman-Monteith equation, which [19] calculated, was used to measure the amount of water used in each irrigation interval of yield during the plant season:

$$IWR = ET^c A F$$

Where: ET_c is actual wheat evapotranspiration (mm/day IWR is irrigation water consumed (*ℓ/Irri*., A is the wheat area (m^2 and F is the irrigation interval (day.

The applied irrigation regime percentages were as follows 100, 75 and 50% ET_c. The time of water application (T_w, h for each ET_c% was measured by equation:

$$T_w = \frac{IWR}{q}$$

Where: q is the sprinkler discharge (*ℓ/h*.

Irrigation regime may have an impact on water use efficiency; it would be important to specify how these modifications would affect plant season and plant water consumption. Additionally, the relationship between seed yield (kg/fed and water applied (m^3/fed during the growing season was used to compute the water use efficiency (WUE, kg/m^3. This was done using the following equation:

$$WUE = \frac{Grains\ wheat\ (kg/fed)}{Water\ applied\ (m^3/fed)}$$

3 .RESULTS AND DISCUSSION

3.1. Effects of operating pressure on discharge, wetted area and application rate Table (4) showed the effects of various operating pressures on the overhead floppy sprinkler's discharge, wetted area and application rate. The findings demonstrated the impact of operating pressure on the floppy sprinkler's discharge, application rate and wetted area. It is evident that the sprinkler's discharge was significantly impacted by operating pressure. The results showed a direct relationship between the floppy sprinkler's discharge and pressure. As result when the pressure was increased from 100 to 300 kPa the floppy sprinkler's discharge increased by 71.6%. Meanwhile the rate of application increased by 36% in tandem with an increase in operating pressure. The results make it clear that a high application rate for the floppy sprinkler

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might be produced by high operating pressure. As pressure increases, the application rate increases due to the increased discharge this results agreement with the results reported by [25]. Wetted area displayed a similar trend; for floppy sprinklers wetting area was generally influenced by operating pressure. The results indicated that increasing the operating pressure from 100 to 300 kPa resulted in a 11.40% increase in the wetting area. Comparable trends were also observed for all assessed operating pressures under study conditions.

Table 4: Effects of operating pressure on discharge, wetted area and rate of application for overhead floppy sprinkler.

Operating pressure (kPa)	Discharge (l/h)	Wetted area (m^2)	Rate of application (mm/h)
100	600	139.53	4.30
150	771	163.00	4.73
200	939	178.85	5.25
250	984	175.40	5.61
300	1030	176.06	5.85

3.2.Effects of operating pressure on water uniformity

The coefficient of uniformity (CU is a numerical representation of the soil surface water distribution uniformity index. The coefficient of uniformity was computed at a floppy height of three meters and operating pressures of 100, 150, 200, 250 and 300 kPa. Figure (2 illustrates the relationship between the coefficient of uniformity and operating pressure. As can be seen when operating pressure rose from 100 to 200 kPa CU rose from 73.52 to 82.37%. Conversely as the operating pressure rose from 200 to 300 kPa the CU for the floppy sprinkler decreased from 82.37 to 77%.

At both low and high operating pressures the coefficient of uniformity may decrease due to nonuniform water distribution. Large water droplets formed close to the sprinkler reducing sprinkler throw as a result of the water jet's inability to break down easily at low operating pressure levels. Furthermore, at high working pressure levels the jet split up excessively creating small water droplets that were simple to blow off and discard from the sprinkler. The results demonstrated that the greatest coefficient of uniformity was attained at 200 kPa of operating pressure across all assessed operating pressure ranges. This result is in line with the

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pressure recommended by the manufacturer of the floppy sprinkler as reported by [26,7]. According to the results 200 kPa of operating pressure is recommended to achieve a high coefficient of uniformity for the sprinklers that were tested even with the identical operating pressure settings this results agreement with the results reported by [25].

Consistency of application is one of the primary concerns during the sprinkler irrigation design process. The DU trends for floppy sprinklers at different operating pressures are shown in Figure (3. The DU typically increased as operating pressure increased for all tested operating pressures peaking at 200 kPa. But the DU dropped again for operating pressures above 200 kPa. When the operating pressure was elevated from 100 to 200 kPa, the DU values climbed from 65.21 to 72.91% when the operating pressure was raised from 200 to 300 kPa the DU values decreased from 72.91 to 66.20%. The findings showed that the maximum DU values 72.91% were achieved at an operating pressure of 200 kPa. The data clearly show that CU and DU follow a parallel pattern at every evaluated operating pressure level. The maximum CU and DU values were obtained at an operating pressure of 200 kPa. This suggests that a more consistent water application might be achieved using the operating pressure previously specified. Moreover at every working pressure level that has been measured. This might be because to the unreliable sprinkler production as mentioned by [25,26,7].

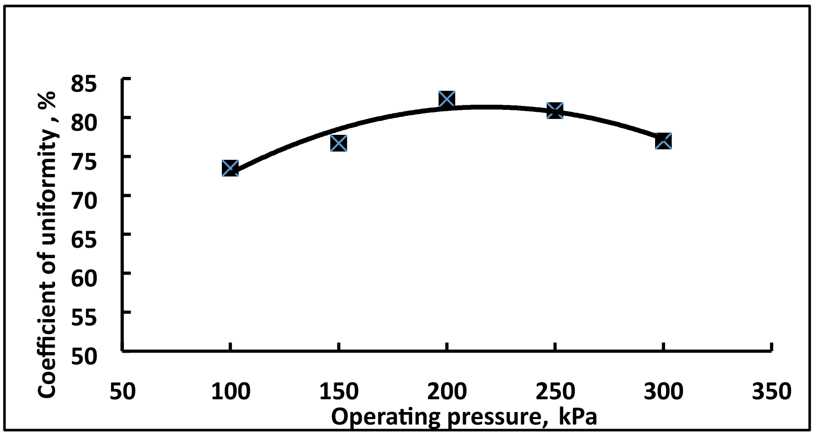

Fig.2. Effects of operating pressure on coefficient of uniformity .

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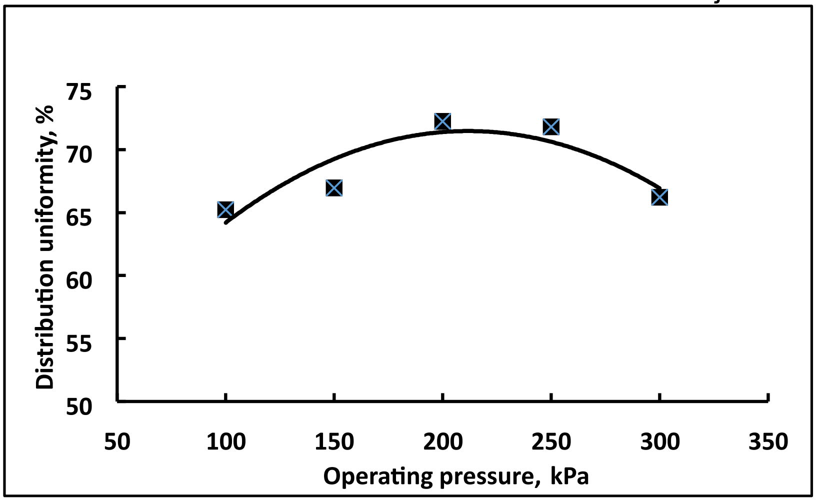

Fig.3. Effects of operating pressure on distribution uniformity.

3.3. Wheat yield and yield components

Growth characteristics were examined in relation to the impacts of an irrigation regime ranging from 100 to 50% ETc and ideal operating circumstances, which included an overhead floppy sprinkler at a height of 3 meters and a pressure of 200 kPa. Plant height, spike number per square meter, spike length, 1000 grain mass, spike grain mass and grain number per spike of wheat were all measured. Table (5 and Figure (4 showed the wheat and straw yields (kg/fed at 142 days of seeding during the growing season. The findings demonstrated that an increase in irrigation regime led to an increase in yield production and yield components. As ETc climbed from 50% to 100%, the overall yield of wheat and straw increased as well.

3.4 Grain yield and applied water

Grain yield of wheat was significantly affected by irrigation levels Table (5. The highest yield 2750 kg/fed was obtained under full irrigation 100% ETc followed by 75% ETc 2550 kg/fed while

the lowest yield 1750 kg/fed was recorded under 50% ETc. The gradual decline in yield with decreasing irrigation water reflects the direct effect of water deficit on grain filling and overall biomass production. Similar findings were reported by several researchers who found that water stress at critical growth stages reduces photosynthetic activity and assimilate translocation to grains.

Although grain yield decreased under deficit irrigation the applied water also decreased substantially from 1800 m^3/fed to 900 m^3/fed. Therefore when water use efficiency (WUE was considered both 75% and 50% ETc treatments recorded higher WUE values 1.88 and 1.94 kg/m^3 respectively compared with 100% ETc 1.53 kg/m^3. This indicates that moderate water deficit improved the efficiency of water utilization producing more yield per unit of water applied.

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Most yields related traits (spike grain mass, 1000 grain mass, grains per spike and spike number/m² were significantly influenced by irrigation levels. The 100% and 75% ETc treatments were statistically similar for these traits whereas 50% ETc produced markedly lower values. These results suggest that moderate water reduction 25% did not significantly harm yield components but severe deficit 50% caused clear reductions in spike development and grain weight. Water stress limits carbohydrate accumulation and reduces spikelet fertility leading to lighter grains and fewer grains per spike. Consequently the observed yield decline under 50% ETc can be attributed to the cumulative effect of reductions in spike mass and grain number.

3.5 Spike length and plant height

Spike length showed no significant differences among treatments indicating that this trait is relatively stable and less sensitive to moderate water stress. In contrast plant height decreased sharply as irrigation level decreased 95.5 cm to 82.55 cm. This reduction is a common response to water deficit due to limited cell expansion and reduced internode elongation. Similar patterns were reported by [17] who found that water stress shortened wheat plants but did not necessarily reduce the number of spikes per unit area.

Table 5 : Yield wheat characteristics and water use efficiency under treatments (ETc) .

Treatment *(ET_c)*	Yield and wheat characteristics						Applied water (m^3/fed)	Grain yield (kg/fed)	*WUE* (kg/m^3)
	Plant height (cm)	Spike length (cm)	Grain n/Spike	Spike n/m^2	1000 grain mass (g)	Spike grain mass (g)			
100 %	95.50	9.85	45	350	36.55	1.70	1800	2750	1.53
75 %	90.31	9.15	43	345	35.22	1.60	1350	2550	1.88
50 %	82.55	9.12	39	334	27.86	1.20	900	1750	1.94

The figure (4): shows that both grain yield and straw yield decreased progressively with the reduction in irrigation water from 100% to 50% ETc. At 100% ETc the crop produced the highest grain yield and straw yield indicating that adequate water supply supported vegetative growth and grain filling. At 75% ETc both yields decreased slightly but remained close to those of full irrigation, suggesting that moderate water deficit did not severely limit productivity. However at 50% ETc both grain and straw yields dropped markedly reflecting the strong negative impact of severe water stress on plant growth and dry matter accumulation. This

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pattern confirms that wheat yield is highly sensitive to irrigation level and the 75% ETc treatment could be a promising compromise saving irrigation water while maintaining acceptable yield performance.

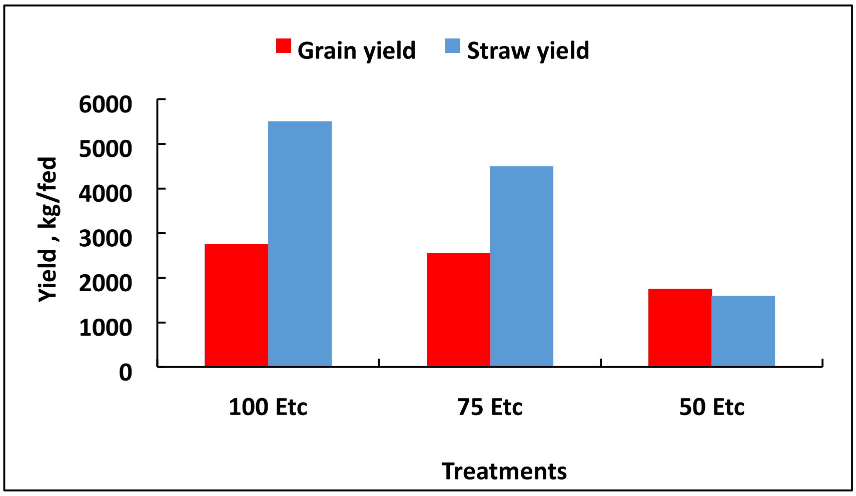

Fig.4. Effects of irrigation regime on grain and straw yield.

At 100% ETc under overhead floppy conditions, the maximum wheat yield parameters were plant height, spike length, number of grains per spike, spike n/m^2, 1000 grain mass and spike grain mass of wheat which were 95.5 cm, 9.85 cm, 45 n, 350 n/m^2, 36.55 g and 1.70 g respectively. Conversely at a pressure of 200 kPa and a height of 3 m the wheat characteristics declined by 82.55 cm, 9.12 cm, 39 n, 334 n/m^2, 27.86 g and 1.20 g respectively when the ETc dropped from 100 to 50%. Thus the higher level of soil moisture content and uniformity may be the source of this rise.

When compared to all treatments the treatment with 50% ETc had the lowest value while the treatment with 100% ETc had the highest values. These outcomes were caused by the overhead floppy's maximum water uniformity at 200 kPa of pressure and 3 m of height. Additionally lowering the 25% (75% ETc of water applied for overhead watering only resulted in a 7.27 and 18.18% drop in grain and straw production from 2750 to 2550 and from 5500 to 4500 kg/fed respectively. Figure (4 illustrates how the grain and straw yields of 1750 and 1600 kg/fed were lowered by 36.36 and 70.90% when 50% of the water (50% ETc was reduced. Therefore treatment 50% ETc could not be suggested for wheat

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production in sandy soil due to the water deficiency which lead to low soil moisture content plant stress and minimum grain yield according to [27,5].

Moderate water deficit 75% ETc can be adopted as an efficient irrigation strategy for wheat conserving water by about 25% without a significant yield penalty. These results highlight the importance of optimizing irrigation to improve water productivity under arid and semi-arid conditions.

3.6 The effect of irrigation regime on water use efficiency

Table (5) and Figure (5) showed that water use efficiency increased as the irrigation level decreased. The lowest WUE value 1.53 kg/m³ was recorded under the 100% ETc treatment while higher values were obtained under 75% and 50% ETc were 1.88 and 1.94 kg/m³ respectively. This trend indicates that reducing irrigation water improved the efficiency of water utilization since the relative decrease in yield was smaller than the reduction in applied water. The improvement in WUE under deficit irrigation could be attributed to better partitioning of assimilates towards grain production and reduced non-productive water losses through evaporation and transpiration. However under severe deficit 50% ETc the apparent increase in WUE does not necessarily reflect economic efficiency because the total yield dropped substantially.

Additionally WUE values between 50% and 75% were roughly equal to and superior to 100% ETc. However the results showed that the overhead floppy sprinkler in sandy soil produced the highest value WUE of 1.94 kg/m^3 at 50% ETc. According to the results presented using 75% ETc boosted wheat productivity for floppy sprinklers and conserved 25% of water. Addressing future water shortages on newly acquired lands in order to promote good agricultural productivity and food security is the main objective of this study and comparable future research this results agreement with the results reported by (Hilal, 2023.

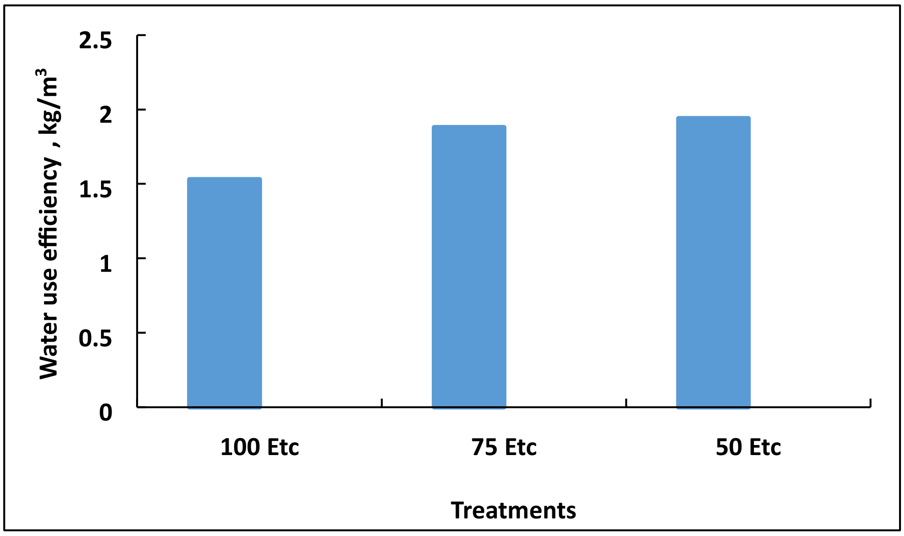

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Fig.5. Effects of irrigation regime on water use efficiency.

4. Statistical Analysis

Data were analyzed using ANOVA and Duncan's multiple range test at P < 0.05 are shown in Table (6 the results indicated that water use efficiency (WUE increased as irrigation decreased showing the highest values under 50% and 75% ETc. Grain yield declined significantly with reduced irrigation with the 100% ETc treatment producing the highest yield. Spike grain mass, 1000 grain mass, grains per spike and spike number per m² were significantly reduced under water deficit (50% ETc. Plant height also decreased consistently with reduced irrigation levels. Overall the 75% ETc treatment maintained good yield performance while improving water use efficiency suggesting it as the optimal irrigation regime under water limited conditions.

Table 6: Effect of irrigation treatments on wheat yield and related Treatment

Treatment	100% ETc	75% ETc	50% ETc	LSD (0.05)*	Duncan grouping
WUE (kg/m³)	1.53 b	1.88 a	1.94 a	0.20	75% = 50% > 100%
Grain yield (kg/fed)	2750 a	2550 b	1750 c	180	100% > 75% > 50%
Applied water (m³/fed)	1800 a	1350 b	900 c	150	100% > 75% > 50%
Spike grain mass (g)	1.70 a	1.60 a	1.20 b	0.12	100% = 75% > 50%
1000 grain mass (g)	36.55 a	35.22 a	27.86 b	2.10	100% = 75% > 50%
Spike number/m²	350 a	345 a	334 b	10	100% = 75% > 50%
Grains/spike	45 a	43 a	39 b	3	100% = 75% > 50%
Spike length (cm)	9.85 a	9.15 a	9.12 a	ns	Not significant
Plant height (cm)	95.50 a	90.31 b	82.55 c	4.5	100% > 75% > 50%

*LSD values are estimated; different letters within a row indicate significant differences according to Duncan's multiple range test at P < 0.05., ns = not significant.

4 .CONCLUSIONS

Among the most significant research this one is regarded as strategically significant for the nation. The findings demonstrated that using an overhead floppy sprinkler is advised and produced a good yield of wheat. The findings might be summed up as follows:

1. For an overhead floppy sprinkler the maximum uniformity CU and DU were measured at a height of 3 meters and a pressure of 200 kPa.

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2. By increasing ETc% and values CU and DU plant wheat characteristics, grain production and straw yield enhanced.
3. 100% ETc produced the highest yield and yield components while 50% ETc produced the highest WUE values.
4. According to the current study employing 75% ETc reduced water consumption by 25%, which will help address future water shortages.
5. Overall the 75% ETc treatment maintained good yield performance while improving water use efficiency suggesting it as the optimal irrigation regime under water limited conditions.

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6.CONFLICT OF INTEREST

There are no conflicts of interest with the publication of this work.

REFERENCES

[1] Alobaidy,T.S. & Hesham M.H. (2024). Predction of soil moisture charactric curve by using van genuchten model (1980) and soilpar2 for some soil at nineveh governorate. Mesopotamia Journal of Agriculture, 52 (2), 46-57. http://doi.org/10.33899/mja.2024.146131.134018

[2] Franco-Luesma, S., Álvaro-Fuentes, J., Plaza-Bonilla, D., Arrúe, J. L., Cantero-Martínez, C., & Cavero, J. (2019). Influence of irrigation time and frequency on greenhouse gas emissions in a solid-set sprinkler-irrigated maize under Mediterranean conditions. Agricultural Water Management, 221, 303-311. https://doi.org/10.1016/j.agwat.2019.03.042

[3] Eskander H. Alqysy; Muna A. ALamadani; Sura S. Alaidham (2020). Meta – analysis for agricultural researches (review). Mesopotamia Journal of Agriculture, 48(4), 2020,23-34. http://doi.org/10.33899/magrj.2014.88439

[4] Hilal, Y. Y. , Khessro, M. K. , van Dam, J. , & Mahdi, K. (2022). Automatic water control system and environment sensors in a greenhouse. Water, 14(7). http://doi:10.3390/w14071166

[5] Hilal, Y. Y., EliÇIn, A. K., Sedeeq, A. M. A., & Shahin, A. A. (2023). Developing a model using neural networks to predict wheat production in the Kirkuk governorate. Mesopotamia Journal of Agriculture, 51(4), 106-118. https://doi.org/10.33899/mja.2023.140455.1238

[6] Rayan R. Kadem (2022). Application level of drip irrigation technology by the vegetable growers in alqosh district/ nineveh, Mesopotamia Journal of Agriculture, Vol. 50, No. 2, 2022 (38-46): https://10.33899/magrj.2022.133802.1172

[7] Hashim, S., Khan, A. A., Ikram, R. M., Mehvish, F., Saifullah, M., Ali, M., & Almalki, M. (2021). Performance evaluation of indigenous floppy sprinkler irrigation system for various crops water management. Journal of King Saud University-Science, 33(8), 101636. https://doi.org/10.1016/j.jksus.2021.101636

[8] Yahya, L. M. (2023). Evaluation of the performance of new rotary plow blades (t-shape) under different levels of soil moisture and plowing depths at some field indicators. Mesopotamia Journal of Agriculture, 51 (3), 67-78. http://doi:10.33899/mja.2023.141041.1249

10.48047/jocaaa.2024.33.06.187

[9] Bahram kh. Mohammed, Hussein Th. Tahir and Talat M. Amin (2008): Efficiency of modification of emitter locations for sub main pipes in trikle irrigation system. Mesopotamia Journal of Agriculture, Vol. 36, No. 3, 2008. https://iasj.rdd.edu.iq/journals/journal/issue/5742

[10] Khalid E. Al-Mastawi, Ahmed M. A. Saeed, Ghazwan A. Dahham, Mahmood H. Rafik (2024). Predicting soil water contents under semi-arid climate. Mesopotamia Journal of Agriculture, Vol. 52, No. 4, 2024 (46-58). https://doi.org/10.33899/mja.2024.147569.1388

[11] Shabbir, A., Mao, H., Ullah, I., Buttar, N. A., Ajmal, M., and Lakhiar, I. A. (2020). Effects of drip irrigation emitter density with various irrigation levels on physiological parameters, root, yield, and quality of cherry tomato. Agronomy 2020, 10(11), 1685; https://doi.org/10.3390/agronomy10111685

[12] Roberts, C., Yost, M., Ransom, C., & Creech, E. (2021). Effects of Irrigation, Herbicide, and Oat Companion Crop on Spring-Seed Alfalfa. *In Western Society of Crop Science Annual Meeting (WSCS).* ASA-CSSA-SSSA.

[13] Zhu, X., Fordjour, A., Dwomoh, F. A., Lewballah, J. K., Ofosu, S. A., Liu, J., & Oteng, J. (2024). Experimental study on the effects of pressure loss on uniformity, application rate and velocity on different working conditions using the dynamic fluidic sprinkler. Heliyon, volume 10, issue 5, https://doi.org/10.1016/j.heliyon.2024.e27140

[14] Fordjour, A., Zhu, X., Jiang, C., & Liu, J. (2020). Effect of riser height on rotation uniformity and application rate of the dynamic fluidic sprinkler. Irrigation and Drainage, 69(2), 618-632. doi:10.1002/ird.2462

[15] Kuti, I. A., Ewemoje, T. A., Musa, J. J., & Nwosu, S. C. (2019). Effect of different riser heights on sprinkler irrigation performance under constant operating pressure. AZOJETE, March, 2019. Vol. 15(1):124-132. https://www.researchgate.net/publication/333340744

[16] Elhussiny, K. T., Hassan, A. M., Habssa, A. A., & Mokhtar, A. (2023). Prediction of water distribution uniformity of sprinkler irrigation system based on machine learning algorithms. Scientific Reports, 13(1), 20885. https://doi.org/10.1038/s41598-023-477169

[17] El-Kholy M.A, Samiha A. Ouda, Maybelle Saad Gaballah & Mahmoud Hozayn (2005). Predicting the Interaction Between the Effect of Anti-transpirant and Climate on Productivity of Wheat Plant Grown under Water Stress, Journal of Agronomy 4 (1) 75-82, 2005, doi:10.3923/ja.2005.75.82

[18] Alkhoury, S. G. Y., Adel, A. A. & Anas O. E. (2022). Evaluating the performance of a hammer mill through using different types of locally manufactured hammers, Mesopotamia Journal of agriculture, 50 (3), 1-18. http://doi.org/10.33899/mja.2022.13416.1177

[19] Allen, R. G.; L. S. Pereira; R. Dirk & M. Smith (2011). Crop Evapotranspiration Guidelines for computing crop water requirements. FAO Irrigation and Drainage Paper No. 56, 1998. Food and Agriculture Organization. Rome, Italy, pp. 83. https://www.researchgate.net/publication/235704197

[20] Page, A.L., (1982). Methods of soil analysis, part 2. Chemical and microbiological properties. Amer. Soc. of Agron, Madison, Wisconsin, USA. .doi:10.2134/agronmonogr9.2.2ed

[21] Klute, A., (1986). Methods of soil analysis, Part (1). Physical and Mineralogical Methods-Agronomy monograph No. 9 (2nd Edition). ASA and SSSA, Madison, WI, USA: 635 – 660. https://www.cabidigitallibrary.org/doi/full/10.5555/19881917612

[22] Ayers, R.S. and D.W. Westcot, (1994). Water Quality for Agriculture, Irrigation and Drainage Paper No 29, FAO, Rome, Italy. https://www.fao.org/4/t0234e/t0234e00.htm

[23] James, L.G., (1988). Principles of farm irrigation systems design. John Willey & Sons. Inc., Washington State University, 73, 152-153, 350-351. https://www.amazon.com/Principles-Farm-Irrigation-System-Design/dp/0894648020

[24] Christiansen, J. E. (1942). Irrigation by sprinkler. *Bulletin 670. California Agricultural Experiment Station. University of California. Berkeley, California*. urn:oclc:record:1047433836

10.48047/jocaaa.2024.33.06.187

[25] Taha Essam A. (2008). Studying the effect of three factors on the water distribution uniformity using stationary sprinkler irrigation system. Mesopotamia Journal of Agriculture 36(3): 217-221. http://doi:10.33899/magrj.2008.26793

[26] Aboamera, M. & H. Sourell (2003). Characteristics of water distribution and irrigation intensity for floppy sprinklers. The 11th Annual Conference of Misr Society of Agricultural Engineering, Egypt, 20(4): 937 - 948.

[27] Solomon, K H, (1998). The economics of uniformity. California Polytechnic University, San Luis Obispo, California 93407, USA.