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Design and Manufacture an Automatic Riser Sprinkler Riser in the Fixed Sprinkler Irrigation System and its Impact on the Performance of the System and Zea Maize Yield

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Abstract

This research is aimed to conducting a field experiment for designing and manufacturing an automatic sprinkler riser for fixed sprinkler irrigation system with an operating pressure of 1, 1.5, and 2 bar and evaluated its impact on the system performance and the growth and production of Zea maize in silt clay loam soil for the agricultural season of 2021. Moisture homogeneity coefficient, soil moisture content, sprinkler discharge, sprinkler service area, plant height and plant yield were studied in this research Nested deign with a randomized complete block design (RCBD) with three replications and used the least significant difference was used under the probability level of 0.05 ($LSD_{0.05}$) for comparison in the averages of the coefficients of the experiment. Results from this research showed that an automatic sprinkler riser with the outer tube was significantly superior in obtaining the highest mean coefficient of moisture homogeneity of 82.8% and the highest mean moisture content of 37.29% and the highest mean value of the sprinkler service area amounted to 247.98 m^2 and the highest mean yield of the crop was 6.38 tons.ha^{-1}, while the self-propelled riser with inner tube outperformed in obtaining the highest value of plant height amounted to 189.67 cm. The success of using the locally designed and manufactured an automatic sprinkler "self-rising" riser according to the plant's height and used in the fixed sprinkler irrigation system to irrigate the maize crop.

Keyword: Automatic riser, Zea maize yield, Water Content, Sprinkler Irrigation

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تصميم وتصنيع قصبة مرشات أوتوماتيكية في نظام الري بالرش الثابت وتأثيرها على أداء النظام ومحصول الذرة الصفراء

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المستخلص

يهدف البحث الى إجراء تجربة حقلية لتصميم وتصنيع قصبة مرشات لنظام الري بالرش الثابت وتقييم تأثيره على أداء النظام ونمو وإنتاج الذرة الصفراء في محطة ابحاث الرائد التابعة للمركزالوطني لأدارة الموارد المائية احدى تشكيلات وزارة الموارد المائية الواقعة في منطقة عكركوف تربتها ذات نسجة مزيجة طينية غرينية للموسم الزراعي للموسم الزراعي 2021 .استعمل في التجربة عاملان هما نوع القصبة شملت ثلاث مستويات هي(قصبة اعتيادية و قصبة ذاتية الحركة انبوب داخلي وقصبة ذاتية الحركة انبوب خارجي) والضغط التشغيلي بثلاث مستويات هي 1 و 1.5 و 2 بار. تم دراسة مؤشرات التالية وهي معامل تجانس، محتوى الرطوبي للتربة، تصريف المرشة، مساحة خدمة المرشة، ارتفاع النبات وإنتاجية النبات. استخدم تصميم القطاعات العشوائية الكاملة (RCBD)بثلاثة مكررات، واستخدم أقل فرق معنوي تحت مستوى الاحتمال (LSD0.05)للمقارنة في متوسطات معاملات التجربة وأظهرت النتائج تفوق القصبات الذاتية الحركة ذات الانبوب الداخلي والخارجي على القصبة الاعتيادية بشكل كبير في الحصول على أعلى معدل معامل تجانس بنسبة 82.8٪ وأعلى معدل محتوى رطوبي بنسبة 37.29٪ وأعلى معدل قيمة مساحة خدمة المرشة بلغت 247.98 م^2 وأعلى معدل إنتاجية للمحصول. 6.38 طن /هكتار، تفوقت القصبات الذاتية الحركة ذات الانبوب الداخلي في الحصول على أعلى قيمة لارتفاع النبات وبلغت 189.67 سم. نجاح استخدام جهاز الري بالرش الآلي المصمم محليًا والمصنع "ذاتي الارتفاع" وفقًا لارتفاع النبات واستخدامه في نظام الري بالرش الثابت لري محصول الذرة.

الكلمات المفتاحية: القصبة ذاتية الحركة، محصول الذرة الصفراء، المحتوى الرطوبي، الري بالرش.

1. Introduction

Modern irrigation mechanization especially sprinkler irrigation systems is one of the modern and advanced irrigation systems that are widely used in many countries of the world to exploit the available water resources and invest them in ideal ways with the aim of saving water in the quantities required for the expansion of agriculture and filling the needs of the agricultural sector of water and raising the efficiency of irrigation in terms of the water resource and increasing agricultural production (Jasim & Nafawah, 2017). Agricultural mechanization is one of the most significant indicators of the transfer of traditional agricultural operations to modern agricultural operations, as it is an important factor in regularity and speed (Al-Banna, 1990) and Peng , et al., 2022.

Researchers and scientists were interested in studying the effect of fixed sprinkler irrigation systems on the growth and production of maize crop and some physical properties of soil through knowledge of water productivity and efficient use of available water, (Kirda, Kanber, & Tulucu, 1996), (Jasim, Qazzaz, & Naoum, 2009) and (Isaac , et al., 2023).

One of the problems that reduce the efficiency of using the fixed sprinkler irrigation system in irrigating the maize crop is the problem of the height of the riser, because the maize crop has long stems that may reach 150-200 cm, which leads to water colliding with the stems during the irrigation process, it works on the irregularity of the process of distributing irrigation water to all the crop plants, and the farmer begins to replace the riser with a riser higher than the plant. This process is considered expensive and tiring and led to the design and work of a automatic riser with the height of the plant using sensors placed at the top of the plant and at the top of the spray riser so that the height is uniform without the need to replace another riser (Okasha & Sabreen, 2016) and (Kuti, et al., 2019).

The operating pressure is one of the main factors responsible for the consistency of the water distribution in the sprinkler. The correct performance of the sprinkler requires breaking, dispersing and spreading the water extrusion into droplets that cover the land in consistency and reduce the relatively large droplets. The good feature of the large droplets is that they move in the air for a longer time and reach a longer distance. The optimum operating pressure varies depending on the size of the sprinkler nozzle and wind speed (Mohamed, Hamed, Ali, & Abdalhi, 2019).

The main objective of using the fixed sprinkler irrigation system is to deliver water in an efficient and sufficient manner suitable for the field without wasting the quantities of irrigation water, and this lies through the use of suitable operating pressure for the sprinklers to cover an area and suitable quantities for the soil and the crop, and this leads to reducing energy waste and reducing the quantities of irrigation water (Al-Kubaisi, 2001).

Zea Maize corn is one of the most important agricultural crops in the production of food and industrial grains in multiple regions in the world. The extent of the crop's use has been estimated at 150 uses and Plants can used as green fodder. As for grains, they are used in preparing a concentrated diet for poultry and cows and grains can also used as food for humans through grinding. Its grains are used to obtain flour that is used in the manufacture of bread, biscuits, pasta and sweets, as well as in preparing food for children (Diederichsen, Richards, Boguslavskij, & Halan, 2007) and (FAO, 2013).

The objective of the current research is to design and manufacture an automatic sprinkler riser for fixed sprinkler irrigation system and evaluate its impact on the system performance and the growth and production of Zea maize in silt clay loam soil for the agricultural season of 2021 at Al-Raad Research Station affiliated to the National Center for Water Resources Management one of the formations of the Ministry of Water Resources, located in the Akrekof area. In view of the importance of this system, a self-rising riser was designed according to the height of the maize plant without the need to replace the riser during the plant growth period, and knowing its impact on the performance of the system and plant growth came this study.

2. Methodology

As mentioned earlier, the main goal of the current study is to design and manufacture an automatic sprinkler riser for fixed sprinkler irrigation system and evaluated its impact on the system performance and the growth and production of Zea maize at Al-Raad Research Station located in the Akerkof area, 1 km north of the highway (Baghdad - Anbar) in silt clay loam soil for the agricultural season of 2021.

Use two factors: The type of sprinkler riser includes three levels: A – regular riser B – riser Locally manufactured "containing an external tube (self-propelled) C - a locally manufactured riser

containing an inner tube (automotive)and The operating pressure of the system included three levels: A - pressure of 1 bar, B - pressure of 1.5 bar and C - pressure of 2 bar.

3. Study Area

Al-Raad Research Station affiliated to the National Center for Water Resources Management one of the formulations of the Ministry of Water Resources that is located in Akrekof Area. The following characteristics were studied: Moisture homogeneity coefficient and soil moisture content %, sprinkler filtering, liters.min^{-1} and sprinkler service area, m^2, the plant height (cm) and yield of yellow corn, the total of the experimental units was 27 experimental units. The area of the experiment field was 3888 m^2 It is 108m long and 36m wide.

3.1. Design and Manufacture the Riser:

The riser was made in the form of aluminum rings, one inside the other according to the size (telescopic), meaning the small ring is inside the large ring according to the size. The dimensions of the rings, starting from the big ring to the small one, were 27 cm, 24 cm, 21 cm, 18 cm, 15 cm. The rings move by means of rails installed on the rings. Two types of risers are designed, the first is the internal sprinkler feeding tube, and the second design is the external sprinkler feeding pipe. The rings were also connected to each other using sliding rails that were installed in the ribs to install the ring from four sides and to give the cane more durability and for easy movement of the rings during the height of the sprinkler cane to the top. Also, all the rings were installed on a wooden base of an area of 1.225 m^2. Two types of bronchi were designed, the first to be with an internal sprinkler feeding tube and the second to be an external sprinkler feeding tube. An Ultrasonic sensor was used, which is a sensor that can be measured by means of ultrasound, HC-SR04-Sensor, which measures the distance with high accuracy and at a distance of 2.5 m. It is not affected by water and the sensor was connected to the Arduino to complete the electrical circuit by giving the required command to the device to start the rising process, (Carullo & Parvis, 2001).

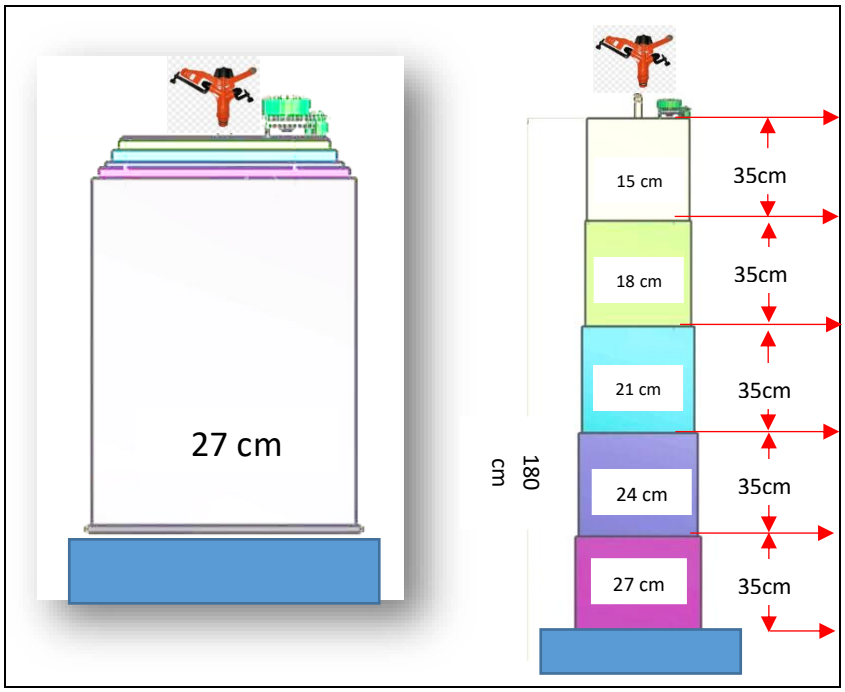

Figure (1): Dimensions of the manufactured riser

3.2. Agricultural Operations and Crop Service:

The maize crop, Oryx variety, was planted on 15/7/2021. The planting was carried out using the Gaspardo seed of Italian origin with four lines. The seed was calibrated before the sowing process, with a distance of 75 cm between one line and another and 25 cm between the hollows, after which the germination process was carried out by keeping one plant. Each hole has a plant density of 53,333 plants per hectare-1The control of the bush was carried out manually and the control of infection with the corn riser borer was carried out using the granular pesticide diazinon and in two doses, the first after germination by 25 days and the second after the first dose by 20. Phosphate fertilizer (triple super phosphate by 46%) was added at once before the planting process at a rate of 200 kg / hectare and manure Nitrogenous (urea at 46% N) at a rate of 200 kg / hectare and the second batch after planting a month (Al-Ma'ini, & Al-Sahouki, 1987) and the irrigation process was determined after the soil was depleted 25% of the ready water after determining the volumetric moisture content of the soil at the field capacity and the volumetric moisture content at the point of withering, and then the amount of ready water for the irrigation process was determined. The moisture content of the soil was measured using the gravimetric method to calculate the moisture content by taking daily soil samples and diluting them in the drying oven located in the station laboratory for 24 hours at a

temperature of 105 degrees Celsius, after which a Dutch-made volumetric moisture content meter (Eijkelkamp soil, water) was used in Different locations in the experiment at a depth of (10, 20, 30, 40, 60, 100 cm) in the soil. The device contains field tubes that are installed inside the soil for the duration of the experiment. The measurement process is carried out by the device by placing it inside the field device tube.

3.3. Studied traits:

1 - Moisture homogeneity coefficient %: The following equation proposed (Christiansen J. E., 1942) and followed by, (Jasim & Nafawah, 2017) was applied to calculate the homogeneity coefficient of the system by distributing cans within the sprinkler service area for each experimental unit)

$$Cu = 100\left[1 - \frac{\Sigma|S|}{M\,x\,N}\right] \quad (1)$$

whereas:

Cu = Coefficient of homogeneity

S =. Deviation of the values of individual observations from the average depths of the added water

M= Average values of all views (average addition rate)

N= Views

2- Soil moisture content %: Soil moisture content was measured using a Dutch-made volumetric moisture content meter (Eijkelkamp soil, water) (Fig. 2). The gravimetric method was also used to calculate the moisture content, which is the direct method by taking samples of wet soil and drying them in the oven for 24 hours at a temperature of 105 degrees Celsius, and then weighing while it was dry using the following equation used by (Gardner, 1965), and suggested by (Jasim & Nafawah, 2017)

Pw =((Msw-Ms)/Ms) x 100 (2)

The volumetric moisture content was calculated using the following equation and suggested by (Hillel, 1980).

Pv = Pw x Pp

d = Pv x D

Q = dxa

Since:

Pw = (%) weight moisture content

Pv = (%) Volumetric moisture content= Pv

Msw = wet soil mass

Ms =Dry soil mass

Pp = Soil Bulk Density

d = Irrigation water depth, cm

D =Root zone depth, cm

Q =Amount of water used for irrigation, m^3

A = field area, m^2

Figure (2): Eijkelkamp soil, water

3 - Sprinkler Discharge:

The discharge of sprinklers is a function of the rate of water addition (perfusion rate) in the fixed sprinkler irrigation system, as the sprinkler discharge was calculated using the following equation proposed by (Jasim & Nafawah, 2017)

$$\mathbf{Q = CA\ \sqrt{2gh}} \quad (3)$$

Since:

Q =Sprinkler discharge l/sec = Q

C=Sprinkler modulus constant (ranging from 0.95 - 0.98) = C

A=Orifice area, cm^2

G =ground acceleration, cm/s^2

H= head

Also, the discharge of each sprinkler was calculated by (hydrometer) according to the required pressure, and the pressure was controlled by using the water lock.

4 - The sprinkler service area: The sprinkler service area was calculated according to the following equation and suggested by, (Jasim & Nafawah, 2017)

$$R = 1.35\ \sqrt{d} * h \quad (4)$$

whereas:

R=Radius of wetting area

d = Discharge l/min

h = Pressure applied to the sprinkler opening

5- Plant height cm: Ten plants were selected from the middle areas of the experimental units after leaving the guard lines at random from the sprinkler service area, marking them and measuring their height after the flowering stage was completed, starting from the base of the plant at the surface of the soil to the top node of the plant and taking the average heights for each experimental unit , (Al-Sahoki, 1990)

6- Zea Maize Crop Yield, ton. ha^{-1}: Ten plants were selected from the middle areas of the experimental units within the limits of the sprinkler service area after leaving the guard lines at random, and then they were harvested on 11/23/2021 and the weight of the seeds was calculated (gm/ per 10 plants) after the nubs were neglected for each experimental unit. Production per hectare, and then weight was adjusted on the basis of 15.5% moisture, according to the following equation , (Al-Sahoki, 1990):

Weight at 15.5% humidity = ((100 - original humidity) / 84.5) x original weight (5)

4. Result and discussion

4.1. Moisture uniformity coefficient %

Table (1) shows the effect of the type of riser used on the uniformity coefficient, as it was shown that the riser type had a significant effect on the value of the uniformity coefficient. Where the averages of the regular riser recorded the lowest value for the averages of the coefficient of uniformity (75.07%), while the automatic external tube recorded the highest coefficient of uniformity of 82.8%. These results were in agreement with the results obtained by (Fordjour, Zhu, Jiang, & Liu, 2020) and (Kuti, Ewemoje, Adabembe, Musa, & Nwosu, 2019). The results also indicate the significant effect of operating pressure on the value of the uniformity coefficient. The average value of the uniformity coefficient increased from 78.20, 80.03 to 82.15% for the operating pressures 1, 1.5 and 2 bar, respectively. The low uniformity coefficient at low operating pressures could be due to the large water droplets falling close to the sprinkler. At high operating pressure, small water droplets are produced which are easy to throw away from the sprinkler. These results are in agreement with the results obtained by (Osman, Hassan, & Yusof, 2015) and (Khedr, 2020).

The results also indicate significant effect of the two-way interaction between the type of riser and the operating pressure. The automatic external tube at a pressure of 2 bar outperformed in obtaining the highest value of the uniformity coefficient, which reached 85.35%. While the regular riser at 1 bar recorded the lowest value of the uniformity coefficient amounted to 74.48%.

Table (1): Effect of the riser type and the operating pressure on the moisture uniformity coefficient (%)

Riser type (R)	Operational Pressure (P)			Mean (riser type)
	1 bar	1.5 bar	2.0 bar	
Normal	74.48	74.86	75.86	75.07
automatic inner tube	79.96	82.34	85.23	82.51
Automatic external tube	80.17	82.89	85.35	82.8
$LSD_{0.05}$		0.90		$LSD_{0.05}$ 0.60
Operational Pressure mean	78.2	80.03	82.15	
$LSD_{0.05}$		0.53		

4.2. Soil moisture content %

Table (2) shows the effect of the riser used on the moisture content, as it turns out that the type of riser had a “significant” effect on the moisture content of the soil, as the average riser recorded the lowest soil moisture content of 36.52%, while the average of the self-moving riser with an external tube was recorded on the highest Its value for the average homogeneity coefficient amounted to 37.29%, and the reason may be due to the increase in moisture content in the designed riser s as a result of the uniformity and homogeneity of irrigation water distribution within the sprinkler service area, and these results may agree with the results obtained (Khedr, 2020).

It also appears from the results that there are no significant differences between the averages of the automatic self-moving riser s with inner and outer tubes in the moisture content amounted to 37.28%

and 37.29%, respectively. The table also shows that the operating pressure had a significant effect on the moisture content, as the value of the average moisture content increased from 78.20, 80.03 and 82.15% for the operating pressures 1, 1.5 and 2 bar, respectively, and the reason may be due to the dispersion and spread of water extrusion into droplets Covers the territory uniformly and reduces of relatively large droplets, and these results may agree with the results obtained, (Mohamed, Hamed, Ali, & Abdalhi, 2019)

It is also noted from the table that the bilateral interaction between the type of riser and the operating pressure did not have a "significant" effect, as the self-propelled riser with an external tube at a pressure of 2 bar outperformed in obtaining the highest value of the moisture content, which amounted to 85.35%, while the regular riser scored 1 Bar with the lowest moisture content valued at 35.50%.

Table (2): The effect of the riser used, the operating pressure used and the interactions between them on the content soil moisture%

Riser type (R)	Operational Pressure (P)			Mean (riser type)
	1 bar	1.5 bar	2.0 bar	
Normal	35,5	36,37	37,7	36,52
automatic inner tube	36,48	37,23	38,13	37,28
Automatic external tube	36,63	37,17	38,07	37,29
$LSD_{0.05}$		N.S		$LSD_{0.05}$ 0,40
Operational Pressure mean	36,2	36,92	37,97	
$LSD_{0.05}$		0.43		

4.3. Sprinkler drain liter. min^{-1}

It is noted from Table (3) the effect of the riser used to drain the sprinkler, as it was found that the type of riser did not have a "significant" effect on the sprinkler discharge. Sprinkler discharge, where the average value of sprinkler discharge increased from 23.73, 27.38 and 33.07 liters.min^{-1} for operating pressures of 1, 1.5 and 2 bar, respectively. This may be due to the fact that the

discharge rate of sprinklers is strongly affected by the operating pressure of the system, as the discharge rate increased with the increase in operating pressure and these results may agree with the results obtained (Khedr, 2020).

It is also noted from Table (3) that the bilateral interaction between the type of straw and the operating pressure had a "significant" effect, as the self-propelled riser with an inner tube at a pressure of 2 bar outperformed in obtaining the highest value of the sprinkler discharge, which amounted to 33.40 liters. min^{-1} While the self-propelled riser with an external tube of 1 bar recorded the lowest value for the sprinkler discharge amounted to 23.20 liters.min^{-1}.

Table (3): The effect of the used riser and the operating pressure used and the interactions between them in the discharge Sprinkler L.min^{-1}

Riser type (R)	Operational Pressure (P)			Mean (riser type)
	1 bar	1.5 bar	2.0 bar	
Normal	24.60	27.60	32.80	28.33
Automatic inner tube	23.40	27.00	33.40	27.93
Automatic external tube	23.20	27.53	33.00	27.91
$LSD_{0.05}$		0.90		)5
Operational Pressure mean	23.73	2.76	2.67	
$LSD_{0.05}$		0.49		

4.4. Sprinkler service area m^2

It was shown from Table (4) that the type of riser had a “significant” effect on the sprinkler service area, as the average riser recorded the lowest area for the sprinkler service was 233.8 m^2 While the averages of self-propelled riser s with an external tube recorded the highest value of the average sprinkler service area of 247.98 m^2 The reason may be due to the fact that increasing the height of the riser helps to increase the service area of the sprinkler by not impeding the plants to distribute water because the riser is higher than the plant. These results agree with the results obtained (Abd El-Wahed, Sabagh, Saneoka, Abdelkhalek, & Barutçular, 2015).

The table also shows that the operating pressure had a significant effect on the value of the sprinkler service area, as the value of the average sprinkler service area increased from 130.49, 226.05 and 367.71 m^2 The operational pressures are 1, 1.5 and 2 bar, respectively. The reason may be that increasing the operating pressure helps push the water to a greater distance, which increases the sprinkler service area. These results may be consistent with the results obtained (Montero, Tarjuelo, & Ortega, 2000). The binary interaction between the type of straw and the operating pressure had a "significant" effect, as the self-propelled riser with an external tube at a pressure of 2 bar outperformed in obtaining the highest value of the sprinkler service area, which amounted to 377.69 m^2 While the normal straw 1 bar recorded the lowest value for sprinkler discharge, which was 129.33 m^2.

Table (4): The effect of the used riser and the used operating pressure and the interactions between them in a service space sprinkler m^2

Riser type (R)	Operational Pressure (P)			Mean (riser type)
	1 bar	1.5 bar	2.0 bar	
Normal	129.33	219.75	352.32	233.8
Automatic inner tube	129.33	224.9	373.12	242.45
Automatic external tube	132.77	233.49	377.69	247.98
$LSD_{0.05}$		4.48		)5
Operational Pressure mean	130.48	2.76	2.67	
$LSD_{0.05}$		2.97		

4.5. Plant height cm

Table (5) shows that the type of riser had a “significant” effect on plant height, as the inner tube riser achieved the highest plant height of 189.67 cm, while the regular riser achieved the lowest value for plant height of 173.78 cm. It is also noted that there are no significant differences between the averages of the two risers. With the inner and outer tubes, which achieved plant heights of 189.67 cm and 189.22 cm, respectively. The reason may be due to the increase in plant height in the designed risers by increasing the homogeneity of the moisture content of the soil

through the regular distribution of water and in turn providing good moisture for plant growth. These results may agree with the results obtained On it (Maazou, Tu, Qiu, & Liu, 2016). It is also noted from the table that "there are significant differences between the average pressures used, as the pressure exceeded 2 bar by achieving the highest plant height of 190.11 cm, While the operating pressure of 1 bar achieved the lowest plant height of 177.44 cm. The reason may be due to the fact that the regulation of the operating pressure led to an increase in the moisture content of the soil, which increased the growth of the plant. These results may agree with the results obtained (Montazar & Sadeghi, 2008).

It is also noted from Table (5) that the bilateral interaction between the type of riser and the operational pressure had a "significant" effect, as the self-propelled riser with the inner tube at pressure 2 bar outperformed in obtaining the highest value of plant height of 194.67 cm, while the regular riser recorded 1 The lowest value for plant height was 163.33 cm.

Table (5) The effect of the riser used and the operating pressure used and the interactions between them on the height of the plant

Riser type (R)	Operational Pressure (P)			Mean (riser type)
	1 bar	1.5 bar	2.0 bar	
Normal	163.33	176	182	173.78
Automatic inner tube	185	190.33	193.67	189.67
Automatic external tube	184	189	194.67	189.22
$LSD_{0.05}$		3.63		$LSD_{0.05}$ 2.30
Operational Pressure mean	177.44	185.11	2.67	
$LSD_{0.05}$		2.24		

4.6. Zea Mayz crop yield, ton. ha^{-1}

Table (4) shows that the type of riser had a significant effect on the yield of maize grains, as the riser with automatic inner tube achieved the highest yield of maize, which reached 6.38 tons. hectare^{-1}, while the regular riser achieved the lowest grain yield, which reached 5.61 tons. hectare^{-1}. These results are in agreement with the results obtained (Mohamed, Hamed, Ali, & Abdalhi, 2019). The results showed no significant differences between the averages of the two inner and external tubes, which achieved the yield of maize 6.34 and 6.38 tons. hectare^{-1}.

It is also noted from the table that there is a significant difference between the operation pressures used, as the pressure 2 bar outperformed by achieving the highest yield of maize (6.46 tons. hectare^{-1}). While the operating pressure of 1 bar achieved the lowest yield of maize yield, which reached 5.80 tons. These results are in agreement with the results obtained by (Warda, 2014)

The results showed a significant two-way interaction between the type of riser and the operational pressure, as the automatic external tube at a pressure of 2 bar outperformed in obtaining the highest value of the maize yield of 6.89 tons. hectare^{-1}, while the regular riser with 1 bar, produced the lowest yield of maize at 5.34 tons hectare^{-1}.

Table (6): The effect of the riser used, the operating pressure used, and the interactions between them on the yield yellow corn crop

Riser type (R)	Operational Pressure (P)			Mean (riser type)
	1 bar	1.5 bar	2.0 bar	
Normal	5.34	5.59	5.89	5.61
Automatic inner tube	6.00	6.42	6.60	6.34
Automatic external tube	6.05	6.20	6.89	6.38
$LSD_{0.05}$		0.130		)5
Operational Pressure mean	5.80	6.07	6.46	
$LSD_{0.05}$		0.080		

5. Conclusions and Recommendations

We conclude the success of using the designed riser s in the self-height fixed sprinkler irrigation system, where the outer-tube riser excelled in the highest coefficient of homogeneity, the highest moisture content and the highest value for the sprinkler service area, while the self-propelled riser with the inner tube outperformed in obtaining the highest value for plant height,, Also, The two-way interaction between the self-propelled reed with an inner tube and the operating pressure of 2 bar was superior in obtaining the highest moisture content and the highest discharge of the sprinkler, while the bilateral interference between the self-propelled reed with the outer tube and the operating pressure 2 bar was superior to the highest value of the homogeneity coefficient and the highest value of the service area. Sprinkler and higher plant height. We therefore recommend the use of designed bronchi and appropriate operating pressure.

References

Abd El-Wahed, M., Sabagh, A. E., Saneoka, H., Abdelkhalek, A., & Barutçular, C. ,2015, Sprinkler irrigation uniformity and crop water productivity of barley in arid region. *Emirates Journal of Food and Agriculture*, 770-775.

Al-Banna, A. ,1990, *Soil preparation equipment. Directorate of Books House for Printing and Publishing. faculty of Agriculture and forests.* University of Al Mosul . Ministry of Higher Education and Scientific Research. The Republic of Iraq.

Al-Kubaisi, A. M. ,2001, Sprinkler irrigation. *Iraqi Journal of Agricultural Sciences, Ministry of Agriculture*, 7- 12.

Al-Ma'ini,, I. H., & Al-Sahouki, M. M. ,1987, Yellow corn response to tillage depth and markup. . *Zanko Magazine*, 5 (2): 180-197.

Al-Sahoki, M. M. ,1990, *Yellow corn production and improvement. Ministry of Higher Education and Research Scientific.* . Baghdad University.

Carullo, A., & Parvis, M. ,2001, An ultrasonic sensor for distance measurement in automotive applications. *IEEE Sensors journal,* , 1(2), 143.

Christiansen, J. E. ,1942, Irrigation by sprinkling (Vol. 4). Berkeley: University of California.

Christiansen, J. E., & John, R. D. ,1967, Sprinkler irrigation systems. *Irrigation of agricultural lands*, 11, 885-904.

Diederichsen, A., Richards, K. W., Boguslavskij, R. L., & Halan, M. S. ,2007, Collecting plant genetic resources in the eastern Carpathian Mountains within the territory of Ukraine in 2005. *Plant Genetic Resources Newsletter= Bulletin de Ressources Phytogénétiques= Noticiario de Recursos Fitogenéticos*, (151), 14-21.

FAO. ,2013, Food and Agriculture Organization, Bulletin of statistics. P.148 Iqbal, K., T. Mahmood and M. Usman. 2001. Yield and quality of two maize hybrids as affected by different planting patterns. *Journal of Biological Sciences*, 1(4): 249-250.

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(4), 618-632.

Gardner, W. H. ,1965, Water content. Methods of Soil Analysis: Part 1 Physical and Mineralogical Properties. *Including Statistics of Measurement and Sampling*, 9, 82-127.

Hillel, D. ,1980)., Fundamentals of soil physics. Academic Press, New York.

Isaac A Ramos-Fuentes, Yassin Elamri, Bruno Cheviron, Cyril Dejean, Gilles Belaud et al. Effects of shade and deficit irrigation on maize growth and development in fixed and dynamic AgriVoltaic systems. Agricultural Water Management ,2023, 280, pp.108187.

Jasim, A. A., & Nafawah, S. M. ,2017, *Irrigation and Puncture Equipment Book.* Al Dar University for printing, publishing and translation.

Jasim, A., Qazzaz, K. M., & Naoum, M. S. ,2009, The effect of some sprinkler irrigation systems Surface irrigation on some physical properties of the soil and the production of maize crop. *J Misr Journal of Agricultural Engineering*, 26(4), 1827-1835.

Khedr, A. F. ,2020, Optimum Operating Conditions for Impact Sprinkler. *Journal of Soil Sciences and Agricultural Engineering*, 11(7), 325-332.

Kirda, C., Kanber, R., & Tulucu, K. ,1996, Yield response of cotton, maize, soybean, sugarbeet, sunflower and wheat to deficit irrigation In nuclear tec hniques to assess irrigation schedules for field crops. *Iaea. Tecdoc*, 888, 131-138.

Kuti, I. A., Ewemoje, T. A., Adabembe, B. A., Musa, J. J., & Nwosu, S. C. (2019). Effect of different riser heights on sprinkler irrigation performance under constant operating pressure. *Arid Zone Journal of Engineering, Technology and Environment*, 15(1), 124-132.

Maazou, A. S., Tu, J., Qiu, J., & Liu, Z. ,2016, Briser ing for drought tolerance in maize (Zea mays L.). . *American Journal of Plant Sciences*, 7(14), 1858.

Mansour, H. A., El-Hady, A., M., Eldardiry, E. I., & Aziz, M. ,2019, Wheat crop yield and water use as influenced by sprinkler irrigation uniformity. *Plant Archives*, 19(2), 2296-2303.

Mohamed, A. E., Hamed, A. N., Ali, A. M., & Abdalhi, M. A. ,2019, Effect of Weather Conditions, Operating Pressure and Riser Height on the Performance of Sprinkler Irrigation System. *IOSR Journal of Agriculture and Veterinary Science*, 12(1), 01-09.

Montazar, A., & Sadeghi, M. ,2008, Effects of applied water and sprinkler irrigation uniformity on alfalfa growth and hay yield. *Agricultural water management* , 95(11), 1279-1287.

Montero, J., Tarjuelo, J. M., & Ortega, J. F. ,2000, Heterogeneity analysis of the irrigation in fields with medium size sprinklers.

Okasha, E. M. and Sabreen Kh. Pibars. ,2016, investigation of riser height and operating pressure on sprinkler irrigation performance under different wind condition. International Journal of ChemTech Research, Vol.9 (7), PP. 292-299.

Osman, M., Hassan, S. B., & Yusof, K. W. ,2015, Effect of combination factors of operating pressure, nozzle diameter and riser height on sprinkler irrigation uniformity. *In Applied Mechanics and Materials* , (Vol. 695, pp. 380-383). Trans Tech Publications Ltd.

Peng, J., Zhao, Z. and Liu, D. ,2022, Impact of agricultural mechanization on agricultural production, income and mechanism: Evidence from Hubei Province, China. Sec. Environmental Informatics and Remote Sensing.

Warda, M. S. ,2014, Effect of different irrigation methods on water use efficiency and corn productivity yellow; (36) Tishreen University Journal-Biological Sciences Series. productivity of barley in arid region. *Emirates Journal of Food and Barutçular. (2015). Sprinkler irrigation uniformity and crop water*.