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Improving Water Use Efficiency in Corn (*Zea mays L.)* Cultivars Using Responsive Drip Irrigation

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ABSTRACT

Excessive water use is one of the world's largest problems today. Using an appreciating irrigation system rather than a conventional irrigation system to irrigate agriculture is one way to address this problem. The research was carried out in the Grdarasha Field, College of Agricultural Engineering Sciences, Salahaddin University, Erbil, Kurdistan Region. The location was divided into lines for three sweet corn hybrids (Talar F1 (Biotek) H1, MESSENGER (Semins) H2 and SENTINEL (Talar type) EliSem (CLAUSE) H3, with seven irrigation systems. The experiment was applied with (3×7) Factorial randomized complete block design with three replicates. Implement Responsive Drip Irrigation (RDI) systems with axial pipes were installed at two depths (8 cm and 16 cm) and at varying distances (0 cm, 7.5 cm, and 15 cm) from the axial pipe. The irrigation systems assigned as follows: I1 Standard Drip Irrigation (SDI), I2: (RDI. 16 cm, 0 cm), I3: (RDI. 16 cm, 7.5 cm), I4: (RDI. 16 cm, 15 cm), I5: (RDI. 8 cm, 0 cm), I6: (RDI. 8 cm, 7.5 cm) and I7: (RDI. 8 cm, 15 cm). At eight Weeks After Emergence the tallest plant was recorded for H1 with I1 and I2. According the irrigation systems, RDI (I2, I3, I4 and I5) increased significantly ($P<0.05$) the wet kernal weight per cob compared with SDI. Kernal yield and harvest index increased significantly ($P<0.05$) for all RDI systems compared with SDI; the highest Kernal yield recorded for I2 (10.83 ton/ha) compared with SDI (6.66 ton/ha). Also, all RDI treatments reduced water use compared to SDI. Irrigation Water Use Efficiency (IWUE) increased significantly ($P<0.05$) in all RDI system compared to SDI system. This investigation found that the treatments using responsive drip irrigation (RDI) show substantial promise in reducing water use while maintaining crop productivity.

1.Introduction

Corn (*Zea mays* L.) is one of the world's most important cereals. With global annual production reaching approximately 1.2 billion tonnes and an average productivity of about 5.8 tonnes per hectare (FAO, 2021).

Irrigation is often known that plays a crucial role in maintaining food security (Wang *et al.*, 2021). It has been estimated that between 70% and 90% of the world's freshwater resources were used for agricultural production (Wu *et al*., 2022; Ju *et al.*, 2023; Liu *et al*., 2024). Global water scarcity has become a non-negligible problem that threatens the sustainable development of agriculture. In order to alleviate the contradiction between grain demand and water resource constraints, it is particularly important to explore appropriate irrigation strategy so as to synergistically increase grain yield and water use efficiency (Bian *et al.*, 2024).

Irrigation efficiency is defined by irrigation scientists and engineers as "the ratio of irrigation water transpired by the crops of an irrigation farm or project during their growth period to the water diverted from a river or other natural source into the farm or project canal or canals during the same period of time." It is used to describe how efficiently water is delivered to crops and to indicate the amount of water wasted at the plot, farm, command, or system level (Fereres and Maria, 2007). The implementation of innovative irrigation technology and the development of ideal irrigation plans have made simpler to use the water resources that are available sensibly, which has improved irrigation management overall (Li *et al*., 2019). Research indicates that employing techniques can enhance soil water retention and decrease wasteful water use in agricultural areas (Wang *et al.*, 2024), straw covering (Zhao *et al.*, 2024), subsurface drip irrigation (Namdarian *et al.*, 2024), deficit irrigation (Comas *et al.*, 2019), and applying anti-transpirant agents (Dass and Bhattacharyya, 2017). These techniques can therefore boost productivity and the effectiveness of agricultural water use (Alvar-Beltrán *et al.*, 2021).

The company that invented the revolutionary water distribution technique that has totally changed the norm for irrigation systems is called Responsive Drip Irrigation (RDI). In comparison to all other forms of forced irrigation, Grow Stream™ tubing is the first and only plant-responsive irrigation and fertigation system in the world. It enables the plant to self-regulate its own water flow, leading to unparalleled water savings and plant performance. A smart subsurface watering tube called Grow Stream™ interacts with and reacts to chemical cues given out by plant roots (Gultekin, 2023). With operations in over 40 countries, RDI is expanding.

The objective of this study was to optimize water use efficiency for different sweet corn hybrids through responsive drip irrigation (RDI).

2. MATERIALS AND METHODS

2.1 Experimental Design Components, Plant Treatment, Cultivation Conditions

The study was carried out at Salahaddin University- Erbil, College of Agricultural Engineering Sciences, in the Grdarasha Field in Erbil, Kurdistan Region. The experiment was conducted with GPS coordinates at (Latitude: 36° 6' 45.054" N; Longitude: 44° 0' 44.2512" E, and an elevation of 400 m) between August 4 and October 20, 2024. Representative air- dried soil samples were taken from the field at a depth (0-30 cm), then sieved twice with mish (2 mm) and analyzed for some physical and chemical properties as shown in table (1). Soil tests were analyzed at the Directorate of Agriculture Research Centre, Erbil.

The location was divided into lines for three sweet corn hybrids (Talar F1 (Biotek) **H1**, MESSENGER (Semins) **H2** and SENTINEL (Talar type) EliSem (CLAUSE) **H3**, with seven irrigation systems. The experiment was applied with (3×7) Factorial randomized complete block design with three replicates. Beside Standard Drip Irrigation, implement Responsive Drip Irrigation (RDI) systems with axial pipes were installed at two depths (8 cm and 16 cm) and at varying distances (0 cm, 7.5 cm, and 15 cm) from the axial pipe (Figure 1). The treatments assigned as follows:

I1: Standard Drip Irrigation (SDI)

I2: Responsive Drip Irrigation (RDI), (Axial pipes embedded at (8 cm) and distances (0 cm direct) from the axial pipe)

I3: Responsive Drip Irrigation (RDI), (Axial pipes embedded at (8 cm) and distances (7.5 cm) from the axial pipe)

I4: Responsive Drip Irrigation (RDI), (Axial pipes embedded at (8 cm) and distances (15 cm) from the axial pipe)

I5: Responsive Drip Irrigation (RDI), (Axial pipes embedded at (16 cm) and distances (0 cm direct) from the axial pipe)

I6: Responsive Drip Irrigation (RDI), (Axial pipes embedded at (16 cm) and distances (7.5 cm) from the axial pipe)

I7: Responsive Drip Irrigation (RDI), (Axial pipes embedded at (16 cm) and distances (15 cm) from the axial pipe).

The length of each line was 15 m long. Each five-meter counted per replicates. The distance between lines in each treatment was 70 cm and the distance between plants was 20 cm on a line. A week prior to planting, the soil and irrigation systems were prepared, and one kernel was hand planted in each hole. The total volume of actual usage of water that had passed through the water meter (Flow meter) was measured for each treatment (Table 2). Average monthly air temperature and precipitation over the months of the year were collected at the experimental site in 2024 (Figure 2).

Figure 1: Two irrigation systems was used in this field experiment, right: Standard drip Irrigation system (SDI), left: Responsive drip Irrigation system (RDI).

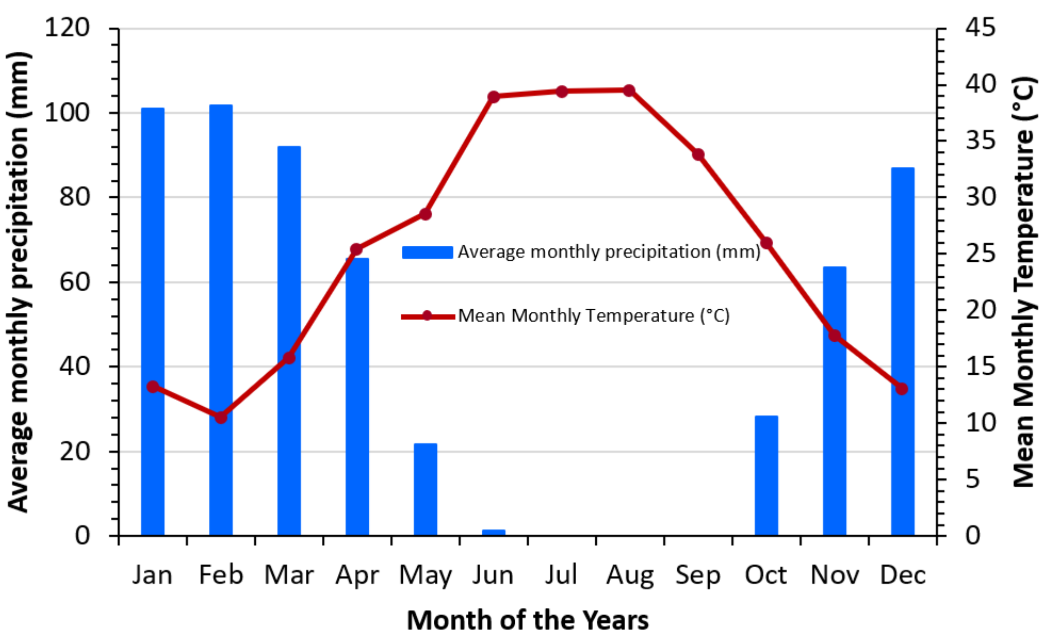

Figure 2: Average Monthly air temperature and precipitation over the months of the year at the experimental site (2024).

Table 1. Physical and chemical properties of experiment soil at a depth (0-30 cm).

Soil properties		**0-30 cm**
Physical properties	Sand %	36.23
	Silt %	32.94
	Clay %	30.83
	Soil texture	Clay Loam
Chemical properties	OM %	0.80
	N Total (%)	0.06
	P Available (ppm)	4.64
	K Available (ppm)	177.33
	EC $dS.m^{-1}$	0.23
	pH	7.70
	Total Boron (ppm)	1.90
	Boron (Hot water soluble) (ppm)	0.90

Table 2. Total Applied Water during the sweat corn growing seasons as affected by different irrigation systems.

Irrigation System	**Total Volume of Applied Water (m^3)**
I1	76.58
I2	49.06
I3	27.24
I4	26.02
I5	38.36
I6	27.10
I7	25.91

2.2 Examined traits

2.2.1 height of Plants (cm)

Plant height was monitored every two weeks after seedling emergence. After measuring the distance between the ground and the growing points of fifteen randomly selected plants in each replicate, the average height of plants was determined (centimetres).

2.2.2 Leaf area index and Light extinction coefficient (K)

At the end of the experiment, five plants from each replicate were destructively sampled to determine the leaf area. Image J software was used to compute the leaf area (Easlon and Bloom, 2014; Marofi and Amin, 2019). The leaf area index (LAI) was calculated using the determined leaf area. The LAI was calculated using the following equation (Bocanski *et al.*, 2009).

$$\text{Leaf area index} = \text{Total leaf area of plant} / \text{Area per plant}$$

Light intensity was measured as light extinction coefficient with Photometer Luxomet 300 Model (M/S Research Instrumentation, New Delhi, India) at lower and upper of crop canopy (Sarlikioti, 2011).

$$I = I_0 \exp(-K_L\, L)$$

Whereas: I: Irradiance inside canopy, I_0: Irradiance above canopy, Exp: exponential k_L: Attenuation coefficient and L: leaf area index

2.2.3 Tassel, Spike and Silky length (cm)

The silky length, spike, and tassel were measured using a ruler at 12 WAE. The spike length, including the husks was measured from the stalk to the tip, and the tassel length was measured from the flag leaf to the tip.

2.2.4 Vegetable trait parameters

The measurements include the number of nodes, Internodes, leaves/plant and stem diameter. Additionally, after drying for 48 hours at 75 ºC with the assistance of a fan (Gallenkamp Oven BS, OV-160, England), the wet and dried leaf and stem were weighed until a constant weight was reached.

2.2.5 Yield and its Component Parameters

The measurements included the number of ears per plant, wet ear weight, cob length, row numbers per each cob, kernel numbers per each row, and mass of kernel per each cob, the length of ear, including the husks, was measured from the tip to the stalk, biological yield, harvest index and fresh and dry forage yield (ton/ha).

Harvest Index (HI) %: was calculated from the following equation (Donald and Hamblin, 1976):

$$\text{Harvest Index}\,\% = GY/BY * 100$$

GY: Grain Yield (ton/ha), BY: Biological Yield includes all parts of the plant above the soil surface (ton/ha).

2.2.6 Water Save and Irrigation Water Use Efficiency

Irrigation scheduling was applied according to SDI of readily available water and the irrigation interval was set such that the percent of available water depletion be 55%. The percent of depletion was checked by taking soil samples throughout the root zone by a small auger. The following equations were used to calculate the depth and volume of soil moisture deficit and time of operation of the pump during

SDI irrigation only, because for RDI the water was always opened depending on the plant and how much water needed to be used.

$$SMD = \left[\frac{\theta FC - \theta i}{100}\right] Drz$$

$$\theta i = P * TAW(\%) + \theta_{pwp}$$

$$TAW = \theta Fc - \theta_{pwp}$$

where SMD = soil moisture deficit (mm), θ_{FC} and θ_{pwp} = Soil moisture content of the root zone at field capacity and permanent wilting point on mass basis, θ_i= Soil moisture content of the root zone prior to irrigation on mass basis. It was obtained from:

P = depletion fraction (0.55 for corn)

D_{rz}= root zone depth at the time of irrigation (mm)

TAW = Total available water (%)

The water use was determined for each separate treatment. The irrigation water use efficiency (IWUE, kg/m^3) was determined using the following equation (Stanhill, 1986; Howell et al., 1990):

$$IWUE = Ya/I$$

where: Ya: actual yield (kg/ha), and I: is the total irrigation water applied (m^3/ha).

2.3 *Statistical Analysis*

The data was analyzed using the SPSS software, which employed a Factorial Randomized Complete Block design and a general linear model (SPSS, 2020). Descriptive statistics were used to examine the data results, such as means at the 0.05 level, Duncan's multiple range test was used to identify significant differences among the various results (Duncan, 1955).

3.RESULTS and DISCUSSION

Table 3 revealed the responses of three sweet corn hybrids (H1, H2, and H3) to different irrigation systems (I1 to I7) during an 8-week period on plant height of corns. The results showed that both hybrid H1 and H2 significantly (P<0.05) compared to H3 at two and four Week After Emergence. While at six and eight weeks, the plant length of H1 significantly (P<0.05) recorded the tallest plant compared to H2 and H3. In comparison among the irrigation systems, I4 and I6 typically resulted in higher plant heights at two weeks. While, I3 and I7 had lower plant height compared to others at two and eight WAE, respectively. At eight WAE the tallest plant was recorded for I1 and I2. But there were no significant differences among I1, I2, I3 and I6. Different outcomes were obtained from the interactions of hybrids and different irrigation systems. For instance, at two WAE, the interaction between H1 and I6 produced the tallest plants. Good outcomes were also shown by H1 with I7 and H2 with I2, especially at four WAE. All irrigation systems showed consistently lower heights for H3, suggesting that its growth may have been limited under the investigated conditions. At eight WAE the tallest plant was recorded for H1 with I1 and I3. At various stages of growth, there were notable variations in plant height. H1 and H2 performed better than H3 at two and four weeks after emergence (WAE), indicating a quicker initial growth rate. Nonetheless, H1 continuously maintained the tallest stature by six and eight WAE. Analogous results in corn indicate that early-season genotype-specific growth vigour may impact later-season canopy structure and light interception (Sharma *et al*., 2018). The consistently lower H3 heights across all irrigation systems point to possible restrictions in either its water-use efficiency or its ability to adjust to the tried-and-true irrigation techniques.

Table 4 showed the responses of three sweet corn hybrids (H1, H2, and H3) to different irrigation systems (I1 to I7) on LA, LAI and K of corns at different growth stages. The results showed that there were no significant (P>0.05) was recorded among the hybrids at two growth stages. While, the LA and LAI for I2 and I3 significantly (P<0.0) increased compared with all other irrigation systems. **Table 4** also showed the light extinction coefficient (K) at both growth stages that significantly (P<0.05) improved with I2 and I3 compared with all other irrigation systems. Different outcomes were showed when hybrids and irrigation systems interacted. The hybrid fared well under these irrigation circumstances, as evidenced by the maximum leaf area and leaf area index values produced and improved K at both growth stages by H3 in combination with I2 and I3. According to earlier studies on corn crops, for certain varieties, a LAI of 3 - 4 would be appropriate for optimizing grain yields (Lindquist *et al*., 1998). Research indicates that the higher value of LAIs might be due to the necessity for effectively preventing sunlight at low lightning intensity ranges (Maddonni and Otegui, 1996). Increased K values indicate better light interception, which could contribute to higher biomass accumulation. Interestingly, H3 performed well in LA and LAI under I2 and I3, suggesting that while it lagged in height, it may have optimized leaf canopy characteristics under favourable irrigation. LA, LAI, and K were greatly increased by irrigation systems I2 and I3, which is consistent with findings that adequate soil moisture promotes leaf expansion and photosynthetic area (Fischer and Turner, 1978).

Table 5 showed the three important morphological traits which were tassel length, spike length, and silk length of three corn hybrids (H1, H2, and H3) respond to different irrigation systems. The findings are statistically ($P<0.05$) significant, for all measured traits, suggesting that hybrid type and irrigation system significantly affect these traits. The tassel length of H3 was taller than H1 and H2. Also, the spike length of both H2 and H3 higher than H1. While, silky length of H1 was taller than other hybrids. The tallest tassel, spike and silky were recorded for I1, I2 and I3 irrigations systems. The maximum tassel length (37.93 cm) was produced by interaction between H1 and I1, indicating that this hybrid does best with ideal watering. While there were no significant ($P>0.05$) differences observed among H1×I1, H2×I1, H3×I1 and H3 with I2, I3, I4 and I7. Also, spike length of interaction between H2×I3, H3×I2 and H3×I7 was higher than other groups. While tallest and shortest silky length were recorded for H1×I3 and (H1×I7, H3×I4 and H3×I5), respectively.

Table 6 showed the responses of three sweet corn hybrids (H1, H2, and H3) to different irrigation systems (I1 to I7) on vegetable growth of corns. The results showed that there were no significant ($P>0.05$) was recorded among the hybrids on the node and internodes number per plant. While, the leaves number and stem diameter of H3 significantly ($P<0.05$) higher than H1 and H2, except leave number of H1. The highest number of nodes, internode, leave number and stem diameter were recorded for I2 and I3 irrigations systems, and the lowest were recorded for I6 and I7. While, the highest number of nodes, internodes and leave number were recorded for interaction between H3×I3 and H1×I3 compared with other interaction. But the thickest stem diameter was recorded for interaction between H3×I5 and H3×I4.

The response of three sweet corn hybrids (H1, H2, and H3) to various irrigation schemes is shown in **Table 7**, with an emphasis on the wet and dry weights of stems, leaves, and whole plants at maturity. Significant differences ($P<0.05$) are shown by the means in each column with distinct subscripts. Regarding sweet corn hybrids, there were no significant differences ($P<0.05$) observed among the three hybrids in the wet weight category, except the leaves wet weight of H3 increased significantly ($P<0.05$) compared both other hybrids, whereas H3 (Talar) had the greatest values for leaves and whole plants. While, the irrigation systems, I2 (RDI. 16 cm, 0 cm) and I3 (RDI. 16 cm, 7.5 cm) were recorded the maximum wet and dry weight for stems, leaves, and whole plant weights. Also, the highest weight of stem, leaves and whole plant weight were recorded for interaction between H3×I2 compared with other interactions. Although most wet weight traits were similar across hybrids, H3 consistently achieved higher leaf and whole-plant weights, particularly under I2. Irrigation systems I2 and I3 maximized both wet and dry biomass, reflecting the efficiency of well-timed RDI in supporting vegetative and reproductive growth without excessive water use (Zhang *et al*., 2018).

Table 8 shows three sweet corn hybrids (H1, H2, and H3) responded to various irrigation systems. Among the corn hybrids, H3 (Talar) had the greatest cob length (21.143 cm), wet ear weight (437.381 g), and ear length (42.952 cm). This implies that H3 could have better growth traits than the other hybrids. Also, wet ear weight of H2 was more than H1. While, there were no significant difference recorded for number of ears per plant and number of kernels per cob among the hybrids. According to irrigation systems, I2, I3 and I5 generated the largest wet ear weight compared with other irrigation systems. Also, I2 recorded the highest value of all grain parameters. suggesting that this technique might improve ear growth. Wet ear weight and cob weight, on the other hand, were lowest for I6 system. The highest value of number of ears per plant was recorded for interaction between H2×I2 compared with other interactions. While, lowest value was recorded for H1×I1 and H3×I1. Also, the highest number of kernels per cob was recorded for interaction between H3×I2, H2×I5 and H1×I2 compared with other interactions. H3 outperformed other hybrids in cob length, ear length, and wet ear weight, indicating strong reproductive potential when water was managed optimally. I2 and I3 consistently enhanced ear parameters, while I6 produced the lowest values, showing the susceptibility ear growth is to insufficient water availability throughout the reproductive stages (Edmeades *et al*., 1993).

Table 9 showed the grain yield parameters of three corn hybrids (H1, H2, and H3) respond to different irrigation systems. There was no significant difference among hybrids on the wet kernal weight, kernal yield (ton/ha), harvest index and fresh forage yield (ton/ha). While H2 and H3 decreased significantly ($P<0.05$) the dry kernal weight per cob (51.14 and 49.47 g) and increased dry forage yield (17.77 17.81 ton/ha) compared with H1 (55.57 g and 16.28 ton/ha), respectively. According the irrigation systems, RDI (I2, I3, I4 and I5) increased significantly ($P<0.05$) the wet kernal weight per cob compared with SDI. While, only I2 significantly ($P<0.05$) increased the dry kernal weight per cob compared with SDI. Kernal yield (ton/ha) and harvest index increased significantly for all RDI systems compared with SDI, the highest yield recorded for I2. Also, the highest value of fresh forage yield (ton/ha) recorded I2 and I3. While, the highest value of Kernal yield (ton/ha) were recorded for interaction between H2×I2 and H2×I3 compared with other interactions. But the lowest value was recorded for interaction between H2×I1. The highest value of biological yield and fresh forage yield (ton/ha) were recorded for interaction between H3×I2 compared with other interactions, while, lowest value was recorded for H3×I6. Also, the highest harvest index was recorded for interaction between H3×I7 and H2×I2 compared with other interactions. These results reinforce the role of deficit irrigation in optimizing both grain and forage yields while conserving water (Geerts and Raes, 2009). The high biological yield for H3×I2 underscores the potential of hybrid-specific irrigation pairing.

Table 10 showed the irrigation water use efficiency (IWUE) of corn was significantly ($P<0.05$) influenced by hybrids, irrigation systems, and their interaction. Among hybrids, SENTINEL (H3) recorded the highest IWUE (0.408 kg/m^3), followed by MESSENGER (H2) with 0.390 kg/m^3, while Talar F1 (H1) had the lowest (0.360 kg/m^3). Irrigation systems showed highly significant differences ($P<0.001$), with the highest IWUE obtained under RDI 16 cm, 7.5 cm (I3: 0.567), followed by RDI 16 cm, 15 cm (I4: 4.79) and RDI 8 cm, 15 cm (I7: 0.428). The lowest IWUE occurred under standard drip irrigation (I1: 0.134). The interaction effect was also significant ($P<0.001$), where the combination H2 × I3 (MESSENGER under RDI 16 cm, 7.5 cm) produced the highest WUE (0.651 kg/m^3), followed by H3 × I4 (0.559) and H3 × I7 (0.547). Conversely, the lowest IWUE values were observed for H3 × I1 (0.129 kg/m^3), H1 × I1 (1.32), and H2 × I1 (0.141), all under standard drip irrigation. These results indicate that both hybrid selection and precise irrigation scheduling substantially affect IWUE in sweet corn production.

Differences in WUE among hybrids are likely attributable to genetic variations in root architecture, transpiration efficiency, and biomass partitioning (Condon *et al*., 2004; Blum, 2009). Hybrids with more efficient stomatal regulation and greater capacity to maintain photosynthetic rates under mild water stress often achieve higher WUE (Sinclair *et al*., 1984). The superior performance of SENTINEL and MESSENGER suggests that these cultivars may possess drought-adaptive traits, making them suitable for water-limited conditions. These results align with previous findings that regulated deficit irrigation can enhance WUE by reducing non-productive water losses, encouraging deeper rooting, and improving transpiration efficiency (Fereres and Maria, 2007; Katerji *et al*., 2008). The lowest WUE occurred under standard drip irrigation (I1: 1.34 kg/m^3), likely due to excessive water application, which increases soil evaporation and leaching losses without proportionally increasing yield (Howell, 2001).

The RDI systems increase crop productivity and lessen environmental impact by effectively managing and using the water resources that are available. Crop productivity can be increased and the amount of water supplied to agricultural fields can be greatly reduced with effective water management techniques (Cotera *et al.*, 2024). The results of our irrigation systems study showed highly significant differences, with the highest IWUE obtained under RDI 16 cm, 7.5 cm compared with standard drip irrigation system. A higher WUE is considered better because it indicates that the crop is producing more yield with less water, which is crucial in water-scarce environments and under climate change conditions. An increase in WUE means the plant utilizes available water more effectively, thereby improving productivity without additional water inputs (Kang *et al*., 2017). Conversely, a decrease in WUE suggests inefficient water use, where more water is lost through evaporation or transpiration relative to yield, which is not desirable in sustainable agriculture. Therefore, agricultural practices such as deficit irrigation, drought-tolerant hybrids, and improved irrigation systems are often adopted to enhance WUE (Farooq *et al*., 2014).

Figure 3 shows the water saving for RDI compared with SDI. The RDI treatments show notable water savings. All RDI treatments reduced water use compared to SDI that might not implement deficit irrigation, which can lead to less efficient water use and a higher environmental impact to growth stages and crop production. The more efficient use of water is one of the primary goals of responsive drip irrigation technologies as a smart irrigation. Smart irrigation systems can optimize irrigation needs and more accurately monitor plants' water requirements. By continuously monitoring soil moisture levels and meteorological circumstances, these devices make sure that water is applied at the appropriate time and in the appropriate amount. The data in (Figure 3) confirm that RDI treatments achieved significant water savings about 60% compared to SDI. Pereira *et al*. (2002) showed that in their result RDI can reduce water use by up to 30% without sacrificing yield. Responsive drip Irrigation, enable precise water delivery that aligns with crop evapotranspiration needs, improving both water productivity and environmental sustainability (Cotera *et al.*, 2024).

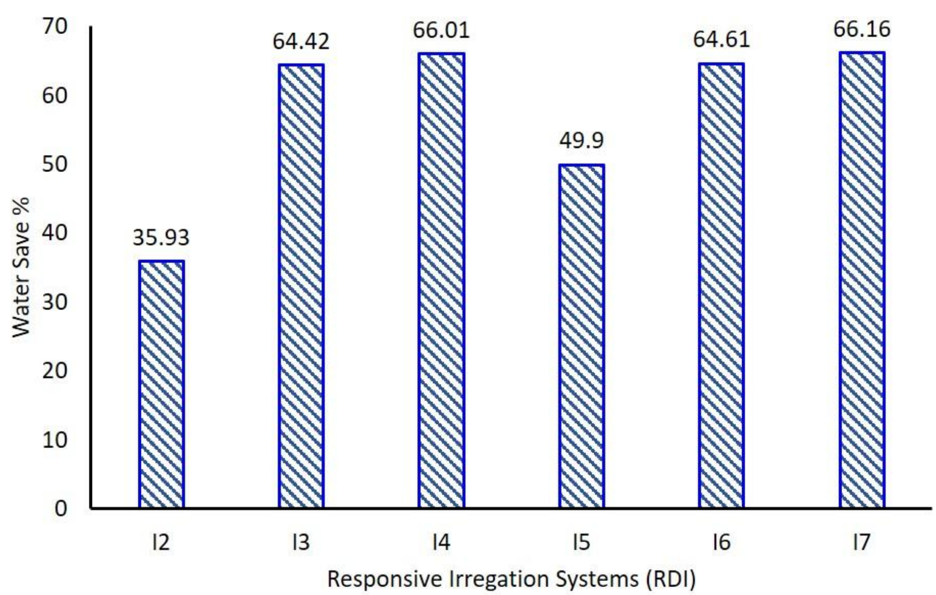

Figure 3: Water saved with installed responsive irrigation system RDI over standard irrigation system (SDI). I2: (RDI. 16 cm ,0 cm), I3: (RDI. 16, 7,5 cm), I4: (RDI. 16, 15 cm), I5: (RDI. 8, 0 cm), I6: (RDI. 8, 7.5 cm) and I7: (RDI. 8, 15 cm).

Table 3. Response of three sweet corn hybrids to different irrigation systems and their interaction on plant height.

Treatment	**Plant Height (cm) WAE**			
	2 weeks	**4 weeks**	**6 weeks**	**8 weeks**
Sweet Corn Hybrids				
H1	25.92 [a]	85.32 [a]	155.37 [a]	179.68 [a]
H2	26.89 [a]	83.91 [a]	138.34 [b]	161.01 [b]
H3	20.77 [b]	71.75 [b]	132.51 [b]	155.34 [c]
P. value	<0.001	<0.001	<0.001	<0.001
Irrigation Systems				
I1	23.60 [bc]	81.07 [a]	147.13 [ab]	172.20 [a]
I2	23.58 [bc]	82.54 [a]	152.94 [a]	171.97 [a]
I3	21.74 [c]	77.68 [a]	145.71 [ab]	167.40 [ab]
I4	26.47 [a]	84.47 [a]	143.98 [abc]	162.37 [bc]
I5	25.76 [ab]	80.25 [a]	139.54 [bc]	160.80 [bc]
I6	26.45 [a]	78.51 [a]	132.51 [c]	164.55 [abc]
I7	24.08 [abc]	77.77 [a]	132.71 [c]	158.13 [c]
P. Value	0.002	0.110	0.006	0.004
Interaction between Hybrids and Irrigation systems				
H1 × I1	17.20 [i]	73.96 [efgh]	161.73 [a]	191.33 [a]
H1 × I2	19.96 [hi]	72.10 [efgh]	161.00 [a]	188.46 [a]
H1 × I3	18.86 [hi]	72.53 [efgh]	155.70 [ab]	188.93 [a]
H1 × I4	31.93 [ab]	94.93[ab]	151.36 [abc]	174.93 [abc]
H1 × I5	31.23 [abc]	92.53 [abc]	154.26 [ab]	171.00 [bcd]
H1 × I6	33.90 [a]	94.53 [ab]	153.00 [ab]	178.26 [ab]
H1 × I7	28.40 [bcde]	96.70 [a]	150.56 [abc]	164.86 [bcdef]
H2 × I1	30.43 [abcd]	90.46 [abcd]	149.23 [abc]	167.00 [bcde]
H2 × I2	29.06 [bcde]	97.06 [a]	154.20 [ab]	172.26 [bcd]
H2 × I3	27.03 [cdef]	80.60 [bcdef]	139.50 [abcd]	164.53 [bcdef]
H2 × I4	27.90 [bcde]	81.06 [bcdef]	138.46 [abcd]	157.26 [def]
H2 × I5	25.86 [defg]	82.50 [abcde]	134.73 [bcd]	160.26 [cdef]
H2 × I6	25.53 [efg]	79.06 [cdef]	126.46 [cd]	151.06 [ef]
H2 × I7	22.43 [fgh]	76.66 [defg]	125.80 [cd]	154.73 [def]
H3 × I1	23.16 [fgh]	78.80 [cdef]	130.43 [bcd]	158.26 [cdef]
H3 × I2	21.73 [ghi]	78.46 [cdef]	143.63 [abcd]	155.20 [def]
H3 × I3	19.33 [hi]	79.93 [bcde]	141.93 [abcd]	148.73 [f]
H3 × I4	19.60 [hi]	77.43 [cdef]	142.13 [abcd]	154.93 [def]
H3 × I5	20.20 [hi]	65.73 [fgh]	129.63 [bcd]	151.13 [ef]
H3 × I6	19.93 [hi]	61.93 [gh]	118.06 [d]	164.33 [bcdef]
H3 × I7	21.43 [ghi]	59.96 [h]	121.76 [d]	154.80 [def]
P. value	0.001	<0.001	0.002	<0.001

H1: Talar F1 (Biotek), **H2:** MESSENGER (Semins) and **H3:** SENTINEL (Talar type) EliSem(CLAUSE).
I1 (SDI, standard drip irrigation), **I2**: (RDI. 16 cm ,0 cm), **I3**: (RDI. 16, 7,5 cm), **I4**: (RDI. 16, 15 cm), **I5**: (RDI. 8, 0 cm), **I6**: (RDI. 8, 7.5 cm) and **I7**: (RDI. 8, 15 cm).
[a-i] Means within each column had the different subscript differing significantly (P<0.05).

Table 4. Response of three sweet corn hybrids to different irrigation systems and their interaction on LA, LAI and K at tow growth stages.

Treatment	Before Maturity			After Maturity		
	LA (cm^2)	LAI	K	LA (cm^2)	LAI	K
Sweet Corn Hybrids						
H1	1516.75 ^{a}	3.79 ^{a}	0.52 ^{a}	1648.09 ^{a}	4.12 ^{a}	0.29 ^{a}
H2	1466.18 ^{a}	3.66 ^{a}	0.52 ^{a}	1567.74 ^{a}	3.91 ^{a}	0.29 ^{a}
H3	1641.47 ^{a}	4.10 ^{a}	0.49 ^{a}	1772.23 ^{a}	4.43 ^{a}	0.28 ^{a}
P. value	0.187	0.187	0.525	0.160	0.160	0.758
Irrigation Systems						
I1	1480.60 ^{b}	3.70 ^{b}	0.50 ^{b}	1602.03 ^{b}	4.00 ^{b}	0.28 ^{bc}
I2	2098.85 ^{a}	5.24 ^{a}	0.37 ^{c}	2258.42 ^{a}	5.64 ^{a}	0.23 ^{cd}
I3	2193.36 ^{a}	5.48 ^{a}	0.37 ^{c}	2348.02 ^{a}	5.87 ^{a}	0.20 ^{d}
I4	1408.56 ^{bc}	3.52 ^{bc}	0.57 ^{ab}	1506.59 ^{bc}	3.76 ^{bc}	0.32 ^{b}
I5	1325.45 ^{bc}	3.31 ^{bc}	0.55 ^{b}	1448.57 ^{bc}	3.62 ^{bc}	0.31 ^{b}
I6	1099.68 ^{c}	2.74 ^{c}	0.66 ^{a}	1185.06 ^{c}	2.96 ^{c}	0.38 ^{a}
I7	1183.68 ^{bc}	2.95 ^{bc}	0.57 ^{ab}	1290.13 ^{bc}	3.22 ^{bc}	0.31 ^{b}
P. Value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Interaction between Hybrids and Irrigation systems						
H1 × I1	1400.48 ^{defgh}	3.50 $^{d-f}$	0.561 $^{a-d}$	1533.61 $^{d-h}$	3.83 $^{d-h}$	0.276 ^{bcd}
H1 × I2	1963.39 ^{cd}	4.90 ^{cd}	0.370 ^{efg}	2129.99 ^{bcd}	5.32 ^{bcd}	0.247 ^{cde}
H1 × I3	2033.06 ^{bc}	5.08 ^{bc}	0.391 $^{d-g}$	2199.65 ^{bc}	5.49 ^{bc}	0.224 ^{de}
H1 × I4	1693.37 $^{c-g}$	4.23 $^{c-g}$	0.530 $^{b-e}$	1826.82 $^{c-g}$	4.56 $^{c-g}$	0.289 ^{bcd}
H1 × I5	1292.83 ^{fgh}	3.23 ^{fgh}	0.589 ^{abc}	1412.49 $^{e-h}$	3.53 $^{e-h}$	0.322 ^{bcd}
H1 × I6	1134.44 ^{gh}	2.83 ^{gh}	0.631 ^{ab}	1267.75 ^{fgh}	3.16 ^{fgh}	0.370 ^{ab}
H1 × I7	1099.68 ^{gh}	2.74 ^{gh}	0.627 ^{ab}	1166.32 ^{gh}	2.91 ^{gh}	0.342 ^{abc}
H2 × I1	1668.75 ^{cdef}	4.17 $^{c-e}$	0.437 $^{c-g}$	1768.55 $^{c-h}$	4.42 $^{c-h}$	0.268 $^{b-e}$
H2 × I2	1787.21 ^{cdef}	4.46 $^{c-f}$	0.473 $^{b-f}$	1920.48 $^{c-f}$	4.80 $^{c-f}$	0.295 ^{bcd}
H2 × I3	1926.87 ^{cde}	4.81 ^{cde}	0.410 $^{c-g}$	2026.78 ^{cde}	5.06 ^{cde}	0.230 ^{de}
H2 × I4	1336.41 ^{efgh}	3.34 $^{e-f}$	0.572 $^{a-d}$	1402.88 $^{e-h}$	3.50 $^{e-h}$	0.303 ^{bcd}
H2 × I5	1223.05 ^{fgh}	3.05 ^{fgh}	0.594 ^{abc}	1346.33 ^{fgh}	3.36 ^{fgh}	0.327 ^{bcd}
H2 × I6	1123.96 ^{gh}	2.81 ^{gh}	0.647 ^{ab}	1182.99 ^{gh}	2.95 ^{gh}	0.363 ^{ab}
H2 × I7	1197.02 ^{fgh}	2.99 ^{fgh}	0.552 $^{a-e}$	1326.17 ^{fgh}	3.31 ^{fgh}	0.308 ^{bcd}
H3 × I1	1372.56 $^{d-h}$	3.43 $^{d-f}$	0.513 $^{b-e}$	1503.94 $^{d-h}$	3.76 $^{d-h}$	0.296 ^{bcd}
H3 × I2	2545.96 ^{ab}	6.36 ^{ab}	0.277 ^{g}	2724.79 ^{ab}	6.81 ^{ab}	0.169 ^{e}
H3 × I3	2620.14 ^{a}	6.55 ^{a}	0.320 ^{fg}	2817.61 ^{a}	7.04 ^{a}	0.169 ^{e}
H3 × I4	1195.92 ^{fgh}	2.99 ^{fgh}	0.627 ^{ab}	1290.05 ^{fgh}	3.22 ^{fgh}	0.374 ^{ab}
H3 × I5	1460.47 $^{c-h}$	3.65 $^{c-f}$	0.486 $^{b-f}$	1586.89 $^{d-h}$	3.96 $^{c-h}$	0.290 ^{bcd}
H3 × I6	1040.64 ^{h}	2.60 ^{h}	0.725 ^{a}	1104.43 ^{h}	2.76 ^{h}	0.430 ^{a}
H3 × I7	1254.62 ^{fgh}	3.13 ^{fgh}	0.541 $^{a-e}$	1377.89 $^{e-h}$	3.44 $^{e-h}$	0.282 ^{bcd}
P. value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

H1: Talar F1 (Biotek), **H2:** MESSENGER (Semins) and **H3:** SENTINEL (Talar type) EliSem(CLAUSE).
I1 (SDI, standard drip irrigation), **I2**: (RDI. 16 cm ,0 cm), **I3**: (RDI. 16, 7,5 cm), **I4**: (RDI. 16, 15 cm), **I5**: (RDI. 8, 0 cm), **I6**: (RDI. 8, 7.5 cm) and **I7**: (RDI. 8, 15 cm).
$^{a-i}$ Means within each column had the different subscript differing significantly (P<0.05).

Table 5. Response of three sweet corn hybrids to different irrigation systems and their interaction on tassel length, spike length and silky length.

Treatments	Tassel Length (cm)	Spike Length (cm)	Silky Length (cm)
Sweet Corn Hybrids			
H1	31.81 ^{c}	19.53 ^{b}	8.00 ^{a}
H2	33.09 ^{b}	22.99 ^{a}	7.06 ^{b}
H3	34.92 ^{a}	23.01 ^{a}	6.32 ^{c}
P. value	<0.001	<0.001	<0.001
Irrigation Systems			
I1	37.13 ^{a}	23.24 ^{a}	7.12 ^{b}
I2	34.77 ^{b}	23.06 ^{a}	8.28 ^{a}
I3	34.64 ^{b}	23.44 ^{a}	8.15 ^{a}
I4	32.86 ^{c}	21.86 ^{ab}	6.93 ^{b}
I5	31.31 ^{de}	19.97 ^{c}	5.93 ^{c}
I6	30.02 ^{e}	19.93 ^{c}	6.66 ^{bc}
I7	32.20 ^{cd}	21.40 ^{bc}	6.82 ^{b}
P. Value	<0.001	<0.001	<0.001
Interaction between Hybrids and Irrigation systems			
H1 × I1	37.93 ^{a}	23.46 $^{a-d}$	8.86 ^{abc}
H1 × I2	32.46 $^{e-h}$	19.86 ^{efg}	9.20 ^{ab}
H1 × I3	31.40 $^{f-i}$	20.33 ^{efg}	9.66 ^{a}
H1 × I4	29.93 ^{hi}	17.93 ^{fg}	8.40 ^{abc}
H1 × I5	30.86 $^{e-i}$	17.93 ^{fg}	6.86 $^{d-g}$
H1 × I6	30.66 $^{e-i}$	19.53 ^{efg}	7.66 $^{b-e}$
H1 × I7	29.46 ^{i}	17.667 ^{g}	5.33 ^{g}
H2 × I1	37.53 ^{a}	24.33 ^{ab}	6.53 ^{efg}
H2 × I2	34.26 $^{b-e}$	23.73 $^{a-d}$	8.33 ^{abc}
H2 × I3	36.46 $^{a-d}$	25.93 ^{a}	7.40 ^{cde}
H2 × I4	33.20 $^{d-g}$	23.73 $^{a-d}$	7.06 ^{def}
H2 × I5	29.66 ^{hi}	20.86 ^{def}	5.60 ^{fg}
H2 × I6	30.06 ^{hi}	21.13 ^{cde}	6.93 $^{d-g}$
H2 × I7	30.46 ^{ghi}	21.20 ^{cde}	7.60 $^{b-e}$
H3 × I1	35.93 $^{a-d}$	21.93 $^{b-e}$	5.96 ^{efg}
H3 × I2	37.60 ^{a}	25.60 ^{a}	7.33 ^{cde}
H3 × I3	36.067 ^{abc}	24.06 ^{abc}	7.40 ^{cde}
H3 × I4	35.46 $^{a-d}$	23.93 $^{a-d}$	5.33 ^{g}
H3 × I5	33.40 $^{c-f}$	21.13 ^{cde}	5.33 ^{g}
H3 × I6	29.33 ^{i}	19.13 ^{efg}	5.40 ^{fg}
H3 × I7	36.66 ^{ab}	25.33 ^{a}	7.53 $^{b-e}$
P. value	<0.001	<0.001	<0.001

H1: Talar F1 (Biotek), **H2:** MESSENGER (Semins) and **H3:** SENTINEL (Talar type) EliSem(CLAUSE).
I1 (SDI, standard drip irrigation), **I2**: (RDI. 16 cm ,0 cm), **I3**: (RDI. 16, 7,5 cm), **I4**: (RDI. 16, 15 cm), **I5**: (RDI. 8, 0 cm), **I6**: (RDI. 8, 7.5 cm) and **I7**: (RDI. 8, 15 cm).
$^{a-i}$ Means within each column had the different subscript differing significantly (P<0.05).

Table 6. Response of three sweet corn hybrids to different irrigation systems and their interaction on vegetable growth after maturity.

Treatments	**No. of Node/Plant**	**No. of Internode/Plant**	**No. of Leaves/Plant**	**Stem diameter (cm)**
Sweet Corn Hybrids				
H1	11.429 [a]	10.429 [a]	10.333 [ab]	1.790 [b]
H2	11.048 [a]	10.048 [a]	9.762 [b]	1.814 [b]
H3	11.476 [a]	10.476 [a]	10.905 [a]	2.090 [a]
P. value	0.245	0.245	0.002	<0.001
Irrigation Systems				
I1	11.889 [ab]	10.889 [ab]	10.111 [ab]	1.856 [b]
I2	12.000 [ab]	11.000 [ab]	11.000 [a]	2.044 [a]
I3	12.444 [a]	11.444 [a]	10.889 [a]	1.944 [ab]
I4	11.222 [bc]	10.222 [bc]	10.667 [ab]	2.022 [a]
I5	11.222 [bc]	10.222 [bc]	10.222 [ab]	1.900 [ab]
I6	10.444 [cd]	9.444 [cd]	9.778 [b]	1.689 [c]
I7	10.000 [d]	9.000 [d]	9.667 [b]	1.833 [bc]
P. Value	<0.001	<0.001	0.033	<0.001
Interaction between Hybrids and Irrigation systems				
H1 × I1	11.66 [a-d]	10.66 [a-d]	10.66 [bc]	1.80 [e-h]
H1 × I2	11.66 [a-d]	10.66 [a-d]	11.00 [bc]	2.06 [a-e]
H1 × I3	13.00 [a]	12.00 [a]	10.33 [bc]	1.90 [c-g]
H1 × I4	11.33 [a-e]	10.33 [a-e]	11.00 [bc]	2.00 [b-f]
H1 × I5	11.66 [a-d]	10.66 [a-d]	10.00 [bc]	1.60 [h]
H1 × I6	10.66 [b-e]	9.66 [b-e]	9.66 [bc]	1.60 [h]
H1 × I7	10.00 [b-e]	9.00 [de]	9.66 [bc]	1.56 [h]
H2 × I1	12.33 [ab]	11.33 [ab]	10.00 [bc]	1.83 [d-h]
H2 × I2	12.33 [ab]	11.33 [ab]	10.33 [bc]	1.96 [c-f]
H2 × I3	11.33 [a-e]	10.33 [a-e]	9.33 [c]	1.93 [c-f]
H2 × I4	10.33 [cde]	9.33 [cde]	10.00 [bc]	1.80 [e-h]
H2 × I5	10.33 [cde]	9.33 [cde]	9.333 [c]	1.76 [fgh]
H2 × I6	10.33 [cde]	9.33 [cde]	9.66 [bc]	1.63 [gh]
H2 × I7	10.33 [cde]	9.33 [cde]	9.66 [bc]	1.76 [fgh]
H3 × I1	11.66 [a-d]	10.66 [a-d]	9.66 [bc]	1.93 [c-f]
H3 × I2	12.00 [abc]	11.00 [abc]	11.66 [ab]	2.10 [a-d]
H3 × I3	13.00 [a]	12.00 [a]	13.00 [a]	2.00 [b-f]
H3 × I4	12.00 [abc]	11.00 [abc]	11.00 [bc]	2.26 [ab]
H3 × I5	11.66 [a-d]	10.66 [a-d]	11.33 [abc]	2.33 [a]
H3 × I6	10.33 [cde]	9.33 [cde]	10.00 [bc]	1.83 [d-h]
H3 × I7	9.66 [e]	8.66 [e]	9.66 [bc]	2.16 [abc]
P. value	<0.001	<0.001	<0.001	<0.001

H1: Talar F1 (Biotek), **H2:** MESSENGER (Semins) and **H3:** SENTINEL (Talar type) EliSem(CLAUSE).
I1 (SDI, standard drip irrigation), **I2**: (RDI. 16 cm ,0 cm), **I3**: (RDI. 16, 7,5 cm), **I4**: (RDI. 16, 15 cm), **I5**: (RDI. 8, 0 cm), **I6**: (RDI. 8, 7.5 cm) and **I7**: (RDI. 8, 15 cm).
[a-i] Means within each column had the different subscript differing significantly (P<0.05).

Table 7. Response of three sweet corn hybrids to different irrigation systems and their interaction on weight of wet and dry (g) of stem, leaves and whole plants after maturity.

Treatment	Wet weight/Plant (g)			Dry weight/Plant (g)		
	Stem Weight	**leaves Weight**	**Plant Weight**	**Stem Weight**	**leaves Weight**	**Plant Weight**
Sweet Corn Hybrids						
H1	177.33 ^{a}	49.619 ^{b}	226.95 ^{a}	51.31 ^{b}	17.08 ^{b}	68.39 ^{b}
H2	190.71 ^{a}	51.952 ^{b}	242.66 ^{a}	56.67 ^{a}	17.97 ^{b}	74.64 ^{a}
H3	189.76 ^{a}	57.429 ^{a}	247.19 ^{a}	55.52 ^{ab}	19.31 ^{a}	74.83 ^{a}
P. value	0.276	0.006	0.093	0.049	0.001	0.015
Irrigation Systems						
I1	207.11 ^{ab}	55.667 ^{bc}	262.77 ^{ab}	61.48 ^{a}	16.44 ^{d}	77.92 ^{a}
I2	229.33 ^{a}	61.667 ^{ab}	291.00 ^{a}	63.58 ^{a}	19.33 ^{b}	82.91 ^{a}
I3	218.66 ^{a}	68.222 ^{a}	286.88 ^{a}	57.17 ^{ab}	21.68 ^{a}	78.85 ^{a}
I4	185.88 ^{bc}	48.778 ^{cd}	234.66 ^{bc}	56.57 ^{ab}	18.63 ^{bc}	75.20 ^{a}
I5	166.11 ^{cd}	48.222 ^{cd}	214.33 ^{cd}	50.72 ^{bc}	16.83 ^{d}	67.55 ^{b}
I6	142.33 ^{d}	44.556 ^{d}	186.88 ^{d}	46.77 ^{c}	17.23 ^{cd}	64.00 ^{b}
I7	152.11 ^{d}	43.889 ^{d}	196.00 ^{d}	45.20 ^{c}	16.70 ^{d}	61.91 ^{b}
P. Value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Interaction between Hybrids and Irrigation systems						
H1 × I1	205.33 $^{c-g}$	62.00 ^{cd}	267.33 ^{cde}	52.74 $^{d-h}$	16.21 ^{de}	68.95 $^{d-g}$
H1 × I2	175.00 $^{c-h}$	47.00 ^{efg}	222.00 $^{e-h}$	52.63 $^{d-h}$	15.25 ^{e}	67.88 $^{d-g}$
H1 × I3	209.00 $^{c-f}$	52.66 $^{c-g}$	261.66 $^{c-e}$	49.65 $^{e-h}$	18.20 ^{cde}	67.85 $^{d-g}$
H1 × I4	175.33 $^{c-h}$	51.00 $^{d-g}$	226.33 $^{e-h}$	58.44 $^{b-f}$	20.77 ^{ab}	79.21 ^{bcd}
H1 × I5	157.66 $^{e-h}$	48.66 $^{d-g}$	206.33 ^{fgh}	46.81 $^{e-h}$	16.02 ^{de}	62.83 ^{efg}
H1 × I6	152.66 ^{efg}	43.33 ^{g}	196.00 ^{gh}	50.52 $^{e-h}$	16.76 ^{de}	67.28 $^{d-g}$
H1 × I7	166.33 $^{d-h}$	42.66 ^{g}	209.00 ^{fgh}	48.39 $^{e-h}$	16.33 ^{de}	64.73 $^{d-g}$
H2 × I1	266.66 ^{ab}	60.33 ^{cde}	327.00 ^{b}	81.76 ^{a}	17.40 ^{cde}	99.16 ^{a}
H2 × I2	214.00 ^{cde}	60.00 $^{c-f}$	274.00 $^{b-e}$	69.69 ^{b}	20.55 ^{ab}	90.25 ^{abc}
H2 × I3	218.33 ^{bcd}	66.66 ^{bc}	285.00 ^{bcd}	55.90 $^{c-h}$	20.73 ^{ab}	76.64 ^{cde}
H2 × I4	201.33 $^{c-g}$	41.33 ^{g}	242.66 $^{d-g}$	54.45 $^{d-h}$	16.09 ^{de}	70.54 $^{d-g}$
H2 × I5	160.33 $^{e-h}$	44.00 ^{g}	204.33 ^{fgh}	46.29 $^{e-h}$	16.77 ^{de}	63.06 ^{efg}
H2 × I6	136.00 ^{h}	46.00 ^{efg}	182.00 ^{h}	45.99 $^{e-h}$	16.88 ^{de}	62.87 ^{efg}
H2 × I7	138.33 ^{h}	45.33 ^{fg}	183.66 ^{h}	42.58 ^{h}	17.40 ^{cde}	59.99 ^{g}
H3 × I1	149.33 ^{gh}	44.66 ^{g}	194.00 ^{gh}	49.94 $^{e-h}$	15.71 ^{de}	65.65 $^{d-g}$
H3 × I2	299.00 ^{a}	78.00 ^{ab}	377.00 ^{a}	68.42 ^{bc}	22.18 ^{b}	90.60 ^{abc}
H3 × I3	228.66 ^{bc}	85.33 ^{a}	314.00 ^{bc}	65.97 ^{bcd}	26.11 ^{a}	92.08 ^{ab}
H3 × I4	181.00 $^{c-h}$	54.00 $^{c-g}$	235.00 $^{d-h}$	56.82 $^{b-g}$	19.04 ^{bcd}	75.86 ^{def}
H3 × I5	180.33 $^{c-h}$	52.00 $^{d-g}$	232.33 $^{d-h}$	59.07 $^{b-d}$	17.69 ^{cde}	76.76 ^{cde}
H3 × I6	138.33 ^{g}	44.33 ^{g}	182.66 ^{h}	43.80 ^{gh}	18.06 ^{cde}	61.86 ^{efg}
H3 × I7	151.66 ^{gh}	43.66 ^{g}	195.33 ^{gh}	44.64 ^{fgh}	16.37 ^{de}	61.01 ^{efg}
P. value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

H1: Talar F1 (Biotek), **H2:** MESSENGER (Semins) and **H3:** SENTINEL (Talar type) EliSem(CLAUSE).
I1 (SDI, standard drip irrigation), **I2**: (RDI. 16 cm ,0 cm), **I3**: (RDI. 16, 7,5 cm), **I4**: (RDI. 16, 15 cm), **I5**: (RDI. 8, 0 cm), **I6**: (RDI. 8, 7.5 cm) and **I7**: (RDI. 8, 15 cm).
$^{a-i}$ Means within each column had the different subscript differing significantly (P<0.05).

Table 8. Response of three sweet corn hybrids to different irrigation systems and their interaction on grain yield parameters.

Treatment	Parameters							
	No. Ear/Plant	**Ear Length (cm)**	**Wet Ear Weight (g)**	**Cob Length (cm)**	**Wet cob weight (g)**	**Row/Cob**	**Kerels/ Row**	**Kerels/ Cob**
Hybrids								

H1	1.74 a	36.00 c	350.61 c	19.76 b	280.85 b	41.76 a	15.71 b	658.47 a
H2	1.78 a	38.73 b	402.23 b	20.57 ab	309.38 a	38.71 b	15.95 b	621.71 a
H3	1.81 a	42.95 a	437.38 a	21.14 a	326.33 a	39.57 b	17.14 a	679.33 a
P. value	0.129	<0.001	<0.001	0.008	0.001	0.013	0.002	0.061
Irrigation S.								
I1	1.46 d	38.77 bc	380.22 b	21.22 a	296.33 b	40.88 ab	17.00 ab	697.33 ab
I2	2.12 a	41.77 a	423.33 a	21.33 a	348.88 a	43.22 a	17.77 a	770.22 a
I3	1.88 b	41.05 ab	449.11 a	20.66 ab	344.33 a	40.33 ab	17.11 ab	684.88 b
I4	1.84 b	37.44 cd	385.11 b	19.33 bc	284.22 bc	39.44 bc	16.00 bc	632.22 bc
I5	1.71 c	40.33 ab	445.33 a	21.22 a	348.11 a	40.33 ab	16.66 ab	674.22 b
I6	1.69 c	35.00 d	338.22 c	19.22 c	249.11 c	36.44 c	15.11 cd	550.00 d
I7	1.72 c	40.22 ab	355.88 bc	20.44 abc	267.66 bc	39.44 bc	14.22 c	563.33 cd
P. Value	<0.001	<0.001	<0.001	0.004	<0.001	0.007	<0.001	<0.001
Hybrids × Irrigation S.								
H1 × I1	1.46 hi	37.00 fghi	357.33 efg	20.00 c-h	291.33 efgh	42.66 abc	18.00 ab	768.00 abc
H1 × I2	2.06 b	39.00 efgh	400.00 cde	20.00 c-h	348.33 a-e	43.66 ab	18.00 ab	786.00 ab
H1 × I3	1.95 bcd	38.66 efgh	370.66 d-g	19.66 d-h	300.00 defg	44.66 ab	16.00 b-e	714.66 abcd
H1 × I4	1.85 cde	34.667 hij	377.00 d-g	19.33 efgh	239.00 gh	42.33 abc	16.66 a-d	704.00 abcd
H1 × I5	1.82 def	32.667 ij	311.00 g	19.33 efgh	260.66 fgh	38.66 abcd	14.66 def	565.33 defg
H1 × I6	1.74 efg	33.333 ij	329.33 fg	20.33 b-h	283.00 efgh	41.33 abc	14.00 ef	578.66 defg
H1 × I7	1.78 def	36.66 fghi	309.00 g	19.66 d-h	243.66 gh	39.00 abcd	12.66 f	492.66 g
H2 × I1	1.53 ghi	42.66 bcde	403.33 cde	22.66 ab	297.00 defg	38.33 bcd	16.33 a-e	630.66 c-g
H2 × I2	2.26 a	40.66 defg	406.66 cde	21.333 a-f	338.33 a-e	41.00 abc	16.66 a-d	682.66 bcde
H2 × I3	2.04 bc	40.16 defg	491.66 ab	21.66 a-e	361.66 abcd	39.33 abcd	16.66 a-d	654.66 b-f
H2 × I4	1.72 efg	39.00 efgh	378.33 d-g	18.66 gh	300.00 defg	39.00 abcd	14.00 ef	550.66 efg
H2 × I5	1.70 efg	41.66 cdef	506.66 ab	22.00 abcd	400.00 a	42.33 abc	18.66 a	792.00 ab
H2 × I6	1.67 efgh	31.333 j	308.66 g	19.00 fgh	228.66 h	34.00 d	15.33 cde	523.33 fg
H2 × I7	1.54 ghi	35.66 ghij	320.33 g	18.66 gh	240.00 gh	37.00 cd	14.00 ef	518.00 fg
H3 × I1	1.38 i	36.66 fghi	380.00 d-g	21.00 a-f	300.66 defg	41.66 abc	16.66 a-d	693.33 bcde
H3 × I2	2.03 bc	45.66 abc	463.33 abc	22.66 ab	360.00 abcd	45.00 a	18.66 a	842.00 a
H3 × I3	1.66 efgh	44.33 abcd	485.00 ab	20.66 a-h	371.33 abc	37.00 cd	18.66 a	685.33 bcde
H3 × I4	1.95 bcd	38.66 efgh	400.00 cde	20.00 c-h	313.66 cdef	37.00 cd	17.33 abc	642.00 b-f
H3 × I5	1.61 fgh	46.66 ab	518.33 a	22.33 abc	383.66 ab	40.00 abcd	16.66 a-d	665.33 b-f
H3 × I6	1.67 efgh	40.33 defg	376.66 d-g	18.33 h	235.66 gh	34.00 d	16.00 b-e	548.00 efg
H3 × I7	1.86 cde	48.33 a	438.33 bcd	23.00 a	319.33 b-f	42.33 abc	16.00 b-e	679.33 bcde
P. value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

H1: Talar F1 (Biotek), **H2:** MESSENGER (Semins) and **H3:** SENTINEL (Talar type) EliSem (CLAUSE).
I1 (SDI, standard drip irrigation), **I2**: (RDI. 16 cm ,0 cm), **I3**: (RDI. 16, 7,5 cm), **I4**: (RDI. 16, 15 cm), **I5**: (RDI. 8, 0 cm), **I6**: (RDI. 8, 7.5 cm) and **I7**: (RDI. 8, 15 cm).
a-i Means within each column had the different subscript differing significantly (P<0.05).

Table 9. Response of three sweet corn hybrids to different irrigation systems and their interaction on grain yield and forage yield parameters.

Treatment	Parameters						
	Wet Kernel weight/cob (g)	**Dry Kernel weight/cob (g)**	**Kernel Yield** (ton/ha)	**Biological Yield (g/plant)**	**Harvest index (%)**	**Fresh Forage Yield** (ton/ha)	**Dry Forage Yield** (ton/ha)
Sweet Corn Hybrids							
H1	202.61 ^{a}	55.57 ^{a}	8.75 ^{a}	429.57 ^{b}	2.04 ^{a}	54.03 ^{a}	16.28 ^{b}
H2	203.76 ^{a}	51.14 ^{b}	8.71 ^{a}	446.42 ^{ab}	1.96 ^{a}	57.77 ^{a}	17.77 ^{a}
H3	212.47 ^{a}	49.47 ^{b}	8.80 ^{a}	459.66 ^{a}	1.93 ^{a}	58.85 ^{a}	17.81 ^{a}
P. value	0.177	0.013	0.952	0.010	0.202	0.093	0.015
Irrigation Systems							
I1	192.25 ^{b}	49.44 ^{b}	6.66 ^{e}	455.33 ^{b}	1.47 ^{c}	62.56 ^{ab}	18.55 ^{a}
I2	214.88 ^{a}	58.00 ^{a}	10.83 ^{a}	505.88 ^{a}	2.18 ^{a}	69.28 ^{a}	19.74 ^{a}
I3	212.66 ^{a}	53.33 ^{ab}	9.54 ^{b}	499.55 ^{a}	1.92 ^{b}	68.30 ^{a}	18.77 ^{a}
I4	216.66 ^{a}	52.77 ^{ab}	9.53 ^{b}	451.33 ^{b}	2.12 ^{ab}	55.87 ^{bc}	17.90 ^{a}
I5	214.44 ^{a}	50.55 ^{b}	8.72 ^{bc}	428.77 ^{bc}	2.03 ^{ab}	51.03 ^{cd}	16.08 ^{b}
I6	188.55 ^{b}	48.77 ^{b}	7.62 ^{d}	375.44 ^{d}	2.02 ^{ab}	44.49 ^{d}	15.24 ^{b}
I7	204.22 ^{ab}	49.33 ^{b}	8.41 ^{cd}	400.22 ^{cd}	2.08 ^{ab}	46.66 ^{d}	14.73 ^{b}
P. Value	0.007	0.034	<0.001	<0.001	<0.001	<0.001	<0.001
Interaction between Hybrids and Irrigation Systems							
H1 × I1	196.66 ^{bcd}	57.66 $^{a-d}$	6.89 ^{ghi}	464.00 ^{cdef}	1.49 ^{gh}	63.65 ^{cde}	16.42 $^{d-g}$
H1 × I2	214.66 ^{abc}	57.00 $^{a-d}$	10.52 ^{ab}	436.66 ^{defg}	2.41 ^{a}	52.85 $^{e-h}$	16.16 $^{d-g}$
H1 × I3	197.00 ^{bcd}	52.00 $^{b-e}$	9.15 ^{bcde}	458.66 ^{cdef}	1.99 $^{b-f}$	62.30 $^{c-f}$	16.15 $^{d-g}$
H1 × I4	233.33 ^{a}	65.66 ^{a}	10.31 ^{abc}	459.66 ^{bcde}	2.24 ^{ab}	53.88 $^{e-h}$	18.86 ^{bcd}
H1 × I5	193.33 ^{cd}	47.33 $^{b-f}$	8.39 ^{defg}	399.00 ^{gh}	2.10 $^{a-e}$	49.12 ^{fgh}	14.96 ^{efg}
H1 × I6	215.00 ^{abc}	58.33 $^{a-d}$	8.90 ^{bcde}	411.00 ^{fgh}	2.16 ^{abc}	46.66 ^{gh}	16.02 $^{d-g}$
H1 × I7	168.33 ^{de}	51.00 $^{b-e}$	7.13 ^{fghi}	377.33 ^{hi}	1.88 $^{b-f}$	49.76 ^{fgh}	15.41 $^{d-g}$
H2 × I1	156.33 ^{e}	36.33 ^{f}	5.69 ^{i}	483.33 ^{bcde}	1.17 ^{h}	77.85 ^{b}	23.61 ^{a}
H2 × I2	213.33 ^{abc}	57.66 $^{a-d}$	11.53 ^{a}	487.33 ^{bcd}	2.37 ^{a}	65.23 $^{b-d}$	21.49 ^{abc}
H2 × I3	224.33 ^{abc}	57.33 $^{a-d}$	10.92 ^{a}	509.33 ^{bc}	2.14 ^{abcd}	67.85 ^{bcd}	18.24 ^{cde}
H2 × I4	203.33 ^{abc}	47.33 $^{b-f}$	8.33 ^{defg}	446.00 ^{defg}	1.90 $^{b-f}$	57.77 $^{d-g}$	16.79 $^{d-g}$
H2 × I5	223.33 ^{abc}	60.00 ^{ab}	9.05 ^{bcde}	427.66 ^{efgh}	2.11 $^{a-e}$	48.65 ^{fgh}	15.01 ^{efg}
H2 × I6	193.33 ^{cd}	52.00 $^{b-e}$	7.70 ^{efgh}	375.33 ^{hi}	2.05 $^{a-e}$	43.33 ^{h}	14.97 ^{efg}
H2 × I7	212.33 ^{abc}	46.66 $^{c-f}$	7.79 ^{efgh}	396.00 ^{gh}	1.96 b-f	43.73 ^{h}	14.28 ^{g}
H3 × I1	224.66 ^{abc}	54.33 $^{a-e}$	7.42 ^{efgh}	418.66 ^{fgh}	1.77 ^{defg}	46.19 ^{gh}	15.63 $^{d-g}$
H3 × I2	216.66 ^{abc}	59.33 ^{abc}	10.44 ^{abc}	593.66 ^{a}	1.76 ^{efg}	89.76 ^{a}	21.57 ^{abc}
H3 × I3	216.66 ^{abc}	56.66 $^{a-e}$	8.56 ^{defg}	530.66 ^{b}	1.63 ^{fg}	74.76 ^{b}	21.92 ^{ab}
H3 × I4	213.33 ^{abc}	45.33 ^{def}	9.94 ^{abcd}	448.33 ^{defg}	2.21 ^{abc}	55.95 $^{d-h}$	18.06 ^{def}
H3 × I5	226.66 ^{abc}	44.33 ^{ef}	8.71 ^{cdef}	459.00 ^{cdef}	1.90 $^{b-f}$	55.31 $^{d-h}$	18.27 ^{cde}
H3 × I6	157.33 ^{e}	36.00 ^{f}	6.25 ^{hi}	340.00 ^{i}	1.84 $^{c-g}$	43.49 ^{h}	14.73 ^{efg}
H3 × I7	232.00 ^{ab}	50.33 $^{b-e}$	10.30 ^{abc}	427.33 ^{efgh}	2.40 ^{a}	46.50 ^{gh}	14.52 ^{fg}
P. value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

H1: Talar F1 (Biotek), **H2:** MESSENGER (Semins) and **H3:** SENTINEL (Talar type) EliSem (CLAUSE).
I1 (SDI, standard drip irrigation), **I2**: (RDI. 16 cm ,0 cm), **I3**: (RDI. 16, 7,5 cm), **I4**: (RDI. 16, 15 cm), **I5**: (RDI. 8, 0 cm), **I6**: (RDI. 8, 7.5 cm) and **I7**: (RDI. 8, 15 cm).
$^{a-i}$ Means within each column had the different subscript differing significantly (P<0.05).

Table 10. Effect of three sweet corn hybrids to different irrigation systems and their interaction on water use efficiency.

Treatment	**IWUE** (kg/m^3)
Sweet Corn Hybrids	
H1	0.360 ^{b}
H2	0.390 ^{ab}
H3	0.408 ^{a}
P. value	0.026
Irrigation Systems	
I1	0.134 ^{d}
I2	0.359 ^{c}
I3	0.567 ^{a}
I4	0.479 ^{b}
I5	0.366 ^{c}
I6	0.371 ^{c}
I7	0.428 ^{b}
P. Value	<0.001
Interaction between Hybrids and Irrigation Systems	
H1 × I1	0.132 ^{g}
H1 × I2	0.348 ^{ef}
H1 × I3	0.511 ^{bc}
H1 × I4	0.406 ^{de}
H1 × I5	0.295 ^{f}
H1 × I6	0.432 ^{cde}
H1 × I7	0.398 ^{def}
H2 × I1	0.141 ^{g}
H2 × I2	0.372 ^{def}
H2 × I3	0.651 ^{a}
H2 × I4	0.471 ^{bcd}
H2 × I5	0.421 ^{cde}
H2 × I6	0.336 ^{ef}
H2 × I7	0.339 ^{ef}
H3 × I1	0.129 ^{g}
H3 × I2	0.357 ^{ef}
H3 × I3	0.538 ^{b}
H3 × I4	0.559 ^{b}
H3 × I5	0.383 ^{def}
H3 × I6	0.345 ^{ef}
H3 × I7	0.547 ^{b}
P. value	<0.001

H1: Talar F1 (Biotek), **H2:** MESSENGER (Semins) and **H3:** SENTINEL (Talar type) EliSem (CLAUSE).
I1 (SDI, standard drip irrigation), **I2**: (RDI. 16 cm ,0 cm), **I3**: (RDI. 16, 7,5 cm), **I4**: (RDI. 16, 15 cm), **I5**: (RDI. 8, 0 cm), **I6**: (RDI. 8, 7.5 cm) and **I7**: (RDI. 8, 15 cm).
$^{a-i}$ Means within each column had the different subscript differing significantly (P<0.05).

CONCLUSIONS

In conclusions, the treatments using responsive drip irrigation (RDI) show substantial promise in reducing water use while maintaining crop productivity. Comparatively, standard drip irrigation (SDI) practices may lack these efficiencies, leading to higher water consumption and potentially less sustainable agricultural products. Moving towards RDI not only preserves water but might also enhance the resilience of crop yields.

Conflict of interests

A conflict of interest does not exist.

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