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EMPACT OF IRRIGATION SCHEDULING, SUBSURFACE DRIP FERTIGATION, AND FURROW INTENSIFICATION ON CROP YIELD (WHEAT AND PEAS)

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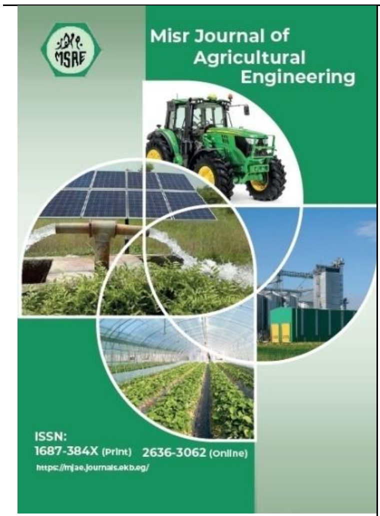

Keywords:
Irrigation scheduling; Subsurface drip irrigation; Fertigated; Cropping intensification of furrow (wheat and peas);

ABSTRACT

The experiment at the General Authority for Agricultural Research in Thamar Governorate – YEMEN during January–May 2024/2025 evaluated irrigation and fertilization effects on wheat and peas. Irrigation schedules of 4 days (ETc 100%) and 8 days (ETc 70%), along with fertilization levels at 1 ppm, 2 ppm, and 3 ppm, were tested. For wheat, the 8-day irrigation schedule yielded the highest output at 12.122 tons/hectare, compared to 9.536 tons/hectare for the 4-day schedule. Fertilization at 3 ppm produced the highest yield (11.461 tons/hectare), while 1 ppm resulted in the lowest (10.338 tons/hectare). The 4-day schedule generated more tillers per plant (8,744) but fewer grains (148,444 per three wheat ears). Conversely, the 8-day schedule yielded fewer tillers (7,606) but more grains (158,889 per three ears) and recorded longer spikes (10.9556 cm compared to 10.556 cm). Straw weight peaked under the 8-day schedule with an average of 28.032 tons/hectare, while the 4-day schedule yielded the lowest at 27.3 tons/hectare. For peas, the 4-day irrigation schedule resulted in the highest yield at 5.918 tons/hectare, while the 8-day schedule recorded the lowest at 3.393 tons/hectare. The best yield came from the 2 ppm treatment at 5.380 tons/hectare, whereas the lowest was under 3 ppm at 4.583 tons/hectare. Pod production was highest under the 4-day irrigation schedule with an average of 74,441 pods per three plants, compared to 54,889 pods under the 8-day schedule. The most productive fertilization level for pods was 2 ppm (75,000 pods), while the least was 1 ppm (56,833 pods).

INTRODUCTION

Wheat is one of the most important economic crops, covering 23.4% of global food needs. It is also a major food source for approximately 40% of the world's population, providing 20% of calories and 55% of total carbohydrates.

Yemen produces 138,027 tons of wheat annually from an area of 60,935 hectares, with an average productivity per unit area of 2.27 tons/hectare. Thamar Governorate produces 18,959 tons of wheat annually from an area of 12,793 hectares, with an average productivity per unit area of 1.5 tons/hectare. (Annual Agricultural Statistics Book,2021).

Yemen also produces 2,794 tons of peas annually from an area of 1,789 hectares, with an average productivity per unit area of 1,562 tons/hectare. Thamar Governorate produces 489 tons of peas annually from an area of 319 hectares, with an average productivity per unit area of 1,533 tons/hectare. (Annual Agricultural Statistics Book 2021)

Therefore, the productivity of wheat and peas is considered very low for several reasons, the most important of which are the traditional methods used in agriculture, the poor use of agricultural fertilizers properly, which exposes the fertilizers to loss and the plant not benefiting from them, traditional irrigation methods using surface irrigation (basins and furrow), and the spread of diseases such as rust and smut of the wheat ears, which spreads with surface irrigation methods to increase humidity.

Therewith, in this research, we seek to increase the productivity of wheat and peas using scientific methods and agricultural inputs by using a subsurface drip irrigation network to save the amount of water used and adding fertilizers with irrigation water to reduce fertilizer loss and ensure that they reach the root zone of the plants for their benefit. The research aims to achieve the following:

1. Increasing the unit area productivity of wheat and peas crops using modern agricultural techniques.

2- Conserving irrigation water using a subsurface drip irrigation network.

3- Using fertilizers efficiently to achieve high wheat and pea yields.

4- Evaluating the productivity of wheat and pea crops under intercropping and intensive cultivation using modern agricultural techniques.

Dhayal Diana et al. (2023) found that the fertigation using SDI or SSDI reduced fertilizer requirements by 20% for this cropping system while still achieving yields comparable to the conventional approach. When applied at levels of 60%, 80%, and 100% RDF, fertigation significantly improved grain yield, with increases of 36%, 55%, and 67% in wheat; 25%, 31%, and 34% in moong bean; and 33%, 49%, and 62% in maize compared to the fertilizer control (0% RDF). Additionally, irrigation scheduling at 0.8 ETc consistently resulted in grain yields approximately 10% higher than those obtained at 0.6 ETc.

Bajpai Arpna et al. (2021) indicated that the conservation agriculture combined with drip irrigation techniques significantly reduced irrigation water usage by 46.7% and 44.7% within the rice-wheat cropping system when compared to conservation agriculture systems utilizing flood irrigation. Additionally, the integration of conservation agriculture with drip irrigation in this system resulted in an 11.2% increase in crop productivity, a 145% improvement in irrigation water efficiency, and a 29.2% boost in profitability compared to conventional farming practices. Subsurface drip irrigation under conservation agriculture further demonstrated notable water savings, reducing irrigation water consumption by 48–53% for rice and 42–53% for wheat.

AL-fares Abbas Muneer et al. (2014) showed that the quality characteristics influenced by the three inputs and their interactions revealed the highest significant values as follows: 14.28% for grain protein, 93.72% for Vitreousness, 36.2% for wet gluten, and 51.03 ml for the Zeleny index. These values were observed when applying the highest nitrogen fertilizer level of 225 kg N h^{-1}, combined with a moderate irrigation water level of 70%, along with the application of nitrogen fertilization at 225 kg N h^{-1}. Conversely, the lowest significant values occurred under the interaction involving the lowest nitrogen fertilizer level of 75 kg N h^{-1}.

Tong Jin et al. (2025) reported that the increased above-ground nitrogen (AGN) observed under drip fertigation (DF) was linked to enhanced soil nitrogen availability within the 0–40 cm soil depth. Drip fertigation reduced residual soil NO_3^- - N levels in deeper layers (40–200 cm) while increasing NO_3^- - N concentration in the upper soil layer (0–40 cm). Furthermore, combining drip fertigation with a nitrogen application rate of 80 kg ha^{-1} resulted in superior root length density, surface density, and dry weight density. This combination also boosted nitrogen use efficiency (NUE) and water use efficiency (WUE). The practice supported higher crop yields and optimized water and nitrogen utilization, with a nitrogen topdressing rate (NTR) threshold ranging from 61.75 to 119.50 kg ha^{-1} under production conditions similar to those at the experimental site.

Karangiya B.A. et al. (2019) found that the fertigation levels were considered the primary factor, while irrigation levels served as the secondary factor. The highest plant height at harvest, grain yield, straw yield, and yield attributes were recorded at the fertigation level of 100% RDF-N combined with an irrigation level of 1.0 IW/ET_C. However, the irrigation level of 0.8 IW/ET_C was found to be statistically comparable to 1.0 IW/ET_C.

Zakharova N. N. et al. (2024) found that the wheat yield has shown a consistent rise of 0.202 t/ha every five years, with the global average reaching 3.48 t/ha during the 2016-2020 period. Ireland (9.37 t/ha), New Zealand (9.21 t/ha), and the Netherlands (8.77 t/ha) lead the world in terms of productivity. Meanwhile, the highest gross grain harvests were recorded by China with 133.2 million tons, India with 98.6 million tons, and Russia with 76.5 million tons.

Chouhan Sanjay Singh et al (2014) The findings showed that drip irrigation achieved approximately 9.7% greater water savings compared to the solid-set sprinkler irrigation system. Data on wheat grain yield and 1000-grain weight (test weight) highlighted a 12.14% higher grain yield and a 17.86% increase in test weight for wheat grown under drip irrigation compared to sprinkler irrigation.

Eric Watson a farmer in Ashburton (2025), In 2020, New Zealand set a new world record for the highest wheat yield, reaching an impressive 17.39 tons per hectare. This surpassed the previous record of 16.79 tons per hectare, achieved in 2017, which was also held by Eric Watson. With this second consecutive Guinness World Record under his belt, it's no surprise that many are eager to learn more about his techniques and agricultural practices.

Soman P (2022) This report highlights data on the yield, water consumption, and water productivity of basmati rice cultivated in selected farmers' fields using drip irrigation in Haryana. The findings indicate a 10–18% improvement in rice yield, a 51% reduction in water consumption, and a 63% increase in water productivity. Additionally, the drip irrigation system can be effectively adapted for rotational crops within the rice-wheat cropping sequence.

ÇETİN Öner et al. (2019) said that the fertigation is an advanced agricultural technique that integrates the application of water and fertilizers directly to the soil or plants. By combining irrigation with fertilization, it enhances both crop yield and fertilizer use efficiency while minimizing nutrient leaching. To implement fertigation effectively, four key factors must be taken into account: (i) the rate of water and nutrient consumption throughout the growing season to achieve optimal yields, (ii) the variation in nutrient uptake among different crops based on soil and solution concentrations, (iii) the continuous monitoring of soil water potential, nutrient concentrations in the soil solution, and elemental ratios in plants over time, and (iv) the distribution and mass of roots within the soil in relation to specific irrigation practices and soil types.

Patra S.K. et al. (2022) stated that the drip- fertigation, combined with well-planned irrigation scheduling, offers a practical and effective alternative to conventional irrigation and fertilizer practices. This approach enhances crop productivity, optimizes water and nutrient use efficiency, and improves overall economic returns. Utilizing gravity-fed drip fertigation with moderate deficit or optimal irrigation has demonstrated significant results, yielding as much as 9.9 to 43.3 tons per hectare.

Zhao Guoqiang *et al*. (2024) indicated that the study assessed the effects of subsurface drip fertigation (SDF) on soil moisture dynamics, potato growth, and tuber yield in loam soils, comparing its performance against conventional surface drip fertigation (CF). The primary aim was to evaluate whether SDF could enhance water use efficiency and optimize yield quality, especially in regions facing water scarcity. Results indicated that SDF promoted a more uniform distribution of soil moisture, leading to improved root zone hydration. Potato plants under SDF exhibited better growth parameters, with increases in both biomass development and tuber yield compared to CF. Furthermore, the system demonstrated remarkable efficiency in conserving water while maintaining high-quality yields, highlighting its potential as a sustainable irrigation strategy in resource-limited areas.

Karuthamani M. et al. (2018) found that the experiment was conducted using a Randomized Block Design (RBD) with three replications. The application of 75% RDF through fertigation and biofertigation resulted in the highest concentrations of nitrogen, phosphorus, and potassium in the leaves during the vegetative, flowering, fruit development, and harvest stages. Similarly, the application of 75% RDF (drip fertigation) through fertigation and biofertigation showed the highest available levels of nitrogen, phosphorus, and potassium in the soil across the same growth stages. A consistent decline in soil nutrient levels was observed from the vegetative stage to the harvest stage in all cases.

MATERIALS AND METHODS

This experiment was carried out at the General Authority for Agricultural Research and Extension in Government Thamar – YEMEN during the winter-spring season of 2024/2025.

The physical soil properties and moisture content were analyzed, with the summarized results provided in Table (1).

Table (1): Analysis of soil physical properties and measurement of soil moisture content in the experimental area.

Physical Soil Analysis				
Sand %	Silt %	Clay %	Textural class	Balk Density Kg m^{-3}
20.57	48.57	30.86	Loamy clay	1.46
Soil Moisture content				
Field Capacity % volumetric	Wilting Point % volumetric	Available Water cm volumetric	Saturation point %	
42.35	17.82	37.65	51.5	

1- Materials: Use the irrigation network as follows:

The main and sub-main lines were 63 and 25 mm in diameter, respectively, of PVC pipe. A 16 mm diameter built-in drip liner with 8 Lph/25 cm flow rates under 1-1.5 bar operating pressure was used. The distance between the emitters was 25 cm, to ensure uniform moisture distribution and fluctuate the irrigation time and the time of meeting the wetness diameter between the emitters, because the cultivated plants are wheat, which is a grass and its roots are superficial and do not exceed 15 cm in depth.

A centrifugal pump type E5300 with operating pressure head ranging between 13.5 and 32 m and corresponding discharge rates ranging from 500 to 100 L/min. was used to connect directly to an electric motor of 2.25 kW power.

The fertilization was carried out through types of (N, P, K) resources, i.e.,

- N.P.K 40-10-10.
- N.P.K 15-40-15.
- N.P.K 15-15-40.
- Minor elements.
- Humic acid.

Fertilizer was added to each treatment at the required concentration for all treatments: 1 ppm, 2 ppm, 3 ppm. according to the following equation (Ismail, S.M.,2002):

$$X = \frac{V}{C} \times \frac{Q}{q_F} \times \frac{ppm}{10^6}$$

where;

X quantity of commercial fertilizer, kg

V fertilizer tank capacity, liters.

C the percentage of the active ingredient or fertilizer element in commercial fertilizer.

Q pump flow rate, L/s.

q_F fertilizer injection rate, L/hr.

ppm required concentration of fertilizer in irrigation water in parts per million.

The wheat seeds (Bakil Wheat seeds) and Pea seeds (Amran Pea seeds) are supplied by the General Authority for Agricultural Research and Extension.

The balance of the harvested wheat and pea was measured by digital balance, whereas the length of wheat ears and pea pods was measured by rule.

2- Experimental Design

A randomized complete block design was used, where the two scheduling irrigation treatments (4 and 8 days) were placed on the main plots and the three fertigation treatments (1 ppm, 2 ppm and 3 ppm) were placed on the sub-main plots. The experimental area is 1500 m^2 (30*50 m) and the area of each plot (terrace) is 66 m^2, as shown in the Fig. (1).

The terraced crops were arranged in rows. The wheat crop (the main crop) was placed on both sides of the emitter lateral, 20 meters long and 25 cm wide. Between every two rows, there was a row of wheat crops and a row of pea crops, 20 meters long and 20 cm wide, as shown in the Fig, (2).

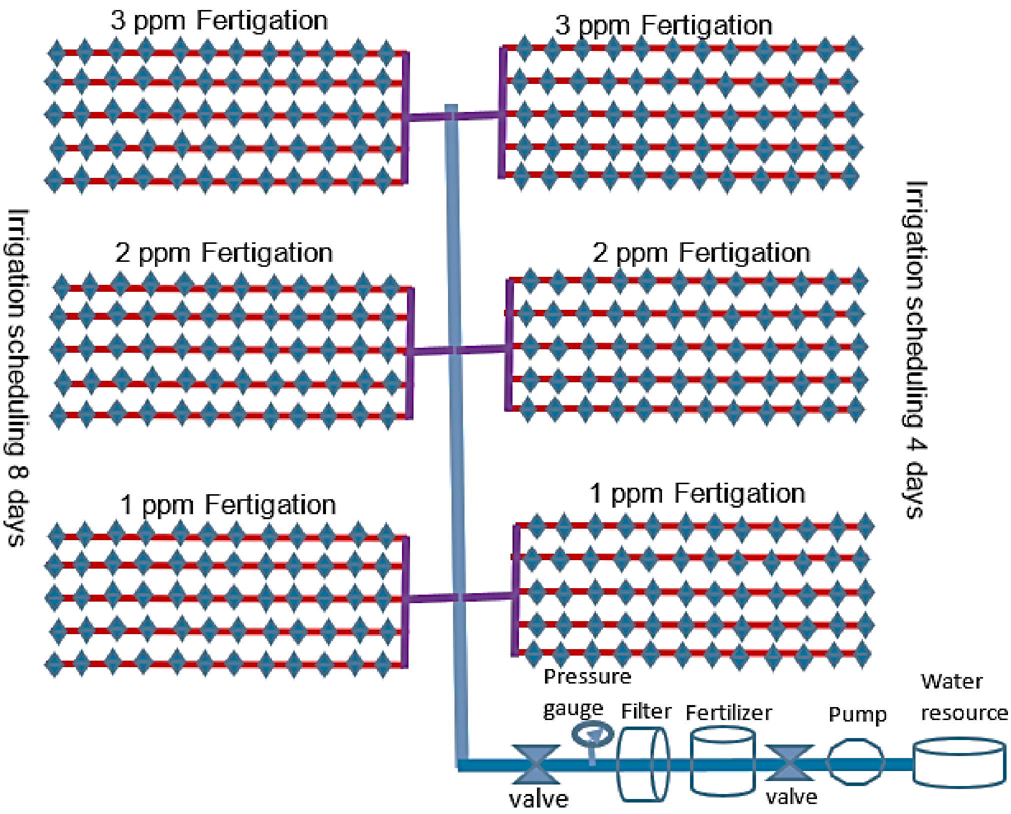

Fig. (1) planning showing the distribution of experimental treatments

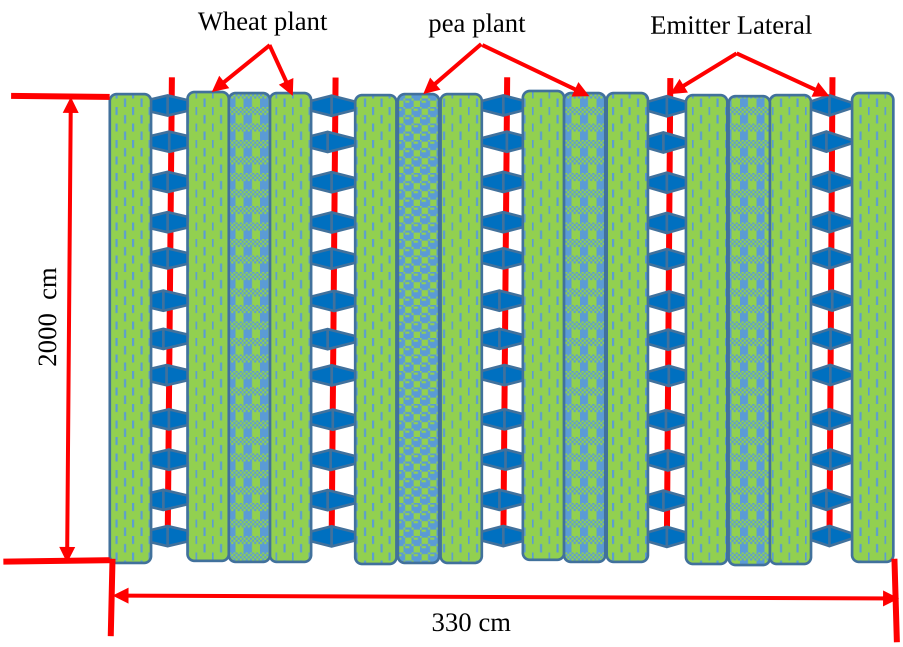

Fig. (2) A diagram showing the distribution of plants on the agricultural terrace in the experimental field

3- Amount of Water Application per Irrigation

Before each irrigation for each treatment, the amount of water used for irrigation was calculated. An evapotranspiration pan is used from the meteorological station near the research experiment, and the amounts of water evaporated from the basin are calculated to compensate for the lack of moisture in the soil to reach the field capacity in the treatment (ETc100%) water level of the crop requirements, and twenty-one percent (21%) of water is added. Calculated as water washing salts out of the root zone. The following formula was used to determine the depth of water to use for each irrigation:

$$Water\ Added\ = (ETp\ \times Kc)\ \times Area\ of\ Experimental \times II$$

where;

ETp Evapotranspiration of pan, cm/day.
Kc is the crop Coefficient.
II Irrigation Interval, day.

The interval between successive irrigations was 4 and 8 days. The full irrigation treatment 100% ETc, (4 days) was equivalent to ETc of wheat and pea crops. The deficit irrigation treatments 8 days (70% ETc) was 70 % from the full irrigation (ETc 100%).

RESULTS AND DISCUSSION

- Wheat crop

From Table (2), the data show that the 8-day irrigation schedule gave the highest wheat crop yield with an average of 12.122 t/ha, while the 4-day irrigation schedule gave the lowest wheat crop yield with an average of 9.536 t/ha, under different fertilization irrigation treatments and using a subsurface drip irrigation system.

The 3 ppm fertilization irrigation treatment also gave the highest wheat yield with an average of 11.461 t/ha, while the 1 ppm fertilization irrigation treatment gave the lowest wheat yield with an average of 10.338 t/ha, under different fertilization irrigation treatments and using a subsurface drip irrigation system.

The highest wheat yield was achieved by the interaction between the 8-day irrigation schedule and the 3 ppm fertilization irrigation treatment, with an average of 12.749 t/ha. The lowest wheat yield was achieved by the interaction between the 4-day irrigation schedule and the 2 ppm fertilization irrigation treatment, with an average of 8.998 t/ha, under the subsurface drip irrigation system.

The results showed significant differences between the irrigation scheduling treatments (1.5654 at a significance level of 0.05), and no significant differences between the fertilization irrigation treatments and the interactions between the irrigation scheduling treatments and fertilization irrigation.

Table (2): shows the average wheat crop productivity, t/ha, under irrigation scheduling and fertilization irrigation treatments using the subsurface drip irrigation system.

Treatments		Fertigation			Average
		1 ppm	2 ppm	3 ppm	
scheduling	4 Days	9.438	8.998	10.174	9.536
irrigation	8 Days	11.237	12.379	12.749	12.122
	Average	10.338	10.689	11.461	10.829

From Table (3), the data shows that the 4-day irrigation schedule gave the highest number of tillers for the wheat crop, with an average of 8,744 tillers/wheat plant, while the 8-day irrigation schedule gave the lowest number of tillers for the wheat crop, with an average of 7,606 tillers/wheat plant, under different fertilization irrigation treatments and using a subsurface drip irrigation system.

The 3 ppm fertilization irrigation treatment also gave the highest number of tillers for the wheat crop, with an average of 9.317 tillers/wheat plant, while the 1 ppm fertilization irrigation treatment gave the lowest number of tillers for the wheat crop, with an average of 6.938 tillers/wheat plant, under different fertilization irrigation treatments and using a subsurface drip irrigation system.

The highest number of tillers for the wheat crop was achieved by the interaction between the 4-day irrigation schedule and the 3 ppm fertilization irrigation treatment, with an average of 9,890 tillers/wheat plant. The lowest productivity of the wheat crop was achieved by the interaction between the 8-day irrigation schedule and the 1 ppm fertilization irrigation treatment, with an average of 6,200 tillers/wheat plant, under the subsurface drip irrigation system.

The results showed significant differences between the irrigation scheduling treatments (0.6268 at a significance level of 0.05), as well as significant differences between the fertilization irrigation treatments (0.7677 at a significance level of 0.05), and interactions between the irrigation scheduling and fertilization irrigation treatments.

Table (3): shows the average number of tillers for the wheat crop (Number) under irrigation scheduling and fertilization irrigation treatments using the subsurface drip irrigation system.

Treatments		Fertigation			Average
		1 ppm	2 ppm	3 ppm	
Scheduling irrigation	4 Days	7.677	8.667	9.890	8.744
	8 Days	6.200	7.873	8.743	7.606
Average		6.938	8.270	9.317	8.175

From Table (4), the data shows that the 8-day plot schedule gave the number of grains to obtain an average method of 158,889 grains/3 ears, while the 4-day irrigation schedule gave the lowest number of grains to obtain an average method of 148,444 grains/3 ears, under the different fertilization irrigation trade-offs and using the subsurface drip irrigation system.

The 3 ppm and 2 ppm fertilization treatments gave the highest number of grains for the wheat crop, with an average of 154,667 grains/3 ears, while the 1 ppm fertilization treatment gave the lowest number of grains for the wheat crop, with an average of 151,667 grains/3 ears, under different fertilization irrigation treatments and using the subsurface drip irrigation system.

The highest number of grains for the wheat crop was achieved by the interaction between the 8-day irrigation schedule and the 3 ppm fertilization irrigation treatment, with an average of 162,667 grains/3 a ears, and the lowest number of grains for the wheat crop was achieved by the interaction between the 4-day irrigation schedule and the 3 ppm fertilization irrigation treatment, with an average of 146,667 grains/3 ears, under the subsurface drip irrigation system.

The results showed significant differences between the irrigation scheduling treatments (5.6630 at a significance level of 0.05), and no significant differences between the fertilization irrigation treatments and the interventions between the irrigation scheduling treatments and the fertilization irrigation.

Table (4): shows the average number of grains for 3 ears of wheat crops (Number) under irrigation schedule and fertilization irrigation treatments using the subsurface drip irrigation system.

Treatments		Fertigation			Average
		1 ppm	2 ppm	3 ppm	
Scheduling irrigation	4 Days	147.667	151.000	146.667	148.444
	8 Days	155.667	158.333	162.667	158.889
Average		151.667	154.667	154.667	153.667

Table (5) shows that the 8-day irrigation schedule gave the highest an ear length for wheat crops with an average of 10.944 cm/ ear, while the 4-day irrigation schedule gave the lowest ear length for wheat crop, with an average of 10.556 cm/ ear, under different fertilization irrigation treatments and using a subsurface drip irrigation system.

Also, the 3 ppm fertilization irrigation treatment gave the highest ear length for the wheat crop, with an average of 10.833 cm/ ear, while the 2 ppm fertilization irrigation treatment gave the lowest ear length for wheat crop, with an average of 10.667 cm/ ear, under different fertilization irrigation treatments and using a subsurface drip irrigation system.

The highest ear length of wheat crop was achieved by interaction between the 8-day irrigation schedule and the 3 ppm and 1 ppm fertilization irrigation treatments, with an average of 11,000 cm/ ear, and the lowest an ear length of wheat crop was achieved by interaction between the 4-day irrigation schedule and the 2 ppm and 1 ppm fertilization irrigation treatments, with an average of 10,500 cm/ ear, under subsurface drip irrigation system.

The results showed significant differences between the irrigation scheduling treatments (0.3320 at a significance level of 0.05), of the ear length of the wheat crop, and there were no significant differences between the fertilization irrigation treatments and the interventions between the irrigation scheduling treatments and the fertilization irrigation.

Table (5): shows the average an ear length of wheat crop (cm/ear) under irrigation schedule and fertilization irrigation treatments using the subsurface drip irrigation system.

Treatments		Fertigation			Average
		1 ppm	2 ppm	3 ppm	
Scheduling irrigation	4 Days	10.500	10.500	10.667	10.556
	8 Days	11.000	10.833	11.000	10.944
Average		10.750	10.667	10.833	10.750

From Table (6), the data show that the 8-day irrigation schedule gave the highest straw weight (biological weight) for the wheat crop with an average of 28.032 tons/ha, while the 4-day irrigation schedule gave the lowest straw weight (biological weight) for the wheat crop with an average of 27.30 tons/ha, under different fertilization irrigation treatments and using a subsurface drip irrigation system.

Also, the 3 ppm fertigation treatment gave the highest straw weight (biological weight) of wheat crop with an average of 30.668 tons/ha, while the 1 ppm fertigation treatment gave the lowest straw weight (biological weight) of wheat crop with an average of 24.917 tons/ha, under different fertigation treatments and using a subsurface drip irrigation system.

The highest straw weight (biological weight) of the wheat crop in the interactions between treatments was the interaction between the 8-day irrigation schedule treatment and the 3 ppm fertilization irrigation treatment, with an average of 32.057 tons/ha, and the lowest straw weight (biological weight) of the wheat crop in the interactions between treatments was the interaction between the 4-day irrigation schedule treatment and the 1 ppm fertilization irrigation treatment, with an average of 23.919 tons/ha, under the subsurface drip irrigation system.

The results showed that there were no significant differences between the irrigation scheduling treatments, and there were also no significant differences between the fertilization irrigation treatments and the interventions between the irrigation scheduling treatments and the fertilization irrigation treatments.

Table (6): shows the average straw weight (biological weight) of the wheat crop (ton/hectare) under irrigation scheduling and fertilization irrigation treatments using the subsurface drip irrigation system.

Treatments		Fertigation			Average
		1 ppm	2 ppm	3 ppm	
Scheduling irrigation	4 Days	23.919	28.702	29.278	27.300
	8 Days	25.915	26.125	23.057٧	28.032
Average		24.917	27.413	30.668	27.666

- pea crop

From Table (7), the data indicate that the 4-day irrigation schedule gave the highest productivity for the pea crop with an average of 5.918 tons/ha, while the 8-day irrigation schedule gave the lowest productivity for the pea crop with an average of 3.939 tons/ha, under different fertilization irrigation treatments and using the subsurface drip irrigation system.

The 2 ppm fertilization irrigation treatment also gave the highest pea crop productivity with an average of 5.380 tons/ha, while the 3 ppm fertilization irrigation treatment gave the lowest pea crop productivity with an average of 4.583 tons/ha, under different fertilization irrigation treatments and using a subsurface drip irrigation system.

Table (7): shows the average productivity of pea crop (tons/hectare) under irrigation scheduling and fertilization irrigation treatments using the subsurface drip irrigation system.

Treatments		Fertigation			Average
		1 ppm	2 ppm	3 ppm	
Scheduling irrigation	4 Days	6.114	5.714	5.927	5.918
	8 Days	3.533	5.046	3.238	3.939
Average		4.824	5.380	4.583	4.929

The highest pea crop productivity was achieved by the interaction between the 4-day irrigation schedule and the 1 ppm fertilization irrigation treatment, with an average of 6.114 tons/ha. The lowest pea crop productivity was achieved by the interaction between the 8-day irrigation schedule and the 3 ppm fertilization irrigation treatment, with an average of 3.238 tons/ha, under the subsurface drip irrigation system.

The results showed significant differences between the irrigation scheduling treatments (0.9420 at a significance level of 0.05) in the productivity of the pea crop, and there were no significant differences between the fertilization irrigation treatments and the interventions between the irrigation scheduling treatments and the fertilization irrigation.

From Table (8), the data show that the 4-day irrigation schedule gave the highest number of pods for the pea crop, with an average of 74,444 pods/3 plants, while the 8-day irrigation schedule gave the lowest number of pods for the pea crop, with an average of 54,889 pods/3 plants, under different fertilization irrigation treatments and using a subsurface drip irrigation system.

The 2 ppm fertilization irrigation treatment also gave the highest number of pods for the pea crop, with an average of 75,000 pods/3 plants, while the 1 ppm fertilization irrigation treatment gave the lowest number of pods for the pea crop, with an average of 56,833 pods/3 plants, under different fertilization irrigation treatments and using a subsurface drip irrigation system.

The highest number of pods for the pea crop, with interventions between treatments was for the interaction between the 4-day irrigation schedule treatment and the 2 ppm fertilization irrigation treatment, with an average of 84,333 pods/3 plants, and the lowest number of pods for the pea crop with interventions between treatments was for the interaction between the 8-day irrigation schedule treatment and the 1 ppm fertilization irrigation treatment, with an average of 43,333 pods/3 plants, under the subsurface drip irrigation system.

The results showed significant differences between the irrigation scheduling treatments (13.4315 at a significance level of 0.05) in the productivity of pea pods, and there were no significant differences between the fertilization irrigation treatments and the interventions between the irrigation scheduling treatments and the fertilization irrigation.

Table (8): shows the average number of pods of 3 pea plants (Number) under irrigation schedule and fertilization irrigation treatments using the subsurface drip irrigation system.

Treatments		Fertigation			Average
		1 ppm	2 ppm	3 ppm	
Scheduling irrigation	4 Days	70.333	84.333	68.667	74.444
	8 Days	43.333	65.667	55.667	54.889
Average		56.833	75.000	62.157	64.667

CONCLUSION AND RECOMMENDATION

The objectives of this study were to evaluate the effect of scheduling irrigation levels. fertigation and cropping intensification of furrow (wheat and peas) on production of the wheat and the pea crops, under drip subsurface irrigation. The results of this study showed that:

1- The use of modern irrigation networks (subsurface drip irrigation systems) is suitable for wheat cultivation and improves its productivity.
2- Using the technique of intercropping with intensive planting increases the productivity of the area and improves soil fertility.
3- The 8-day irrigation schedule resulted in high wheat productivity and saved 50% of irrigation water compared to the 4-day irrigation schedule.

4- Fertigation technology has resulted in high productivity in wheat and pea crops and increased the return per unit area and water.
5- It is recommended; to use a subsurface drip irrigation system to conserve water and reduce the incidence of plant diseases.
6- It is recommended; to use intercropping of several crops (grasses and legumes) in agriculture to fertilize the soil, increase the productivity per unit area, and maximize the use of irrigation water.

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تأثير جدولة الري والتسميد وتكثيف الزراعة التحميلية في خطوط (القمح والبازلاء) على إنتاج المحاصيل باستخدام نظام الري بالتنقيط تحت السطحي

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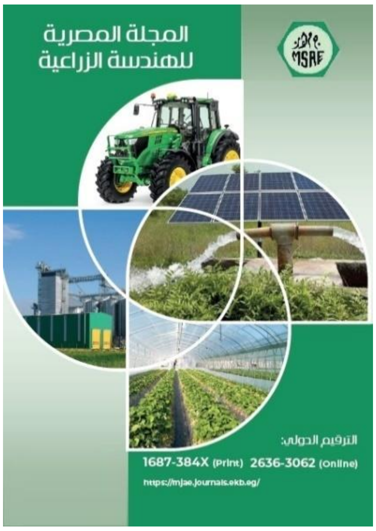

الكلمات المفتاحية:
جدولة الري؛ الزراعة التحميلية؛ الري التسميدي؛

الملخص العربي

أجريت التجربة في الهيئة العامة للبحوث الزراعية – محافظة ذمار، للموسم الزراعي مايو(ربيع) ٢٠٢٤/٢٠٢٥م. وكانت المعاملات 2 (a) معاملات جدولة الري ٤ أيام (ETc 100%) و ٨ أيام (ETc 70%) و٣ (b) معاملات ري تسميدي 1 ppm و 2 ppm و3 ppm و٢ معاملات نباتية (القمح و البازلاء). وأظهرت النتائج أن جدولة الري ٨ أيام أعطت أعلى إنتاجية للقمح بمتوسط ١٢,١٢٢ طن/هكتار، بينما أعطت جدولة ٤ أيام أقل إنتاجية بمتوسط ٩,٥٣٦ طن /هكتار. واعطت 3 ppm أعلى إنتاجية للقمح بمتوسط ١١,٤٦١ طن/هكتار، بينما أعطت 1ppm أقل إنتاجية للقمح بمتوسط ١٠,٣٣٨ طن/هكتار.

وكذلك، أعطت جدولة الري جدولة الري ٨ أيام أعلى طولاً سنبلة القمح بمتوسط ١٠,٩٥٥٦ سم/للسنبلة، بينما أعطت جدولة الري ٤ أيام أقل طول سنبلة القمح بمتوسط ١٠,٥٥٦ سم/للسنبلة. وأعطت جدولة ري ٨ أيام أعلى وزن القش للقمح بمتوسط ٢٨,٠٣٢ طن/هكتار، بينما جدولة ري ٤ أيام أقل وزن للقش بمتوسط ٢٧,٣٠٠ طن/هكتار.

وأظهرت النتائج أن جدولة الري ٤ أيام أعطت أعلى إنتاجية للبازلاء بمتوسط ٥,٩١٨ طن/هكتار، بينما جدولة الري ٨ أيام أقل لإنتاجية للبازلاء بمتوسط ٣,٣٩٣ طن/هكتار. وأعطت 2 ppm أعلى إنتاجية البازلاء بمتوسط ٥,٣٨٠ طن/هكتار، بينما 3 ppm اقل إنتاجية لمحصول البازلاء بمتوسط ٤,٥٨٣ طن/هكتار.

وأيضاً، معاملة جدولة الري ٤ أيام أعطت أعلى عدد قرون لـ ٣ نبات بازلاء بمتوسط ٧٤,٤٤١ قرن/٣ بنات بازلاء، بينما جدولة ري ٨ أيام أقل عدد قرون لـ ٣ نبات بازلاء بمتوسط ٥٤,٨٨٩ قرن/٣ نبات بازلاء. وأعطت 2 ppm أعلى عدد قرون لـ ٣نبات بازلاء بمتوسط ٧٥,٠٠٠ قرن/٣نبات بازلاء، بينما 1 ppm أقل عدد قرون لـ ٣ نبات بازلاء بمتوسط ٥٦,٨٣٣ قرن/٣نبات بازلاء.