EFFECT MICRO IRRIGATION SYSTEMS, IRRIGATION PERIOD AND SEED THICKNESS ON BARLEY SPROUT PRODUCTION

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ABSTRACT

The experiments carried out during July 2014 in hydroponics unit in Qwisna, El-Minufia governorate .The objective of this experiment is to study the effect of different nozzles (fogger, mist and mini sprinklers), irrigation periods (30sec, 60sec and 90sec) for (2hr,4hr and 6hr) respectively and seed thickness in the trays (0.5, 1.0 and1.5 cm) on barely sprouts produced hydroponically. Measurements were taken for every production unit (WUE, yield/tray, yield/kg seed, protein %, fibers%). Data showed that using fogger gave the highest CU% , DU% ,water use efficiency, yield/kg seed, protein %, fiber % and carbohydrates %. On the other hand, data illustrated that using 0.5 cm seed thickness recorded the highest yield/kg seed, protein %, fiber % and carbohydrates %. Concerning using 30 sec/2hr recorded the highest water use efficiency, yield/kg seed, protein %, fiber % and carbohydrates %.

Finally, from the overall results it can concluded that using 0.5 cm seed thickness irrigated 30 sec/2hr with fogger recorded the highest tested parameters.

INTRODUCTION

Water and agriculture are interdependent and critical to the well-being, economy, and security of our society. The safety, security, sustainability, and policy issues associated with water and agriculture are vital to Egyptian interests. Irrigated agriculture is the major user of water in most parts of the world.

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Stress on water availability and associated impacts among competing user groups in the region is increasing due to population growth, development, environmental & wildlife concerns, the persistence of below-normal precipitation, and water compact requirements on river Nile. The science of using hydroponically grown forage to provide cattle and sheep with sustenance is not a new one, but its application in the Egypt has only recently begun. Where commercial operations and applications for forage has served as a viable option where water conservation is a central issue or where reliable forage quality desired. The process is started over again after cleaning the tray. With a greenhouse, there are 7 to 10 different crops growing at any one time and only a fraction of the greenhouse contents is harvested each day, including weekends . So, it is essentially a forage factory. The covered structure eliminates the evaporative loss that dominates the water consumption by open field forage crops **(Al-Hashmi, 2008)** .

The process for growing hydroponic forage goes as follows. The grain, which can be wheat, corn, barley, sorghum or oats cleaned with a dilute chlorine solution and then rinsed. **(Rodriguez-Muela et al., 2004)** The seeds are then placed in a tub with water for 12 hours and soaked to loosen the seed coat. The seeds are then drained and placed on trays for growing. The trays are kept wet with a sprinkler system and in 7-10 days are 10 inches tall and fed to the livestock, roots and all. **(Dung et al. 2010)**.

Hydroponic forage is comparable in most of the categories and above in a few. The only category in which hydroponic forage is at a disadvantage is that of dry matter percent. But this is an advantage in that cattle then require less water when they're being fed the green grass. **(Howard, 1989)** In essence, we are getting the most crops per drop and also getting a second use out of the irrigated water by reducing the water intake by the livestock **(Schroder and Leith 2002)** .

Water use efficiency under hydroponic system :

About 1.5-2 liters are needed to produce 1 kg of green fodder hydroponically in comparison to 73, 85, and 160 liters to produce 1 kg of green fodder of barley, alfalfa, and Rhodes grass under field conditions, respectively . Water is one of the basic requirements for seed germination and seedling growth as it is essential for enzyme activation, reserve storage breakdown, translocation, and use in seed germination and seedling growth **(Al-karaki, 2010)**. Hydroponically produced fodder was found to enhance the efficiency of water use (WUE). Hydroponic green fodder production technique requires only about 10 –20% of the water needed to produce the same amount of crop in soil culture **(Bradley and Marulanda, 2000)**. While only 3–5% of water is needed to produce the same amount of fodder in comparison to that produced under field conditions. Water use efficiency (WUE) of only 14 and 12 Kg forage fresh matter/m^3 water for field irrigated barley and alfalfa, respectively, compared to that of 645 and 521 kg fresh matter/m3 water in barley and alfalfa obtained in hydroponic system, respectively reported by **(Al-Karaki and Al-Momani 2011)**.

Overall, the main advantages of hydroponics over soil culture are:
More efficient nutrition regulation, availability in regions of the world having non arable land, efficient use of water and fertilizers units, no water stress on plants, ease and low cost of sterilization of the media, no need weed controlling ability medium temperature can be maintained optimum by flooding with the nutrient solution and higher density planting, leading to increased yields per unit area **(El-Deeba 2009)**. The aim of this paper investigate the effect of micro irrigation system , irrigation period and seed thickness in the tray on barley sprout produced hydroponically.

MATERIALS AND METHODS

The experiments carried out during July 2014 in private hydroponics unit in Qwisna city , El-Minufia governorate, Egypt .

1-Experimental layout :
Experimental layout had been described in Fig (1), the experimental layouts included:

Hydroponic room

Hydroponic unit (4*6) m^2 constructed from cconcrete and its components are [lighting system, aeration and cooling system, irrigation and nutrients applying system and cultivation units (stands & trays)] . The lighting system was used to provide forage with its light requirement. Digital

Thermometer used for measuring temperature and humidity inside room to control it and maintain the growth chamber with appropriate temperature and humidity and avoid the problems caused by increasing temperature and humidity. The irrigation system was controlled by control panel.

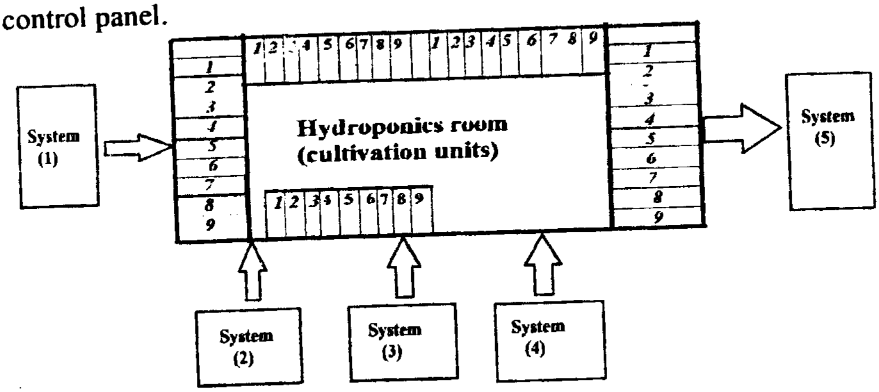

Fig (1): Experimental layout

Fig (1) shows the experiment layout included :

System (1) Seed preparation and batching,

System (2) Lighting ,aeration , humidity and temperature control,

System (3) Applying and and nutrient solution,

System (4) Irrigation and nutrient and

System (5) Green fodder harvesting system.

Irrigation system

Irrigation system consists of:

1.Three HP pump to convey the water from storage tank to supplementary irrigation system.

2.Water storage tank with 500 liter size for storing the water and nutrients solution.

3.Tubes (P.E) 32 mm outside diameter connected pump to the irrigation system

4.Tubes (P.E) 16 mm outside diameter was connected tubes 32mm to mini sprinkler.

5.PVC valves to control the amount of water fed to every stand.

6.Electronic controller circuit to control the timing and duration of opening and closing of the valve.

7– Different type of nozzles :

Three different types of nozzles used in the experiment shows as in Table (1):

Table (1): Sprayer systems specifications :

Nozzle type	Head (m)	Discharge (Lph)	Coverage diameter (cm)	Droplets volume (micron)
Fogger	35	40	70	70
Mist sprayer	30	61	110	100
Mini sprinkler	20	130	150	200

Technical properties of micro irrigation systems :

*The application uniformity (CU) .

* Distribution uniformity (DU) .

*Water use efficiency (WUE) .

Hydraulic performance of different nozzles :

The intensity was determined by measuring the volume of water accumulated during known interval, in closely placed containers. However, the collected water in the catch cans during the selected operating time were measured by means of a graduate glass cylinder.

The intensity of sprinkler is usually expressed as the depth of water falling in unit time, and calculated by the following equation:

$$I = \frac{Q}{A \times T} \times 600 \qquad \rightarrow Eq\ (1)$$

Where:

I : Sprinkler intensity, (mm/h)

Q : Water volume, (cm^3).

A : Area of unit , (cm^2).

T : Operating time, (min.)

Experimental procedure and treatments:

Technical parameters and associated treatments had been considered to evaluate the grass-fodder production under hydroponic system, as following:

Engineering factors:

1- Irrigation systems :

Three different nozzles of irrigation systems were used in the experiment, systems (fogger, mist sprayer and mini sprinkler) have different (discharges, operating pressures, wet diameters and droplets volume).

2- Irrigation period :

Three irrigation period were used in the experiment 30 , 60 , 90 sec for 2,4,6 hour respectively .

Agro-biotechnology

1- Seed layer thickness

Different Seed layer thickness 0.5cm = 692 gm , 1cm = 1253 gm , 1.5 cm = 1620 gm in growth unit (tray) (30 *70*5) cm^3 .

2- Nutrient solution concentration

Solution applied was N.P.K (20: 20: 20) with concentration 1cm/litre EC and pH of the nutrient solution had been adapted by pH and EC meter.

Growing considerations:

- Barley seeds (Giza, 121), was used in this study.
- Barely was sterilized before transplant in tray by using sodium hypochlorite in water.

Quality indictors:

At the end of experiment (6 days after seeding), the produced green fodder was ready for harvest, and green plants with their roots in the trays were harvested and the following data were recorded

Performance evaluation of s:

1- Uniformity coefficient (CU%) :

For specifying the best shape of water distribution over the trays , the application uniformity was determined to see how evenly the water distribution for different discharges, operating pressure, cans were distributed in growth units (trays) to evaluate nozzles performance during operating. The application uniformity is estimated using Christiansen uniformity coefficient (CU) and distribution uniformity (DU). The Christiansen uniformity coefficient is a parameter that is widely used to evaluate application uniformity (Mosh, 2006; Sandra, et al, 2001).

$$CU = 100 \left(1.0 - \frac{\sum_{i=1}^{n} |z - m|}{\sum_{i=1}^{n} z}\right) \rightarrow Eq\ (2)$$

Where :

CU = Christiansen uniformity coefficient % ,

z = Individual depth of catch observations from uniformity test (mm) ,

m = Mean depth of observations (mm) and

n = number of observations .

2- Distribution uniformity (DU%) :

Determination of CU has an advantage of controlling all factors in the process, especially sprinkler water distribution. Thus allowing us to establish comparisons between different sprinklers **(Montero *et al.* 1999)** . The distribution uniformity is a ratio expressed in a percent of the average low-quarter amount caught to the average amount caught as express in equation (Keller and Blienser 1990).

$$DU = \frac{\hat{X}_L}{\hat{X}} \times 100 \rightarrow Eq\ (3)$$

Where :

$\hat{X}_L$: The average low-quarter amount caught or infiltrated (mm) ,

$\hat{X}$: The average amount caught or infiltrated (mm) .

3 - Water use efficiency (WUE):

Water use efficiency is The total added and drained water out of trays were recorded to compute for total water use (liters water used/ kg fresh fodder produced) and water use efficiency (kg fresh fodder produced/liter water used) **Al-karari and Al-Momani (2011)** , it is an indicator of efficiency of irrigation unit for increasing crop yield. Water use efficiency of yield was calculated according to **(Al-karari ana Al-Hashimi, 2012)**.

$$WUE\,(kg / L) = \frac{T_p\,(kg / tray)}{T_l\,(L / tray)} \times 100 \rightarrow Eq(4)$$

Where :

T_p : Total green fodder produced (kg/ tray) .

T_l : Total water used (liter/ tray) .

Technical properties of micro irrigation systems :

* The application uniformity (CU) .
* Distribution uniformity (DU) .
* Water use efficiency (WUE) .

Yield quality parameters:

* Sprout yield weight (g /tray) ,
* Sprout yield (g /kg seeds) ,
* Protein content % ,
* Fiber content % ,
* Carbohydrates content % .
* Samples were taken from every tray, weighed and put in the oven in 70°C for 48 hours to evaluate moisture content (%) , dry matter (%) , then protein (%) , fibers (%) and carbohydrates (%).

Experimental design and statistical analysis

A factorial complete randomize block design with three factors (sprinkler type, irrigation period and seed thickness in the tray) was used for analysis all data with three replications. The treatment means were compared by least significant difference (LSD) test as given by **(Snedecor and Cochran (1994))**. Statistical analysis was carried out by special statistical program **(ASSISTAT) (Silva and Azevedo , 2009)** .

RESULTS AND DISCUSSION

Technical properties of nozzles :

Table (2) : CU% and DU% of utilized nozzles were calculated in the experiment as follows :

Sprayer system	Head (m)	Discharge (Lph)	Coverage diameter (cm)	CU%	DU %
Fogger	35	40	70	95.6	90.82
Mist sprayer	30	61	110	91.42	82.6
Mini sprinkler	20	130	150	86.43	80.8

CU and DU were determined to see how evenly the water distribution patterns under three types of microspriklers for different discharges, operating pressure and nozzle heights. The values of CU and DU for different discharges are illustrating in Tables (2) .

From the values of CU and DU for different types of microsprinkler, it can be arranged in descending order as follows; fogger microsprinkler type > mist sprayer type > mini sprinkler type .

The water droplet volume of fogger microsprinkler type is smaller than of those for mist sprayer type and mini sprinkler . The maximum CU and DU were adopted under 3.5 and 3 bar operating pressure for both types fogger sprinkler type and mist sprayer type under 70 cm and 110 cm coverage diameter for, respectively .

Water use efficiency

The effect of sprinkler type, period of irrigation and thickness of seeds in the tray on water use efficiency presented in Table (3). Regarding the type of sprinkler, data showed that sprinkler had a significant effect on WUE where the WUE were the highest using the mist sprayer comparing with the other sprinkler types.

On the other hand, data showed that irrigation period (30 sec/2hr) increased WUE significantly comparing with the other irrigation period.

Concerning the seed thickness, data showed that using 1 cm thickness of seeds recorded the highest WUE comparing with the other seed thickness.

Data in table (3) show that the effect sprinkler type, period of irrigation and thickness of seeds in the tray on water use efficiency (WUE). Data showed that using mist sprayer increased water use efficiency (WUE) significantly compared with the other type of sprinkler.

Regarding the effect of irrigation period, data showed that 30sec/2h increased water use efficiency (WUE) significantly comparing with the other irrigation periods.

Data showed also that using 1 cm thickness of seeds in the tray increased water use efficiency (WUE) significantly comparing with other seed thickness. Regarding the interaction between sprinkler types and irrigation period, data showed that the highest WUE recorded by fogger combined with (30 sec/ 2hr).

Table (3): WUE (g / L) affected by sprinkler type , period of irrigation and thickness of seeds in the tray

Sprinkler	Periods (Sec)	Thickness of seeds (cm) 0.5	1	1.5	Mean
	30sec/2hr	471.28	752.55	877.57	700.47
	60sec/4hr	377.54	815.02	0	397.52
Fogger	90sec/6hr	200.39	0	0	66.8
Mean		349.74	522.52	292.52	**388.26**
	30sec/2hr	384	547.99	711.92	547.97
	60sec/4hr	302.07	467.01	467.01	412.03
Mist sprayer	90sec/6hr	412.37	576.3	0	329.56
Mean		366.15	530.43	392.98	**429.85**
	30sec/2hr	289.5	366.4	0	218.63
	60sec/4hr	232.29	328.44	289.98	283.57
Mini sprinkler	90sec/6hr	270.7	213	0	161.23
Mean		264.16	302.61	96.66	**221.15**
Fogger		381.59	555.65	529.83	**489.02**
Mist sprayer		303.97	536.82	252.33	**364.37**
Mini sprinkler		294.49	263.1	0	**185.86**
Mean		**326.68**	**451.86**	**260.72**	

LSD value at 0.05:

Sprinkler (A) : 0.99 Periods (B) : **0.99**

Thickness (C) : 0.99 **Interactions (A × B × C) : 2.96**

A × B **A × C**

B × C

On the other hand, data showed that using fogger combined with 1 cm seed thickness recorded the highest WUE followed by mist sprayer with 1cm seed thickness while the lowest WUE recorded by mini sprinkler combined with 1.5 cm seed thickness

Concerning the interaction between irrigation period and seed thickness, data showed that highest WUE obtained using (30 sec/ 2hr) combined with 1 cm seed thickness while the lowest WUE recorded by mini sprinkler combined with 1.5 cm seed thickness.

Concerning the interaction among sprinkler type, irrigation period and thickness of seeds layer data in Table (3) showed that the highest WUE was obtained by using fogger with irrigation period (30 sec/ 2hr) and seeds layer thickness was (1.5 cm) in the tray .

Yield parameters

Sprout yield

Data in Table (4) illustrated the effect sprinkler type, period of irrigation and thickness of seeds in the tray on sprout yield/ tray. Data showed that using mist sprayer increased sprout yield/tray significantly compared with the other type of sprinkler.

Table (4) Sprout yield (g / tray) at harvest affected by sprinkler type, period of irrigation and thickness of seeds in the tray.

Sprinkler	Periods (Sec)	Thickness of seeds (cm) 0.5	1	1.5	Mean
Fogger	30sec/2hr	5000	8001	9334	7445
	60sec/4hr	4000	8667	0	4222
	90sec/6hr	3000	0	0	1000
Mean		4000	5556	3111	4223
Mist sprayer	30sec/2hr	4667	6667	8667	6667
	60sec/4hr	3667	5667	5667	5000
	90sec/6hr	5001	7000	0	4000
Mean		4445	6445	4778	5223
Mini sprinkler	30sec/2hr	5001	6334	0	3778
	60sec/4hr	4000	5667	5000	4889
	90sec/6hr	4667	3667	0	2778
Mean		4556	5223	1667	3815
Fogger		4889	7001	6000	5963
Mist sprayer		3889	6667	3556	4704
Mini sprinkler		4223	3556	0	2593
Mean		4334	5741	3185	

LSD value at 0.05:

Sprinkler (A): 822

Periods (B) : 822

Thickness (C) : 822

Interactions: 2466

A × B

A × C

B × C

Regarding the effect of irrigation period, data showed that 30sec/2h increased sprout yield/tray significantly comparing with the other irrigation periods. Data showed also that using 1 cm thickness of seeds in the tray increased sprout yield/tray significantly comparing with other seed thickness.

Concerning the effect of the interaction between sprinkler type and irrigation period on sprout yield/tray, data showed that the highest yield/tray recorded using fogger combined by (30 sec/2hr) followed by mist sprinkler with the same irrigation period while the lowest yield/tray obtained by mini sprinkler combined with (90 sec/6hr).

Regarding the interaction between sprinkler type and seed thickness on sprout yield/tray, data should that using mist sprinkler combined with 1 cm thickness recorded the highest sprout yield/tray followed by using similar sprinkler with 1.5 cm thickness and mist sprinkler combined with 1 cm seed thickness. The lost yield/ tray obtained by mini sprinkler combined with 1.5 cm seed thickness.

On the other hand, data illustrated that using 1 cm thickness irrigated by 30sec/2h recorded the highest sprout yield/tray followed by 1.5 cm seed thickness irrigated by 30sec/2hr while the lowest yield/ tray obtained by mini sprinkler irrigated by 90sec/6hr.

Regarding effect of the interaction among sprinkler type, irrigation period and thickness on sprout yield/tray, data showed that the highest yield was recorded using fogger combined with 1.5 cm seed thickness irrigated 30 sec/2hr followed by mini sprinkler combined with the same seed thickness irrigated 30 sec/2hr. The lowest yield/tray recorded using all sprinkler combined with 1.5 cm irrigated 90sec/6hr.

Sprout yield (g /kg seed):

Data in Table (5) illustrated the effect sprinkler type, period of irrigation and thickness of seeds in the tray on sprout yield (g/kg seed). Data showed that using mist sprayer increased sprout yield (g/kg seed) significantly compared with the other type of sprinkler. Regarding the effect of irrigation period, data showed that 30sec/2h increased sprout yield (g/kg seed) significantly comparing with the other irrigation periods. Data showed also that using 0.5 cm thickness of seeds in the tray increased sprout yield (g/kg seed) significantly comparing with other seed thickness.

Table (5) Sprout yield (g /kg seed) at harvest affected by sprinkler type, period of irrigation and thickness of seeds in the tray.

Sprinkler	Periods (Sec)	Thickness of seeds (cm) 0.5	1	1.5	Mean
Fogger	30sec/2hr	7225	6384	5759	6456
	60sec/4hr	5780	6916	0	4232
	90sec/6hr	4335	0	0	1445
Mean		5780	4433	1919	4044
Mist sprayer	30sec/2hr	6743	5320	5347	5803
	60sec/4hr	5298	4522	3496	4438
	90sec/6hr	7226	5586	0	4270
Mean		6423	5143	2948	3837
Mini sprinkler	30sec/2hr	7226	5054	0	4093
	60sec/4hr	5780	4522	3085	4462
	90sec/6hr	6743	2926	0	3223
Mean		6583	4167	1028	3926
Fogger		7064	5586	3702	5450
Mist sprayer		5619	5320	2194	4377
Mini sprinkler		6102	2837	0	2979
Mean		6262	4581	1965	

LSD value at 0.05:

Sprinkler (A): 783 Periods (B) : 783

Thickness (C) :783 Interactions: 2359

A × B **A × C**

B × C **A × B × C**

Concerning the effect of the interaction between sprinkler type and irrigation period on sprout yield (g/kg seed), data showed that the highest yield (g/kg seed) recorded using fogger combined by (30 sec/2hr) followed by mist sprinkler with the same irrigation period. The lowest yield (g/kg seed) obtained by fogger sprinkler combined with (90 sec/6hr).

Regarding the interaction between sprinkler type and seed thickness on sprout yield (g/kg seed), data should that using mini sprinkler combined with 0.5 cm seed thickness recorded the highest sprout yield (g/kg seed) followed by using mist sprinkler with the same seed thickness. The lowest yield (g/kg seed) obtained by mini sprinkler combined with 1.5 cm seed thickness.

On the other hand, data illustrated that using 0.5 cm thickness irrigated by 30sec/2h recorded the highest sprout yield (g/kg seed) followed by the same seed thickness irrigated by 90sec/6hr while the lowest yield/ tray obtained by mini sprinkler irrigated by 90sec/6hr.

Regarding effect of the interaction among sprinkler type, irrigation period and thickness on sprout yield (g/kg seed), data showed that the highest yield was recorded using mini sprinkler combined with 0.5 cm seed thickness irrigated 30 sec/2hr followed by mist irrigated 90sec/6hr and fogger combined with the same seed thickness irrigated 30 sec/2hr. The lowest yield/tray recorded using all sprinkler combined with 1.5 cm irrigated 90sec/6hr.

Data in Table (6) presented the effect sprinkler type, period of irrigation and thickness of seeds in the tray on protein percentage in sprout. Data showed that using mist sprayer increased protein percentage in sprout significantly compared with the other type of sprinkler.

Regarding the effect of irrigation period on protein percentage in sprout, data showed that 30sec/2h increased protein percentage in sprout significantly comparing with the other irrigation periods.

Data showed also that using 0.5 cm thickness of seeds in the tray increased protein percentage in sprout significantly comparing with the other seed thickness.

Concerning the effect of interaction between sprinkler type and irrigation period on protein percentage in sprout, data showed that the highest protein percentage in sprout recorded using fogger combined by (30 sec/2hr) followed by mist sprinkler with the same irrigation period. The lowest protein percentage in sprout obtained by fogger sprinkler combined with (90 sec/6hr).

Table (6) Protein (%) affected by sprinkler type, period of irrigation and thickness of seeds in the tray.

Sprinkler	Periods (Sec)	Thickness of seeds (cm)			Mean
		0.5	1	1.5	
Fogger	30sec/2hr	16.07	15.64	15.26	15.66
	60sec/4hr	14.78	13.54	0.00	9.44
	90sec/6hr	12.83	0.00	0.00	4.28
Mean		14.56	9.73	5.09	9.79
Mist sprayer	30sec/2hr	15.03	15.14	15.76	15.31
	60sec/4hr	13.58	14.53	9.93	12.68
	90sec/6hr	14.12	12.73	0.00	8.95
Mean		14.24	14.13	8.56	12.31
Mini sprinkler	30sec/2hr	14.08	14.69	0.00	9.59
	60sec/4hr	13.14	13.32	9.76	12.07
	90sec/6hr	14.03	8.84	0.00	7.62
Mean		13.75	12.28	3.25	9.76
Fogger		15.06	15.16	10.34	13.52
Mist sprayer		13.83	13.80	6.56	11.40
Mini sprinkler		13.66	7.19	0.00	6.95
Mean		14.19	12.05	5.63	

LSD value at 0.05:

Sprinkler (A): 1.54 Periods (B) : 1.54

Thickness (C): 1.54 Interactions: 4.61

A × B **A × C**

B × C **A × B × C**

Regarding the interaction between sprinkler type and seed thickness on protein percentage in sprout, data should that using fogger sprinkler combined with 0.5 cm seed thickness recorded the highest protein percentage in sprout followed by using mist sprinkler with the same seed thickness. The lowest protein percentage in sprout obtained by mini sprinkler combined with 1.5 cm seed thickness. On the other hand, data illustrated that using 1 and 0.5 cm thickness irrigated by 30sec/2h recorded the highest protein percentage in sprout while the lowest protein percentage in sprout obtained by mini sprinkler irrigated by 90sec/6hr.

Regarding effect of the interaction among sprinkler type, irrigation period and thickness on protein percentage in sprout, data showed that the highest protein percentage in sprout was recorded using fogger sprinkler combined with 0.5 cm seed thickness irrigated 30 sec/2hr followed by mist with the same seed thickness irrigated 30 sec/6hr. The lowest protein percentage in sprout recorded using all sprinkler combined with 1.5 cm irrigated 90sec/6hr.

Table (7) Fiber percentage affected by sprinkler type, period of irrigation and thickness of seeds in the tray.

Sprinkler	Periods (Sec)	Thickness of seeds (cm)			Mean
		0.5	1	1.5	
Fogger	**30sec/2hr**	19.29	19.75	19.90	19.65
	60sec/4hr	19.15	17.18	0.00	12.11
	90sec/6hr	14.44	0.00	0.00	4.81
Mean		17.63	12.31	6.63	12.19
Mist sprayer	**30sec/2hr**	18.05	20.05	19.24	19.11
	60sec/4hr	15.91	19.25	13.09	16.08
	90sec/6hr	17.29	16.73	0.00	11.34
Mean		17.08	18.67	10.78	15.51
Mini sprinkler	**30sec/2hr**	19.68	20.81	0.00	13.50
	60sec/4hr	15.71	15.92	11.53	14.39
	90sec/6hr	18.22	11.29	0.00	9.84
Mean		17.87	16.01	3.84	12.57
Fogger		19.01	20.20	13.05	17.42
Mist sprayer		16.92	17.45	8.21	14.19
Mini sprinkler		16.65	9.34	0.00	8.66
Mean		17.53	15.66	7.08	

LSD value at 0.05:

Sprinkler: 1.95 **Periods: 1.95**

Thickness: 1.95 **Interactions: 5.86**

A × B **A × C**

B × C **A × B × C**

Data in Table (7) presented the effect sprinkler type, period of irrigation and thickness of seeds in the tray on fiber percentage in sprout. Data showed that using mist sprayer increased fiber percentage in sprout significantly compared with the other type of sprinkler.

Regarding the effect of irrigation period on fiber percentage in sprout, data showed that 30sec/2h increased fiber percentage in sprout significantly comparing with the other irrigation periods.

Data showed also that using 0.5 cm thickness of seeds in the tray increased fiber percentage in sprout significantly comparing with the other seed thickness.

Concerning the effect of interaction between sprinkler type and irrigation period on fiber percentage in sprout, data showed that the highest fiber percentage in sprout recorded using fogger combined by (30 sec/2hr) followed by mist sprinkler with the same irrigation period. The lowest fiber percentage in sprout obtained by fogger sprinkler combined with (90 sec/6hr).

Regarding the interaction between sprinkler type and seed thickness on fiber percentage in sprout, data should that using mist sprinkler combined with 1 cm seed thickness recorded the highest fiber percentage in sprout followed by using mini sprinkler combined with 0.5 cm seed thickness. The lowest fiber percentage in sprout obtained by mini sprinkler combined with 1.5 cm seed thickness.

On the other hand, data illustrated that using 1 and 0.5 cm thickness irrigated by 30sec/2h recorded the highest fiber percentage in sprout while the lowest fiber percentage in sprout obtained by mini sprinkler irrigated by 90sec/6hr.

Regarding effect of the interaction among sprinkler type, irrigation period and thickness on fiber percentage in sprout, data showed that the highest fiber percentage in sprout was recorded using mist and mini sprinklers combined with 1 cm seed thickness'8 irrigated 30 sec/2hr. The lowest fiber percentage in sprout recorded using all sprinkler combined with 1.5 cm irrigated 90sec/6hr.

Carbohydrates percentage :

Data presented in Table (8) presented the effect sprinkler type, period of irrigation and thickness of seeds in the tray on carbohydrate percentage in sprout. Data showed that using mist sprayer increased carbohydrate percentage in sprout significantly compared with the other type of sprinkler.

Table (8) Carbohydrates percentage affected by sprinkler type, period of irrigation and thickness of seeds in the tray.

Sprinkler	Periods (Sec)	Thickness of seeds (cm) 0.5	1	1.5	Mean
Fogger	**30sec/2hr**	59.51	59.25	59.32	59.36
	60sec/4hr	60.63	64.67	0.00	41.77
	90sec/6hr	61.01	0.00	0.00	20.34
Mean		60.38	41.31	19.77	40.49
Mist sprayer	**30sec/2hr**	61.05	59.73	60.31	60.36
	60sec/4hr	63.76	62.21	40.48	55.48
	90sec/6hr	61.80	63.30	0.00	41.70
Mean		62.20	61.75	33.60	52.51
Mini sprinkler	**30sec/2hr**	61.01	58.78	0.00	39.93
	60sec/4hr	63.21	60.86	40.58	54.88
	90sec/6hr	59.85	44.04	0.00	34.63
Mean		61.35	54.56	13.53	43.15
Fogger		60.52	59.26	39.88	53.22
Mist sprayer		62.53	62.58	27.02	50.71
Mini sprinkler		60.88	35.78	0.00	32.22
Mean		61.31	52.54	22.30	

LSD value at 0.05:

Sprinkler: 6.74 **Periods: 6.74**

Thickness: 6.74 **Interactions: 20.22**

A × B **A × C**

B × C **A × B × C**

Regarding the effect of irrigation period on carbohydrate percentage in sprout, data showed that 30sec/2h increased carbohydrate percentage in sprout significantly comparing with the other irrigation periods.

Result showed that using 0.5 cm thickness of seeds in the tray increased carbohydrate percentage in sprout significantly comparing with the other seed thickness.

Concerning the effect of interaction between sprinkler type and irrigation period on carbohydrate percentage in sprout, data showed that the highest carbohydrate percentage in sprout recorded using mist followed by fogger sprinklers irrigated 30 sec/2hr. The lowest carbohydrate percentage in the sprout obtained by fogger sprinkler combined with (90 sec/6hr).

Regarding the interaction between sprinkler type and seed thickness on carbohydrate percentage in sprout, data should that using mist sprinkler combined with 0.5 cm seed thickness recorded the highest carbohydrate percentage in sprout followed by using the same sprinkler combined with 1 cm seed thickness. The lowest carbohydrate percentage in sprout obtained by mini sprinkler combined with 1.5 cm seed thickness.

On the other hand, data illustrated that using 1 and 0.5 cm thickness irrigated by 30sec/2h recorded the highest carbohydrate percentage in sprout while the lowest carbohydrate percentage in sprout obtained by mini sprinkler irrigated by 90sec/6hr.

Regarding effect of the interaction among sprinkler type, irrigation period and thickness on carbohydrate percentage in sprout, data showed that the highest carbohydrate percentage in sprout was recorded using fogger combined with 1 cm seed thickness followed by mist sprinklers combined with 0.5 cm seed thickness irrigated 60 sec/2hr. The lowest carbohydrate percentage in sprout recorded using all sprinkler combined with 1.5 cm irrigated 90sec/6hr.

CONCLUSION

From the overall results, it is clear that using 0.5 cm seed thickness irrigated by fogger every 30 sec/2hr the best combination to get the highest yield and other parameter of sprouts.

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الملخص العربى

تأثير نظم الرى الصغيرة وفترة الرى وسمك طبقة البذور على محصول الشعير المستنبت

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كان الهدف الرئيسي من هذا البحث دراسة تأثير نظم الرى المختلفة في الزراعة المائية لإنتاج الأعلاف الخضراء . التجربة تتضمن عددا من الأليات من خلال استخدام أنواع مختلفة من فوهات الرى (ضبابى، رذاذى والرش صغير) ذات التصرفات المختلفة (٤٠ , ٦١ , ١٣٠) لتر/ساعة على التوالي ، وهذه النظم تعمل في فترات الري المختلفة (٣٠ ، ٦٠ ، ٩٠) ثانية كل (٢، ٤ ، ٦) ساعة على التوالي وتطبيق ذلك على ثلاثة سمك لطبقات البذور (٠,٥ ، ١ و ١,٥) سم/صينية.

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وكانت أهم النتائج على النحو التالي : وكان أفضل انتظامية اضافة مياه على الصواني (معامل كريستيانسن CU٪) باستخدام النظام الضبابى في نظام الزراعة المائية لإنتاج العلف، كان أفضل انتظامية توزيع (DU٪) باستخدام النظام الرذاذى في الزراعة المائية ، تم أخذ القياسات لكل وحدة إنتاج (WUE، وزن المحصول/صينية ، ووزن الانتاج / كجم من البذور، والبروتين٪، والألياف٪، والكربوهيدرات٪).

ويتضح البيانات أن استخدام ٠,٥ سم من البذور/ صينية سجلت أعلى محصول / كجم من البذور، والبروتين٪، والألياف والكربوهيدرات٪ ، كذلك استخدام ٣٠ ثانية / ٢ساعة سجلت أعلى كفاءة استخدام المياه، وانتاجية/ كجم من البذور، والبروتين٪، والألياف والكربوهيدرات٪.

وفيما يتعلق بنوع الرشاشات أظهرت البيانات أن استخدام النظام الضبابى أعطى أعلى كفاءة استخدام المياه، وانتاج / كجم من البذور، والبروتين٪، والألياف والكربوهيدرات٪.

أخيرا من النتائج العامة يمكن استنتاج أن النظام الضبابى مع فترة رى ٣٠ ثانية / ٢ساعة مع ٠,٥سم سمك البذور داخل الصينية سجلت أعلى المعايير التي تم اختبارها.