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WATER UPTAKE MANAGEMENT FOR SOME VEGETABLE CROPS GROWN IN HYDROPONIC CONDITIONS

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This investigation is an attempt to clarify the effect of agriculture systems, irrigation duration time, drippers discharge and their interactions in green house to improve water use efficiency of some vegetable plants (tomatoes and sweet pepper) in an experimental green house unit located at El-Sheikh Zuwayid Research station, North Sinai, Egypt.

The study was conducted in split-split-plot design with four replicates. The treatments include: main plots as two agriculture systems in slope basin: gullies and pillow systems, sub-main plots as three daily irrigation duration times, i.e.; 12 hours continuous, 8 hours continuous and 8 hours intermittent as 4 hours twice and by a constant rate of 10 minute/hour and sub sub-main plots as two dripper discharges, i.e.; 8 and 4 liter/hour. The results were analyzed statistically. From the experiments, the following results were obtained:

There is a positive effect on number of fruits, plant yield weight for both early and total yields, water use efficiency and investment ratio by cultivating in pillow and by decreasing irrigation duration times and drippers discharge, while negative effect has been found with water consumptive use values for tomatoes and sweet pepper plants. All parameters show highly significant differences among used treatments. The applied managements improved water uptake and water use efficiency as well. The results of applying 4 hours twice daily comparing to 12 hours continuous irrigation application (which is the already used rate in the site) show water saving amounts by about 26.5 and 29.3 % for tomatoes and sweet pepper plants, respectively.

It is suggested to cultivate in pillow filled by peat-moss under green house with twice daily-irrigation application by times of 4 hours with 4 liter/hr dripper discharge under the conditions of El-Sheikh Zuwayid.

Keywords: hydroponics, irrigation duration time, drippers discharge, tomatoes, sweet pepper, water consumptive use, water use efficiency.

Maximizing agriculture production from the unit of cultivated land became the main target of all agronomists to fill the gap between food supply and demands of the ever increasing population. Hydroponics are recommended worldwide as a tool for intensive farming and a technique for farming in areas where crops cannot be grown due to poor soils, high salinity or other reasons (Ali, 2004).

Hydroponics is often defined as "the cultivation of plants in water" or soilless cultivation. By this technique the plants can mature faster, yielding an earlier harvest for vegetable and flower crops. Hydroponic gardens use less space as the roots do not need to spread out in searching for food and water. Automation reduces the actual duration time it takes to maintain plant growth requirements. Automation also provides flexibility to the gardener as one can go for long periods of duration time without having to worry about watering the plants (Howard, 1989).

Soilless cultivation of vegetables could be a good alternative to solve several problems. Moreover, it has some further advantages related to the improvement of plant growth, yield and earliness, especially in arid region, where water is scarce commodity. It has the potential ability to reduce the water consumption of crops to very low levels, not just because it eliminates the normal loss of water by drainage and evaporation, but it is the only method of agricultural production that can reduce water consumption to the essential water loss through the leaves of the plants (Salman, 1995). Sen and Sevgican (1999) reported that in countries like Holland, Japan, USA, England, Canada, Germany and Belgium almost all of the protected cultivation of vegetables is carried out by culture. Ymeri *et al.,* (1999) demonstrated that culture of tomato is becoming traditional in the protected cultivation of vegetables. The difficulty and cost of controlling soil borne pests and diseases, soil salinity, lack of fertile soil, water shortage etc., have led to the development of substrates for cultivation (Olympios, 1992). Rodriguez (1999) evaluated tomato and sweet pepper grown in Argentina culture so as to improve the investment decisions. The feasibility and economic indicator such as net present value and internal return rate indicated that sweet pepper production is economically more attractive than tomato production. Tuzel *et al.* (2001) indicated that using closed system could save up to 24 % of water and 34 % of nutrients compared to the open system. Noguera *et al.* (1988) found that plants water consumption grown on hydroponics was lower, and positively linearly related to crop evapotranspiration. Ali (2004) found that water consumption of tomato and sweet pepper growing in culture in Egypt is less than growing in soil. So, water use efficiency and water economy were greater compared to soil cultivation.

Open cultivation in the study area lasted in soil for 120 days growth season and gets 1680 m^3/fed (14 m^3/fed/day) for tomato crop with 19 to 27 ton/fed yield, while for sweet pepper it gets 1200 m^3/fed (10 m^3/fed/day) for yielding 8 to 11 ton/fed. So, water use efficiency values were 10 to 12 and 1.5 to 3 kg/m^3 for the two crops, respectively as recorded by Doorenbos and Kassam (1979).

However, in the El-Sheikh Zuwayid experiment station of Desert Research Center, some weak plant growth and production were noted, despite the high doses of irrigation water. Therefore, there was a need to determine the extent to which water application rates could be adjusted under green house conditions especially when using the modest soilless techniques of pillow and gullies systems in cultivation. The experiment was planned on the basis of conserving the total water application and managing the applied water rate.

This investigation is an attempt to clarify the effect of agriculture systems, irrigation duration time, drippers discharge and their interactions on improving water use efficiency of some vegetable plants (tomatoes and sweet pepper) under green house conditions.

MATERIALS AND METHODS

The investigation was carried out during the 2003/2004 season, in a green house (double span) in the El-Sheikh Zuwayid experimental station of the Desert Research Center, North Sinai Governorate, Egypt. This experimental green house is 36m long, 18m wide and 3.25m in height.

The study was conducted in split-split-plot design with four replicates. The applied irrigation system is drip irrigation with drippers having 8 and 4 liter/hour discharges with three irrigation application rates, i.e., a- 12 hours continuous irrigation application (which is the resident rate in the site), b- 8 hours continuous irrigation application and, c- 8 hours intermittent irrigation application in equal 4 hours, twice irrigation application. However, for all methods, the time of application was 10 minute/hour. Two agriculture systems in slope basins were used; gullies and pillow methods. Each basin was filled with 60 kg peat-moss by means of 15 kg for each gully and pillow. Table (1) shows irrigation water amounts of tomatoes and sweet pepper crop grown under green houses.

TABLE (1). Amounts of irrigation water for tomatoes and sweet pepper crops grown under green houses at El-Sheikh Zuwayid region.

Irrigation periods	Emitters discharge L/hr	Liter/m^2 /day	m^3/plant /213 days	Liter/plant /day	Liter / basin / day
12 hours	8	16.00	0.84	4.00	384
	4	8.00	0.42	2.00	192
8 hours	8	10.66	0.56	2.67	256
	4	5.33	0.28	1.33	128

The drained water was recycled to be applied to plants; therefore, a 200 liters plastic tank was used for each basin for this purpose. The recycling of drained water aimed to prevent rapid changes in nutrient concentrations. The nutritional concentrations of irrigation water were daily fixed using 5 % acid mixture of nitric and phosphoric acid (3 parts of HNO_3 + 1 part of H_3PO_4) at pH between 5.5 – 6.0 and EC between 1.8 – 2.0 dS/m. Two stock solutions were prepared in two separate containers for compensation was carried out automatically, as described by El-Behiary (1994) and Ahmed (2003), table (2). The flow rate of stock solutions was adjusted to 2.5 liter/min.

TABLE (2). Some chemical properties of stock solutions.

Tank A ppm	N	P	K^+	Ca^{++}	Mg^{++}	S
	259.6	35.0	300.0	160.2	50.0	221.0
	Fe	Mn	B	Cu	Mo	Zn
	5.0	1.0	0.3	0.1	0.1	0.1
Tank B	Calcium nitrate and iron					

ppm = part per million

Tomato seeds, *Lycopersicon esculentum*, variety Samson and seeds of sweet pepper, *capsicum annuum* were sown on foam cubes in November 10, 2003 and in December 25, 2003, respectively. Seedlings were transferred after the cotyledon leaves were fully expanded. When seedlings reached proper vigor, they were further selected and placed in the final place, made of peat-moss culture media. Plant density for either vegetable crop was four plants/m^2. The nutrient solution was immediately circulated through the basins and returning to the tank by gravity.

The greenhouse was divided into two parts. Each part has 6 tilted basins, 1: 12 cm slope directed towards the middle of the greenhouse. Each basin was 2.25 m wide, 12 m long, 50 cm apart containing 96 plants. Table (3) shows some the chemical properties of the used peatmoss.

TABLE (3). Some chemical properties of the peat-moss used.

Culture media	pH	E.C. dS/m	O.M. %	C %	N %	P %	K %	C/N
Peatmoss	7.72	1.84	52.28	29.33	2.21	0.48	0.81	13.27

OM = Organic matter C = Carbon N = Nitrogen C/N = ratio

White and black polyethylene sheets, 200-micron thickness, 90 cm wide and 12 m long were used to form either gullies or pillows. Four gullies or pillows were placed on each elevated basin. To construct channels, the polyethylene sheets were laid down. The white side faced the sand fills. A rectangular galvanized frame 25 cm wide, 6 cm in height and 12 m long were laid down on the polyethylene sheets. The sides of the sheets were raised and turned around the galvanized frame then stapled together at one edge of the frame. Plant holes were made in the middle of the formed gullies or pillows.

The solution volume was measured twice a week and adjusted to a constant volume by adding tap water (Table 4), Richards (1954) up to a recognized mark in the tank. The amount of water consumption was measured and recorded.

TABLE (4). Chemical analysis of tap water used for irrigation.

pH	E.C.		S.A.R	R.S.C me/l	T.D.S. ppm	Units	Soluble cations				Total	Soluble anions				Total	Class
	ppm.	dS/m					Ca^{++}	Mg^{++}	Na^{+}	K^{+}		$CO_3^{=}$	HCO_3^{-}	$SO_4^{=}$	Cl^{-}		
7.3	602	0.94	1.74	-1.1	473.9	ppm.	68.54	22.61	64.86	19.6	175.6	0.00	257.46	54.75	114.9	298.38	C_3S_1
						epm.	3.42	1.86	2.82	0.50	8.60	0.00	4.22	1.14	3.24	8.60	
						%	39.8	21.63	32.79	5.81	100.0	0.00	49.07	13.26	37.67	100.0	

pH = soil reaction E.C. = electrical conductivity dS/m = deci Siemens per metre
S.A.R = Sodium adsorption ratio R.S.C. = Residual sodium carbon
T.D.S. = Total dissolved solids ppm = part per million epm.= equivalent per million

It is important to note that both crops lasted in open fields about 120 days for each growth season, while under greenhouse conditions they lasted for 213 days. At the end of the experiment the number of fruits, plant yield weight and total yield of tomato and sweet pepper were harvested and recorded respectively. Accumulative water consumptive use was recorded using water budget method described by Cooper (1979). Water use efficiency was calculated by dividing the crop yield by the amount of seasonal actual evapotranspiration (Giriappa, 1983). Data were subjected to the analysis of variance according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Yield

Table (5) reveals a highly significant increase in number of fruits, weight plant yield for early and total yield of tomatoes and sweet pepper plants by cultivated pillows than gullies and by decreasing irrigation duration times and drippers discharge. All parameters show highly significant effect and highly significant differences among treatments.

For convenience, the highest values for growth parameters, yield and yield components were commonly associated with agriculture in pillow and daily irrigated 4 hours twice with drip irrigation dripper 4 L/hr, while the lowest values were associated with agriculture in gully and daily irrigated 12 hours continuous with drip irrigation dripper of 8 L/hr.

These decreases with the excess amount of irrigation water could be attributed to fast circulation of irrigation water through the saturated root zone, which could result in minimizing the time of contact between the solution and plant roots (circulation cycles in the highest irrigation rate of 12 hrs with 8 L/hr dripper reaches to about 7 times daily). Also, the excess wetting of the top soilless strata may have resulted in declining solution uptake time with increasing solution flow and may leach some nutrients from the root zone. These results are quite similar to those reported by Howard (1989); Sen and Sevgican (1999); Ymeri *et al.*, (1999) and Ali (2004).

Water Consumptive Use

One of the important objectives of this research was to maximize the beneficial use of water under green house conditions, as the general notices about growth under ordinary practices were negative. The results suggest that the water cycling under green house conditions needs proper management which has been adopted by irrigation treatments either by changing irrigation duration or application.

Tables (6 a and b) show the effect of soilless agriculture systems in slope basin (gullies & pillows), irrigation duration time (12 and 8 hrs), drippers discharge (8 and 4 L/hr) and their interactions on water consumptive use of tomatoes and sweet pepper under green house conditions, the data reveal the following findings:

1- The ordinary applied rates of irrigation water under green house conditions were higher than the recommended consumptive use value (Doorenbos and Kassam, 1979) with about 49.36 and 63.83 % for tomato and sweet pepper crops.

TABLE (5). Effect of cultivation systems, irrigation duration and drippers discharge and their interaction on tomatoes and sweet pepper yield grown under green houses at El-Sheikh Zuwayid region.

Treatments			Tomato crop					Sweet pepper crop				
			Early yield		Total yield			Early yield		Total yield		
Cultivation systems	Irrigation periods	Emitters discharge	No. fruits	kg/plant	No. fruits	kg/plant	Ton/fed	No. fruits	kg/plant	No. fruits	kg/plant	Ton/fed
Gullies	12 hours	8 L/hr	20.65	2.71	61.45	7.31	50.53	13.41	1.59	43.16	4.37	30.21
		4 L/hr	21.79	3.38	68.23	9.11	62.97	15.34	1.79	48.17	5.83	40.30
	Average		21.22	3.05	64.84	8.21	56.75	14.38	1.69	45.67	5.10	35.25
	8 hours	8 L/hr	21.87	2.89	66.23	8.17	56.47	15.44	1.83	46.37	5.77	39.88
		4 L/hr	23.75	3.63	71.35	10.23	70.71	17.23	1.91	52.26	6.38	44.10
	Average		22.81	3.26	68.79	9.20	63.59	16.34	1.87	49.32	6.08	41.99
	4 hours twice	8 L/hr	22.98	3.00	77.28	9.75	67.39	16.78	1.91	50.27	6.29	43.47
		4 L/hr	26.14	3.69	82.15	11.86	81.98	18.24	2.05	56.78	6.85	47.35
	Average		24.56	3.35	79.72	10.81	74.68	17.51	1.98	53.53	6.57	45.41
Average irrigation periods			22.86	3.22	71.12	9.41	65.01	16.07	1.85	49.50	5.92	40.88
Pillows	12 hours	8 L/hr	21.11	2.89	73.44	8.45	58.41	15.14	1.88	49.37	5.87	40.57
		4 L/hr	22.68	3.56	78.27	10.25	70.85	16.89	2.03	53.24	6.59	45.55
	Average		21.90	3.23	75.86	9.35	64.63	16.02	1.96	51.31	6.23	43.06
	8 hours	8 L/hr	22.17	3.05	79.33	9.08	62.76	16.54	1.98	51.13	6.11	42.23
		4 L/hr	24.24	3.71	83.25	11.34	78.38	18.11	2.09	57.43	6.78	46.86
	Average		23.21	3.38	81.29	10.21	70.57	17.33	2.04	54.28	6.45	44.55
	4 hours twice	8 L/hr	23.54	3.13	85.17	10.15	70.16	17.44	2.02	53.16	6.48	44.79
		4 L/hr	27.11	3.82	91.11	12.87	88.96	19.36	2.13	62.17	7.19	49.70
	Average		25.33	3.48	88.14	11.51	79.56	18.40	2.08	57.67	6.84	47.24
Average irrigation periods			23.48	3.36	81.76	10.36	71.59	17.25	2.02	54.42	6.50	44.95
Average emitters discharge 8 L/hr			22.05	2.95	73.82	8.82	60.95	15.79	1.87	48.91	5.82	40.19
Average emitters discharge 4 L/hr			24.29	3.63	79.06	10.94	75.64	17.53	2.00	55.01	6.60	45.64
L.S.D.	Cultivation systems		0.11	0.13	0.14	0.24	**	0.43	0.04	1.03	0.07	**
	Irrigation times		0.48	0.17	0.51	0.21	**	0.52	0.07	1.23	0.06	**
	Emitters discharge		0.33	0.31	0.36	0.38	**	0.41	0.03	1.15	0.08	**
	Interaction		0.13	0.23	0.15	0.29	**	0.37	0.02	1.21	0.09	**

** = significant at 0.01

2- Some rates of the applied irrigation water treatments were higher than the recommended open field values, while others were lower.

3- All measured ETa values for the applied irrigation treatments gave lower values than the recommended ones as follow;

   a- Gully method consumed more water than pillow method. The difference in values was smaller in the former than the latter.

   b- The large values of water application periods (12 hrs) gave the highest differences than for 8 L/hr drippers between measured and applied ETa values.

   c- The differences between the two treatments of 8 hrs irrigation periods were almost similar for both crops.

   d- The 4 L/hr drippers were generally superior to the 8 L/hr ones for making water consumptive use values close to the applied rates which is the main philosophy of using green house and hydroponic system.

e- Sweet pepper show higher response than tomato to variations in the application of irrigation water.

f- Evaluating the ETa data given in tables 6 a and b, indicate that;

i- Pillow cultivation system saved water more than gully system.

ii- 8 hrs irrigation period save water more than 12 hrs irrigation period.

iii- 4 L/hr drippers saved water more than 8 L/hr ones.

iv- Sweet pepper generally consumed lower values than tomato.

These findings are in harmony with Noguera *et al.* (1988); Tuzel *et al.* (2001) and Ali (2004).

TABLE (6 a). Effect of cultivation systems, irrigation durations and drippers discharge and their interaction on water consumptive use and water use efficiency of tomatoes and sweet pepper crops grown under green houses at El-Sheikh Zuwayid region.

Treatments			Tomato crop				Sweet pepper crop			
			Seasonal ETa			WUE	Seasonal ETa			WUE
Cultivation systems	Irrigation periods	Emitters discharge	m^3/fed /day	m^3/fed	m^3/plant /season	kg/m^3	m^3/fed /day	m^3/fed	m^3/plant /season	kg/m^3
Gullies	12 hours	8 L/hr	10.387	2212.52	0.320	22.84	6.214	1323.50	0.191	22.82
		4 L/hr	9.988	2127.44	0.308	29.60	5.977	1273.10	0.184	31.65
	Average		10.188	2169.98	0.314	26.15	6.095	1298.30	0.188	27.15
	8 hours	8 L/hr	9.600	2044.82	0.296	27.62	6.046	1287.82	0.186	30.97
		4 L/hr	9.055	1928.66	0.279	36.66	5.690	1211.87	0.175	36.39
	Average		9.327	1986.74	0.287	32.01	5.868	1249.84	0.181	33.60
	4 hours twice	8 L/hr	9.412	2004.80	0.290	33.62	5.892	1254.94	0.182	34.64
		4 L/hr	8.873	1889.85	0.273	43.38	5.641	1201.63	0.174	39.40
	Average		9.142	1947.32	0.282	38.35	5.767	1228.29	0.178	36.97
Average irrigation periods			9.552	2034.68	0.294	31.95	5.910	1258.81	0.180	32.48
Pillows	12 hours	8 L/hr	8.308	1769.59	0.256	33.01	6.151	1310.11	0.190	30.97
		4 L/hr	7.934	1690.00	0.245	41.92	5.984	1274.61	0.184	35.74
	Average		8.121	1729.80	0.250	37.36	6.067	1292.36	0.187	33.32
	8 hours	8 L/hr	8.268	1761.07	0.255	35.64	6.093	1297.79	0.188	32.54
		4 L/hr	7.663	1632.27	0.236	48.02	5.791	1233.42	0.178	37.99
	Average		7.966	1696.67	0.245	41.59	5.942	1265.61	0.183	35.20
	4 hours twice	8 L/hr	8.109	1727.24	0.250	40.62	5.556	1183.46	0.171	37.85
		4 L/hr	7.635	1626.26	0.235	54.70	4.394	936.02	0.135	53.09
	Average		7.872	1676.75	0.243	47.45	4.975	1059.74	0.153	44.58
Average irrigation periods			7.986	1701.07	0.250	42.13	5.662	1205.90	0.170	37.70
Average emitters discharge 8 L/hr			9.014	1920.01	0.278	32.22	5.992	1276.27	0.185	31.63
Average emitters discharge 4 L/hr			8.525	1815.75	0.263	42.38	5.580	1188.44	0.172	39.04
L.S.D.	Cultivation systems		**	**	0.013	6.55	**	**	0.008	0.19
	Irrigation times		**	**	0.003	4.46	**	**	0.003	0.37
	Emitters discharge		**	**	0.004	5.12	**	**	0.007	0.33
	Interactions		**	**	0.005	4.75	**	**	0.002	0.28

ETc value calculated for open field is 2.71 and 3.04 L/plant/day for tomatoes and sweet pepper, respectively, Doorenbos and Kassam (1979).

** = Significant at 0.01

TABLE (6 b). Effect of cultivation systems, irrigation periods and drippers discharge on differences between amounts of applied irrigation water and water consumptive use of tomatoes and sweet pepper grown under green houses at El-Sheikh Zuwayid region.

Cultivation systems	Irrigation periods	Emitters discharge	Applied irrigation water L/plant/day	Tomato measured ETa L/plant/day	Pepper measured ETa L/plant/day	Differences between applied and measured ETa for tomato L/plant/day	% of differences from tomato ETa	Differences between applied and measured ETa for pepper L/plant/day	% of differences from pepper ETa
Gullies	12 hours	8 L/hr	4.00	1.50	0.90	2.50	62.43	3.10	77.53
		4 L/hr	2.00	1.45	0.86	0.55	27.75	1.14	56.76
	Avg. irrigation periods		3.00	1.47	0.88	1.53	50.87	2.12	70.61
	8 hours	8 L/hr	2.67	1.39	0.87	1.28	47.92	1.79	67.20
		4 L/hr	1.33	1.31	0.82	0.02	1.75	0.51	38.26
	Avg. irrigation periods		2.00	1.35	0.85	0.65	32.53	1.15	57.55
	4 hours twice	8 L/hr	2.67	1.36	0.85	1.30	48.94	1.81	68.04
		4 L/hr	1.33	1.28	0.82	0.05	3.73	0.52	38.79
	Avg. irrigation periods		2.00	1.32	0.83	0.68	33.87	1.17	58.29
Average cultivation systems			2.33	1.38	0.86	0.95	40.77	1.48	63.36
Pillows	12 hours	8 L/hr	4.00	1.20	0.89	2.80	69.95	3.11	77.75
		4 L/hr	2.00	1.15	0.87	0.85	42.61	1.13	56.71
	Avg. irrigation periods		3.00	1.17	0.88	1.83	60.84	2.12	70.74
	8 hours	8 L/hr	2.67	1.20	0.88	1.47	55.14	1.79	66.94
		4 L/hr	1.33	1.11	0.84	0.22	16.85	0.50	37.17
	Avg. irrigation periods		2.00	1.15	0.86	0.85	42.38	1.14	57.02
	4 hours twice	8 L/hr	2.67	1.17	0.80	1.49	56.01	1.86	69.86
		4 L/hr	1.33	1.10	0.64	0.23	17.15	0.70	52.32
	Avg. irrigation periods		2.00	1.14	0.72	0.86	43.06	1.28	64.01
Average cultivation systems			2.33	1.16	0.82	1.18	50.48	1.51	64.90
Average			2.33	1.27	0.84	1.06	40.25	1.50	60.69

ETc value calculated for open field is 2.71 and 3.04 L/plant/day for tomatoes and sweet pepper, respectively, Doorenbos and Kassam (1979).

Water Use Efficiency

Data in table (6 a) show highly significant increase of water use efficiency values for tomatoes and sweet pepper plants by cultivation on pillow greater than gully system and decreasing irrigation durations and drippers discharge. All parameters show highly significant differences among treatments. From table (6 a) of WUE as a parameter for both water consumption and yielded crops; the following can be noted:

a- Pillow systems gave higher WUE values than recommended methods of Doorenbos and Kassam (1979) for the two crops as ≈ 78 and 94 % for tomato and sweet pepper, respectively.

b- The increase in WUE values were in the order of 4 hours twice > 8 hours > 12 hours irrigation periods by 35, 25 & 12 % and 34, 22 & 12 % for tomatoes and sweet pepper, respectively.

This increase in WUE was due to: a) the decrease of actual evapotranspiration at low amount of irrigation water and b) the correspondent high yield. It is suggested that these practices activate both water and nutrient consumptions by plant roots which increased crop yield, thus increased WUE. These findings are in harmony with Rodriguez (1999), Sen and Sevgican (1999), Tuzel *et al.* (2001) and Ali (2004). Nevertheless, the best treatment was apparently the cultivation on pillow and 4 hours twice-daily irrigation with 4 L/hr drippers.

Economic Evaluation

Table (7) shows the economic evaluation of the investigated ratio (IR) for the cultivation systems, irrigation period and drippers discharge rates. The obtained results are as follows:

1. Pillow soilless cultivation system is more beneficial than gully system.
2. For irrigation duration, 8 hours intermittent (4 hours twice) is more beneficial than 8 hours continuous, while both are higher than 12 hours continuous.
3. Drippers discharges, 4 L/hr are more beneficial than 8 L/hr one.

CONCLUSION AND RECOMMENDATIONS

From the aforementioned discussion, it is suggested to cultivate in pillow system filled by peat-moss under green house conditions and daily-irrigated by 4 hours twice duration with drip irrigation dripper 4 L/hr. However, there are several beneficial alternatives that could be used in which their investment ratios are smaller than the best former one. This management method improved irrigation cycle, water and nutrients uptake and water use efficiency as well. However, these treatments saved water by about 26.5 and 29.3 % compared to 12 hours continuous irrigation application (which is the resident rate in the site) for tomatoes and sweet pepper plants, respectively.

Finally, it is recommended that more work under green house conditions for detecting the nutritional status for irrigation water and plants could be undertaken in order to get more information about nutrient uptake situation.

TABLE (7). Input and output items for tomatoes and sweet pepper yield grown under green houses at El-Sheikh Zuwayid region.

Economical items			Slope basin cultivation											
Items	Management	Units	Gullies system						Pillows system					
			12 hours		8 hours		4 hours twice		12 hours		8 hours		4 hours twice	
			8 l/h	4 l/h	8 l/h	4 l/h	8 l/h	4 l/h	8 l/h	4 l/h	8 l/h	4 l/h	8 l/h	4 l/h
List of Inputs	Land preparation	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Green house cost	LE/fed	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000
	Seeds	LE/fed	120	120	120	120	120	120	120	120	120	120	120	120
	Cultivation	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Irrigation	LE/fed	553	532	511	482	501	472	442	423	440	408	432	407
	Culture media	LE/fed	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
	Stock solution	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Weed control	LE/fed	120	120	120	120	120	120	120	120	120	120	120	120
	Pest control	LE/fed	120	120	120	120	120	120	120	120	120	120	120	120
	Labors costs	LE/fed	120	120	120	120	120	120	120	120	120	120	120	120
	Instruments	LE/fed	120	120	120	120	120	120	120	120	120	120	120	120
	Fuel	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Harvesting	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Crop transport	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Rent (per season)	LE/fed	600	600	600	600	600	600	600	600	600	600	600	600
	Total input	LE/fed	21913	21892	21871	21842	21861	21832	21802	21783	21800	21768	21792	21767
List of Outputs	Yield	kg/fed	50527	62968	56471	70710	67392	81976	58406	70848	62761	78382	70157	88957
	Price	LE/kg	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Total price	LE/fed	25264	31484	28236	35355	33696	40988	29203	35424	31381	39191	35079	44479
	Net income	LE/fed	3350	9592	6364	13513	11835	19156	7401	13642	9580	17423	13287	22712
Investment ratio		LE/ILE	1.15	1.44	1.29	1.62	1.54	1.88	1.34	1.63	1.44	1.80	1.61	2.04
Irrigation water		m^3/fed	2212.5	2127.4	2044.8	1928.7	2004.8	1889.9	1769.6	1690.0	1761.1	1632.3	1727.2	1626.3
Avg. IR for cultivation systems			1.49						1.64					
			1.56											
Avg. IR for irrigation period			1.30		1.45		1.71		1.48		1.62		1.83	
									1.39		1.54		1.77	
Avg. IR for dripper discharges							1.33	1.64					1.46	1 82
													1.40	1.73
Economical items			Sweet pepper yield											
List of Inputs	Land preparation	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Green house cost	LE/fed	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000	12000
	Seeds	LE/fed	120	120	120	120	120	120	120	120	120	120	120	120
	Cultivation	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Irrigation	LE/fed	331	318	322	303	314	300	328	319	324	308	296	234
	Culture media	LE/fed	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
	Stock solution	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Weed control	LE/fed	120	120	120	120	120	120	120	120	120	120	120	120
	Pest control	LE/fed	120	120	120	120	120	120	120	120	120	120	120	120
	Labors costs	LE/fed	120	120	120	120	120	120	120	120	120	120	120	120
	Instruments	LE/fed	120	120	120	120	120	120	120	120	120	120	120	120
	Fuel	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Harvesting	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Crop transport	LE/fed	360	360	360	360	360	360	360	360	360	360	360	360
	Rent (per season)	LE/fed	600	600	600	600	600	600	600	600	600	600	600	600
	Total input	LE/fed	21691	21678	21682	21663	21674	21660	21688	21679	21684	21668	21656	21594
List of Outputs	Yield	kg/fed	30205	40297	39882	44099	43476	47347	40573	45550	42232	46863	44790	49697
	Price	LE/kg	0.75	0.75	0.75	0.75	0.75	0.75	0 75	0.75	0.75	0.75	0.75	0 75
	Total price	LE/fed	22654	30223	29912	33074	32607	35510	30430	34163	31674	35147	33593	37273
	Net income	LE/fed	963	8544	8230	11411	10933	13850	8742	12484	9990	13479	11937	15679
Investment ratio		LE/ILE	1.04	1.39	1.38	1.53	1.50	1.64	1.40	1.58	1.46	1.62	1.55	1 73
Irrigation water		m^3/fed	1324	1273	1288	1212	1255	1202	1310	1275	1298	1233	1184	936
Avg. IR for cultivation systems			1.41						1.56					
			1.49											
Avg. IR for irrigation period			1.22		1.45		1.57		1.49		1.54		1.64	
									1.35		1.50		1.61	
Avg. IR for dripper discharges							1.31	1.52					1.47	1.64
													1.39	1.58

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إدارة امتصاص المياه لبعض محاصيل الخضر المنزرعة في ظروف الزراعات المائية

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يهدف هذا البحث إلى دراسة تأثير تحسين دورة الرى وامتصاص المياه ونظام الزراعة وأزمنة الري ومعدلات تصرف النقاطات المختلفة على ترشيد استهلاك مياه الرى ورفع كفاءة استخدام كل من محصولى الطماطم والفلفل الحلو للمياه تحت ظروف الزراعة اللاأرضية والري بالتنقيط في الصوب البلاستيكية المزدوجة بمحافظة شمال سيناء.

لذلك أقيمت تجربة فى صوبة بلاستيك مزدوجة من خلال تصميم قطع منشقة مرتين خلال موسم ٢٠٠٣ / ٢٠٠٤ بمزرعة محطة بحوث الشيخ زويد بشمال سيناء وتضمنت التجارب نظامين للزراعات اللاأرضية فى الأحواض ذات الميول (نظام الأخاديد ، ونظام المخدات) & ثلاثة أزمنة رى يوميا (١٢ ساعة مستمرة & ٨ ساعات مستمرة & ٤ ساعات مرتين) بمعدل دورة رى ١٠ دقائق/ساعة & معدلى تصرف نقاط (٨ ، ٤ لتر/ساعة) & أربعة مكررات. حللت النتائج إحصائيا وأوضحت:

زيادة معنوية لكل من عدد الثمار ووزن محصول النبات للمحصول المبكر والمحصول الكلي وكفاءة استخدام المحصول للمياه ومعامل الاستثمار ، ونقص معنوى للاستهلاك المائي لكل من الطماطم والفلفل الحلو بالزراعة فى المخدات أكبر من الأخاديد ، وبنقص كل من زمن الري وتصرف النقاطات. وكانت الفروق معنوية بين المعاملات والتفاعل بينهم على كل الصفات المدروسة.

أوصت النتائج أنه لزيادة المحصول وكفاءة استخدام المحصول للمياه ومعامل الاستثمار وترشيد مياه الري لكل من الطماطم والفلفل الحلو يوصى بالزراعة فى المخدات المملوءة ببيئة البيتموس تحت ظروف الزراعة اللاأرضية والري بالتنقيط في الصوب البلاستيكية المزدوجة بالرى يوميا بزمن رى ٤ ساعات مرتين يوميا بنقاط تصرفه ٤ لتر/ ساعة تحت الظروف المشابهة لمنطقة الدراسة. هذه التقنيات أدت الى تحسين دورة الرى وامتصاص المياه والمغذيات ورشدت استخدام مياه الري بحوالى (٢٦,٥ & ٢٩,٣ %) مقارنة للنظام المتبع ككنترول لكل من الطماطم والفلفل الحلو على الترتيب. وتوصى الدراسة بمزيد من الأبحاث حول الحالة الغذائية فى كل من المحاليل المغذية والنبات النامى لضمان ضبط عملية الرى مع التسميد كما هى مطبقة فى هذه النظم.