TRYING A FERTIGATION PROGRAM FOR BEAN USING EXPERT SYSTEM

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ABSTRACT

The objective of this study is to design a fertigation program for bean (Phaseolus vulgaris L.) using the expert system (ES).To achieve the objective of this study, the following steps were required: i. identification of the problem ii. analysis of the information iii. characterizing the variables of the key factors and qualifiers. The study involved also a comparison between the ES program outputs and the corresponding ones recommended by the Ministry of Agriculture. To establish such a comparative study, a field experiment was executed on bean plant after dividing the filed of study into two sections. In the first, the experimental work was carried out using the ES fertigation management, while in the second section, the well known "CROPWAT Program", was used for the scheduling of the irrigation together with the traditional methods of fertigation outlined by the Ministry of Agriculture, Egypt. The results of comparison assured the superiority of the ES over the other traditional one, where higher values of water use efficiency "WUE" and nutrient use efficiency "NUE" were achived by the former than the latter.

Keywords: expert system, fertigation, irrigation, scheduling, WUE, NUE.

INTRODUCTION

Fertigation is a technique of fertilizer application through the water of irrigation. With the use of modern water saving irrigation systems such as drip and sprinkler systems, fertigation will be a promising technique. There are some advantages of fertigation which include easy application, use in adverse factors, low hazards, conservation of proper soil structure, possible control of pests and weeds and decreasing the adverse effect of salinity. However, the disadvantages of this system include increases in capital expenditure, incidents of orifices clogging, incidents of salinity build-up and need for technical handling **(Charles, 2007).**

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The agricultural sector in Egypt consumes about more than 81 percent from total available water and about 1.25 million tons of fertilizer annually **(FAO, 2005).** This problem forces the scientists to find out a new technique to overcome reasons of such problem. One of these techniques is using the fertigation system to increase the efficiency of both fertilization and irrigation.

The expert system (ES) is a computer program designed to simulate the problem solving behavior of an expert in a narrow domain or discipline **(Rafea, 1998).** The advantages of ES programs are minimizing or avoiding errors in complex tasks, protecting the perishable knowledge of experts and make it available and where required, systematically considering all possible alternatives, displaying unbiased judgment, available for use unlike human experts and less expensive to consult than human experts **(Kabany, 2003, Awady, 2010 and Dent et al., 1989).**

There are several problems associated with using the fertigation in terms of its management, these are lack in the efficiency of fertilizer and water management in the combined system of fertigation, fail in the finding of the best source of nutrients, optimum rates of fertilization, optimum rates of water, suitable timing, proper fertilizer placement and there is no particular system available to control fertigation technique under different conditions (**Charles, 2007).**

The objective of this research is to design an expert system to provide farmers by the sound decisions on the management of irrigation and fertilization (fertigation). There are also some specific objectives of this study which can be summarized in the following:

1 - Improving the efficiency of fertilizer and water use.

2 - Finding best sources of nutrients, optimum rates of fertilization, optimum water requirement, suitable timing and proper of fertilizer placement.

MATRIALS AND METHODS

To design the fertigation expert system program, we used the following materials:

- Microsoft visual C#.net 2005
- Microsoft Access 2003
- Pc. Pentium 4.

1. Building the expert system

The following steps were conducted for designing the expert system:

a. Identification of the problem

The problem of this study is to find out a new technique for solving the problems associated with fertigation system.

b. Conceptualization

This process involves the information analysis and identifying the decision making process and activities related to the application priorities of fertigation under different farm systems.

c. Formulation

Formulation involves characterizing the variables; the key factors and qualifiers for fertigation technique under diverse farm situation and conditions. Also, this procedure involves the representation of the variables; key factors and qualifiers into the production rules that make it usable within the development environment of the construction of the expert system rule-based program. Easiest and best ways to represent knowledge and data analysis is the development of knowledge and data as rules.

d. Implementation

We designed a computer program to represent and analyses fertigation data by using Visual C#.net language.

e. Verification:

We compared the program ES output with the well-known “CROPWAT Program” used for the scheduling of the irrigation together with the traditional methods of fertigation outlined by the Ministry of Agriculture, Egypt.

f. Validation of the expert system:

We used fertigation program to manage the experimental management on bean in the Farm of the Faculty of Agriculture at Moshtohor.

Inference Knowledge

The design of inference knowledge consists of two main parts namely: inference structure and inference specification. The following paragraphs explain them.

Inference Structure

As shown in the following the inference structure includes six inference steps. The objective of the expand inference is to use known data to derive new ones using a set of relations that forms the expansion model. The goal of Et0 irrigation schedule is to use the evapotranspiration (Et0) model. The goal of EtCrop is to use the model to generate an EtCrop. The goal of Water requirement is to generate a Water requirement more details.the goal of fertilization model is to get the results of concentration of fertilizer in irrigation water.

2. Input data of the expert system

a. Soil data

Soil texture is clay loam, soil test type is Colwell P (mg/kg), soil type is medium, critical phosphorus is 35 mg.kg^{-1}, critical potash is 130 mg.kg^{-1}, critical sulfate is 7.5 mg.kg^{-1}, soil field capacity is 36.8 %, soil weilting point is 17.4%, bulk denisity is 1.4, EC is 1.7 dS m^{-1}, pH is 8.05, calcium carbonate is 10 %, depletion ratio is 50 %, soil nitrogen content is 0.11 mg.kg^{-1}, soil phosphorus content is 41.1 mg.kg^{-1}, soil potash content is 389.7 mg.kg^{-1} and C/N ratio is 37.2/1.

b. Climate data

The climate data of Kaliobia Governorate are shown in Table (1).

Table (1): Climate data of Kaliobia Governorate, average values for the period extending form 1997 until 2006

Month	Extra radiation	Mean relative humidity	Mean daily actual sun-shine hours	Mean daily max. Sunshine hours	Max. temp.	Min. temp.	Average temp.
1	8	60.58	12	8	19.7	8.9	12.35
2	9	59.02	12	8	20	8.5	13.1
3	13	61.60	12	9	22.8	10	15.25
4	15	57.96	12	8	28.3	13.6	18.85
5	16	52.37	10	8	33	17.1	23.05
6	17	56.02	10	9	32.9	19.7	25.6
7	17	59.81	10	9	35	22	26.85
8	16	62.72	10	9	35.2	22.2	26.85
9	14	57.17	10	7	32.6	20.2	24.9
10	12	56.24	10	7	30.4	18.5	22.75
11	10	55.01	11	8	25.7	14	19.35
12	8	58.70	11	8	21.2	11.1	15.1

c. Water data

Water source was analysed and the results of analyses are presented in Table (2):

Table (2): The properties of the used irrigation water

Property	Unit	Value
Electrical conductivity	dS/m	1.5
pH		7.3
Total Nitrogen	%	0.001
Na^{+}	$mg.L^{-1}$	219
Cl^{-}	$mg.L^{-1}$	418
Mg^{2+}	$mg.L^{-1}$	0.48

d. Fertilizer data

For the bean crop, the following fertilizers were used

Table (3): The fertizers used for the bean crop

Fertilizer	State	N%	P_2O_5 %	K_2O %	S %
Ammonium nitrate	Solid	34	0	0	0
Phosphoric acid	liquid	0	85	0	0
Potassium sulfate	Solid	0	0	50	18

e. Crop data

The bean crop data were: Crop name = bean, Plant age = 110 days, Plant height = 40 cm, Root depth = 60 cm, Intial stage = 20 days, Develpement stage = 30 days, Middle stage = 40 days, Late stage = 20 days, Depletion = 45 %, Nitrogen requirement = 40 kg / fed., P_2O_5 requirement = 48 kg / fed., K_2O requirement = 48 kg / fed., Kc_{intial}= 40, Kc_{mid} =115 and Kc_{late}= 35.

f. Irrigation system data

Three irrigation systems (sub-drip irrigation, drip irrigation and furrow irrigation) were used. The pump discharge was 5 m^3/h.

- Data of the drip irrigation system and sub drip irrigation system:

Injection device type = Differential Tank, Pump discharge = 5 m^3 / h, Efficiency = 90 %, wilting area = 35% and volume of fertilizer tank = 0.4 m^3

- Data of the surface irrigation (Furrow irrigation):

Injection device type = Differential tank, Pump discharge = 5 m^3 / h, Efficiency = 60 %, Wilting area = 100% and Volume of fertilizer tank = 0.4 m^3

g. Data of crop tolerance

EC_e 100% = 1, EC_e 90% = 1.5, EC_e 75% = 2.2, EC_e 50% = 3.9, EC_e 0 % = 6.3, EC_w 100% = 0.7, EC_w 90% = 1, EC_w 75 % = 1.5, EC_w 50% = 2.4, EC_w 0%= 4.2.

h. Farm data

Field study was applied in the Farm of the Faculty of Agriculture, Moshtohor, Tokh, Kaliobia, Egypt from March1, 2009 to June 19, 2009. The input farm data were area = 225 m^2, farm latitude = $30^0\ 21^{\backslash}21^{\backslash\backslash}$, farm longitude =$31^0\ 13^{\backslash}\ 8^{\backslash\backslash}$, previous crop = other, crop type = summer crop, used pre-fertilization = no, calcium carbonate >= 10 %, Manure use = no, farm type = open field and pump discharge = 5 m^3/h.

<u>3- Measurements</u>

The following parameters were determined under field and laboratory conditions. The farm was divided into six plots to study the effects of expert system management on the WUE and NUE for bean crop.

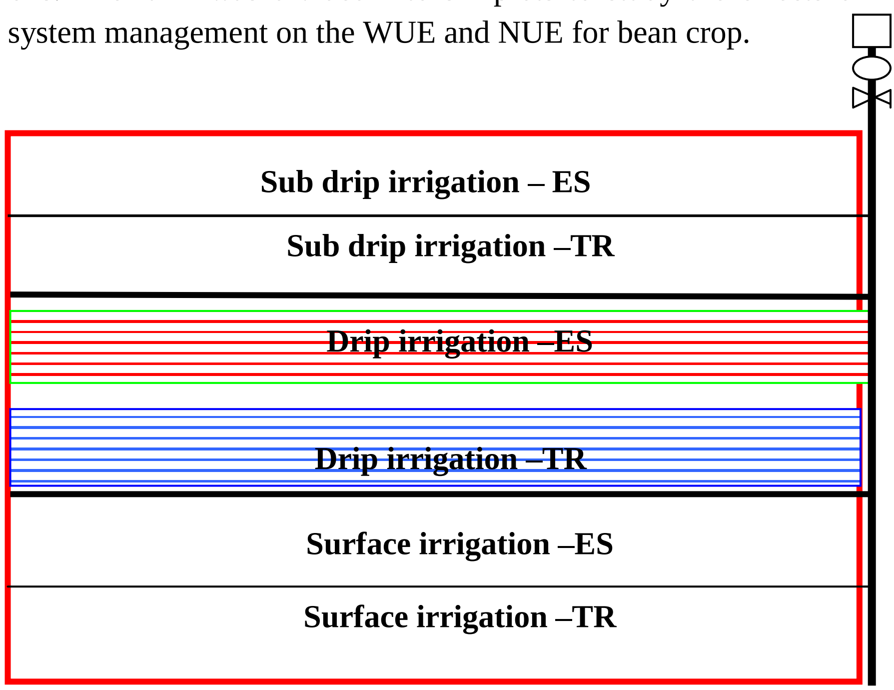

Fig (1): Layout of the experimental plots.

3.1 Crop biological properties

Each experimental plot consisted of 9 lines and was represented by 12 random locations. Plant growth parameters were measured in each of the chosen locations. The investigated growth parameters were plant hight, root depth, plant weight, number of leaves, chlorophell percentage by chlorophell meter and stem weight

3.2 Crop chemical properties:

After measuring the biological properties, plant leaves were dried and analysed for O.C %, O.M %, Ash %, T.N % and C/N ratio.

RESULTS AND DISCUSSION

3-1 The “OA-Fertigation” program

The new software program, designed for fertigation in different locations depending on the expert system “ES”, was given the name “OA-Fertigation Program”,. This system consists of user interface, concepts, data bases and rules (**Farag, 2011**).

3-1-1 The userinterface

This consists of menu bar comprising three menus. The first one is start menu: consisting of three orders (open database, run and fertilizer selection). The second menu bar consists of several orders i.e. (climate database, soil database, water database, farm database, fertilizer database, manure database, crop database and irrigation system database) and the third menu is information about the program, as shown in Fig. (2).

Fig (2): The program user interface.

3-2 Outputs of OA-Fertigation program and CROPWAT program

3-2-1 Calculation of Eto in Kaliobia governorate according to different methods

Table (4) shows the evapotanspiration reference (Et_o) calculated by OA-Fertigation program, CROPWAT and CLAC.

Table (4): Comparison between Et_o calculation from CROPWAT model and irrigation model

Month	Et_o Model BM *	Et_o HG**	Et_o CROPWAT***	From CLAC****
1	1.537	1.86	1.91	1.5
2	1.764	2.71	2.33	2.1
3	2.583	3.74	3.25	3.38
4	3.747	5.01	4.85	3.2
5	4.43	6.05	6.52	4.6
6	4.969	6.33	6.78	6.7
7	4.97	6.34	6.6	6.2
8	4.646	5.98	6.21	5.9
9	4.112	4.91	5.1	4.9
10	3.375	3.89	4.1	3.7
11	2.642	2.88	2.81	3.2
12	1.604	1.90	1.96	1.2

*Evapotranspriation calculated by OA-Fertigation program according to the equation of Penmann Montieth for open field and low tunnel.

** Evapotranspriation calculated by OA-Fertigation program according to the equation of Hargrivis for high tunnel.

*** Evapotranspriation calculated by "CROPWAT program".

**** Evapotranspriation measuerd by Center Laboratory of Agricultural Climate (CLAC).

3-2-2 Water requirement

Table (5-a) shows the data required for irrigatin scheduling as outputs of the "CROPWAT" program under drip and sub-drip irrigation systems.

Table (5-a): Water requirement for bean under drip and sub-drip irrigation systems from the "CROPWAT program"

Date	Day	Stage	Depl	dn	dg	T	II
			%	mm	mm	(min)	days
5-Mar	1	Init	57	16.8	18.7	50	-
12-Mar	8	Init	51	18.3	20.4	55	7
20-Mar	16	Init	50	22	24.5	66	8
28-Mar	24	Dev	54	27.5	30.6	83	8
4-Apr	31	Dev	57	32.8	36.4	98	7
10-Apr	37	Dev	53	33.7	37.4	101	6
14-Apr	41	Dev	48	32.6	36.2	98	4
19-Apr	46	Dev	56	40.7	45.2	122	5
23-Apr	50	Dev	50	38.3	42.5	115	4
27-Apr	54	Mid	51	38.9	43.2	117	4
1-May	58	Mid	52	39.6	44	119	4
5-May	62	Mid	55	41.9	46.5	126	4
9-May	66	Mid	55	41.9	46.5	126	4
13-May	70	Mid	58	43.8	48.6	131	4
17-May	74	Mid	58	44.4	49.3	133	4
21-May	78	Mid	59	44.5	49.5	134	4
25-May	82	Mid	59	45	50	135	4
29-May	86	Mid	59	45	50	135	4
2-Jun	90	Mid	56	42.5	47.2	127	4
6-Jun	94	End	53	39.9	44.3	120	4
10-Jun	98	End	53	39.9	44.3	120	4
17-Jun	105	End	56	42.5	47.2	127	7
22-Jun	End	End	29				
Total					**902.5**		
3790.5 m^3 / f							

- * Irrigation intervals
- ******Irrigation of net water requirement depth
- *******Irrigation of growth water requirement depth

Table (5-b) shows the data required for irrigatin scheduling as outputs of the “CROPWAT” program under furrow irrigation

Table (5-b): Water requirement for bean under furrow irrigation system from CROPWAT program

Date	Day	Stage	Depl	dn	dg	Tn	Tco	II
			%	mm	mm	min		
5-Mar	1	Init	57	16.8	28	8.4	15	-
12-Mar	8	Init	51	18.3	30.6	9.18	16	7
20-Mar	16	Init	50	22	36.7	11.01	18	8
28-Mar	24	Dev	54	27.5	45.9	13.77	21	8
4-Apr	31	Dev	57	32.8	54.7	16.41	23	7
10-Apr	37	Dev	53	33.7	56.2	16.86	24	6
14-Apr	41	Dev	48	32.6	54.3	16.29	23	4
19-Apr	46	Dev	56	40.7	67.8	20.34	27	5
23-Apr	50	Dev	50	38.3	63.8	19.14	26	4
27-Apr	54	Mid	51	38.9	64.8	19.44	26	4
1-May	58	Mid	52	39.6	66.1	19.83	27	4
5-May	62	Mid	55	41.9	69.8	20.94	28	4
9-May	66	Mid	55	41.9	69.8	20.94	28	4
13-May	70	Mid	58	43.8	72.9	21.87	29	4
17-May	74	Mid	58	44.4	74	22.2	29	4
21-May	78	Mid	59	44.5	74.2	22.26	29	4
25-May	82	Mid	59	45	75	22.5	30	4
29-May	86	Mid	59	45	75	22.5	30	4
2-Jun	90	Mid	56	42.5	70.8	21.24	28	4
6-Jun	94	End	53	39.9	66.5	19.95	27	4
10-Jun	98	End	53	39.9	66.5	19.95	27	4
17-Jun	105	End	56	42.5	70.8	21.24	28	7
22-Jun	End	End	29					
Total					**1354.2**		**5687.64 m^3 / f**	

See footnotes of Table (5-a)

Table (6-a) shows the data required for irrigatin scheduling as outputs of the "OA-Fertigation" program under drip and sub drip irrigation systems.

Table (6-a): Water requirement for bean under drip and sub drip irrigation systems as outputs of OA-Fertigation program

Irrigation date	Root depth (cm)	Etc (mm)	dn (cm)	dg (cm)	Irrigation time (min)	WR**	II*
3/5/2010	15	0.73	0.77	0.96	26	2.17	-
3/16/2010	15	0.73	0.77	0.96	26	2.17	11
3/27/2010	18.88	1.73	0.97	1.21	33	2.75	11
4/2/2010	26.23	2.28	1.35	1.68	45	3.75	6
4/8/2010	32.83	2.83	1.69	2.1	57	4.75	6
4/14/2010	37.8	3.38	1.94	2.41	65	5.42	6
4/20/2010	40	3.93	2.05	2.56	69	5.75	6
4/25/2010	40	5.71	2.05	2.56	69	5.75	5
4/29/2010	40	5.71	2.05	2.56	69	5.75	4
5/3/2010	40	5.71	2.05	2.56	69	5.75	4
5/7/2010	40	5.71	2.05	2.56	69	5.75	4
5/11/2010	40	5.71	2.05	2.56	69	5.75	4
5/15/2010	40	5.71	2.05	2.56	69	5.75	4
5/19/2010	40	5.71	2.05	2.56	69	5.75	4
5/23/2010	40	5.71	2.05	2.56	69	5.75	4
5/27/2010	40	5.71	2.05	2.56	69	5.75	4
5/31/2010	40	5.71	2.05	2.56	69	5.75	4
6/4/2010	40	5.32	2.05	2.56	69	5.75	4
6/8/2010	40	4.52	2.05	2.56	69	5.75	4
6/13/2010	40	3.53	2.05	2.56	69	5.75	5
6/19/2010	40	2.34	2.05	2.56	69	5.75	-
Total						**107.26**	
2002.2 m^3 / f							

- * Irrigation intervals, days.
- ** Water requirement, m^3/225 m^2/II.

Table (6-b) shows the data required for irrigatin scheduling as outputs of the "OA-Fertigation" program under furrow irrigation.

Table (6-b): Water requirement for bean under furrow irrigation systems as outputs of the "OA-Fertigation" program.

Irrigation date	Root depth (cm)	Etc (mm)	dn (cm)	dg (cm)	Irrigation time (min)	WR	II
3/5/2010	15	1.03	2.2	4.26	14	1.17	-
3/26/2010	17.65	1.69	2.59	5.01	15	1.25	21
4/10/2010	34.7	3.09	5.09	9.85	22	1.83	15
4/26/2010	40	5.71	5.87	11.35	25	2.08	16
5/6/2010	40	5.71	5.87	11.35	25	2.08	10
5/16/2010	40	5.71	5.87	11.35	25	2.08	10
5/26/2010	40	5.71	5.87	11.35	25	2.08	10
6/5/2010	40	5.12	5.87	11.35	25	2.08	10
6/16/2010	40	2.93	5.87	11.35	25	2.08	-
Total					**16.73**	**2810.64 m^3 / f**	

<u>3-2-3 Nutrient requirements:</u>

Table (7): Fertilizer requirements for bean under drip and sub drip irrigation system (ppm) as outputs of OA-Fertigation program and the traditional method.

Stage	Ammonium nitrate (ppm)		Phosphoric acid(ppm)		Potassium sulfate(ppm)	
	ES	**TR**	**ES**	**TR**	**ES**	**TR**
S1	65	161	44	120	0	200
S2	84	250	36	100	0	230
S3	57	170	29	80	0	300
Tank	**A or B**		**A**		**A or B**	

- S1= From beginning of seedling emergence up to beginning of flowering
- S2= From beginning of flowering up to beginning of harvesting
- S3= From beginning of harvesting up to one week before end of harvesting

- TR=Traditional method (CROPWAT program was used for the scheduling of the irrigation together with the traditional methods of fertigation as outlined by the Ministry of Agriculture, Egypt).
- ES=OA-Fertigation program.

Table (8): Fertilizer requirements for bean under drip and sub drip irrigation (g / week) as outputs of OA-Fertigation program.

Stage	**Ammonium Nitrate (g /week)**		**Phosphoric acid (cm^3/ week)**		**Potassium sulfate (g / week)**	
	ES	**TR**	**ES**	**TR**	**ES**	**TR**
S1	445	2080	185	843	0	2584
S2	664	3231	155	702	0	2972
S3	510	2197	124	562	0	3877
Tank	**A or B**		**A**		**A or B**	

Table (9): Fertilizer requirements for bean under furrow irrigation (g / week) as outputs of OA-Fertigation program

Stage	**Ammonium Nitrate (g /week)**		**Phosphoric acid (cm^3 / week)**		**Potassium sulfate (g / week)**	
	ES	**TR**	**ES**	**TR**	**ES**	**TR**
S1	648	3122	342	1265	0	3878
S2	972	4847	288	1054	0	4460
S3	747	3296	225	843	0	5817
Tank	**A or B**		**A**		**A or B**	

3-3 Biological properties

Data presented in Table (10) illustrate values of the growth prarameters of the bean crop achieved by the designed fertigation system (ES) and Traditional fertigation system (TR).

Table (10): The biological properties for bean crop under the ES and TR systems

prameters	Units	Irrigation system					
		SD		DR		FR	
		ES	TR	ES	TR	ES	TR
Plant Height	cm	32.8	31.8	30.7	27.5	37.2	34.1
Root mass	g	1.7	1.4	1.3	1.1	1.9	1.3
Root depth	cm	23.9	22.9	20.5	18.2	26.9	25.7
Plant mass	g	31.5	30.2	25.8	22.3	60.7	36.3
Chlorophyll	%	47.7	46.4	45.8	41.1	41.9	41
Stem mass	g	12.7	10.7	17.7	6.4	21.8	13.1
Number of leaves	-	13	12	11	10	18	13

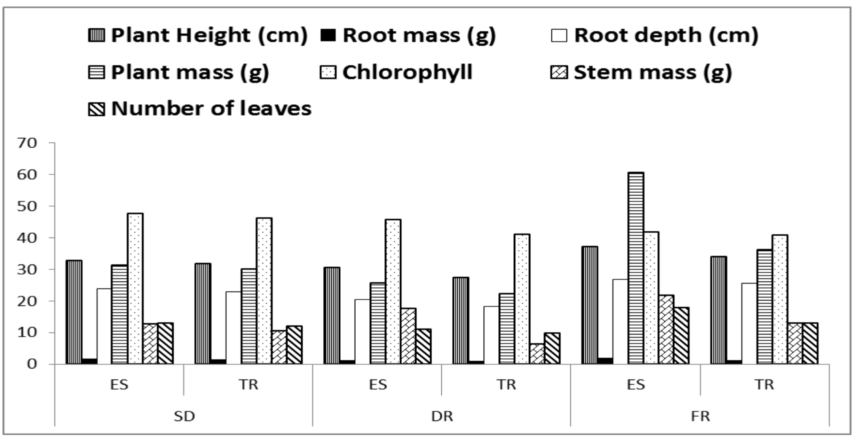

Fig (3): The biological properties for bean crop under the ES and TR systems.

- SD= sub drip irrigation
- DR=drip irrigation
- FR=furrow irrigation

It is obvions from Tables (10, 11, 12 and 13) and Fig. (3) That values of all the studied growth parameters, yield and its components achiveved due to the fertigation management according to the OA-Fertigation program were obviously higher than the corresponding ones from the traditional fertigation system. Such a finding indicates the superiority of the “OA-Fertigation” program as a tool, which means more accurate and fast knowledge for better management of irrigation and fertilization.

3-4 Chemical properties

3.4.1 Plant analysis

We have taken 12 plants from each replicate, and the chemical analyses are as shown in Table (11).

Table (11): Bean crop analysis

Irrigation systems	Fertigation system	O.C %	O.M %	Ash %	T.N %	C/N Ratio
Sub Drip Irrigation	ES	45.8	79	21	5.38	8.5
	TR	47	81	19	5.4	8.8
Drip Irrigation	ES	47.1	81.3	18.8	5.21	9
	TR	47.3	81.5	18.5	4.76	9.9
Furrow Irrigation	ES	49	84	16	5.6	8.7
	TR	47.7	82.2	17.8	5.04	9.5

<u>3-5 Mass of 100 seeds</u>

Data presented in Table (12) illustrate values of 100 seed mass of bean.

Table (12): Mass of 100 seeds

Mass of 100 seeds (g)					
Irrigation systems	Fertigation system	R1	R2	R3	Mean
Sub Drip Irrigation	ES	37	36	38	37
	TR	33	32	34	33
Drip Irrigation	ES	39	40	38	39
	TR	38	37	36	38
Furrow Irrigation	ES	43	41	42	43
	TR	42	40	41	42

3-6 Seed dry-yield

Data presented in Table (13) illustrate values of seed dry-yield of bean.

Table (13): Seed dry-yield

Seed dry-yield (kg / f)					
Irrigation systems	**Fertigation system**	**R1**	**R2**	**R3**	**Mean**
Sub Drip Irrigation	**ES**	1857.1	1764.3	1860.9	1827.4
	TR	1095.7	797.3	1690.0	1194.3
Drip Irrigation	**ES**	1329.7	1300.0	1314.9	1314.9
	TR	1113.0	1105.6	1109.3	1109.3
Furrow Irrigation	**ES**	2864	2805	2923	2864.0
	TR	2564	2500	2628	2564.0

3-7 Water Use Efficiency (WUE) and Nutrient Use Efficiency (NUE)

Data in Table (14) reveal that values of. WUE, as well as those of NUE, under the “OA-Fertigation” program were higher than the corresponding ones achieved under the traditional method. Accordingly, we can deduce that the “OA-Fertigation” program resulted in higher yield of bean crop than the traditional method and, at the same time, could provide better management for both irrigation and fertilization as noticed from the values of both WUE and NUE.

Table (14): WUE and NUE for bean crop

Irrigation systems	**Fertigation system**	**Bean**	
		WUE Kg. m^{-3}	**NUE Kg. Kg^{-1}**
Sub Drip Irrigation	**ES**	0.91	13.4
	TR	0.32	8.8
Drip Irrigation	**ES**	0.66	9.7
	TR	0.29	8.2
Furrow Irrigation	**ES**	1.02	21.1
	TR	0.45	18.9

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الملخص العربي

تجربة برنامج رسمدة للفاصوليا بإستخدام نظام خبير

أبوسريع أحمد حسن[١] منتصر عبد الله عواد[٢] محمد تهامي عفيفي [٣]

الرسمدة هي إضافة الماء والسماد متزامنين في شبكة الري ، ويوجد للرسمدة مزايا عديدة.
الهدف الرئيس من البحث هو تصميم نظام خبير يمد المزارعين بالقرارات الصائبة في مجال إدارة الري والتسميد (الرسمدة)
وهناك بعض الأهداف الفرعية التي سوف تتحقق من تحقيق الهدف الرئيس وهي كتالي:
١- تحسين كفاءة إستخدام الماء والسماد.
٢- إيجاد أنسب مصدر سمادي، المعدل المناسب من إضافة الأسمدة ، المعدل المناسب من الإحتياجات المائية، زمن الري المناسب و المكان المناسب لإضافة السماد.

المواد والطرق:

لتحقيق الأهداف السابقة تم إجراء الخطوات التالية:
أ-بناء النظام:
a. المواد المستخدمة في بناء النظام:
i. جهاز كمبيوتر بنتيوم ٤
ii. ميكروسوفت فيجول سي شارب دوت نت ٢٠٠٥
iii. ميكروسوفت أكسس ٢٠٠٣

١- مدرس مساعد - قسم الهندسة الزراعية – كلية الزراعة بمشتهر ٢- أستاذ مساعد الهندسة الزراعية – قسم الهندسة الزراعية – كلية الزراعة بمشتهر ٣- مدرس – قسم الهندسة الزراعية – كلية الزراعة بمشتهر

b. الطرق المتبعة لبناء النظام:

i. تعريف المشكلة:

المشكلة التي يدرسها هذا البحث هي إيجاد تقنية جديده تستخدم في حل المشاكل المتعلقة بإدارة الرسمدة.

عمل برنامج كمبيوتر يستطيع أن يحلل ويمثل البيانات وذلك إعتمادا علي لغة البرمجة فيجول سي شارب دوت نت. تم عمل مقارنة بين مخرجات البرنامج وبعض آراء الخبراء في مجال الرسمدة ، وذلك من خلال مقانة مخرجات البرنامج

مع طرق مختلفة لحساب البخر نت و برنامج CROPWAT والمتخصص في جدولة الري ، ونشرة إرشادية خاصة بالرسمدة .

تم إجراء تطبيق حقلي للبرنامج علي محصول الفاصوليا في مزرعة كلية الزراعة بمشتهر.

ب- مدخلات النظام:

بيانات التربة - بيانات المناخ - بيانات الماء - بيانات الأسمدة - بيانات المحصول- بيانات نظام الري - بيانات تحمل المحصول للملوحة - بيانات المزرعة

ت- القياسات :

تم تقسيم التجربة إلي ست قطاعات ، القطعة الأولي والثانية بها نظام الري بالتنقيط تحت السطحي ، القطعة الثالثة والرابعة بها نظام الري بالتنقيط ، والقطعة الخامسة والسادسة بها نظام الري السطحي في خطوط. أبعاد القطعة ٢٥ × ٩ متر ، تم تطبيق النظام الخبير علي القطع الأولي، الثالثة والرابعة ، والقطع الآخرى تم تطبيق الطريقة التقليدية في باقي القطع.

a. الخواص البيلوجية للمحصول:

كل قطعة تجريبية تتكون من ٩ خطوط ، تم أخذ ١٢ عينة نباتية من كل قطعة تجريبية بطريقة عشوائية، وذلك لقياس طول النبات، وعمق الجذر ، وزن النبات، عدد الأوراق، نسبة الكلوروفيل، وزن الساق.

b. الخواص الكميائية للمحصول:

بعد إجراء الإختبارات البيلوجية علي النبات تم إجراء تجفيف لأوراق كل قطعة علي حدة تجفيف هوائي، وبعد التجفيف تم عمل تحليل للأوراق لتقدير المادة العضوية، الكربون العضوي ، ونسبة العناصر المعدنية، والتركيز الكلي للنيتروجين، ونسبة الكربون إلي النيتروجين.

أوضحت أهم النتائج ما يلي :

١- تفوق النظام الخبير في سرعة وسهولة إستخدامعه عن الطريقة التقليدية.

٢- أوضحت دراسة الخواص البيولوجية والكيميائية تفوق النظام الخبير عن الطريقة التقليدية.

٣- زيادة إنتاج المحصول تحت النظام الخبير عنه للطريقة التقليدية تحت نظم الري الثلاثة (الري بالتنقيط تحت السطحي، الري بالتنقيط ، الري السطحي في خطوط).

٤- زيادة وزن ١٠٠حابة تحت النظام الخبير عنه تحت الطريقة التقليدية.

٥- زيادة كفاءة إستخدام المياه و السماد تحت النظام الخبير عنه في حالة الطريقة التقليدية.