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EFFECT OF LAND LEVELLING ON MAIZE CROP UNDER PERFORATED IRRIGATION PIPES IN OLD LAND

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ABSTRACT

The experimental fieldwork was conducted during the growing seasons 2000 and 2001 at Sids- Beni Sueif Governorate in silty clay soil. The experiment studied the effect of land leveling (0.0, 0.05 and 0.1% slope) (T1, T2 and T3) respectively using laser technique under perforated pipes for conveying and distributing irrigation water on maize yield, advance time, recession time, opportunity time and water use efficiency compared with traditional irrigation method at zero level (T4). Different soil slopes with the same discharge of perforated pipe (1.5 l/s /orifice / furrow) were compared with traditional irrigation on maize crop. The results showed that, the average measured orifices discharge rate was equivalent 98% from the recommended discharge rate per each furrow, the perforated pipes have a positive effect on increasing agricultural production by increasing yield per unit area and through saving water in order to irrigate more area. The water applied through perforated pipe decreased with percentage (9.38 %, 16.03 % and 21.35%) and (12.50 %, 19.07 % and 25 %) under different treatments (T1, T2 and T3) respectively compared with traditional irrigation (T4) in two seasons 2000 and 2001. The total water advance time, water recession time and infiltration opportunity time decreased with ratios (40.98 %, 58.3 % and 67.6 %), (17.68 %, 24.5 % and 29.7) and (11.09 %, 114.8 % and 18.7) under different treatments (T1, T2 and T3) respectively, compared with traditional irrigation method (T4). The crop grain yield increased with percentages (8.3 %, 18.85% and 22.04%) and (8.75%, 18.44 % and 21.25 %) respectively compared with traditional irrigation in two seasons 2000 and 2001. The water use efficiency for crop grain yield increased with percentages 19.13%, 41.74% and 55.65%) and (22.32%, 46.43% and 61.61%) respectively compared with traditional irrigation in two seasons 2000and 2001. So it is better to improve surface irrigation in old lands especially in maize crop through perforated pipe under discharge 1.5 L/s/orifice/furrow with slope 0.1% to improve the pervious parameters.

Keywords:
Perforated pipes, precision land leveling, surface irrigation, water advance time, recession time, infiltration opportunity time, maize grain yield and water use efficiency.

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INTRODUCTION

Surface irrigation is the oldest most used method of irrigation in Egypt, at least from 4000 years ago .In surface irrigation, basin, border, or furrows are the primary methods of applying water, and the field has to be cut into rather narrow strips by numerous field ditches to convey water from the source to fields. These results in field land and loss of up to 10 percent **(Hanna and El Awady, 1970)** if equipment have to run between ditches. Moreover, the ditches have to be rebuilt for practically every irrigation to allow for forming operation. It is necessary to save water for the new land by minimizing water loss of traditional surface irrigation methods.

The overall irrigation efficiency is a function of a number of efficiencies as application, conveyance, and distribution efficiency. An increase of one efficiency may increase the overall irrigation efficiency. The perforated pipes are convenient means of distributing water to surface irrigated crops. **Hassan (1998)** reported that surface irrigation has low irrigation efficiency to maximum 50 percent, because a great amount of water runs through seepage, deep percolation, and evaporation waste canal. In addition, the farmer does not recognize measuring or controlling the amount of water application to the field but leaves water flow through a field until reaching to the drain in the tail of the field. Also, in many cases, yields actually decrease when excessive water is applied. Generally, surface irrigation system entails one or more of the following shortcomings: very low water uses efficiency, low net land and very high labor requirement.

Krinner and Estrada (1994) reported that the factors influencing the conveyance and global efficiency are irrigation method (gravity or pressure), ages of irrigation system, annual gross supply, amount of water charge, and potential evapo-transpiration. He found that an automatic surface irrigation system with gated pipe and with a re-use system can be a very efficient method of applying irrigation " 91.9 percent water application efficiency". **Sakla (1991)** concluded the factors affecting the water irrigation efficiency, are the irrigation method, soil type water irrigation depth, furrow width, soil texture, land preparation, soil type and the infiltration rate variability. **Omara (1997)** found that the irrigation application efficiency and irrigation distribution efficiency increased to 72.5 percent and 92 percent respectively by using gated pipe system through furrow irrigation. **Mc Clung et al. (1985)** found that land leveling using laser controlled equipment increased irrigation efficiency and yield in large level basin. **El-Yazel et al. (1985)** found that precision land leveling (controlled with laser equipment) saved 42% of the irrigation water compared with traditional leveling and increased onion production by 60%.

Osman (1988) reported that laser land leveling with spile and siphon irrigation systems in onion farm saved and controlled irrigation water. Yield per unit of water applied in a laser leveling was 13.2 kg onion per cubic meter of water compared with 3.28 kg onions per cubic meter of water in traditional leveling. **El- Sahrigi et.al. (1983)** Stated that land leveling using laser grade control equipment showed significant water saving and yield increased over the conventionally leveled land and reduced the average costs of production by 6.3 to 15.4 for wheat, beans, cotton and maize. **Kholeif et al. (1997)** showed that modern irrigation systems in sugarcane under Upper Egypt condition gave highest cane yield and quality.

Steynberg et al. (1989) demonstrated that maize plant was more sensitive to drought during the reproductive phase than during vegetative phase. **El-Mowelhi (1995)** reported that in Egypt maize consumed 17% of the yearly total amount of water required for the main field crops, while its cultivated area represented only 19% of the whole cropped area.

Hanna and Awady (1970) reiterated the furrow slopes reported by Israelsen and Hansen (1962) by the theoretical means. They range from 0.005 lower limit in loamy soil, and 0.15 as extreme slope in sandy soil. **Doorenbos and pruit (1976)** stated that land slopes should range between 0.05 and 0.2% depending on furrow stream size, longer border may require some land slopes to obtain efficient irrigation. **El-Saadawy and Abd- El Latif (1998)** studied the effect of land leveling under 0.10% slope and traditional methods on advance, infiltration rate, recession time and water use efficiency of clover yield in Egyptian old land. **Willardson and Bishop (1967)** also found that high water application efficiency could attained under a wide variety of intake and advance conditions. The faster advance rate increases the water application efficiency or net stored water.

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Jensen (1980) mentioned that for increasing the uniformity of application of water to their furrow irrigated crops, gated pipe was suggested especially to be helpful. Gated pipe can regulate of the size of stream flowing into the furrow. He also stated that the hydraulic characteristics of each outlet are directly related to the mode of fluid motion (flow regime) inside the orifice as characterized by the Reynolds number "Rn"

$$Rn = \frac{VD}{\upsilon} \quad \dots (1)$$

Where (V) fluid flow velocity, m/s, D is the orifice diameter, m and (v) is kinematics viscosity, m^2/s.

Morcos et al. (1994) proposed mathematical relationship relates the affecting factors with water distribution rates and uniformity for perforated tube. He also reported that the total friction head losses inside the perforated pipe and the superimposed pressure head are estimated by the following equations:

$$Q_n = \sum_{n=1}^{N} q_n \quad \dots\dots (2)$$

$$Vn = 0.001 . Q_n / A \quad \dots\dots (3)$$

$$h_{fn} = k \left(\frac{Qn}{CHw}\right)^{1.852} . \times D^{-4.87} \times s \quad \dots (4)$$

$$hft = \sum_{n=1}^{N} h_{fn} \text{ , m} \quad \dots\dots (5)$$

$$Hsn = (V^2_{max} - V^2_n) / 2 \quad \dots\dots (6)$$

$$Hcom = hp + Hsn - hft \quad \dots\dots (7)$$

Where:

Qn = the flow rate inside the perforated pipe just before any orifice, l/s,

qn =the actual measured orifice discharge rate, l/s,

D = inside perforated pipe diameter, mm,

x = the spacing between orifice along the perforated pipe, m,

CHw = Hazen William' s coefficient, dimensionless,

h_{fn} = the friction head losses inside the perforated pipe just before any orifice, m,

hft = total friction head losses inside the perforated pipe just before any orifice, m

V_n = the flow velocity inside the perforated pipe just before any orifice, m/s

A = the perforated pipe cross section area, m^2.

Hsn= The superimposed pressure head, m,

V_{max} = The maximum inside flow velocity at perforated pipe inlet, m/s,

V_n = The velocity of flow inside the perforated pipe just before any orifice, , m/s and

g = Gravitational field, m/s^2.

Hcom =The resultant pressure head, cm.

Heerman et al. (1990) said that the uniformity for surface irrigation system is more commonly characterized by a distribution uniformity, defined as the average depth infiltrated in the low one- quarter of the field divided by the average depth infiltrated over the entire field. **Morsi and Nor Eldin (1977)** mentioned that the losses of irrigation water from main canal until reaching to the field range from 10 - 20 % according to soil type and the spacing from field to the canal. Improving the water irrigation conveyance from source to the field increases water conveyance efficiency. **Jensen (1980)** defined that the uniformity distribution as: The expression of evaluating uniformity distribution through the variation of flow through orifices along the lateral line named as flow variation along the lateral line. The uniformity distribution increased as flow variation decreased.

$$q_{var} = \frac{q_{max} - q_{min}}{q_{max}} \quad \ldots (8)$$

In which

q_{var} = The orifice flow variation %,

q_{max} = The maximum orifice flow along the lateral line.

q_{min} = The minimum orifice flow along the lateral line.

Guirguis (1988) found that the best inflow rate required per furrow in surge flow cases 1.7 L/S to give high application efficiency at furrow spacing 0.85 m, furrow length of the 90 m and a slope of 0.10 percent. **Hassan (1990)** referred to the best flow rate per furrow in clay soil as 1.2 L/s at furrow length 100 m, and furrow spacing of 0.60 m or 2 l/s per one meter of width. Generally, using of perforated pipe system instead of ditches for conveying and distribution of the irrigation water over the entire field may improve the surface irrigation. Also, weed problems, loss of productive land, and loss of water by seepage are avoided.

MATERIALS AND METHODS

The field experimental work was conducted at the experimental research station of the Agricultural Research Center, Sids- Ben Suief Governorate during the growing season 2000- 2001. The main objective of this work was to study the effect of different land slopes 0.0, 0.05 and 0.1% as treatments (T1, T2 andT3) respectively using perforated piping system for conveying and distributing irrigation water on the yield of hybrid maize (323), and water use efficiency compared with traditional method (T4) in Egyptian old valley. To achieve these objectives, the following work was carried out :

1-The determination of the flow head inside the perforated pipe along its whole length to compute the suitable orifice diameters along the perforated pipes giving the flow rate required per each furrow and its calibration experimentally on the operating field condition.

2- Field experimental work to study the effect of land slope using perforated piping system for conveying and distributing irrigation water on the yield of hybrid maize (323), and water use efficiency in Egyptian old valley.

A perforated pipes system serving an area about 0.3 feddan, with a field length of about 100-meter, the width of this area was about 12 meter. A 0.75 meter spacing between the orifices of the perforated pipes, the number of the discharging orifices of perforated pipes were about 16 orifices. The flow rate recommended per meter width having 100 meter long in clay soil was about 2 l/s. Therefore the designed flow rate per each orifice was about 1.5 l/s. Thus the total flow rates required was about 24 l/s (86.4 m^3/h). Since the average flow velocity inside the pipes is about 1.5 m/s. Therefore the suitable inside diameter of perforated pipe computed by equation (3) is about 150 mm.

Thus six inches diameter, 6 meter length aluminum alloy pipes were used for the perforated pipe system. The specifications of these pipes are shown in table (1).

Table (1) The Specifications of the used pipes for the perforated pipes system.

No.	Item	Specifications
1	Pipe source	Helwan Co. for nonferrous industries.
2	Manufacturing	Longitudinal welding
3	Length	6.0 m
4	Outside diameter	154 mm
5	Inside diameter	150 mm
6	Metal thickness	1.2 mm
7	Pipe weight	9.38 Kg
8	Operating head	11 ATM
9	Explosion pressure	36 ATM
10	Operating pressure	263 N/mm
11	Maximum stress	273 N/mm
12	Equipped fittings	Quick coupler at one end

The calibration of the pumping unit was tested through water re-circulation system, in which the pumping unit received water from long lining canal, was constructed in the field. The pumping unit discharge rate was adjusted to be as close as possible to pumping discharge rate 87 m^3/h measured by 6 inches flow meter. The specifications of the pump and engines are shown in table (2).

Table (2): The specification of the pumping unit.

Type of pump	Type of Engine	Motor Power (Hp) /KW	Rpm	Max. discharge m3/h	Max. operating pressure Bar	Suction pipe Diameter Inch	Delivery pipe Diameter Inch
Centrifugal	Diesel	5.1/4.1	1450	90	1.0	6	5

The actual pressure head measured by the manometer at the perforated pipe inlet was about 0.75 meter. The determination of the flow head inside the perforated pipe along its whole length were carried out to compute the suitable orifices diameters along the perforated pipes giving the flow rate required per each furrow. The determination was be based on the actual flow rate and the actual pressure head measured from pumping unit. As a general assumption for determination, the flow rates from all the orifices along the perforated pipe are equal. The perforated pipes system designed for testing on the field were locally manufactured in the workshop of the Agricultural Research Station - Sids - Beni Suief Governorate. They were constructed of two pipes of 150 mm inside diameter. The system designed consists of 12 meter long of 150 mm inside diameter, pipe with closed end having 16 circular orifices of different diameters were drilled and was equipped with the required valves, flow meter, pressure gauge and peizometers. Measuring the orifice flow rate along the perforated pipes system under actual field operating condition tested the actual performance of the perforated pipes system. From the experimentally measured of pressure head, the discharge velocity of each outlet, and flow rate passing before any orifice, the friction losses, the superimposed pressure head were estimated from equation 2 through equation 7. Also the water uniformity distribution from orifices along the perforated pipe system was experimentally tested under the field condition using equation (8).

The experimental work divided into four plots. Each plot has 12m width and 100m length. It has sixteen furrows at 0.75 m spacing irrigated at the same time. The irrigation interval was fifteen days. Water meter measured the water applied. The layout of the experiments is shown in fig (1).

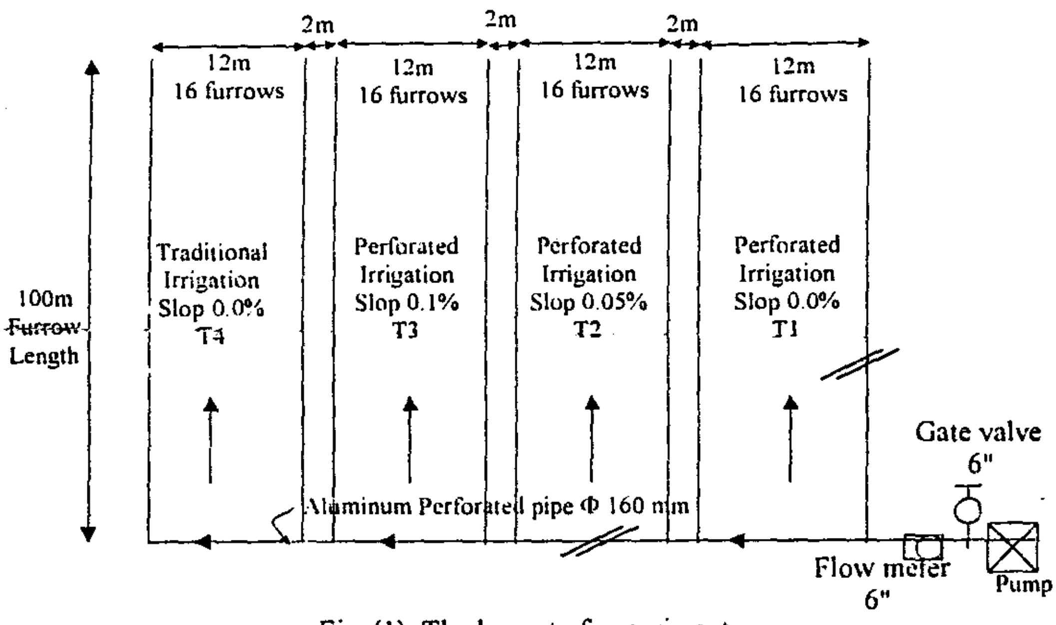

Fig. (1): The lay out of experiment

Maize crop was planted in first June in both tow seasons 2000and 2001until harvest In fifteenth September 2000 and 2001. The trial was harvested as the first and second yield crops respectively. Physical and mechanical analysis of the soil samples was determined by Soil and Water Research Institute, Agricultural Research Center, Giza, **According to Black et al 1965.** The soil samples were taken until depth 90 cm to calculate the physical and mechanical soil properties such as, field capacity, wilting point and density for each depth as shown in table (3).

Table (3): The physical and mechanical analysis of the soil.

Soil depth (cm)	soil type	Mechanical analysis %			Field capacity %	wilting point %	Density g/cm^3
		Silt	Clay	Sand			
0-15	Silty clay	50	31	19	30	14	1.11
15-30		52	30	18	31	13	1.12
30-45		51	30	19	29	14	1.10
45-90		50	33	17	31	13	1.11

RESULTS AND DISCUSSION

The results and discussion cover the following:

1-Theoretical determination of the suitable orifice diameters along the perforated pipes giving a required flow per each furrow and giving a uniformity distribution of flows discharging from the orifices along the perforated piping system. Comparing the experimentally measured orifices flow rate and those of the theoretically obtained results. 2-Study the effect of land slope using perforated piping system for conveying and distributing irrigation water on the yield of hybrid maize (323), and water use efficiency in Egyptian old valley.

The theoretical determination of the flow head inside the perforated pipe along its whole length based on the actual discharge rate and actual pressure head was experimentally measured from the pumping unit. The theoretical determination and calculation in predicting the flow pressure head at each orifice along the perforated piping system was carried out to estimate the expected suitable orifices diameter along the perforated pipes giving the discharge rate recommended per each furrows (1.5 L/s) by using step- step method proposed by **Morcos et.al. 1994.** Also the uniformity distribution was determined using eq. (8).The results of the theoretical computation of the orifices diameters along the perforated pipes and the orifices flow rates experimentally measured are shown in table (4).

Table (4): Expected perforating of the 12 meter length of inches perforated pipe based on the experimental 87 m^3/h and pumping unit discharge head of 75 cm of water.

No.	x	q.rec	Qn	Vn	RNn	Hft	Hsn	hexp	d.cop	q.m.	Hon
1	12.00	1.5	24.0	1.358	2.0E+5	1.164	0.300	73.836	27.8	1.44	74.6
2	11.25	1.5	22.5	1.273	1.9E+5	2.196	1.136	73.940	27.8	1.45	74.2
3	10.50	1.5	21.0	1.188	1.8E+5	3.150	2.201	74.096	27.8	1.46	73.3
4	9.75	1.5	19.5	1.104	1.7E+5	3.897	3.193	74.296	27.7	1.46	72.6
5	9.00	1.5	18.0	1.190	1.5E+5	4.580	4.310	74.531	27.7	1.45	71.2
6	8.25	1.5	16.5	0.093	1.4E+5	5.162	4.956	74.794	27.7	1.46	72.4
7	7.50	1.5	15.0	0.849	1.3E+5	5.649	5.727	75.078	27.7	1.46	73.2
8	6.75	1.5	13.5	0.764	1.1E+5	6.050	6.425	75.375	27.6	1.48	73.2
9	6.00	1.5	12.0	0.679	1.0E+5	6.372	7.049	75.677	27.6	1.48	74.6
10	5.25	1.5	10.5	0.594	8.9E+4	6.624	7.600	75.976	27.6	1.48	74.1
11	4.50	1.5	9.0	0.509	7.6E+4	7.205	8.77	75.872	27.6	1.48	74.5
12	3.75	1.5	7.5	0.424	6.4E+4	7.786	8.481	75.695	27.6	1.49	74.8
13	3.00	1.5	6.0	0.340	5.1E+4	7.876	8.812	75.936	27.6	1.49	75.0
14	2.25	1.5	4.5	0.255	3.8E+4	7.928	9.069	76.141	27.6	1.51	75.3
15	1.50	1.5	3.0	0.170	2.5E+4	8.953	9.253	76.300	27.6	1.51	75.8
16	0.75	1.5	1.5	0.085	1.3E+4	8.534	9.363	75.829	27.6	1.52	76.5

The table shows the orifice number along the perforated piping system (No), the orifice spacing from the perforated pipe dead end (x), m, flow rate recommended per each orifice (q.rec), l/s , the flow rate passing just before any orifice (Qn), L/s computed by using equation (2), the average flow velocity inside the perforated piping system just before any orifice (Vn), m/s computed by using equation (3), the pipe Reynolds number just before any orifice (RNn) computed by equation(1), the head losses due to friction just before any orifice (hft), cm, computed by using equation 4 through equation (5) the pressure head generated due to the decreasing in the flow velocity inside the perforated piping system (HSn), cm along the perforated piping system computed by using equation (6), the orifice pressure head expected (h.exp), cm computed by using equation (7), the orifice diameter computed (qm),mm computed by using equation (3). Also the original pressure head (hon) was measured using a pressure gauge and the actual measured orifice flow rate experimentally measured along the perforated pipe (qm), L/s by using direct method.

Table (4) shows that most flow in perforated pipes occurs at Reynolds number between 10^4 and 10^5 and the flow was about fully turbulent flow in agreement with **Kincaid and Kemper (1982)**. There was slight deviation between orifice flow measured along the perforated pipes and the orifice flow recommended per furrow due to coefficient of discharge resulting from the orifice manufacturing. The total head losses due to friction increased gradually until reaching 0.11% of the original pumping pressure head measured. However the pressure head generating due to decrease in flow velocity along the perforated pipe increased towards the pipe dead end until reach about 12.5 % of the original pumping pressure head measured. The flow variation through 12 meters spacing of the perforated piping system was computed as equation (8), about 5.3 %. Therefore the uniformity distribution of flow through orifices along the perforated pipes was about 94.7 %. The pressure head increased gradually until reach the maximum at the pipe dead end due to the increasing in pressure head gained to overcome the pressure head losses by friction. The variation of the measured pressure head along the perforated pipe was about 6.93 %.

One of the major tasks in planning a system of surface is preparation of land surface to permit uniform distribution of the water and provide for drainage of excess water. The amount of water applied through seven irrigations through different treatments of perforated pipes under slopes 0.0, 0.05 and 0.1% is compared with traditional methods were about (2460.9,2280.3,2135.8, and 2715.5 m^3/fed.) and (2500.1, 2312.2,2142.9, and 2857.2 m^3/fed.) in seasons 2000 and 2001 respectively as shown figures (2and 3). The data presented in table (5) shows that the amount of water saved through different treatments of perforated pipes under slopes (T1) 0.0, (T2) 0.05 and (T4) 0.1% compared with traditional methods (T4) as a percentage were (9.38, 16.03, 21.35%) and (12.5,19.07,25.0 %) in seasons 2000 and 2001

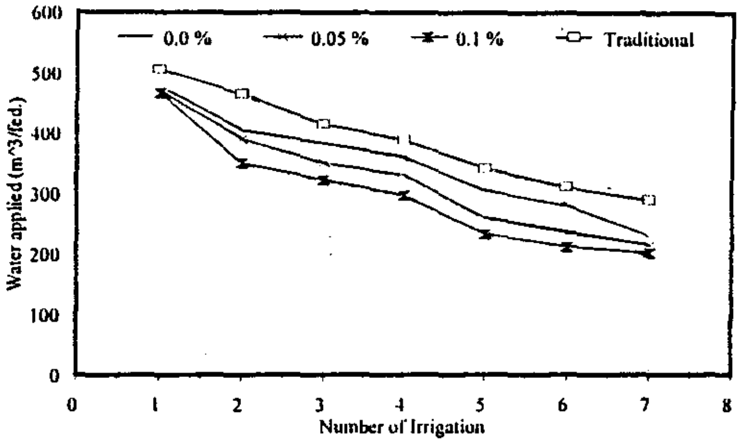

Fig. (2) : The amount of water applied per irrigation at differeent slopes by usingperforated pipe compared with traditional method in season 2000.

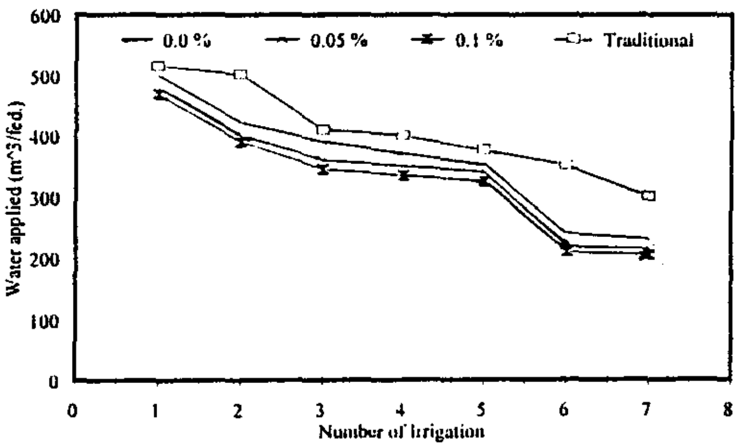

Fig. (3) : The amount of water applied per irrigation at differeent slopes by using perforated pipe compared with traditional method in season 2001.

respectively. The irrigation applied with discharge of 1.5 L/s and slope 0.1% (T3) through perforated pipe affected yield in both growing seasons. The maximum crop yield was obtained under the irrigation with (T3) while the lowest crop yield was recorded when traditional irrigation was adopted (T4).

Table (5): Amount of water, yield and water use efficiency as affected by different slopes through perforated irrigation pipes compared with traditional irrigation systems in seasons 2000and 2001.

Season	2000				2001			
Character	Traditional irrigation (T4)	Different slopes (%)			Traditional irrigation (T4)	Different slopes (%)		
		0.0 (T1)	0.05 (T2)	0.1 (T3)		0.0 (T1)	0.05 (T2)	0.1 (T3)
Amount of water (m^3/feddan)	2715.5	2460.9	2280.3	2135.8	2857.2	2500.1	2312.2	2142.9
Difference %	-----	-9.38	-16.03	-21.35	-----	-12.5	-19.07	-25.0
Yield (kg./feddan)	3130	3360	3720	3820	3200	3480	3790	3880
Difference %	------	+8.3	+18.85	+22.04	---.---	+8.75	+18.44	+21.25
Water use efficiency for yield(kg/m^3)	1.15	1.37	1.63	1.79	1.12	1.39	1.64	1.81
Difference %	------	+19.13	+41.74	+55.65	------	+22.32	+46.43	+61.61

Also, the results showed that the water use efficiency increased under (T3) compared with both two treatments (T1) and (T2) in both growing seasons. The water use efficiency increased with treatments T1, T2, T3 compared with T4 by 19.13, 41.74 and 55. 65 % in season 2000 and 22.32, 46.43 and 61.61% in season 2001 in case of applying the different treatments with perforated pipe system compared with traditional surface irrigation system.

The advance of water in surface irrigation, especially on old lands plays an important role in the application of the soil and the distribution of water in the soil root zone. The water advance and recession times were recorded at equal distance

(25 m.). That means, there were four stations /100m furrow length along different treatments. The difference between recession and advance time at each station gives the infiltration opportunity time for each station. All these data are recorded in table (6).

Table (6) : Infiltration opportunity time , min. , for different surface slopes using perforated Pipes compared with traditional irrigation method.

Treatments	Distance, m	Water advance time, min	Water recession time, min	Infiltration opportunity, min
T1(0.0%)	0	0	211	211
	25	18	223	205
	50	39	241	202
	75	59	252	193
	100	77	260	183
T2 (0.05 %)	0	0	205	205
	25	10	210	200
	50	28	220	192
	75	42	225	183
	100	55	228	173
T3 (0.1 %)	0	0	193	193
	25	8	197	189
	50	23	205	182
	75	34	209	175
	100	40	210	170
T4 Traditional	0	0	306	306
	25	46	261	215
	50	61	288	227
	75	98	301	203
	100	119	286	167

It was clarified that the infiltration opportunity time under perforated pipes on different surface slopes (0,0.5,0.1%) at same discharge 1.5 L/s/furrow were for (T1, T2, and T3) less than traditional irrigation method T4. Meanwhile, in the case of 0.1%, surface slope the water advance time, water recession time and the infiltration opportunity time were more efficient as shown and recorded in table (7). So, by good land leveling along the furrow length good water distribution can be obtained

Table (7): Total water advance time, water recession time and infiltration opportunity time affected by different slopes through perforated irrigation pipes compared with traditional irrigation systems in seasons 2000and 2001.

Season	2000			
Character	Traditional irrigation (T4)	Different slopes (%)		
		0.0 (T1)	0.05 (T2)	0.1 (T3)
Total water advance time(min)	324	193	135	105
Difference %	-----	-40.98	-58.3	-67.6
Total water recession time(min)	1442	1187	1088	1014
Difference %	-----		-24.5	-29.7
Total infiltration opportunity time(min)	1118	994	953	909
Difference %	-----	-11.09	-14.8	-18.7

REFERENCES

Black, C.A., D.D. Evans , L.E.Ensminger, and R.C. Dinauer, (1965). Methods of Analysis(part1) . American society of Agronomy, Inc., puplisher.Modison, Wisconsin, U.S.A.

Doorenbos. J. and W.o. Pruitt (1977). "Guidelines for predicting crop water requirement. F.A.O. Irrigation engineering and drainage paper 24, IAO, Rome, 144p.

Fischbach, P. E. and B. R. Somerhalder, 1971 : Efficiencies of an automated surface irrigation system with and without runoff re-use system. Trans. of the ASAE, 14 (4) : 717 - 719.

Guriguis, A. E., 1988 : Evaluation studies of surge flow furrow irrigation. M. Sc. Thesis, FAC. Of Agric. Eng. Dep., Alex. Univ.

Hanna, K. F., and El Awady, M.N., 1970, Analysis of the irrigation with long furrows , Res. 674, Eac. Ag,, Ain – Shames u. : 20 p.

Hassan, S. S. A., 1990 : The performance of perforated tubes for surface irrigation in small holdings in Egypt. M. Sc. Thesis, Agric. Eng. Dept., Cairo Univ.

Hassan, S. S. A., 1998: Enginerring studies for increasing water distribution uniformity distribution uniformity of perforated pipes for surface irrigation system Ph.D. Thesis, Agric. Eng. Dept., Cairo Univ.

Heerman, D. F., W. W. Wallender and M. G. Bos, 1990 : Irrigation efficiency and uniformity. ASAE. 2950 Niles Road, Palnela De vore_Hansen : p 125 - 147.

Israelsen , O.W., and Hansen , v.,1976, Irrigation principles and practices, John Wileg and Sonc, (C.L . Hanna and Awady, 1970) .

Jensen, M. E., 1980 : Design and operation of farm irrigation system. ASAE, Monogr 3, ASAE., St. Joseph, MI, p 829.

Kincaid, D. C. and W. D. Kemper 1982. Cablegation : 11. Simulation and design of the moving plug gated pipe irrigation system. Trans. of the ASAE 25 : p 388 - 395.

Kholeif, M.A., G. K. Sayed and R. A. Said (1997). "Modern Irrigation in sugar cane under upper Egypt conditions, "28th yearly conf. of Egyptian Soc. of Sugar Tech. Egypt,: 28-38P.

Krinner, W. A., A. Garcfa and F. Estrada 1994. Method for estimating efficiency in Spinach irrigation systems. J. of Irrig. And Drain. Eng. ASCE. 120 (5): p 979 - 986.

McClung, J.A.; S. Shepley; M. Ismail and M. N. Seif El-Yazal (1985). "Mechanical and Economic study of land leveling in Middle Egypt." Agric. Mech Proj. Paper work No. 21. Ministry of Agric. Egypt

Morcos, M. A., A. F. El-Sahrigi, M. Hanafy and S. S. Hassan 1994. A mathematical approach to predict the pressure head inside the perforated tubes Misr. J. Agr. Eng. 11 (4) : p 1041 – 1065

El- Mowelhi, N.M.; Abou Bakr, A.A. (1995). Rationalization of irrigation water use in Egypt. Proc. 2 nd. Conf. irrigation and Agroclimatology: 12-32.

Omara, A. I. 1997. Implementation and evaluation of gated pipe for furrow irrigation system M. Sc. Th. Agric. Eng. Dept. Alex. Univ.

Osman, H.E. (1988). "Effect of different methods of land leveling and improved surface irrigation method and vegetable crop." M.Sc. Thesis, Moshtohor, Fac. of Agr. Univ. of Zagazig, Egypt, : 56 p.

El- Saadawy, A.M and Abd-Elatif, Z.Y. (1998), Rational application of water through land leveling. Misr J.Agric. Eng 15 (2) : 304-312.

El-Saharigi, A.F., M.N. Saif El-yazal and A.A.M. El-Gindy, (1993). "On-farm improved irrigation management using laser technology, farm mechanization and irrigation systems",Agri. Eng Res. Inst., Agri Res. Center, Ministry of Agriculture and Land Reclamation, Egypt,56-66P.

Stenberg, R.E., Nel, P.C and Hammes, P.S. (1989), Drought sensitivity of maize in relation to soil fertility and water stress during different growth stages. South Africa Journal of Plant and soil., 6(2): p 83-85.

Willardson, L. S. and Bishop, A. A. 1967. Analysis of surface irrigation application efficiency. J. of the Irrig. And Drain. Div. ASCE 93 (IR3) Proc. Paper 5267: p 21 - 26.

El-Yazal, N.S., M. Ismail, and H.E. Osman (1985). "P. L. L. on water use and onion yield." Ministry of Agri., Egypt. USAID Project No 263-0031.

• مرسي، م. ع. ونور الدين ، ن. 1977 ري المحاصيل الحقليـــة. مكتبـــة الأنجلـــو المصريـــة

1991 . هندسة الري والصرف. دار المعارف.

تأثير التسوية علي إنتاجية محصول الذرة تحت نظام الري بالأنابيب المثقبة بالأراضي القديمة

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الملخص العربي

أجريت التجربة في محطة بحوث سدس – محافظة بني سويف موسمي 2000، 2001 في أرض طفلية طينية لتقييم نظام الري السطحي المطور من خلال الأنابيب المثقبة للفتحة الواحدة تحت تصرف (1.5 لتر / ثانية/ خط) باستخدام التسوية بميول (صفر، 0.05، 0.1%) تسمي معاملات T1, T2 ,T3 علي الترتيب مقارنة بالري بالغمر التقليدي لمحصول الذرة الشاميةT4. وكان عرض المعاملة 12متر وطولها 100متر، والمسافة بين الخطوط 0.75 م ، ومتوسط تصرف الخط 1.48 لتر/ ثانية. تم تقدير أقطار الفتحات للأنابيب المثقبة التي يمكن أن تعطي تصرفات متساوية علي طول خط النظام لكي تعطي تصرف الخط الموصي بـــه. واتضح من النتائج التالي :

1-يوجد اختلاف طفيف في تصرفات الفتحات المقاسة فعليا وذلك ناتج من دقة عمليات التصنيع ولكن التصرفات الخارجة تعطي حوالي 98% من التصرفات الموصي بها للخط.

2-انخفض معدل الماء المضاف من خلال الأنابيب المثقبة بنسب مئوية (9.38%، 16.03%،21.35%) (12.5%، 19.07 %،25%) لموسمي (2000)، (2001) في المعاملات T1, T2 ,T3 علي الترتيب مقارنة بالري بالغمر التقليديT4 .

3-زادت إنتاجية المحصول من خلال الأنابيب المثقبة بنسب مئوية (8.3%، 18.85%،22.04%) ، (8.75%، 18.44 %،21.25%)لموسمي (2000)،(2001) المعاملات T1, T2 ,T3 علي الترتيب مقارنة بالري بالغمر التقليديT4 .

4- زادت كفاءة الاستخدام المائي للمحصول من خلال الأنابيب المثقبة بنسب مئوية (19.31%، 41.74%، 55.65 %) ، (22.32%، 46.43 %،61.61%)لموسمي (2000)، (20001) في المعاملات T1, T2 ,T3 علي الترتيب مقارنة بالري بالغمر التقليدي T4.

5-انخفض كل من زمن تقدم المياه وزمن انحسارها والفرق بين زمني انحسار المياه و تقدم المياه (زمن بقاء المياه) من خلال الأنابيب المثقبة بنسب مئوية (40.98%، 58.3%،67.6%) ، (17.68%، 24.5%،29.7%) ،(11.09%، 14.8%،18.7%) في المعاملات T1, T2 ,T3 علي الترتيب مقارنة بالري بالغمر التقليدي T4.

6- من النتائج السابقة اتضح أن الري من خلال الأنابيب المثقبة بصفة عامة يعمل علي انتظامية التصرف الخارجة للخطوط ويقلل من الماء المضاف وأزمنة تقدم المياه وانحسار المياه و بقاء المياه ويزيد المحصول وكفاءة الاستخدام المائي لمحصول الذرة الشامية وخاصة المعاملة T3 عند تصرف فتحة 1.5 لتر / ثانية/خط وميل 0.1% عن جميع المعاملات السابقة .

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