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ENGINEERING PARAMETER PERFORATED PIPES SYSTEM AFFEECTIN ON WATER IRRIGATION EFFICIENCY OF THE YIELD WHEAT CROP.

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ABSTRACT

The field experimental work was carried out at the Experimental Research Station of the Agricultural Research Center, Sids- Ben Suief Governorate during two growing season 2005/2006 and 2006/2007. The research aimed to study the effect of some engineering parameters designed of perforated pipes system as outlets spacing, outlets diameters and number of outlets discharging simultaneously on the yield of wheat grains crop, application efficiency, distribution efficiency, and water use efficiency in order to choose the appropriate engineering parameters designed of perforated pipes system using for wheat crop production.

The results indicated that:

1- The water advance time, water recession time and the infiltration opportunity time were more efficient in case of treatment (3).

2- The water distribution efficiencies (WDE) are closed to each other for all treatment.

3- The highest values of water application efficiencies and The water use efficiency were achieved in case of treatment (3) and saving about 14.5% of irrigation water applied in average.

4- The uniformity distribution of the perforated pipe system decreased as the number of outlets discharging simultaneously decreased.

As a general recommendation using a perforated pipes system having engineering parameters described as treatment T3 (12 outlets, outlet diameter 36mm, 1.0 m spacing, and between two consecutive outlets and outlet flow rate about 2.0 l/s) giving a highest values of both water application efficiency and water use efficiency of the yield of Wheat crop and received less amount of irrigation water than another treatment.

Keywords*:* Perforated pipes, surface irrigation, border irrigation, irrigation efficiency, wheat crop.

INTRODUCTION

The major challenge facing water planners and managers is that while availability of water is fixed, the demand will continue to increase steadily in the foreseeable future. Shortage of water resources and increasing demand for water have created a whole new set of issues and problems confronting irrigated agriculture. Accordingly, the problem is how to balance demand and supply of water under those difficult condition. Improving irrigation system efficiency requires changes in operation, of on- farm water management. So this improving will be a tool in increasing yield productivity, land use efficiencies population rate. The perforated pipes system is one of the technologies, which offers many unique agronomic, water conservation and economic advantages needed to address the challenges for irrigated agriculture in the future.

The research aimed to study the effect of engineering parameters designed of perforated pipes system as outlets spacing, outlets diameters and number of outlets discharging simultaneously on the yield of wheat grains crop, application efficiency, distribution efficiency, and water use efficiency in order to choose the appropriate engineering parameters designed of perforated pipes system using for border irrigation system.

Michael (1978) explained that, the border method of irrigation makes use of parallel ridges to guide sheet flowing water as it moves down the slope. The border strip has little or no cross slope but has a uniform gentle slope in the direction of irrigation. Mc Clung *et al.* (1985) found that land leveling using laser controlled equipment increased irrigation efficiency and yield in large level basin. Doorenbos and Pruit (1976) stated that land slopes should be ranged between 0.05 and 0.2% depending on furrow stream size, longer border may require some land slopes to obtain efficient irrigation. Key (1986) mentioned that, the slope of the land is the most critical factor when selecting an irrigation method. If the land slope is more than 0.1%, it may be better to use border or furrow methods. Hanson *et al.* (1993) reported that the efficiency of surface irrigation is a function of the field design, infiltration characteristics of soil and irrigation management practices such as application rate and time. Abd El-Motaleb *et al.* (2006). mentioned that Controlled surface irrigation systems by using enclosed pipelines have been successfully demonstrated in recent years. The common type of pipes system is perforated pipes technique, which is a simplified type of gated pipes. Krinner and Estrada (1994) 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". El-Tantawy *et al.* (2005) showed that 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. Osman (2000) mentioned that, good design of gated pipes with precision land-leveling improved the water distribution uniformity and saved irrigation water by 12 and 29.24 % in cotton and wheat respectively. El-Yazal *et al.* (2002) found that using irrigation perforated pipe system increased the water use efficiency by 38.8% in average compared with traditional irrigation method. El-Berry *et al.* (2006) reported that using developed surface irrigation system saved applied irrigation water by about 30.54% to 37.37% compared with traditional irrigation system. Hassan (2004) reported that the Maximum wheat crop yield was obtained under the irrigation with gated pipe due to good condition of plant growth by regulating and controlling of water application to affect the soil water balance. Meanwhile, the lowest crop yield was recorded in the case of traditional irrigation method due to non-uniformity distribution of discharging flow along the border length. Tadele and Yohannes (2001) reported that water-application efficiency by definition is directly proportional to the amount of water stored in the root zone of the soil. Hence, any lost from the root zone as run off, deep percolation or evaporation will lower the value of water application efficiency. 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. Smith and Watts (1986) stated that volumetric water control and distribution uniformity in irrigation system are essential factors in achieving accurate water

water application. Hassan (1990) referred to the best flow rate 2 l/s per one meter of width.

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:

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

$$Vn = 0.001.\ Q_n / A \quad \ldots\ldots (2)$$

$$h_{fn} = k\left(\frac{Qn}{CHw}\right)^{1.852} . \times D^{-4.87} \times s \quad \ldots\ldots (3)$$

$$h_{ft} = \sum_{n=1}^{N} h_{fn}\ ,\ m \quad \ldots\ldots (4)$$

$$H_{sn} = (V^2_{max} - V^2_n) / 2 \quad \ldots\ldots (5)$$

$$H_{com} = h_p + H_{sn} - h_{ft} \quad \ldots\ldots (6)$$

$$q_n = 3.479\ (d_{com})^2\ (H_{com})^{0.5} \quad \ldots\ldots (7)$$

Where:

Q_n = the flow rate inside the perforated pipe just before any orifice, l/s,
q_n = The required outlet discharge rate, l/s,
D = inside perforated pipe diameter, mm,
x = the spacing between outlets along the perforated pipe, m,
CHw = Hazen William' s coefficient, dimensionless,
h_{fn} = the friction head losses inside the perforated pipe just before any outlet, m
h_{ft} = total friction head losses inside the perforated pipe just before any outlet, m
V_n = the flow velocity inside the perforated pipe just before any outlet, m/s
A = the perforated pipe cross section area, m^2.
H_{sn}= The superimposed pressure head, m,
V_{max} = The maximum inside flow velocity at perforated pipe inlet, m/s,
g = Gravitational field, m/s^2.
H_{com} =The resultant pressure head, cm.
d_{com} = The computed outlet diameter, m

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 outlet flow variation %,
q_{max} = The maximum outlet flow along the lateral line.
q_{min} = The minimum outlet flow along the lateral line.

Chu (1984) stated that For a practical design the pressure head variation is usually kept less than 20%, which is about equivalent to 10% Variation of lateral line flow along sub-main. The pressure head variation can be determined by:

$$H_{var} = (H_{max} - H_{min}) / H_{max} \qquad \text{.....…………..} (9)$$

Where:

H_{var} = pressure head variation along sub-main,

H_{max} = maximum pressure head in sub-main, m, and

H_{min} = minimum pressure head in sub-main, m

Douglas *et al.* (1992) reported that the coefficient of discharge might be defined as the ratio between actual discharge and the theoretical discharge passing through an orifice. He also stated that the average value of the discharge coefficient of the circle outlet was about 0.68. It is denoted by "Cd", Mathematically;

Cd = Actual discharge/ Theoretical discharge ....(10)

MATERIALS AND METHODS

The field experimental work was carried out at the Experimental Research Station of the Agricultural Research Center, Sids, Ben Suief Governorate during two growing season 2005/2006 and 2006/2007. The research aimed to study the effect of some engineering parameters of the perforated pipes system as, outlets diameters, outlets spacing and numbers of outlets discharging simultaneously along the perforated pipes system on water application efficiency (WAE), water distribution efficiency (WDE) and water use efficiency (WUE) of the yield of wheat crop. The effects of applying such methods on advance and recession time, total water applied and yield for wheat crop were considered.

Perusing the above-mentioned objective, the following work was carried out:

1. The theoretical determination of suitable outlet area in three cases of treatments by the mathematical approach proposed by Morcos et al. (1994).
2. The calibration of the three cases of the six inches aluminum perforated pipes system designed on the operating field condition.
3. Field experimental work to study the effect of some engineering parameters designed of perforated pipes system on the yield of wheat grains crop, application efficiency, distribution efficiency, and water use efficiency in order to choose the appropriate engineering parameters designed of perforated pipes system using for planting wheat crop.

1 Experimental procedure

An experimental area plot (Fig. 1) was about 0.9 feddan, with a field length of about 100-m. The pilot area was leveled using laser technique with 10cm/100m slope. The experimental area plot was divided into 3 sub-plots (T_1, T_2 and T_3). Each subplot was considered a separate treatment with 12-m width, 100 m length and 2-m strip of untilled land was thus left between adjacent plots. Therefore, each treatment having an area about 0.3 feddan at a maximum field length of about 100-meter and the width of this area was about 12 meter. Each treatment was repeated at three replicates.

The flow rate recommended per meter width having 100 meter long in clay soil was about 2 l/s as (Hassan 1998). Thus, the total flow rates required was about 24 l/s (87 m^3/h). That means the water was supplied through lining canal by a diesel pump discharging 87 m^3/h of water. Since the average flow velocity inside the pipes recommended is about 1.5 m/s (Larry and James 1988). Therefore, the suitable inside diameter of perforated pipes system computed by equation (2) is about 150 mm.

2 Treatments description

Each treatment served by six inches diameter, 12-meter length of aluminum alloy perforated pipes system and the pipe with closed end.

The first treatment designed (T_1) consists of perforated pipes system having 4 circular outlets of different diameters were drilled. The spacing between two consecutive outlets along the used pipe was chosen to be 3.0 m. Each outlet along the system design discharging 6 l/s.

The second treatment designed (T_2) consists of perforated pipes system having 6 circular outlets of different diameters were drilled. The spacing between two consecutive outlets along the used pipe was chosen to be 2.0 m. Each outlet along the system design discharging 4 l/s.

The third treatment designed (T_3) consists of perforated pipes system having 12 circular outlets of different diameters were drilled. The spacing between two consecutive outlets along the used pipe was chosen to be 1.0 m. Each outlet along the system design discharging 2 l/s.

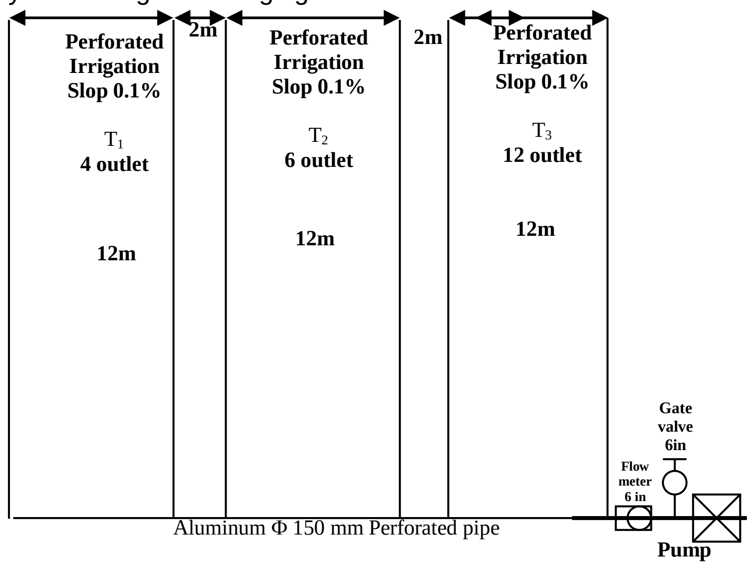

Fig. (1): The description of the field experimental test.

3 Pump calibration and its specification

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 and attached with Ibrahimia canal. Valves (to control irrigation) and water flow meters of 0.1 cubic meter accuracy (to measure the amount of water applied), pressure gauge and peizometers (to measure pump and outlets pressure head) were attached to the pump by flexible quick hitch hose. The pumping unit flow rate was adjusted to be as close as possible to pumping flow rate 87 m^3/h measured by six inches flow meter also, the actual pressure head from pumping unit and at inlet perforated pipes system were measured. The actual pressure head measured by the manometer at the perforated pipe inlet was about 0.75 meter. The specifications of the pump and engines are shown in table (1).

Table (1): The specification of the pumping unit.

Type of pump	Type of Engine	Motor Power (Hp) /KW	Rpm	Max. discharge m^3/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

4 The theoretical determination of the appropriate perforated pipes outlet diameter

As a general assumption for estimation, the flow rates from all the outlets along the perforated pipes are equal. Also, the determination would be based on the actual pump flow rate (Q_p) and actual inlet perforated pipes pressure head (h_p) measured from pumping unit. From the experimentally measured of pump discharge rate (Q_p) and the actual inlet perforated pipes pressure head (h_p), the average flow velocity inside the perforated piping system just before any orifice (V_n), flow rate passing just before any outlet (Q_n), the total friction losses (h_{ft}), and the superimposed pressure head (H_{sn}) were estimated from equation (1) through equation (5). Also, the determination of the flow heads inside the perforated pipes along its whole length (h_{com}) were carried out by equation (6) to estimate the appropriate outlets diameters (d_{com}) along the perforated pipes from Eq. (7) at discharge coefficient 0.68 recommended as Dougles et al. (1992) giving the flow rate required per unit length (q_n).

5 Field experimental work

The perforated pipes systems designed for testing on the field were locally manufactured in the workshop of the Agricultural Research Station - Sids - Beni Suief Governorate. The perforated pipes systems designed were equipped with the required valves, flow meter, pressure gauge and peizometers. The individual pipe connected with a spigot and faucet rubber to prevent water leakage. Measuring the outlets flow rate (q_o) by direct method (by measuring the time to fill a certain volume of a tin) along the perforated pipes system under actual field operating condition tested the actual performance of the perforated pipes system. Also the original pressure head (hon) was measured using a pressure gauge. The water uniformity distribution from outlets along the perforated pipe system was experimentally tested under the field condition using equation (8). The pressure head variation along the perforated pipe system was experimentally tested and can be determined by equation (8).

6 Soil analysis

The soil samples were taken until depth 60 cm to calculate the physical and mechanical soil properties such as, field capacity, wilting point and density for each depth as shown in table (2). 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**.**

Table (2): The physical and mechanical analysis of the soil.

Soil depth (cm)	Mechanical analysis %			Soil type	Field capacity %	Wilting point %	Density g/cm³
	Silt	Clay	Sand				
0-15	49	34	17	Silty clay	30	14	1.11
15-30	51	33	16		31	13	1.12
30-45	52	30	18		29	14	1.10
45-60	51	32	17		31	13	1.11

7- The infiltration rate

the depth of infiltration is the basic function for evaluating the distribution uniformity and application efficiency. It is, therefore an index for selecting the best surface irrigation regime (Guirguis, 1988). The basic infiltration rate was determined by using a double ring infiltrometer.

8- Advance and recession times

At each station along the border length, the water advance and recession times were recorded at equal spacing (20 m) along each treatment. Also, the opportunity times (time while water was above the ground), was found by measuring the time interval between the advance and recession.

9- Irrigation water amount:

The amount of irrigation water for each treatment was measured by 6 inches flow meter mounted on the pumping unit. The soil moisture was determined before and after irrigation. The stream of irrigation was cut off at 100 % of the irrigation run. After that, for all treatments, all the agricultural processes were the same.

10- The water application efficiency(WAE)

Jensen (1983) stated that the water application efficiency is the ratio of the average depth of the irrigation water infiltrated and stored in the root zone to the average depth of water applied as follows:

$$WAE = \frac{\text{Average depth of water infiltrated and stroed into root zone} \times 100}{\text{Average depth of water applied}} \quad \text{……. (11)}$$

11- Water distribution efficiency(WDE)

Water distribution efficiency indicates the extent to which water is uniformly distribution along the run. Israelsen and Hansen (1962) as defined it:

$$WDE = \left[1.0 - \left(\sum |Y_i - d|\right) / (N \times d)\right] \quad \text{………………………. (12)}$$

Where:

$WDE =$ Water distribution efficiency, percent.

$d =$ Average depth of water stored along the run during the irrigation.

$|Y_i - d| =$ Average absolute numerical deviation from d.

$N =$ Number of readings

12- Water use efficiency (WUE):

Water use efficiency (WUE) values were calculated according to Jensen (1983) as follows:

$$WUE = \frac{\text{Sugar beet root yield or Sugar yield (Mg/fed.)}}{\text{Applied irrigation water (m}^2\text{/fed.)}} \quad (\text{Mg/m}^3) \text{ ……. (13)}$$

RESULTS AND DISCUSSION

The results and discussion cover the following:

1- The theoretical determination of the appropriate perforated pipes outlet diameter in three cases of treatments by the mathematical approach proposed by Morcos *et al.* (1994) and its performance on the operating field condition.

2- Field experimental work to study the effect of some engineering parameters designed of perforated pipes system on the yield of wheat grains crop, application efficiency, distribution efficiency, and water use efficiency in order to choose the appropriate engineering parameters designed of perforated pipes system using for producing wheat crop.

1 Perforated pipes outlet diameter determination and its calibration

The theoretical determination and calculation in predicting the flow pressure head at each outlet along the perforated pipes system determined using step- step method proposed by Morcos *et al.* (1994) to compute the expected appropriate outlets diameters along the perforated pipes in three cases of the treatments T_1, T_2 and T_3 giving the flow rate determined depending upon the flow rate recommended in these cases. The results of the theoretical computation of the engineering parameter of the used perforated pipes in three cases of treatment are shown in table (3). The result of table (3) showed that decreasing outlet flow rate by about one and half the outlet diameter decreased by about 18.46%. on the other hand decreasing outlet flow rate by about three times the outlet diameter decreased by about 44.52%.

Table (3): Engineering parameters of the used perforated pipes in three cases of treatment.

	Treatments		
	T_1	T_2	T_3
d_{com}, mm	65	53	36
q_{rec}, l/s	6	4	2
Spacing, m	3	2	1

The total friction head losses computed by equation (3) and (4) in the cases of T_1, T_2 and T_3 were found about 11.0, 8.5 and 7.3 % of the original pressure head measured respectively. Concerning the superimposed pressure head computed by equation (5) in the cases of T_1, T_2 and T_3 were found about 11.5, 12.0 and 12.5% of the original pressure head measured repectively respectively. The flow variation through 12 meters apart of the perforated tubes system computed as equation (8) in cases of T_1, T_2 and T_3 were about 14.7, 10.3 and 7.5 % respectively. Therefore the uniformity distribution of flow through outlets along the perforated pipes system in cases of T_1, T_2 and T_3 were about were about 85.3, 89.7 and 92.5% respectively. Dealing with the pressure head variation computed by equation (9) in the cases of T_1, T_2 and T_3 were found about 11.0, 6.3 and 2.5% respectively. In three cases of treatments the pressure head increasing gradually until reached the maximum at the tube dead end due to the increasing in pressure head gained overcome the pressure head losses by friction. Generally, the results showed that the uniformity distribution of the perforated pipe system decreased as the number of outlets discharging simultaneously decreased.

2 Field experimental work:

2-1 Infiltration rate

The infiltration rate and cumulative infiltration were measured based on a two-point approximation to mass balance of water on the field during the advance phase. Field experimental results of accumulated infiltration versus time are given in Fig. (2).

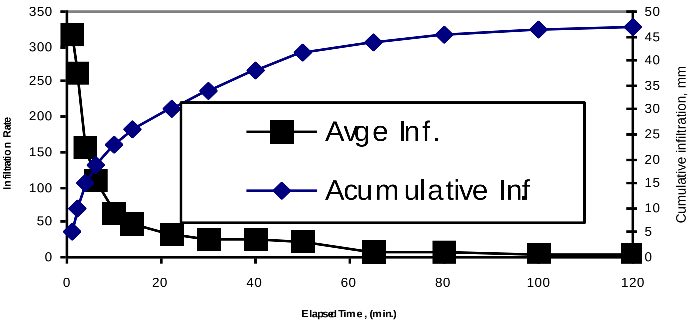

Fig. 2: Infiltration and cumulative for tested irrigation border.

2-2 Advance and recession times:

The time required for the water to advance to the end of the field length or to cover the field completely for surface irrigation system is an important consideration in the application of the soil and the water distribution in the soil root zone. The results recorded in table (4) showed that the total advanced time, water recession time and the infiltration opportunity time decreased as the numbers of outlets flowing per unit length increased. Meanwhile, in the case of T_3 the water advance time, water recession time and the infiltration opportunity time were more efficient.

Table (4): Infiltration opportunity time and average depth infiltration rate.

Treatments	Distance, m	Water advance time, min	Water recession time, min	Infiltration opportunity, min
T1	0	0.0	151.6	151.6
	20	18.0	163.0	145.0
	40	35.4	170.6	135.2
	60	54.7	173.3	118.6
	80	61.4	176.5	115.1
	100	70.3	180.7	110.4
T2	0	0.0	142.8	142.8
	20	14.5	147.6	133.1
	40	29.3	150.3	121.0
	60	39.4	153.6	114.2
	80	48.6	155.2	106.6
	100	58.4	160.4	102.0
T3	0	0.0	130.7	130.7
	20	13.0	134.2	121.2
	40	22.5	140.7	118.2
	60	30.2	145.3	115.1
	80	41.7	147.2	105.5
	100	49.3	149.6	100.3

2-3 Irrigation water amounts:

The amount of the irrigation water applied through six irritations through treatments T_1, T_2, and T_3 were presented in Fig. (3). The average water irrigation applied in case of treatment T_1, T_2, and T_3 were about 2285, 2015 and 1881 m^3/fed, respectively. Moreover, T_1, T_2 and T_3 treatments saved about 22.3%, 33.4% and 37.3% of water applied comparing with the traditional method respectively due to uniformity of outflows from the perforated pipes and increasing losses of water by deep percolation and runoff due to increase the opportunity time in case off. The results showed that the total amount of the irrigation water applied decreased as the numbers of outlets flowing per unit length increased. Meanwhile, in the case of T_3 was more efficient in saving the irrigation water applied. Moreover T_3 treatment saved about 14.5% of irrigation water applied than others treatment.

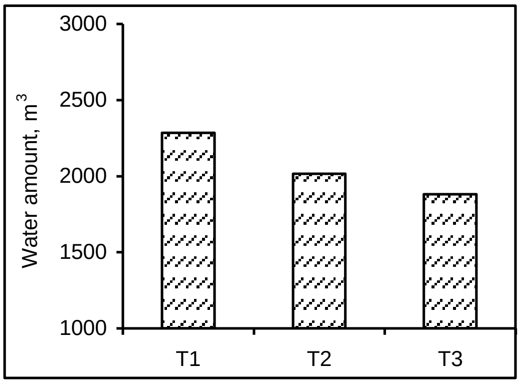

Figure 3: The amount of the irrigation water applied affecting by engineering parameter of perforated pipes.

2-4 Water Distribution Efficiency (WDE):

The values of distribution efficiency, (WDE) determined according to equation (11) were 95.3, 97.0 and 98.1 for T_1, T_2, and T_3 respectively. The results of the water distribution efficiency for treatments T_1, T_2, and T_3 were graphically expressed in figure (4) to facilitate the discussion. The figure showed that T_3 increased in water distribution efficiency by about 2.03% in average than another two treatment. The result showed that the water distribution efficiencies (WDE) are closed to each other for all treatments in spite of the treatment (3) recorded slightly increasing than others treatment by about 2.03% as a maximum.

2-5 Water Application Efficiency (WAE)

The water application efficiency, (WAE) computed as equation (10) were 66.3, 75.2 and 81.6 for T_1, T_2 and T_3 respectively. The results of water application efficiency for all treatments T_1, T_2, and T_3 were graphically expressed in figure (5). The results of water application efficiency in case of T_3 showed that the treatment T_3 increased by about 15.5 % than others treatment. The figure (5) showed that The treatment (T_3) gives the highest water application efficiency than T_1 and T_2 treatments because increasing the number of outlets flowing per unit width decreasing the spacing between them increasing the interference between the discharging outlets and the water spread quickly across the soil surface. Therefore the advance time decreased and also the water losses by deep percolation decreased.

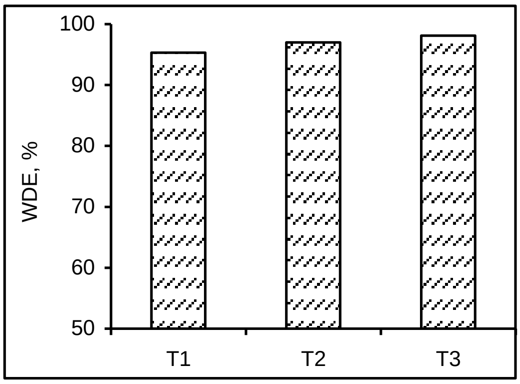

Figure 4: The water distribution efficiency (WDE %) affecting by engineering parameter of perforated pipes.

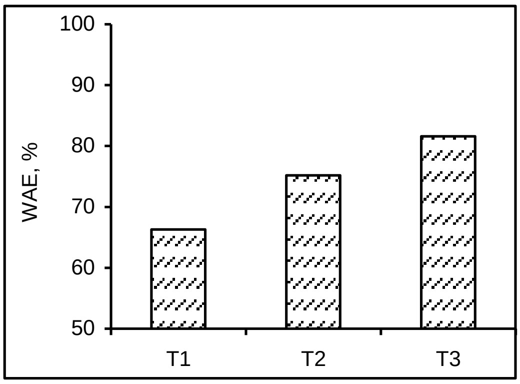

Figure 5: The water application efficiency (WAE %) affecting by engineering parameter of perforated pipes.

2-6 Wheat yield and water use efficiency (WUE)

Wheat yield and water use efficiency (WUE) for each treatment is shown in table (5). The value of water use efficiency (WUE) increased under treatment T_3 compared with both treatments T_1 and T_2 in both growing seasons. The results of the water use efficiency of treatments T_1, T_2, and T_3 were graphically expressed in figure (6) to facilitate the discussion. The figure showed that the maximum water use efficiency obtained in case of treatment T_3 due to decrease the water irrigation applied and increased the average yield of the wheat grain crop .

Table 5: Average wheat yield and water use efficiency (WUE %) for all treatments.

Character	Treatment		
	T_1	T_2	T_3
Yield ton/fed	2.73	2.88	2.93
Water use efficiency, kg/ m^3	1.195	1.43	1.56

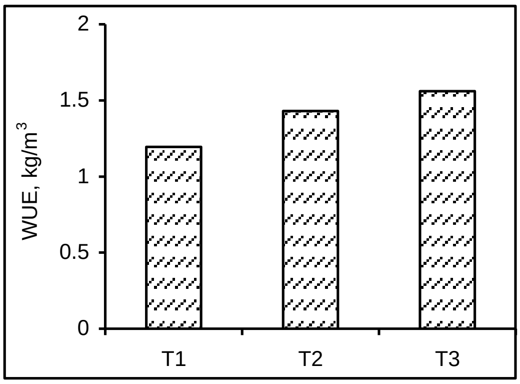

Figure (6): The water use efficiency (WUE %) affecting by engineering parameter of perforated pipes.

As a general recommendation using a perforated pipes system having 12 outlets, 1.0 m spacing between two consecutive outlets and outlet flow rate about 2.0 l/s increasing wheat grain yield about 6.5 %, giving application efficiency about 76.5%, water use efficiency about 1.47 kg/ m^3 and saving about 37.3% of irrigation water applied.

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الأبعاد الهندسية لنظام الري بالأنابيب المثقبة المؤثرة علي كفاءة الري لمحصول القمح

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أجريت التجارب البحثية بمحطة البحوث الزراعية بسدس - محافظة بني سويف خلال الموسميين الزراعيين متتاليين (٢٠٠٥/٢٠٠٦) ، (٢٠٠٦/٢٠٠٧) في ارض سلتيه طينية علي محصول القمح بهدف دراسة تأثير بعض الأبعاد الهندسية لنظام الري بالانابيب المثقبة والموضحة بالجدول التالي علي انتاجية محصول القمح من الحبوب و علي كل من كفاءة توزيع و اضافة مياه الري لمحصول القمح و كذلك كفاءة الاستخدام المائي لمحصول الحبوب من القمح.

Parameter	*Treatments*		
	T_1	T_2	T_3
d_{com}, mm	65	53	36
q_{rec}, l/s	6	4	2
Spacing, m	3	2	1

و اشتملت التجربة علي:

١- الدراسات النظرية لتقدير الابعاد الهندسية الموضحة بالجدول السابق و التي تمثلت في المعاملات (T3-T2-T1) المعتمدة أساسا علي القياسات الفعلية للتصرفات و الضغوط لوحدات الضخ المسخدمة في التجارب الحقلية و الذي يتلائم مع محصول القمح.

٢- التجارب الحقلية لمعايرة المعاملات التي تم تصميمها و تقديرها لنظام الانابيب المثقبة وذلك من خلال تقدير معامل تماثل توزيع المياه المتدفقة من فتحات نظام الري الانابيب المثقبة و تقدير التغير في الضغوط علي امتداد النظم المصممة.

٣- الدراسات الحقلية لدرلسة تأثير المعملات السابقة علي كل من محصول حبوب القمح و كل من كفاءة توزيع و اضافة مياه الري لمحصول القمح و كذلك كفاءة الاستخدام المائى لمحصول القمح.

وأوضحت التجارب النتائج التالية :

١. تم الحصول علي اعلي تماثل لتوزيع المياه المتقبة و اقل تغير للضاغط المائي على امتداد نظام الري بالانابيب من خلال المعاملة (T3).
٢. أعطت المعاملة (T3) أكفأ النتائج المتحصل عليها في قياسات التقدم و الانحسار أفضل التقديرات لزمن التلامس.
٣. بالنسبة لكفاءة توزيع المياه لم تكن الفروق ملموسة بالنسبة للمعاملات الثلاثة علي الرغم من أن المعاملة(T3) تعطي أفضل النتائج الطفيفة عن المعاملتين (T3-T2).
٤. أعطت المعاملة (T3) أعلي كفاءة اضافة لمياه الري حيث بلغت ٨١,٢% وأكثر المعاملات توفيرالمياه الري حيث بلغت نسبة التوفير حوالي ١٤,٥% في المتوسط عن المعاملتين الاخريتين.
٥. كما أعطت أيضا المعاملة (T3) أعلي كفاءة استخدام مائي لمحصول الحبوب من القمح حيث بلغت ١,٥٦ كجم/م٣.

النتائج النهائية توصي باستخدام نظام الري بالانابيب المثقبة ذات الابعاد الهندسية التي تتوافق مع المعاملة (T3) ليمكن الحصول علي أعلي عائد من الحبوب لمحصول و توفير حوالي ١٤,٥% من مياه الري المسخدمة في ري محصول القمح تحت نظام الري بالانابيب المثقبة وكذلك الحصول علي أعلي كفاءة اضافة لمياه الري و أعلي كفاءة استخدام مائي.

التوصيات للدراسات المستقبلية لنظام الري بالانابيب المثقبة:

١. الدراسات التي تتمثل في امكانية الحصول علي اعلي تماثل للمياه المتدفقة من خلال نظام الري بالانابيب المثقبة باستخدام الانابيب البلاستيكية أو الكاوتشوك المرنة و تثبيتها بفتحات النظام بأطوال مختلفة اعتمادا علي العلاقات الهندسية لسريان المياه و كيفية استخدامها كبدائل للبوابات بهدف توفير نفقات انتاجها.
٢. الدراسات الهندسية التي تتمثل في كيفية تقليل أو تلافي النحر الحادث من فتحات نظام الري بالانابيب المثقبة أو المبوبة.
٣. الدراسات الهندسية المفسرة لشكل خروج المياه من فتحات النظام و خاصة عند مدخل وحدات الضخ و التي تؤدي الي خروج المياة بزوايا مختلفة قد تؤدي الي خروج المياه بعيدا عن الاماكن المخصصة لها خاصة تحت نظم الري بالخطوط و دراسة الوسائل الهندسية لتلافي ذلك.