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IRRIGATION AND DRAINAGE

HYDRAULIC STUDIES ON SURGE FLOW FURROW METHOD BY USING GATED PIPE SYSTEM FOR CLAY LOAM SOIL.

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ABSTRACT

The study was conducted to evaluate surge flow technique comparing with continuous irrigation. This study was conducted at the Experimental Farm of Faculty of Agriculture, Ain Shams University , at Shalaqan village 1km from El-Kanater El-Kairea District, Kaliobia Governorate, Egypt. Two furrows length were selected 70 and 90m with and 0.75 m furrow spacing and gated pipe was used for irrigation on 0.2% average slope on a clay loam soil.

The field experiment comprises one continuous treatment and three surges(3 , 4 and 5) treatment with two inflow rates of 1.67 and 2.1 l/s, and two cycle ratios (CR1 = 0.33 with 15 min on and 30 min off) and (CR2 =0.50 with 15 min on and 15 min off) , along with two steady flow treatments with the same inflow rates in order to analyze the advance and recession phases, wetted depth, cumulative infiltration , application efficiency, storage efficiency, distribution uniformity, absolute distribution uniformity, deep percolation ratio and tail water ratio.

Results indicated that surge flow treatments advanced rate faster than the respective continuous flow treatments. Surge treatment had a better application efficiency and distribution uniformity than the continuous treatments. On other hand the continuous treatments had better storage efficiency than surge treatments. The maximum deep percolation loss (41%) was observed in continuous treatment.

keywords: surge flow – surface irrigation – cycle ratio –furrow irrigation.

INTRODUCTION

Irrigated agriculture in Syria faces a number of problems. So that that t the Ministry of Irrigation try to use new techniques in irrigation and modernize the irrigation networks **(Alshami, 2000).** Surface irrigation efficiency is maximum when systems are managed to minimize deep percolation and runoff while meeting irrigation requirements **(Kanber et al., 2001).**

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Surge irrigation, is defined as the intermittent application of water to furrow, rills or borders in a series of relatively short on- and off-time periods of constant or variable time spans **(Humphreys, 1989)**.

Potential benefits of using surge irrigation over continuous irrigation may include faster water advance, an increase in distribution uniformity, reduction in the total volume of water required for an irrigation event, and reduction in irrigation time **(Allen, 1980; Bishop et al., 1981; Mahmood et al., 1993; El- Dine et al., 2000; Kanber et al., 2001).**

Izuno and Podmore (1986) demonstrated the effect on the predicted advance and performance by changing the input parameters of a surge model. The conclusion was that, changing physical parameters such as slope, Manning roughness and hydraulic cross-sectional area characteristics has little effect on the predicted advance. On the other hand changing the most important factors such as: stream size, cycle time, number of surges and cycle ratio has the largest effect on advance and performance predictions.

(Henggeler et al., 1996) stated that proper cycle times vary from 30 minutes to several hours depending on soils, length of furrow, furrow stream size and other variables.

The cycle ratio is defined as the surge on-time divided by the cycle time. With a cycle ratio of 0.5 for the same instantaneous discharge, surge flow irrigation reduces advance time by 50% compared to continuous flow **Purkey and Wallender (1988).**

The furrow stream size is usually between 0.2 and 3 L/s and in more permeable soils, the maximum non-erosive flow should be used for wetting the end of the furrow as early as possible. The maximum slope is usually related to a non-erosive stream size. The land slope should generally be less than 3% . Furrows are usually V-shaped where the width varies from 0.25 - 0.4 m and the depth from 0.15 - 0.3 m **(Depeweg, 1998).**

Number of cycles for furrows one/fourth of a mile long or less, the required is usually 3 or 4 surges and for furrows over one/fourth of a mile long, the number of cycles is between 4 and 6. Additional surge cycles will be required during the soaking phase **Rogers and Sothers (1995).**

The roughness of furrow determines the average velocity of water in an open canal and the roughness factor represents the effect of roughness and geometric characteristics of the canal material upon the energy losses **(Depeweg, 1999).**

Regarding the evaluation of surface irrigation methods , a complete set of parameters should be calculated. These parameters are: application efficiency (Ea), requirement efficiency (Es) , distribution uniformity (DU), deep percolation ratio (DPR) and tail water ratio (TWR), **(Walker, 1989).**

The literature on surge irrigation indicates that this method can help save irrigation water . So that , the principal purpose of this research was:

1- Evaluate the surge flow under furrow irrigation and clay loam soil.
2- Efficiency comparing surge flow with conventional continuous flow applications in furrow irrigation .

MATERIALS AND METHODS

All equipment needed for recording the required water measurements were installed in the field at the beginning of the experimental work.

1-The field:

Two different furrow lengths 70 and 90 m with 0.2 % slope were selected. Furrow geometry was measured (as average of cross sections along 20 in individual furrows) manually by a locally manufactured furrow profile mete **Walker and Skogerboe (1987).**

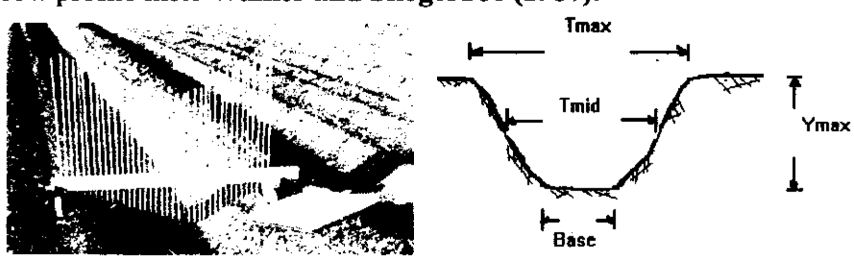


Figure 1: Furrow profilometer for determining cross-sectional area.

Table 1: Unit width flow cross section of furrows:

Parameter	Measured value, m
Top width (T max)	0.48
Middle width (T mid)	0.37
Base	0.132
Maximum depth (Y max)	0.15

Elliott and Walker (1982) found that the wetted perimeter and cross-sectional area could be expressed as simple power functions of depth :

$$WP = \gamma_1 y^{\gamma_2} \qquad (1)$$

where WP is the wetted perimeter of the furrow in m, y is the flow depth in m, and γ_1 and γ_2 are numerical fitting parameters; and

$$A = \sigma_1 y^{\sigma_2} \qquad (2)$$

in which A is the cross-sectional area of the furrow in m^2,and σ1 and σ2 are numerical fitting parameters. Values of ρ_1, ρ_2, γ_1, γ_2, σ_1, and σ_2 can be computed by the equations presented in Appendix A:

2-Soil and water analysis:

The field was plowed with a chisel plow to 30 cm depth, and leveled manually to 0.2% slope. Soil and water of irrigation samples were collected and were analyzed in the standard soil at Testing Laboratory of Soil Department in the Faculty of Agriculture, Ain Shams University. The analysis are presented in Tables(2),(3) and (4).

Table 2: Some physical properties of soil.

Sample depth cm	Particle size distribution , %				F.C	PW.P	B.D	Texture Class
	C. sand	F. sand	silt	clay				
0-30	3.32	35.21	21.17	40.3	29	17	1.26	C.L
30-60	3.4	33	20.6	43	30	19	1.44	C.L
60-100	4.7	29	26.1	40.2	30	18	1.46	C.L

F.C.= field capacity (%); PW.P.=permanent welting point (%), F.C. and PWP were determined as percentage in weight; B.D.= bulk density(g/cm3); C.L.= clay loam.

3-Infiltration test:

Infiltration test was measured by double ring infiltrometer , and the result presented in figure 2.

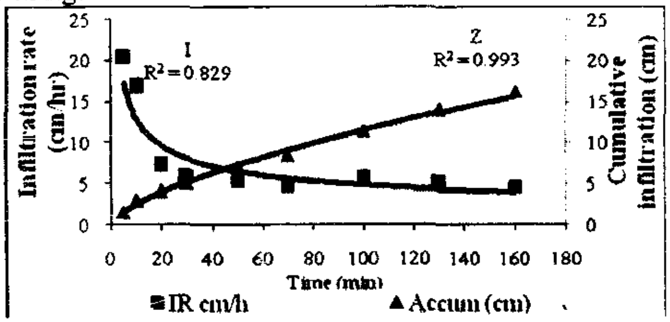


Figure 2: Cumulative infiltration and infiltration rate.

Cumulative infiltration rate was determined by using the Kostiakov relation:

$$\mathbf{Z = aT^b} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

D = cumulative infiltration (cm).

T = cumulative time (min)

a and b: coefficients of equation and from infiltration test a = 0.5638 and b = 0.65436.

For infiltration rate process :

$$\mathbf{I = Kt^n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

I = infiltration rate (cm/hr).

T = is the time that water is on the surface of soil (min).

K and n: coefficients of equation and from infiltration.

4-Gated pipe:

Gated pipe irrigation system tested was a single length of 6" diameter light weight aluminum pipe 6 m length with infinitely adjustable plastic sliding gates was used. The gates were located at 75cm spacing and were circle shape with 0.04m diameter. The head used for test was 1.25m. The discharge rate from gated pipe was calibrated manually three time at the beginning of the every irrigation

5-Field measurements:

5-1-Advance and recession rates of the water :

To measure the rate with which the advancing front moves across a surface-irrigated field, stakes are placed along the length of the furrows. In this study the spacing between the stakes was 10 m. The clock time recorded when the irrigation water supply is diverted into the field and when the advancing front reaches each stake. The recession phase ends when the surface water disappears at each measuring station and was recorded too.

5-2-Wetted depth in furrow :

Soil augers was used to measure the wetted depth at five points along the furrow 0 ,15,35,55and 70m for length of furrow 70m and at 0,15,55,75 and 90m for length of furrow 90m.The measurements was taken after 24 hours of irrigation.

5-3- Cumulative infiltration by infiltration opportunity time:

The water level was fixed during all treatments of the experiment. The cumulative infiltration calculated by infiltration opportunity time and by using cumulative infiltration equation eq(3) . The infiltration opportunity time defined here as the time during which water remains standing at each station in the test furrows was obtained from the difference between the recession and the advance times **(Merriam et al, 1980).**

5-4-Evaluation for continuous and surge flow irrigation:

Regarding the evaluation of surface irrigation methods a complete set of parameters should be calculated. These parameters are: application efficiency (Ea), storage efficiency (Es) , distribution uniformity (DU), deep percolation ratio (DPR) and tail water ratio (TWR), **Walker (1989).**

5-4-1- Application Efficiency, E_a%:

$$Ea = \frac{\text{Depth of water stored to root zone (mm)}}{\text{Deepth of water applied to the furrow (mm)}} 100 \ldots\ldots\ldots\ldots(5)$$

5-4-2- Storage Efficiency, E_S% :

$$Es = \frac{\text{Stored water depth in root zone (mm)}}{\text{Required water depth in root zone (mm)}} 100 \ldots\ldots\ldots\ldots(6)$$

5-4-3-Distribution Uniformity, DU %:

Merriam and Keller (1978) propose that distribution uniformity be defined as:

$$DU = \frac{\text{Low-quarter minimum infiltrated water depth (mm)}}{\text{Average infiltrated water depth (mm)}} 100 \ldots(7)$$

The same authors also suggest an absolute distribution uniformity **DU_a%**:

$$DU_a = \frac{\text{Minimum infiltrated water depth(cm)}}{\text{Average infiltrated water depth (cm)}} 100 \ldots\ldots\ldots\ldots(8)$$

5-4-4-Deep Percolation, DPR%:

$$DPR = \frac{\text{Deep percolated water (mm)}}{\text{Applied water to the furrow (mm)}} 100 \ldots\ldots\ldots\ldots(9)$$

5-4-5- Tail water ratio, TRW%:

$$TWR = \frac{\text{Average Runoff water (mm)}}{\text{Average Applied water to the furrow (mm)}} 100 \ldots\ldots\ldots(10)$$

6-Experiment design :

The experimental design for both of CR1 and CR2.

- Main treatment : Three number of surges 3,4 and 5 and one continuous flow.
- Sub treatment : Two furrow length 70m and 90m.
- Sub- sub treatment : Two flow rate 1.67L/s and 2.1 L/s.

Number of surges 3 and 4 were selected according to Rogers and Sothers (1995) , where the length of furrows were one/fourth of a mile

70 and 90 m) and we add the treatment (5 surges) after field experiments to achieve beat evaluation.

RESULTS AND DISCUSSION

4-1-Flow shape:

Numerical fitting parameters presented in table (3).

Table 3: Numerical fitting parameters for flow shape.

ρ_1	ρ_2	σ_1	σ_2	γ_1	γ_2
0.445	2.833	0.763	1.429	1.657	0.536

The wetted perimeter WP of the furrow in m, y is the flow depth in m, and the cross-sectional flow area at the furrow inlet, A_o for both discharge rates was calculated and presented in table (4).

Table 4 : wetted perimeter ,flow depth , and the cross-sectional flow area at the furrow inlet:

Discharge rate (L/s)	Wetted perimeter (m)	Flow depth (m)	Cross-sectional flow area (m^2)
1.67	0.366	0.06	0.0138
2.1	0.392	0.068	0.0163

The change in flow shape before and after the irrigation was presented in figure 3.

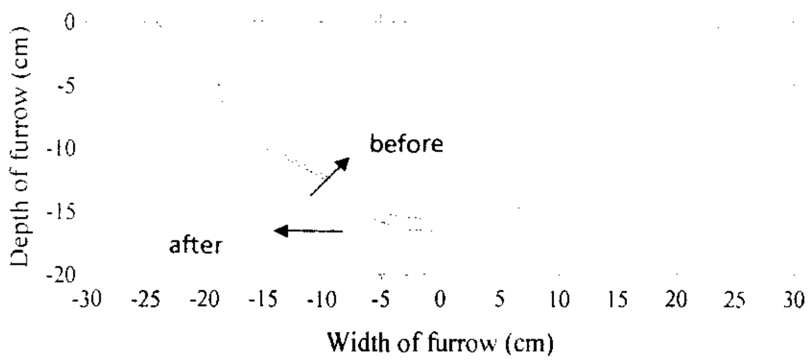
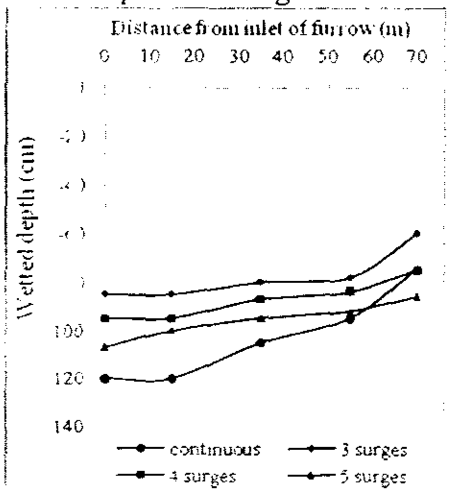


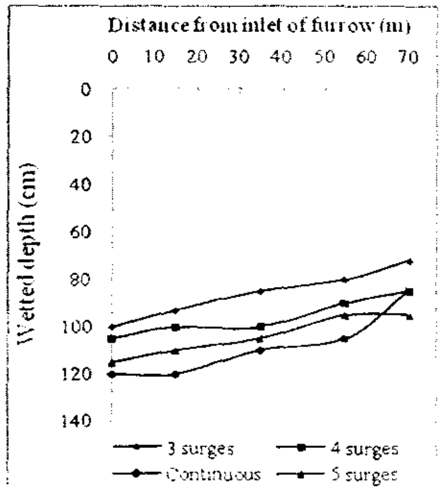
Figure 3: The change in flow shape before and after the irrigation.

4-2-Wetted Depth:

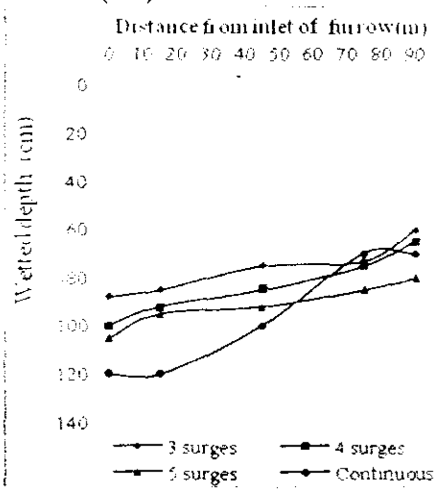
The wetted depth along the furrows after 24h of irrigation was measured by augers and presented in figures 4 and 5. Figures 4 and 5 show that the biggest wetted depth in the first half length of the furrow was for continuous treatment and for 5 surges treatment in the second half of furrow. This is due to longer contact time was bigger in continuous one in first half and in 5 surges in second half length of the furrow and the advance phase was higher



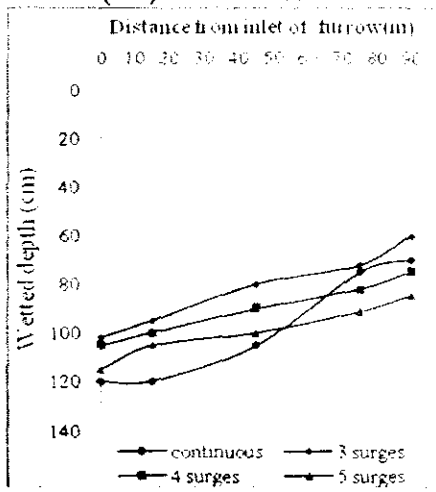
(4.a) 70 m-1.67 l/s



(4.b) 70 m-2.1 l/s



(4.c) 90 m-1.67 l/s

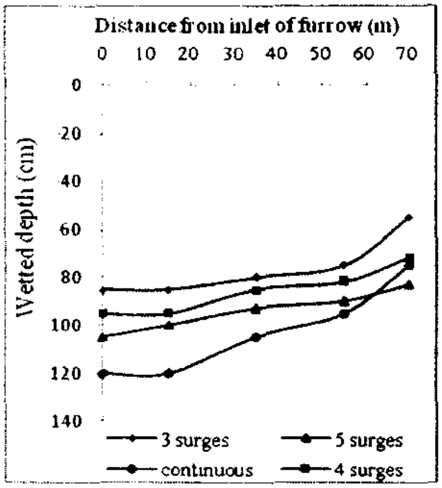


(4.d) 90 m-2.1 l/s

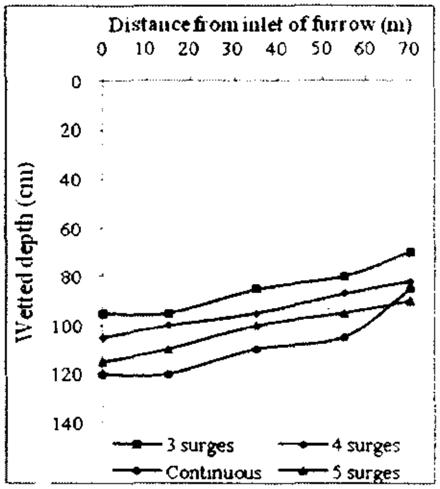
Fig.(4): Wetted depth for CR1.

in 5 surges treatment too. Wetted depth in 5 surges treatment was deeper than 3 and 4 surges because the irrigation time was higher. The wetted depth for discharge rate 2.1 L/s was higher than that the discharge rate

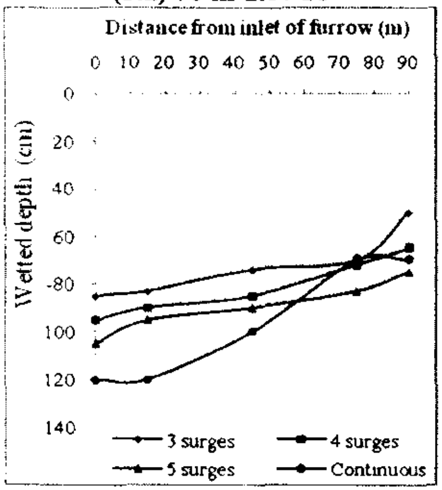
1.67 l/s. The results of wetted depth were close in both cycle ratios but it was higher in CR1 than at CR2 because the off- time in CR1 was longer than CR2.



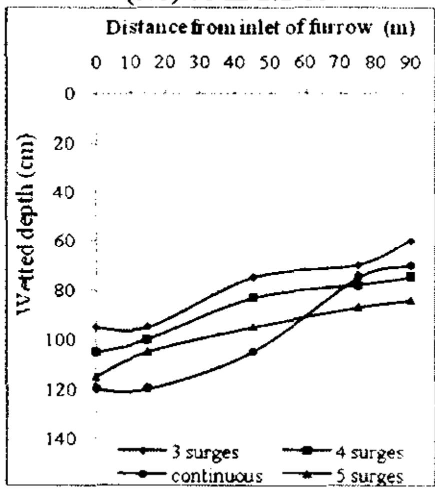
(5.a) 70 m-1.67 l/s



(5.b) 70 m-2.1 l/s



(5.c) 90 m-1.67 l/s



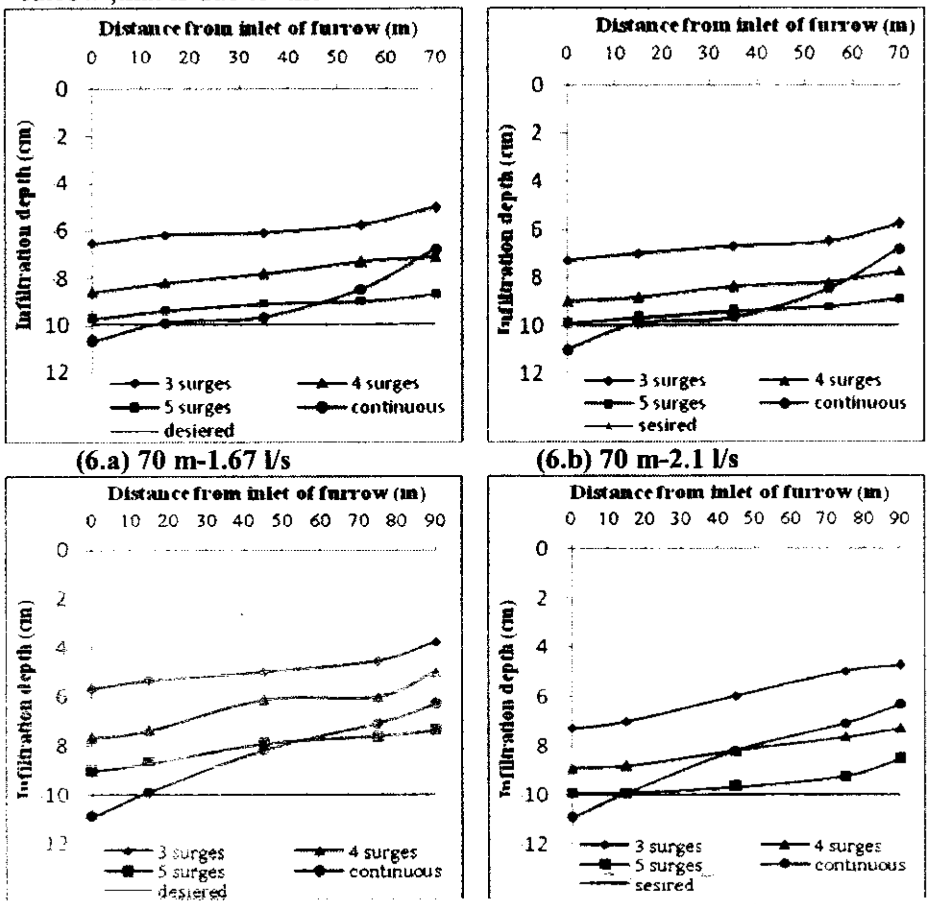
(5.d) 90 m-2.1 l/s

Fig.(5): Wetted depth for CR2.

4-3-Cumulative infiltration by infiltration opportunity time:

The infiltration opportunity time or contact time was measured from curves of advance and rescission for all treatments. The infiltration opportunity time was obtained from the difference between the recession and the advance times at five places in every length of furrow. For furrow

70m the places were 0, 15 , 35 , 55 and 70m and for furrow 70m the places were 0, 15 , 45 , 75 and 90m. Figures 6 and 7 refer that the biggest cumulative infiltration in the first half length of furrow was for continuous treatment. For 5 surges treatment in the second half length of furrow ,that is due to the

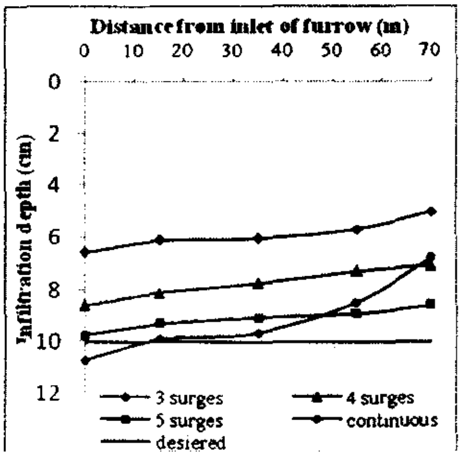


(6.a) 70 m-1.67 l/s (6.b) 70 m-2.1 l/s

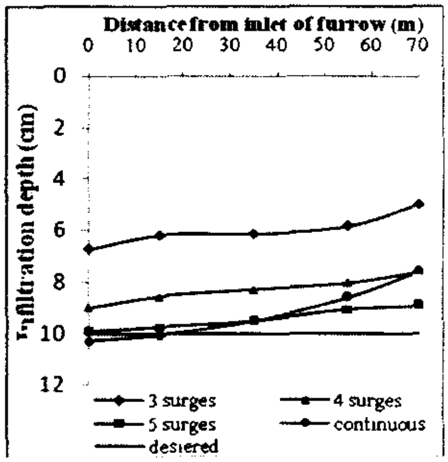
(6.c) 90 m-1.67 l/s (6.d) 90 m-2.1 l/s

Fig.(6): Cumulative infiltration for CR1.

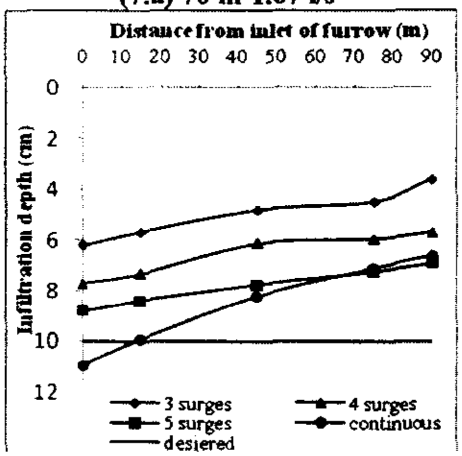
longest infiltration opportunity time was the longest in continuous one and because the advance phase was bigger in 5 surges treatment than that at 3 and 4 surges. Cumulative infiltration in 5 surges treatment was higher than 3 and 4 surges because the irrigation time was longer. Discharge rate 2.1 l/s the cumulative infiltration was higher than that discharge rate 1.67 l/s. The results of wetted depth was close in both cycle' ratios but it was higher in CR1.



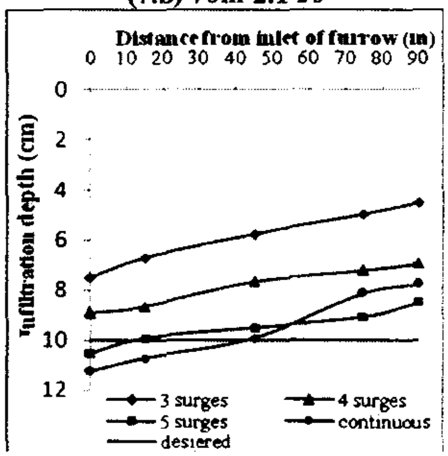
(7.a) 70 m-1.67 l/s



(7.b) 70m-2.1 l/s



(7.c) 90 m-1.67 l/s

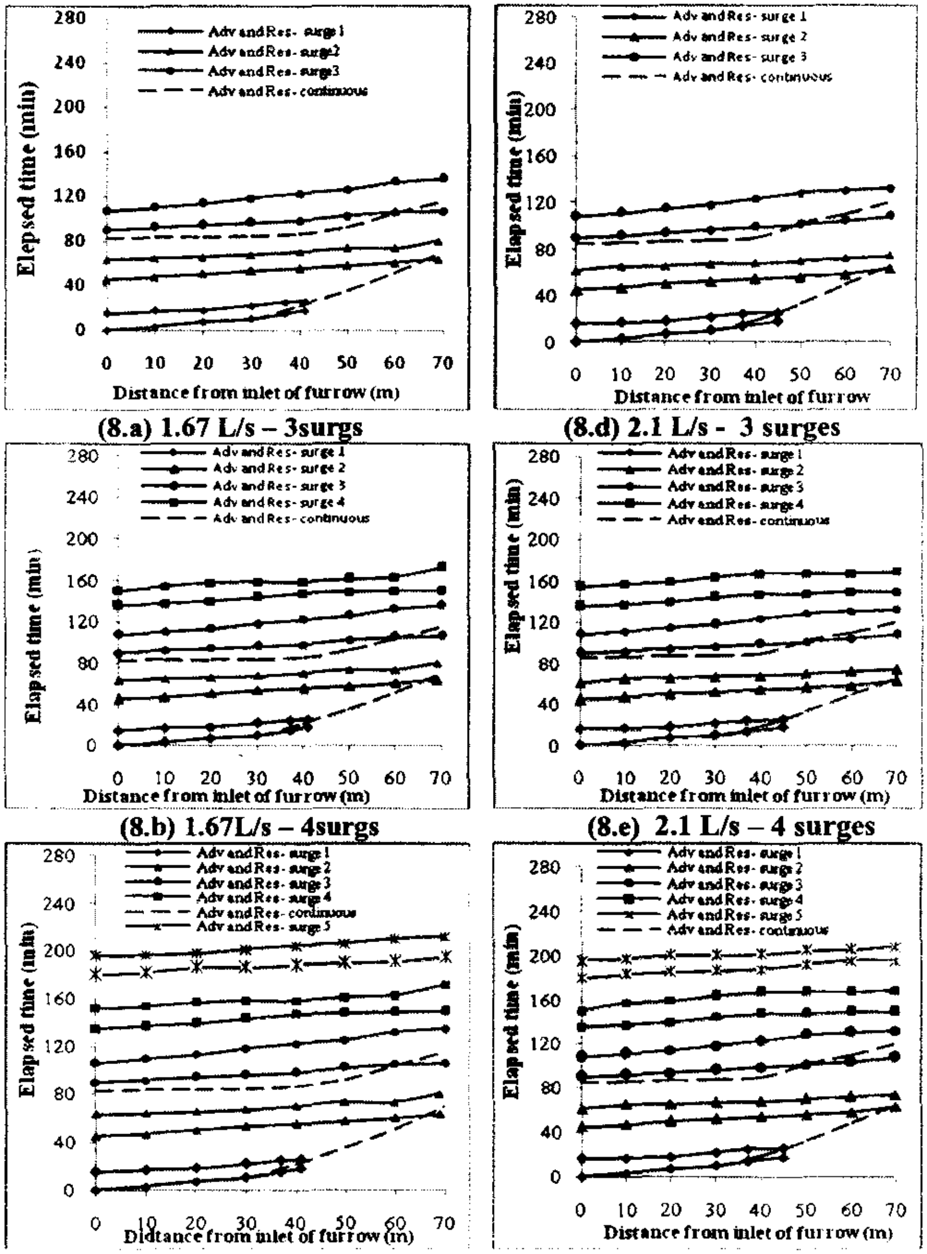


(7.d) 90 m-2.1 l/s

Fig.(7): Cumulative infiltration for CR2.

4-4-Advance and rescission phases:

The advance and rescission phases presented in figures 8,9,10 and 11.
it can be observed that the surge flow advanced faster than the respective continuous flow treatments. It can be also observed that there was a greater difference in advance time between surge and continuous for the lower inflow rate. It was also observed that surge flow treatments with small cycle ratio and large discharge had faster advance rate. then we can say that surge flow with the small cycle ratio and high discharge has the greatest effect on reducing the advance time.



(8.a) 1.67 L/s – 3surgs

(8.d) 2.1 L/s - 3 surges

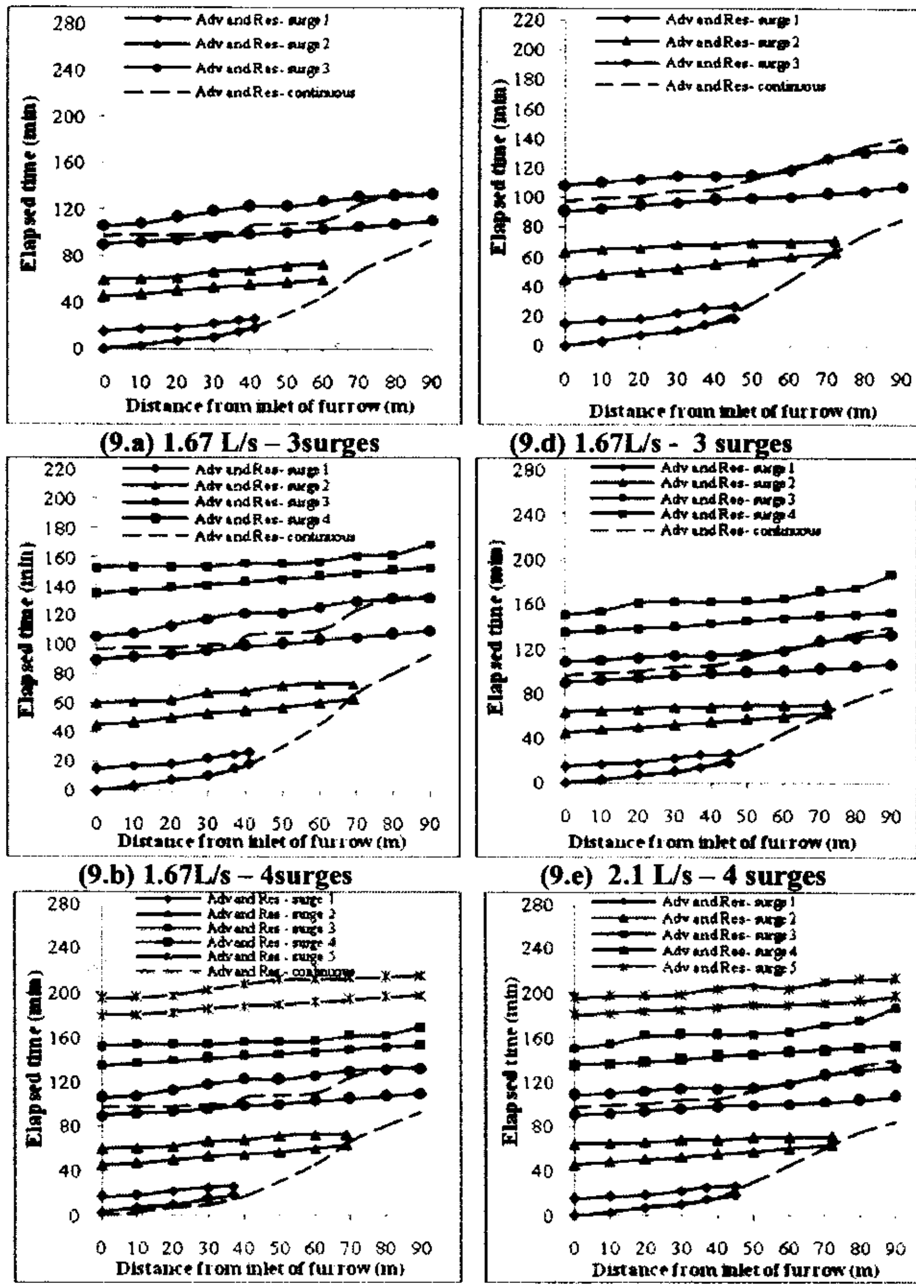
(8.b) 1.67L/s – 4surgs

(8.e) 2.1 L/s – 4 surges

(8.c) 1.67 L/s – 5surgs

(8.f) 2.1 L/s – 5 surges

Fig.(8): Advance and recession curves for 70m , CR1.



(9.a) 1.67 L/s – 3surges

(9.d) 1.67L/s - 3 surges

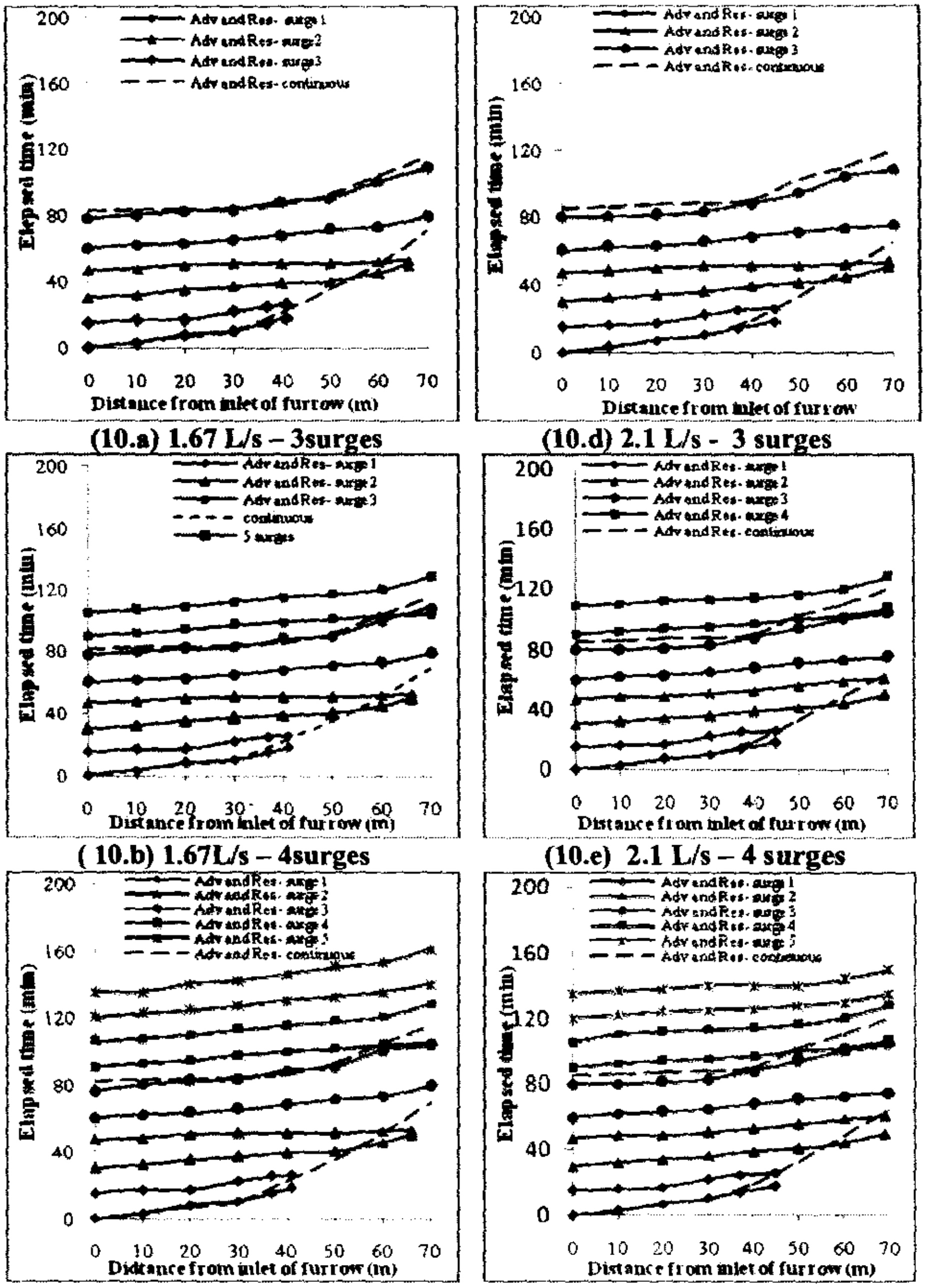
(9.b) 1.67L/s – 4surges

(9.e) 2.1 L/s – 4 surges

(9.c) 1.67 L/s – 5surges

(9.f) 2.1 L/s – 5 surges

Fig.(9): Advance and recession curves for 90m , CR1.



(10.a) 1.67 L/s – 3surges

(10.d) 2.1 L/s - 3 surges

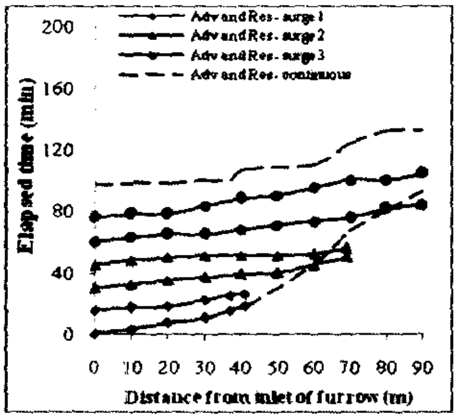
(10.b) 1.67L/s – 4surges

(10.e) 2.1 L/s – 4 surges

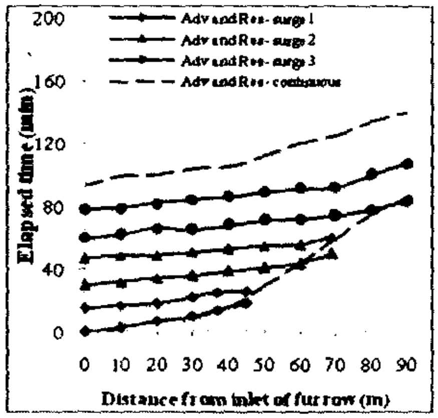
(10.c) 1.67 L/s – 5surges

(10.f) 2.1 L/s – 5 surges

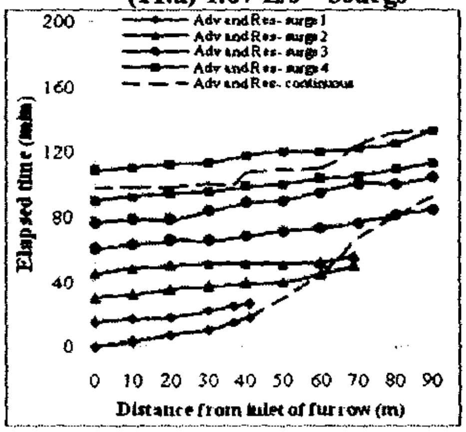
Fig.(10): Advance and recession curves for 70m , CR2.



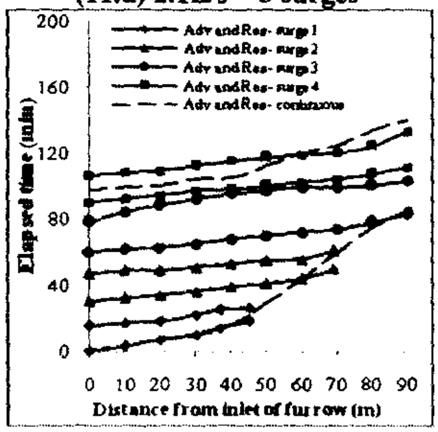
(11.a) 1.67 L/s – 3surgs



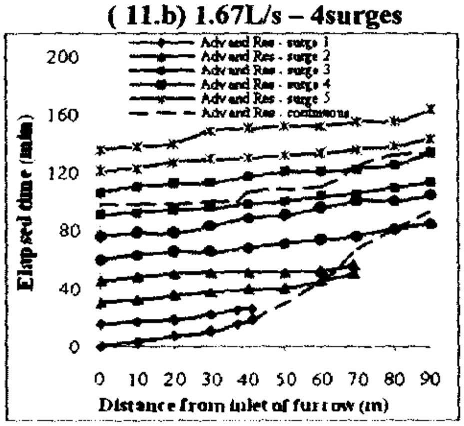
(11.d) 2.1L/s - 3 surges



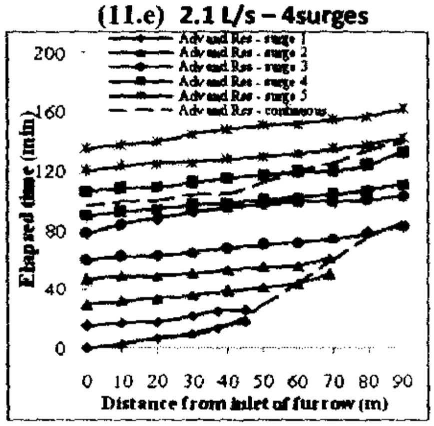
(11.b) 1.67L/s – 4surges



(11.e) 2.1 L/s – 4surges



(11.c) 1.67 L/s – 5surgs



(11.f) 2.1 L/s – 5 surges

Fig.(11): Advance and recession curves for 90m , CR2.

A longer advance time, normally, increases the water loss by deep percolation due to slow advance rates , Therefore, a high inflow is recommended to obtain a rapid stream advance.

For both cycle ratios the advance time is reduced compared to continuous flow .This reduction was due to the effect of off-time. When the off-time is long enough to infiltrate all the water before the second surge starts, the mechanism of surge flow works effectively **Ismail (2003).**

4-5- Performance of surge and continuous irrigation:

Irrigation performance parameters calculated for treatments are given in Table (5).

4-5-1-Application efficiency Ea:

Application efficiency was computed using Eq(3) for surge flow and continuous treatments from cumulative infiltration equation. The average application efficiency for continuous treatments ranged from 59 to 78% while the Ea ranged from 69 to 98 in surge flow treatments and this indicates that surge treatment combinations had a better application efficiency than the continuous treatments.

For CR1 the application efficiency was higher than CR1 and this could reduce the infiltration rate. Therefore, the low application efficiency recorded for continuous irrigation is due to its inherent property relative to surge irrigation and be due to the consolidate of the furrow during the long off time and this results is applied. Then we can conclude that the surge flow treatments had better application efficiency than the continuous flow treatments.

4-5-2- Storage efficiency, E_S:

Storage efficiency was computed using Eq(6). The storage efficiency observed for the larger discharge (2.1 L/s) was higher than that recorded for the smaller discharge (1.67 L/s). Generally, continuous flow treatments had better storage efficiency than surge flow treatments. This might be due to the fact that the continuous flow treatments obtain higher amounts of water applied than the surge flow treatments.

4-5-3-Distribution uniformity, DU:

Distribution uniformity was computed using Eq (7). Higher distribution uniformity was observed for surge flow treatments than for the continuous flow treatments. This may be due to the fact that surge flow irrigation reduced the infiltration rate and increased the advance rate. The average

Table (5): Evaluation for continuous and surge flow .

treatment	Cycle ratio	Length of furrow (m)	Discharge rate L/s	No of surges	Application Efficiency Ea %	Storage Efficiency Es %	Distribution Uniformity DU%	Absolute Distribution Uniformity DUa %	Deep Percolation DPR %
Continuous		70	1.67		78	91.5	82	73	22
			2.1		59	91.6	82	73	41
		90	1.67		77	83	79	74	23
			2.1		70	93	82	80	30
Surge Flow	0.33	70	1.67	3	92	59	90	83	8
				4	90	78	92	91	10
				5	85	91	96	94	15
			2.1	3	82	67	91	86	18
				4	78	84	94	91	22
				5	69	94	96	94	31
		90	1.67	3	98	49.5	84	76.5	2
				4	96	64	85	77	4
				5	97	81	92	91	3
			2.1	3	95	59	81	79	5
				4	97	82	91	88	3
				5	90	95	93	89	10
	0.5	70	1.67	3	90	58	91	86	10
				4	90	77	92	91	10
				5	84	91	95	94	16
			2.1	3	74	60	89	83	26
				4	76	83	94	91	24
				5	69	94	95	94	31
		90	1.67	3	97	49	81	72	3
				4	96	64	89	87	4
				5	95	77	90	88	5
			2.1	3	92	58	81	77	8
				4	93	78	89	88	7
				5	90	94	92	89	10

distribution uniformity for continuous treatments ranged from 79 to 82% while the DU ranged from 81 to 95 % in surge flow treatments and this indicates that surge treatment combinations had a better distribution uniformity than the continuous treatments. The surge flow irrigation helps to obtain a uniform wetting of the root zone with minor differences in the infiltration depth at the beginning and the end of a furrow. In surge flow the water was allowed to run long enough to completely fill the root zone area. Therefore, water has more time to infiltrate on the inflow end of the field compared to the bottom end, leading to low distribution uniformity along the furrows.

Absolute distribution uniformity, DU:

Absolute distribution uniformity was computed using Eq (8). The lowest absolute distribution uniformity was observed for continuous treatments than for the surge flow treatments. This may be due to the fact that continuous flow irrigation has shorter infiltration opportunity time at end of furrow compared with the beginning the furrow.

4-5-4-Deep percolation, DPR:

Deep percolation was determined using Eq (9). The highest deep percolation loss was observed for continuous treatments and the least deep percolation losses for the CR1 (Table 5). The maximum deep percolation loss (41%) was observed in continuous treatment(2.1 L/s and 70m) and the least deep percolation loss (2%) was recorded for surge flow treatment (CR1 , 2.1 L/s , 70m and 3surges) . So that , the deep percolation was very high for continuous flow treatment but small for surge flow irrigations.

4-5-5- Tail water ratio, TRW:

This parameter is ignored in this study because the furrows had a blocked end and that implies that all the loss during irrigation are only due to deep percolation.

CONCLUSION

Results indicated that the water in surge flow treatments advanced than the respective continuous flow treatments due to the influence of the wetting and drying cycles on soil infiltration characteristics. Surges treatment had a better application efficiency and distribution uniformity than the continuous treatments but continuous treatments had better storage efficiency. The maximum deep percolation loss was observed in continuous treatment. Therefore, less water was consumed to attain a given advance distance. Thus, a better water distribution in the soil was observed.

Surge flow irrigation can apply under short length of furrow for acceptable results regarding to water saving . It is comparable to the results obtained in long field conditions. The evaluation of the field experiments and selection of the best treatments in view of application efficiency, water saving and crop production will be further investigated.

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Appendix A:

$$\gamma_2=\frac{\log\left[\left(\sqrt{Y_{max}^2+(T_{mid}-Base)^2}+\sqrt{Y_{max}^2+(T_{max}-T_{mid})^2}\right)/\sqrt{Y_{max}^2+(T_{mid}-Base)^2}\right]}{\log 2}$$

$$\gamma_1=\frac{\left[\sqrt{Y_{max}^2+(T_{mid}-Base)^2}+\sqrt{Y_{max}^2+(T_{max}-T_{mid})^2}\right]}{Y_{max}^{\gamma_2}}$$

$$\sigma_2=\frac{\log\left[\left(\left(\frac{Y_{max}}{2}\right)\left(\left(\frac{Base}{2}\right)+T_{mid}+\left(\frac{T_{max}}{2}\right)\right)\right)/\left(\left(\frac{Y_{max}}{2}\right)\left(\left(\frac{Base}{2}\right)+\left(\frac{T_{mid}}{2}\right)\right)\right)\right]}{\log 2}$$

$$\sigma_1=\frac{\left[\left(\frac{Y_{max}}{2}\right)\left(\frac{Base}{2}\right)+T_{mid}+\left(\frac{T_{max}}{2}\right)\right]}{Y_{max}^{\sigma_2}}\ ,\ \rho_2=\frac{10}{3}-\frac{4\gamma_2}{3\sigma_2}\ ,\ \rho_1=\frac{\sigma_1^{10/3}}{\gamma_1^{4/3}}$$

الملخص العربي

دراسات هيدرولية على طريقة الري النبضي بالخطوط باستخدام الأنابيب المبوبة في تربة طينية طمية

باسل تركي الدعفيس[١] ، محمود محمد حجازي[٢] ، خالد فران الباجوري[٣]

أجريت هذه الدراسة لتقييم الري النبضي مقارنة" بالري المستمر في مزرعة تجارب كلية الزراعة جامعة عين شمس ،الكائنة في قرية شلقان والتي تبعد مسافة ١ كم عن منطقة القناطر الخيرية في محافظة القليوبية في مصر وذلك على خطوط بطول ٧٠ و ٩٠ متر والمسافة بين الخطوط ٠,٧٥ متر وبميل 0.2 % على تربة طينية طمية وذلك بالأستعانة بنظام ري الانابيب المبوبة.

التجربة الحقلية كانت مؤلفة من معاملة ري مستمر و٣ معاملات ري نبضي (٣ و٤ و ٥ نبضات) وبمعدلي تدفق إلى الخط ١,٦٧ و٢,١ ل/ثا وكانت لدينا نسبتين للدورة ٠,٥ بمعدل فتح ١٥ دقيقة وغلق ١٥ دقيقة والنسبة الاخرى ٠,٣٣ بمعدل فتح ١٥ دقيقة وغلق ٣٠ دقيقة.

وكان الهدف من التجربة لقياس معدل التقدم والإنحسار وعمق البلل والتسرب التراكمي وكفاءة التطبيق وانتظامية التوزيع وانتظامية التوزيع المطلقة وكفاءة التخزين والتسرب العميق ونسبة فقد المياه من اخر الخط. دلت النتائج على أن سرعة تقدم المياه كانت اعلى في الري النبضي عنه في الري المستمر وكذلك كفاءة التطبيق وانتظامية التوزيع كانت اعلى في معاملات الري النبضي حيث تراوحت قيم كفاءة التطبيق بين ٦٩ الى٩٨% بالنسبة للري النبضي ومن ٥٩ الى ٧٨% بالنسبة للري المستمر ، أما انتظامية التوزيع فسجلت ٨٢% عند أفضل معاملة للري المستمر بينما كانت قيم الانتظامية اكبر من ٨٢% في ٨٧% من معاملات الري النبضي ، في نفس الوقت كانت كفاءة التخزين أعلى منها في الري المستمر عنها في الري النبضي ، وسجل اكبر تسرب عميق تحت منطقة الجذور ٤١% وكان ذلك في إحدى معاملة ري المستمر.

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