Manufacture a local device for water automatically distribution using surge furrow irrigation

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Abstract: -

Application of surge irrigation has a great effect on Vertisol manipulation as the soil consumes huge amount of water during summer season. As there is no available mechanism to reduce the risk of water loss in the soil. Therefore, this study attempt to design a proto type model that can spray water very easily in the field using solar energy. The system was installed in the field to determine its ability for working during several months with high efficiency. It was noticed that the merino was able to give a high efficiency with coefficient of variation (CV) less than 10%, moreover the results demonstrated that the system can generate enough power to control swich on awls Wien off the machine and many the time opened and closure time synchronizing. Finally, the new automatic surge irrigation system is economic and mobile. It could offer reasonable beneficial for the farmer in Iraqi Kurdistan region.

Keywords**:** Surge irrigation, Solar energy, Vertisol

Introduction: -

Furrow irrigation is one of the immemorial and common methods used in irrigation, in this method soil surface is utilized to covey and infiltrate water. Comparative with other methods such as sprinkler or trickle methods this method is inexpensive, therefore more attention is considering to improve the efficiency of this irrigation. using of surface irrigation in Vertisols has many obstacles. To syudy this effect, it is important to go forward and make more progress of using new innovation for irrigating to overcome the restraints in these soils , and to irrigated a large area very easily with short time (12and3). During the summer season, these soils shrink and the shrinkage is manifested in form of deep, wide and extensive cracks, these soils can produce high productivity, if a good soil management can be achieved (17). In Kurdistan region there are more than 7000 hectares of Vertisols where most of these soils are fine textured soils and exhibit high swell shrink potential(8, 18). Surge irrigation consider as alternative water management method for furrows irrigation especially in Vertisols because the soil under this class usually exhibit to appear a cracks and high water and solute will loss (6). Khursheed (9) indicate that the water and solutes flow rapidly through the cracks that are formed during the summer season, thus by passing the relatively dry root zone. This process leads to nutrient shortage for crops and to pollution of subsoil and ground water. Surge flow irrigation is the intermittent application of water to furrows or borders in a series of relatively short on and off time periods, which usually vary from about 5 minutes to several hours. This method is an attempt as to reduce the deep percolation and amount of irrigation lost by runoff (5). The flow of surge system will increase the advance phase of water as well as decrease the deep percolation by reduce amount of water to irrigate the field when compare to the traditional methods and labor as well as improve distribution uniformity (13 and 4).The surge flow technology was first developed and used by Stringham and Keller(14) and Varlev *et. al*.(15). There are many efforts to develop design of surge irrigation system by using automatic butter fly valve, solenoid valve and pneumatic control system(16),also another attempt was conducted to make the system mobile and fueled by renewable energy sources(1). However, the lack of significant interest by farmers did not allow for a widely-spread application of this advanced technology. Finally,

the goals of this study were focused on design, manufacture and testing of automatic surge irrigation driving by solar energy cell to improve the efficiency of irrigation and control the restrictions in Vertisols due formation of cracks at Duhok province soils of Kurdistan region.

2-Materials and methods

Location**:**

This study was conducted at the faculty of agriculture and forestry, College in Sumailcity about 13 km

west of Duhok province(36° 51′ N, 52° 02′ E), and at an altitude of 473 m above sea level. The soil texture is salty clay as it shown with soil physical properties in Table 1.

Automatic surge setup:

Energy unit:

Solar energy panel(PV) was used as an essentially source of energy for automatic surge system, the cell dimension is52*58 cm, output power 25 as shown in figure (1), this panel supply 22.3v and generate 2.07A of current. The solar energy is originally imported from (Rich solar company, Nevada, USA).The solar cell was connected to solar charge controller which suitable for 12 or 25V and can automatically operates to 10A (*CE,China*). The energy container at this unit is Mobile battery with DC 50A and 12v. The battery connected to control charge and from other side connected with electricity converter which supplies the ability of the system to work in both AC and DC current.

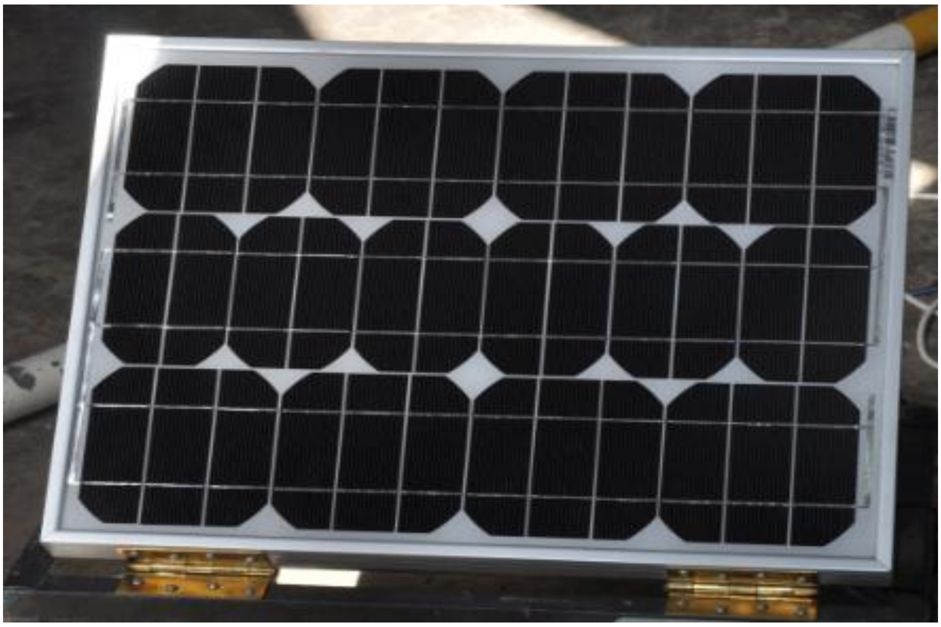

Figure (1): solar energy cell

Table (1)Soil texture and Physical properties.

Depth (cm)	Particle size distribution g/kg			Textural name	PLS (%)	Bulk density (Mg m^{-3})
	Sand	Silt	Clay			
0 – 10	42.9	452.2	504.9	Silty clay	12.23	1.34
10-20	44.9	542.8	412.3	Silty clay	13.19	1.496
20-40	58	414.3	527.7	Silty clay	11.34	1.55

Valves:

The solenoid valve with diaphragm gate was used in this system; orifice diameter was 85.4 mm with two-way direction, the valve work in the pressure from 1 to 6 Par (TDRK, com.). The surge valve is placed in the middle of the gated pipe and act as switcher of water from one side to another side in the field as presented in Figure(2). The solenoid connected with electronic timing system which controls the timing in advance regarding to the cycle time of irrigation that determined by the operator.

Figure (2): surge gets valve system

Electric controller:

The electric controller board includes two Automatic timers which have the ability to control the time in second, minute and hour, also each timer connected to conductor which element the overheat for each timer during the operation for long period as shown in figure (3). The input current for system timer 10 A, and we can set the timer manually or automatically.

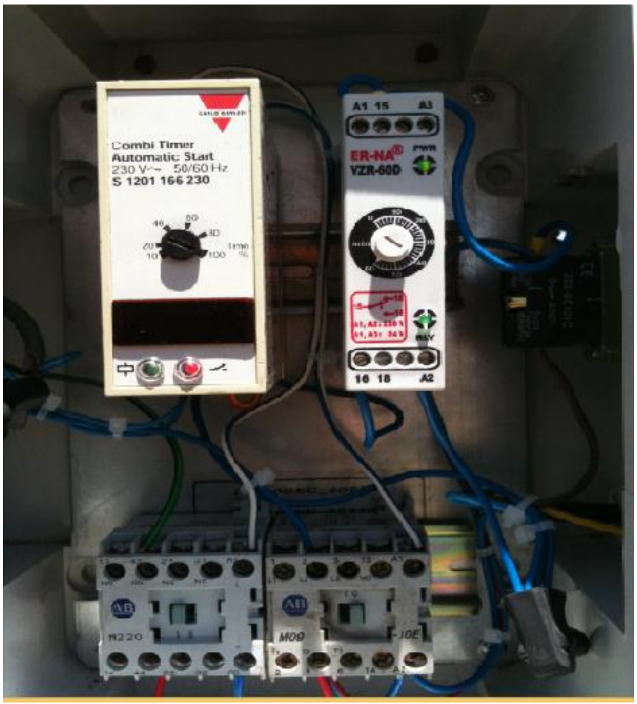

Figure (3)Electric controller board

Experimental procedure:

The automatic surge irrigation was located in the middle of the field, regarding to position of surge the piping system divides in two sides A and B, the length of each side was six meter. The diameter of this sub pipe (PVC) was 3in. At each side, we have 5 mechanical orifices which control led manually, the distance between this orifice is constant at each side as Shawn in figure (4). The main pipe is pumped the water at constant pressure of 2 bar which highly stable during the experiment.

Figure (4): main line pipes on both sides

Statistical analysis:

The statistical analysis was conduct using factorial statistical analysis under completed randomized design (CRD). The first factor was the distance from automatic surge which was six levels included (0.4, 1.15., 1.9, 2.65, 3.4 and 4.15 m), the second factor was the time with six levels included (10, 20, 30,40,50 and 60 min).This experiment was replicated three times and the average of both sides was adopted. The difference between means was determined using Duncan's test.

3-Result and Discussion:

Effect of study parameter on discharge stability:

The statistical effect of study parameters on discharge stability can be seen in Table (2). The analysis of variance was showed high significant effect at statistical level of < 0.01 for the distance, time and the interaction between distance and time on water discharge stability at automatic surge irrigation system. This result indicated that both distance from surge system and time had a significant effect on discharge stability.

Table (2): ANOVA table of Automatic surge discharge stability

Sources	DF	SS	MS	F-table		F-C
Distance (m)	5	0.0996	0.0199	7780.5**		<0.0001
Time (min)	5	0.2275	0.0455	1782**		<0.0001
Distance*Time	25	0.0421	0.0016	66**		<0.0001
Rep	2	0.0001	0.0006	2.87		0.9609

** High significantly effect at 0.01

The results at Table (3) was showed the lowest discharge (0.42l.sec^{-1}) at distance of 4.1 m, whereas the highest value (0.51 l.sec^{-1}) with distance of 2.55 m which was 21.4% more than the lowest value. All the distance of research obtained close values excepted the distance of 2.55m. This result may be due to industrial manufacturing of this water orifice which purchase from local market. Moreover, the different of discharge between closely and far orifice was less than 10%, which about 9.5%, and this result reflected the efficiency of surge irrigation system. Furthermore, the effective of time on water discharge with presence of automatic surge showed the highest discharge (0.50 l.sec^{-1}) are given after 10 min, while the lowest discharge (0.36 l.sec^{-1}) recorded after 50 min, the different in percentage of discharge between 10 to 60 min was about 38.8%.The interaction between distance and time recorded higher discharge (0.58 l.sec^{-1}) to the interaction of 10 min and 2.55 m, whereas the lower irrigation discharge (0.33

l.sec^{-1}) was observed after 50 min and 4.8 m of distance from the surge irrigation.

Table (3): effect of distance and irrigation time on discharge stability

Distance (m)	Irrigation time(min)						Distance Average
	10	20	30	40	50	60	
0.4	0.49 f	0.46 ji	0.47hg	0.47 hg	038 p	0.48 g	0.46 c
1.15	0.47 hi	0.46 jk	0.44 nm	0.44 n	0.36 q	0.44 n	0.43 e
1.9	0.58a	0.56bc	0.55 c	0.54 c	0.36 q	0.44 nm	0.51 a
2.65	0.53 d	0.55 c	0.51 e	0.51 e	0.40 o	0.51 e	0.44 b
3.4	0.49 f	0.46 ji	0.47 hi	0.47 hi	0.35 r	0.47 hg	0.45 d
4.15	0.44 nm	0.45 kl	0.45ml	0.45 ml	0.33 s	0.44 m	0.42 f
Time Average	0.50 a	0.43 b	0.48 c	0.48d	0.36 e	0.46 f	

The regression relation of distance with discharge presented in fig.5. The correlation relation showed positive relation with (R^2=0.307) between distance as an independent factor and surge system discharge as dependent factor, also the quadratic equation model can fit and well represent this relation.

The regression relation between time and surge system discharge showed fig.6. The quadratic equation model was fit and represents this relation of time and discharge stability of surge system in a good way. Moreover, the relation was obviously positive and the correlation factor is(R^2=0.34).

3-2- Effect of study parameter on coefficient of variation (C.V):

The analysis of variance of study parameters on coefficient of variation (C.V) are presented in table (4). The observed analysis of variance was recorded high significant differed at statistical level of < 0.01 for the distance, time and the interaction between distance and time on coefficient of variation at automatic surge irrigation system. This result explained how both of distance from surge system and time affected deeply in coefficient of variation of designed system.

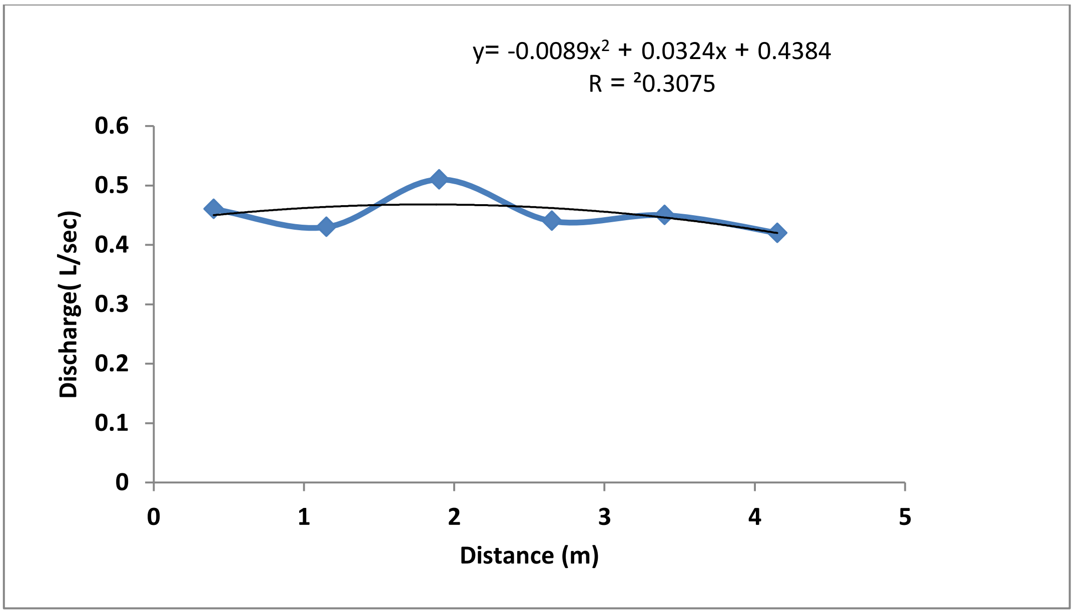

Figure (5): Regression relation of distance with discharge

Effect of study parameter on coefficient of variation (C.V):

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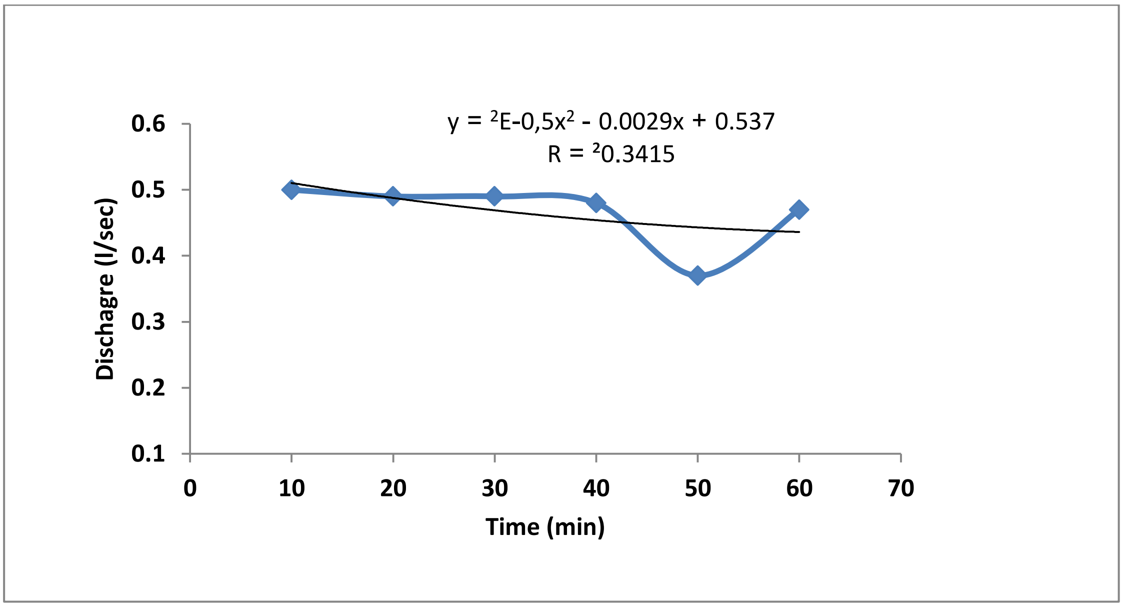
Table (4) was showed the effects of distance and time of automatic surge on coefficient of variation (C.V). The distance of 1.15m recorded higher C.V which was 2.64, whereas the lowest coefficient was 2.06at distance of 1.9 m, the distance of 0.4, 1.15. 2.65, and 3.4 m obtained insignificant different. The standard acceptable of coefficient variation was 10% and the study distances was given lower than this value, these results indicated that our system was durable and can adopt for commercial application. The times obtained highest coefficient of (2.66%) after time of 30 min, and this time have on significant differed from times of

Table (4): ANOVA table of Automatic Surge Coefficient of variation

Sources	DF	SS	MS	F-table		F-C
Distance (m)	5	5.7979	1.1596	7.3**		<0.0001
Time (min)	5	4.4365	0.8873	5.53**		0.0002
Distance*Time	25	17.4237	0.6969	4.39**		<0.0001
Rep	2	0.01266	0.0063	0.04		0.9609

** High significantly effect at 0.01



Figure(6): The regression releation of time with dischrage

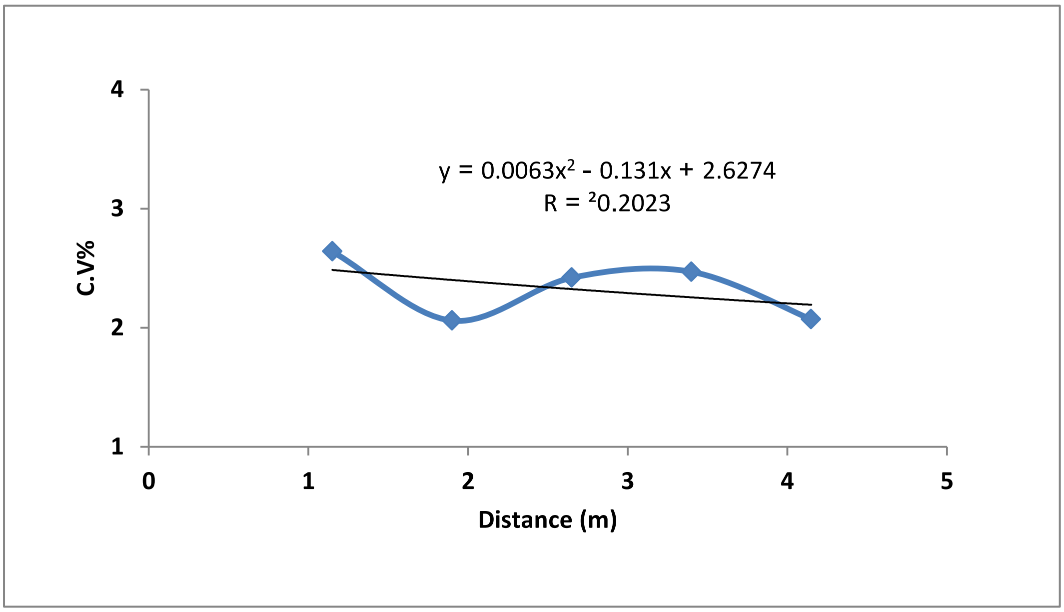
10 and 20 min. whereas the lowest coefficient of variation was (2.15%) obtained after 60 min. This result explained that the superior of C.V was recoded after 60 min of time and the at all times the coefficient was less than 3% which is high acceptable C.V for farmer application and utilizing of surge automatic system. The binary interaction between distance and time was given lowest coefficient (1.51%) in the interaction of 1.15 m and 50 min of time, whereas the highest coefficient was (3.63%) at distance of 3.4 m and time of 20 min. The interaction results were showed that the C.V of all experimental treatments were within acceptable average of any product.

The relation between time in mintues and C.V can be seen in Fig.8. The relation showed high positive correlation with factor of correlation of (R^2=0.675), this factor can be considered reflect high corelation bewteen independent and dependeut factors. Although, the quradctic equition are fit with this relation.

Table (5): effect of distance and irrigation time on coefficient of variation

Distance (m)	Irrigation time(min)						Distance Average
	10	**20**	**30**	**40**	**50**	**60**	
0.4	2.43 defhij	2.32 fhij	3.30 abc	2.24efgh ij	2.93bcde	2.36 eghji	2.6 0a
1.15	3.16 bcd	2.24 efghij	3.96 a	2.73 def	1.54 j	2.23efghji	2.64 a
1.90	2.06 bcd	2.36 efghi	2.05efgh ji	1.71 ji	2.14efgh ij	2.07 fghij	2.06 b
2.65	2.53 dfgh	2.83 cdef	2.15efgh ji	2.44efgj hi	2.31efgh j	2.25 efgjhi	2.42 a
3.4	2.63 cdefg	3.63 ab	2.45defj hi	1.75 hij	2.26efgh j	2.10 fghji	2.47 a
4.15	2.36 efghi	1.77 h ji	2.07fghji	2.15efgh ji	2.13efgh ji	1.88hij	2.07 b
Time Average	2.53 a	2.66 a	2.66 a	2.18 b	2.22 b	2.15 b	

The regressin relation of distance in meter with coefficient of varition (C.V%) can be showed in fig.7. The relation was postive bewteen distance as an indepemdent and C.V as dependent with corleation factor of (R^2=0.202), also the level of quradtic regression equation is repsented this realtion verywell.

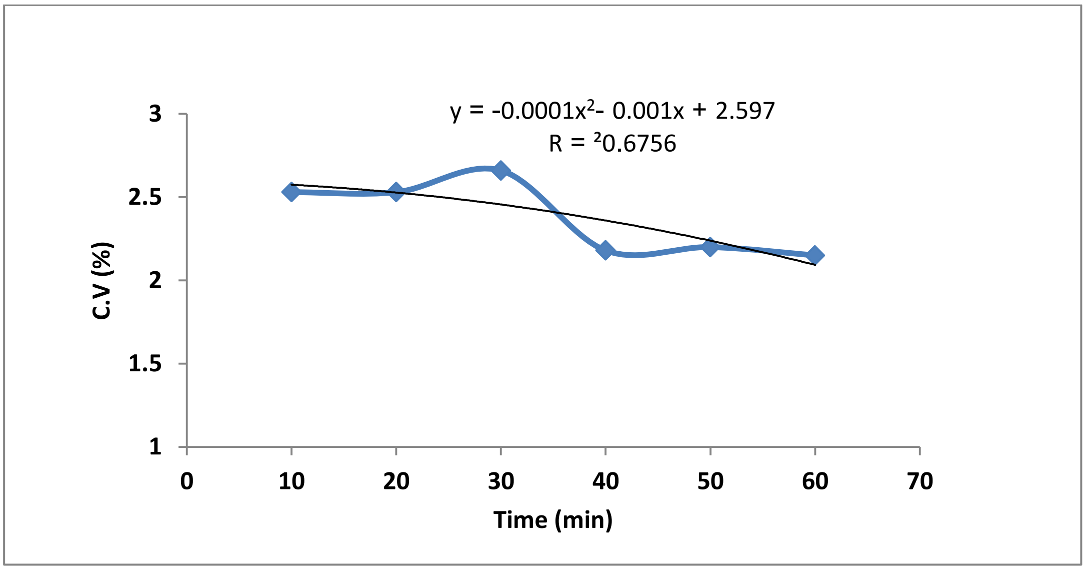


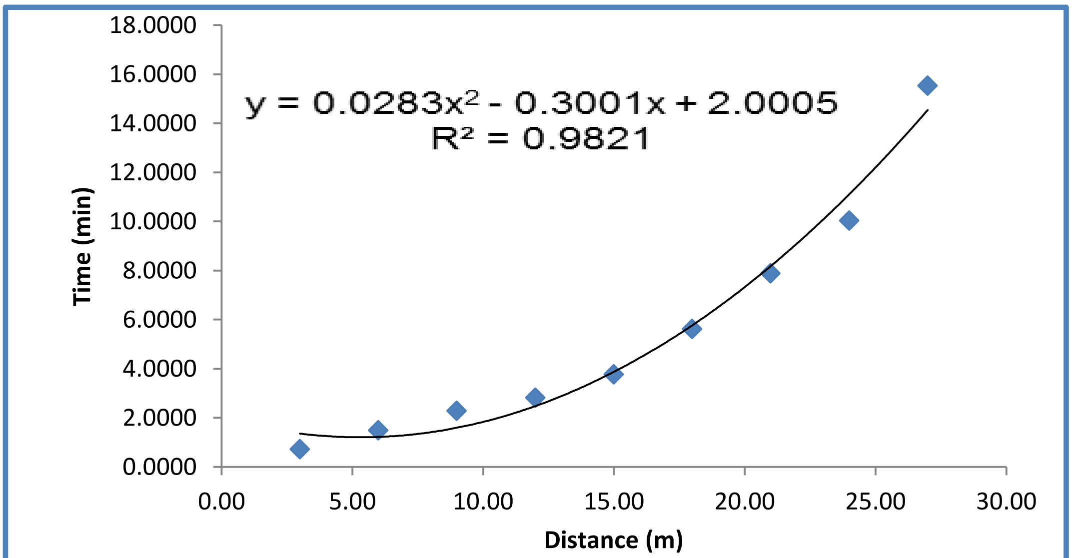
Figure(7): Regression relation of time with C.V

Field test for advance time

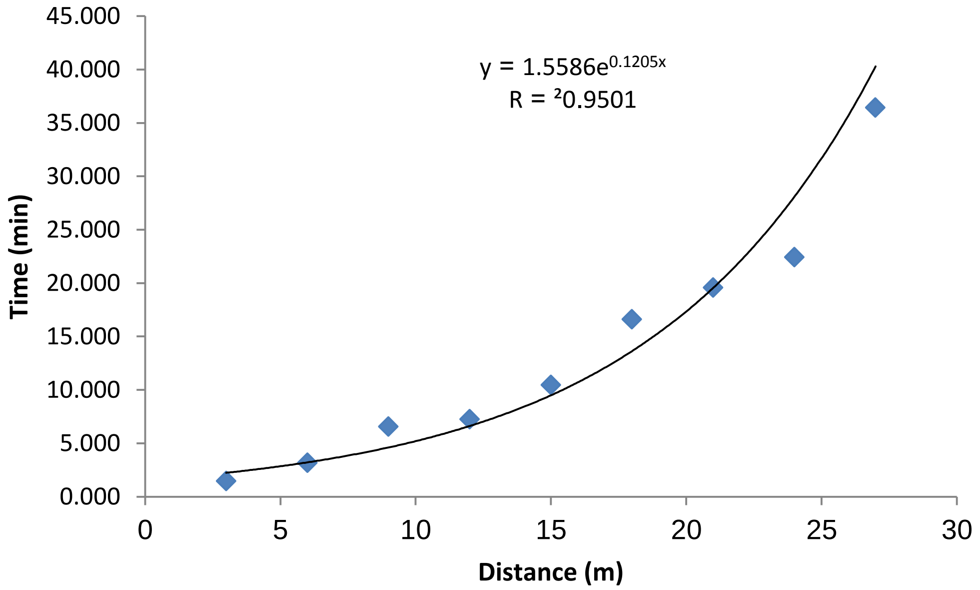
Fig. 9 and 10 showed the advance time flow in furrow irrigation in both surge and continuous respectively. The advance time for surge irrigation was faster than continuous irrigation with using the same furrow dimension and flow rate, here each furrow received the same volume of water. In the same study done by Fard *et. al.*(1) showed that with the same furrow inflow rate and volume of irrigation water the advance of water in surge flow irrigation was faster as compared to the continuous flow. It is commendable to notice that the surge irrigation has a great effect on water distribution compared to the continuous irrigation. This may be due to the fact that surge flow irrigation reduced the infiltration rate and increased the advance rate (10). The study done by Horst *et. al.*(2) ,Ismail *et. al.*(7) , Latif *et. al.*(11) and Zaghloul *et. al.*(19) that the advance distance is completed with less time in surge flow compared to the continuous flow irrigation. Finally, the using of surge irrigation can get amazing results and land can irrigate easier to apply with using Automatic surge irrigation apparatus.

Figure(8): The regression relation of time with C.V





Figure(9): Advance curve for the surge flow irrigation



Figure(10): Advance curve for the continuous flow irrigation

Conclusion

It is concluded that the system able to irrigate a vast area in a very short time with using surge irrigation technique that lead to reduce water loss compare to the traditional method. The results appear that the system is durable to operate for the long period with high efficiency, the system was manufacturing to be portable and simple using for farmer and the parts needed are available and inexpensive in the same time, the system can able to irrigate a number of furrows depending on the available discharge. The results were showed that the stability of irrigation system after one hour high stability and uniform. Also, the coefficient of variation (CV) given low and acceptable value and can be adopted as industrial product

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تصميم جهاز محلى لغرض توزيع المياه بشكل تلقائى باستخدام تقنية الري المتقطع على طريقة الري بالمروز

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المستخلص:-

اضافة الماء بطريقة الري المتقطع في المروز لها تاثير ايجابى لمعالجة ترب الفيرتيسول، حيث تستهلك هذه الترب كميات كبيرة من الماء خلال موسم الصيف ولعدم توفر الية لتقليل فقد الماء من التربة لذلك مما دفعنا لتصميم جهاز محلي الصنع متنقل يمكن ان يوزع الماء بشكل سهل جدا يعمل بالطاقة الشمسية. تم نصب هذا الجهاز في الحقل ولعدة اشهر ولذلك للاختبار كفائتة، حيث وجد بان الجهاز له قابلية وبكفاءة عالية وبعد تحليل البيانات وجد بأن معامل اختلاف اقل من 10%،واظهرت النتائج حيث ان الجهاز يمكن ان يولد كمية كافية من الطاقة للسيطرة على غلق وفتح الماء وتنظيم الوقت. اضافة الى أن الجهاز اقتصادي في اضافة الماء ومتنقل حيث يمكن ان يعطي نتائج مرضية للفلاحين والعاملين في مجال الزراعة في اقليم كردستان العراق.

كلمات مفتاحية :-الري المتقطع، تلقائى، طاقة شمسية، فيرتسول