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Finding the Optimized Distance of Emitters in the Drip Irrigation in Loam-Sandy Soil in the Ghaeme Abad Plain of Kerman, Iran

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Abstract: In this research, the effect of emitter discharge amount and period of irrigation instead of applied water volume, on amount of wetted area was examined. The field measurements on sand- loamy soil was done in GHAEME ABAD of Kerman. Three amounts of discharge emitter, 4,8,24 lit per hour was chose and after installation of emitters on pipes the water flowed and amount of wetted soil instead of different period of irrigation was determined and measured as if after finishing the period of irrigation, the flow of per bifurcation is interrupted and immediately the movement moisture on the surface soil in two directions which are vertical, were measured. Also, after passing 24hours when the period of irrigation is finished and existence of water gravity with creating a vertical shear in the location of emitters the amount of diameter and depth of wetted soil with 10 Cm distance to the end of wet bulb were determined and compared with the measures which were measured after interruption of flow. The maximum diameter and depth of wetted soil for calculations were choose and after analysis of data, the evaluations were presented for determining the amount of diameter and depth of wetted soil by per emitter with certain discharge. These relations determine the amount moisture advance in vertical and horizontal directions. Accordingly, the suitable distance among the emitters on laterals is guessed.

Key words: Drip irrigation · Point source · Wet barrier · Optimized distance · Wet bulb

INTRODUCTION

The movement of water in the soil is one of most important parameters in the designing of irrigation systems. The water advance in the soil from a point source, emitter and expansion of wet bulb depends on many factors such as soil texture, amount of discharging of emitters, the period of performance and bulk density of soil. The selection of emitter in the drip irrigation method is one of the most important factor of designing because the efficiency of a drip system depends on the selection of emitters and standards of designing and not paying attention to the problem of emitters contribute to decrease of monotony of water distribution, increasing in period of performance of system and permanent replacement of emitters [1-4].

Hoori and Alizadeh, 2007 In the drip irrigation method, some parts of soil usually become wetted. This amount of wetting depends on miscellanies factors which include discharge of emitter, the distance among the emitters, the distance of laterals from each other, kind of soil and the slope of land and period of irrigation or volume of water which is left from emitter in per irrigation. The wetted parts which are around per emitter is usually small and it is extended like a upside down bulb in the depth of soil as if under per emitter the volume of soil which is called wet bulb becomes wet [1]. Accordingly, it is necessary that the wetting pattern of soil profile or the volume of wet bulb will be predetermined for per land which should be irrigated with drip method [5, 1].

The water volume of irrigation have effect on wet bulb which is one of the most important and effective parameters in selection of emitter. The distance among the emitters is determined on the basis of form of wet pattern and area which is occupied with per emitter. The period of irrigation depends on when wet barrier arrives to root of a plan after beginning of irrigation. The distance of out lets, the flow intensity and period of irrigation should be designed as though the volume of wetted soil close to the volume of root plant. Thus, the observation of form and volume of wetted soil under emitters in order to supplying the demand of plant water, optimistic management and increasing of irrigation efficiency is necessary. For knowing that whether the referred emitter soak the

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favorable area or not, the concluded wet pattern is needed so that on basis of this patterns, the distance among the emitters could be determined [2-4].

The Kerman province which has about 18.2 million Hectare is located on the southern east of Iran and it covers about eleven percent of country. Its climate has a various conditions. The severe differences of heights, latitude and locating beside of one of the driest desert in the world are the reasons of this diversity. This province whose average annual rainfall is about 140mm always is facing the running sands for it is located in the desert region. In order to lands stabilization and preventing of the movement of running sands the application of drip irrigation method in the province sounds necessary. According to presented statistic with the management of water and soil organization of province on Dec of 2010, about 20500 Hectare of north lands of province except Jiroft and Kahnooj are equipped with drip irrigation [2-4,6-11].

In recent years, many researchers have examined the dimensions of the wetted pattern of soil in drip irrigation and determination of wet bulb form and the distance of emitters and in all of them miscellanies factors, such as discharge of emitter, the volume of output water of emitter, texture and structure of soil, are interfered in such away. Moreover, analytic solutions and miscellanies factors with considering making simples, different theories are presented which show the importance of examination and state of distribution of moisture from drip source in drip irrigation in order to designing of this system with the circumstances of the farm as if the lack of humidity of region of root of plan supply and the minimum wasting and maximum of irrigation is resulted [2-4,10].

Haghighati, 1998, in order to evaluate the effect of soil kind, discharge, distance and emitter pattern on the wetted surface made a design by three soil texture, three emitter distance, three amount discharge of emitter: 4,8,12 lit per hour, three emitter pattern :one, two, rows and centralized. The results of this plan showed that the increase in discharge of emitters contribute to increase the percent of wetted surface of soil and the increase trend according to soil texture and pattern of emitters is different. Also, he presented tables for the soils which were under study for different amounts of discharge and distances of emitters and distances among the rows of plants, so that the percent of wetted surface can be estimated [12].

Mostafazadeh. *et at* 2001, they made desert studies on three kinds of soil texture, three amount of emitter discharge: 4,8,12, lit per hour, four surface ground slope: 0,2,5,10 percent and five water volume of irrigation :10,20,30,40 and 50 lit in order to evaluate the effect of land slope, the discharge of emitter, the water volume of irrigation and soil texture on the moisture barrier from a drip point and they concluded that with increasing of emitters discharge, the wetted surface was increased and the same water volume of irrigation with less discharge the wetted barrier had more depth, but in general, the volume of wetted moisture barrier increased with the increasing of discharge. The volume of water irrigation had a direct impact on volume of moisture barrier and the volume of wetted barrier had increased with increasing of water volume of irrigation as if they reported that the effect of water volume of irrigation on the wetted surface of irrigation is more than the discharge of emitter in this volume [13].

Mirzaee *et al,* 2008 in order to making samples of wetted barrier, they earned equations by effective physical factors on the volume of moisture soil under linear simple borrow and BAKINGHAM Theory and dimension analysis which showed good harmony with the results of experiments as if there is always the possibility of calculation of diameter and depth of wetted surface of soil [14].

Pelangi and Akhondali, 2008they evaluated the soil which has sand texture, for estimating the form of wetted barrier which is resulting from a point source and they measured the maximum diameter and depth of wet bulb in different times after beginning of irrigation instead of per discharge. Thus, the semi-experimental equations were earned with the assistance of physical factors which dominate the movement of water in the soil in the drip irrigation, under a drip source and Buckingham Theory and dimension analysis [15].

Koo and Tucker, 1975they had examined the effect of various discharges on distribution of soil moisture under drip irrigation in the citrus fruits garden and they concluded that the lateral movement of water in the grain soil texture is more than in the soil with coarse texture. Also, the maximum horizontal diameter distribution of water with the discharge: from378 to 453 lit per hour from0.6 to 1.5m according to soil texture is varied. Hence, 6 percent of root's soil region contributes to have satisfied product in the citrus fruits [16].

Schwartzman and Zur, 1986 they evaluated the volume form of wetted soil under drip irrigation and they presented experimental equations. Also, they earned coefficients for these equations on the basis of experiments and solutions of two dimension flow equations. oreover, hey showed that the ratio of width

to depth of wetted soil, with increasing in amount of hydraulic conduction of soil tended to decrease and increasing in amount of depth of applied water will decrease the ratio of width to depth, particularly in the soils with fine texture is significant. In addition, increasing in amount of emitter discharge, the ratio of width to depth with a certain impact on soils with moderately-coarse texture will increase [17].

Chu,1994 he presented an equation by three dimensional Green AMPT model for achieving depth and diameter of wetted soil with certain discharge of emitter which is function of wetted radius and saturation radius in area and the period of irrigation [18].

Ali khan *et al,* 1996 they studied the distribution of water in profile soil under a drip point and they concluded that the ratio of wet barrier advance changes with changing discharge of emitter and the water volume of irrigation as if in less discharges the depth of wet barrier became more wetted and in more discharges, the horizontal movement increase and the depth of penetration is reduced [19].

Alqinna and Abuawwad, 2001 they studied the effect of superficial crust on advance of moisture barrier instead of applied different amounts of water from a source in drip irrigation and th ey presented equations for horizontal and vertical advance of wet barrier. They saw that increasing in amount of discharge increase the ratio of horizontal movement of water, but vertical advance of water decrease significantly because of surface crest which contribute to decrease of amount of penetration. The distance of emitters in the soils which are faced to surface crest usually should be wider than distance of emitters in the soil without crest instead of one kind of soil and certain ratio of discharge. Moreover, they suggested that the discharge of emitter should be selected small in order to improvement of depth penetration of water and decrease of wetting of soil surface in regions which are in dry and semi-dry and the soils that are facing crust, for wasting of water with and decrease of supplement of soil water in the zones of expansion growth increase [20].

Thorburn *et al,* 2003 they concluded that among the distance of drip irrigation, the ratio of flow, the wet characteristics of soil and period of irrigation should be a harmony in the drip irrigation for improvement of efficiency of consumption water and mineral material [21].

Li *et al,* 2004 they studied on the sandy and loamy soils and they recorded the replacement situation of the wet barrier on the soil surface and in vertical surface in the different times in the period of examination [22]. Therefore, they saw that wet patterns which are determined according to wet radius and depth of wetting, z, from a drip source and they presented equations which are effective for determination of this wet dimensions for estimating of essential period of irrigation in order to achieving radius and depth of wetted with selection of amount of discharge for a certain soil [22,4].

Thabet and Zayani 2008, they studied the effect of emitter discharge: 1.5 and 4 lit per hour on the wetted patterns in sandy- loamy soil and they achieved equations in order to determination of ratio of wet barrier advance in different directions. They saw that with the passing of time, the vertical amount of advance in the emitters which have more ratio of discharge is more than the emitters that have fewer amounts of discharge. Also, after passing 180 minutes from beginning of examination, increasing of ratio wet radius was related with more discharge. However, after that the behavior was inverted and the maximum wetted radius was selected according to lower discharge and more amounts of discharge bring more lateral advance [23].

Acer *et al* 2009 they examined the effect of discharges: 2 and 4 lit per hour on amount of vertical and horizontal advance of wet barrier in the soil which have loamy- sandy soil and they saw that different values of discharge of emitter have no significant impact on horizontal and vertical movement on the wet barrier,but the application of different values of water has significant effect on vertical movement of wet barrier; also, increase of water irrigation volume cause the growth of vertical movement. Consequently, increase of applied water volume and discharge of emitter provide the maximum wetted volume of soil [24].

Similarly, in this research, the effect of factors on advance of wet barrier, such as the amount of emitter discharge and period of irrigation instead of certain volume of applied water in a soil which has loamy- sandy texture has examined and finally the equations in order to determine the amount of horizontal and vertical movement of moisture have presented and with the usage of these equations, the amount of diameter and depth of wet bulb with considering the ratio of applied discharge instead of different period of irrigation will be determined. Consequently, with paying attention to area in which per emitter with certain discharge soak, the best distance between the emitters is estimated.

MATERIALS AND MATERIALS

The available research on July of 2010 on a soil which has sandy- loam texture around the city of Kerman and GHAEME ABAD region that has 57°, 07’ eastern

Table 1: The measured results of soil textures and physical and chemical characteristics of soil

The depth of making samplis (cm)	Sand (%)	Clay (%)	Silt (%)	Soil texture	The ratio of sodium absorption (SAR)	ρb (gr/cm^3)	PH	EC (ds/m)
30-0	65.60	8.60	25.80	Loam-sandy	8.07	1.73	8.09	1.92
60-30	54.00	17.40	28.60	Loam-sandy	8.76	1.70	7.88	5.30
90-60	50.00	11.00	39.00	Loam	12.85	1.72	7.770	10.73
120-90	71.00	5.00	24.00	Loam-sandy	10.67	1.75	7.66	8.15

Fig. 1: A view of emitters which are compensating emitter

Fig. 2: A view of pipes and emitters situation on the soil surface

longitude and 30°, 18' northern latitude and with 1754 height from the sea surface was done. The climate of this region which has 140 mm average annual rainfall and the average of temperature on Jul is 28°c, is dry.

In order to achieving soil texture which has effect on developing of wetted pattern, making samples from soil in different depths: 0-30, 30-60, 60-90, 90-120 Cm was done and not only the soil texture but also the bulk density was achieved. The conclusions of measurement of texture percent of soil and physical and chemical characteristics of soil which is under study are collected. (Table1)

Three types of emitter which are compensating emitter for doing examination, were selected,And they have different discharges: 4,8,24 lit per hour. (Fig1)

Three rows of polyethylene pipe which have two meters distance with considering three amount of discharge emitter, were put on the soil surface for per step of examination. The selection of pipes distance with paying attention to the amount of discharge and work-hours of discharge for convenient digging, the observation of wetting pattern and not facing of wet bulb was done. After installation of pipes on the soil surface, two emitters were located on per bifurcation with the same discharge with two meter distance on per bifurcation in order that not overlapping and not effecting on each others. (Fig 2)

There was one orchard value in the beginning of per bifurcation in order to provide the possibility of breaking off and connecting for per series of emitter in favorable time.

After finishing of period of irrigation of per series of emitters, the flounce of that bifurcation broke off and immediately the amount of advance of moisture on the soil surface from the place of installation of emitter in the two directions which are vertical, were measured.

After interruption of flow and finishing of irrigation period, the movement of wet barrier continued, so after passing 24 hours from interruption of flow that the gravity water was existed and the soil moisture arrived in the farming capacity, the measurement of ratio of horizontal movement of wet barrier in the profile soil was done as thought with creating a vertical cut from the installation of the emitter to the end of wet bulb, the wetting pattern was observed and the amount of diameter and depth of wetted soil with 10 Cm distance in where the border between volume of wetted soil and dry soil was determined well instead of different period of irrigation, was recorded. Also, they were compared with the measured amounts immediately after interruption of flow. Consequently, the maximum amount of diameter and depth of wet bulb instead work-hours of emitter for related calculations and different steps of research were chose.

After collecting and acquisition of data, the statistic calculations were done and equations in order to determination of vertical and horizontal advancing of wet barrier were achieved so that with the assistance of these equations the ratio of depth and diameter of wetted soil will be determined and the suitable distance among the outlets will achieve.

RESULTS

In order to more explanation of results, the alterations of vertical and horizontal advancing of wet barrier in proportion to different work-times of emitter for discharges :4,8 and 24 lit per hour were evaluated then equations of lines that have the best fitting on all of the data instead of per amount of discharge by the statistical section of EXCEL software was extracted and related graphs were drawn. Also, a significant comparison was done by SPSS software.

Horizontal Movement of Wet Barrier: The measured amounts of maximum diameter of wetted soil as the function of different irrigation in order to determination of equations of advance horizontal is drowned and its fitting graph is in general following form:

$$D_f = \alpha e^{bt} \quad (1)$$

Where

Df : Horizontal advance of wet barrier, diameter of wet bulb, Cm.

t : The period of irrigation,hr

a,b : equivalent safety (Table2)

According to these equations the amount of diameter of wetted soil instead of different period of irrigation with considering the ratio of emitters discharge is determined. (Fig 3)

The amount of wetted diameter changes with increase of period of irrigation in emitters which has 4 lit per hour discharge is ascending and this trend instead of 4, 24 lit per hour have the same trend. The drawn graphs and amount of correlation coefficient from 0.995 to 0.997, showed the proper fitting of this equations. (Fig 4)

According to this fig, the amount of diameter of wetted soil instead of different periods of irrigation with considering the amount of emitter discharge is achieved. For example, after passing 12 hours from irrigation and increasing the volume of irrigation with growth of discharge from 4 to 8 lit per hour, the amount of horizontal movement rose from 76Cm to 132Cm which shows about 70 percent rose. Also, with going up in discharge from 8 to 24 lit per hour, the amount of horizontal movement has increased from 132 to 246Cm which shows about 86 percent increase.

Fig. 3: The advancing of wet barrier on the soil surface by the emitter which has 8 lit per hour discharge.

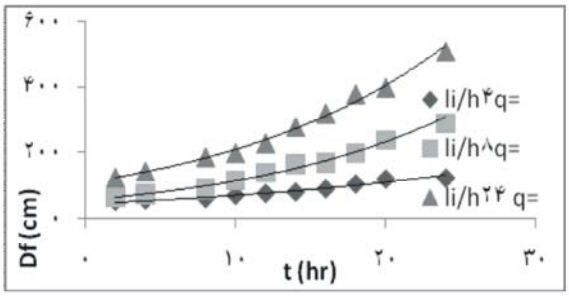

Fig. 4: The comparison of horizontal advancing of wet barrier changes as function of time instead of different amounts of applied discharge

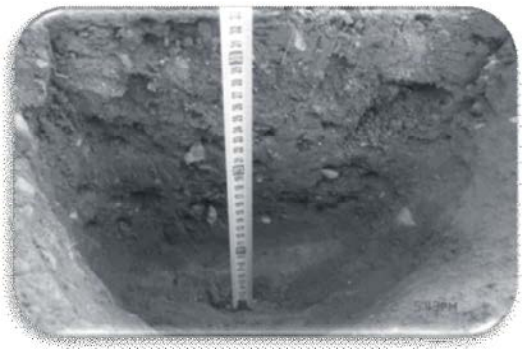

Fig. 5: The vertical advancing in the emitter which has 4 lit per hour discharge after 4 hours - working.

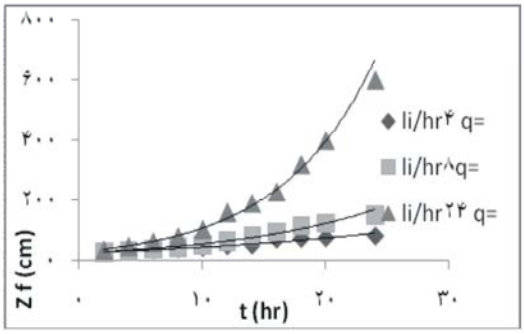

Fig. 6: The comparison of vertical advancing changes of wet barrier as function of time instead of different ratios of applied discharge

Table 2: The equations parameters of maximum changes of horizontal movement of wet barrier with time

q (lit/hr)	a	b	R
4	42.48	0.038	0.997
8	56.86	0.071	0.995
24	110.4	0.067	996.0

Table 3: The vertical advancing equation parameters of wet barrier with time

q (lit/hr)	K	u	r
4	26.67	0.042	0.990
8	23.69	0.083	0.979
24	28.07	0.131	0.995

Vertical Advancing of Wet Barrier under Emitter: For determination of equations of vertical movement under point source, emitter, the measured depth under soil surface as function of different period of irrigation is drawn and the fitting graph is shown as general form:

$$Z_f = Ke^{ut} \quad (2)$$

Where:

Cm Z_f : Vertical advance, depth of wet barrier under emitter, Cm
t : The period of irrigation
u and k : Equitation factor (Table3)

According to presented equations, instead of different period of irrigation the amount of depth of wetted barrier instead of different amounts of discharge which are examined is achieved and according to depth of roof of plant for planting, the period of irrigation which is needed to arrive to the depth of plant can be determined. (Fig 5)

According to graph in (Fig 6) instead of different hours of irrigation with considering the amount of emitter discharge, the amount of wetted depth under point source is achieved. For example, after passing 12 hours from irrigation and increasing volume of irrigation with augmentation of discharge from 4 to 8lit per hour the amount of advance increased from 44 to 64 Cm which shows about 45 percent rose. Also, with increasing of discharge from 8 to 24 lit per hour the amount of vertical movement went up from 64 to around 135Cm which shows about 110 percent growth. The graph illustrates that the diagram which is related to discharge: 8 lit per hour is located lower than the diagram of discharge: 4 lit per hour because with considering that the amounts of vertical advance of wetted barrier are recorded for discharges 4, 8; lit per hour instead of certain volumes of irrigation and in a certain volume of irrigation with increasing of discharge, the amount of vertical movement has decreased. Consequently, the related diagram, 8 lit per hour is located lower than 4 lit per hour. The drawn graphs and correlation coefficient, in the range of 0.979 to 0.995 shows the proper value these equations.

The Optimized Distance of Emitters: The form and dimension of wet bulb is the main factor in determination of distance of laterals and emitters in the drip irrigation for row plants, so many models are presented for presenting an acceptable estimated form of moisture distribution with having physical characteristic of soil.

In the drip irrigation, volume and dimension of wet bulb has a significant impact on performance of plants and it is often necessary that wetted area with the emitter which has certain discharge and outlet water will be estimated in the different soils in order that standards of designing such as distance of emitters or laterals will be resulted. Consequently, manufacturing factories of irrigation devices and water and soil research institutions has presented different tables and graphs which are used with designers and experts and on this basis the distance of emitters should be chose as if a continues row of wetted soil can be provided across the row of cultivation

In designing of drip irrigation system, the wetted area which usually occurs lower than surface land, with emitter is needed and Keller et.al presented tables that are used by engineers. Because the amount of wetted volume of soil or wet bulb can be controlled according to the ratio of discharge emitter and distance among the emitters, doing experimental examinations in the farm and creating relations among soil texture, emitter discharge, volume of penetrated water into land, the volume of wetted soil,

Table 4: The comparison of calculated distance for emitters with KELLER and KARMELI Table.

q (lit/hr)	t (hr)	W=Df (cm)	Se'(m)=0.8 w calculated	Se' (m) Keller table
4	24	120	0.96	1
8	12	133	1.06	1.3
24	9	200	1.6	1.6

Table 5: The welled percent of soil and suitable emitter distance on lateral instead of different applied discharge

Effective spacing between laterals, m* (1.0 m = 3.3 ft)	Effective emission point discharge rate†														
	under 1.5 lph (0.4 gph)			2 lph (0.5 gph)			4 lph (1 gph)			8 lph (2 gph)			over 12 lph (3 gph)		
	Soil texture and recommended emission point spacing on the lateral - m‡														
	C 0.2	M 0.5	F 0.9	C 0.3	M 0.7	F 1.0	C 0.6	M 1.0	F 1.3	C 1.0	M 1.3	F 1.7	C 1.3	M 1.6	F 2.0
	Percentage of soil wetted§														
0.8	35	88	100	50	100	100	100	100	100	100	100	100	100	100	100
1.0	33	70	100	40	80	100	80	100	100	100	100	100	100	100	100
1.2	25	58	92	33	67	100	67	100	100	100	100	100	100	100	100
1.5	20	47	73	26	53	80	53	80	100	80	100	100	100	100	100
2.0	15	35	55	20	40	60	40	60	80	60	80	100	80	100	100
2.5	12	28	44	16	32	48	32	48	64	48	64	80	64	80	100
3.0	10	23	37	13	26	40	26	40	53	40	53	67	53	67	80
3.5	9	20	31	11	23	34	23	34	46	34	46	57	46	57	68
4.0	8	18	28	10	20	30	20	30	40	30	40	50	40	50	60
4.5	7	16	24	9	18	26	18	26	36	26	36	44	36	44	53
5.0	6	14	22	8	16	24	16	24	32	24	32	40	32	40	48
6.0	5	12	18	7	14	20	14	20	27	20	27	34	27	34	40

* Where double laterals (or laterals with multiple outlet emitters) are used in orchards, enter the table with both the spacing between outlets to either side of the tree row and across the space between the rows and proportion the percentages

† Where relatively short pulses of irrigation area applied, the effective emission point discharge rate should be reduced to approximately half of the instantaneous rate for safety

‡ The texture of the soil is designated by C, course; M, medium; and F, fine. The emission point spacing is equal to approximately 80 percent of the largest diameter of the wetted area of the soil underlying the point. (Closer spacings on the lateral will not affect the percentage area wetted)

§ The percentage of soil wetted is based on the area of the horizontal section approximately 0.30 m (1.0 ft) beneath the soil surface. Caution should be exercised where less than 1/3 of the soil volume will be wetted.

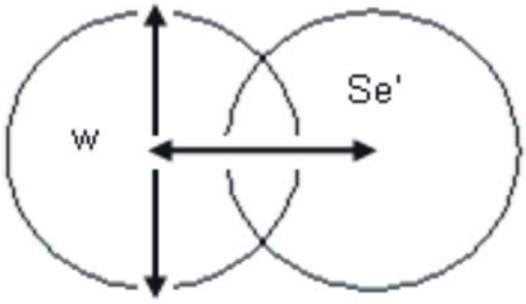

Fig. 7: The maximum width wetted and the most suitable emitter distance for wetted row.

depth and diameter of wet bulb for achieving equations which are experimental, for assisting in designing and management of a irrigation system, sounds necessary. Presented tables and relations by researches which are used in estimating of emitters distance have limitations, so proper distance among emitters with considering technical and economic issues cannot be selected.

In the presented tables for estimating wetted area of soil by emitter, the numbers are presented in a rectangular form in order to designing of wetted row, distance of emitters and maximum width of wetting can be resulted. The wetted area by per emitter is assumed as a rectangle which it's length is equivalent of maximum diameter of wetted circle of wet bulb,w and width is equivalent of 80 percent of its length. (Fig7) In fact the wetted area of soil sounds circle. Considering rectangular area is because of making simple of designing operation in the aspect of laterals and distance of emitter as thought the diameter of wetted circle(w) and distance of emitters on the laterals:0.8W, overlapping of wetted circles contribute to wet the monotonous row with the width: w across the lateral (3).

For determining proper distance of outlets, the diameter of wetted soil by per emitter which has certain discharge, is resulted by equation 1, then the amount of $se^{?}$ is estimated as if the overlapping of wetted circles cause to wet a monotonous row of soil with width(w) across the laterals.

The optimum distance of emitters in the research and which belong to Keller kamel(1974) has compared with considering the soil texture and it is seen that there is a proper harmony between the presented results and results of tables. (Table 4,5)

DISCUSSION

According to (Fig 4) and (Table 2) the correlation coefficient was shown from 0.995 to 0.997 which shows suitable fitting of these equations.

Thabet and Zayani, 2008, they evaluated the wetting patterns in sand- loamy soil and they presented the same equations for horizontal advance of wet barrier. The correlation coefficient of these equations was 0.998 for 4lit per hour discharge.In this research, for this discharge, the correlation coefficient was 0.997.Thus, it was so close to previous one.

Li *et al.* 2004, they presented the same equations for horizontal advancing of wet barrier instead of different amounts of discharge. These equations estimate the ratio of soil wetting in horizontal direction with high correlation coefficient which is about 0.993 to 0.999.

Also, according to (Fig 6) and (Table 3) correlation coefficient was 0.979 to 0.995 for vertical advancing of wet barrier's equations under emitter. Hence, they have suitable fitting.

Thabet and Zayani 2008, they evaluated the wetting patterns in a sand loamy soil and they presented the same equations for vertical advance of wet barrier. The correlation coefficient of these equations was 0.999 for 4 lit per hour applied discharge. In this research, for this discharge, the correlation coefficient was 0.990 which is close to previous one.

Li *et al*. 2004, they presented the same equations for vertical advancing of wet barrier instead of different amounts of discharge. These equations estimate the ratio of soil wetting in vertical direction with a high correlation coefficient: about 0.923 to 0.995.

Analysis and variance of evaluated characteristics was done with SPSS software and the averages were compared with TUCKY test in a significant level : 5 percent. After finishing the certain period of irrigation, there is a significant difference among the discharges : 4,8 with 24 lit per hour for movement of moisture in horizontal direction but for vertical movement of moisture this difference is not significant and with increasing the discharge the amount of depth of wet barrier would be decreased. (Table6)

Table 6: The effect of discharge changes on the area and depth of wet bulb

q (lit/h)	D f (cm)	Z f (cm)
4	5.07a±43.00	6.50 A±50.40
8	5.08 A ±48.20	5.80±44.20
24	2.06 B ±64.60	A 2.50±39.00
a significant area (tucky test)	S	Ns

□ S: Significant

· Ns: Non significant

The averages that have the same words have not significant difference in five percent level.

CONCLUSIONS

- According to presented equivalents in this research according to difference times of irrigation, the amount of wetted surface soil with considering the amount of applied discharge for per emitter is determined. Accordingly with paying attention to determination of area which is wetted with emitter with certain discharge the distance of emitters, the distance among the emitters is estimated.
- Instead of different times of irrigation the depth of wetted barrier instead of different discharges under examination is resulted and with paying attention the depth of root plant for planting, the period of irrigation which is needed that water arrive to plant root, is determined.
- By collected data from measurement of depth and diameter of wet bulb an extensive interval from horizontal and vertical movement instead of three amounts of discharge in different times was resulted and it aids the designer and exploiter to choose the most proper discharge with considering the working-time and expansion of root.
- The results can be used in designing of drip irrigation system and a relation is presented between the distance of row plants and discharge as thought for the crops with high space of cultivation and surface roots, the amount of emitters discharge should be considered more and for products which are close to each other's and have depth roots the amount of discharge of emitter should be considered less.
- The distance of emitters should be selected according to soil texture and emitter discharge, so that overlapping of wetted circles contributes to monotonous row of soil across of lateral. Thus, the distance of emitters should be considered less in the soils which have fine texture and this gap should be observed more in soils which have coarse texture and increasing in distance of outlets is better to accomplish with increasing in amount of discharge and vice versa.

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