# Evaluation the losses of irrigation on the performed constant classic sprinkler systems in Fars-Eghleid, Iran

Saeed Boroomand Nassab *, Samane kazemi, Zahra Izad panah

Department of water Science Engineering, Shahid Chamran University of Ahvaz, Ahvaz, Iran
boroomandsaeed@yahoo.com

**Abstract:** The use of sprinkler irrigation methods is one of the effective ways to saving of irrigation water. If these systems are properly designed, implemented and managed, will cause to reduce water losses and increase uniformity of water distribution. In this study, eight sprinkler irrigation system (constant classic with portable sprinklers) was chosen as samples and evaluation in the Eghleid city. The average value of the losses deep percolation, evaporation and drift losses, application efficiency and combined efficiency calculated in order 5.31, 12.83, 50 and 82.09 percent in the constant classic system. The lowest application efficiency of the systems is respectively $GK_2$, $GK_3$, $GK_6$ and $GK_8$. The most efficiency combination is related to $GK_4$ system that has the least amount of losses irrigation. Decrease in application and efficiency is caused the high losses can be reduced the amount of losses by choosing interval and time of a proper irrigation. The simultaneous use of the large number of sprinklers, using several types of sprinklers on a farm and their improper intervals are the main reason that causes the low level of uniformity of water distribution systems.

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## 1. Introduction

The lack of resources water because recently droughts in most parts of the country and also the farmers' trend towards mechanized of agricultural operations and expedite irrigation practices have caused that felt completely requires to the existence irrigation systems with high efficiency (mclean, 2000). Water use efficiency in sprinkler irrigation systems, first and foremost dependent on the amount losses of wind and evaporation. and wind speed and vapor pressure deficit are the most important effective factors on the losses percentage of evaporation and wind removal (Bavi, 2009).

Mean coefficient of uniformity of water for a new sprinkler obtained 86 percent In different conditions (Ahaneku, 2010). In one study were investigated the effect the air temperature on the amount of evaporation of water in sprinkler irrigation systems. In this study, by fixing the other affecting evaporation indexes, was shown that evaporation of sprinklers as a logarithmic function dependent on the air temperature. This dependence is such that with increasing air temperature from 21 to 27°C, evaporation increase from 4.15 to 7.73 percent (Lovenzini, 2000).

Ascough et al. (2002) had studied central rotary sprinkler irrigation systems and semi-fixed for sugar cane plantations and reported the average application efficiency for these systems, respectively 83.6 and 73.5 percent).

Mikhak Beiranvand et al. (2014) showed the efficiency of constant classic irrigation systems in the review and that all the systems have few application and combination efficiency and the high losses rate had caused reduce these amounts.

Talebi et al. (2013) concluded at the research on the constant classic sprinkler irrigation systems with portable sprinklers that the maximum Changed real application efficiency of the system, from 38.3 to 64.3 percent is real in the Shosh city. The because of low efficiency had expressed the use simultaneous of a large number of sprinklers, wind blow and inaccuracy in the design and implementation.

## 1. materials and methods:

In this study, eight constant classic sprinkler irrigation system with portable sprinklers selected acceptable dispersion and completely random in the eight points of the Eghleid city. Such that have passed them at least one season of exploitation. Table 1 shows the measured sprinkler irrigation systems.

The questionnaire was prepared in order to evaluate systems and obtained conditions the topography, main and semi-main pipes, water supply source, characteristics sprinklers, switch water faucet. The next step is to evaluate parameters measured in the field, that including:

- Measurement of soil parameters are such as texture, soil density, electrical conductivity, deficiency of soil moisture and the speed of the final permeability.

- Measurement of vegetation and climate parameters that includes deep development root, wind speed and direction, evaporation, moisture and temperature.

- Measurement related to system that includes measurement of discharge sprinkler, water pressure and distribution.

A) discharge sprinklers were measured with a 20 liter container and hose and stopwatch.

B) pressure sprinkler was measured by using a barometer of 10 atmosphere and pitot tube attached to it.

C) For measurement the distribution water in field, was used lateral tube in the middle the field which has an average pressure. The area of between two sprinklers was latticed cans by a distance of 5 ×5 and after a period of 1 to 2 hours immediately was measured volume of collected water in the cans by using a graduated cylinder.

Table (1) Characteristics of the sprinkle irrigation system in the present study

| System Code | Type of system | Area (ha) | Water supply | Crop | Sprinkler spacing (m × m) | Sprinkler Crop Model |
|---|---|---|---|---|---|---|
| **$GK_1$** | Solid set | 25 | well | Clover | 25×25 | VYR |
| **$GK_2$** | Solid set | 10 | well | Wheat | 25×25 | AMBOO |
| **$GK_3$** | Solid set | 5 | well | Potato | 25×25 | VYR |
| **$GK_4$** | Solid set | 10 | well | Beetroot | 25×25 | VYR |
| **$GK_5$** | Solid set | 8 | well | Potato | 25×25 | VYR |
| **$GK_6$** | Solid set | 10 | well | Alfalfa | 25×25 | AMBOO |
| **$GK_7$** | Solid set | 10 | well | Wheat | 25×25 | VYR |
| **$GK_8$** | Solid set | 5 | well | Potato | 25×25 | VYR |

Application efficiency is the volume of stored water in the area of development root relative to the volume of water that has been entered by sprinklers that was used according to percent relationship between 1 and 2 for full irrigation and incomplete irrigation.

Full irrigation:

$$Ea = \left(\frac{SMD}{D_r}\right) \times 100 \qquad (1)$$

Incomplete irrigation:

$$Ea = \left(\frac{(SMD \times AD_{irr} \times S_l \times S_m) + V_{zi}}{q \times T_{irr}}\right) \times 100 \qquad (2)$$

$$V_{zi} = \sum_{i:D_i \le SMD}^{N} (D_i \times A_i) \times S_l \times S_m \qquad (3)$$

Where:

SMD= deficiency moisture soil (mm/m)

Dr= average depth water irrigation (measured from the nazzl) (mm)

$S_l$= sprinklers distance from each other on the lateral pipes (m)

$S_m$= sprinklers distance from each other on the main pipes (m)

q= average discharge sprinklers (m/s)

Tirr = duration of irrigation (s)

$AD_{irr}$= adequacy irrigation (%)

$V_{zi}$= the total volume of penetrated water in the regional has irrigated area that is less or equal to SMD ($m^3$)

$$AD_{irr} = \left(\frac{N_1}{N}\right) \times 100 \qquad (4)$$

Where:

$N_1$= Number of cans examined that the collected water in them is greater or equal to SMD.

N= The total number of cans examined

Water turn small droplets when is exiting from sprinklers that taken out the effect of the wind from irrigated areas and some of it evaporates and plant was not obtain them, and named wind removal and evaporation losses (WDEL) that to assess wind removal and evaporation losses was used (5) relationship.

$$WDEL = \left(\frac{D_r - \bar{D}}{D_r}\right) \qquad (5)$$

Where:

$\bar{D}$=The average depth of collected water in cans (mm)

To calculate the percentage of deep percolation $D_p$, in order for two modes complete and incomplete irrigation used relations (6) and (7):

Full irrigation:

$$Dp = \frac{\bar{D} - SMD}{Dr} \times 100 \qquad (6)$$

Incomplete irrigation:

$$D_p = \left(\frac{V_{zi} - (SMD \times AD_{irr} \times S_l \times S_m)}{q \times T_{irr}}\right) \times 100 \qquad (7)$$

$$Vzi = \sum_{i=1}^{i:D \ge SMD} (Di \times Ai) \times Sl \times Sm \qquad (8)$$

Where:

$V_{zi}$ = The total volume permeated water in an area that is greater or equal irrigated area SMD ($m^3$).

To calculate the uniformity coefficient Christensen test blocks ($CU_t$) and uniform distribution of test block ($DU_t$) used (9) & (10):

$$CU_t = \left(1 - \frac{\sum|D_i - \bar{D}|}{\bar{D} \times n}\right) \times 100 \quad (9)$$

$$DU_t = \left(\frac{D_q}{\bar{D}}\right) \times 100 \quad (10)$$

Where:

$D_q$= The average water depth in the lowest quarter of the measured values (mm)

Di= Water depth in each of collected cans (mm)

$\bar{D}$=The average depth of collected water in cans (mm)

n= The number of observations

The values for these parameters should be determined according to the difference pressure in the system to be adjusted so it can be attributed the entire system that relations follow:

$$CU_s = CU_t \left[\frac{1+\left(\frac{P_{min}}{P_{mean}}\right)^{0.5}}{2}\right] \quad (11)$$

$$DU_s = DU_t \left[\frac{1+3\left(\frac{P_{min}}{P_{mean}}\right)^{0.5}}{4}\right] \quad (12)$$

Where:

$CU_s$= Uniformity coefficient system (%)

$DU_s$= Uniformity of distribution system (%)

$P_{min}$= Minimum pressure (bar)

$P_{mean}$= Average pressure (bar)

## 3. Results and discussion:

Table 2. Results of evaluation parameters in the solid set sprinkle systems

| parameter / System Code | Application efficiency $E_a$ (%) | Combination efficiency $E_C$ (%) | Distribution Uniformity $DU_s$ (%) | Christensen uniformity coefficient $CU_s$ (%) | Adequacy irrigation $AD_t$ (%) | Deep percolation losses $DP$ (%) | wind and evaporation losses $WDEL$ (%) |
|---|---|---|---|---|---|---|---|
| **$GK_1$** | 44 | 87.2 | 68.73 | 75.19 | 29 | 8 | 5.2 |
| **$GK_2$** | 45 | 75 | 72.99 | 81.77 | 31 | 7.2 | 18.5 |
| **$GK_3$** | 55 | 89 | 62.88 | 74.71 | 5 | 1.31 | 9.9 |
| **$GK_4$** | 64 | 91 | 63.11 | 70.59 | 11 | 2.73 | 5.81 |
| **$GK_5$** | 50 | 85.34 | 67.76 | 81.48 | - | - | 14.66 |
| **$GK_6$** | 44 | 69 | 68.99 | 79.43 | - | - | 31.12 |
| **$GK_7$** | 61 | 86 | 33.44 | 56.38 | - | - | 14.3 |
| **$GK_8$** | 37 | 74.25 | 56.65 | 67.40 | 77 | 23.29 | 3.2 |
| **Average** | 76.22 | 82.09 | 61.82 | 73.37 | 19.13 | 5.31 | 12.83 |

Table 3. Follow of table 2

| Parameter / System Code | The amount of water used (mm) | The water Reached to earth (mm) | The average discharge of the riser (lit/s) | The intensity of risers discharge (mm/hr) | The avgerage Intensity of the earth Fracture (mm/hr) |
|---|---|---|---|---|---|
| **GK1** | 71.2 | 67.5 | 3.1 | 17.8 | 16.88 |
| **GK2** | 33.25 | 27.1 | 2.31 | 13.3 | 10.84 |
| **GK3** | 36.3 | 32.7 | 2.1 | 12.1 | 10.9 |
| **GK4** | 30.28 | 28.52 | 2.63 | 15.14 | 14.26 |
| **GK5** | 41.75 | 35.63 | 2.9 | 16.7 | 14.25 |
| **GK6** | 48.72 | 33.56 | 2.82 | 16.24 | 11.19 |
| **GK7** | 31.1 | 26.64 | 2.7 | 15.55 | 13.32 |
| **GK8** | 32.98 | 31.9 | 2.29 | 13.19 | 12.76 |

According to Table 2 and average losses of irrigation are relatively low and about of 18% which 5.31 percent of this amount is related to deep percolation losses and 12.83 percent related to evaporation losses and wind removal. Most losses deep penetration is related to $GK_8$ system.

Allowed lack of soil moisture in this system was more than a real lack of soil moisture and shows that irrigation is carried out earlier than required. In systems $GK_5$, $GK_6$ and $GK_7$ none of the points of field has not been sufficiently watering. And there are no deep percolation losses and shows that irrigation is done late that can cause stress deficit of water in field. Since, represents the combined effect of deep percolation and evaporation and drift losses in sprinkler irrigation, average the combination efficiency is 82.1 percent in these systems that is good value. Water application efficiency indicates the percentage of water supply is that applied to the root zone of plant. The application efficiency is 50% in these systems, due to the high evaporation and drift losses have been slightly.

The highest and lowest application efficiency $GK_4$ and $GK_8$ systems and the highest and lowest combination efficiency is respectively related to $GK_4$ and $GK_6$ systems. Reforming systems have to reduce the irrigation losses so that to achieve greater efficiency. As we see, calculated an average Christiansen uniformity coefficient and uniform distribution system that is respectively 73.37 and 61.81 percent, that is less than Merriam and chlorine's recommended amount $((\%67 \le DU \le \%80) \& (\%81 \le CU \le \%87))$.

The highest uniformity coefficient and uniformity distribution of system is respectively $GK_2$, $GK_5$ and $GK_6$. This is because of high values is chosen distance between the sprinklers, sprinkler type and suitable weather conditions. Because of low uniformity of coefficient and distribution uniformity systems than any other systems expressed that can be used simultaneously to a large number of sprinkler for $GK_8$ system and pressure less than expected and perpendicular to the lack of sprinklers for system $GK_7$. In none of the systems do not do complete Irrigation. In systems $GK_1$, $GK_2$, $GK_3$ and $GK_4$ calculated adequacy irrigation, that is below 50%. This means that a small percentage of irrigated area obtain water as much as lack of soil moisture or more than it.

In $GK_2$ system, because of high coefficient of uniformity the stress on plants is low, deep percolation losses in this system is 7.2 percent. Due to the intensity distribution is the important parameters at the design of an irrigation system, also its value should be consistent with water infiltration rate in soil. In systems $GK_4$, $GK_6$, $GK_7$, $GK_8$ because of higher intensity water distribution from sprinkler than the penetrate of water in soil, creates the runoff in the field which can be use less intensity or reduce the irrigation time.

## 4. Conclusion:

Evaluation results of constant classic sprinkler irrigation systems showed in Eghleid city, distance, improper operation pressure and use simultaneous of a large number of sprinkler affected on the system. The long and duration period of time of irrigation cause to increase deep percolation and reduce adequacy irrigation. We can reduce the duration of irrigation to reduce irrigation losses and increase composition and application efficiency of water in the system. Proper exploitation and maintenance of the system and the use of quality equipment can have an important role in increasing irrigation efficiency.

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