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Research Article

Evaluation of Uniformity Coefficient of Four Useful Sprinklers in Khuzestan Province under Different Conditions

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ABSTRACT

Coefficient uniformity in sprinkler irrigation is one of the important parameters in sprinkler irrigation system design that its amount is very effective on quality and investment in sprinkler irrigation projects. In this research, Christiansen's uniformity coefficient (CUC) for a useful sprinkler (Zhaleh 3) with four different nozzle diameters was conducted. In this research, sprinklers arrangement styles were square and rectangle, sprinklers spacing were 9×9, 15×15 and 15×18 m and nozzle-working pressures were 30 m and 40 m. Also, this experiment was conducted in mild wind speed (0-4 $m.s^{-1}$) and severe wind speed (>7 $m.s^{-1}$). This experiment has treatments including: 4 nozzles, 3 sprinkler spacings, 2 nozzle-working pressures, 2 wind speed ranges and with 3 replications, it was conducted 144 experiments totally. The results showed that with decrease of nozzle diameter, CUC decreased. Besides, with increase of nozzle-working pressure, CUC increased. The results showed that CUC in square layout was more than rectangle layout. In addition, with decrease of sprinklers spacing, CUC increased whereas the most CUC was related to sprinkler spacing of 9×9 m and the least CUC was related to sprinkler spacing of 15×18 m. Also, with increase of wind speed in all of treatments, CUC decreased but the effect of wind speed on CUC in square layout was less than rectangle layout. Finally, the most CUC was related to sprinkler with nozzle of 9/32×1/8 inches. So, this sprinkler was recommended as the best for application in Shush region, considering its equal price in comparison with other sprinklers.

Key words: Uniformity coefficient, Twin-nozzle sprinkler, Nozzle diameter

INTRODUCTION

The sprinkler irrigation method is one of the pressurized irrigation systems that takes water from a source and sprays it to the atmosphere as droplets by means of an enclosed system and under pressure. The water is transmitted to the surface of the soil in equal distribution with the sprinkler irrigation system to obtain uniform distribution in the crop root zone (Keller and Bliesner, 2001). The uniformity of water application in a sprinkler irrigation system is an important aspect of the system performance (Solomon, 1979). A sprinkler irrigation system is normally evaluated based on uniformity coefficients determined from field measurements from an array of water collecting devices-catch cans (Topak *et al.*, 2005). Such system requires a minimum value of uniformity to be considered as acceptable by the end users. Keller and Bliesner (2001) classified the irrigation uniformity in solid set systems as "low" when the Christiansen's uniformity coefficient (CUC) was below 84%. Little *et al*. (1993) suggested a classification of uniformity of a sprinkler irrigation system as very good, good, poor and worse if uniformity coefficient (CU) value equals 90%, between 80 to 89%, between 70 to 79% and <69%, respectively. Merkley and Allen (2003) considered CU>78% to be the minimum acceptable performance level for economic system design. A sprinkler water distribution pattern depends on the system design parameters such as: the sprinkler spacing, operating pressure, nozzle diameter, and environmental variables such as: wind speed and direction (Keller and Bliesner 2001). Uniformity coefficient that developed by Christiansen (1942) is stated below (Vories and Von Bernuth, 1986; Losada *et al*., 1990; Allen, 1998).

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$$CU = 100\left(1 - \frac{\Sigma x}{n.m}\right) \quad (1)$$

or

$$CU = 100\left(1 - \frac{\Sigma|z-m|}{\Sigma x}\right) \quad (2)$$

Where, CU: distribution uniformity coefficient developed by Christiansen (%). z: the amount of water measured in each container while testing uniformity (mm or ml).x = |z-m|: the total absolute value of deviations from average of the amount of water measured in all accumulation containers (mm or ml). $m = \frac{\Sigma z}{n}$: average amount of water (mm, ml).n: the number of water accumulation containers. In practice, it‛s not possible to obtain 100% of uniformity on the irrigated area because nozzles distribute water on a circular area, with overlaps between areas of water distribution. It‛s impossible to have equal water distribution on the areas that are being irrigated (Zoldoske *et al*., 1994). Kara *et al*. (2008) reported that by decrease of sprinklers spacing and by increasing of nozzle-working pressure, CUC increased. Sahoo *et al*. (2008) reported that with decreasing of sprinklers spacing and with increasing of nozzles working pressure, the negative effect of wind speed on CUC decreased. Maroufpoor *et al*. (2010) reported that the application of various coefficients of uniformity depends on the field conditions and as any specific coefficient of uniformity is suitable only for specific field conditions. Makki *et al*. (2011) reported that the twin nozzle brass sprinkler gave significantly better efficiency in comparison with twin nozzle plastic sprinkler and single nozzle plastic sprinkler. Stambouli *et al*. (2014) reported that sprinkler model has an important effect on the radial water distribution, even under similar operational conditions. Farzad-Manesh *et al*. (2011) reported that with increasing of riser height from 90 cm to 15 cm, CUC increased. Younesi *et al*. (2015) reported that using from many sprinklers on the laterals, caused decrease in CUC and is not economical in permanent sprinkler irrigation system. Yacoubi *et al*. (2012) reported that wind speed and relative humidity were the most important factor in wind and evaporation losses. The main objective in this research was evaluation of Christiansen's uniformity coefficient in different conditions of wind speed, nozzle diameters, nozzle-working pressure, layout and sprinklers spacing.

MATERIALS AND METHODS

This study was conducted in an uncultivated farm that was located in North West of Shush County from Khuzestan province of Iran with tropical climate. A permanent sprinkler system was located in this farm. The water resource of this farm was provided from Karkheh River. Some weather parameters, in 3 months that experiment was done, are shown in Table 1.

The sprinkler that was used in this plan was from kind of Zhaleh 3 that was made in Techno Zhaleh Company of Iran. It was twin-nozzle sprinkler with four diameters of 9/32×1/8, 15/64×1/8, 7/32×3/32 and 3/16×3/32 inches. The characteristics of Zhaleh 3 sprinkler with 9/32×1/8 inches diameter are presented in Table 2. The riser height was 150 cm. For evaluation of uniformity coefficient of water distribution used from Christiansen equation. The experiment was done on base of a single working sprinkler method. For measuring of wind speed used from four-cup-anemometer. For evaluation of effect of wind speed on CUC used form two ranges of wind speeds (0-4 [mild] and >7 [severe] (m s^{-1})). For evaluation of effect of nozzle-working pressure on CUC used form two pressures (30 and 40 [m]) and for evaluation of effect of sprinklers arrangement style on CUC used form three sprinklers arrangement styles including 9m×9m and 15m×15m for square layout and 15m×18m for rectangle layout. In every sprinklers arrangement style, the first space was sprinklers spacing on the laterals and the second space was laterals spacing on the main pipe. For gathering of sprinklers water, a 3m×3m grid system of catch containers were located around Zhaleh 3 sprinkler for 15m×15m and15m×18m arrangements and a 1.5m×1.5m grid system of catch containers were located around Zhaleh 3 sprinkler for 9m×9m arrangement (Figure 1). Every catch containers had 15cm diameters and 15cm height that were located into the ground, whereas their rims were 5cm above the ground surface. For evaluation of CUC, every sprinklers arrangement style in different ranges of wind speed, working pressures and nozzle diameters, were replicated three times and average of data was considered and presented in Tables. The time of working for every experimental sprinkler was 1 hour.

RESULTS AND DISCUSSION

The impact evaluation of nozzle diameter on CUC

CUC in different conditions of nozzle diameter, sprinklers arrangement style, water pressure and wind speed were presented in Tables 3 to 7.

According to Tables 3 to 7, with decrease of nozzle diameters, CUC decreased and this difference was significant at 5% level. Its reason was because of the decrease of wetted diameter and the decrease of sprayed drops diameter with decreasing of nozzle diameters. So, the sprinkler with nozzle diameter of 9/32×1/8 could create the more CUC in comparison with other nozzle diameters.

The impact evaluation of nozzle-working pressure on CUC

CUC was evaluated under two working pressures of 30 m and 40 m, for every one of nozzle diameters in Khuzestan province of Iran. The results were presented in Tables 8 to 11.

Table 1: Some weather parameters of Shush region

Month	Elevation (m)	Daily sunshine hours	Mean of min temperature (^oC)	Mean of max temperature (^oC)	Mean of humidity (%)	ET_0 (mm d^{-1})
October	65	8.68	18.7	36	35	4.87
November	65	6.9	13.2	26.8	46	3.04
December	65	6.0	8.7	19.9	55	1.95

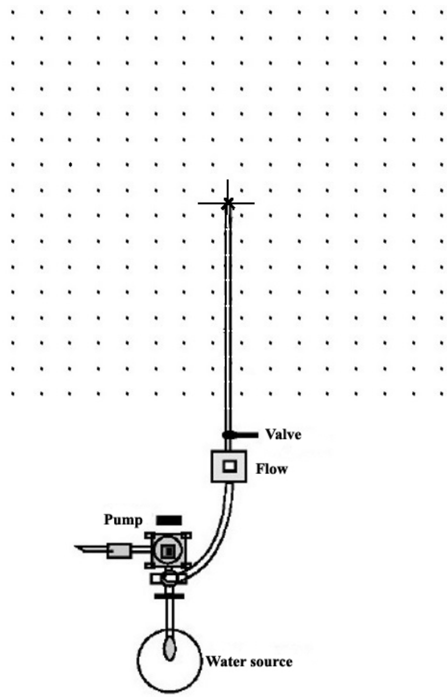

Fig. 1: Grid system of catch containers around Zhaleh 3 sprinkler.

Table 2: The characteristics of Zhaleh 3 sprinkler with 9/32×1/8 inches diameter

Working pressure (m)	Discharge (m^3 hr^{-1})	The wetted diameter (m)
32	4.01	41.5
35	4.21	42.1
39	4.41	42.7
42	4.60	43.6

Table 3: CUC (%) in different conditions of wind speed, layout and sprinklers spacing for 9/32×1/8 inches nozzle

Wind speed (ms^{-1})		Working pressure (m)	Layout and sprinklers spacing(m)		
			Square	Square	Rectangle
			9×9	15×15	15×18
Mild	0-4	30	92.5	89.2	84.3
	0-4	40	97.7	94.4	88.2
Severe	>7	30	84.35	78.51	72.5
	>7	40	89.42	83.4	76.6

Table 4: CUC (%) in different conditions of wind speed, layout and sprinklers spacing for 15/64×1/8 inches nozzle

Wind speed (ms^{-1})		Working pressure (m)	Layout and sprinklers spacing(m)		
			Square	Square	Rectangle
			9×9	15×15	15×18
Mild	0-4	30	89.56	85.7	80.45
	0-4	40	94.67	90.52	84.31
Severe	>7	30	81.48	75.61	69.34
	>7	40	86.57	80.26	73.49

Table 5: CUC (%) in different conditions of wind speed, layout and sprinklers spacing for 7/32×3/32 inches nozzle

Wind speed (ms^{-1})		Working pressure (m)	Layout and sprinklers spacing(m)		
			Square	Square	Rectangle
			9×9	15×15	15×18
Mild	0-4	30	83.35	79.49	72.35
	0-4	40	88.51	84.82	76.42
Severe	>7	30	74.6	69.51	60.57
	>7	40	80.43	74.18	64.67

drops diameter with decreasing of nozzle diameters. So, the sprinkler with nozzle diameter of 9/32×1/8 could create the more CUC in comparison with other nozzle diameters.

The impact evaluation of nozzle-working pressure on CUC

CUC was evaluated under two working pressures of 30 m and 40 m, for every one of nozzle diameters in Khuzestan province of Iran. The results were presented in Tables 8 to 11.

According to Tables8 to 11, with increase of nozzle-working pressure from 30 m to 40 m, CUC increased. In every sprinkler with decrease of water pressure, the spray intensity increased. Because with decrease of water pressure, spray discharge and wetted diameter decreased but the decrease of wetted diameter was more than the decrease of spray discharge. So, this matter caused the increase of spray intensity. Therefore, with increase of spray intensity the stroke of drops on the soil increased and finally CUC decreased. In other words, the decrease of CUC in low nozzle-working pressure, was because of high spray intensity on wetted diameter. With increase of pressure, spray intensity on wetted diameter decreased and the spray pattern was corrected and it caused CUC increase. Considering the decrease of CUC with decrease of nozzle-working pressure, it was recommended that in low working pressure, the sprinklers spacing be decreased. This result was confirmed by Christiansen (1942), Kara *et al*. (2008), Azevedo *et al*. (2000), Koch (2003), Khodadadi Dehkordi (2014) and Sahoo *et al*. (2008).

According to Tables 8 to 11, with decrease of nozzle diameters in every one of pressures (30 m and40 m), CUC decreased and this difference was significant at 5% level. Its reason was because of the decrease of wetted diameter and the decrease of sprayed drops diameter in every one of pressures (30 m and40 m), with decreasing of nozzle diameters. According to these Tables, the most CUC was related to the sprinkler with nozzle diameter of 9/32×1/8 in working pressure of 40 m (88.3%). But, because there was not any significant difference between CUC in working pressures of 30 m and 40 m in sprinkler with nozzle diameter of 9/32×1/8, therefore, recommended to be used from working pressure of 30 m instead of 40 m. Because using of less pressure in system was both safer and more economical.

The impact evaluation of sprinklers arrangement style on CUC

CUC was evaluated for two sprinklers layouts (square [15×15] and rectangle [15×18]), for every one of nozzle diameters in Khuzestan province of Iran. The results were presented in Tables 12 to 15.

According to Tables 12 to 15, CUC in square layout was more than rectangle layout. One of the most important elements in increasing of CUC, was overlap of sprinklers spray in different sides. Therefore, in square layout, the overlap of sprinklers spray was uniform in different sides but in rectangle layout, the overlap of sprinklers spray was non-uniform in different sides, this reason caused the decrease in CUC about rectangle layout. Tarjuelo (1992), Dabbous (1962), Khodadadi Dehkordi (2014) and Kara *et al*. (2008) reported that the square

Table 6: CUC (%) in different conditions of wind speed, layout and sprinklers spacing for 3/16×3/32 inches nozzle

Wind speed (ms^{-1})		Working pressure (m)	Layout and sprinklers spacing(m)		
			Square	Square	Rectangle
			9×9	15×15	15×18
Mild	0-4	30	77.55	71.61	63.46
	0-4	40	82.22	76.43	67.52
Severe	>7	30	68.43	61.31	51.38
	>7	40	74.84	66.22	55.29

Table 7: The effect of nozzle diameter on CUC

Nozzle diameter (inches)	CUC (%)
9/32×1/8	85.92 a*
15/64×1/8	82.66ab
7/32×3/32	75.74bc
3/16×3/32	68.02 cd

*Common letters in every treatment show that there was not any significant difference at 5% level.

Table 8: The effect of working pressure on CUC for 9/32×1/8 inches nozzle

Working pressure (m)	CUC(**%**)
30	83.56 a
40	88.3 a

Table 9: The effect of working pressure on CUC for 15/64×1/8 inches nozzle

Working pressure(m)	CUC(**%**)
30	80.36ab
40	84.97ab

Table 10: The effect of working pressure on CUC for 7/32×3/32 inches nozzle

Working pressure (m)	CUC(**%**)
30	73.31bc
40	78.17bc

Table 11: The effect of working pressure on CUC for 3/16×3/32 inches nozzle

Working pressure (m)	CUC (**%**)
30	65.62cd
40	70.42cd

Table 12: The effect of sprinklers layout on CUC for 9/32×1/8 inches nozzle

Sprinklers layout	CUC (%)
Square	88.69 a
Rectangle	80.4 a

Table 13: The effect of sprinklers layout on CUC for 15/64×1/8 inches nozzle

Sprinklers layout	CUC (%)
Square	85.55ab
Rectangle	76.9ab

Table 14: The effect of sprinklers layout on CUC for 7/32×3/32 inches nozzle

Sprinklers layout	CUC (%)
Square	79.36abc
Rectangle	68.5bc

Table 15: The effect of sprinklers layout on CUC for 3/16×3/32 inches nozzle

Sprinklers layout	CUC (%)
Square	72.33cd
Rectangle	59.41cd

layout in proportion to the rectangle layout had the more CUC and triangle layout had the more CUC in comparison with the rectangle layout, but because of the problems in management and exploitation of triangle layout in portable, semi-portable and semi-permanent sprinkler irrigation systems, using of it was very rare. However, they reported that in permanent sprinkler irrigation system, it could be used from triangle layout instead of rectangle layout and increased CUC.

According toTables12 to 15, with decrease of nozzle diameters in every one of layouts, CUC decreased and this difference was significant at 5% level. Its reason was because of the decrease of wetted diameter and the decrease of sprayed drops diameter in every one of layouts, with decreasing of nozzle diameters. It caused the less overlap of sprinklers spray in every one of layouts and reduced CUC. According to these Tables, the most CUC was related to the sprinkler with nozzle diameter of 9/32×1/8 and layout of square (88.69%).

The evaluation of effect of sprinklers spacing on CUC

CUC was evaluated for sprinklers spacings of 9m×9m,15m×15m and 15m×18m, for every one of nozzle diameters in Khuzestan province of Iran. The results were presented in Tables 16 to 19.

According to Tables16 to 19, sprinklers spacing of 9m×9m had the most CUC and sprinklers spacing of 15m×18m had the least CUC. Actually, by decrease of sprinklers spacing, CUC increased. This was because of better overlap of sprinklers spray in less sprinklers spacing. This result was confirmed by Kara *et al*. (2008), Tarjuelo *et al*. (1999a), Joshi *et al*. (1995), Khodadadi Dehkordi (2014) and Sahoo *et al*. (2008). However, in sprinklers spacing of 15m×15m (square layout) the CUC was more than the CUC of 15m×18m sprinklers spacing (rectangle layout), that it was because of the better overlap of sprinklers spray in square layout in comparison with rectangle layout. For reducing of sprinklers spacing, it was important to consider economic cares in this subject. Actually, reducing of sprinklers spacing should be justifiable from economic aspects.

According to Tables 16 to 19, the proportion of sprinklers spacing to wetted diameter decreased with increasing of nozzle-working pressure. In this research, the least proportion of sprinklers spacing to wetted diameter achieved in nozzle-pressure of 40 m. In this pressure, the proportion of sprinklers spacing to wetted diameter for square layout was 0.2 (for sprinklers spacing of 9m×9m) and 0.34 (for sprinklers spacing of 15m×15m) and for rectangle layout was 0.34×0.41 (for sprinklers spacing of 15m×18m), for the sprinkler with nozzle diameter of 9/32×1/8. Actually increasing of nozzle-working pressure more than 40 m was not economical and had some problems from sides of performance, exploitation, energy supply and efficiency in system. Christiansen (1942) recommended the proportion of sprinklers spacing to wetted diameter: 0.4×0.6 for rectangle and 0.5 for square layouts. Besides, Keller (1983) recommended the proportion of sprinklers spacing to wetted diameter: 0.5 for square, 0.4×0.67 for rectangle and 0.62 for triangle layouts. Although by increasing of nozzle-working pressure, the proportion of sprinklers spacing to wetted diameter decreased but it was important to consider economic cares in this subject.

Table 16: The effect of sprinklers spacing on CUC for 9/32×1/8 inches nozzle

Parameters	Sprinklers spacing (m)		
	9×9	15×15	15×18
CUC (%)	91 a	86.38 a	80.4 a
The proportion of sprinklers spacing to wetted diameter of 42 m (in working pressure of 30 m)	0.21×0.21	0.36×0.36	0.36×0.43
The proportion of sprinklers spacing to wetted diameter of 44 m (in working pressure of 40 m)	0.2×0.2	0.34×0.34	0.34×0.41

Table 17: The effect of sprinklers spacing on CUC for 15/64×1/8 inches nozzle

Parameters	Sprinklers spacing (m)		
	9×9	15×15	15×18
CUC (%)	88.07ab	83.02ab	76.9ab
The proportion of sprinklers spacing to wetted diameter of 38 m (in working pressure of 30 m)	0.24×0.24	0.39×0.39	0.39×0.47
The proportion of sprinklers spacing to wetted diameter of 40 m (in working pressure of 40 m)	0.22×0.22	0.37×0.37	0.37×0.45

Table 18: The effect of sprinklers spacing on CUC for 7/32×3/32 inches nozzle

Parameters	Sprinklers spacing (m)		
	9×9	15×15	15×18
CUC (%)	81.72bc	77bc	68.5bc
The proportion of sprinklers spacing to wetted diameter of 36 m (in working pressure of 30 m)	0.25×0.25	0.42×0.42	0.42×0.5
The proportion of sprinklers spacing to wetted diameter of 38 m (in working pressure of 40 m)	0.24×0.24	0.39×0.39	0.39×0.47

Table 19: The effect of sprinklers spacing on CUC for 3/16×3/32 inches nozzle

Parameters	Sprinklers spacing (m)		
	9×9	15×15	15×18
CUC (%)	75.76cd	68.89cd	59.41cd
The proportion of sprinklers spacing to wetted diameter of 32 m (in working pressure of 30 m)	0.28×0.28	0.47×0.47	0.47×0.56
The proportion of sprinklers spacing to wetted diameter of 34 m (in working pressure of 40 m)	0.26×0.26	0.44×0.44	0.44×0.53

According to Tables 16 to 19, with decrease of nozzle diameters in every one of sprinklers spacings, CUC decreased and this difference was significant at 5% level. Its reason was because of the decrease of wetted diameter and the decrease of sprayed drops diameter in every one of sprinklers spacings, with decreasing of nozzle diameters. It caused the less overlap of sprinklers spray in every one of sprinklers spacings and reduced CUC. According to these Tables, the most CUC was related to the sprinkler with nozzle diameter of 9/32×1/8 and sprinklers spacing of 9m×9m (91%).

The evaluation of effect of wind speed on CUC

CUC was evaluated for two ranges of wind speed (0-4 [mild] and >7 [severe] (m s^{-1})), for every one of nozzle diameters in Khuzestan province of Iran. The results were presented in Tables 20 to 23.

In this research, CUC was measured in two ranges of wind speed. They were mild wind (0-4 m s^{-1}) and severe wind speed (>7 m s^{-1}). According to Tables 20 to 23, with increasing of wind speed, CUC decreased. This result was confirmed by Von Bernuth and Seginer (1990), Seginer *et al*. (1991), Seginer *et al*. (1992), Faci and Bercero (1991), Tarjuelo *et al*. (1992), Tarjuelo *et al*. (1999b), Hans *et al*. (1994), Li and Kawano (1996), Azevedo *et al*. (2000), Urrutia (2000), De Lima *et al*. (2002), Khodadadi Dehkordi (2014) and Dechmi *et al*. (2003).

According to Table 3, with decreasing of sprinklers spacing, the negative effect of wind speed on CUC decreased. Whereas, CUC of sprinklers spacing of 9×9 m, nozzle pressure of 40 m and in severe wind speed was 89.42% but in sprinklers spacing of 15×15 m was 83.4%. It was due to the decrease of sprinklers spacing in proportion to wetted diameter. This result was confirmed by Vories and Von Bernuth (1986); Cuenca (1989); Khodadadi Dehkordi (2014) and Sahoo *et al*. (2008). In addition, according to Table 3, with increasing of nozzles working pressure, the negative effect of wind speed on CUC decreased. Whereas, CUC of sprinklers spacing of 9×9 m, nozzle pressure of 30 m and in severe wind speed was 84.35% but in nozzle pressure of 40 m was 89.42%. It was due to the increase of wetted diameter in proportion to sprinklers spacing. This result was confirmed by Khodadadi Dehkordi (2014) and Sahoo *et al*. (2008). Besides, in square layout in comparison with rectangle layout, the negative effect of wind speed on CUC decreased. Whereas, in severe wind conditions the square layout had more CUC than the rectangle layout. Because in square layout, the overlap of sprinklers spray was more uniform than other layouts. This result was confirmed by Khodadadi Dehkordi (2014) and Sahoo *et al*. (2008).

According to Tables 20 to 23, with decrease of nozzle diameters in every one of wind speed ranges, CUC decreased and this difference was significant at 5% level.

Table 20: The effect of wind speed on water uniformity coefficient for 9/32×1/8 inches nozzle

Wind speed (m s^{-1})		CUC (%)
Mild	0-4	91.05 a
Severe	>7	80.8 a

Table 21: The effect of wind speed on water uniformity coefficient for 15/65×1/8 inches nozzle

Wind speed (m s^{-1})		CUC (%)
Mild	0-4	87.54ab
Severe	>7	77.79ab

Table 22: The effect of wind speed on water uniformity coefficient for 7/32×3/32 inches nozzle

Wind speed (m s^{-1})		CUC (%)
Mild	0-4	80.82bc
Severe	>7	70.66bc

Table 23: The effect of wind speed on water uniformity coefficient for 3/16×3/32 inches nozzle

Wind speed (m s^{-1})		CUC (%)
Mild	0-4	73.13cd
Severe	>7	62.91cd

Its reason was because of the decrease of wetted diameter and the decrease of sprayed drops diameter in every one of wind speed ranges, with decreasing of nozzle diameters and this effect was harsher in severe wind speed than mild wind speed. Because with decreasing of sprayed drops diameter, they were taken easier by wind and it caused the less overlap of sprinklers spray and reduced CUC. According to these Tables, the most CUC was related to the sprinkler with nozzle diameter of 9/32×1/8 and mild wind speed (91.05%).

Conclusion

According to the results, with decrease of nozzlediameters, CUC decreased and this difference was significant at 5% level. Besides, with decrease of nozzle diameters in every one of pressures, layouts, sprinklers spacings and wind speed ranges, CUC decreased. The results showed that with increase of nozzle-working pressure from 30 m to 40 m, CUC increased. Besides, the square layout had more CUC than the rectangle layout, especially in severe wind conditions. The results showed that by decrease of sprinklers spacing, CUC increased. Also, the proportion of sprinklers spacing to wetted diameter decreased with increasing of nozzle-working pressure. However, for reducing of sprinklers spacing, it was important to consider economic cares in this subject. According to results, with increasing of wind speed, CUC decreased. In addition, with decreasing of sprinklers spacing and with increasing of nozzles-working pressure, the negative effect of wind speed on CUC decreased. In the end, According to results, using from the sprinkler with nozzle diameter of 9/32×1/8 was recommended in Shush region of Khuzestan province of Iran, because of achieving the most CUC in that region.

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