PERFORMANCE ASSESSMENT OF CENTER PIVOT IRRIGATION SYSTEM UNDERARID AREASCONDITION

M.H. Abd El-Wahed[1] and Atef Swelam[2]

ABSTRACT

This study was planned to evaluate the effects of operating pressure (P), spacing between sprinklers (S) and height of sprinkler above the ground surface (H) on the uniformity parameters[(coefficient of uniformity (CU),distribution uniformity (DU_{lq}) and coefficient of variation (CV)] under center pivot system.The quantitative variables were (P_{20}, $_{40}$ and $_{60}$), (S_{200}, $_{250}$ and $_{300}$) and (H_{150}, $_{175}$ and $_{200}$).

The obtained values ofCU and DU were higher under the highest P, closer Sand higher H. In contrast, CV was lower under the highest P, closer S and higher H.Both CU and DU_{lq}were increased with increasing the P and S, P andHand decreasing S with an increase H. While the CVdecreased with increasing theP and S, P andH.Also, decreasing Sandincrease H.

The highest CU values were recorded when thecenter pivot was operatedunder (P_{60},S_{200} andH_{200})and(P_{40},S_{200} and H_{200}) without significant differences between them. Also, the highest DU and the lowest CV were recorded when the center pivot wasoperated under (P_{40}, S_{200} andH_{200}). So, it is recommended to operate the center pivot at (P_{40}, S_{200} and H_{200}) to save the pumping costs in studied area and similar conditions.

Keywords: Center pivot, Uniformity parameters, Operating pressure, Spacing between sprinklers and Height of sprinklers.

INTRODUCTION

With response to the increase in water scarcity created by rising demands in several sectors and slowing down of new water source development, irrigated agriculture, the largest user of water in most semi-arid countries is under significant pressure to reduce water consumption.

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Technical solutions to the growing phenomenon of water scarcity abound, and governments throughout the world have undertaken commitments to reduce water use in agriculture by improving the efficiency of water use in that sector (Brennan, 2008).Application efficiency can be increased by adopting pressurized irrigation system like sprinkler irrigation (Rana*et al.*, 2006).

Center pivot irrigation systems are often preferred by farmers due to its robustness and automation possibilities (Hanson and Orloff, 1996 andDechmi*et al*., 2003);low labor requirements and ability to irrigate large fields (Kincaid, 2005);easier operation and have the capacity to attain highly uniform and efficient irrigation results in water saving and farm profitability (Tarjuelo*et al*., 1999).

Theuniformity coefficients are often determined from measurementswith water collection cans located above the cropor on bare soil (Mateos*et al*., 1997). Two methods have been developed to quantify uniformity, CUand the distributionuniformity (DU).Coefficient of uniformity (CU) is a one of the first criteria defined to express uniformity. This coefficientis derived from catch-can data assuming that the catch-cans representthe same area. It is a measure of the absolute difference from themean divided by the mean. Distribution uniformity (DU) is usually defined as a ratio of thesmallest accumulated depths in the distribution to the averagedepths of the whole distribution. The largest depths could also beused to express DU, but since the low values in irrigation are morecritical, the smallest values are used (Burt *et al*., 1997). Distribution uniformity emphasizes the areas which receive the least of irrigation water by focusing on the low quarter (DU_{lq}). They suggested the DU_{lq} is expressed as a decimal. Thus, both CU and DU_{lq} coefficients give complementaryinformation. Uniformity is increased when the two coefficients (CUand DU_{lq}) are closer (Ortı´z*et al*., 2010).

In addition, the coefficient of variation (CV) in application volume can be computed as the standard deviation of all catch can measurements divided by the average catch can volume for a test. Both DU_{lq} and CU have been related to the CV analytically (Warrick, 1983) and verified experimentally on center pivot irrigation machines (Heermann*et al*., 1992 and Dukes, 2006).

Distribution uniformity with center pivotsystems mainlydepends on the sprinkler unit, the type or size of sprinklersand spacing along the lateral, the height above the ground orcanopy, plot topography, and the speed of the machine in order to avoid run-off (Allen *et al*., 2000).

Tarjuelo*et al*. (1999) reported that there was a negative correlation between DU and P.Moazed*et al*. (2010) found that the CU value was increased by increasing P. They added that relation was not linear and with lower P, the slop was steeper. Keller (1983) reported that, in a given sprinkler as the P lowers, the dispersion is intensified and water drops hit the ground greater, but this will decrease the water distribution, also, the relatively excessive sprinkled water in the predefined dispersion range. Pressure enhancement will decrease excessive sprinkled water leading to an improve water distribution uniformity coefficient. Therefore hesuggested that the lower P occurs when sprinkler spacing is lower.

Water distribution uniformityincreases when H is increased (Hills and Barragan 1998 and Tarjuelo*et al*., 1999Alazba*et al*., 2004). Increased height gives a larger wetted diameter for the same nozzle type and size, and consequently the overlap percentage is increased and the water application uniformity along the lateral is improved (Allen *et al*., 2000). IncreasingH usually produces better irrigation uniformity for a specific wind speed and direction, but it also increases evaporation and drift losses (Faci*et al*., 2001). Installing the sprinkler at a lower height reduces the wetted area and increases the applicationrate (Keller andBliesner, 1990 and Faci*et al*.,2001).

Moazed*et al*. (2010) studied the effect of S on CU under solid set system. Also, (Clark*et al*., 2003) studied the effect of S on CU under center pivot system. They reported that the elongated spacing between sprinkler decreasing CU value.

The objective of this study was to quantify the operating effect of some factors influencing the water distribution uniformity undercenterpivot irrigation system. In addition, a set of recommendations will be given for management of center pivot system for Sebha region and other environmentallysimilar regions.

MATERIALS AND METHODS

Field evaluations were conducted on center pivot irrigation systemto quantify the effect of someoperating factors influencing the water distribution uniformityunder Sebha region,south of Libya- conditions. The evaluations were carried out in October 2010 on bare soil to avoid the plant interference of applied water.The experiment was doneduring 09:00 and 12:00 in an attempt to coincide with low temperature and evaporation conditions as well as lower wind speed.

The center pivot systemis a 250 mlength, five spans (where span is defined as the pipeline and support truss between two support towers), each span is 50 m length. Thetotal irrigated area was 19.6 ha.Fixed spray plate sprinklers (FSPS) were used along the spans with the overhang of the center pivot.

The catch can test is a commonly used toassess the uniformity of sprinkler systems. Standards have been developed for determining the uniformity of water distribution of center pivot (ASAE, 2001). All collectors used in the test to measure the depth of water applied was identical and shaped such that water does not splash in or out. The lip of the collector was symmetrical and without depressions.

Catch cans with a 10 cm opening diameter and a 15 cm height were used. The catch can tests were conducted on the outer of the center–pivot irrigation systems(spans three, four and five), which represents 60% of the total irrigated area.So, catch cans began 100 m from the center pivotpoint and the spacing between cans was 1 m. There were 90 catch cans along a line.This line was far away from the pipeline to allow the system achieve working conditionsbefore arriving at the test site. The catch can reading process was carried out as quickly as possible with the aim ofreducing evaporation losses in collectors. The water depth collected was calculated by dividingthe volume caught by the open area of the catch can.

The FSPS were place at 200cm above the ground (H_{200}) inthe third span, at 175cm (H_{175}) in the forth span and150 cm (H_{150}) in the fifth span (Fig.1). The spaced between sprinklers (S) were 200, 250 and 300cm (S_{200}, S_{250} and S_{300}) apart in each span. The operatingpressures (P) at the fixed center pivot point were 20, 40 and 60 bar (P_{20}, P_{40} and P_{60}).

In order to avoid the overlapping effect between treatments under each span, two borders conducted between three spacing treatments. Five m between each two spacing treatments were considered and 2.5 m at the two ends of each span. So, each spacing treatment has a 10 m (Fig.1). All treatments were conducted at 50 % rotation speed.

TheCU,$DU_{lq}$and CV values for each span were calculatedfor evaluating center pivot irrigation system.

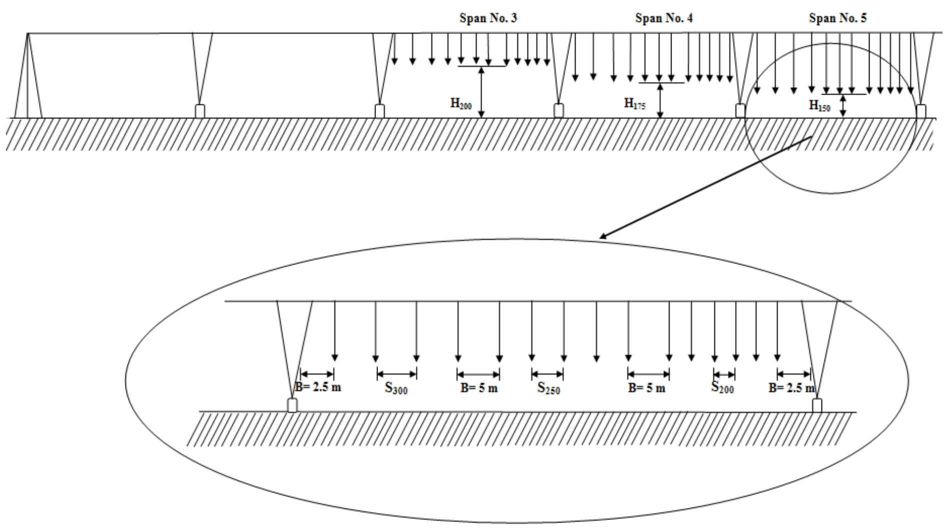

Fig. (1): Diagram of the positioning of sprinklers on the span.

Evaluation of Uniformity:

Several quantitative analyses procedures of water uniformity were used. Theseuniformities were calculated by the following equations:

1- **Coefficient of uniformity (CU)**:

The center pivot coefficient of uniformity was calculated using the modified formula of Heermann and Hein (1968)given by (ASAE, 2001):

$$CU = \left[1 - \frac{\sum_{i=1}^{n} S_s \left| D_s - \frac{\sum_{i=1}^{n} D_s S_s}{\sum_{i=1}^{n} S_s} \right|}{\sum_{i=1}^{n} D_s S_s}\right] \times 100$$

Where:

- D_s water depth (mm) collected by a catch can to a distance S from the center pivot.
- s a subscript that denotes the position to a distance S**.**
- n number of the catch can**.**

2- Distribution uniformity (DU_{lq}):

The low quarter irrigation distribution uniformity (DU_{lq})wascalculated using the following equation (Merriam and Keller 1978):

$$DU_{lq} = \frac{ADC_{25}}{ADC} \times 100$$

Where:

- ADC_{25} lowest quarter of the average water depth of a group of catch-can measurements.
- ADC total average water depth of a group of catch-can measurements.

2- Coefficient of variation (CV):

The coefficient of variation (CV) is the quotient between thestandard deviation of the applied water depths at the differentpoints of the field(σ)and the average of water depth collected:

$$CV = \frac{\sigma}{\bar{Ds}}$$

Where:

- σ the standard deviation of the applied water.
- $\bar{Ds}$ the average of water depth collected.

This experiment was designedas spilt-split-plot design with three replicates. The operating pressure (P_{20},$_{40}$ and $_{60}$) was arranged in main plots, the sprinkler spacing (S_{200}, $_{250}$ and $_{300}$) were allocated in the sub-plots, while sprinkler height (H_{150}, $_{175}$ and $_{200}$) were allocated in the sub-sub-plots.The obtained data were statistically analyzedusing SPSS software program (2008).Differences between means were compared by LSD at 5% level (Gomez and Gomez. 1984).

RESULTS AND DISCUSSION

1- Effect of quantitative variables on CU and DU_{lq}

Data illustrated in Tables (1and 2) focused the significant influence of P, S, H and their interactions on CUand DU_{lq} parameters. However, CU was significantly with increasing the P.The same trend was recorded forDU$_{lq}$ but the increment was insignificant.

The highest P (P_{60}) gained acceptable CU and DU_{lq} values comparing to P_{20} and P_{40} (Tables,1 and 2). Over all testing conditions, under P_{60}, P_{40} and P_{20}, the average CU values were 83.19, 81.00 and 76.20%, while those ofDU$_{lq}$ were 0.785, 0.759 and 0.703, respectively.

Table (1):The effects of operating pressure, spacing between sprinklers and height of sprinkler above the groundsurface on coefficient of uniformity (CU) values.

Pressure(bar)	Spacing(cm)			Sprinkler height (cm)			
				150	175	200	
20	200			**71.26**	**80.05**	**90.72**	
	250			**67.17**	**75.18**	**84.76**	
	300			**63.37**	**71.44**	**82.12**	
	Average			**67.27**	**75.55**	**85.86**	
40	200			**75.02**	**87.00**	**93.93**	
	250			**71.83**	**82.39**	**89.66**	
	300			**65.30**	**79.69**	**84.15**	
	Average			**70.72**	**83.03**	**89.25**	
60	200			**76.32**	**89.12**	**94.67**	
	250			**74.94**	**86.04**	**90.09**	
	300			**69.50**	**81.50**	**86.54**	
	Average			**73.59**	**85.55**	**90.43**	
Average of spacing	200			**74.20**	**85.39**	**93.11**	
	250			**71.31**	**81.20**	**88.17**	
	300			**66.06**	**77.54**	**84.27**	
	Average			**70.52**	**81.38**	**88.52**	
LSD 0.05 for:	**P**	**S**	**H**	**P×S**	**P×H**	**S×H**	**P×S×H**
	1.13	**1.13**	**1.13**	**1.43**	**1.43**	**1.43**	**2.17**

Regardingsprinkler spacing (S) effect onCUand DU$_{lq}$values decreased with increasing SS. CU values decreased by 5.02 and 10.89 % when SS was increased to S_{250} and S_{300}, the corresponding values for DU$_{lq}$were 8.36 and 14.34%, respectively. This result is full agreements with (Clark *et al*., 2003 and Moazed*et al*., 2010). They reported that, CU values tended to decrease with increasingsprinkler spacing.

Tables (1 and 2) show that CU and DU_{lq}were increased with increasing H. CU values increased by 15.39 and 25.48 % when H was increased toH_{175} and H_{200}, respectively.However, the highest and lowestvalues of CU were recorded at sprinkler height H_{200} and H_{150}, respectively. This result occurred because some soil points received larger amount of water, whereas water distribution at otherpoints was very scarce. This trend was also shown by Allen *et al*. (2000), Faci*et al*. (2001) and Alazba*et al*.(2004).As shown in Table (2) the average values of DU_{lq} overall H were 0.647, 0.757 and 0.843for H_{150}, H_{175} and H_{200}, respectively. This means that DU_{lq} was increased by 16.99 and 30.21% as sprinkler height increased toH_{175} and H_{200}, respectively.

As showed in Tables (1 and 2) the different dual interactions between the quantitative variableswere significant.

Table (2):The effects of operating pressure, spacing between sprinklers and height of sprinkler above groundsurface on distribution uniformity (DU_{lq}) values.

Pressure (Bar)	Spacing (cm)	Height (cm)			Average
		150	175	200	
20	200	**0.661**	**0.760**	**0.867**	**0.763**
	250	**0.627**	**0.647**	**0.773**	**0.682**
	300	**0.577**	**0.640**	**0.777**	**0.665**
	Average	**0.622**	**0.682**	**0.806**	**0.703**
40	200	**0.680**	**0.813**	**0.933**	**0.809**
	250	**0.630**	**0.793**	**0.843**	**0.755**
	300	**0.617**	**0.720**	**0.803**	**0.713**
	Average	**0.642**	**0.775**	**0.860**	**0.759**
60	200	**0.717**	**0.880**	**0.920**	**0.839**
	250	**0.680**	**0.820**	**0.860**	**0.787**
	300	**0.637**	**0.743**	**0.810**	**0.730**
	Average	**0.678**	**0.814**	**0.863**	**0.785**
Average of spacing	200	**0.686**	**0.818**	**0.907**	**0.803**
	250	**0.646**	**0.753**	**0.825**	**0.741**
	300	**0.610**	**0.701**	**0.797**	**0.703**
	Average	**0.647**	**0.757**	**0.843**	

LSD 0.05 for:	**P**	**S**	**H**	**P×S**	**P×H**	**S×H**	**P×S×H**
	NS	**0.117**	**0.117**	**0.171**	**0.171**	**0.171**	**0.242**

Both CU and DU_{lq}were increased with increasing both the P and S. The lowest P (P_{20}), caused reduction in throw radius. These reductions in radius of throw would result in sprinkler overlap changing this will reduce the water distribution uniformity.Under S_{200} and different P (P_{20}, P_{40} and P_{60}), the uniformity parameter values of CU were 80.67, 85.32 and 86.70%,(Table, 1). The corresponding values for DU_{lq}were0.763, 0.809 and 0.839 (Table, 2),respectively. At the highest spacing (S_{300}) the uniformity parameter values were 72.31, 76.38 and 79.18% for CU and 0.665, 0.713 and 0.730 for DU_{lq}, respectively in the same order. The highest CU values 85.32 and 86.70% were recorded at P_{40} and P_{60} at S_{200}. But the difference between CU resulted from P_{40} and P_{60} (85.32 and 86.70%) was not significant. Thus, to save the pumping costs, it's recommended to operate the center pivot at P_{40}.It's clear from Table (1), that in the case of the closer spacing (S_{200}), to obtain the acceptable CU, operate thecenter pivot at lower P (P_{20}) to gainCU = 80%. This result is in an agreement with Keller, (1983). He suggested that the lower P occurs when S is lower.

To obtain the highest CU under combinations ofP and S parameters,center pivot irrigation system has to operate at pressure P_{40} and S_{200} (the difference between CU resulted from P_{40} and P_{60} (85.32 and 86.70%) was not significant.).

Data in Tables (1 and 2) illustrate the data of grouped P and Hwhere the CU and DU_{lq} increased by increasing P and H. The lowest CU and DU_{lq}values (67.27% and 0.622) were recorded under low P and H (P_{20} and H_{150}), respectively. The highest CU and DU_{lq}values (90.43% and 0.863) were recorded under high P and H (P_{60} and H_{300}), respectively.

Under H_{200} and both $P_{40}$and P_{60} the highest CU(89.25 & 90.43%) and DU_{lq}(0.860 & 0.863)were recorded. The difference between CU and DU_{lq}values resulted from P_{40} and P_{60} was insignificant. Also, to save the pumping costs, it's recommended to operate thecenter pivot at P_{40}. To obtain the highest CUand DU_{lq} under grouped P and Hconditions, and at the same time save the pumping cost, the center pivot must operate at pressure P_{40} and H_{200}.

From Tables(1 and 2) the CU and DU_{lq}values were increased by increasing H and decreasing S.The lowest CU and DU_{lq}values (66.06 %

and 0.610, respectively) were recorded under the lowest H (H_{150}) and the widest S(S_{300}). The highest CU and DU_{lq} values (93.11% and 0.907) were recorded under the highest H (H_{200}) and closer S (S_{200}). To obtain the height CU andDU_{lq} (93.11 %and 0.907, respectively) under grouped H and Sconditions sprinklers must be install at S_{200} and H_{200}. Fig (2) show that,under S_{200}, when the Hwas increased from H_{150} to H_{175} and H_{200} the CU values increased by 15.08 & 25.49%, while those of DU_{lq}were 19.24&32.22%, respectively.

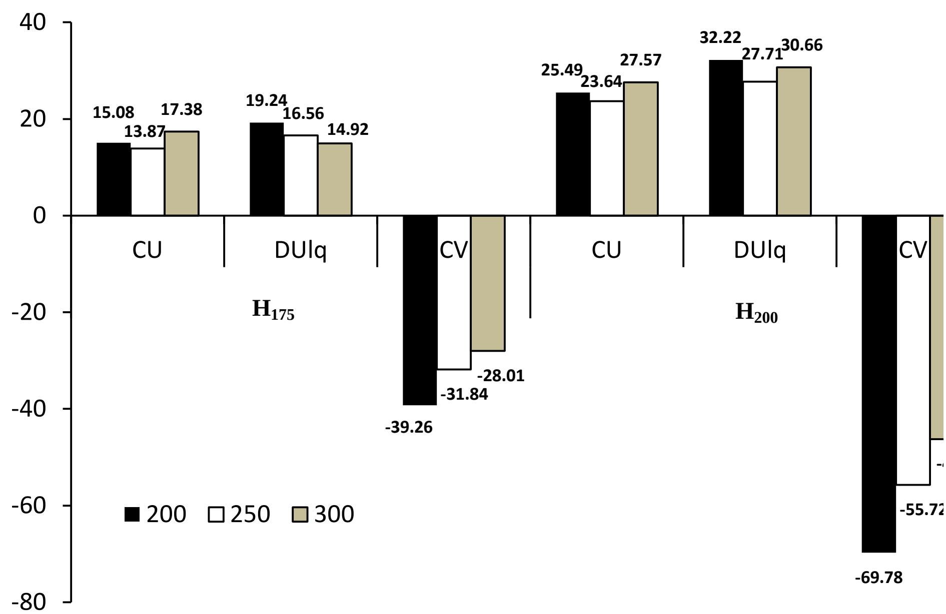

Fig. (2): The percentage of uniformity parameters under H_{175} and H_{200} compared to H_{150} one.

As shown in Tables (1and 2) the trio-interactions between the quantitative variableswere significant. Thehighest CUvalues (94.67 and 93.93 %) were recorded when the center pivot operated under (P_{60}, H_{200} and S_{200}) and(P_{40}, S_{200} and H_{200}), respectively without significant differences between them. While, the lowest CUvalue (63.37%) wasrecorded when operate the center pivot under P_{20}, H_{150} and S_{300}. So, to save the pumping costs, it's recommended to operate the center pivot at (P_{40},$S_{200}$and H_{200}) (Table, 1).

The highest DU_{lq}value (0.933) was recorded when the center pivot operatedunder P_{40}, $S_{200}$and H_{200}, while the lowest one (0.577) was recorded at P_{20}, $S_{300}$and H_{150}(Table, 2).

From Tables (1and 2), it's clear also that, when the center pivot wasoperatedunder both H_{200} and S_{200}at different P treatments (P_{20}, P_{40} and P_{60}) gained the highest CU (CU > 90%) and DU_{lq} (DU_{lq}> 0.867).

2- Effect of quantitative variables on CV:

Data illustrated in Table (3) focused on the significant influence of P, S, H and their interactions on CV. The CV value was significantly decreased with increasing each P and H, but increased with increased with increasing spacing between sprinklers.

Table (3):The effects of operating pressure, spacing between sprinklers and height of sprinkler above the groundsurface on coefficient of variance (CV) values.

Pressure (bar)	Spacing(cm)			Height (cm)			Average
				150	175	200	
20	200			**35.39**	**23.69**	**12.97**	**24.02**
	250			**38.36**	**28.82**	**19.30**	**28.83**
	300			**40.58**	**33.53**	**23.84**	**32.65**
	Average			**38.11**	**28.68**	**18.70**	**28.50**
40	200			**27.92**	**16.16**	**6.98**	**17.02**
	250			**33.23**	**20.94**	**13.06**	**22.41**
	300			**37.91**	**25.00**	**19.39**	**27.43**
	Average			**33.02**	**20.70**	**13.14**	**22.29**
60	200			**26.24**	**14.54**	**7.12**	**15.97**
	250			**28.00**	**18.12**	**11.74**	**19.29**
	300			**33.44**	**22.07**	**16.94**	**24.15**
	Average			**29.23**	**18.24**	**11.93**	**19.80**
Average of spacing	200			**29.85**	**18.13**	**9.02**	**19.00**
	250			**33.20**	**22.63**	**14.70**	**23.51**
	300			**37.31**	**26.86**	**20.05**	**28.08**
	Average			**33.45**	**22.54**	**14.59**	**23.53**
LSD 0.05 for:	**P**	**S**	**H**	**P×S**	**P×H**	**S×H**	**P×S×H**
	1.12	1.12	1.12	1.41	1.41	1.41	2.15

CV value at the lowest height P_{20} was higher than those at P_{40} and P_{60} by 27.86 and 43.94%, respectively. Also, CV at the lowest sprinkler height (H_{150}) was higher than those at H_{175} and H_{200} by 48.40 and 129.27 %, respectively. CV at the lowest sprinkler spacing (S_{200})was lower than those at $S_{250}$and $S_{300}$by 23.74 and 47.79%, respectively.

As shown in Table (3) the dual interactions between the quantitative variables were significant.

The CV decreased with increasing both P and S. Under S_{200} and different P (P_{20}, P_{40} and P_{60}) the uniformity parameter values were 24.02, 17.02 and 15.97 %, respectively.Thecorresponding values under S_{300}were 32.65, 27.43 and 24.15%, respectivelyin the same order.

Data grouped according to P and H(Table 3), the CV was decreased by increasing P and H.The lowest CVvalue (11.93%) was recorded under the highest P and Htreatment (P_{60} and H_{200}). While the highest CV value (38.11%) was recorded under the lowest P and Htreatment (P_{20} and H_{150}). Under H_{200} and both $P_{40}$and P_{60} was recorded the lowest CV (13.14 and11.93, respectively). The difference between CV resulted from P_{40} and P_{60} was insignificant. Therefore, to obtain the lowest CV under grouped according to P and Hconditions the center pivot must operate at pressure of P_{40} and height of H_{200}.

The interaction between S and H was significant and declare thatthe lowest CV value (9.02%) was recorded under the highest H (H_{200}) and closer S (S_{200}). While the highest CV value (37.31%) was recorded under the lowest H (H_{150}) and the widest S(S_{300}). To obtain the lowest CV sprinklers must be installed at S_{200} and H_{200}.

From Fig (1), under S_{200}, when the H increased from H_{150} to H_{175} and H_{200} the CV declined to -39.26&-69.78%. The same trend was recorded under S_{250} and S_{300}.

Thetrio-interaction between the quantitative variableswas significant. According to the interaction between the overall testing conditions the lowest CV (6.98 %)was recorded when the centerwas operated under P_{40},

H_{200} and S_{200} conditions. While, the highest CV (40.58%) was recorded when operate the center pivot under P_{20}, H_{150} and S_{300}conditions(Table 3).

It is clear that, when operate the center pivot under both H_{200} and S_{200} and different P (P_{20}, P_{40} and P_{60}) gained the lowest CV (CV < 12%).

3- Correlation coefficient:

The correlation coefficient between the uniformityparameters and the considered quantitative variableswere arranged in (Table,4). The correlation coefficients between the uniformity parameters and the quantitative variables were very strong.

There were negative correlations between both the CU &DU_{lq} and S,but it waspositive with each of P and H.An opposite trend was recorded with CV. So, its correlations with both P and H were negative, while it was positive with S.

Table (4): Correlation coefficientbetweenthe uniformity parametersand the quantitative variables.

Quantitative variables	Uniformity parameters		
	CU	DU_{lq}	CV
P	0.978	0.979	-0.971
S	-0.994	-0.991	1.000
H	0.993	0.997	-0.996

As shown in Fig. (3), the CU was consistently higher than DU_{lq} and both are inversely related to CV. This result is on line with Keller and Bliesner(2000). They reported that, according to the mathematical relationship between CU andDU_{lq}, CU will always be larger (when both are decimals or a percentage) since positive and negative deviations from the mean application volume are used in the calculation of CU. whereas, only negative deviations are used in the calculation of DU_{lq}. Both DU_{lq} and CU are linearly related to CV (Fig.3), similar results were reported by Tarjuelo*et al*.,(1999). Warrick (1983) showed similar relationships in an analytical analysis of CU, DU_{lq}, and CV.

As shown in Fig. (3), the obtained relation between CU and DU_{lq} against CV were:

$$CU = 101.82 - 0.92\ CV,\ R^2 = 0.99$$

$$DU_{lq} = 99.21 - 1.03CV,\ R^2 = 0.96$$

The relationships from the present studywere close to relationships found by Heermann*et al*. (1992) and Dukes (2006) despite there were differences and variation in the testing conditions.

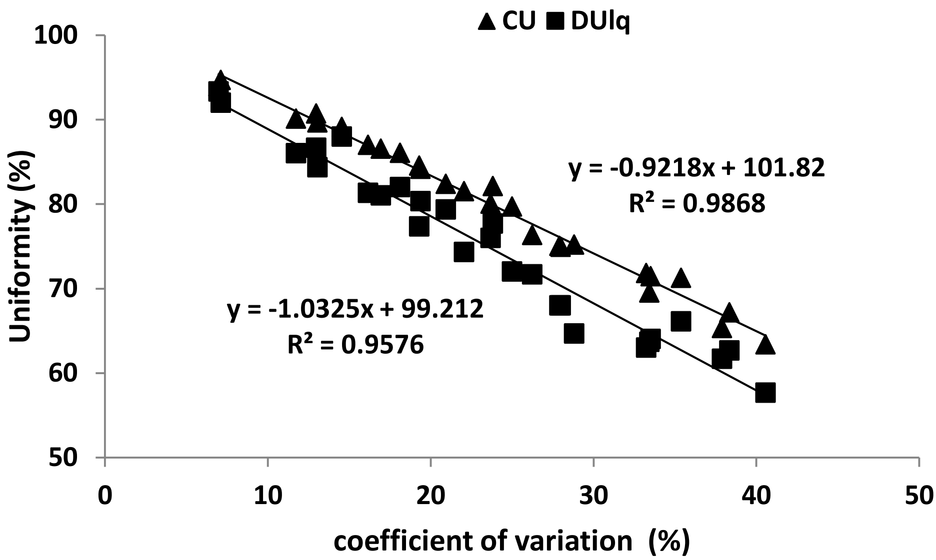

Fig. (3): Relationships between DUlq and CU with (CV).

CONCLUSIONS

From the obtained results, it is recommended to apply the highest uniformity parameters and good management of center pivot irrigationunder Sebha region and other similar regions.Tooptimize the system performance, center-pivot shouldbe operatedunder 40 bar pressure (P_{40}), 200 cm between sprinklers (S_{200}) and 200 cm height of sprinklers above the ground (H_{200}).

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الملخص العربى

تقييم آداء نظام الرى بالرش المحورى تحت ظروف المناطق الجافة

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تهدف هذه الدراسة إلى تقييم تأثير ضغط التشغيل(P)، المسافة بين الرشاشات (S)وارتفاع الرشاشات عن سطح الأرض (H)على معامل الانتظامية (CU)وإنتظاميةالتوزيع (DU_{lq})ومعامل الاختلاف(CV)تحت نظام الري بالرش المحوري. وكانت المعاملات كما يلي: ثلاثة ضغوط تشغيل (P_{20}، P_{40} و P_{60}) بار، ثلاثة مسافات بين الرشاشات (S_{200}، S_{250} و S_{300}) سم وثلاثة ارتفاعات للرشاشات عن سطح الأرض (H_{150}، H_{175} و H_{200})سم.

وقد أظهرت النتائج أن أعلى قيم CU و DU_{lq} كانتا تحت ضغط التشغيل العالي (٦٠ بار) والمسافة الضيقة بين الرشاشات (٢٠٠ سم) والمسافة الأعلى للرشاشات عن سطح الأرض (٢٠٠سم). بينما كان على النقيض من ذلك بالنسبة لمعامل الإختلاف حيث كانت قيمته الدنيا عند قيم المتغيرات سابقة الذكر. وقد لوحظ أن CU و DU_{lq} تزيد بزيادة ضغط التشغيل (OP) وإرتفاع الرشاشات عن سطح الأرض (HS) وأيضا بتقليل والمسافة بين الرشاشات (SS). بينما CV تقل بزيادة OP وHS وبتقليل SS. كما أظهرت النتائج أنه لا يوجد فرق معنويفي قيم معامل التوزيع عند تشغيل النظام على (OP_{60}و SS_{200}و HS_{200}) و (OP_{40} و SS_{200} وHS_{200}) في حين سجلت اعلي قيم DU_{lq} واقل قيمة CV عند تشغيل النظام على (OP_{40} و SS_{200} وHS_{200}).

وعلية توصى الدراسة بتشغيل نظام الري بالرش المحوريتحت ظروف منطقة الدراسة والمناطق المماثلة مناخيا عند (OP_{40} و $SS_{٢٠٠}$ وHS_{200}) وذلك لتقليل تكاليف التشغيل.

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