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Effect of Foliar- Applied potassium Fertilizer on Sunflower Water use efficiency under deficit irrigation Concept

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Abstract:

Field experiment was conducted as randomized complete block design (RCBD) during the spring season 2015 at soil and water Resources center (Baghdad). The main objective was to evaluate enhancing sunflower water use efficiency using deficit irrigation practice with and without foliar- application of potassium. Treatments were two level of deficit irrigation namely, 20% and 40% of full applied irrigation water, without potassium fertilizer application and with potassium foliar application 20, 35 and 50 days after germination. Amount of soil water content to depth 0-0.3m was determined by using Diviner – 2000 sensor. Deficit irrigation practices of 20% and 40% reduction from applied irrigation water to full irrigation caused decreasing in irrigation water amount with 1180 and 2320 m^3. $ha^{-1}season^{-1}$ respectively as compared with full irrigation treatment (6180 m^3. $ha^{-1}season^{-1}$). Water use efficiency was not affected significantly by using 20 and 40 % reducin in applied water. On the other hand, WUE_f and WUE_c. were increased significantly in each spraying treatments, when compared with the treatments before it was (0.61, 0.63 Kg. ha^{-1}) at first spray and (0.66, 0.69 Kg.ha^{-1}) in second spray, 0.70 and 0.73 Kg. ha^{-1} in third spray. While control treatment were 0.41and 0.40 kg.

ha^{-1}. Deficit irrigation treatments have significant effected on oil content percent and seed yield. Reducing 20% from applied irrigation water caused increased in oil content percent and seed yield with 4.5% and 12.6% respectively as compared to reduction 40% from applied irrigation water. The foliar spraying of potassium fertilizer effected positively with significant differences in oil content percent and seed yield. Oil content percent was increased by 12.2%, 20.4% and 26.8% respectively when compared with control, and the other hand the seed yield increased significantly in each spraying treatments when compared with the treatments before it was (2781.0 Kg / ha) at first spray and (3031.5 Kg/ ha) in second spray, (3242 Kg / ha) in third spray. While control treatment was (2431/ Kg. ha^{-1}. The results showed that substantial increased in WUE, oil content percent and seed yield under three times foliar spraying potassium fertilized for sunflower.

Key words: Sunflower, Diviner-2000, Foliar K, WUE

INTRODUCTION

Shortage of water supply is a serious problem and large challenge in the coming decade due to the decline of water resources and increasing demand for food. Therefore, water use has to be efficient to reduce loses during the entire process of irrigation. Accordingly, there is large concerns over the water use efficiency over the past few years. Low quality of both water and soil are serious problem factor threating food production. Achieving greater efficiency of water use will be a primary challenge for the near future and will include the employment of advanced techniques and practices that deliver a more accurate supply of water to crops. The deficit irrigation is a method of rationing, Which was identified as a key limited process, which, add the less amount of water than that required. This in return will increase productivity of irrigation water. Adequate water and nutrient supply are important

factors affecting optimal plant growth and successful crop production. Water stress is one of the severe limitation of crop growth especially in arid and semi – arid regions of the world as it has a vial role in plant growth and development at all growth stages. Potassium is an essential nutrient that increases drought tolerance, stem strength, and improve plant growth(Faisal et al, 2013). Plant uptake of K is primary by diffusion through roots and under drought conditions limited uptake may occur (Sardi and Fulop, 1994). Major threat to reduce growth and yield of a plant is drought stress (Souza et al., 2004). Nutrional status of the plant is the indicator of its response to environment stress. Cakmak 2005 reported that potassium enhanced drought tolerance in plants by mitigating harmful effects by increasing translocations and by maintaining water balance. Crop easily absorb foliar applied nutrients in return crop yield increased (Ari fetal, 2006). El- Ashry et al.(2005) reported that the negative effect of drought on growth can be decreased by spraying K to plants. Sunflower is an important oil seed crop in the world and it belongs to the family Asteraceae. Use of oil of sunflower increased in last few years as a result of the decreasing in the quantity of other produced oils because of using them in many fields of life. In addition, the seeds contain high percentage of protein ranging from 20- 30%. Therefore, issued in poultry food as well (Murphy, 1978). Also the seeds contain high percent of oil reach to 50% (Syed. et al, 2000). Sunflower oil is low saturated faty acids oil that have essential role in arteries intransigence and high content of E vitamin (Abdul- Motagally, 2010). The demand for oil seed has increased several times for the past few years but the acreage cannot be increased because of increasing competition with major cereal crops. Sunflower is one of the four major oil seed crops (soybean, peanut, rapeseed and sunflower) grown for edible oil in the world. It is cultivated on about 23.31 mha all over the world. This study aims to enhancing sunflower water

use efficiency and the role of foliar- Applied potassium in increasing water use efficiency under deficit irrigation practices.

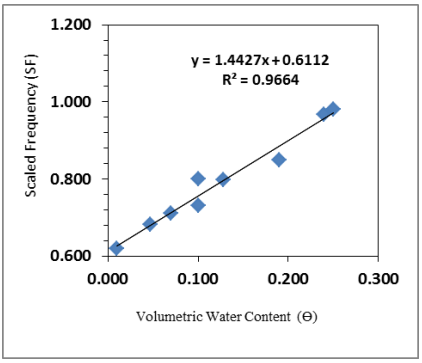
MATERIAL AND METHODS

Field experiment was conducted in Research Station of Irrigation Technology. Soil and water Resources Center in Tuwaitha Agricultural research directorate, 40 Km East- south of Baghdad , Iraq during the spring season 2015. The experiment involved the following treatments: two treatments of deficit irrigation which are 20 and *4*0% reduction of full irrigation. Other treatments are those concerning the date of potassium foliar application. These were: 20 days after germination 35 days after germination and 50 days after germination. Control trial, growing plant under full irrigation practice, was included which. The soil has silty clay loam texture and classified as ((fine loam, mixed, hypothermic, typic , terrified events), Relevant soil physical and chemical properties were determined according to standard methods (Black,1965, page et-al,1982,Richarads , 1931). The field was divided by three equally blocks 3m apart of each. Block was divided by eight experimental unit 4X4, 2m apart. Experiment was conducted as randomized completed block design (R.C.B.D) with three replicates.

Properties	Unit	Value
Sand	$g.Kg^{-1}$	257
Silt		408
Clay		335
Texture		Silty Clay Loam
Bulk density	$\mu g.m^{-3}$	1.36
Volumetric moisture content at 33 Kpa	$cm^{-3}.cm^{-3}$	0.34
Volumetric moisture content at 1500 Kpa	$cm^{-3}.cm^{-3}$	0.14
Available water	$cm^{-3}.cm^{-3}$	0.20
EC_e	$dS.m^{-1}$	3.4
pH		7.6

Table 1: Relevant soil physical and chemical properties of soil

Nitrogen fertilization was applied as urea (46% N) at a rate of 400 kg.ha^{-1} on two batches : the first with 260 kg.ha^{-1} from T.S.P at before planting. the second was added after five weeks from planting ,Potassium fertilizer was applied at rate of 200 kg.ha^{-1} as K_2SO_4.Sunflower seeds were sown on 15/3/2015 in rows of 0.75m between rows and 0.25 among plants. Amounts of irrigation water required was estimated based on measurement of soil water content by using Diviner-2000 sensor for soil depth 0-0.8m depending on particular calibration equation for the soil (Fig.1).



Fig(1): Diviner-2000 calibration equation for (Si.C.L.) soil.

Linear correlation with r =0.966 was found between Volumetric water content (Θ) and scaled frequency (S.F.).

$$SF = 1.443\Theta + 0.611 \quad \text{.....(1)}$$

$$SF = \frac{FA - Fs}{FA - Fw} \quad \text{.....(2)}$$

Where:

F_A =Diviner count in air.

Fs = Diviner count in soil.

Fw = Diviner count in water.

to moistening the 0-0.3m during growing season after irrigated and before next irrigation using equation (Kovda, et.al , 1973)

$$d = (\theta_{fc} - \theta_{bi}) * D \quad \text{..... (3)}$$

where:

d= depth of water applied (m)

θ_{fc} = Volumetric moisture content at field capacity ($m^3.m^{-3}$)
θ_{bi} = Volumetric moisture content before irrigation ($m^3.m^{-3}$)
D= soil depth (m).

The water equilibrium equation was used as a direct method to calculate actual water use for the crop, according (Dooge , 1960)

$$(I+P+C) – (ET_a+D+R) = \pm \Delta S \ldots . (4)$$

Where:
I = Irrigation water applied (mm).
P= Precipitation (mm) .
C= Ground water input by capillary effect (mm)
ET_a = actual evapotranspiration (mm).
D= Deep percolation (mm)
R=Surface runoff (mm).
ΔS=Soil moisture storage at beginning and end of the season.

Thus equation (*4*) will be as follow:

$$I+P= ET_a \pm \Delta S \ldots\ldots\ldots\ldots (5)$$

Because of
R=0 (Runoff equal Zero).
C = 0 (ground water table deep about 2m).
D = 0 (because we irrigation when 50-55% of available water is depleted and for certain depth of the soil 0-0.20 and 0-0.4 m).

RESULTS AND DISCUSSION

Figure 2 shows that deficit irrigation practices (20% and 40% reduction from applied irrigation water to full irrigation) caused decreasing in irrigation water amount with 1180 and 2320 m^3. $ha^{-1}season^{-1}$ respectively, as compared with full irrigation treatment(6180 m^3. $ha^{-1}season^{-1}$).

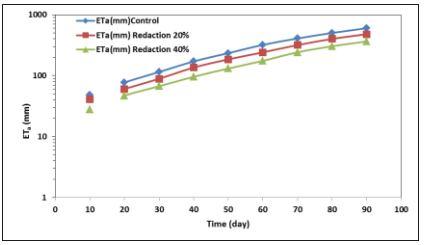


Fig (2): Cumulative of ET_a for difference treatment.

Table (2) shows both crop and field water use efficiency was not significantly affected by 20 and 40 % reduction in applied water. On other hand, affected of time spraying on WUE_f and WUE_c were increased significantly in each spraying treatments, WUE was, however, (0.61, 0.63 Kg. ha^{-1}) at first spray , (0.66, 0.69 Kg.ha^{-1}) in second spray(0.70 and 0.73 Kg. ha^{-1}) in third spray for sprayed and unsprayed, respectively. While control treatment were (0.41 and 0.40 Kg. ha^{-1}). The results showed that substantial incrusted in WUE_f and WUE_c when used three time spray with foliar- Applied potassium fertilizer for sunflower. Deficit irrigation significantly increased seed and biomass WUE, is a technique to conserve water and improve WUE, increasing WUE under drought stress has been reported by (Egilla, et.al, 2005 and Jaleel, e.tal, 2008).

S T	WUE_c Kg.m^{-3}			WUE_f Kg.m^{-3}		
	S1	**S2**	**Mean**	**S1**	**S2**	**Mean**
Control	0.41	0.41	0.41	0.40	0.40	0.40
T1	0.61	0.66	0.63	0.59	0.63	0.61
T2	0.68	0.70	0.69	0.65	0.66	0.66
T3	0.75	0.72	0.73	0.72	0.68	0.70
Mean	0.61	0.62	0.0432	0.59	0.59	0.0443
LSDS = (0.03) LSDT = (0.04)				LSDS = (0.03) LSDT = (0.04)		

Table (2): The effect of different treatments of WUE_c Kg.m^{-3} and WUE_f Kg.m^{-3}.

Deficit irrigation treatments showed significant effect on oil content percent and seed yield. Reduction 20% from applied irrigation water showed that oil content and seed yield was 4.5%, 12.6%, respectively, higher than that of 40% reduction in applied irrigation water. Erdem et.al, 2006. Found that there is xx% reported in seed yield under water stress conditions compared to that of no stress. Foliar- application of potassium fertilizer 20, 40 and 60 days after germination resulted in oil content increase by 12.2%, 20.4% and 26.8% respectively, Over that of no potassium application. Yield of the seeds under the above three potassium application were 14%, 25% and 33% over that of control, respectively. The results showed that substantial increase in oil and seed yield when used three time spraying with foliar Applied potassium fertilized for sunflower. Table (3). These results are in agreement with those of (Lahnood, 1999 and Adnan, 2011). Potassium application may cause more accumulation of oil in seeds and in return increase the yield Moreover, the role of potassium application may increase seed yield.

S / T	Oil Percentage %			Seed Yield (Kg.ha^{-1})		
	S1	**S2**	**Mean**	**S1**	**S2**	**Mean**
Control	*37.41*	*37.41*	*37.41*	*2431.0*	*2431.0*	*2431.0*
T1	*41.97*	*39.22*	*40.60*	*2930.0*	*2632.0*	*2781.0*
T2	*45.03*	*41.32*	*43.18*	*3282.0*	*2781.0*	*3031.5*
T3	*47.42*	*44.81*	*46.12*	*3612.0*	*2872.0*	*3242.0*
Mean	*42.60*	*40.69*		*3063.8*	*2679.0*	
LSDS = (1.4) LSDT = (1.9)				LSDS = (142.3) LSDT = (201.7)		

Table (3): The effect of different treatments of Oil content Percent %, and Seed Yield (Kg.ha^{-1}) .

Table (4) shows the effect of deficit irrigation on plant height and leaf surface area. Plant height and leaf surface area

increased by 1.48% and 4.71% respectively, under that of 20% reduction over that under 40% reduction in irrigation water. Plant height was found to be 125.5 cm, 131.6 cm and 137.3cm , under first, second and third sprayed, respectively, while under control treatment it was 121.6 cm. on the other hand, the leaf surface area increased significantly by 9%, 46% and 47% under the three spraying time compared to that of control. The adverse effect of water stress may also be decreased by increasing the transpiration by partial closure of stomata (Alfredo and setter, 2000, Hoad.et.al, 2001) It has been suggested that plants mineral nutrient status plays a vital role in improving the resistance of plant to stress conditions (yafov, 2006). Potassium plays a key role in improving the plant tolerance to stress condition. K is essential element (Menget and Kirkby, 2001). The exogenous application of K improved the plant height, It was found more effective in increasing the plat height when sprayed under drought. Leaf area $(cm)^2$ significantly incensed by add potassium fertilizer as compared with control, has been reported by Rania that, 2014.

S T	**Plant height(cm)**			**Leaf surface area (cm^2)**		
	S1	**S2**	**Mean**	**S1**	**S2**	**Mean**
Control	*121.6*	*121.6*	*121.6*	*2712.0*	*2712.0*	*2712.0*
T1	*127.2*	*123.8*	*125.5*	*3040.0*	*1816.0*	*2927.8*
T2	*132.1*	*131.1*	*131.6*	*4062.0*	*3832*	*3947.0*
T3	*139.8*	*134.7*	*137.3*	*4092.0*	*3891.0*	*3991.5*
Mean	*130.2*	*127.8*	*7.2262*	*3476.5*	*3312.7*	*47.833*
LSDS = (1.6) LSDT = (2.2)				LSDS = (33.8) LSDT = (47.7)		

Table (4): The Effect of different Treatment of Plant height(cm) and Leaf surface area (cm^2).

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