THE IMPACTS OF DRIP TAPE IRRIGATION ON WATER USE EFFICIENCY OF SUNFLOWER IN ROTATION WITH WHEAT

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ABSTRACT

As the competition for the finite water resources on earth increases due to growth in population and affluence, agriculture is faced with intensifying pressure to improve the efficiency of water used for food production. The study was carried out to improve water use efficiency (WUE) and water productivity (WP) on sunflower, using split–plot design on base of randomized complete blocks with two different cultivation management (Sw:sunflower after wheat, Ss:only sunflower), 3 irrigation treatments (Is-60: furrow irrigation and rows 60cm, It-50: drip irrigation and rows 50cm, It-60:drip irrigation and rows 60cm) in 3 replications in Meandoab Agricultural Research Station in production season 2007-2008. Irrigation treatment significantly affected seed yield. Although the highest seed yield (5.10 t ha-1) was obtained from It-50 treatment, increasing 23.3% in compared with Is-60 treatment, the effect of main factor on oil content was significant at P≤5% but irrigation treatment didn't have any significant effect on it. Sw treatment significantly (P≤1%) increased WP and WUE. Water use efficiency and water productivity were increased by 18.9% and 18.1% in treatment of Sw. Maximum water productivity was 0.761 Kg m-3 in treatment of It-50. The research results revealed that the drip irrigation system could be used successfully for irrigation of sunflower crops under the arid climatic condition of west Azerbaijan for improving WP and WUE.

Key words: sunflower, drip irrigation, furrow irrigation, water use efficiency, water productivity

1. INTRODUCTION

The sustainable use of scarce water resources in Iran is a priority for agricultural development. The pressure of using water in agriculture sector is increasing to create ways to improve water-use efficiency and taking a full advantage of available water. Therefore, adoption of modern irrigation techniques is needed to be emphasized to increase water use efficiency. Drip irrigation is the most effective way to convey directly water and nutrients to plants and not only save water but also increases yields of vegetable crops.

Surface irrigation methods are utilized for more than 80% of the world's irrigated lands yet its field-level application efficiency is often only 40–50%. In contrast, drip

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irrigation may have field-level application efficiencies of 70–90% as surface runoff and deep percolation losses are minimized (Heermann *et al.,* 1990; Postel, 2000). Hence tendency in recent years has been towards conversion of surface to drip irrigation, which is considered to be more efficient delivery system. Scheduling water application is very critical to make the most efficient use of drip irrigation system, as over irrigation reduces yield, while inadequate irrigation causes water stress and reduces yield. On the other hand, the intensity of operation requires that the soil water supply be kept at the optimal level to maximize returns to the farmer. High-frequency water management by drip irrigation minimizes soil as a storage reservoir for water, provides at least daily requirements of water to a portion of the root zone of each plant, and maintains a high soil matric potential in the rhizosphere to reduce plant water stress (Phene and Sander, 1976; Nakayama and Bucks, 1986). Micro irrigation has become widespread in agriculture in recent years in Iran because of advantages of this system and attention to shortage of water resources meanwhile by using tape irrigation we can irrigate the crops easily, that helps the plants grow, increasing yield and improving of water productivity. According to Sivanappan (1994) research studies in India water saving is about 40–80% and the yield increase is up to 100% for different crops by using micro-irrigation. The incremental benefit-drip cost ratio (BI/CD) worked out for various crops ranges from 1.35 to 13.35 excluding water saving and 2.78 to 32.32 including water saving. It has also been proved that drip irrigation, which is a type of micro-irrigation, is technically feasible and socially acceptable not only for large farms but also in small and marginal farms. A study by Purser (1993) show that using tape irrigation and polyethylene mulch cause the temperature of soil goes up and the yield increases 2 to 5 times. Sepaskhah *et al*. (1976) reported that micro irrigation system decrease water consumption by 55% in comparison with furrow irrigation system in planting beans. The effect of irrigation systems (micro irrigation by tape and furrow) and plant density on yield and water use efficiency studied by Ghadami et al., (2007). they reported that irrigation systems don't have significant effects on yield of garlic but water consumption has decreased 44% and water use efficiency has increased 41% in tape irrigation system in comparison with furrow irrigation.

The aim of this research was to study the effects of micro-irrigation (tape) and plant density at two different growth periods of sunflower, on yield, certain yield-components and quality traits of sunflower for water usage under Meandoan region conditions.

2. MATERIAN AND METHODS

Field trials were conducted for 2 years (2007–2008) at Agricultural Research Station, Meandoab(MARS), West Azarbaijan, which is situated in the north–western semi arid zone of Iran (36^{o}, 58` N latitude; $46^{o}$, 60` E longitude and altitude of 1314m above mean sea level). The soil of the site was silty loam in texture having an infiltration rate of $14mmh^{-1}$ and a bulk density of 1.3 g cm^{-3} with field capacity of 0.25 $m^{3}.m^{-3}$ and permanent wilting point of 0.12 $m^{3}\ m^{-3}$. The plant available water is observed as 150 mm in the upper 90 cm of the soil profile. The soil pH was 7.9. cold climate is dominant in the area. Average temperature and annual precipitation is 10.5 ^{0}C and 280 mm, respectively, based on the many years of observation data collected by the station located in the experimental farm. Annual average humidity and wind rate are 61% and 1.2 m s^{-1}, respectively.

Treatments including 2 different cultivation management (Sw:sunflower after wheat, Ss:only sunflower), 3 irrigation and plant density treatments (Is-60: furrow irrigation and rows 60cm, It-50: drip irrigation and rows 50cm, It-60:drip irrigation and rows

60cm) as main and sub plots respectively, were studied using split plots on the base of Randomized Complete Blocks Design (RCBD) in 3 replications during 2007-2008. Every plot had 30 m long and 3.0-3.6 m wide and with 6 rows of plants spaced 50 and 60 cm on row and 30 cm in row. Every plot was separated and irrigated independently. For SW treatment at main factor we plant wheat on fall and we plant sunflower immediately after harvesting wheat on spring. All of plots were uniformly irrigated after sowing at first irrigation on the base of soil moisture deficit compensation to the field capacity point in depth of 30 cm. Thereafter, irrigation was changed in each plot according to the related treatments. sunflower water requirement was estimated in each growth stage on the base of potent evapotranspiration(ETo) and crop coefficients(kc). ETo was determined by using relationship between pan evaporation (Ep) and potent evapotranspiration (ETo) obtained from lysimeter data presented in MARS. Water efficiency considered 90% for tape irrigation system and was calculated on farm for furrow irrigation in every irrigation time. In this context inlet flow and runoff at end furrow was measured by WSC flume that installer at first and end of furrows.

3. RESULS AND DISCUSSION

The results of analysis of Variance in two years trial have been showed in table 1. The effect of main factor (different cultivation management or planting time) on the grain yield was not significant. The effect of main factor on oil content was significant at P≤5% but irrigation treatment didn't significant effect on it. The difference between WUE and WP of different cultivation management treatment was significant. Sw treatment significantly (P≤5%) increased WP and WUE. Water use efficiency and water productivity were increased by 18.9% and 18.1% in treatment of S in comparison with Ss (table 2). The effect of irrigation treatment on grain yield, WUE and WP was significant at P≤1%. The highest grain yield was obtained from tape drip irrigation with 50 cm row space (5103.7 kg ha^{-1}). It was 23.3 % more than Ss.Is-60 treatment (common treatment). The grain yield of It-60 treatment (tape drip irrigation and 60 cm row space) with 6.3% increase in related to Is-60 treatment expanded to 4400.6 kg ha^{-1}. The sub main factors were effected on the height of plant at 1% level of probability (table 1).

Table 1. Combined analysis of Variance of treatments on sunflower characteristics in two years of experiment

S.O.V	d.f	MEAN of SQUARS					
		Grain yield	1000 grain weight	Oil content	Plant height	WUE	WP
year	1	3297056.37**	6424.02 **	441.70 **	4268.23**	0.080 *	0.048 *
S	1	292302.18 ns	3.55 ns	3.39 *	14.78 ns	0.188 **	0.101 **
Y*S	1	7196.12 ns	1.73 ns	6.09 **	38.71 ns	0.008 ns	0.004 ns
Error(S)	4	98416.07	1.97	0.25	25.00	0.005	0.010
I	2	2993104.74 **	5.10 ns	0.21 ns	62.07 **	0.031 **	1.403 **
Y*I	2	35628.22 ns	32.49 ns	0.94 ns	27.65 ns	0.002 ns	0.009 ns
S*I	2	116397.62 ns	5.07 ns	0.59 ns	27.97 ns	0.004 ns	0.021 *
Y*S*I	2	9653.47 ns	2.64 ns	0.36 ns	37.78 *	0.001 ns	0.001 ns
Error	16	108981.48	9.74	1.16	10.01	0.004	0.038
C.V		7.26 %	5.02 %	2.49 %	1.83 %	7.28 %	7.57 %

ns: not significantly different ; *and ** : significant at the 5% and 1% levels of probability respectively.

WUE and WP were influenced highly significant by different cultivation management and irrigation treatment. Sunflower as second planting case (Ss) caused 3.95 % reduction of grain yield but in the other hand the water usage decrease 18 % and WUE and WP 18.9 % and 18.1 % increased respectively(table 2).
Water productivity of furrow irrigation and 60 cm row space treatment (Is-60) was 367 gr m^{-3}. Replacing tape drip irrigation in same plant density caused saving in water consumption about 5500 m^3 ha^{-1} and improvement of WP up 107.6 %. WP in It-60 was 761 gr m^{-3}. Increasing plant density with reduction row space from 60cm to 50 cm under tape drip irrigation bring about increasing of WP from 846 gr m^{-3} to 897 gr m^{-3} that was not significant. In spit of 6.8% of increasing WUE by replacing surface irrigation by micro irrigation, the difference was not significant but with changing irrigation system together the reduction of row space(It-50 treatment) WUE increased to 897 gr m^{-3} significantly (P≤1%).

Table 2. Mean Comparison for yield and water consumption index of sunflower

Treatment	Yield kg.ha^{-1}	ET_c mm	Water consumption	WP kg.m^{-3}	WUE kg.m^{-3}
Sw	4457.3	485	7077.0	0.918 a	0.699 a
Ss	4650.2	562	8324.0	0.773 b	0.592 b
IS-60	4137.8	527	11356.0	0.794 b	0.367 b
It-50	5103.7	572	6365.0	0.897 a	0.807 a
It-60	4400.6	526	5847.0	0.846 ab	0.761 a
SwIS-60	4020.7	467	10260.0	0.86 a	0.39 a
SwIt-50	4931.4	517	5743.0	0.95 a	0.86 a
SwIt-60	4419.7	471	5230.0	0.94 a	0.85 a
SsIS-60	4254.8	588	12453.0	0.72 a	0.34 a
SsIt-50	5276.1	629	6989.0	0.84 a	0.75 a
SsIt-60	4381.6	582	6465.0	0.75 a	0.68 a

4. Conclusions

The research results revealed that the tape drip irrigation system could be used successfully for irrigation sunflower crops under the arid climatic condition of west Azerbaijan for improving WP and WUE. Under tape drip irrigation system we recommend increasing plant density by reduction row space from 60 cm to 50 cm also sunflower be cultivated after wheat or lately in Meandoab region. Finale the SwIt-50 treatment is recommended.

5. References

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