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Study of sensitivity of Autumnal wheat to under irrigation in Shahrekord, Shahrekord City,Iran

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ABSTACT: In order to study the sensitivity rate of autumnal wheat (Omid variety) to under irrigation, a fully random project was conducted in the research farm of the Shahrekord University, Iran including 9 irrigation treatments and four replications. Irrigation treatments were applied form May 22, 2007 since before this data in Shahrekord, Iran there is no need to irrigation. Irrigation time was when 50% of the soil (humidity in the treatment receiving full irrigation was discharged. This was done through placing gypsum blocks in the root zone. Therefore the irrigation water depth was half of the water retention capacity in the root zone. Based on the consumed water values and yield, relation between percentage of yield decrease and percentage of water consumption was achieved. Contrary to the Stewart's relation, this relation was a nonlinear one. Based on these relations, for a specific decrease of consumed water (ex 30%), yield decrease is about 3%. This finding indicates that the Omid variety of wheat in Shahrekord, Iran shows little sensitivity to under irrigation.
***Keywords**: under irrigation; Production functions; Wheat.*

INTRODUCTION

Regarding the issue of drought in Iran, optimal use of water and soil resources is quite essential. Paying attention to the irrigation issue in irrigated farming is one of the important methods for achieving this goal. Therefore application of correct irrigation management especially in surface irrigation methods is essential. Under irrigation is one of the irrigation managerial methods which in the conditions of water deficiency can be very beneficial. Sensitivity of various plants to under irrigation varies. In 1980 Mucik and Dusk (Musick et al., 1980) studied the effects of under irrigation on wheat. They pointed out that in case water potential in leaf is decreased from a critical level, negatively influences yield. Tomas et al. (Thomas et al., 1970) found out that those plants that during their vegetative growth period can tolerate water stress have higher tolerance for drought in their later periods of growth compared with other plants. Stewart (Stewart et al., 1982) concluded from their investigations that those plants are suitable for under irrigation that their growth season is short and can tolerate drought. In 1983 Hang and Miller (Hang et al., 1983) cultivated wheat at condition of under irrigation in two types of sandy and loamy soils.

In 1990, Stag man et al. (Stegman et al., 1990) reported that although water stress close to flowering period might cause decreased flowering rate in lower part of the plant crown, through beginning of full irrigation amount of pods at higher parts of the plant crown increase and compensate the previous part. In 2000, smith and Quiombi (Smith et al., 2000) applied the CROPWAT model (developed by FAO in 1992) for under irrigation studies.

Their goal was improvement of water consumption efficiency using under irrigation. This project was conducted through cooperation of FAO and the International Atomic Energy Agency (section of unclear techniques in food and agriculture).

In 2000, Corida (Kirda, 2000) applied the following production function which was developed in 1977 by Stewart et al. (Stewart et al., 1977) for various crops and under varied conditions.

$$\frac{Y}{Y_{\max}} = 1 - K_y\left(1 - \frac{ET_a}{ET_{\max}}\right) \qquad (1)$$

Where:

Y= obtained yield, Y_{max}= Maximum yield, K_y= Crop sensitivity factor, ET_a= real evaporation and transpiration, ET_{max}= maximum evaporation and transpiration. (unit used for yield is kg/ha and evaporation and transpiration unit is millimeters. Equation (1) indicates that the relation between decreased yield and water decrease percentage is a linear one. The higher the K_y, the more plant is sensitive to water stress which depends on the plant type, variety, irrigation method and stage or stages of growth when under irrigation has been applied. He obtained K_y values for different crops in Turkey and for various irrigation conditions. Results indicate that in case under irrigation is applied only in the vegetative growth phase; K_y would be less than in the case this has been done in the flowering stage. For example he reported the K_y values for wheat at various conditions as in table 1.

The objective of this research is to study sensitivity of autumnal wheat to under irrigation. This sensitivity will be expressed by the relationship between percentage of crop decrease and percentage of water decrease.

MATERIALS AND METHODS

This project was conducted on autumnal wheat (Omid variety) in the university farm (with a sandy-loamy fabric) as follows in the water year 2005-2006:
A fully random project with 36 1 m^2 plots including 9 irrigation treatments and 4 replications and in each plot in late November 2005 about 30g wheat was sown by hand.
Nitrogen fertilizer at a rate of 30gr/plot was applied in March and June 2005.
Irrigation treatment started for the beginning of June 2005 since before this date in Shahrekord, Iran there is no need for irrigation. Irrigation time was when 50% of soil humidity in fully irrigated treatments was discharged. This was done by installing gypsum blocks at the root zone. Therefore the irrigation water depth was equal to half of the water retention capacity at the root zone. Then this depth is multiplied as surface of a plot and irrigation volume at each turn was computed and measured by a counter. For example if in a known irrigation turn, irrigation water depth for providing will full requirements of the plant is equal to d and irrigation water volume is equal to V, irrigation treatments applied in the above said turn were performed in accordance with table 2.

Therefore, from the 9 treatments, the two treatments T1 and T2 were over irrigated, treatment T3 was irrigated as needed and the 6 other treatments were subjected to under irrigation. Table3 indicates the fully random plan used in this research.

During the stress period, six irrigations were done that regarding the above details, the volume of irrigation water for each treatment in each irrigation turn was computed the results of which are summarized in table 4 (since surface of each block is 1m^2).

It is worth mentioning that in the project of optimizing the agricultural water consumption model prepared by the National Department of Jihad Keshavarzi and Aerology, the rate of autumnal wheat requirement to water has been computed to be 381mm.

In late July 2006 wheat crop of each block was harvested, then the total weight, weight of grains, and weight of one thousand grains were measured.

CONCLUSION AND DISCUSSION

In tables 5 to 7 results of total yield, gran and straw presented.

Regarding the above tables it can be found out that the maximum values of the yield components concern treatment T2 and it minimum values are those of treatment T9. Because treatment T2 has the maximum yield, it can be concluded that in this treatment full irrigation has been done while in the previous season treatment T3 had been considered as the full irrigation. This is due to error in measuring the soil humidity followed by water requirement of the plant.

Also, based on the rate of consumed water (table 4) and yield (tables 5 to 7), the relation between percentage of decreased yield and percentage of water decrease can be obtained. This had been done and depicted by figures 1 to 3 for total grain yield and straw yield. Regarding these figures, the relation between decreased yield and decreased water consumption for wheat in Shahrekord, Iran contrary to Stewart relation (Chapter one), is a nonlinear relation. These figures indicate that for a definite decrease of water consumption (i.e. 30%), yield decrease is about 3%. This finding shows that the Omid variety of wheat in Shahrekord, Iran shows little sensitivity to under irrigation.

Table 1. Different levels of sensitivity factor product

K_y	Irrigation method	Irrigation procedures
0.76	Springer irrigation	Whole growth season
0.93	Plot irrigation	Whole growth season
0.39	Plot irrigation	Flowering and filing period

Table 2. Irrigation treatments.

Treatment	T9	T8	T7	T6	T5	T4	T3	T2	T1
Irrigation volume	0.4V	0.5V	0.6V	0.7V	0.8V	0.9V	V	1.1V	1.2V

Table 3. Representation of the used research project

T1	T9	T2	T1	T7	T8	T3	T2	T9
T9	T5	T7	T1	T6	T5	T3	T8	T2
T3	T5	T9	T7	T5	T4	T7	T6	T8
T4	T6	T1	T4	T3	T6	T8	T4	T2

Table 4. Total irrigation volume (l) in all treatments.

Treatment	T9	T8	T7	T6	T5	T4	T3	T2	T1
Total irrigation volume	120	150	180	210	240	270	300	330	360

Table 5. The total yield (grams per square meter in half)

Treatment	T1	T2	T3	T4	T5	T6	T7	T8	T9
1	632	618	610	602	598	571	579	530.2	521
2	601	625	607	611	597	670	585.2	547	517
3	630	600	630	618	630	589	590	542	520
4	630	653	625	620	600	565	580	544	529
Mean	623.25	624	618	612.75	606.25	598.75	583.55	540.8	521.75

Table 6. The grain yield (grams per square meter in half)

Treatment	T1	T2	T3	T4	T5	T6	T7	T8	T9
1	287	280	275	273	271	273	263	241	241
2	268	285	277	279	266	253	266	269	235
3	287	269	291	280	290	285	269	245	233
4	290	302	282	281	276	280	280	248	245
Mean	283	284	281.25	278.25	275.75	272.75	269.5	260.75	238.5

Table 7. The straw yield (grams per square meter half)

Treatment	T1	T2	T3	T4	T5	T6	T7	T8	T9
1	345	338	335	329	327	298	316	290.2	281
2	333	340	330	332	331	417	318.9	280	283
3	343	331	339	337.7	340	304	320.5	297	287
4	340	351	342.8	338.3	325	285.6	300	296	284
Mean	340.25	340	336.7	334.35	75/330	326.15	313.85	290.8	283.75

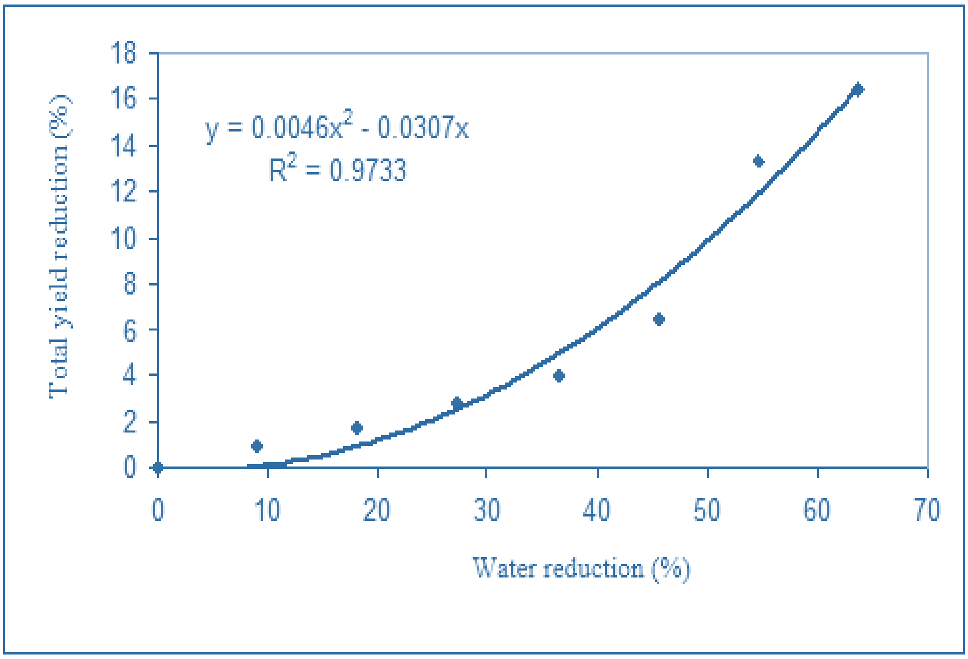

Figure 1. The relationship between the product and the percent reduction in water

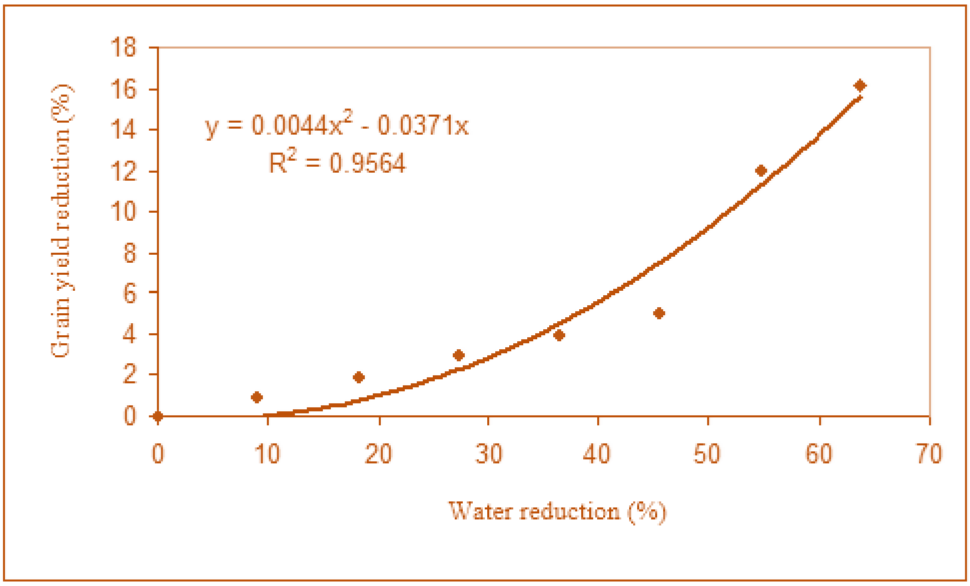

Figure 2. The relationship between grain yield and percent reduction in water.

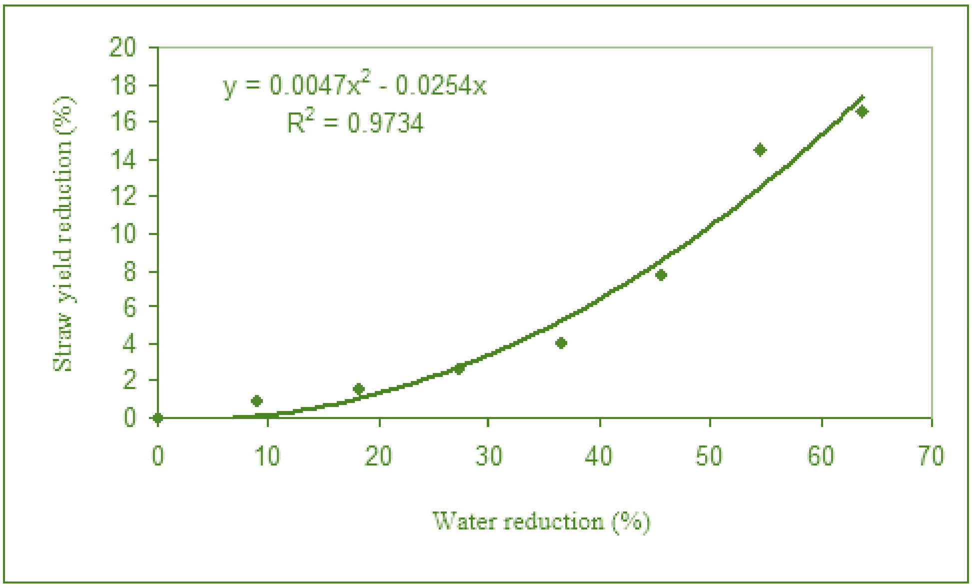

Figure 3. the relationship between wheat yield reduction of water loss

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