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The Yield Functions of Maize toward the Deficit Irrigation in the Tropical Climate of Dezfoul

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ABSTRACT
The surface area under cultivation can be increased by the deficit irrigation in the condition of water restriction through water savings. The management of deficit irrigation is one of the savings strategies in water resources in agricultural sector. In the condition of deficit irrigation, the amount of product per unit area is less than the maximum production per unit of area, but the profit is increased. A factorial experiment with a randomized complete block design with three replicates was conducted in the 1389-90(AHS) crop year in order to study the yield functions toward the deficit irrigation of maize in the hot and dry climate of Dezful. The first factor included four levels of water I100%, I80%, I60% and I120% crop water requirement and the second factor consisted of three levels of nitrogen fertilizer, N200, N150 and N250 kg nitrogen per hectare. The result of this research showed that in irrigation treatments 60%, 80%, 100% and 120% water requirement in the fertilizer level of 150 kg of nitrogen per hectare, the slope reduction of yield was 0.14, in fertilizer level of 200 kg of nitrogen per hectare, the slope reduction of yield was 0.15 and in 250 kg fertilizer level of nitrogen per hectare, the slope reduction of yield was 0.44. The investigation also indicated that because there is no significant difference in the grain yield between the water level of 80% and 100% water requirement, in conditions which we have to apply mild deficit irrigation, the irrigation treatment of 80% water requirement for corn is recommended.
Key words: *Water, Nitrogen, Maize, Grain yield, Production function*

INTRODUCTION

The restriction of water resources and the improvement of modern agriculture have caused the progress in the value of production inputs and the researches position of optimizing consumption of water and fertilizer. Considering that in some sources, in order to maximum use of water resources, the possibility of reduction of water usage in vegetative phase has been suggested, and it is stated that the reduction of water usage in the flowering stage might be justifiable [7]. For semi arid area, the control of soil moisture profile is suggested as the appropriate method of irrigation mnagement and it is estimated that the water requirement of maize in this region is 1.561 mm [5]. To achieve the prospect of strategic method and sustainable use of water and soil resources, some indicators are effective, which the compilation and explanation of optimal model of water and fertilizer usage in agriculture is among the most important ones. Any deficiency in the amount of water or nitrogen will reduce the product [2]. Optimization of water consumption means timely and enough irrigation, and is consistent with the principle of irrigation engineering [4]. There is a relatively linear relationship between the amount of irrigation water and the crop yield but if the amount of water is more than 50% of full irrigation, the relationship will be nonlinear [6]. According to Bolls' report, the number of grain in maize, the weight of thousand grains, the maize diameter, the maize length and the grain yield will be increased by increasing the level of consumed nitrogen fertilizer [9]. In the condition of deficit irrigation, the amount of produced yield per unit area becomes less than the maximum yield per unit area, but the profit will be increased. This study has been carried out to investigate the yield production functions toward the deficit irrigation of maize in the hot and arid climates of Dezful.

MATERIALS AND METHODS

The research was carried out during the 2011-2012 crop year, at experimental field and laboratories of Department of Irrigation and Drainage engineering, Department of Agronomy and Department of Soil Science of agricultural faculty, Azad university of Dezful, and laboratories of Safiabad Agricultural Research Center of Dezful (Iran), (with latitude of 32º16'N, longitude of 48º26'E, and with the elevation of 147 meter above the sea level). Some characteristics of the soil under investigation are presented in table (1). The texture of field soil was Silty clay loam. Field experiments was conducted in a factorial randomized complete block design in 3 replicates on the furrows with open end , with 0.75m spacing ,

25m length and 6.75m width for each treatment. The first factor consists of four levels of irrigation (I): 60%, 80%, 100%, 120% water requirement and the second factor consists of four levels of nitrogen fertilizer: 150 kg/ha, 200kg/ha, 250kg/ha which was fertilizer recommendation. Irrigation levels were applied 25 days after planting. For applying irrigation treatments, water requirement for each treatment was determined by using of pan evaporation data, at first. Inflow discharge into furrows were measured and controlled by the flume WSC shaped (1), a U-p.v.c pipe used at the beginning of each furrow to divide water equally between them. Nitrogen fertilizers distribution was injected in different turns, with accurate measurement and consistent with any treatment. Finally, statistical data was analyzed by MSTATC software; and by using the formula (1), the slope reduction of yield in irrigation treatments was also achieved in different fertilizer levels.

$$\frac{Y}{Ym} = 1 - \beta(1 - \frac{ET}{ETm}) \quad (1)$$

Table 1. Some soil testing

N ppm	K ppm	P ppm	O.C %	PH	EC ds/m	PWP %	FC %	ρb gr/cm³	Soil depth cm
850	140	8.9	0.72	7.37	1.70	12	22	1.64	0-30

Fig 1. Scheme of water distribution in earth canal with W.S.C Flume

Fig 2. Scheme of water movement from the pipe entering furrow

RESULTS AND DISCUSSION

Water requirement

In this research, the required amount of water in different water treatments was measured by using pan evaporation data and KC coefficient; its results are presented in table (2). The results show that the amount of water requirement of maize (100% water requirement treatment) in spring cultivation in 2011-2012 in Dezful region had been approximately 515 mm. In other treatments, water requirement has been calculated based on the investigated irrigation level.

Table 2. Amounts of consumptive use water in different irrigation treatments

I 120%	I 100%	I 80%	I 60%	irrigation treatments
608.4	515	421.6	328.2	Amounts of consumptive water (mm)

Water production function

The results obtained in this research shows that the diagram of water production function in figure (3) has been drawn on the basis of the amount of consumed water in different fertilizer levels. The figure shows that, at first by reducing the amount of irrigation water, the grain yield production function is reduced, and then by increasing the amount of irrigation water up to optimal level (full irrigation) yield production function is increased and again by 20% increase in irrigation, compared to full irrigation, the yield production function decreases; therefore, it is not recommended to use water more than the crop water requirement. On the other hand, the increase in the amount of nitrogen fertilizer will increase the grain yield production function. So, the maximum of grain yield function is produced in 250% fertilizer level of recommended fertilizer.

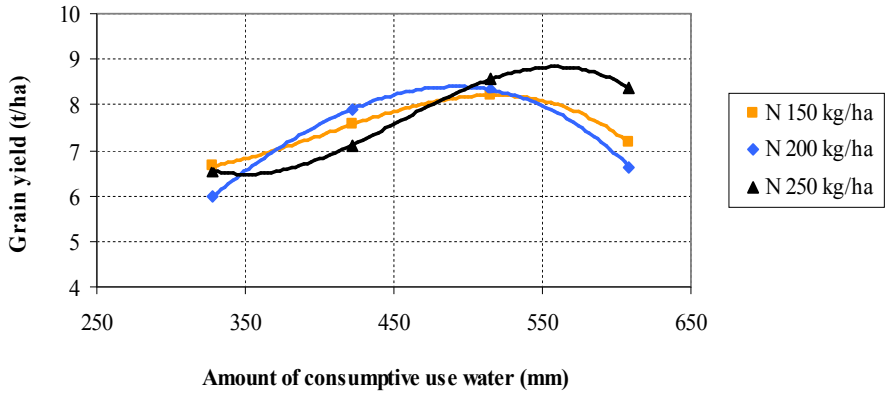

Fig 3. Yield functions toward water

Considering the mentioned matters, and given that there is no significant difference in grain yield between water levels of 80% and 100% water requirement, applying mild deficit irrigation 80% water requirement is recommended for maize in the region. These results are consistent with the results of [3] and [8].

Nitrogen production function

The diagram of fertilizer production consumption function in terms of the amount of consumed fertilizer in different levels of water requirement is presented in figure (4). The results show that the increase of the amount of nitrogen increases the grain yield at first, and then, after reaching the optimal level of consumption, the grain yield decreases again. The optimal level of fertilizer is different for various water levels. So that the optimal consuming fertilizer level for 60%, 80%, 100%, 120% water level were, respectively, 150, 200, 250 kg. Therefore, it can be concluded that, in the deficit irrigation conditions, the increase of the amount of consumed fertilizer will not cause the increase of the yield, but rather it will decrease its value. Also, by increasing the amount of consuming water up to 100% water requirement, the grain yield increases and per further increment of the depth of consuming water, due to leaching of nitrate and occurring of the nitrate reduction phenomenon, the grain yield decreases. On the other hand, the increase of the amount of nitrogen to neutralize the effect of the drought stress on

yield loss is not a correct strategy; rather the amount of consumed fertilizer in drought conditions should be reduced. These results are similar to the results of [1], [10] and [3].

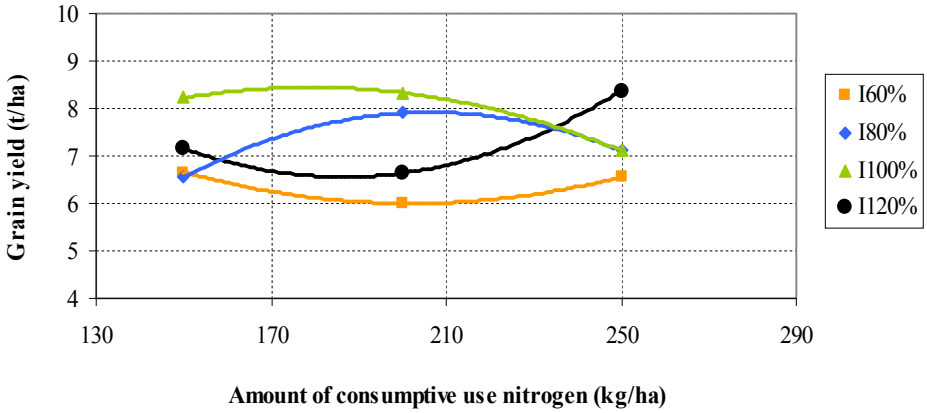

Fig 4. Yield functions toward nitrogen

CONCLUSION

In this research, the yield production functions toward the deficit irrigation of maize in the hot and dry climate of Dezful were investigated. The results showed that the curves of the yield production function are under the influence of the irrigation water and the consumed fertilizer meaningfully. The yield and its components are increased by increasing the amount of water and fertilizer up to the optimal consumption level, and if the irrigation water is used more than the corn's requirement, further leaching of nitrate will cause the reduction of the yield. The results also revealed that if we want to apply the deficit irrigation for production functions, the irrigation treatment of 80% water requirement is recommended for the maize in this region.

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