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ORIGINAL ARTICLE

Effect of Drought Stress on Yield and Yield Components of Maize Hybrids

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ABSTRACT
Water scarcity is one of the most important factors limiting crop production such as corn worldwide. Corn Belt in the world, due to the special characteristics of the plant in terms of four-carbon, particularly in arid and semi-arid region it is a close match. The research program for irrigation planning and management in the agricultural field as an option to crop, it is necessary. Therefore, in order to test plot in a randomized complete block design with 3 replications. Treatments include 4 irrigation as the main factor and three corn hybrids subplot involves the measurement of yield and yield components were studied. The results showed that drought on grain number per row, number of rows per year, *grain weight, grain yield, biological yield were significant. According to the results, the highest yield of 10,450 kg per hectare for the treatment of the Karun is 75 mm evaporation.*
Keywords; *Irrigation regime, Maize, Varieties*
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INTRODUCTION

Drought, one of the most important factors of plant growth worldwide and the most common environmental stress that almost 25% of the world's land is limited. Khuzestan, flat and fertile land due to the high energy of the light, suitable for planting crops, especially corn. Grain yield under drought stress, water stress depends on the severity and duration. In corn, grain yield stress can directly and indirectly affect. Most research has shown that the most sensitive life stages of corn, the stress can cause a serious decrease in performance, and in particular the reproductive stage pollination, the pollen shedding and silking. By applying stress in the early stages of maize, found that water loss at this stage will reduce dry matter. Shortage of water in arid and semiarid regions of the main problems that affect the growth of plants. Reduce the amount of water available to plants leads to stress and inappropriate morphological and physiological changes in the plant [1]. Plants to absorb water and soil resources related to their root system, the growth and development environment, the availability of food, soil temperature, water availability varies in depth and tillage operations. Maize, cereals such valuable tropical and temperate world. Zea maize of the world production of wheat and rice is the third most important cereal [2].

Nelson [3] reported in maize, grain yield stress can directly and indirectly affect. Most research has showed that the most sensitive life stages of corn that stress can cause a serious decline in performance, the reproductive stage anthesis, silking and pollen shedding. Hugh [4] concluded, mild and severe drought hybrid maize grain yields were reduced by 63 and 85 percent. Sherbaf Khojaste and Ahmad [5]

reported that maize grain yield under drought stress during the period of growth; by reducing the number of grains per year was performed.

Majidian *et al* [6] concluded that the level of 50 and 75 percent of the irrigation water requirement of maize grain yield, 63% and 41% decrease. The researchers reported that irrigation water requirements of the plant have the highest water productivity and irrigation levels were significantly different from the rest. With increasing water productivity decrease the amount of stress.

Sinclair [7] reported that the total number of grains per year, determined at the time of pollination. Assimilates inadequate for the growing embryo cells, has a negative effect on the number of grains per year. He also reported that water stress by reducing the number of grains per year and grain weight, grain yield was reduced.

Khalily [9], according to the results of the stress, as one of the constraints expressed in maize seed production in dry conditions, the distance between the flag of the Silk Overall, the number of days to silk emergence, green cover percentage and number seeds in a row, the properties for the selected hybrids are resistant to drought stress in maize.

Cakir [8], The Effects of Stress on Characteristics of vegetative and reproductive growth stages of maize, concluded that stress during vegetative growth and Tasl Overall, reduced plant height and the leaf area. Since deficit irrigation in the study of all plant growth was continued until the end of the 8-leaf, the leaf area index, declined. LAI between stress and non-stress conditions, but no significant difference between mild and severe stress, no significant differences were observed. Although reduced leaf area to reduce stress levels and helps the evaporator as one of the known mechanisms of coping with stress, but will also reduce the level of photosynthesis.

Turkan [10] reported that the land as the most important factor controlling the performance of the products, nearly all of the processes that affect plant growth.

Setter [11] stated that the granulation process in maize leaves by photosynthesis, sugars, starches, abscisic acid and cytokinins determined. Lack of water, shade for five days before pollination and early stage after pollination, reducing the size of the distal region of the year.

MATERIALS AND METHODS

The trial, in the summer of 2013 in the field of agricultural research was conducted Safiabad. The center of the longitude 48 degrees 32 minutes east and latitude 32 degrees 22 minutes north and 82 meters above sea level at a distance of 120 km from the provincial capital is located in the North West province.

In general, Khuzestan subtropical climate, with warm dry summers and rainy winters are long and humid. Khuzestan heating season begins in May and continues until October. Of rainfall between the months of November to April is usually the most rainfall in the northern plains of Khuzestan and southern and East is lower and narrower. Climatic conditions, in particular the characteristics of the soil and water, fertile for growing most crops (sugarcane, maize and sorghum) and physiological adaptation to climate plants province has caused the plant dry matter accumulation, highly significant and close to its genetic potential is.

Pilot projects on land that has been cultivated wheat, respectively. Therefore, prior to the project and to determine the nutrient status of the soil, the six-point bottom 30-0 cm soil sampling and laboratory Safiabad Agricultural Research Center, was analyzed. The results of the soil analysis are shown in Table 1.

To investigate the effect of water stress on morphological characteristics, yield and yield components of three maize hybrids Safiabad climate, cultivation experiment in the 2013 summer season Safiabad Agricultural Research Center, located in the South West of the country, was conducted.

The experimental design was a randomized complete block, in a 3 × 4 × 3 was implemented. Four irrigation S1: irrigation after 75 mm evaporation, S2: irrigation after 110 mm evaporation, S3: irrigation after 145 mm evaporation and S4: irrigation after 180 mm evaporation as the main factor and three corn hybrids (Bc678, Sc704 and Karun) as subplot. Thus, taking into account the margins and spacing treatments iterations of the experiment was about 1300 square meters. It should be noted that the numbers will be randomly assigned to each block. Landing stage on the 20th of July, and then take care of the farm-based standards were applied.

Table 1. Test results of chemical soil test piece

Potassium acidity saturation	Phosphorus acidity saturation	Soluble nitrogen	Total acidity saturation	Conductivity
mg/Kg	mg/Kg	mg/Kg	pH	$ds.m^{-1}$
158	7.1	37	7.95	1.2

Table 2. Test results of soil physical test piece

Sand	Silt	Clay	
27	35	38	Percent

Number of kernels per row, the number of kernel rows per year, grain weight, grain yield, biological yield, harvest index, leaf area, plant height, ear diameter, ear length, hair length, root dry weight, root volume, root diameter the upper one-third of the number of aerial roots, the largest part of the root, rooting depth, root fresh weight.

The study of software to analyze the data to help MSTATC Duncan test at 5% level is used to draw graphs and Excel software was used for data analysis.

RESULTS AND DISCUSSION

THE NUMBER OF KERNEL ROWS PER YEAR

Analysis of variance showed that water stress and the number of kernel rows per year at a significant rate, but the interaction of water stress and cultivars showed no significant effect on this trait (Table 3).

The results of the comparison showed that water stress treatments with the greatest number of kernel rows per year row 14.5 to 12.2 treated with rows least 75 mm evaporation and evaporation of 180 mm (Fig. 1). In treatments with 14 digits maximum number of kernel rows per year row to the Karun and the lowest tier of the 678 belonged to 6.12 (Figure 2).

Although the number of kernel rows further back, but stress can reduce the plant's genetic traits stress is higher. Photosynthesis and respiration of soil temperature and outside the control of flowering and maturity distribution of photosynthesis becomes effective. Wind consists mainly of increased evapotranspiration and evaporation from the soil surface. By displacing the humid air around the stomata on the leaf surface, increased transpiration and leaf temperature rises to prevent sweating. Hot, dry winds through leaf stomata close, even when soil moisture is adequate adverse effect on photosynthesis and reduce production finds. Researchers reported a very strong relationship between the rise of the reproductive organs and the number of fertilized seeds of the plant is under stress conditions, seeds decreased [12].

Sinclair [7] reported that the total number of grains per year at anthesis assimilates determined to be inadequate for the growing embryo cells, has a negative effect on the number of kernels per year. He also reported that water stress by reducing the number of grains per year and grain weight, grain yield was reduced

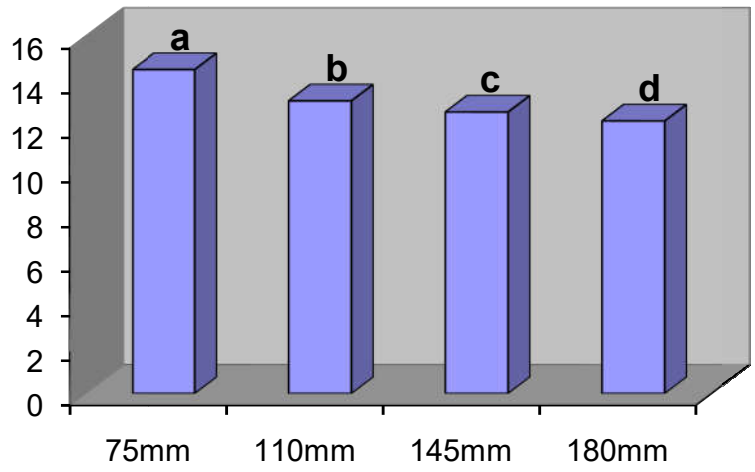

Figure 1. Comparison of mean stress on the number of rows per year

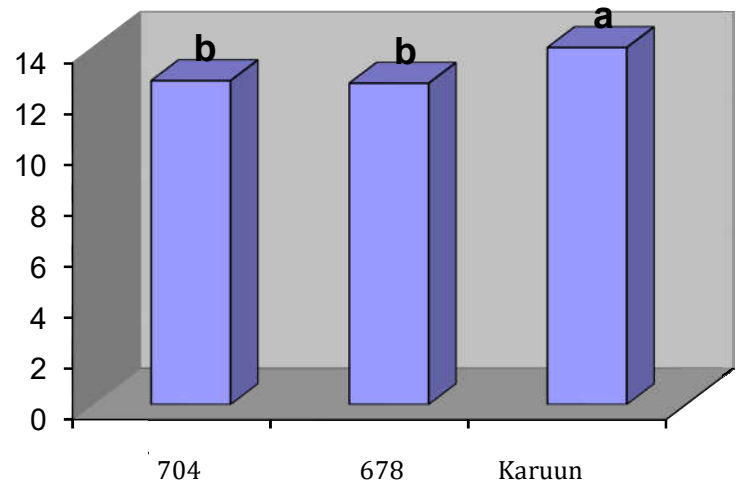

Figure 2: Comparison of hybrid treatments on the number of rows per year

Analysis of variance showed that water stress and figures on the number of seeds in a row at one percent, were significant and the interaction of water stress, no significant effect on this trait (Table 3).
The maximum number of kernels per row numbers in treatments with 30.9 grains of the Karun and lowest with 24.7 grains belonging to the 678 (Fig. 4).
Drought, the growth of pollen grains and pollen tube growth in the style and ovary and eggs are also affected. Also, low stigma pollen tube growth is inhibited. Stress at grain filling stage, is very significant, because the potential yield depends on the weight and number of seeds. This requires full and open pollinated seed is the accumulation of photosynthesis. Material Storage of seeds in seed and move food through photosynthesis from other parts of the plant are the seed supply. One of the physiological changes that may occur during drought, osmotic pressure is adjusted.

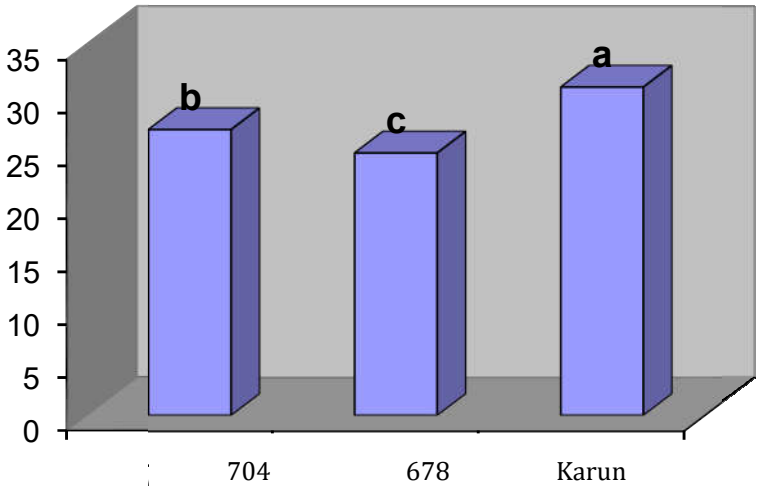

Figure 3. Comparison of hybrid on seed number per row

1000 SEEDS WEIGHT

Analysis of variance showed that the amount of water and grain weight were significant at the one percent level. And the interaction of water stress on the seed, showed no significant effect (Table 3).
The results of the comparison showed that water stress, maximum grain weight of 349 g to 194 g were treated with 75 mm minimum 180 mm evaporation and evaporation (Figure 5). Treatments, the highest seed weight of 298 grams to 272 grams with the Karun and the lowest figure of 678 g (Fig. 6).
Water stress in vegetative and reproductive stages, grains and at grain filling stage, grain weight decreases. Grain yield is reduced. Shortage of water, the reduction of leaf area index and a decrease in

photosynthesis per unit leaf provides the result of reduced supply of assimilate it, and its negative effect on grain weight loss.

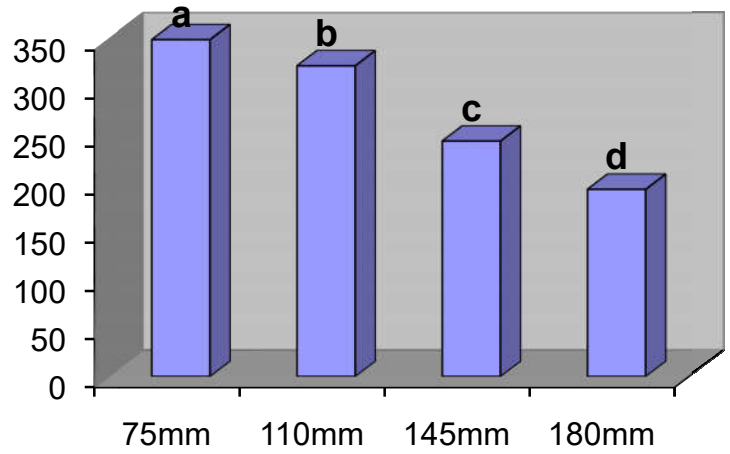

Figure 4. Comparison of mean stress on seed weight (g)

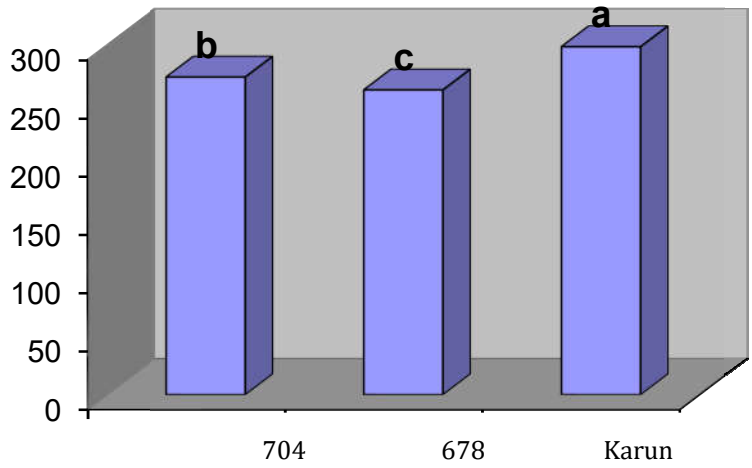

Figure 5. Comparison of hybrid treatments on grain weight (g)

YIELD

Analysis of variance showed that water stress on yield data and the interaction of water stress and the level of one percent, five percent significance level (Table 3).

The results of the comparison showed that water stress, the maximum yield of 8474 kg ha belonged to the group of 75 mm evaporation. Less with 3113 kg per hectare to 180 mm of evaporation, which was treated with 145 mm evaporation from the difference in a group (c) was used (Fig. 7). Figures treatments, the highest yield of 6767 kg per hectare, the figure was owned Caron. Less with 4434 kg per hectare, the figure of 678, which is statistically in a group with the 704 (b) was used (Fig. 8).

Hugh [4] concluded, mild and severe drought hybrid maize grain yields were reduced by 63 and 85 percent. Sherbaf Khojaste and Ahmad [5] reported that maize grain yield under drought stress during the period of growth, by reducing the number of grains per year were performed.

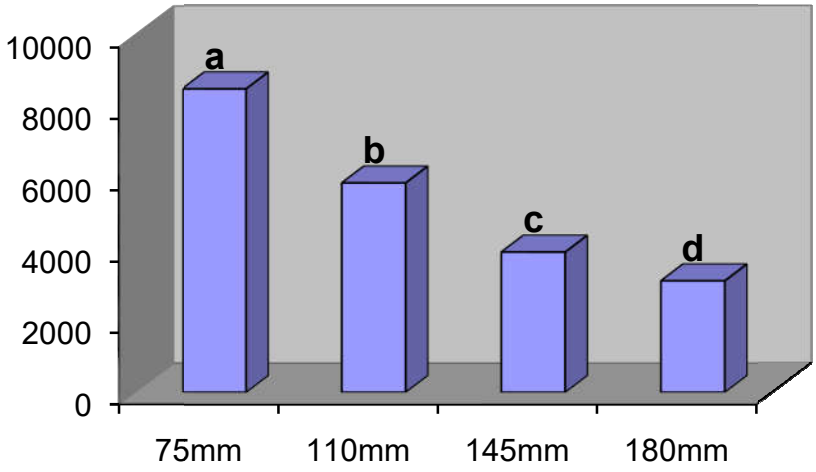

Figure 6. Comparison of stress on seed yield (kg/ha)

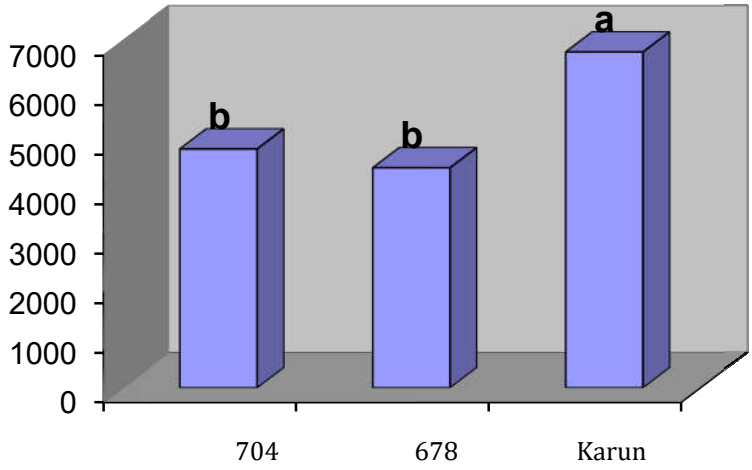

Figure 7. Comparison of hybrid treatments on seed yield (kg/ha)

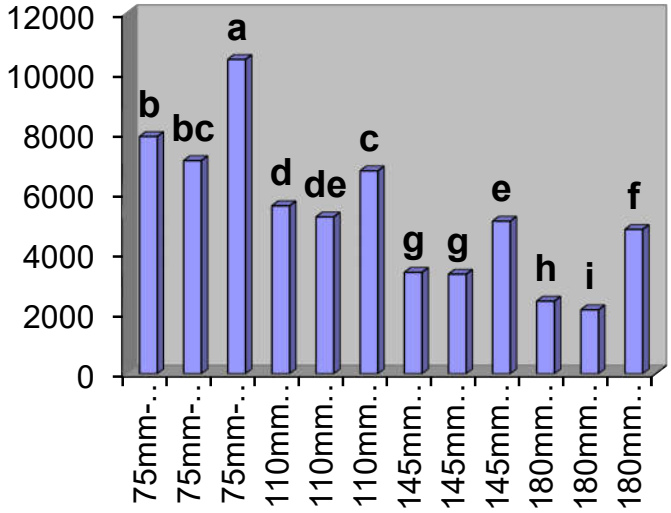

Figure 8. Comparison of the interaction of the stress on seed yield (kg/ha)

BIOLOGICAL YIELD

Analysis of variance showed that water stress, water stress and the number of interactions on biological function at a significant level (Table 3).

The results of the comparison showed that water stress, maximum biological yield of 17,246 kg ha belonged to the group of 75 mm evaporation. Least 180 mm to 7398 kg per hectare to 145 mm evaporation from the evaporation of the difference in the treatment group (c) was used (Fig. 10). Figures treatments, with the highest biological yield 12 590 kg per hectare, the figure was owned Caron. At least 10,907 kg per hectare, the figure of 678 (Figure 11). Also, the interaction of water stress and the highest biological yield of 18,066 kg per hectare, corresponding to the Karun was evaporated at 75 mm. Minimum of 6426 kg per hectare, the figures were 687 and 704 belonging to 180 mm evaporation (Figure 12).

The researchers studied the effects of drought in the early and late hybrid maize hybrids have concluded that early, rather than late maturing hybrids, have more endurance. This action can improve the performance. The drought in the reproductive stage of growth showed yield decreases. During drought, plant height and leaf area development in maize decreases. Thus, water loss during rapid growth, reduced 28_32% of the total dry matter [13].

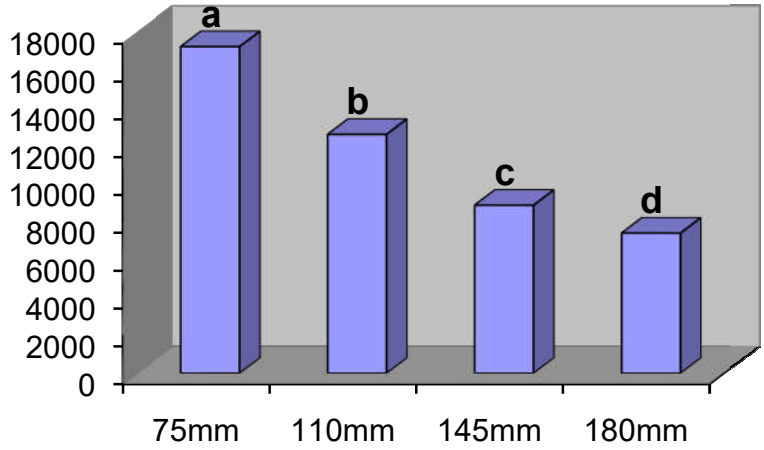

Figure 9. Comparison of stress on biological yield (kg/ha)

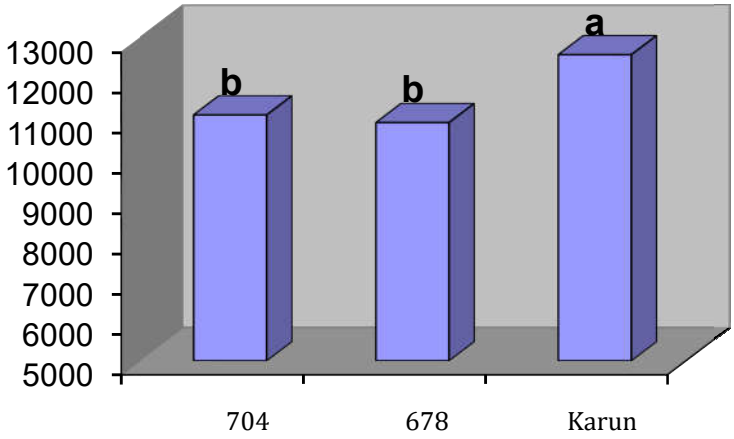

Figure 10. Comparison of hybrid on the performance of biological yield (kg/ha)

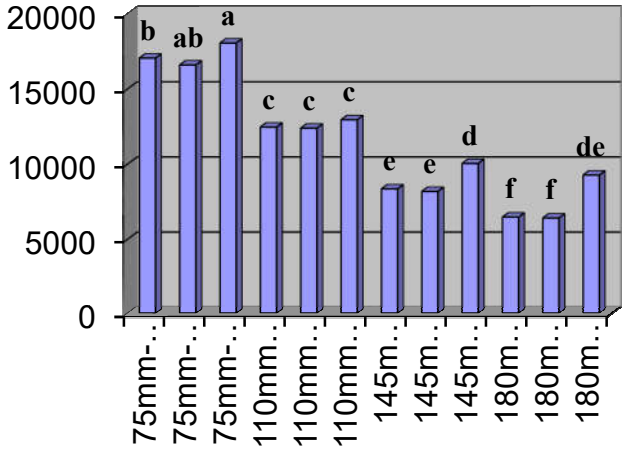

Figure 11. Comparison of the interaction of the stress and hybrid on yield (kg/ha)

Table 3. Analysis of variance for grain yield and yield components of maize

MS							
HI	Biological Yield	Yield	1000 seeds weight	Number of seeds per row	number of kernel rows per year	DF	SOV
ns25	ns1228811	ns328825	11.1 ns	2.11 ns	0.36 ns	2	Rep
105 *	173979439**	51189988**	45541 **	1153 **	9.21 **	3	Drought
16.7	181881	104113	28.9	1.07	0.65	6	Error
574 **	10199511 **	18813958**	4480 **	117 **	6.69 **	2	hybrid
19.1 ns	970981**	612580 *	222 ns	5.63 **	0.32 ns	6	Drought * hybrid
10.9	141063	184862	93.1	2.25	0.29	16	Error
7.2	6.2	8.05	8.4	5.4	4.1	-	CV%

The results of this study showed that the number and drought have had a significant effect on grain yield. In the case of the treatment, the best treatment and drought Caron, best treatment, treatment was seventy mm evaporation. The results showed that drought on grain number per row, number of rows per year, grain weight, grain yield, biological yield, were significant. According to the results, the highest yield of 10450 kg ha plots in the Karun is 75 mm evaporation.

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