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Effects of Water Stress on Yield and Some Agronomic Traits of Maiz [SC 301]

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Abstract: Field experiments were carried out at the Agricultural Experimental Station of Varamin Agricultural Research Centre on a clay loam soil to study the effect of water deficits at different growth stages on growth, some physiological aspects and yield of maize (*Zea mays* L.) Hybrid maize [SC 301], with the use of a randomized complete block design with three replications .Studied treatments were including drought stress in 3 growth stages as before silking, during silking and in seed filling period in compare with normal irrigation as check. Water stress at before silking, silking or grain filling growth stages caused a significant reduction in the different growth parameters studied at 90 days after planting as compared with the normal irrigation regime. Data showed that water deficit significantly decreased yield. Water deficit at before silking, silking and filling growth stage decrease yield by 12.5, 42.0 and 22.5% respectively. Data indicated that the most sensitive growth stage to water stress is silking growth stage and should be attention that to avoid of yield decreasing, contraception of water stress in this growth stage is necessary.

Key words: Water deficits % Maize % Yield

INTRODUCTION

Maize is one of the most important crops which grown on an area of 700 thousand hectares in Iran [1]. The water availability is considered one of the most important factors to increase crop yields. Drought stress is one of the most important environmental stresses affecting agricultural productivity worldwide and can result in considerable yield reductions [2-3]. The physiological mechanisms involved in cellular and whole plant responses to water stress, therefore, generate considerable interest and are frequently reviewed [4-8] .Numerous physiological and biochemical changes occur in response to drought stress in various plant species. Changes in quantitative and qualitative parameters have been observed in many plant species as a result of plant exposure to drought stress during growth [9-11]. Drought stress in plants occurs when evaporative demand exceeds water uptake. Water deficit budgets lead to numerous physiological alterations, both in the long term and the short term. Long-term drought responses include altered root to shoot ratio [12] and reduced leaf area [13]. Short-term responses include altered stomatal function [14] and osmotic adjustment [15]. According to Kramer and Boyer [16] plants respond to drought either by delaying dehydration where the plant maintains a relatively high plant water potential or by tolerating dehydration where the plant continues to function but at lower plant water potentials. Drought has different effects on maize plants depending on the development growth stage at which it occurs. Previous reports showed that stress during tasseling and silking was most harmful and stress during grain filling was more drastic than that during the vegetative growth stage [17]. Further studies demonstrated that stress during early vegetative growth was more drastic than that during the grain filling growth stage [18]. Additional data indicated that drought during pre or post silking reduced the grain yield by 9 and 10% compared to the conventional irrigation, respectively [19].Quaranta *et al.* [20] found that post-sowing irrigation with two further applications gave highest 1000 grains weight and grain yield of maize genotypes. Vicente *et al.* [21] reported that the reduction in grain yield was 70% and 90% in intermediate water stress and severe water stress, respectively with grain yield fluctuating between 0.30 and 2.41 t ha^{-1} in severe stress. Normal irrigation and

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Table 1: Soil characteristic of the experimental site

Sand	17.0
Silt	29.0
Clay	54.0
Texture	Clay
Field capacity [%]	21.7
Wilting point [%]	10.1
Soil reaction pH	7.2
EC[dS m^{-1}]	0.8
Organic matter [%]	0.5
Calcium carbonate [%]	17.0

number of cobs per plant were reduced by 50% in severe stress. Moreover, the reduction in plant height was found to be 36 cm in severe stress. The present study was conducted to determine the best irrigation levels suited to agro-ecological conditions of Varamin and investigate the response of maize plants to water deficits on some growth stages.

MATERIALSANDMETHODS

Field experiments were carried out at the Agricultural Experimental Station of Varamin Agricultural Research Centre on a clay loam soil to study the effect of water deficits at different growth stages on growth, some physiological aspects and yield of maize plants. The experiment was laid out in randomized complete block design with three replications having a net plot size of 3.0×3.75 m. Four levels of irrigation were randomized in plots as follows: 1] Control where maize plants received 8 irrigations at 15 days intervals after the first irrigation (S0), 2] Missing one irrigation before silking growth stage(S1) and 3] Missing one irrigation at silking(S2) and 4] missing one irrigation at grain filling growth stage(S3). Soil characteristics of the experimental locations are shown in Table 1. Grains of maize (*Zea mays* L.) cv. Single Cross [SC301] was sown on 14 June ,2005. The crop was sown in 75 cm apart furrows by using a seed rate of 30 kg ha^{-1}. The regular tillage and agricultural operations of growing maize of the location were followed. All other agronomic practices were kept normal and uniform for all the treatments. Representative plant samples were collected after 90 days from sowing and their growth criteria were recorded for plant height (cm), total leaf area per plant (cm^2). After harvest the following data were recorded grain yield, 1000 grains weight, number of cobs per plant, number of seed per cob and days to physiological maturity. Data collected were statistically analysis using Fisher's analysis of variance technique and Duncan's multiple range tests at 0.05 probability was employed to compare the differences among the treatments mean.

RESULTS AND DISCUSSION

Data presented in Table 2 showed that missing one irrigation at any of the studied growth stages significantly decreased grain yield. The application of normal irrigation (8 irrigations) significantly produced the maximum grain yield (8 t ha^{-1}) while the lowest grain yield (4.6 t ha^{-1}) was obtained by applying water stress at silking growth stage. These results are in agreement with those of Quaranta *et al.* [20], Vicente *et al.* [21] and Sheikh [22].The results also showed that 1000 grains weight followed the same trend. Irrigation levels had a significant effect on 1000-grain weight. Normal irrigation (application of 8 irrigations) showed significantly the maximum 1000-grain weight (226 g), whereas the water stress at silking growth stage produced the minimum 1000 seed grain weight (152 g). These results are in confirmation with those of Quaranta *et al*. [20]. Simpson [23], who reported that the variations in yield and its components due to drought stress at different growth stages could be ascribed to the impairment of many metabolic and physiological processes in plants. In this regard, Song *et al.* [24] showed that water stress led to slower pollen and filament development decreased filament fertility and resulted in a reduction in grain number and weight per ear. Similar results were recorded by Batanouny *et al.* [13], Grant *et al.*[17], Ahmed and Mekki [18] and El-Sheikh [19]. Data presented in Table 2 also showed that subjecting maize plants under water deficits conditions i.e. missing one irrigation at different reproductive growth stages significantly reduced plant height and area of leaves per plant as compared with the control. The depression in these growth parameters as results of water deficits may be attributed to the loss of turgor which affects the rate of cell division and enlargement. In this concern, Kramer and Boyer [16] reported that the growth of plants is controlled by rates of cell division and enlargement and by the supply of organic and inorganic compounds required for the synthesis of new protoplasm and cell walls. Cell enlargement is particularly dependent on at least a minimum degree of cell turgor and stem and leaf elongations are quickly checked or stopped by water deficits. Many investigators Batanouny *et al.* [13], Ahmed and Mekki [18], E1-Sheikh [19], El-Noemani *et al*. [25] and Mahrous [26] reported that growth criteria of maize plants

Table 2: Some characteristics of corn

Treatments	Grain yield (Ton ha^{-1})	No of cobs plant^{-1}	No of grains cob^{-1}	1000 grains weight (g)	Plant height (cm)	Total leaf area plant^{-1} (cm^2)	Days to physiological maturity
Normal irrigation[S0]	8.0a	1.3a	670a	226a	180a	3562a	118a
Stress before silking[S1]	7.0b	1.06b	571b	206b	160b	2840b	101b
Stress at silking [S2]	4.6c	0.60d	478c	170c	153b	2540c	89d
Stress at filling[S3]	6.8b	0.91c	663a	152d	146b	2580c	100c

were reduced when plants were subjected to drought stress through decreasing number of irrigations or prolonging the irrigation intervals. Significant differences were observed among treatments for number of cobs per p1ant (Table 2). The normal irrigation produced the maximum number of cobs per plant [13], while the minimum number of cobs per plant [0.60] was given by supplying stress at silking growth stage. Vicente *et al.* [21] had also reported reduction in number of cobs plant under severe water stress. The present data also showed that yield reduction was greatly governed by the time of water stress. The grain yield was reduced by 12.5,42 and 22.5% when the plants were exposed to missing irrigation at silking and grain filling growth stages in comparison to the plants received normal irrigation, respectively. The lowest seed yield was obtained from missing one irrigation at grain filling growth stage. The finding is in agreement with those obtained by Kostandi and Soliman [27] who stated that the depressing effects of water stress were comparatively, high at silking, intermediate at filling and low at vegetative growth stages. In this respect, Westgate [28] suggested that grain water status is affected directly by drought and may be an important determinant of grain development and that a water deficit after anthesis shortens the duration of grain filling by causing premature desiccation of the endosperm and by limiting embryo volume. Similar results were recorded by Grant *et al*. [17] and Ahmed and Mekki [18].

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