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Research Article

Standardization of the Effect of Water Stress on the Yield and Productivity of Corn (Zea maize L.) According to the Stages of Growth

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Abstract

A field experiment was carried out for the purpose of studying the effect of water stress, according to stages of growth of maize where the experiment was carried out at the Agra technology Research Station, University Malaysia Perlis Padang Besar, Perlis, Malaysia in March 2014 to June 2014, to investigate the influence of studying the effect of irrigation dates on maize crop. For the purpose of studying the effect of irrigation dates on maize crop. The results showed the superiority of the plants that were not exposed to water stress along the growing season, compared with plants that were exposed to water stress along the stages of growth. The results also showed the sensitivity of the plant at the flowering stage and the apparent effect of water stress at this stage on the yield and production of corn. This has a great effect on flowering and grain formation. The results also showed the effect of water stress on the deeper roots as the plant when exposed to water stress will lead to increased root deepened, thereby raising the possibility of access to water. Valley water stress at maturity to influence the characteristics of growth, but this effect was not significant since this stage reached the plant to the end of its growth; therefore, no longer water stress had a significant impact. It is concluded that the amount of irrigation water can be reduced in the maturation stage for low impact. The results showed the importance of providing appropriate moisture in the period of flowering.

Keywords: Corn, Water stress, Resistance, Irrigation dates

Introduction

The most limiting and most variable environmental factor affecting the productivity of plants is water. Whenever adequate water is not available, farmers have always tried to irrigate their crops. Irrigation water has always been in short supply, but it is becoming a scarce commodity in many regions. Even where it is available, pumping and/or transportation costs have increased dramatically in many locations. Today, the profitability of irrigated agriculture is dependent on the efficient use of water. The effective and efficient use of irrigation is dependent on four factors:

- The effect of irrigation on plant production
- The best system for a given field and water supply
- Determining how much water to apply at the peak usage rate and when to apply it
- The quality of the water

Agricultural plants need warm temperatures, sunlight, nutrients, and water to grow. In many regions of the world, the required temperature and sunlight are available, but water is not. All plants have a minimum annual water requirement to survive and an optimum annual water requirement for maximum production. Historically, the availability of water has determined where crops can be grown. A high-demand crop, such as rice, could not be grown in a region that has a low annual rainfall. In addition,

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whenever the water available to the plant is less than the optimum amount, the production is reduced.[1]

Grain maize originated in the tropics, where environmental factors such as high light intensities, high temperatures, and water deficit exist. Since grain maize possesses the C4 photosynthetic pathway, it is well adapted to these environmental conditions. The lowest level of photorespiration and high water-use efficiency are responsible for the adaptation of corn to tropical environments.[2] Water deficit or drought probably limits plant production more than any other environmental parameter. Drought is a deficiency of available soil moisture, which produces internal water deficits which are severe enough to reduce plant growth. Drought resistance may be attributed to either drought tolerance or avoidance. Drought avoidance includes any mechanism which allows the plant to keep its tissue water potential above that which would cause injury to the cells.[3] Roots are very important in plant growth as they absorb soil moisture and nutrients. Drought deficit affects root weight of the plant during water deficit conditions. Root length is often directly related to absorbed water from soil.[4] Root growth is an important drought-tolerance mechanism in beans for drought avoidance and absorbing water from a depth of soil, but root growth decreases in drying soil.[5] Proline content accumulation is a common metabolic response of higher plants to water deficits and salinity deficit and substantially increases in both young and old leaves during dry period.[6]

Materials and Methods

The field was plowed and divided to prepare for planting. The plot units measured 2m×2m each and space, 1m apart between the plot units and between replicate spaced 1.5m for the purpose of controlling the water movement. Recommended quantities of NPK fertilizer was added to the soil before planting.[7] Soil samples were collected from the field before planting in different areas at a depth of 20, 30, and 40 cm. The samples then were analyzed using standard methods to determine their physical and chemical properties. The corn seeds (seedling length of 5 cm) were planted in containers using media culture (peat moss) for a week and then planted in the field. The seedlings were planted in rows (spaced 50 cm apart) and between plants (spaced 25 cm apart). It had manual weeding continuously during the growing season to ensure the flow of water and distribution evenly on the board. The seedlings were planted on 15/2/2014 for the first season, as for the second season these were planted on 15/2/2015. It was estimated the field capacity of the field soil and it was measured the soil moisture directly in the field.[8]

According to the field capacity, which had been measured previously, soil samples were taken from the experimental treatments at depths (20, 30, 40) by soil auger. Mixed the samples, weighed and put in an electric oven at a temperature of 105°C for 24 hours. After drying, the samples were weighed and calculated the moisture loss and compared with field capacity, after that, be completed moisture in the soil to field capacity depending on the experimental factors (25%, 50%, and 75%).[9]

The data was statistically analyzed in accordance with the design randomized complete block sectors (R.C.B.D) by program (GenStat Discovery Edition 3). Also been used least significant difference test (LSD) to distinguish the different statistical averages. At the level of probability of 5% (Steel and Torrie, 1960). The experiment included three treatments for irrigation in given symbols W1, W2, W3. Treatments were distributed indiscriminately in an experiment with three replications.[10]

Statistical Analysis

Data were subjected to statistical analysis using the statistical software GenStat (Payne et al., 2012). Varity ANOVA was used to analyze the experimental results of dependent variables (treatments). The least significant difference (LSD) was calculated at P≤0.01.

Results and Discussion

Number of Grains per Cob (Ears)

Results are shown in Fig. 1, showing a significant influence of water stress on the number of grains per cob.

Found a significant impact of water stress on the number of grains per cob, as the excellence factor (25% of field capacity) the highest rate of number of grains per cob, it was (355.76), with a significant difference from the other treatment (50% and 75% of field capacity) which has given number of grains per cob, rate (332.22) and (318.87), while it was the lowest number of grains per cob, rate when irrigated plants by (75% of field capacity) with a significant difference from the rest of the treatments (25% and 50% of field capacity).

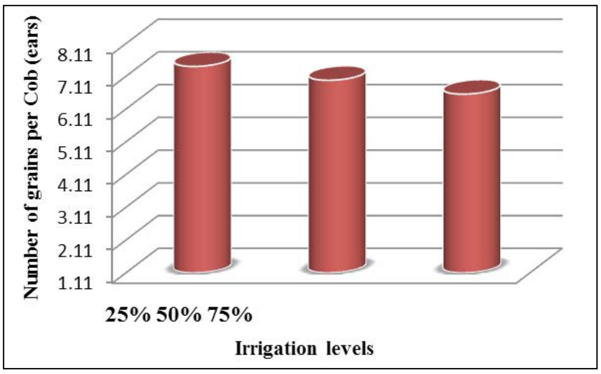

Figure 1.Effect of the Irrigation Levels on the Number of Grains per Cob

This may be attributed to availability of appropriate moisture on all growing season, which has a positive effect in increasing the leaf area, thereby increasing the products of photosynthesis, which contributes effectively in the supply of new emerging sites, their requirements of nutrients in the reproductive stage of the plant to increase the percentage of fertility in ears and thus increase the number of grain ears. Concurred with this conclusion,11 he reported that drought stress happening between initial flowering and grain fill decreases total grain yield primarily by reducing branch vegetative growth, which reduces branch grain number and branch grain yield.

Weight of 500 grains (g)

Results are shown in the Fig. 2, showing a significant influence of water stress on weight of 500 grains (g).

Found a significant impact of water stress on the weight of 500 grains (g), as the excellence factor (25% of field capacity) the highest rate of weight of 500 grains (g), it reached (113.33g), with a significant difference from the other treatment (50% and 75% of field capacity) in which has given weight of 500 grains (g), rate (108.34g) and (106.11g), while it was the lowest number of weight of 500 grains (g), rate when irrigated plants by (75% of field capacity) with a significant difference from other treatments (25% and 50% of field capacity). It was concluded that this reduction in kernel weight was due to the reduced capacity of assimilating production and storage during grain filling. These results are contrary to those of Mubeen et al.[12] who described the demonstrable effect of water stress regarding 500 kernel weight of corn. These results also are in line with those of Hernández et al.[13] who noticed that grain weight in maize was reduced by increasing water stress.

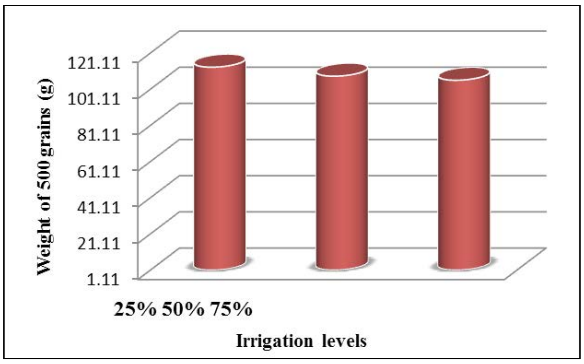

Figure 2.Effect of Irrigation Levels on the Weight of 500 Grains (g)

Total Dry Matter Production tons/ha (TDM)

Figure 3 indicates the effect of water stress on the total dry matter production tons/ha (TDM).

Results are shown a superiority of the plants was irrigated (25% of field capacity) in the highest average of total dry matter production tons/ha reached (12.693 tons/ha), with a significant difference from the other treatment (50%) and (75%) that has given (12.634 tons/ha) and (11.324 tons/ha) respectively. While the lowest average of total dry matter production tons/ha was irrigated (75% of field capacity) with a significant difference from the other treatment (50% and 25% of field capacity). As the plant exposed to water stress it reduces the expansion and elongation of the plant leaves, thereby affects the photosynthesis and other bioactivities of the plant. These results are confirmed by Yang and Grassini,14 who says that the shortage of water in the vegetative stage leading to decrease in the dry matter between 25% and 15%, either in early reproductive stage water stress may reach to 50%. Supported those findings of Muhumed et al.[15] the lack of water for the plant in late reproductive stages (before pollination grains) leads to reduce the dry matter by up to 25%.

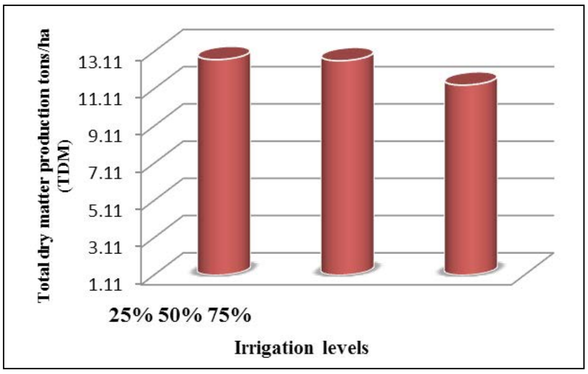

Figure 3.Effect of the Irrigation Levels on the Total Dry Matter Production tons/ha

Conclusion

The previous results showed the importance of water at all stages of plant growth, also the results showed that the flowering stage is the most important stage of the plant. Irrigate the plant with the quantity it needs is one of the most important ways to rationalize the water use. Using the correct and modern techniques in irrigation will be able to provide irrigation water thereby increasing cultivated areas.

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