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Research Application Summary

The effects of water stress on yield and water productivity of two newly released wheat varieties

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Abstract

This experiment was conducted under Gezira condition,Wad Medani, latitude 14º 242 N, longitude 33º 292 E and with an elevation of 405 m above the sea level, during season (2008-2009). A split plot design with four replications and nine irrigation treatments was used. Treatments included full irrigation, i.e., water applied every ten days and other eight treatments where water stress conditions were imposed by skipping one irrigation at different irrigation times. Two wheat varieties namely Tagana and Khalifa were grown under the different water stress treatments. Water treatments were assigned to main plots and varieties as subplots. Soil samples were collected every 20 cm down to one meter depth after and before each irrigation for soil moisture depletion determination. Penman-Monteith reference evapotranspiration, ET_o was estimated using meteorological data collected from Wad Medani Station. Data collected included actual evapotranspiration, ETa, amount of applied irrigation water (m^3/ha) applied, yield, yield components and soil parameters. Result indicated that Tagana was more tolerant to water stress compared to Khalifa. Booting and anthessis were the most sensitive stages to water stress. To maximize yield, moisture stress should be avoided during these stages. This experiment will be repeated during the (2010/2011) winter season to confirm these results.

Key words: Evapotranspiration, irrigation, Khalifa, Tagana, stress

Résumé

Cette expérience a été menée sous la condition de Gezira, Wad Medani, latitude 14 º 242 N, longitude 33 º 292 E et avec une altitude de 405 m au-dessus du niveau de la mer, pendant la saison (2008-2009). Une conception des parcelles à fente avec quatre répétitions et neuf traitements d'irrigation a été utilisée. Les traitements incluaient une irrigation complète, c'est à dire, l'eau étant appliquée tous les dix jours et huit autres traitements où les conditions de stress hydrique ont été imposées en sautant une irrigation à des moments différents d'irrigation. Deux

variétés de blé, à savoir Tagana et Khalifa ont été cultivées dans différents traitements de stress hydrique. Les traitements hydriques ont été affectés aux parcelles principales et les variétés comme sous-parcelles. Des échantillons de sol ont été prélevés tous les 20 cm vers le bas à un mètre de profondeur avant et après chaque irrigation pour la détermination de l'appauvrissement de l'humidité du sol. L'évapotranspiration (ET) de référence Penman-Monteith a été estimée à partir des données météorologiques recueillies à la station de Wad Medani. Les données recueillies comprenaient l'évapotranspiration réelle (ETa), la quantité de l'eau d'irrigation appliquée (en m^3/ha), le rendement, les composants du rendement et les paramètres du sol. Les résultats ont indiqué que Tagana était plus tolérant au stress hydrique que Khalifa. L'amorçage et la floraison ont été les étapes les plus sensibles au stress hydrique. Pour maximiser le rendement, le stress hydrique devrait être évité au cours de ces étapes. Cette expérience sera répétée au cours de la saison d'hiver (2010/2011) pour confirmer ces résultats.

Mots clés: Evapotranspiration, irrigation, Khalifa, Tagana, stress

Background

Sudan is the largest country in Africa with 238 m ha of land. Its population in 2008 was approximately 40 m people. Arable land is estimated at 75- 84 m ha but the area currently under crop is not more than 7.5 m ha. Wheat is a crop of temperate origin but cultivated in Sudan as a winter crop. Average annual flow of the Nile is about 84 bcm, measured at Aswan. According to the 1959 Nile Water Agreement between Sudan and Egypt, respective shares of the two countries are 18.5 and 55.5 bcm. Currently, annual amount of water available to the Sudan from national and international sources is about 35.5 to 37 bcm. Agricultural sector consumes more than 90 percent of this amount. The Ministry of Irrigation and Water Recourses, under the Long Term Agricultural Strategy, projected that the irrigation water needs, human and animal consumption, domestic and other uses and evaporative losses by the year 2027 will be about 59.2 bcm. This implies the need for very efficient use of water resources.

The major wheat growing area in the Sudan is the Gezira scheme where it is grown as a winter crop in rotation with cotton, groundnut and sorghum. The main objective of this study was to estimate crop water requirement of the newly released wheat varieties Tagana and Khalifa and to evaluate their response to water stress imposed at different growth stages. Above data

will be used to schedule irrigation using the FAO CROPWAT model, i.e., water applied every ten days and other eight treatments where water stress conditions are imposed by skipping one irrigation at different irrigation times.

Literature Summary

Detection of crop water stress is critical for efficient irrigation water management, especially in the semi-arid regions. Water stress corresponded to reduction in evaporation due to the limited availability at root zone soil moisture (Bolute *et al.,* 2006). Deficit irrigation imposed during flowering and grain filling stages of wheat will provide acceptable and visible option for minimal yield reduction with limited supplies of irrigation water (Kirda, 2004). Wheat can tolerate irrigation intervals of up to 21 days during the vegetative growth stage and omissions of the second or the final (at grain filling stage) irrigation and for attaining maximum yield, moisture stress should be avoided at the time of booting and anthesis.

Study Description

The experimental treatment and data measurement started after crop established. The seed rate was 55 kg/fed and field plot size was (4m*6m). Soil moisture depletion was determined by gravimetric soil content method to measure the soil felid capacity (FC), permanent wilting point (PWP) and available soil moisture content. Treatments included watering every ten days (T1) and other eight treatments where water stress conditions were imposed by skipping one irrigation at different irrigation times (T2 Stresses in the 2^{sec} irrigation time of applying water, T3 Stresses in the 3rd irrigation, T4 Stresses in the 4th irrigation, T5 Stresses in the 5th irrigatation and T9 Stresses in the 9th time of irrigation). Metrological data collected included (minimum and maximum temperature ^{o}C, wind speed (m/s at 2m depth) and sun shine (hr) to estimate reference evapotranspiration.

Research Application

The crop water requirement (CWR) for two newly wheat verities was established at 4290 m^3/fed for 11 irrigation times. The result indicated the positive response of two Wheat varieties to irrigation water. The full irrigation water applied gave the maximum yield. The result showed that the highest grain yield (1563 to 1313) kg/ha was obtained from T1, T9 respectively, and when water stress increased grain yield decreased as was the case for Khalifa (229 kg/ha, 267kg/ha) under T4 (44 days from planting), T5 (54 days from planting) respectively. On the other hand, (392 kg/ha, 371kg/ha) for Tagana under T4 andT5. These results are in agreement with those of Ishag *et*

al. (1992) and Farah (1987) where highest grain yield was obtained from irrigating every 10 days throughout the season. These authors also reported that water stress should be avoided at time of booting and anthesis.

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