

**Effectiveness of silicon for mitigating drought stress in sorghum
(*Sorghum bicolor* L.)**

By

Aaftab Ahmad

M.Sc. Student

Student ID Number: 1602743

Advisory Committee

Advisor: Dr. Burhan A.M Niyazi

CO- Advisor: Dr. Ihsanullah M. Aslam

Department of Hydrology and Water Resources Management,

Faculty of Meteorology, Environment and Arid Land Agriculture

King AbdulAziz University, Jeddah,

Kingdom of Saudi Arabia

Thesis Abstract

A field experiment (March 2017 to September 2017) was conducted at Hada Al-Sham research station of King Abdulaziz University Jeddah Saudi Arabia using multi-cut sorghum crop. The main objective of this study was to obtain the maximum crop yield at minimum water use under natural arid conditions. Multi-cut sorghum fodder crop was grown under natural drought condition of Hada Al-Sham until three cuts. In this study, different irrigation scheduling treatments and silicon foliar treatments were applied to reduce drought stress. Daily weather data was collected from Hada Al-Sham meteorological station to estimate the crop water requirement. Penmen-Monteith equation (PME) (FAO-56) was used to estimate reference evapotranspiration and then crop evapotranspiration was calculated by using crop coefficient (K_c) for sorghum. The irrigation was applied as main plot treatments (100% ET_c , 80% ET_c and 60% of ET_c) with three replications. The silicon was applied as foliar spray comprising 0 kg/ha as control, 1 kg/ha and 2 kg/ha as sub-plot treatments. Irrigation and silicon treatments were applied at five leaves stage during all three cuts, before treatments 100% ET_c was applied to all the plots. Three cuts were harvested at 50% spikes initiation to determine 1) the number of plants per square meter, 2) plant height, 3) fresh yield and 4) dry yield. The results revealed that drought during growing season severely affected the morphological characters of sorghum. The decrease in irrigation from 100% to 60% decreased the plant height, fresh and dry yields while the number of spikes during 2nd and 3rd cuts increased. Meanwhile the foliar application of silicon improved the number of spikes, plant height, fresh and dry yields under drought conditions. This study concluded that under severe drought stress the application of silicon can improve the crop production. And the PME is reliable and easy way to determine crop water requirements and irrigation scheduling tool under arid climatic conditions of Hada Al-Sham Saudi Arabia.

DEVELOPMENT OF AN OPTIMUM IRRIGATION SCHEME USING LEAST-COST PATH ANALYSIS AND DIGITAL ELEVATION MODELING

Aaftab Ahmad¹, Burhan A.M Niyazi¹, Chaabani Anis¹

¹ Department of Hydrology and Water Resources Management, King Abdul Aziz University, Jeddah,
Saudi Arabia

Email: aftabagri@yahoo.com

ABSTRACT

Irrigation suffices crop water requirements for optimum crop production in arid regions. It consumes about 70% of available fresh water in the world while contributing 40% of the world food supply. As the global population increasing rapidly and the available fresh water per capita is decreasing, so scarce natural resources (such as land and water) must be used wisely. Development of an optimum water supply and on farm distribution system for irrigated lands will increase water use efficiency and will reduce water supply cost. Different techniques of GIS have been used in irrigated agriculture to increase water use efficiency and yield in farm lands. In this study, the combination of least cost path analysis (LCPA) and digital elevation modelling (DEM) was used to develop an optimum irrigation scheme. Digital elevation model was used to generate the complete topography of the irrigated farms to determine water flow path from Haddah treated sewage water plant (Makah Province Saudi Arabia) to farm fields(date palm) near Bahrah town (in downstream of Wadi Fatima, Makkah province). Least-cost path analysis was used to find cheapest water supply path between source and the irrigated lands to decrease construction cost. The combining of least-cost path analysis and digital elevation model in water allocation for irrigated lands was efficient and cost effective as compared to the existing unlined water allocation channel. Construction and material cost was more as compared to unlined channel but it saved more than 50% water for more crop production and increased water use efficiency.

Keywords: Irrigation, GIS, DEM, LCPA, Water resources, modelling.

Effectiveness of silicon and irrigation scheduling for mitigating drought stress in sorghum (*Sorghum bicolor* L.) in arid region of Saudi Arabia.

Aaftab Ahmad¹, Burhan A.M Niyazi², Ihsanullah Daur³, Sidra Riaz⁴

1, 2 Department of Hydrology and water resources management, faculty of meteorology, environment and Arid land Agriculture King Abdulaziz University Jeddah, Saudi Arabia

3 Department of arid land agriculture, faculty of meteorology, environment and Arid land Agriculture King Abdulaziz University Jeddah, Saudi Arabia

4 Department of Botany, Faculty of Sciences University of agriculture, Faisalabad Pakistan

Abstract

A field experiment with three treatments of irrigation and three treatments of silicon in triplicate was conducted at Hada Al-Sham research station of King Abdulaziz University Jeddah Saudi Arabia using multi-cut sorghum crop. The main objective of this study was to obtain the maximum crop yield at minimum water use under natural arid conditions. The crop was grown for fodder under natural drought condition of Hada Al-Sham until three cuts. Daily weather data was collected from Hada Al-Sham meteorological station to estimate the crop water requirement. Penmen-Monteith equation (PME) (FAO-56) was used to estimate reference evapotranspiration and then crop evapotranspiration was calculated by using crop coefficient (Kc) for sorghum. The irrigations (100%, 80% and 60% of ETc) were applied as main plot treatments and silicon (0, 1, and 2 kg ha⁻¹) were applied as sub-plot treatments. Three cuts were harvested at 50% spikes initiation to determine 1) the number of plants per square meter, 2) plant height, 3) fresh yield and 4) dry yield. The results revealed that drought during growing season severely affected the morphological characters of sorghum. The decrease in irrigation from 100% to 60% decreased the plant height, fresh and dry yields while the number of tillers during 2nd and 3rd cuts increased. Meanwhile the foliar application of silicon improved the number of tillers, plant height, fresh and dry yields under drought conditions.

Key words: Sorghum, Silicon, Foliar application, Irrigation scheduling

Response of fodder Sorghum (*sorghum bicolor* (L)) yield to the deficit irrigation under arid climate of eastern province of Saudi Arabia.

Burhan Abdul Kabeer Muhammad Niyazi¹, Aaftab Ahmad¹, Ihsanullah Daur²

¹*Department of Hydrology and water resources management, King Abdulaziz University Jeddah, Saudi Arabia*

²*Department of arid land agriculture, King Abdulaziz University Jeddah, Saudi Arabia*

***Corresponding Author:** Burhan Niyazi bniazzi@kau.edu.sa

Abstract

A field experiment with two deficit irrigation (DI) treatments (80% and 60% of ET_c) with control (100% ET_c) in triplicate was conducted at Hada Al-Sham research station of King Abdulaziz University Jeddah Saudi Arabia using multi-cut sorghum fodder crop. The main objective of this study was to obtain the fodder yield response of sorghum to DI and to check the reliability of reference evapotranspiration (ET_r) estimated via Penmen-Monteith equation (PME) (FAO-56) along with crop evapotranspiration (ET_c) estimated using crop coefficient of sorghum (K_c) with real field water holding capacity (moister content) at Hada Al-Sham area. The crop was grown for fodder purposes until three cuts. Daily weather data was collected from Hada Al-Sham meteorological station to estimate the ET_r and ET_c (crop water requirement). The DI treatments were applied at five leaves stage and the crop was harvested at 50% spikes initiation. The results revealed that during growing season the yield reduced with reduction in irrigation amounts (DI). The difference in moister contents readings was negligible between DI treatments during whole growing season as compared to control.

Key word: Deficit irrigation, water management, arid regions sorghum fodder yield.

(Submitted for publication in King Abdulaziz University Journal)