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ORIGINAL ARTICLE

Employment of Eddy Covariance technique for the analysis of Carbon dioxide, Water vapor and Energy fluxes over alfalfa field under Hyper-arid conditions

[1]**Rangaswamy Madugundu,** [1]**ElKamil Tola,** [1,2]**Khalid A. Al-Gaadi**
[1]Precision Agriculture Research Chair, King Saud University, Riyadh, Saudi Arabia
[2]Department of Agricultural Engineering, College of Food and Agriculture, King Saud University, Riyadh, Saudi Arabia

ABSTRACT
This study reported results on carbon dioxide (CO_2), water vapor (H_2O) and energy fluxes over a center pivot irrigated alfalfa field in the Eastern region of Saudi Arabia. The experimental work was carried out during winter (November 2013 to January 2014) and summer (February to May 2014) seasons, using an Eddy Covariance system. Continuous fast response measurements of the above-canopy CO_2, H_2O and heat fluxes were recorded at a frequency of 10 Hz. Subsequently, the collected observations were averaged out at 30 minutes. Simultaneous measurements of meteorological parameters (wind speed, wind direction, air temperature, relative humidity, vapor pressure deficit (VPD), incoming solar radiation and soil heat flux) were also carried out. Diurnal and seasonal variations of CO_2, H_2O and heat fluxes were analyzed and correlated with the meteorological variables.The diurnal and seasonal mean weekly variations of CO_2 flux above the crop canopy indicated that a maximum CO_2 flux (−35 μmol/m^2/s) was recorded during summer and gradually decreased to −6 μmol/m^2/s with the progress of winter season towards December. Energy flux analysis (weekly mean) showed more energy being portioned into sensible heat during winter (489 W/m^2, 71%) and into latent heat during summer (614 W/m^2, 68%) during full coverage of alfalfa crop. The highest crop water use efficiency (WUE)of 1.61 kg/m^{3}was obtained during November 2013, while, the lowest WUE (0.37 kg/m^3) was recorded in May 2014.
Keywords; *Center pivot irrigation, Dry climate, Eddy covariance, Photosynthesis, Saudi Arabia*

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INTRODUCTION

Modern agricultural systems provide accurate estimates of crop acreage and productivity for the optimum use of irrigation water and fertilizers. However, significant variations in the seasonal water use and total carbon dioxide (CO_2) uptake are common, especially in multi-cut forage crops such as alfalfa. In general, crop yields are basically driven by the photosynthetic rate and the assimilation of adequate amounts of CO_2 and water vapor (H_2O). The rate of photosynthesis is associated with the phenology and the length of the day. Therefore, measurements of CO_2, $H_2O$and heat fluxes across the vegetation–atmosphere interface are essential to underst and the major processes controlling carbon storage in agriculture fields. There is a remarkable evolution in the technological approaches used for measuring the carbon fluxes at the leaf level [1,2], at the whole plant level [3]and at the ecosystem scale using modernmethods such as Eddy Covariance (EC) system [4-6]. Most of the research studies which used the EC technique concentrated on monitoring the net ecosystem exchange (NEE) of CO_2 to understand the various processes affecting the fluxes. The advantages of using the EC system are that it is scale-appropriate, directly measures the CO_2 flux of the canopy-atmosphere interface [7,8]and provides information over the tower footprint across different time scales [9-11].

Biomass stocks produce indirect estimates of the net primary productivity (NPP), using standard measurement relationships to measure the incremental changes in the NPP estimates at field and farm