Second RUFORUM Biennial Meeting 20 - 24 September 2010, Entebbe, Uganda
Research Application Summary

Determination of crop coefficient of local barley cultivar in Tigray, Northern Ethiopia using drums

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Abstract

Barley is a major staple food crop in the highlands of northern Ethiopia. The crop is used for preparing various types of traditional foods. Barley yield over the northern Ethiopia is severely affected mainly due to water stress. To minimize the problem, household ponds were constructed to supplement rain water. However management of this irrigation water is very poor because the crop coefficient of the local barley is not known. To measure crop coefficient, lysimeters are needed. Unfortunately they are not available in Ethiopia. A locally made lysimeter was designed and installed in 2010 in northern Ethiopia to measure the evapotranspiration and determine the crop coefficient for barley. Preliminary results showed that the seasonal evapotranspiration of barley was 375 mm which is similar to many other cereal crops in the region. The one year single crop coefficient values for early, vegetative, mid and late crop stages were 0.7, 0.85 1.05 and 0.6 respectively.

Key words: Crop coefficient, evapotransipiration, lysimeter, soil water balance, water stress

Résumé

L'orge est une culture alimentaire de base importante dans les montagnes du nord de l'Ethiopie. Elle est utilisée pour la préparation de différents types d'aliments traditionnels. La production de l'orge dans le nord de l'Ethiopie est gravement affectée principalement par le stress hydrique. Afin de minimiser le problème, les étangs des ménages ont été construits pour suppléer l'eau de pluie. Cependant la gestion de cette eau d'irrigation est très faible parce que le coefficient cultural de l'orge locale n'est pas connu. Pour mesurer le coefficient cultural, les lysimètres sont nécessaires. Malheureusement, ils ne sont pas disponibles en Ethiopie. Un lysimètre fabriqué localement a été conçu et installé en 2010 dans le nord de l'Ethiopie pour mesurer l'évapotranspiration et déterminer le coefficient cultural pour l'orge. Les résultats préliminaires ont montré que l'évapotranspiration saisonnière de l'orge a été de 375 mm qui est semblable à beaucoup d'autres cultures céréalières dans la

région. Les valeurs du coefficient cultural pour une seule année concernant les stades culturaux précoce, végétatif, moyen et récent ont été de 0.7, 0.85 ,1.05 et 0.6 respectivement.

Mots clés: Coefficient cultural, évapotranspiration, lysimètre, bilan hydrique des sols, stress hydrique

Background

Barley is a major staple food crop in the highlands of northern Ethiopia. Although the day to day survival is linked to barley, little focus has been given to improve the productivity of the crop in the dryland area.

The crop is adapted to the climatic stress but its yield has been severely affected mainly due to water stress which may occur during part of its growing period. The crop was known to respond positively to deficit irrigation (Nagaz *et al.*, 2008; Araya *et al.*, 2010b) however the minimum amount of water needed to improve yield from a barley crop land has not been documented. The government in its effort to reduce yield loss and improve food security, spearheaded the construction of household ponds a decade ago. However their irrigation water management has been very poor mainly due to inadequate knowledge of the water requirement of the local crops. The k_c values for barley growing in the semi-arid northern Ethiopian highlands are not available. Crop coefficients specific to the climatic condition are a pre-requisite to effective irrigation water management and use (Li *et al.*, 2003). To develop crop coefficient, standard lysimters are recommended, however, they are very expensive and not available in the region. The objective of this study is therefore to determine local crop coefficient values for local barley using locally made lysimeters.

Study Description

The experiment is being conducted in northern Ethiopia (latitude 13^o 29' N and long 39^o 35'E, 2130 m above sea level. Evapotranspiration data were collected using four drums (Figs. 1 and 2), installed at four representative positions of the barley field. The drums were installed 3 to 5 m apart. The drums had a diameter of 0.6 m and were 1 m tall. They were designed to replace the more expensive lysimeters (Figs. 1 and 2).

Soil water balance. Time domain reflectometry (TDR) (Eijkelkamp, 1996) was used to measure soil moisture. In the drum experiments, a depth of about 15-45 mm irrigation water was applied every 3 to 4 days depending on the availability of

Figure 1. Scientists taking evapotranspiration data based on the locally fabricated drum technology.

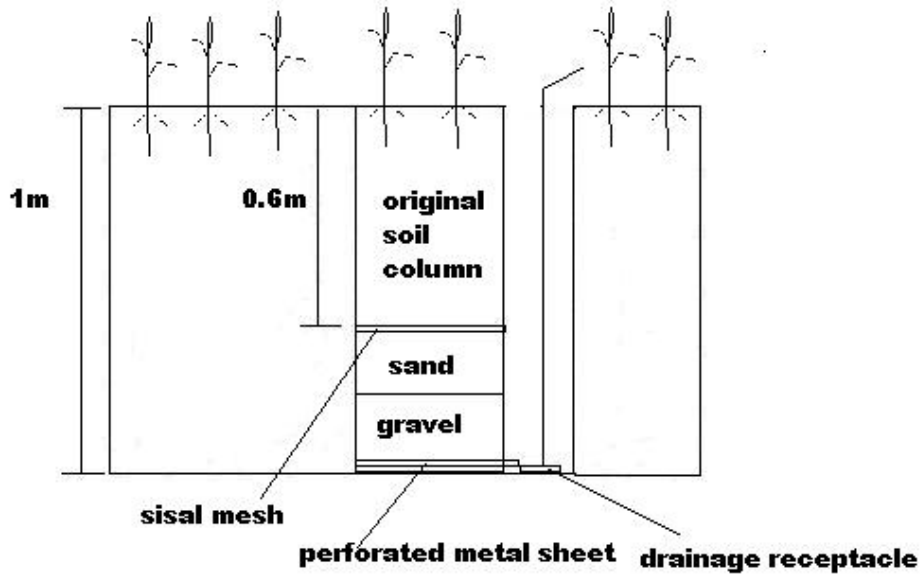

Figure 2. Illustration of the cross-section of the drum used to measure the evapotranspiration and its placement in the ground.

soil water in the root zone. Barley evapotranspiration was computed from the water balance (Eq. 1) (Allen *et al.*, 1998):

$$ET_c = I + P - D - Ro \pm \Delta S \quad \text{..... (1)}$$

Where, "*S* is the change in soil moisture storage between soil moisture measurements (mm), *I* is irrigation (mm); *P* is rainfall (mm); *D* is drainage (mm); *Ro* is runoff (mm). Groundwater effect was ignored because the water table was deeper than 100 m.

Crop coefficient. Barley crop coefficient (k_c) values for the initial, mid and late season stages were calculated using the technique used in Eq. 2 as described in Doorenbos and Pruitt (1977), Allen *et al.* (1998) and Liu *et al.* (2002).

$$k_c = \frac{ET_c}{ET_o} \quad \text{..... (2)}$$

Research Application

The estimated seasonal barley ET_c in our experiment was about 375 mm (Fig.3). Generally the study results were in close agreement with previous works (Allen *et al.*, 1989). The k_c values presented in this study (Table 1) could be used for irrigation water management of the local barley in the northern Ethiopia.

Table 1. Barley k_c based on single crop coefficient approach.

Category	Initial	Vegetative	Mid	Late	Total
k_c	0.7	0.85	1.05	0.6	
Length of the stage (days)	18	20	30	16	85

Recommendation

The results of the experiment showed the k_c values for barley at the initial, vegetative, mid and late stages was 0.7, 0.85 1.05 and 0.6 respectively. We recommend using these values for irrigation water management for barley in the northern Ethiopia

Acknowledgement

The authors express their sincere appreciation to the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) and the Netherlands Organization for International Cooperation in Higher Education (NUFFIC) for funding this research.

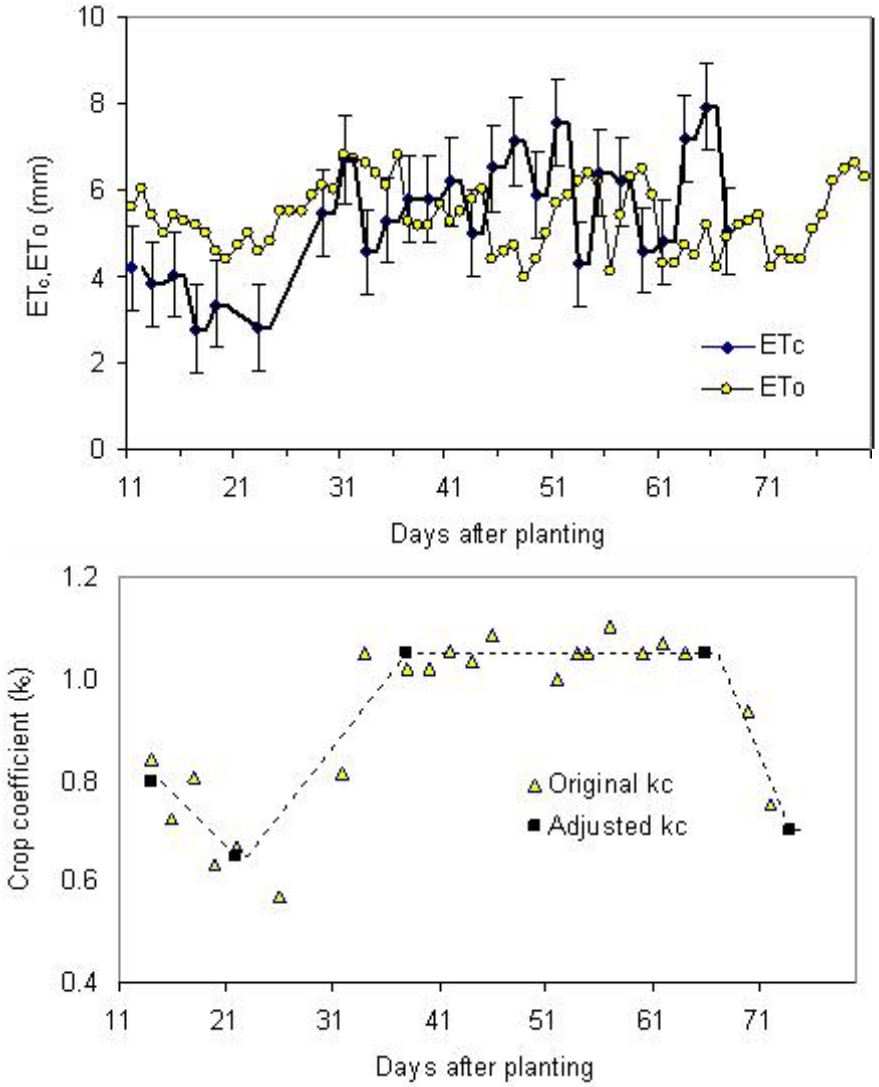

Figure 3. ET_c, ET_0 (above) and k_c values of a barley crop determined using drums in northern Ethiopia.

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