Research Application Summary

# Water productivity and evapotranspiration of teff (*Eragrostis tef*)

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## Abstract

Teff is a staple food crop in northern Ethiopia. The main limitation in stabilizing teff yield in northern Ethiopia is the dependency of the farming system on erratic rainfall. Usually, drought stress occurs in the region at the critical period of the crop growth. If we can increase the efficiency of water usage, we can mitigate the impacts of climate variability and change and thus improve food security in the country. In this research, teff water productivity and evapotranspiration will be quantified and documented. The information generated will be valuable to maximize teff yield in semi arid regions.

Key words: Eragrostis teff, evapotranspiration, pot experiment, water use efficiency

## Résumé

Le teff est une culture alimentaire de base dans le Nord de l'Ethiopie. La principale limitation dans la stabilisation du rendement du teff dans le Nord de l'Ethiopie est la dépendance du système agricole sur des précipitations irrégulières. Habituellement, le stress dû à la sécheresse se produit dans la région pendant la période critique de croissance des cultures. Si nous pouvons augmenter l'efficacité de l'utilisation de l'eau, nous pouvons atténuer les impacts de la variabilité et du changement climatiques et améliorer ainsi la sécurité alimentaire dans le pays. Dans cette recherche, la productivité de l'eau du teff et l'évapotranspiration seront quantifiées et documentées. Les informations générées seront très utiles pour maximiser le rendement du teff dans les régions semi-arides.

Mots clés: Eragrostisteff, évapotranspiration, expérience en pot, efficacité d'utilisation de l'eau

## Background

As the population of Ethiopia is growing in an alarming rate, it is important to keep the pace of food production with that of population growth. Thus, to achieve this high economic growth, the Ethiopian Government is mobilizing the people to participate in all aspects of food security.

Drought is one of the most serious climatic hazards affecting agricultural production in many African countries. Drought events have been causing food crises in Ethiopia since early 70s.

Teff (*Eragrostis teff*) is a rain-fed crop and is the major staple food in Ethiopia. Teff is the principal source of carbohydrate in the diet of Ethiopians and is consumed in various forms. Its production is critical for the national food security. It is a gluten-free food crop which has attracted much interest in the international market (Spaenij-Dekking *et al.*, 2005). It is in high demand and has a high market value, as it brings farmers more revenue than other crops (Seyfu Ketema, 1997).

Teff is adapted to rain fed farming in Ethiopia but it is production is affected by water stress. Teff production is expected to reduce due to water stress if the current climate change persists. One means of enhancing adaptation to climate variability and change is through improving water management in teff fields, however, the detailed teff-water relations is not very well documented. Improving the on-farm efficiency of rain water usage would benefit not only the smallholders who grow it but would also improve food security in the country and bring in revenue from international sales. Thus we hypothesis that understanding the water productivity and evapotranspiration of teff could enhance the mitigation of climate variability and there by contribute to livelihood food security in the region.

Thus, the objectives of this research are to (1) understand the relationship between various water levels and teff yield, (2) to quantify teff evapotranspiration, and (3) to come up with appropriate recommendations pertinent to water application to teff and useful for the farming community.

## Literature Summary

Water is the major crop production limiting factor in semi-arid environments of Africa (Sivakumar, 1992; Barrron *et al.*, 2003; Tesfay and Walker, 2004; Araya *et al*., 2010). However, due to climate variability, the rainfall is erratic in nature. In most cases it is the distribution rather than the total amount of rainfall which determines crop production in most semi-arid areas of Africa including Ethiopia (Barron *et al*., 2003; Meze-Hausken, 2004; Segele and Lamb, 2005). In northern Ethiopia, the uneven distribution of rainfall over the season and the shortening of growing periods due to late start or early cessation of rains have been causing crop failure over the three decades. At

present, the rainy seasons in the northern Ethiopia are shorter than the length of growing period of the currently available crop varieties in the region. Therefore, optimizing the rainwater use has paramount importance. Teff is normally not sown until the peak of the rainy period, which in Tigray is from the third week of July to the first week of August (Araya *et al*., 2010). Often, the rainy period ends 40 to 50 days after the normal planting time of teff, but the duration of teff's growing period ranges from 80 to 85 days. Considering a normal season, the occurrences of late-season (after rainfall cessation) dry spells are more pronounced than intra-seasonal (within the rainy season) dry spells. The occurrence of late-season dry spells coincides with the critical crop growth stage, in particular flowering and yield formation stages. Given that rain ceases in the middle of the growing stage, supplemental irrigation may be necessary for optimum growth (Araya *et al.*, 2010). Enhancing water use efficiency in irrigated agriculture includes increasing output per unit of water (Howell, 2001; Fereres and Soriano, 2006).

Therefore, with the knowledge of teff- water relation, it is possible to determine the optimal planting time to better utilize rainwater for teff, Furthermore water stored using rainwater harvesting structures could also be utilized in more efficient way.

## Materials and Methods

Pot experiment will be conducted in a greenhouse at Mekelle University campus**.** There will be two teff treatments: optimal water and deficit irrigation and each will have five replicates. In the first treatment water will be re-filled to field capacity when it reaches 25% lower than the field capacity. In the second treatment, water will be applied when it reaches 50% lower than the field capacity. Water will be applied using a graduated cylinder. Teff evapotranspiration (ETc) will be estimated by weighing the pot every day at (fixed time interval) using a weighing balance through out the growing period. Reference evapotranspiration (ETo) will be estimated using penmanMonteith method (Allen *et al*., 1998). Daily teff evapotranspiration will be averaged for the weeks during the experimental seasons to give the weekly ETc. The average weekly $ET_C$ and $ET_0$ values will be used to produce weekly teff crop coefficient ($k_c$) values as presented in Doorenbos and Pruitt (1997), Allen *et al.* (1998) and Liu *et al.* (2002). Mean teff crop coefficient ($k_c$) values for the weeks of the four growth

stages will be then obtained as: $(K_C) = \frac{ETC}{ETO}$ Where, ETc = crop evapotranspiration under optimal conditions, Kc = crop coefficient, ETo = reference evapotranspiration, Once KC values are obtained, crop water requirement of teff can be calculated using: $ET_C = k_C \; x \; ET_0$

The actual evapotranspiration ($ET_a$) of teff will be measured from pots with mild water stress. The water used and yield obtained from mild water stress treatment will be used to compare the water productivity of teff with the optimal water condition. Water productivity (WP) which is expressed in kg/ $m^3$ will be calculated. WP is an efficiency term, expressing the amount of marketable product (e.g. kilograms of grain) in relation to the amount of water used to produce that output (cubic meters of water).

## Research Application

It is hoped that the information generated on water productivity (good water management practice) will be applied to effectively use water in this semi arid zones for maximum yield of teff. This would contribute to drought mitigation strategies in Tigray northern Ethiopia and other similar areas. These recommendations generated from the study will be communicated through community service programme of the Mekelle University to Bureau of Agriculture and selected farmers in the region.

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