*Journal of Agrometeorology 5 (2) : 53 - 57 (Dec 2003)*

# Crop coefficient and evapotranspiration of berseem (*Trifolium alexandrinum* L.) grown under semi - arid environment

**PRADEEP BEHARI, J.B. SINGH and R.B. YADAVA**

Indian Grassland and Fodder Research Institute, Jhansi- 284003

## ABSTRACT

Crop evapotranspiration of berseem was determined using weighing lysimeters at IGFRI, Jhansi for seven consecutive *Rabi* seasons. The average water use efficiency ranged between 11- 19.6 kg DM $ha^{-1}$ $mm^{-1}$ in five cuttings, the maximum coincided with 3rd cutting. The crop coefficient (Kc) values during each cut crossed the unit value, the average value being 1.54.

***Key words:*** Berseem crop, Evapotranspiration, Crop coefficient, Water use efficiency,

Berseem *(Trifolium alexandrinum* L.), an important forage crop of India provides nutritious and palatable green fodder to livestock from November to May. It gives 5- 6 cuts and needs copious irrigation. Increasing the irrigation water use efficiency necessitates improved irrigation scheduling techniques considering integrated effect of climate, soil and crop characteristics. The effect of irrigation methods and moisture regimes on the water use efficiency of berseem have been studied by Shukla and Menhi Lal (1988, 1993). Prediction of evapotranspiration (ET) as a function of crop stage is important for determining crop water use and scheduling irrigation. The effect of crop characteristics on crop water requirement is given by the crop coefficient (Kc). Doorenbos and Pruitt (1977) showed the significance of Kc for assessment of crop water requirement for irrigation scheduling. Bredero (1991) reported experimentally determined Kc values of different crops under North Indian conditions. Chaudhary *et. al.* (1999) have reported Kc values of major crops of Gujarat region. However, the crop coefficient for berseem is not available in the literature

The present study was aimed at investigating crop evapotranspiration, water use efficiency and crop coefficient of berseem grown under semi- arid environment.

## MATERIALS AND METHODS

A field experiment was conducted for seven consecutive *rabi* seasons from 1990-91 to 1997-98 (except 1995-96) at the Central Research Farm of IGFRI, Jhansi (25°27' N, 78°35' E, 271 m amsl) situated in semi- arid tract of Central India. It receives an average rainfall of 834 mm of south-west monsoon with annual rainfall of 938 mm compared to the annual potential

**Table 1:** Biomass yield and evapotranspiration of berseem for seven growing seasons

| Cuts | Biomass yield (t ha$^{-1}$) | | Evapotranspiration (mm) | Rainfall (mm) |
|---|---|---|---|---|
| | Green | Dry | | |
| 1st | 12.9 | 1.31 | 121.6 | 28.3 |
| 2nd | 13.9 | 1.62 | 82.6 | 5.2 |
| 3rd | 17.8 | 2.56 | 130.2 | 0.5 |
| 4th | 18.6 | 3.0 | 166.7 | 11.7 |
| 5th | 16.1 | 3.8 | 222.1 | 5.5 |

**Table 2 :** Crop coefficient (Kc) of berseem for different cuts

| Cuts | Cutting duration (days) | Crop coefficient |
|---|---|---|
| 1st | 50 | 1.19 |
| 2nd | 30 | 1.81 |
| 3rd | 30 | 1.76 |
| 4th | 30 | 1.58 |
| 5th | 30 | 1.56 |

evapotranspiration of 1512 mm. The moisture deficit index based on normal data is -39.5% (Nathan and Sinha, 1996). The soil of the experimental site was medium black (Inceptisols) with clay loam texture and neutral reaction (pH 7.35). It was non-saline in salt content (EC 0.09 dSm$^{-1}$) and low in organic carbon (0.39%), available nitrogen (183 kg ha$^{-1}$) and available phosphorus (5.59 kg ha$^{-1}$) and medium in available potassium (264.7 kg ha$^{-1}$). The soil depth was about 100 cm. The crop was sown in last week of October/ 1st week of November. The seeds were sown in and around lysimeters @ 25 kg ha$^{-1}$ and the crop was fertilized with a basal dose of 20 kg N and 35 kg P ha$^{-1}$. The irrigation was scheduled on the basis of irrigation water (IW): cumulative pan evaporation ratio of 1.0 and irrigation was kept at 60 mm per irrigation. Standard agronomic practices were followed for harvesting of the crop i.e., 1st cutting at 50 days after sowing and subsequent cuttings at 30 days interval in all the seven years. Green and dry biomass yields were recorded at each cut. For evapotranspiration measurement two weighing lysimeters having dimensions of 1.3x 1.3x 0.9 m and maximum weighing capacity of 2000 kg were used. The sensitivity of the system was ± 0.2 kg, which is equivalent to 0.12 mm of evapotranspiration or rainfall. The daily evapotranspiration was measured by recording successive weight loss and taking the rainfall/ irrigation into account.

## RESULTS AND DISCUSSION

The total average rainfall during the crop growth period in five cuts was 28.3, 5.2, 0.5, 11.7 and 5.5 mm, respectively whereas, the total average pan evaporation was 125.2, 68.6, 108.9, 148.0 and 207.8 mm from 1st through 5th cut, respectively. This variation in evaporation may primarily be

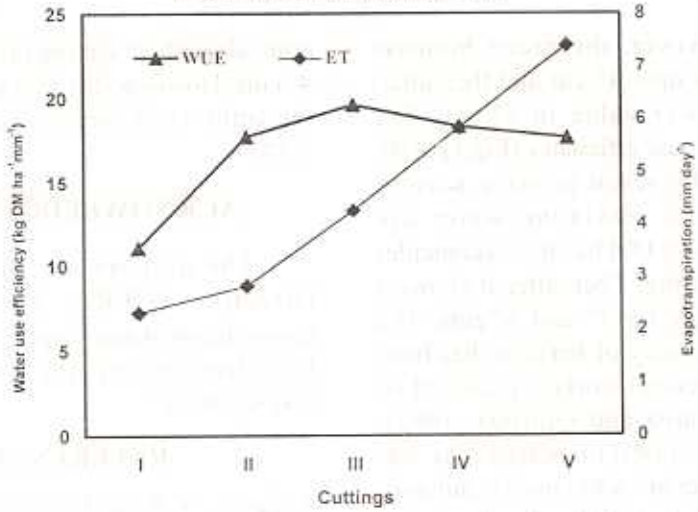


**Fig. 1 :** Water use efficiency (WUE) and evapotranspiration (ET) rate of berseem

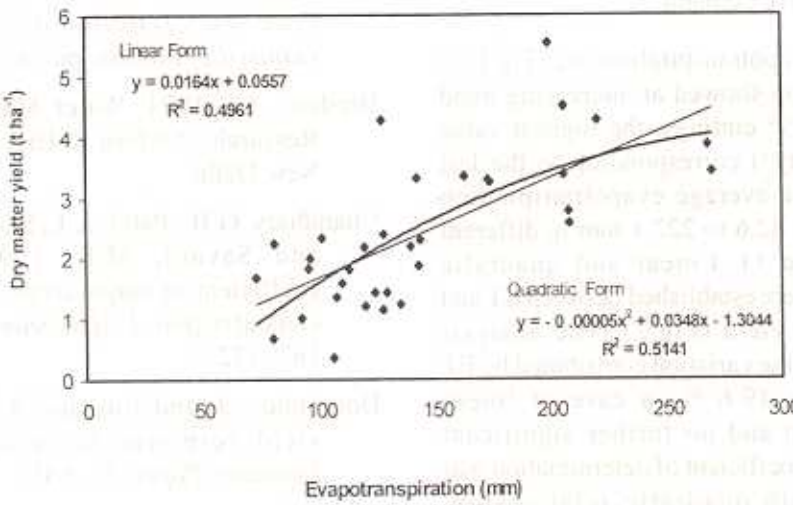


**Fig. 2 :** Relationship between evapotranspiration and dry matter yield of berseem

attributed to weather conditions prevailing during the crop growth period in different years. Doorenbos and Kassam (1986) also recognized climate as one of the important factors determining crop water requirement needed for unrestricted optimum growth and yield.

The total dry matter yield varied from 1.31 to 3.8 t ha$^{-1}$ whereas, the green fodder yield ranged from 12.9 to 18.6 t ha$^{-1}$ during five cuts (Table 1). It is evident from the data that the dry matter yield increased with the advancement of cuttings and a maximum of 3.8 t ha$^{-1}$ was obtained in the

last cut. However, the green biomass increased only upto 4th cut and thereafter, it showed lower value in 5th cut. The estimated water use efficiency (Fig.1) of the crop during the seven growing seasons shows that the maximum water use effciency (19.6 kg DM $ha^{-1}$ $mm^{-1}$) coincides with the 3rd cutting. Thereafter it shows a decreasing value for 4th and 5th cuts. The water use efficiency of berseem has been estimated by several workers (Gaillard *et. al.* 1977; Alvarez and Quiroga, 1992). Williams *et. al.* (1991) reported it as 1.8-2.6 kg dry matter $m^{-3}$ water used in autumn-winter harvest which dropped to an average of 1.3 for the spring harvests with increase in evaporative demand.

The evapotranspiration rate (Fig.1) of berseem crop showed an increasing trend from 1st to 5th cuttings, the highest value (7.4 mm $day^{-1}$) corresponding to the last cutting. The average evapotranspiration varied from 82.6 to 222.1 mm in different cuts (Table 1). Linear and quadratic equations were established between ET and dry matter yield (Fig.2). The analysis reflects that the variation contributed by ET on yield is 49.6 % in case of linear relationship and no further significant increase in coefficient of determination was noticed with quadratic relationship. Gaillard *et. al.* (1977) using lysimeters obtained a quadratic function during the spring months in Algeria.

The crop coefficient values estimated at different cutting stages are presented in Table 2. The crop coefficient value at each cutting stage has crossed the unit value (>1.0). The highest Kc (1.81) was found to coincide with 2nd cutting followed by 3rd and 4th cuts. However, the average Kc value for the entire crop duration was found to be 1.54.

## ACKNOWLEDGEMENTS

The authors are thankful to the Director, IGFRI, Jhansi for his encouragement and support in providing the facilities during the course of this investigation.

## REFERENCES

Alvarez, V.P. and Quiroga, G. 1992. Growth, yield and water use efficiency of berseem clover differently irrigated. Proc. *12th Trifolium Conference, Gainsville,* Florida, pp 74- 75.

Bredero, T.J. 1991. Water Management Research . Oxford & IBH Pub. Co., New Delhi.

Chaudhary, G.B., Patel, K.I., Shekh, A.M. and Savani, M.B. 1999. Crop coefficient of major crops of middle Gujarat region. *J. Agrometeorol.*, 1(2): 167- 172.

Doorenbos, J. and Kassam, A.H. 1986. yield response to water *Irrig. Drainage Paper,* 33, FAO.

Doorenbos, J. and Pruitt, W.C. 1977. Guidelines for predicting crop water requirements. *Irrig. Drainage Paper,* 24, FAO.

Gaillard, B., Legoupil, J.C. and Ruffin, J.C. 1977. Le Bersim ou trefle d' alexandrie fourrage irrigue Mediterraneen dans le haut- cheliff(Algerie). *Agron. Tropical,* 32: 365- 376.

Nathan, K.K. and Sinha, S.K. 1996. Moisture deficit index evaluated for dry regions of India. *Drought Network News*, 8(3): 14- 16.

Shukla, N.P. and Menhi Lal. 1988. Effect of sowing methods and delta of irrigation on forage prodctivity and water use efficiency of berseem. *Haryana J. Agron.*, 4(2): 83- 85.

Shukla, N.P. and Menhi Lal. 1993. Response of berseem varieties to moisture regimes under shallow water table conditions. *Haryana J. Agron.*, 9(2): 153- 156.

Williams, W.A., Graves, W.L., Crassman, K.G., Miller, P.R. and Thomson, G.D. 1991. Water- efficient clover fixes soil nitrogen provides winter forage crops. *California Agriculture*, 45(4): 30- 32.