Status Report VI

Estimation of crop Kc, water and irrigation requirement of *Rabi* Sorghum crop using lysimetric studies

Title of the project	**:**	Determination of crop coefficients for major crops by Lysimetric studies" at Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani.
Location	**:**	Department of Irrigation & Drainage Engineering, College of Agricultural Engineering Research Field, Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani
Duration	**:**	Three years
Total outlay	**:**	Rs. 38.38 lakhs
Investigators	**:**	
Principal Investigator	**:**	**Dr. U. M. Khodke** Associate Dean & Principal College of Agricultural Engineering & Technology VNMKV Parbhani
Co-Principal Investigators	**:**	**1) Dr. H.W. Awari** Head, Deptt. of Irrigation & Drainage Engineering, CAET, VNMKV Parbhani **2) Dr. V.K. Ingle** Assistant Professor, Deptt. of Irrigation & Drainage Engineering, CAET, VNMKV Parbhani
Coordinator for the project		**Dr. S.D. Gorantiwar** PI CAAST-CSAWM and Head, Deptt. of Agril. Engg., MPKV, Rahuri

1. Introduction

This Project is being executed at Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Following activities were undertaken for estimation of crop Kc, water and irrigation requirement for *Rabi* Sorghum crop using lysimetric studies.

1.1 Details of work

The field experiment was planned to determine the crop coefficient of *Rabi* Sorghum crop using Lysimeter. The sowing of Sorghum (CSV-18 Parbhani Jyoti) crop was done on 26th October 2022. Whereas, the harvesting of Sorghum was done on the 7th March 2023. The seed treatment for *Rabi* Sorghum seed was under taken with Rizofos @100 ml per 10kg seed. Table 1 shows various details of sown variety of Sorghum (Parbhani Jyoti).

Details of sown variety of Sorghum (Parbhani Jyoti)

Scientific Name	Sorghum Bicolor
Variety	CSV-18 (Parbhani Jyoti)
Release year	2005
Name of University	Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani
Soil type	Well drained, medium to heavy soils
Climate	Temperate and dry
Sowing Time	1th October to 15th October Duration :125-130 days
Seed rate	10 kg/ha
Productivity	38-40 q/ha
Characters/features	1. This variety has been propagated for irrigation 2. Higher yield of Kadaba 3. Tall growing crop

1.2 Experimental Activity Photo

Plate 1: Sowing of Sorghum crop

Plate 2: Thinning of Sorghum crop

Plate 3: Initial stage of Sorghum crop

Plate 4: Interculture operation in Sorghum crop

Plate 5: Development stage of Sorghum crop

Plate 6: Spraying of insecticide

Plate 7: Weeding operation in Sorghum crop

Plate 8: Harvesting of Sorghum crop

2. Crop Protection Measures for *Rabi* Sorghum

In order to protect the crop from different agents including pests, weeds, plant diseases and other organism, the various insecticide, fungicide and weedicide were used for spraying on *Rabi* Sorghum. Following is the schedule of spraying of pesticide, insecticide, fungicide during growth period of *Rabi* Sorghum crop.

Table 2: Crop Protection Measures in *Rabi* Sorghum

Sr. No	Date of Application	Insecticide/Fungicide/Pesticide	Quantity
1	22/11/2022	Carbofuran 25 STD	20 gm per 10 litre water
2	22/12/2022	0.05% endosulfan 4G	20 ml per 10 litre water
3	28/12/2022	Tafgor Dimetoate 30% EC	20 ml per 10 litre water
4	18/01/2023	Tafgor Dimetoate 30% EC	20 ml per 10 litre water

3. Estimation of Crop Coefficient (Kc) and Reference Evapotranspiration (ETr)

Crop coefficients (Kc) is the ratio of crop evapotranspiration (ETc) to reference crop evapotranspiration (ETr) as given by following equation:

$$Kc = \frac{ETc}{ETr}$$

3.1 Penman Monteith Method

Performance of various estimation methods revealed the need for formulating a standard method for the computation of ETo. The FAO Penman-Monteith method has been recommended as the sole standard method for estimation of ETo. It is a method with strong likelihood of correctly predicting ETo in a wide range of locations (Allen et al., 1998). By defining the reference crop as a hypothetical crop with an assumed height of 0.12 m having a surface resistance of 70 s m^{-1} and an albedo of 0.23, closely resembling the evaporation of an extension surface of green grass of uniform height, actively growing and adequately watered. FAO Penman-Monteith method uses following equation for estimation of ETo.

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u(e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

Where,

ET_O - reference evapotranspiration (mm day^{-1}),
R - net radiation at the crop surface (MJ m^{-2} day^{-1}),
G - soil heat flux density (MJ m^{-2} day^{-1}),
T - mean daily air temperature at 2 m height (°C),
u_2 - wind speed at 2 m height (m s^{-1}),
e_s - saturation vapour pressure (kPa),
e_s - actual va pour pressure (kPa),
$e_s - e_a$ - saturation vapour pressure déficit (kPa),
Δ - slope vapour pressure curve (kPa $°C^{-1}$),
γ - psychrometric constant (kPa $°C^{-1}$).

Phule Jal mobile app, developed by the Mahatma Phule Krishi Vidhyapeeth, Rahuri under the RKVY project on Irrigation Water Requirement Service was used for the estimation of the reference crop evapotranspiration by the Penman Monteith method.

4. Crop Coefficients (Kc) for *Rabi* Sorghum

The crop coefficient Kc, an important item for evaluating crop evapotranspiration is defined as the ratio of actual crop evapotranspiration to reference crop evapotranspiration. Weighing lysimeters measure crop water used by measuring the change in mass of an isolated volume of soil. While irrigation and precipitation, add water and increase the weight of soil voilume, drainage and ET removes water therefore decrease lysimeter weight

Steps for computing of Kc include determination of total growing period of the crop and determination of Kc values for each growth stage. The growing period was divided into four distinct growth stages; initial, development, mid and late-season.

4.1 Actual crop evapotranspiration (ETc)

Actual evapotranspiration under standard conditions denoted as ETc is the evapotranspiration under optimum soil water conditions and achieving full production under the given climatic conditions. The meteorological week wise evapotranspiration of *Rabi* Sorghum is

estimated and presented in Table 3. The mean actual evapotranspiration of *Rabi* Sorghum was recorded between 2.1 to 7.8 mm. From the Table 3, it is found that crop water needs are generally low during the initial growth stages but increases exponentially during the vegetative phases and then again decreases during flowering and fruiting stages.

4.2 Reference evapotranspiration (ETo)

Reference evapotranspiration (ETo) is commonly computed from weather data since, the direct measurements are often expensive. The daily ETo estimated using meteorological data was converted into week wise reference evapotranspiration. Weekly estimation of reference evapotranspiration (ETo) is presented in Table 3. Data presented in Table 3 show that ETo ranges from 4.0 to 8.2 mm/day for *Rabi* Sorghum. Reference evapotranspiration increased with respect to change in climate.

Table 3: Weekly lysimetric crop coefficient (Kc) values for *Rabi* Sorghum

Crop Week	ETc (mm/day)	ET_o (mm/day)	Average Kc	Crop Growth stages	Stage wise Kc values
1	3.0	8.2	0.4	Initial (20 Days)	0.4
2	2.1	5.2	0.4		
3	2.1	4.7	0.4		
4	3.6	7.1	0.5	Development (35 days)	0.6
5	3.8	6.8	0.6		
6	3.9	6.3	0.6		
7	4.2	5.5	0.8		
8	7.0	7.9	0.9		
9	7.8	7.5	1	Mid (45 days)	1.2
10	7.5	6.3	1.2		
11	5.1	4	1.3		
12	5.7	4.4	1.3		
13	5.4	4.5	1.2		
14	5.2	4.7	1.1		
15	4.6	4.6	1	End (20days)	0.7
16	3.7	4.4	0.8		
17	4.2	5.8	0.7		
18	2.9	4.6	0.6		
19	2.4	4.6	0.5		

The computed Kc values for *Rabi* Sorghum during initial, develoement, mid and end stages were 0.4, 0.6, 1.2 and 0.7 respectively. The maximum Kc value was found during mid season stage and lowest was found during intial stages. Fig. 1 represents the weekly lysimetricKc curve during crop growth period of *Rabi* Sorghum.

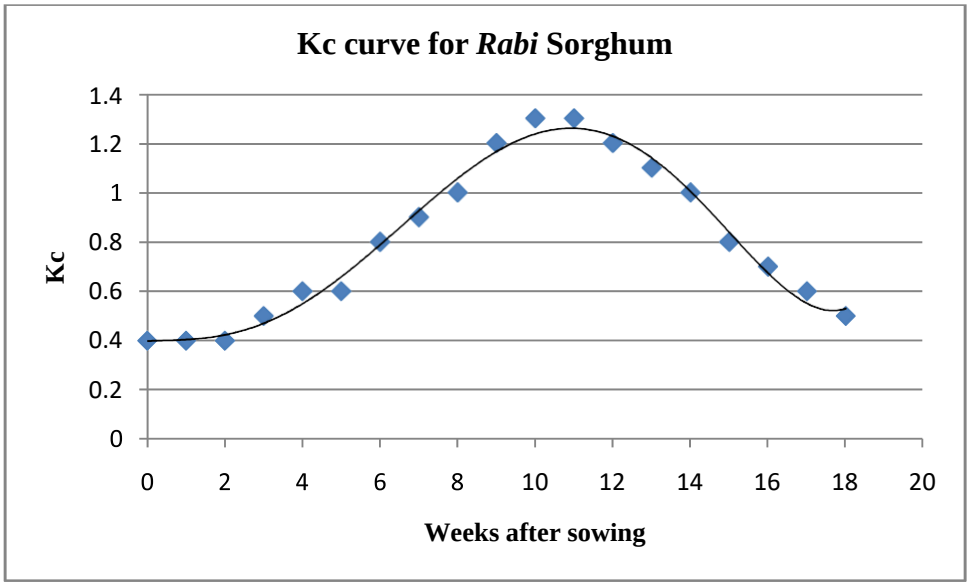

Fig.1: Weekly lysimetric Kc curve of *Rabi* Sorghum during crop growth period

5. Yield data of *Rabi* Sorghum

Table 4: Yield of *Rabi* Sorghum in Lysimeter 2 and field plots

Particular	Yield per unit area
Lys.2	21.75 q/ha
Field Plot 1	17.22 q/ha
Field Plot 2	17.26 q/ha

6. Irrigation water requirement using lysimetric Kc values for *Rabi* Sorghum for Marathwada region

In present, the estimation of crop Kc (lysimetric), water and irrigation requirement by different irrigation practices for *Rabi* Sorghum based on lysimetric Kc was calculated for ignoring effective rainfall by Surface irrigation at 60, 50 and 40%, Sprinkler irrigation at 85 and 80%; and Drip irrigation at 95and 90% system efficiency for all tehsils of Marathwada region.

The details of taluka wise irrigation water requirement for *Rabi* Sorghum are given in **Annexure I.**

Investigators:

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