Status Report VII

Estimation of crop Kc, water and irrigation requirement of Second year *Summer* Groundnut and Okra 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 Second year *Summer* Groundnut and Okra crop using lysimetric studies.

1.1 Details of work

The field experiment was planned to determine the crop coefficient of *Summer* Groundnut and Okra crop using Lysimeter. The sowing of groundnut (TAG-24) and Okra crop (Parbhani Kranti) was done on 6th February 2023 and 24th March 2023. The seed treatment for *Summer* Groundnut and Okra seed was under taken with Rhizobium @ 250 gm / 10 kg. Drip irrigation was used for irrigating the crops considering the reference evapotranspiration. Table 1 sows details of sown variety of Okra crop.

Table 1: Details of sown variety of Okra (Parbhani Kranti)

Scientific Name	Abelmoschus Esculentus
Variety	Parbhani Krani
Release year	2013
Name of University	Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani
Soil type	Well drained, medium to heavy soils
Climate	20-40^{o}C temperature good for well germination of seeds
Sowing Time	Kharif :June-July Summer: January-February
Duration	95 days
Seed rate	Kharif :8-10 kg/ha Summer :10-12 kg/ha
Productivity	92.30 q/ha
Characters/features	1. Beneficial for cultivation in monsoon and summer season 2. Fruits are medium in green color with five veins 3. The variety is moderately resistant to yellow virus disease and fruit borer

1.2 Experimental Activity Photo

The various field operations were conducted during and after the sowing of the *Summer* Groundnut and Okra crop (Plate1-Plate 8).

Plate 1: Preparation of land for groundnut sowing

Plate 2: Sowing of groundnut seeds

Plate 3: Spraying of Pre-emergence weedicide after sowing of groundnut

Plate 4: Growing of Groundnut in lysimeter

Plate 5: Sowing of Okra crop

Plate 6: Spraying of insecticide over Okra crop

Plate 7: Field visit of Co-Principal Investigator Dr. H. W. Awari, Dr. V. K. Ingle

Plate 8: Lysimetric view of Okra crop field

2. Crop Protection Measures for *Summer* Groundnut and Okra

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 *Summer* Groundnut and Okra. Following is the schedule of spraying of pesticide, insecticide, fungicide during growth period of *Summer* Groundnut and Okra crops (Table 2 and 3).

Table 2: Crop Protection Measures in *Summer* Groundnut

Sr.No	Date of Application	Insecticide/Fungicide/Pesticide	Quantity
1	08/02/2022	Supremo Gold (Diclosulam 84%w/w WDG)	5gm / 10 lit.water
3	19/02/2022	Tatamida (Imidachloprid 17.8% SL)	10 ml / 10 lit. water
4	19/02/2022	Fungigaurd (Carbendazim 50% WP)	3gm / 10 lit. water

Table 3: Crop Protection Measures in *Summer* Okra

Sr.No	Date of Application	Insecticide/Fungicide/Pesticide	Quantity
1	17/04/2022	Tatamida (Imidachloprid 17.8% SL)	10 ml / 10 lit.water
2	25/04/2022	Tata Surplus(Liquid Micronutrient Grade-2)	10ml / 10 lit. water
3	10/05/2022	Sefina Insecticide (Afidopyrogen)	15ml / 10 lit. water
4	20/05/2023	Omite Insecticide (Propargite 57%EC)	10ml/10 lit.water

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

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

$$Kc = \frac{ETc}{ETr} \qquad \ldots\ldots. (1)$$

The weekly values of crop coefficients were computed as the ratio of weekly crop evapotranspiration and reference evapotranspiration. Weekly crop evapotranspiration data was obtained from the lysimeters by growing the crop in lysimeters. Two lysimeters was used for this

purpose and the crop evapotranspiration values were measured for both the lysimeters and the ETc values were averaged over both the lysimeters to avoid errors in measurements. Penman Monteith method was used to estimate the reference crop evapotranspiration.

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.

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u(e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)} \text{ ---------- (2)}$$

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 *Summer* Groundnut

The crop coefficient (Kc), an important item for evaluating crop evapotranspiration id defined as the ratio of actual crop evapotranspiration and reference crop evapotranspiration. To calculate weekly reference evapotranspiration, the meteorological data of maximum and minimum temperature, wind speed, relative humidity and solar radiation was recorded from Automatic Weather Station (AWS) installed at PoCRA experimental field, CAET, VNMKV, Parbhani. For summer Groundnut, two lysimeters (L1 & L2) were used to calculate crop coefficient value.

4.1 Actual crop evapotranspiration (ETc)

The daily actual evapotranspiration (ETc) was converted to average mean value of evapotranspiration for every meteorological week during the crop growth period. The meteorological week wise evapotranspiration of *Summer* Groundnut is estimated and presented in Table 4. The mean actual evapotranspiration of *Summer* Groundnut was recorded between 1.92 to 8.91 mm. From the Table 4, it is found that crop water requirement was lowest during initial stages and highest during mid-stage of crop growth period.

4.2 Reference evapotranspiration (ETr)

The daily reference evapotranspiration was converted into week wise average reference evapotranspiration (Table 4). Data presented in Table 4, show that ETo ranges from 3.19 to 11.06 mm/day for *Summer* Groundnut. Reference evapotranspiration increased with respect to change in climate during summer season. The maximum reference evapotranspiration shows there is increase in water requirement. This shows that the crop water requirement is increased from of February to May due to changes in climate.

The computed Kc values for *Summer* Groundnut during initial, development, mid and end stages were 0.59, 0.64, 0.95 and 0.47, respectively. The maximum values of crop coefficient were estimated during mid-stage mainly because of higher canopy. Fig. 1 represents the weekly lysimetric Kc curve during crop growth period of *Summer* Groundnut.

Data presented in Table 4 represents weekly lysimetric crop coefficient values for *Summer* Groundnut.

Table 4: Weekly lysimetric crop coefficient (Kc) values for *Summer* Groundnut

Crop Week	ETc (mm/day)	ET_o (mm/day)	Kc (L1)	Kc(L2)	Average Kc	Crop Growth stages	Stage wise Kc values	FAO Kc values
1	1.92	4.92	0.35	0.37	0.36	Initial (20 Days)	0.59	0.38-0.56
2	3.1	6.29	0.48	0.49	0.48			
3	1.94	3.19	0.6	0.62	0.61			
4	2.97	4.67	0.62	0.63	0.63	Development (35 days)	0.64	0.68-1.03
5	3.82	6.33	0.59	0.61	0.6			
6	3.68	5.65	0.63	0.63	0.63			
7	4.67	6.71	0.67	0.68	0.68			
8	5.88	8.57	0.66	0.67	0.67			
9	5.97	6.54	0.9	0.92	0.9	Mid (45 days)	0.95	1.11-1.04
10	8.91	7.36	1.2	1.2	1.2			
11	7.1	6.54	1.08	1.08	1.08			
12	4.42	5.44	0.81	0.81	0.81			
13	3.4	4.27	0.8	0.81	0.8			
14	4.55	8.58	0.55	0.56	0.56	End (20days)	0.47	0.94-0.81
15	4.15	9.96	0.4	0.42	0.41			
16	4.7	11.06	0.43	0.42	0.43			

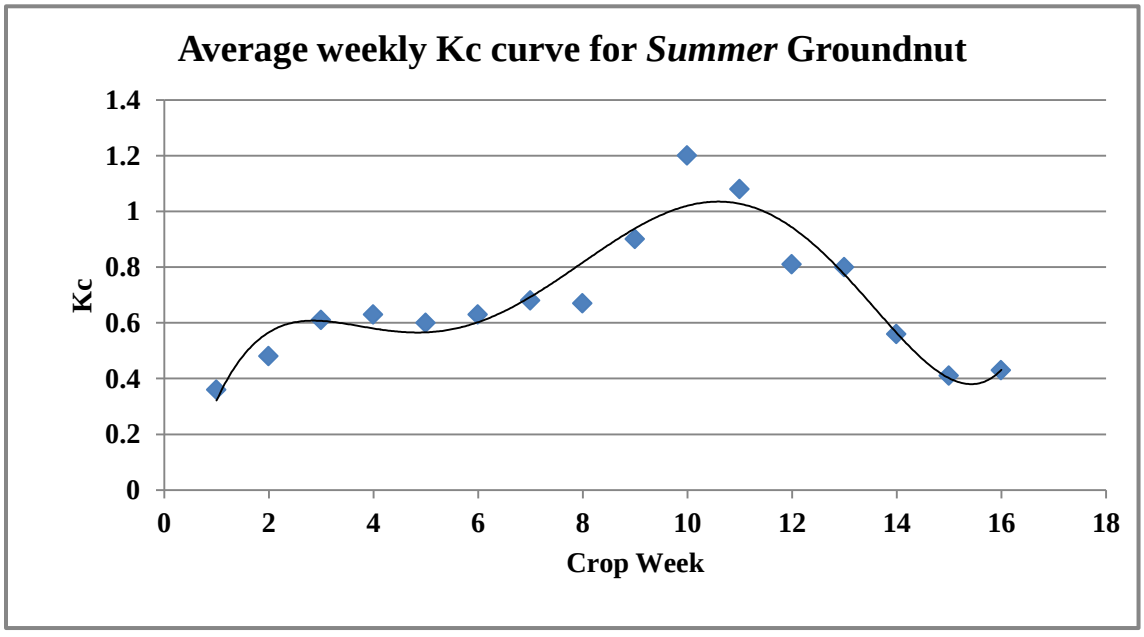

Fig. 1: Weekly lysimetric Kc curve of *Summer* Groundnut during crop growth period

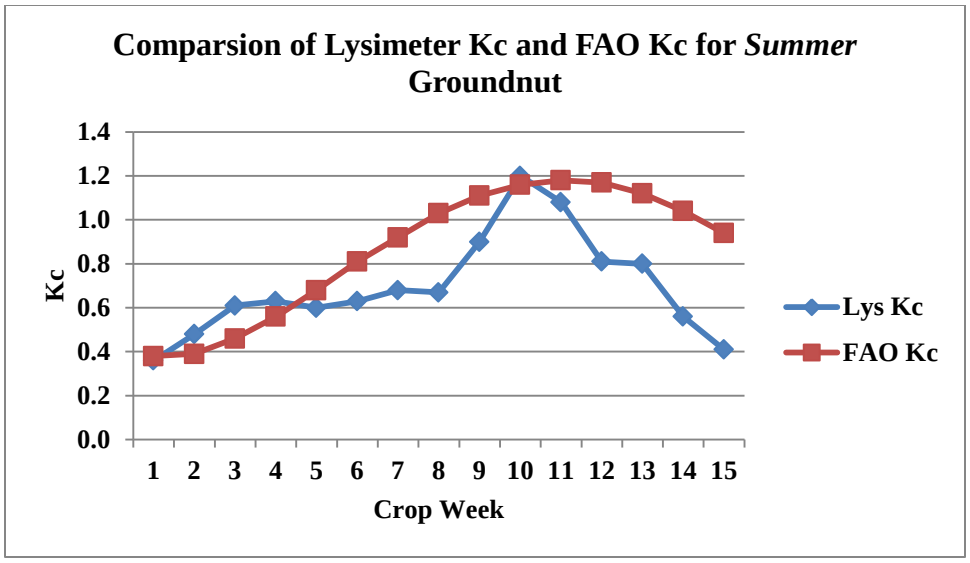

Fig. 2: Comparison between lysimetric Kc and FAO Kc for *Summer* Groundnut

5. Crop Coefficients (Kc) for *Summer* Okra

Crop coefficients (Kc) are properties of plants used in predicting evapotranspiration. The Kc values represent the crop type and the development of the crop. For *Summer* Okra, one lysimeter (L3) was used to calculate crop coefficient value (Kc).

5.1 Actual crop evapotranspiration (ETc)

The daily actual evapotranspiration (ETc) was converted to average mean value of evapotranspiration for every meteorological week during the crop growth period. The meteorological week wise evapotranspiration of *Summer* Okra is estimated and presented in Table 5. The mean actual evapotranspiration of *Summer* Okra was recorded between 4.0 to 17.2 mm. From the Table 5, it is found that crop water requirement was lowest during initial stages and highest during mid-stage of crop growth period.

5.2 Reference evapotranspiration (ETr)

The daily reference evapotranspiration was converted into week wise average reference evapotranspiration (Table 5). Data presented in Table 5, show that ETo ranges between 4.3 mm to 11.7 mm/day for *Summer* Okra. The maximum reference evapotranspiration was recorded in month of April and May. Fig. 2 represents comparative performance of week wise recorded actual evapotranspiration (ETc) and reference evapotranspiration (ETo) *Summer* Okra.

For *Summer* Okra, the crop coefficients are found to be 0.67, 1.10, 1.42 and 0.7 during seedling, pod development, mid-stage and maturity stages, respectively. The average Kc value was low during seedling stage due to low canopy cover, indicating that major loss may constitute through evaporation from bare soil, attained maximum value at flowering to pod development stage due to maximum water loss by greater transpiring surface as a consequence of rapid leaf development. Data presented in Table 5 represents weekly lysimetric crop coefficient values for *Summer* Okra.

Fig. 3 represents the weekly lysimetric Kc curve during crop growth period of *Summer* Okra.

Table 5: Weekly lysimetric crop coefficient (Kc) values for *Summer* Okra

Crop Week	ETc (mm/day)	ET_0	Weekly Kc by lysimeter 3	Crop Growth stages	Stage-wise Kc values	FAO Kc values
1	4.0	6.4	0.6	Initial (20 Days)	0.67	0.60
2	6.1	8.9	0.7			
3	4.5	6.4	0.7			
4	5.2	6.4	0.8	Development (35 days)	1.10	0.6-1.10
5	6.2	6.6	0.9			
6	4.8	4.3	1.1			
7	6.1	4.8	1.3			
8	15.5	11.5	1.4			
9	13.8	9.7	1.4	Mid (45 days)	1.35	1.10
10	17.2	11.7	1.5			
11	12.8	8.8	1.5			
12	11.8	8.5	1.4			
13	9.7	7.3	1.3			
14	4.2	4.4	1.0			
15	4.1	5.6	0.7	End (20days)	0.7	1.10-0.90
16	3.7	6.2	0.6			
17	3.9	6.3	0.6			

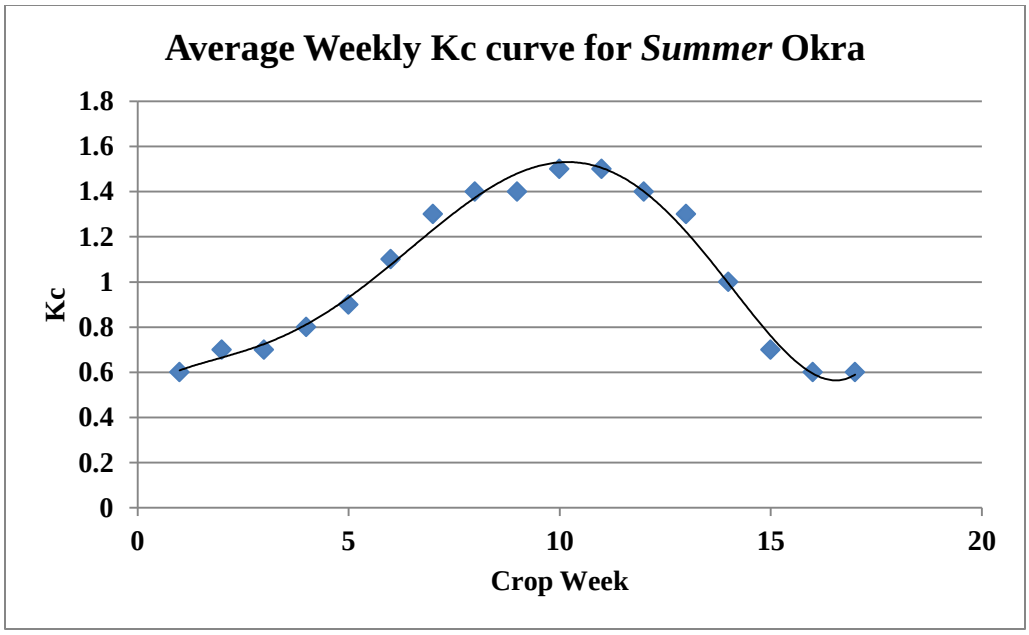

Fig. 3: Weekly lysimetric Kc curve of *Summer* Okra during crop growth period

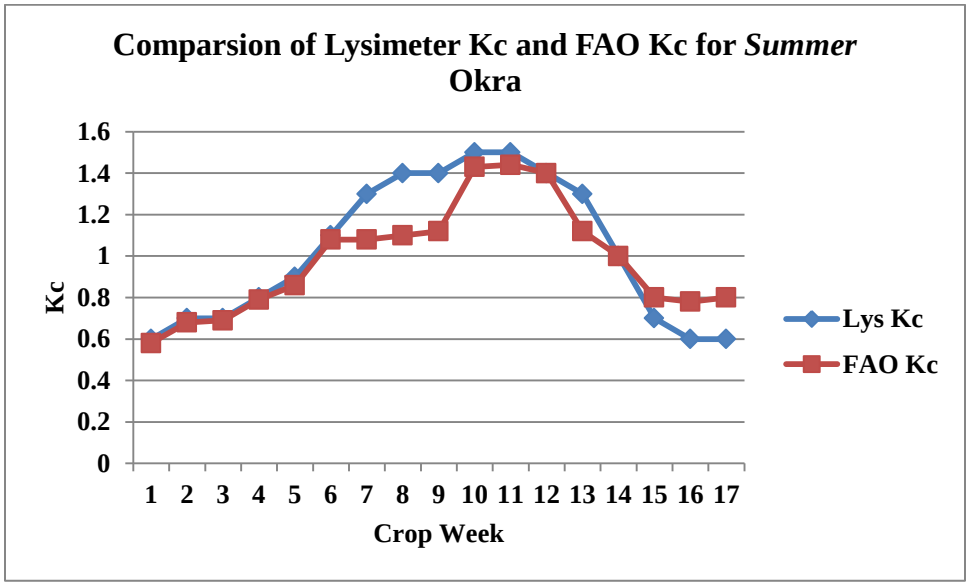

Fig. 4: Comparison between lysimetric Kc and FAO Kc for *Summer* Okra

6. Yield data of *Summer* Groundnut

Table 6: Yield data of *Summer* Groundnut in Lysimeter 1 &2 and field plots

Particulars	Dry pod Yield ($q\ ha^{-1}$)
Lys-1	18.45
Lys-2	17.52
Fp- 1	16.25
Fp-2	15.79

7. Yield data of *Summer* Okra

Table 7: Yield of *Summer* Okra in Lysimeter 3 and field plots

Particulars	No. of fruits per plant	Average weight of fruits/plant (gm)
Lys.3	12.6	123.76
Fp-1	10.06	105.62
Fp-2	9.84	107.14

8. Irrigation water requirement using lysimetric Kc values for Second year *Summer* Groundnut and Okra for Marathwada region

In present, the estimation of crop Kc (lysimetric), water and irrigation requirement by different irrigation practices for Second year *Summer* Groundnut and Okra 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 talukawise irrigation water requirement for Second year *Summer* Groundnut and Okra are given in **Annexure I and II** respectively.

Investigators:

Dr. V. K. Ingle **Co-Principal Investigator :**

Dr. H.W. Awari **Co-Principal Investigator :**

Dr. U. M. Khodke **Principal Investigator :**