Phase VII
Comprehensive Report
on

Crop Kc, Water Requirement of Summer Greengram and Summer Sesame

for

Project on;

"Determination of Crop Coefficients for Major Crops by Lysimetric Studies"

at

DEPARTMENT OF IRRIGATION AND DRAINAGE ENGINEERING,
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AKOLA- 444104 (MAHARASHTRA)

Phase VII

Comprehensive Report on Crop Kc, Water Requirement of Summer Greengram and Summer Sesame

"Determination of crop coefficients for major crops by Lysimetric studies"

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

Title of the Project: Determination of crop coefficients for major crops by Lysimetric studies" at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

Location: **Department of Irrigation and Drainage Engineering, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola.**

Duration: **Three years.**

Total outlay: **Rs. 38.38 lakhs.**

Investigators:

Principal Investigator	:	Dr. M.M. Deshmukh, Associate Professor and Head, Department of Irrigation and Drainage Engineering Dr. PDKV, Akola.
Co-Principal Investigator	:	Dr. A.N. Mankar, Assistant Professor, Department of Irrigation and Drainage Engineering Dr. PDKV, Akola.
Coordinator for the project for three universities **(MPKV, Rahuri; Dr PDKV, Akola and VNMKV, Parbhani)**	:	Dr. S.D. Gorantiwar, PI CAAST-CSAWM and Head, Deptt. of Agril. Engg., MPKV, Rahuri.

INTRODUCTION:

The Project is being executed at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. As per schedule of reporting requirements, following are the details for the fulfillment "Comprehensive Report on Crop Kc, Water Requirement of Summer Greengram and Summer Sesame".

Summer greengram and summer sesame crops for the summer season of year 2022 and 2023 were cultivated inside and around the lysimeters to determine to crop coefficient values.

COMPREHENSIVE (Average of 2022 and 2023) CROP COEFFICIENTS (Kc) FOR SUMMER GREENGRAM:

The weekly crop coefficient values were computed as the ratio of weekly crop evapotranspiration and weekly reference evapotranspiration. Weekly crop evapotranspiration was obtained from lysimeters by growing crop in lysimeters. For summer greengram, two lysimeters were used and the crop coefficient values were measured for both lysimeters. The crop coefficient values obtained from both lysimeters were averaged to avoid errors in the measurement. The weekly crop coefficient values obtained from both lysimeters of summer greengram for summer season of 2022 and 2023 were averaged to get more precise Kc values which are represented in table 1.

Table 1. Average weekly crop coefficient (Kc) values for summer greengram

Crop Week	t/T	Weekly Kc Values			Stagewise Days	Stagewise Kc Values		
		2022	2023	Average		2022	2023	Average
1	0.09	0.59	0.53	0.56	Initial (15 Days)	0.57	0.60	0.59
2	0.18	0.64	0.65	0.65				
3	0.27	0.74	0.79	0.77	Deve. (25 Days)	0.96	0.98	0.97
4	0.36	0.86	0.93	0.90				
5	0.45	1.00	1.06	1.03	Mid (25 Days)	1.17	1.16	1.16
6	0.55	1.11	1.16	1.13				
7	0.64	1.19	1.21	1.20				
8	0.73	1.22	1.20	1.21				
9	0.82	1.16	1.13	1.15	End (12 Days)	0.81	0.78	0.80
10	0.91	1.02	0.96	0.99				
11	1.00	0.75	0.70	0.72				

The comprehensive average weekly Kc values for summer greengram for the growing period of 11 weeks were found 0.56, 0.65, 0.77, 0.90, 1.03, 1.13, 1.20, 1.21, 1.15, 0.99 and 0.72 respectively. Whereas, comprehensive average stage wise Kc values for initial (15 Days), development (25 Days), mid (25 Days) and end stage (12 Days) were 0.59, 0.97, 1.16 and 0.80 respectively. The highest values of crop coefficients were found during the mid-season stage which may be due to the higher canopy during mid stage. Figure 1 shows the comparison between weekly crop coefficient values obtained using lysimeter for summer greengram for season 2022 and 2023.

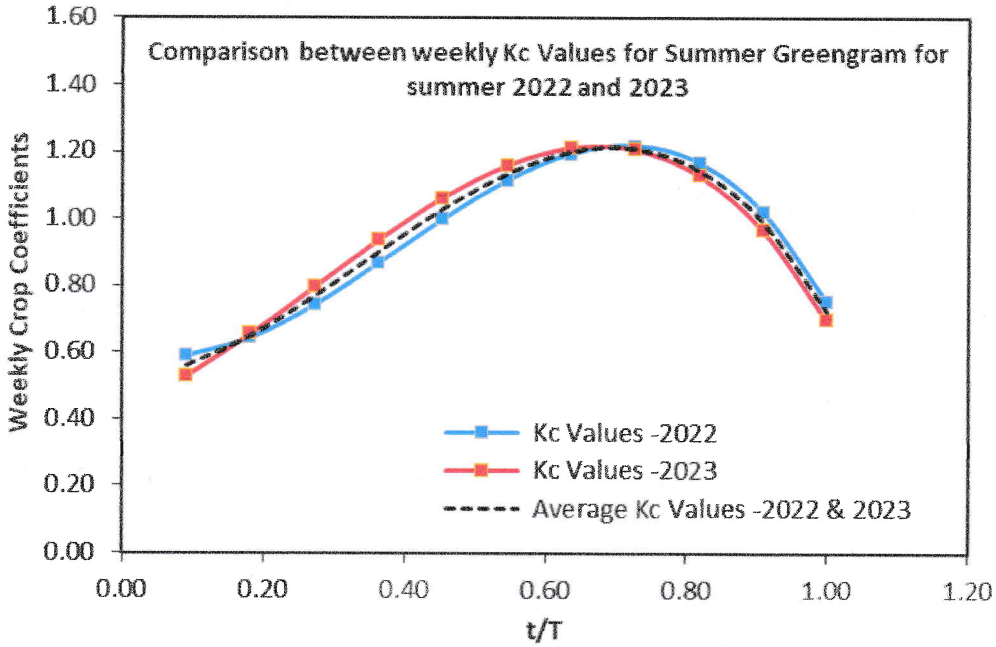

Figure 1. Comparison between weekly Kc values for summer greengram for summer season of 2022 and 2023

Equation No. 1 given below is polynomial equation obtained for comprehensive average weekly K_c values for summer greengram against 't/T' to derive daily K_c values.

$$Kc_t = -3.8882\left(\frac{t}{T}\right)^3 + 3.9756\left(\frac{t}{T}\right)^2 + 0.1172\left(\frac{t}{T}\right) + 0.5182 \quad \text{.....(1)}$$

COMPREHENSIVE (Average of 2022 and 2023) CROP COEFFICIENTS (Kc) FOR SUMMER SESAME:

The weekly crop coefficient values were computed as the ratio of weekly crop evapotranspiration and weekly reference evapotranspiration. For summer sesame, only one lysimeter was used. The weekly crop coefficient values obtained from lysimeter of summer sesame for summer season of 2022 and 2023 were averaged to get more precise Kc values which are represented in table 2.

The comprehensive average weekly Kc values for summer sesame for the growing period of 17 weeks were found 0.43, 0.55, 0.68, 0.81, 0.93, 1.05, 1.15, 1.23, 1.28, 1.30, 1.29, 1.23, 1.12, 0.97, 0.77, 0.57 and 0.47 respectively. Whereas, comprehensive average stage wise Kc values for initial (20 Days), development (30 Days), mid (42 Days) and end stage (15 Days) were 0.55, 1.00, 1.22 and 0.68 respectively. The highest values of crop coefficients were found during the mid-season stage which may be due to the higher

canopy during mid stage. Figure 2 shows the comparison between weekly crop coefficient values obtained using lysimeter for summer sesame for season 2022 and 2023.

Table 2. Average weekly crop coefficient (Kc) values for summer sesame

Crop Week	Weekly Kc Values						Stagewise Days	Stagewise Kc Values		
	t/T	2022	t/T	2023	t/T	Average		2022	2023	Average
1	0.06	0.43	0.07	0.44	0.06	0.43	Initial (20 Days)	0.55	0.54	0.55
2	0.12	0.54	0.13	0.56	0.12	0.55				
3	0.19	0.67	0.20	0.69	0.19	0.68				
4	0.25	0.80	0.26	0.82	0.25	0.81	Deve. (30 Days)	0.99	1.02	1.00
5	0.31	0.93	0.33	0.94	0.31	0.93				
6	0.37	1.05	0.39	1.06	0.37	1.05				
7	0.43	1.15	0.46	1.15	0.43	1.15				
8	0.50	1.23	0.52	1.23	0.50	1.23	Mid (42 Days)	1.21	1.23	1.22
9	0.56	1.29	0.59	1.28	0.56	1.28				
10	0.62	1.31	0.65	1.29	0.62	1.30				
11	0.68	1.31	0.72	1.26	0.68	1.29				
12	0.75	1.27	0.79	1.19	0.75	1.23				
13	0.81	1.19	0.85	1.06	0.81	1.12				
14	0.87	1.07	0.92	0.87	0.87	0.97	End (15 Days)	0.69	0.67	0.68
15	0.93	0.91	0.98	0.62	0.93	0.77				
16	0.97	0.71	1.00	0.43	0.97	0.57				
17	1.00	0.47			1.00	0.47				

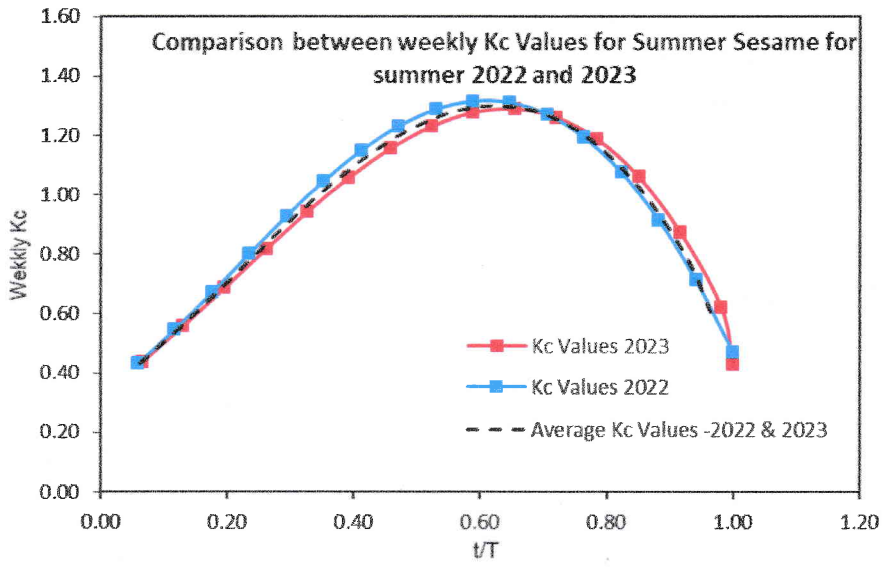

Figure 2. Comparison between weekly Kc values for summer sesame for summer season of 2022 and 2023

Equation No. 2 given below is polynomial equation obtained for comprehensive average weekly K_c values for summer sesame against 't/T' to derive daily K_c values.

$$Kc_t = -3.7933\left(\frac{t}{T}\right)^3 + 2.2841\left(\frac{t}{T}\right)^2 + 1.6237\left(\frac{t}{T}\right) + 0.3229 \quad \ldots\ldots(2)$$

Comparison between Lysimetric and FAO Modified Kc values for Summer Greengram:

Average lysimetric Kc values for the year 2022 and 2023 were found as 0.59, 0.97, 1.16 and 0.80 for initial, development, midseason and late season stages of summer greengram respectively. Whereas the FAO modified Kc values are 0.56, 0.96, 1.12 and 0.83 for initial, development, mid-season and late season stage. Table 3 shows the comparison between comprehensive average lysimetric kc values and FAO modified Kc values for summer greengram.

Table 3. Comparison between average lysimetric and FAO modified Kc values for summer greengram

Growth Stages	Average Lysimetric Kc (2022 &2023)	FAO Kc	FAO modified Kc
Initial season stage	0.59	0.4	0.56
Development Stage	0.97	-	0.96
Mid-season stage	1.16	1.05	1.12
Late season stage	0.80	0.6	0.83

Figure 3 shows the comparison between comprehensive average weekly Kc values obtained from lysimetric and FAO modified K_c values for summer greengram.

The polynomial equation (3) obtained for FAO modified Kc values for summer greengram is as follow;

$$Kc_t = -4.8077\left(\frac{t}{T}\right)^5 + 15.953\left(\frac{t}{T}\right)^4 - 21.272\left(\frac{t}{T}\right)^3 + 10.868\left(\frac{t}{T}\right)^2 - 0.5872\left(\frac{t}{T}\right) + 0.516$$

$$\ldots\ldots\ldots(3)$$

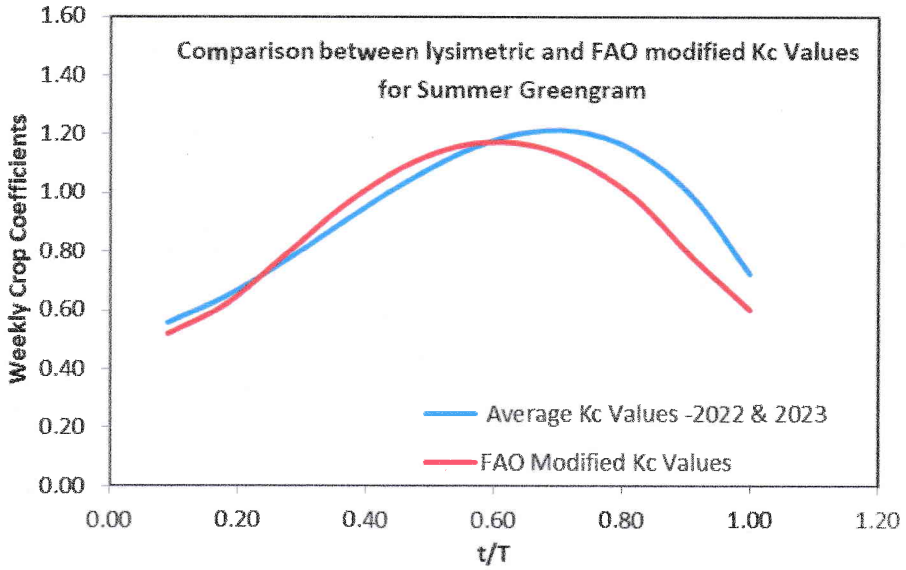

Figure 3. Comparison between average lysimetric (2022 and 2023) and FAO modified Kc values for summer greengram

Comparison between Lysimetric and FAO Modified Kc values for Summer Sesame:

Average Lysimetric Kc values for the year 2022 and 2023 were found as 0.55, 1.00, 1.22 and 0.68 for initial, development, midseason and late season stages of summer sesame respectively. Whereas the FAO modified Kc values are 0.61, 0.90, 1.21 and 0.74 for initial, development, mid-season and late season stage. Table 4 shows the comparison between comprehensive average lysimetric kc values and FAO modified Kc values for summer sesame.

Table 4. Comparison between lysimetric and FAO modified Kc values for summer sesame

Growth Stages	Average Lysimetric Kc (2022 &2023)	FAO Kc	FAO modified Kc
Initial season stage	0.55	0.35	0.61
Development stage	1.00	-	0.90
Midseason stage	1.22	1.10	1.21
Late season stage	0.68	0.25	0.74

Figure 4 shows the comparison between polynomial curves obtained from lysimetric and FAO modified K_c values for summer sesame.

The polynomial equation (4) obtained for FAO modified Kc values for summer sesame is as follow;

$$Kc_t = 2.2581\left(\frac{t}{T}\right)^4 - 8.8507\left(\frac{t}{T}\right)^3 + 6.3618\left(\frac{t}{T}\right)^2 - 0.0535\left(\frac{t}{T}\right) + 0.5663 \quad \text{.....(4)}$$

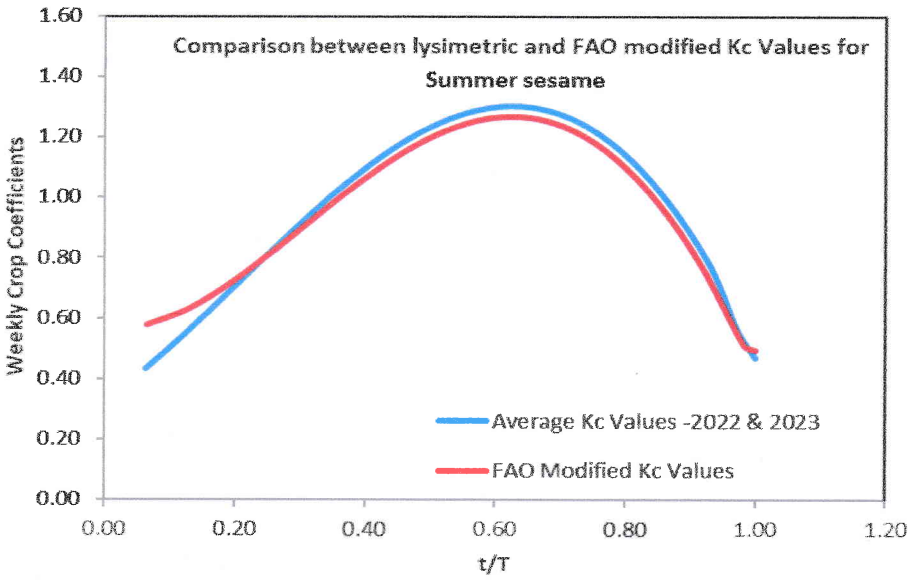

Figure 4. Comparison between lysimetric and FAO modified Kc values for summer sesame

WATER REQUIREMENT FOR SUMMER GREENGRAM AND SUMMER SESAME CROPS:

Taluka wise weekly crop water requirement was determined using comprehensive average lysimetric Kc values obtained during Summer-2022 and 2023 for summer greengram and summer sesame by ignoring the effective rainfall for tehsils in Vidarbha region. Also the irrigation water requirement was determined by considering the crop water requirement at different irrigation efficiencies. It was calculated for surface irrigation at 40%, 50% and 60% irrigation efficiency, for drip irrigation at 90% and 95% irrigation efficiency and for sprinkler irrigation at 80% and 85% irrigation efficiency. The taluka wise water requirement for summer greengram and summer sesame is given in Annexure I and II respectively for above mentioned irrigation efficiencies.

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