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Evapotranspiration and heat unit requirement of cowpea

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सार – भारात्मक माप करने वाले लाइसीमीटरों का उपयोग करते हुए लोबिया की फसल से होने वाले वास्तविक वाष्पोत्सर्जन की मात्रा को मापने के लिए वर्ष 2004 एवं 2005 में खरीफ की फसल के दौरन दो वर्षों तक प्रयोग किए गए हैं। लोबिया की बुआई के बाद फसल गुणांक का सप्ताह के साथ एक बहुगुण समाश्रयण समीकरण तैयार किया गया है। इसकी बुआई के छठे सप्ताह में फसल गुणांक का उच्चतम मान 1.015 पाया गया है। बंगलूरू की जलवायु में लोबिया की फसल में वास्तविक वाष्पोत्सर्जन के औसत मान तथा खरीफ ऋतु में 89 दिनों की अवधि के दौरान ताप इकाई की आवश्यकताएँ क्रमशः 284.8 मि. मी. तथा 1293 डिग्री दिवस पाए गए हैं।

ABSTRACT. Weighing gravimetric lysimeters are used to measure actual evapotranspiration of cowpea for an experiment conducted for two years during Kharif 2004 and 2005. A multiple regression equation has been generated for relating crop coefficient of cowpea with week after sowing. The highest value of crop co-efficient was found to be 1.015 on 6th week after sowing under Bangalore climate, the average values of actual evapotranspiration from cowpea crop and heat unit requirements over a period of 89 days in the Kharif season are found to be 284.8 mm and 1293 degree days respectively.

Key words – Cowpea, Actual ET, Crop coefficients, Heat units.

1. Introduction

Water is a limiting factor of agricultural production especially in the semi arid tropics of world. Consequently, all irrigation water use needs to be optimised. Currently, actual crop water requirements for many crops, detailed by phenological stage, are not available and many producers often apply significantly more or less irrigation water than the crop requirement. Therefore improved estimates of actual evapotranspiration are a prerequisite for optimal irrigation scheduling (Doorenbos and Pruitt, 1977; Doorenbos and Kassam 1979). By relating the required water use of a specific crop to a potential evapotranspiration, crop coefficients can be determined to assist in predicting irrigation needs using meteorological data.

The seeds of cowpea (*Vigna Unguiculata L. Walp*) are used for human consumption whereas the whole plant is used as fodder for livestock. Water stress at flowering stage reduces the seed yield by 44% and at pod filling stage by 29% respectively (Labanauskas *et al*., 1981; Turk *et al*., 1980). Ramana Rao *et al*., (1984) reported that the crop yield of cowpea was influenced by water availability at reproductive stage.

The present study is aimed to determine the crop coefficient for cowpea with time and relating crop coefficient with heat units called growing degree days.

2. Data and methodology

A field experiment on cowpea was conducted at GKVK campus, University of agricultural sciences, Bangalore, at latitude 12° 58′ N, longitude 77° 35′ E and 930 m above sea level during Kharif seasons 2004 and 2005. The crop was raised on red sandy loam soils following the recommended package of practices of University of agricultural sciences, Bangalore. The crop coefficient (K_c) was calculated as the ratio of the actual evapotranspiration (AET) to the potential evapotranspiration (PET). The actual evapotranspiration (AET) was measured through gravimetric lysimeters located in the crop field. Potential evapotranspiration (PET) values were obtained using Penman's modified

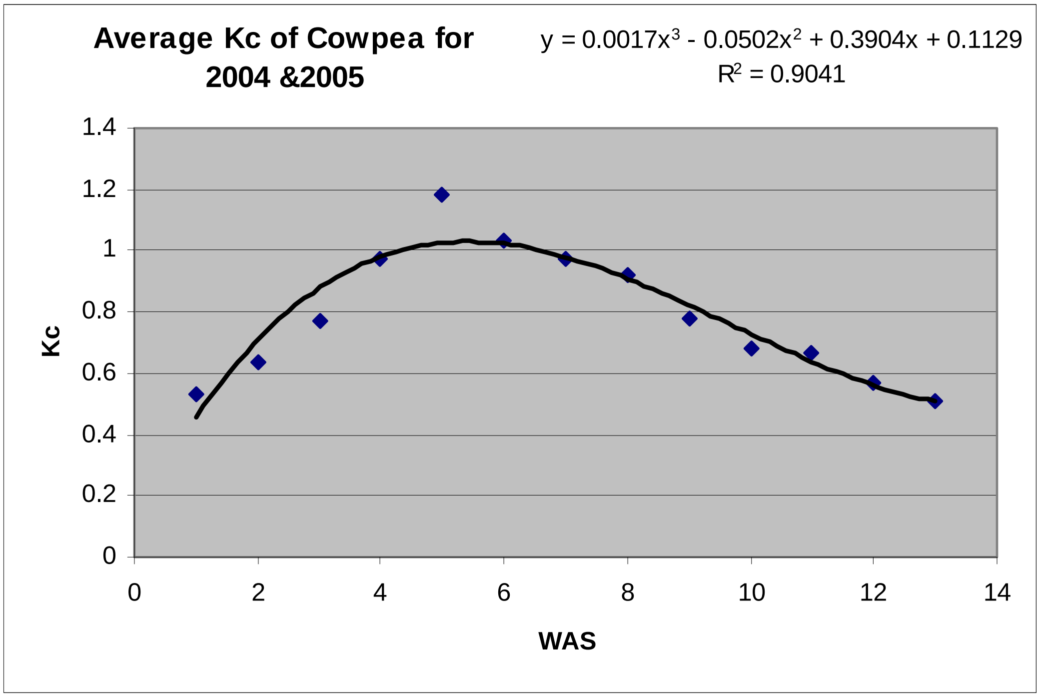

Fig. 1. Variation of crop coefficient (K_c) with week after sowing (WAS)

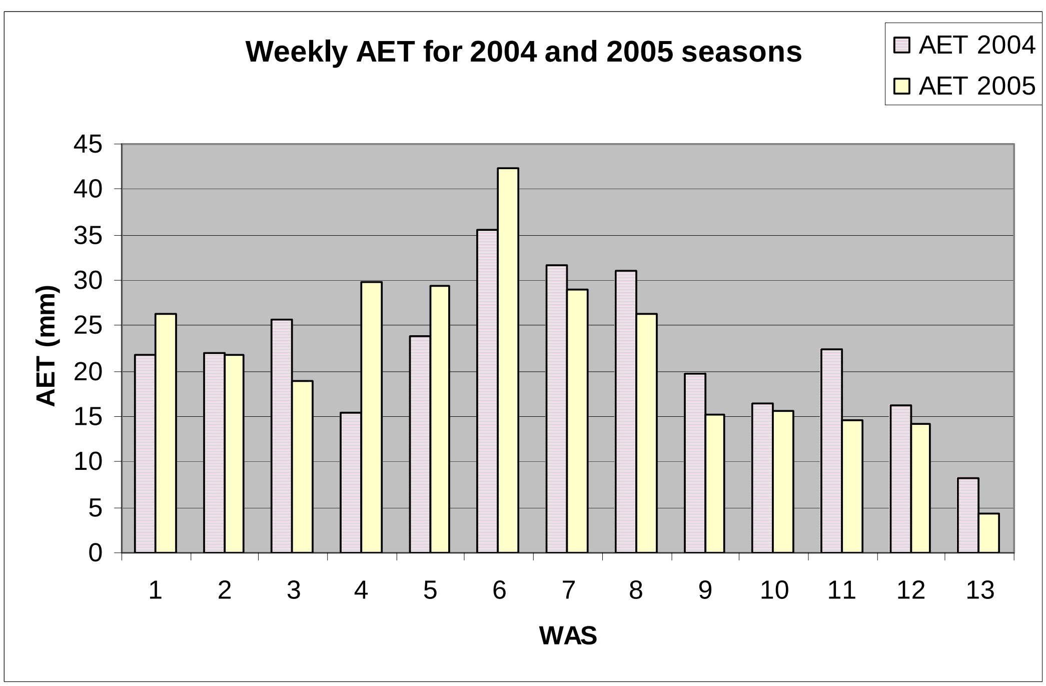

Fig. 2. Distribution of weekly average AET for 2004 and 2005

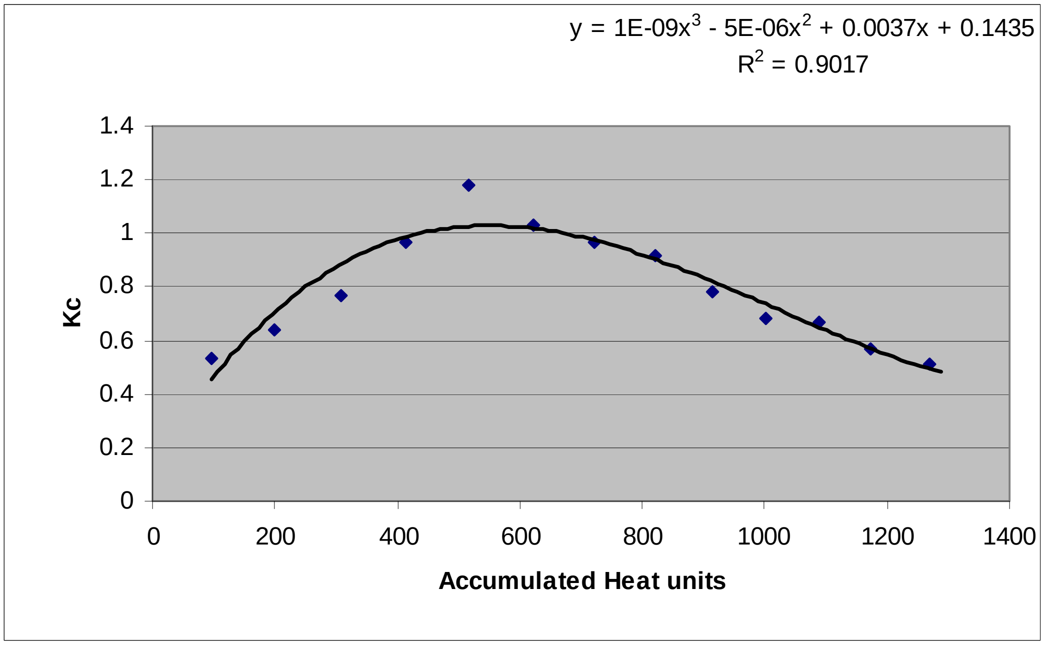

Fig. 3. Average crop coefficients as a function of accumulated heat units

formulae. The data on meteorological parameters from adjacent agro meteorological observatory were used.

The heat units (degree days) were calculated using the threshold temperature of 8° C (Singh *et al.*, 2000) from sowing to physiological maturity.

Heat Units = [(Maximum Temp. + Minimum Temp.)/2] - Threshold Temp.

3. Results and discussion

3.1. *Crop coefficient and Evapotranspiration*

Fig. 1 illustrates the relation between crop coefficient (K_c) and week after sowing (WAS). The multiple regression equation as given below relating crop coefficient (K_c) with week after sowing was obtained and can be used to calculate crop coefficient at any stage after sowing.

$$K_c = 0.1129 + 0.3904 \times (WAS) - 0.0502 \times (WAS)^2 + 0.0017 \times (WAS)^3$$

It is seen that the K_c gradually increases from date of sowing as the plant progresses. The peak value of crop coefficient was found to be 1.015 on 6th week after sowing. The average value of crop coefficient reported with a modified Penman equation (De Tar, 2009) for mid season plateau was 1.211. Factors affecting the value of the crop coefficient are mainly the crop characteristics, sowing data, rate of crop development, length of growing season and climatic conditions. The average value of evapotranspiration and water use efficiency is found to be 284.8 mm and 3.42 kg/ha/mm (Table 1) respectively. The average total evapotranspiration, highest crop coefficient and water use efficiency for cowpea determined by Rao and Singh (2004) is 312 mm, 1.19 and 4.36 kg/ha/mm respectively. The weekly distribution of actual

TABLE 1

Accumulated values of actual evapotranspiration, heat units and water use efficiency

Date of sowing	AET (mm)	Heat units (degree days)	Yield (kg/ha)	WUE kg/ha/mm
04 Sep 2004	281.6	1299.1	840	2.98
12 Sep 2005	288.0	1287.7	1112	3.86
Average values	284.8	1293.4	976	3.42

evapotranspiration (Fig. 2) shows that evapotranspiration rates are maximum during 6th week after sowing for both the years 2004 and 2005.

3.2. *Heat units use*

The average crop coefficients of cowpea as a function of average accumulated heat units were fitted and the results are shown in Fig. 3.

The average heat units from sowing to maturity were found to be 1293.4 degree days (Table 1) while Rao and Singh (2004) had reported from their studies of cowpea at Jodhpur as 1390 degree days.

4. Conclusion

(*i*) The total average actual evapotransipiration, water use efficiency for cowpea were found to be 284.8 mm and 3.42 kg/ha/mm respectively.

(*ii*) The peak value of crop coefficient was found to be 1.015 on 6th week after sowing.

(*iii*) The average heat units from sowing to maturity were found to be 1293.4 degree days.

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