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CROP COEFFICIENT OF COWPEA BEAN IN PIAUI STATE, BRAZIL

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ABSTRACT The crop coefficient (Kc) is fundamental for estimating the crop water requirement. The objective of this work was to determine the Kc values of the cowpea [*Vigna unguiculata* (L.) Walp.], BR-17 Gurgueia cultivar, for Piaui State, Brazil. Three experiments were carried out in three experimental areas of Embrapa Meio-Norte, localizated at Teresina (05°05' S; 42°48' W and 74,4 m), Parnaiba (3°5'S, 41°47'W and 46m) and Alvorada do Gurgueia (8°26'S, 43°47'W and 281m) counties. In each place, four weighing lysimeters were used for measuring the crop evapotranspiration (ETc) in a border area of 1.2 ha. Each lysimeter was composed of a fiber glass box (1.5 m for 1.5 m of width and 1.0 m of depth), mounted over a precision weighing scale, connected to an automatic data logger. The reference evapotranspiration (ETo) was estimated by Penman-Monteith method from meteorological data obtained by an automated weather station installed at each area. Kc was determined by the relation between ETc/ETo. Mean values of Kc for these counties were: 0.6 to 0.7, in the initial phase; 0.7 to 1.1, in the growth phase; 1.1 to 1.3 in reproductive phase and 0.6 in the final phase.

Keywords: *Vigna unguiculata*, evapotranspiration, weighing lysimeter

INTRODUCTION The cowpea [Vigna unguiculata (L.) Walp.] is one of the most important food source for tropical and subtropical regions of the world. Brazil is presented as major producer and consumer of cowpea. In this country, mainly in the North and Northeast regions, the cowpea is a major social and economic alternative food supply for rural populations. In these regions, the cowpea represent about 95% of the total beans cultivated (IBGE, 2006). Nowadays, the cultivation of this crop is growing in other regions of the country (Freire Filho et al., 2005). Despite its socioeconomic importance, the cowpea crop has low grain yield in Brazil, ranging from 300 to 900 kg ha^{-1}. One of the technologies to increase its productivity is the proper irrigation management. Although Piaui State has a potential for high grain yield under irrigation, there is few information about cowpea water demand. The determination of the crop coefficient (Kc) is basic for obtaining the water requirements during the development

phases. Some factors may influence the Kc values such as: cultivar characteristics, soil water content and climate conditions. Therefore, the Kc must be determined in the local conditions. Some works about cowpea Kc were developed in Northeast region (LIMA & SILVA, 1988; ANDRADE et al., 1993; FERREIRA et al., 2006), (SOUZA et al., 2005) and North region (AGUIAR et al., 1992). However, there is no research about cowpea Kc for the Piauí State. Thus, the objective of this work was to determine the Kc values of the cowpea during its development phases in soil and climate conditions of Piaui State.

METHODOLOGY Three experiments were carried out in three experimental areas of Embrapa Meio-Norte, localizated at Teresina (05°05' S; 42°48' W and 74,4 m), Parnaiba (3°5'S, 41°47'W and 46m) and Alvorada do Gurgueia (8°26'S, 43°47'W and 281m) counties, Piaui State (Figure 1), from August to October, 2005.

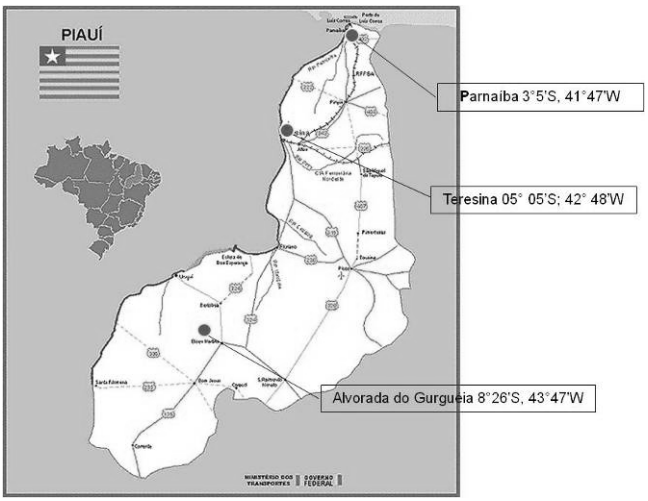

Figure 1. Localization of experimental area

Reference: http://www.ambientebrasil.com.br

The soil of these experimental areas is an Oxisol, whose chemical characteristics are presented in Tables 1, 2 and 3. The climate, according to Köoppen classification is Aw´ (tropical rainy). During the experiment the medium air temperature was 29°C.

TABLE 1. Soil chemical characteristics of the experimental area in Teresina, Piaui, Brazil

Sample	pH	P	K	Ca	Mg	Na	H + Al	CTC	V
	(water)	mg dm^{-3}	----------$cmol_c$ dm^{-3}----------						%
Lysimeter 0 – 0.2 m	5.49	14.40	0.17	1.28	0.82	0.25	1.44	3.96	63.73
Lysimeter 0.2 – 0.4 m	5.30	22.68	0.10	0.71	0.48	0.02	2.00	3.31	39.61
Border 0 – 0.2 m	5.94	25.34	0.30	1.65	0.94	0.01	1.39	4.29	67.66
Border 0.2 – 0.4 m	5.71	14.83	0.22	1.17	1.05	0.01	1.65	4.10	59.75

TABLE 2. Soil chemical characteristics of the experimental area in Parnaiba, Piaui, Brazil

Sample	pH	P	K	Ca	Mg	Na	H + Al	CTC	V
	(water)	mg dm^{-3}	----------$cmol_c$ dm^{-3}----------						%
Lysimeter 0 – 0.2 m	6.03	4.97	0.10	1.72	0.76	0.03	0.58	3.19	81.88
Lysimeter 0.2 – 0.4 m	5.56	3.53	0.08	0.48	0.93	0.09	1.39	2.96	53.23
Border 0 – 0.2 m	5.90	4.18	0.12	1.16	0.83	0.00	1.07	3.18	66.30
Border 0.2 – 0.4 m	5.45	2.95	0.07	0.76	0.32	0.01	1.53	2.69	43.04

TABLE 3. Soil chemical characteristics of the experimental area in Alvorada do Gurgueia, Piaui, Brazil

Sample	pH	P	K	Ca	Mg	Na	H + Al	CTC	V
	(water)	mg dm^{-3}	----------$cmol_c$ dm^{-3}----------						%
Lysimeter 0 – 0.2 m	4.94	16.70	0.17	1.20	0.74	0.01	2.84	496	42.76
Lysimeter 0.2 – 0.4 m	4.96	13.90	0.11	0.86	0.75	0.02	1.90	3.64	47.83
Border 0 – 0.2 m	5.48	14.53	0.16	1.36	0.58	0.01	1.86	3.97	53.08
Border 0.2 – 0.4 m	4.59	7.56	0.08	0.42	0.45	0.01	1.75	2.71	35.43

In each location, four weighing lysimeters were used for measuring the crop evapotranspiration (ETc) in a border area of 1.2 ha. Each lysimeter was composed of a

fiber glass box (1.5 m x 1.5 m width and 1.0 m depth), mounted over a precision weighing scale and connected to an automatic data logger. The reference evapotranspiration (ETo) was estimated by Penman-Monteith method from meteorological data obtained by an automated weather station installed at each area. Kc was determined by the relation between ETc/ETo. Cowpea, "BR-17 Gurgueia" cultivar was evaluated during each development phase. The plants were spaced of 0.8 m x 0.2 m. Fertilization was made with 40 kg of P2O5 ha-1 and 30 kg of K2O ha-1 and were applied in the beginning of planting. Chemical products for aphids control were used. Irrigation was supplied at night, whenever the soil water content was lower than the field capacity. Sprinklers were spaced at 12 m x 12 m with water flow of 400 L.h-1 each one. The soil water tension was monitored by tensiometers. Four weighing lysimeters were used for measuring the crop evapotranspiration (ETc). The harvest occurred around 70 days after planting. For estimating the grain yield all plants in the lysimeter were harvested and, in the border area, ten plots measuring 1.5 m x 1.5 m were evaluated.

RESULTS AND DISCUSSION Mean values of Kc for Teresina, Parnaiba and Alvorada do Gurgueia, Piauí State, during all the cycle of the cowpea is shown in Figure 2. The Kc in inicial phase ranged from 0.6 to 0.7 up to 15 days after planting (DAP), because a small fraction of the soil was covered by crop and due to the small leaf area reduced transpiration. Thus, great part of evapotranspiration can be counted only by water evaporation from the soil surface. Only after 15 DAP, crop coefficient values started to increase significantly, identifying by vegetative phase. During this phase the Kc ranged from 0.7 to 1.1, due to expressive increment in leaf area. The Kc increased reaching the maximum value of the 1.3 at 45 DAP, coinciding with the beginning of the reproductive and filling grains stage. After this period, the Kc values decreased, according to the plant physiology. Other reseachers obtained similar values of Kc cowpea in other regions. ANDRADE et al (1993), evaluating cultivar "BR - 12 Canindé", in Parnaíba county, Piaui State, obtained 1.16 as maximum value at 42 days after planting, coinciding with the flowering phase. In Bragança county, Para State, AGUIAR et al. (1992) obtained a Kc of 1.04 in the same phase for cultivar "Manteiguinha". SOUZA et al. (2005), at Ceara State, observed 0.78 as minimum Kc for the vegetative phase and 1.27 as maximum Kc in the reproductive phase for cultivar "Setentão". These differences can be explained by the genetics background of the cultivar, the different soil water contente and climate conditions (relative humidity and air temperature) during the experiment. The mean grain yield in the lysimeter ranged from 1,728 kg ha^{-1} (Alvorada do Gurguéia) to 2,216 kg ha^{-1}(Teresina). These high values of grain yield demonstrated that the crop development was adequate for soil and climate conditions evaluated, therefore, the kc values are representative for the Piauí State.

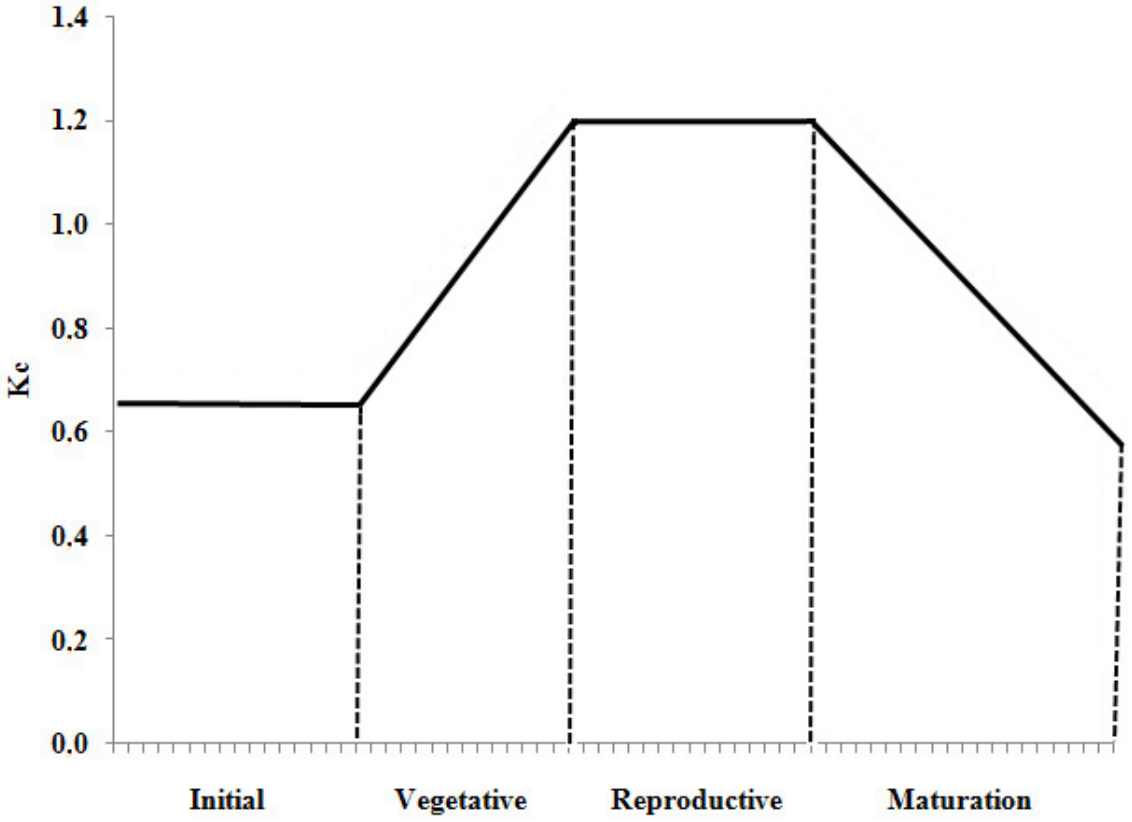

FIGURE 2. Medium values of cowpea coefficient (Kc) in each development phases in Piaui State

CONCLUSION Mean values of Kc for Teresina, Parnaíba and Alvorada do Gurgueia counties were: 0.6 to 0.7, in the initial phase; 0.7 to 1.1, in the growth phase; 1.1 to 1.3 in reproductive phase and 0.6 in the final phase.

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