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Evapotranspiration-Based Irrigation for Agriculture: Crop Coefficients of Some Commercial Crops in Florida[1]

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This article is part of a series on ET-based irrigation scheduling for agriculture. The rest of the series can be found at http://edis.ifas.ufl.edu/topic_series_ET-based_irrigation_scheduling_for_agriculture.

Introduction

The crop coefficient (K_c) is one of the most important variables in the estimation of irrigation water needs for a specific crop. K_c integrates crop properties, related to the plant phenological stage, plus the effects of soil evaporation in one value. Usually, K_c values are estimated in controlled conditions related to the crop type, phenological stage, soil moisture, crop health, and crop management practices. However, these controlled estimations are not possible to reproduce in the field due to timing and management restrictions. This publication identifies typical K_c values for some of the crops commonly grown in Florida. The K_c values listed are only intended for use as guidelines in the absence of locally developed, variety-specific K_c values.

Crop Coefficient (K)

The K_c integrates the characteristics of the crop that distinguish it from the reference crop (usually a short, green, well-watered crop that completely shades the ground) used to estimate reference ET (ET_o). General guidelines on how to obtain ET_o data for most areas in Florida can be found in *Evapotranspiration-Based Irrigation for Agriculture: Sources of Evapotranspiration Data for Irrigation Scheduling in Florida at* http://edis.ifas.ufl.edu/ae455.

The K_c value changes over the growing period for a crop because of changes in the crop characteristics such as ground cover, crop height, and leaf area. For annual crops, the growth period is divided into four stages (i.e., initial stage, crop development, mid-season stage, and late season stage) and K_c values are calculated based on these stages. The initial stage is the period between the planting date and 10% ground cover. The crop development stage refers to the period from 10% ground cover to the initiation of flowering or full cover. The mid-season stage refers to the period between full crop cover and the start of maturity indicated by the aging, yellowing, browning of leaves or leaf drop. The late season stage covers the period between maturity and harvest or full senescence (advanced aging

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of leaves). For most perennial crops in Florida, growth continues year-round, and the K_c varies by month based on the phenological stage (bloom, fruit set, fruit development, fruit maturation) of the plant and percentage of the ground shaded by the tree canopy (Allen et al. 1998).

There is minimal information about locally adapted K_c values for most crops grown in Florida. If field data exist for a crop related to local management practices, variety, and environmental conditions, it should be used to generate ET_c for estimating net irrigation water requirement. General information on estimating ET_c and net irrigation water requirements can be found in *Evapotranspiration-Based Irrigation Scheduling for Agriculture* at http://edis.ifas.ufl.edu/ae457. However, if locally developed K_c values do not exist, typical values listed in Table 1 and Table 2 may be used as guidelines for crops commonly grown in Florida.

Conclusion

The K_c values listed in this publication can serve as useful guidelines for areas where locally developed K_c values are not available for specific crops or cultivars. These K_c values can be adjusted to meet local management requirements if necessary.

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Table 1. Typical crop coefficients (K_c) for perennial crops commonly grown in Florida.

Month	Avocado[1]	Banana[1]	Carambola[2]	Citrus[3]	Guava[4]	Lychee[5]	Mango[6]
January	0.70	1.00	1.00	0.79	0.80	0.40	0.60
February	0.70	1.00	1.00	0.86	0.80	0.40	0.50
March	0.86	1.10	1.15	0.93	0.80	0.90	0.45
April	0.86	1.20	1.20	0.97	0.85	1.2	0.45
May	0.98	1.20	1.20	1.03	0.90	1.2	0.50
June	0.98	1.25	1.20	1.05	1.00	0.85	0.50
July	0.98	1.25	1.15	1.05	1.00	0.85	0.60
August	0.98	1.25	1.15	1.03	1.00	0.40	0.80
September	0.86	1.10	1.20	1.00	1.00	0.40	0.80
October	0.86	1.10	1.20	0.95	0.85	0.40	0.70
November	0.70	1.00	1.10	0.87	0.80	0.40	0.70
December	0.70	1.00	1.10	0.79	0.80	0.40	0.60

Note: These values are only intended for use as guidelines in the absence of locally developed Kc values and may be modified to suit local growing environments and management practices.

[1] Time averaged K_c values for non-stressed, well-watered crops in a sub-humid climate (minimum relative humidity approximately 45% and average wind speed of 2 m/s at a height of 2 m) (Allen et al. 1998). The K_c values have been listed by month to correspond to different phenological stages of plant development. Banana values for summer months are based on Goenaga and Irizarry (2000), which was conducted under Puerto Rican conditions. Avocado values include considerations from current research at the UF/IFAS Tropical Research and Education Center (Personal communication, J. H. Crane 2019).

[2] Carambola K_c is based on the phenology of plants growing in the South Florida conditions (Personal communication, J.H. Crane 2019).

[3] Citrus K_c values are based on recommendations by Morgan et al. (2006). More information about citrus irrigation scheduling can be obtained from Improving Citrus Nitrogen Uptake Efficiency: Effective Irrigation Scheduling (http://edis.ifas.ufl.edu/ss467).

[4] Guava K_c values are taken from a report by Fares (2008) for Hawaiian conditions latitude of about 21° N and longitude 157° W. Kc values in the table have been listed by month to reflect the guava season in South Florida (May to October). More information can be obtained at http://treephys.oxfordjournals.org/cgi/reprint/15/9/611.

[5] Lychee K_c values are based on work by Menzel et al. (1995) and were determined in a lychee orchard in subtropical South Africa using an evaporation pan. More information on the study can be obtained at http://treephys.oxfordjournals.org/cgi/reprint/15/9/611.

[6] Mango K_c values were obtained from De Azevedo et al. (2003) in a study at Petrolina in northeastern Brazil. Mango orchard ET_c was measured using Bowen ratio and soil water balance methods. K_c values in the table have been listed by month to reflect the mango season in South Florida (May to October).

Table 2. Typical crop coefficients (K_c) at various growth stages for annual crops commonly grown in Florida.

Crop	Initial Stage	Mid-stage	Late-stage
Tomatoes[7]	0.4	0.9	0.75
Squash[1]		0.95	0.75
Green pepper[1]		1.05	0.9
Green beans[1]	0.5	1.05	0.9
Cucumber[7]	0.2[7a]–0.4[7b]	0.95	0.9
Cabbage[7]	0.2[7a]–0.4[7b]	1.05	0.95
Potatoes[1]		1.15	0.75
Sweet potatoes[7]	0.2[7a]–0.4[7b]	1.1	0.7
Carrots[7]	0.2[7a]–0.4[7b]	1.05	0.75
Okra[7]	0.2[7a]–0.4[7b]	1.0	0.9
Strawberries[7]	0.2[7a]–0.4[7b]	0.5	0.6
Sweet corn[7]	0.2[7a]–0.4[7b]	1.1	1.0

Note: These values are only intended for use as guidelines in the absence of locally developed K_c values and may be modified to suit local growing environments and management practices.

[1] Time averaged K_c values for non-stressed, well-watered crops in a sub-humid climate (minimum relative humidity approximately 45% and average wind speed of 2 m/s at a height of 2 m) (Allen et al. 1998).

[7] K_c values are from *Vegetable Production Guide for Florida* (SP170), "Principles and Practices of Irrigation Management for Vegetables." More information about this publication can be found at http://edis.ifas.ufl.edu/topic_hs_vegetable_production_guide_for_florida_(sp170).

[7a] represents small row spacing (high population densities).

[7b] represents wide row spacing (low population densities).