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Irrigation schedule of pineapple in Ciego de Ávila province

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Abstract: Based on the available information on the behavior of the water requirements of the pineapple crop in the different stages of development and the crop coefficients of this crop that have been studied, the parameters for irrigation scheduling in the predominant edaphoclimatic conditions in the province of Ciego de Avila are determined. The calculations are made using the methodology proposed by FAO based on the reference evapotranspiration, which has been calculated by the Institute of Meteorology according to the Penman-Monteith equation adjusted for the specific conditions of the meteorological stations in Cuba. The calculations are made for the three predominant soil types in the areas dedicated to pineapple cultivation in Ciego de Avila. The results show that there is no need for irrigation during the months included in the rainy period of the year, while during the rest of the year the irrigation frequencies range between 6 and 10 days and the irrigation norms between 7 and 15 mm according to the type of soil and stage of development, and irrigation should be handled with care to avoid undesirable over-wetting for this crop.

Key words: irrigation norm; irrigation frequency

1 Introduction

Pineapple (Ananasconosus L. Merr) is renowned for its unique flavor and excellent nutritional quality, consumed in the form of fresh fruit and candied fruits. These characteristics make it one of the most in demand agricultural products and enable it to dominate the global tropical fruit trade (Llanos, 1998)[1].

In Cuba, pineapple is one of the economically imported crops, both because of its widespread acceptance among the population and because it has the potential to be produced year-round.

After the triumph of the Revolution, the years of large national harvests were around 47,000 t; such values decreased progressively, even before the arrival of the special period, which accentuated the fall. In 2003, production in Cuba was 40,543 t, which represented 2.8% of world production, occupying the thirty-sixth place among producers (FAO, 2004)[2].

As of the end of December 2006, the production was 16,660 tons, of which only 19.9% was provided by the state-owned sector and 80.1% by the non-state-owned sector (Rodriguez, 2007)[3].

In recent years, a small portion of fresh fruit consumption, tourism, and canning industry has been mainly used in the domestic market. The non-state-owned sector has the largest proportion in production, with the highest output in 2006 at 188 tons ha^{-1}, which is still insufficient to meet expectations.

The Ciego de Ávila region is known as the pineapple capital of Cuba, making this fruit a symbol of young provinces; However, it was not excluded from the production slump.

The province is currently facing a broad program aimed at rescuing pineapple production, which is a dream of the people of Avila because it is the fruit that identifies the territory. This strategy includes the introduction of more productive cultivars (MD-2), the use of micro propagation and the diversification of productive areas in the cooperative and peasant sectors.

The main producing countries of this fruit use irrigation as a way to compensate for water shortages in areas with insufficient or uneven rainfall, which is a characteristic of tropical and subtropical regions where production is concentrated.

Effectively utilizing irrigation water is a fundamental task (Alonso, 2006). In Cuba, irrigation activities have not been included in the production plan of this crop for many years. Research conducted in the 1980s showed that although it has a high resistance to drought, its response to irrigation is positive. These results led to subsequent investments in large areas dedicated to the production of irrigation technology in the province of Ciego de Ávila (Bonet, 2009)[4].

Since then, pineapple plantations in the province have been using various technologies such as central hub machines, local irrigation, winches, and small-scale surface irrigation for irrigation, but the production results do not match the irrigation investment.

The reason is related to the implementation of irrigation, but there is no basic standard established technically based on irrigation rules and frequency according to the main soil climate conditions and water demand characteristics of different stages of crop nutritional development (Besseat, 2005).

At present, pineapple production in Ciego de Ávila is carried out through a large production center owned by Ciego de Ávila Citrus Company and nearly 100 private producers distributed throughout the province.

The areas approved by the Soil and Fertilizer Directorate of MINAG in the province of Ciego de Avila must have a pH of less than 6.5 and good surface and internal drainage.

The present work aims to achieve the following objective: To determine the parameters for irrigation scheduling of pineapple crop under the prevailing soil and climatic conditions in the province of Ciego de Avila.

2 Method

To study irrigation systems, the following stages have been developed:

a) Determine the unique monthly rainfall in Ciego de Ávila province based on the information provided by the meteorological center.

b) Calculate monthly available rainfall using the Savo method (quoted by Reyde la Hoz, 1979).

c) Determine the monthly reference evapotranspiration for the province based on information provided by the Ciego de Ávila Meteorological Center.

For the study of the climatic variables (reference rainfall and evapotranspiration), information from the Ciego de Avila station located in the Venezuela municipality of that province is used because it is the most representative of the areas dedicated to pineapple cultivation, as well as using the data corresponding to the last 10 years, which constitute a more realistic reflection of the current climatic situation.

d) Calculate the monthly evapotranspiration of pineapple crops in the province based on the obtained data and crop coefficient calculated through crop physiological development stages (Bonet et al., 2010).

e) Determination of the monthly water deficit from the ETc and the calculated rainfall.

f) Based on the information provided by the Soil and Fertilizer Department of the province, determine the main production poles and territorial distribution of pineapples in Ciego de Ávila province, and identify them by soil type.

g) The accuracy of soil characteristics and hydrological properties is crucial for pineapple cultivation and production.

h) Define the wetting depth in the different stages of physiological development of the crop based on the results obtained during the experimental stage of the ETc study of the pineapple crop (Bonet et al., 2008a[5],b).

i) Determination of irrigation planning parameters for pineapple planting under main soil and climatic conditions.

3 Results and discussion

The behavior of rainfall in the territory of Ciego de Avila is shown in Annex 1, it is observed that the average value during the last decade practically coincides with the average value of a series of 20 years from 1990, which the criterion of its use for the evaluation of irrigation needs. From these values, the usable rainfall is determined (Table 1), using the Savo method (Annex 2) considering the predominant conditions in the pineapple areas of the province: slope less than 0.01; soil category, leached red color; depth of the root system of 0.20 m (Bonetetal., 2008a).

Table 1. Profitable rain

	Months												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
LL	14.3	23.8	44.4	47.4	142.0	205.9	147.0	165.4	201.5	163.7	36.8	37.7	1229.9
m_1	0.80	0.80	0.75	0.75	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	-
m_2	1.00	1.00	0.90	0.90	0.80	0.80	0.80	0.80	0.80	0.80	1.00	1.00	-
LLap	11.4	19.0	29.7	31.7	79.5	115.3	82.3	92.6	112.8	91.7	29.4	30.2	725.6

Indicator description: LL. Monthly total rainfall (mm); m_1 and m_2: Determine the coefficient of available rainfall; LLap: Available rainfall (mm).

Attachment 3 shows the behavior of ETo over the past decade and its comparison with monthly averages obtained from a 30-year series starting from 1975.

This is consistent with Allen et al. (2006), who proposed that Kc varies depending on the method used to calculate or determine ETo.

With the use of the Kc already determined and using this information, the ETc is calculated (Table 2, 1st, 2nd and 3rd cycle).

Table 2. Crop evapotranspiration divided by developmental cycle, three cycles

	Months											
1st. cycle	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
ETo	93	106	128	143	139	130	139	132	116	108	95	89
Kc	0.50	0.50	0.50	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.92	0.92
ETc	46.6	53.0	64.1	82.9	80.3	75.2	80.4	76.3	67.4	62.4	87.4	81.6

	Months					
1st. cycle (Continued)	I	II	III	IV	V	VI
ETo	93	106	128	143	139	130
Kc	0.71	0.71	0.71	0.71	0.57	0.57
ETc	66.1	75.3	91.0	101.5	79.0	73.9

2ed.	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
	Months											
ETo	139	132	116	108	95	89	93	106	128	143	139	130
Kc	0.53	0.53	0.53	0.53	0.88	0.88	0.63	0.63	0.63	0.63	0.50	0.50
ETc	73.5	69.7	61.6	56.9	83.7	78.1	58.7	66.8	80.7	90.0	69.3	64.8

3 rd. cycle	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
	Months											
ETo	139	132	116	108	95	89	93	106	128	143	139	130
Kc	0.49	0.49	0.49	0.49	0.78	0.78	0.67	0.67	0.67	0.67	0.59	0.59
ETc	68.0	64.5	56.9	52.7	74.2	69.2	62.4	71.1	85.8	95.8	81.7	76.5

Description of indicators: ETo. Reference evapotranspiration (mm); Kc. Crop coefficient; ETc. Crop evapotranspiration (mm)

From these values and the usable rainfall, the moisture deficit is determined (Table 3, in the three cycles).

Table 3. Three cycles of water deficit

1st.cycle	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Months											
ETc	46.6	53.0	64.1	82.9	80.3	75.2	80.4	76.3	67.4	62.4	87.4	81.6
LLap	11.4	19.0	29.7	31.7	79.5	115.3	82.3	92.6	112.8	91.7	29.4	30.2
DH	35.2	34.0	34.4	51.2	0.8	(40.1)	(1.9)	(16.3)	(45.4)	(29.3)	58.0	51.4

1st.cycle	I	II	III	IV	V	VI
	Months					
ETc	66.1	75.3	91.0	101.5	79.0	73.9
LLap	11.4	19.0	29.7	31.7	79.5	115.3
DH	54.7	56.3	59.3	69.8	(0.5)	(41.4)

2ed. cycle	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
	Months											
ETc	73.5	69.7	61.6	56.9	83.7	78.1	58.7	66.8	80.7	90.0	69.3	64.8
LLap	82.3	92.6	112.8	91.7	29.4	30.2	11.4	19.0	29.7	31.7	79.5	115.3
DH	(8.8)	(22.9)	(51.2)	(34.8)	54.3	47.9	47.3	47.8	51.0	58.3	(10.2)	(50.5)

3rd. cycle	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Months											
ETc	68.0	64.5	56.9	52.7	74.2	69.2	62.4	71.1	85.8	95.8	81.7	76.5
LLap	82.3	92.6	112.8	91.7	29.4	30.2	11.4	19.0	29.7	31.7	79.5	115.3
DH	(14.3)	(28.1)	(55.9)	(39.0)	44.8	39.0	51.0	52.1	56.1	64.1	2.2	(38.8)

Indicator description: DH. Water shortage (millimeters)

The water deficit results calculated for pineapple cultivation under climate conditions in Ciego de Ávila province indicate that during periods of low rainfall throughout the year, if rainfall is well distributed, it can meet the water needs of crops. This standard is consistent with the reports by Bartholomew et al. (2003) and Rodríguez et al. (2009b) on pineapple production under tropical country conditions; in addition, according to research conducted in Venezuela, Caraballo, and Jolan (2009), they concluded that some varieties can achieve acceptable yields even without supplementary irrigation, however, the production of the Cayena Lisa cultivar under these conditions was low.

The pineapple production in Ciego de Ávila by the national department is carried out on compacted red soil, while the 93 farms of the farmer department are located in 11 different types of soil, with over 70% concentrated in the following areas: Typical Red Ferrallitic (IIA), Compact Red Ferrallitic (IIW) and Concretionary Yellowish Ferrallitic (IVB) (Figure 1).

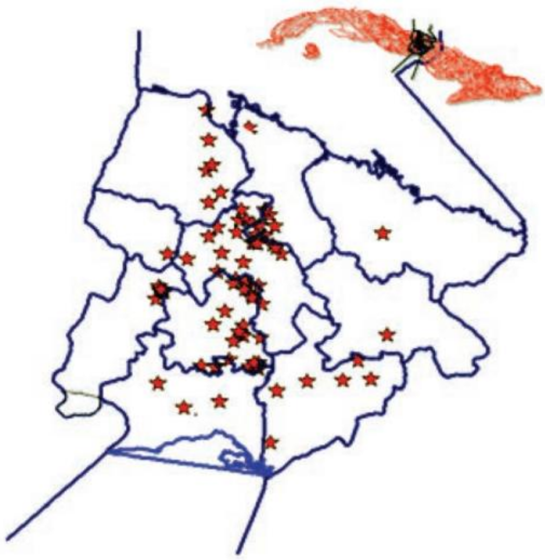

Figure 1. The spatial distribution of Ciego de Ávila Pinia region

According to the research conducted by the Soil and Fertilizer Management Bureau of the province, the average water physical properties of the main soil in the pineapple planting area were determined (Table 4).

Table 4. The water physical properties of pineapple planting soil

Key	Type of soil	Field capacity (% b.s.s.)	Soil density in natural state (g·cm-3)	Infiltration Speed (mm·h-1)
IIA	Typical Red Ferrallitic	30.74	1.20	85.20
IIW	Compact Red Ferrallitic	31.07	1.22	66.00
IVB	Concretionary Yellowish Ferrallitic	26.50	1.27	8.40

The results obtained during the ETc experimental research phase of pineapple cultivation (Bonet et al., 2008a, b) indicate that the greatest volume of ratios is concentrated in the first 0.20 m of soil, from this point on, the increase of the active layer to be wetted is considered as shown in Figure 2.

Based on the available information of soil water physical properties, moist active layer, and monthly water deficit calculation, irrigation planning parameters were determined (Attachment 4), and their summary is shown in Table 5; in this case, the calculation is recalculated starting from the sowing in December, as was done during the experimental phase of ETc research (Bonet et al., 2008a, b).

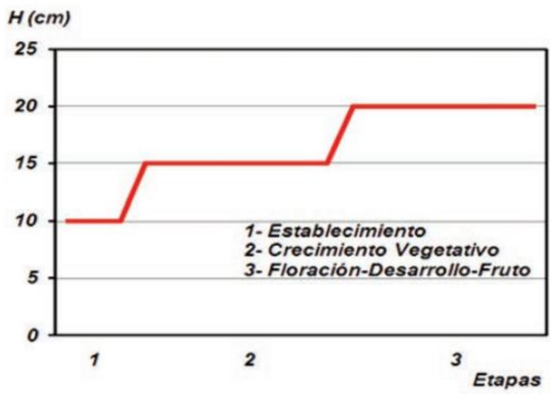

Figure 2. The increase of activity layer

Table 5. Summary of irrigation planning parameters

Nutritional development period	Soil IIA irrigation frequency (days)			Soil IIW irrigation frequency (days)			Soil IIW irrigation Frequency (days)		
	Partial irrigation standard (m^3 -ha^{-1})	1st. cycle	2ed and 3rd. cycle	Partial irrigation standard (m^3 ha^{-1})	1st. cycle	2ed and 3rd. cycle	Partial irrigation standard (m^3 ha^{-1})	1st. cycle	2ed and 3rd. cycle
Establishment	74	5-6	-	76	5-6	-	67	5-6	-
Vegetative growth	111	6	-	114	6	-	101	6	-
Flowering	150	7-10	7-10	152	7-10	7-10	135	7	7-10
Des. of fruit	150	6-7	7-10	152	6-7	7-10	135	6-7	6-7
Harvest	150	-	-	152	-	-	135	-	-

The obtained irrigation frequency indicates that due to similar irrigation rules, the results between soil types II-A and II-W are similar, while in soil type IV-B, due to the use of lower irrigation rules, the irrigation frequency increased in the three cycles (Table 6).

Given the climate conditions in our country, the availability of irrigation makes it possible to sow pineapples throughout the year. The planting time will determine the timing of each crop development stage throughout the year.

Table 6. Irrigation frequency for each soil type

Type of soil	Number of irrigations 1st. cycle	2ed. cycle	3rd. cycle	Total
Typical Red Ferrallitic	46	22	22	90
Compact Red Ferrallitic	46	22	22	90
Concretionary Yellowish Ferrallitic	48	26	24	98

The results obtained were communicated with previous studios, such as Huang and Lee (1969) cited by Bartholomew et al. (2003), who conducted research every two, four, and six weeks during the dry season in Taiwan. It was found to have a significant impact on fruit growth and weight, which is beneficial for increasing irrigation frequency, but has no effect on juice quality.

The results reported for the conditions of Cuba by Rodríguez et al. (2009a) are also coincidental, who have indicated that from transplantation to the third month a weekly irrigation of approximately 3.5 L · $plant^{-1}$ and from the fourth month until the induction of flowering occurs, a watering every 10 days of about 4 L · $Plant^{-1}$. For its part, the Institute of Tropical Fruit Research IIFT (2005)[6] considers that pineapple requires, in Cuban conditions, between 15 and 18 mm per week using drip irrigation and between 30 and 35 mm in the same period when irrigated by sprinkler. IIFT (2007)[7] itself states that this crop tolerates long periods of drought due to its characteristics of taking advantage of and accumulating water, but in the stage from sowing to the first two months and at the beginning of flowering and growth of the fruit it needs a good supply of moisture, which coincides with reports by Rodríguez et al (2009b).

4 Conclusion

• In the average conditions of the province, irrigation of the pineapple crop is usually unnecessary during the rainy season (May-October).

• The net irrigation standard reaches 7 to 15 millimeters, and the irrigation frequency is between 6 and 10 days.

• The sowing time will determine the changes in the physiological development stage of crops, thereby determining the irrigation plan.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] ALLEN, R.; PEREIRA, L.S.; RAE S, D.; SMITH, M.: *Evapotranspiración del Cultivo. Guías para la determinación de los requerimientos de agua delos cultivos*, edit. Estudio FAO Riego y Drenaje 56, Ed. FAO, ISBN-92-5-3 04219 -2, Roma, 2006.

[2] ALONSO, R.: *Uso eficiente del agua en el riego: unatarea esencial [en línea] 2006*, Disponible en: http://www.mesaredonda.cubadebate. cu/ [Consulta: 18 de noviembredel 2006]

[3] BARTHOLOMEW, D.P., PAUL L, R.E., & ROHRBACH, K.G.: The pineapple: botany, production and uses. Ed. CABI. Publishing, Walling- ford, USA, 2003 .

[4] BESSE AT, F.: "Centro virtual para agua en la agricultura", Ed. FAO, Roma, *Revista GRID*, ISSN 1021-268X, 23: 17-18, 2005.

[5] BONET, P.C., ACE A, L.R.I. & HERNÁNDEZ , V.M.: Evapotranspiration of pineapple in Cuba *[en línea] 2008* En: Pineapple News, vol. 15

(2): 5-15, 2008 *Disponible en*: http://www.ishs.horticulture.org.workinggroups/pineapple/ [Consulta: 18 de febrero 2008b].

[6] BONET, P.C., ACEA, L.R.I., BROWN, M.O., HERNÁNDEZ, V.M. & DUARTE, D.C.: "Coeficiente de cultivo para la programación del riego en el cultivo de la piña", *Revista Ciencias Técnicas Agropecuarias*, ISSN: 1010-2760, E-ISSN: 2071-0054, 19(3): 23 -27, 2010.

[7] CARABALLO, L. Y CHAURÁN, O.: "Comportamiento de la piña Cayena Lisa en condiciones de sabana". *Agricultura Andina* ISSN: 1315- 3919, 12 (2): 2009.

[8] REY, R. y D . LA HOZ, L.: *Manual del régimen de riego de los principales cultivos de Cuba*, pp. 51-74, Ed. Orbe. La Habana, Cuba, 1979.

[9] RODRÍGUEZ, D.A., JARDINES, S.D., FARRÉS, A.E., PLACERES, G. J., PEÑA, G.O. y FORNARIS, R.: "Las fincas integrales de frutales en Cuba" *CITRIFRUT*, ISSN: 1607-5072, 29(1): 2009a.

[10] RODRÍGUEZ D.A., FARRÉS, A.E., PLACE RES, G.J., PEÑA, G.O., FORNARIS, R.L. M. y MULÉN, P.L.: "Manejo del cultivo de la piña (Ananascomosus (L.) Merr.) cv. Española Roja, en Cuba", CITRIFRUT, ISSN: 1607-5072, 29(2): 2009b.

Appendices

APPENDIX 1. Rainfall behavior in Ciego de Avila province

Distribution of monthly rainfall during the last decade (mm). Ciego de Avila Station.

	Years										
Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Media
I	50.1	20.1	28.9	4.1	1.3	4.2	4.3	4.0	6.7	19.6	14.3
II	7.3	17.3	28.3	43.4	27.1	29.4	11.4	30.7	27.8	15.7	23.8
III	7.1	29.6	39.7	161.8	14.6	24.0	25.9	17.1	36.1	119.9	44.4
IV	78.9	24.1	15.2	103.1	9.7	15.9	33.7	81.6	14.5	97.3	47.4
V	55.5	201.7	358.7	157.3	19.4	29.1	98.8	172.9	227.9	89.4	142.0

VI	13.1	137.9	428.1	165.5	95.7	133.4	232.7	343.0	313.7	75.9	205.9
VII	113.7	172.6	151.9	166.8	13.1	190.2	221.6	127.2	122.9	69.7	147.0
VIII	116.3	101.0	169.3	150.2	96.0	182.9	221.1	148.4	233.9	234.7	165.4
IX	163.5	302.1	327.7	224.8	90.5	70.4	131.2	149.0	179.0	376.5	201.5
X	119.0	140.0	122.8	82.9	114.8	216.2	351.8	111.0	317.2	61.3	163.7
XI	19.8	88.0	75.9	58.1	24.5	9.7	15.7	27.9	12.6	35.8	36.8
XII	220.8	20.9	19.2	26.1	1.5	1.1	17.3	26.1	22.0	22.3	37.7
Total	1,085.1	1,255.3	1,755.7	1,344.1	628,2	916,5	1,365.5	1,238.9	1,514.3	1,218.1	1,229.9

Average monthly rainfall values for the period 1991-2010 (mm). Ciego de Avila Station.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Rain	25.0	33.5	41.4	51.5	164.5	206.2	126.9	156.1	205.7	145.5	52.6	28.0	1234.9

Source: Meteorological Center of Ciego de Ávila Province

APPENDIX 2. Savo's method for determination of usable rainfall.

m1 coefficient

Pending	< 0.01			0.01–0.05			> 0.05		
monthly rainfall	< 40	40 - 100		< 40	40-100	> 100	< 40	40-100	> 100
Soil category									
1	0.90	0.85	0.80	0.85	0.80	0.75	0.80	0.75	0.70
2	0.85	0.80	0.75	0.80	0.75	0.70	0.75	0.70	0.60
3	0.80	0.75	0.70	0.75	0.65	0.55	0.65	0.55	0.40
4	0.77	0.72	0.67	0.72	0.62	0.52	0.62	0.52	0.37
5	0.77	0.72	0.67	0.72	0.62	0.52	0.62	0.52	0.37
6	0.77	0.72	0.67	0.72	0.62	0.52	0.62	0.52	0.37
7	0.77	0.70	0.60	0.70	0.60	0.40	0.50	0.50	0.25

Coefficient m2

Soil category	Monthly rainfall (mm)	Root system depth (m)					
		0.2	0.4	0.6	0.8	1.0	1.2
	< 40	1.00	1.00	1.00	1.00	1.00	1.00
1	40 - 100	0.80	0.90	1.00	1.00	1.00	1.00
	> 100	0.70	0.80	0.90	1.00	1.00	1.00
	< 40	1.00	1.00	1.00	1.00	1.00	1.00
2	40 - 100	0.80	0.90	1.00	1.00	1.00	1.00
	> 100	0.70	0.80	0.90	1.00	1.00	1.00
	< 40	1.00	1.00	1.00	1.00	1.00	1.00
3	40 - 100	0.90	1.00	1.00	1.00	1.00	1.00
	> 100	0.80	0.80	1.00	1.00	1.00	1.00
	< 40	1.00	1.00	1.00	1.00	1.00	1.00
4	40 - 100	0.80	0.90	1.00	1.00	1.00	1.00
	> 100	0.70	0.80	0.90	1.00	1.00	1.00
	< 40	1.00	1.00	1.00	1.00	1.00	1.00
5	40 - 100	0.80	0.90	1.00	1.00	1.00	1.00

	> 100	0.70	0.80	0.90	1.00	1.00	1.00
	< 40	1.00	1.00	1.00	1.00	1.00	1.00
6	40 - 100	0.80	1.00	1.00	1.00	1.00	1.00
	> 100	0.70	0.90	1.00	1.00	1.00	1.00
	< 40	1.00	1.00	1.00	1.00	1.00	1.00
7	40 - 100	0.80	0.90	1.00	1.00	1.00	1.00
	> 100	0.70	0.80	1.00	1.00	1.00	1.00

Soil category description.

Podsolized yellow, sandy gravelly

Laterite loamy, savanna clay

Red leached shade

Carbonate humic brownish carbonate

Cenagoso, peaty and loamy

Yellow podsolized clayey yellow, on clay

Black gray compact gley black

Source: Reyyd e la Hoz (1979)

ANNEX 3. Reference Evapotranspiration Behavior in the province of Ciego de Ávila

The distribution of ETo in the past decade. Avila Blind Station

Months	Years										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	average value
I	88.3	82.90	95.10	89.70	91.52	98.21	94.29	102.08	95.08	94.18	93.14
II	99.3	102.30	100.90	105.70	102.46	98.12	97.84	113.54	115.77	124.84	106.08
III	132.70	129.80	135.50	130.30	119.35	104.15	100.20	145.45	136.63	146.93	128.10
IV	142.00	151.10	163.60	141.30	123.94	117.13	113.40	165.14	147.15	164.55	142.93
V	152.50	130.50	149.50	141.40	130.12	113.81	106.21	148.76	153.88	158.55	138.52
VI	144.50	144.20	135.40	132.20	110.01	97.71	100.53	137.10	154.25	140.92	129.68
VII	156.60	146.60	155.70	142.00	104.28	111.33	105.16	148.92	160.44	155.41	138.64
VIII	144.00	143.60	143.50	135.90	97.88	99.87	107.96	142.67	149.01	150.97	131.54
IX	126.40	122.00	107.10	128.90	103.24	95.15	92.36	125.05	131.77	129.80	116.18
X	113.40	108.30	117.10	117.3 0	101.32	96.08	94.12	105.81	112.08	109.83	107.53
XI	96 .00	90.10	89.60	96.20	108.97	89.56	86.17	97. 03	97.07	99.95	95.06
XII	77.60	86.20	86.30	80.80	100.23	87.60	91.14	86.95	93.76	96.67	88.72
Total	1473.30	1437.60	1479.30	1441.70	1293.32	1208.72	1189.38	1518.50	1546.89	1572.60	1416.12

Average ETo values for the period 1975-2005 (mm). Ciego de Avila Station

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
ETo	89.72	100.39	135.77	149.14	148.22	138.74	153.19	146.55	124.87	112.58	92.06	85.39	1476.62

Source: Meteorological Center of Ciego de Ávila Province.

Attachment 4. Planning parameters for pineapple irrigation under the main soil and climate conditions in the planting area of Ciego de Ávila province

Soil: Typical Red Ferralitic (II-A)

	Months																	
1st cycle	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
Nn	7	7	7	11	-	-	-	-	-	-	15	15	15	15	15	15	-	-
NR	5	5	5	5	-	-	-	-	-	-	4	3	4	4	4	5	-	-
IR	6	5	6	6	-	-	-	-	-	-	7	10	7	7	7	6	-	-

	Months											
2ed cycle	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
Nn	-	-	-	-	15	15	15	15	15	15	-	-
NR	-	-	-	-	4	3	3	3	3	4	-	-
IR	-	-	-	-	7	10	10	9	10	7	-	-

	Months											
3rd cycle	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
Nn	-	-	-	-	15	15	15	15	15	15	-	-
NR	-	-	-	-	3	3	3	3	4	4	-	-
IR	-	-	-	-	10	10	10	9	7	7	-	-

Soil: Red Ferrallitic Compacted (II-W)

	Months																	
1st cycle	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
Nn	8	8	8	11	-	-	-	-	-	-	15	15	15	15	15	15	-	-
NR	5	5	5	5	-	-	-	-	-	-	4	3	4	4	4	5	-	-
IR	6	5	6	6	-	-	-	-	-	-	7	10	7	7	7	6	-	-

	Months											
2nd cycle	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
Nn	-	-	-	-	15	15	15	15	15	15	-	-
NR	-	-	-	-	4	3	3	3	3	4	-	-
IR	-	-	-	-	7	10	10	9	10	7	-	-

	Months											
3rd cycle	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
Nn	-	-	-	-	15	15	15	15	15	15	-	-
NR	-	-	-	-	3	3	3	3	4	4	-	-
IR	-	-	-	-	10	10	10	9	7	7	-	-

Soil: Ferrallitic Yellowish Concretionary (IV-B)

	Months																	
1st cycle	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
Nn	7	7	7	10	-	-	-	-	-	-	13	13	13	13	13	13	-	-
NR	5	5	5	5	-	-	-	-	-	-	4	4	4	4	4	5	-	-
IR	6	5	6	6	-	-	-	-	-	-	7	7	7	7	7	6	-	-

	Months											
2nd cycle	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
Nn	-	-	-	-	13	13	13	13	13	13	-	-
NR	-	-	-	-	4	4	4	4	4	4	-	-
IR	-	-	-	-	7	7	7	7	7	7	-	-

	Months											
3rd cycle	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI
Nn	-	-	-	-	13	13	13	13	13	13	-	-
NR	-	-	-	-	3	3	4	4	4	5	-	-
IR	-	-	-	-	10	10	7	7	7	6	-	-

Footnotes:

1. LLANOS, M.: "Producción y comercio mundial de frutos tropicales", Revista Valencia Fruits. (1881). P. 1, 1998.

2. FAO: Situación actual de las frutas tropicales (Informe). Roma, 2004.

3. RODRÍGUEZ, D.A.: La piña, Boletín Informativo Noti Citri Frut, IIFT. (1), La Habana, Cuba, 2007.

4. Bonet, P.C. Régimen de riego del cultivo de la piña, Informe final de investigación. Proyecto 22-52. Instituto de Investigaciones de Riego y Drenaje. La Habana, Cuba, 2009.

5. BONET, P.C., ACEA, L.R.I. & HERNÁNDEZ, V.M.: Evapotranspiración del cultivo de la piña. Publicación en CD. En: Memorias de la VIII Conferencia Científica UNICA, ISBN: 1 978-959-16-0934-2, Ciego de Ávila, Cuba. 2008a.

6. IIFT: Guía Técnica para el cultivo de la piña. Ed [sn], La Habana, Cuba, 2005.

7. IIFT: Boletín informativo Noti Citi Frut. No. 1. Enero, La Habana, Cuba, 2007.