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ESTIMATED EVAPOTRANSPIRATION OF RADISH IN UDIC AND ISOHYPERTHERMIC ENVIRONMENT BASED ON CLASS A PAN.

BY

Godwin O. Chukwu[1], Paul C. Oguike[2] And O. Ojimgba[3]

[1]Yam Research Programme, National Root Crops Research Institute, Umudike, P.M.B 7006, Umuahia, Abia State.

[2] Department of Soil Science and Agroclimatology, Michael Okpara University of Agriculture, Umudike.

[3]Faculty of Agriculture and Vet. Med., Abia State University, Umuahia Campus.

ABSTRACT

Evapotranspiration of radish *(Raphanus sativus)* was estimated in Umudike ($5^0 29^1$ N., $7^0 33^1$ E), Nigeria, typical of an environment with udic and isohyperthermic soil water and temperature regimes respectively, based on class A pan and 11 years meteorological data. Results showed that potential evapotranspiration (Et_0) ranged from 1.7 - 2.8 mm and 1.9 - 1.3mm/ month in dry and wet seasons respectively. However, actual evapotranspiration (ET_{crop}) was 20.8mm significantly (P = 0.05) higher in the dry than in the wet season. The low seasonal Et_{crop} of 63.8 and 43.0mm for dry and wet seasons, respectively, was adjudged unreliable based on previous studies. It was concluded that alternative methods other than class A pan should be used in estimating crop evapotranspiration in the area.

INTRODUCTION

Radish *(Raphanus Sativus L.) is* known as an important root crop (Tirrel, 1973). In Nigeria, it is a minor root crop. Its grouping alongside tumeric, sugar beet, rizga etc. under a somewhat miscellaneous programme as 'Other Root Crops Programme' by the National Root Crops Research Institute (NRCRI), Umudike, Nigeria, that has national mandate for research on and improvement of root and tuber crops, attest to it's minor importance. Radish is believed to have originated from Europe and Asia Minor (Kay, 1987). The importance of radish as food, feed and as an industrial raw material for the manufacture of drugs, soap and crayon has been discussed (Kay,1987).

According to the World Water Assessment Programme, the global water supply is expected to decline by a third in the next 20 years, and political inertia is worsening the problem (Roundup, 2003). Numerous reasons have been adduced to buttress the need to estimate evapotranspiration of crops (water consumptive use) (Roundup, 2003; Chukwu and Ikwelle, 2000). The use of evaporimeter is a proven method for estimating crop evapotranspiration. Despite the limitations of class A pan outlined by Chukwu and Eze (2002), it still remains a reference instrument and the most used among other evaporimeters (Miller, 1994). Chukwu and Mbanaso (1999) estimated the water requirements of radish in Southeastern Nigeria based on the modified Blaney-Criddle equation (Brouwer and Heibloem, 1986). Generally there is no information on evapotranspiration of radish based on class A pan, especially, within the udic and isohyperthermic environment in Nigeria.

The gap in knowledge is what we attempted to fill in the present study. The objective of the present study was to estimate potential evapotranspiration and evapotranspiration of radish in the study area, using class A pan.

METHODOLOGY

The Study Area

The study area was Umudike, typical of an environment with udic and an isohyperthermic soil water and soil temperature regimes, respectively (Chukwu and Ifenkwe, 1996). Umudike is located between latitude $5^{\circ} 29'$ N and longitude $7^{\circ} 33'$ E, in the southeast agro-ecological zone of Nigeria. The mean annual soil temperature is above 22°c at the control section of the soil temperature regime. Under non-irrigated condition, the control section for soil temperature is a depth of 50cm from the surface or at the upper boundary of a non-limiting layer, whichever is shallower (Soil Survey Staff, 1998). The soil moisture regimes are such that the soil moisture control section is not dry in any part for as long as 90 consecutive days in normal years. Since the soil textural class of the study area is coarse loamy (Chukwu and Ifenkwe, 1996) the moisture control section is 20-60cm deep (Soil Survey Staff, 1998). Normal year is defined as a year that has plus or minus one standard deviation of 30 years or more mean annual precipitation (Soil Survey Staff, 1998).

The crop evapotranspiration was theoretically estimated from 10 years (199-1999) class A pan data obtained from the meteorological unit of the NRCRI Umudike (Table 1). It is assumed that radish was grown twice in the dry season and twice in the wet season. This gave a total of 4 cropping seasons. The growth period of radish (40 days), disaggregated into various growth stages and the corresponding crop coefficients (Table 2) was used for the study.

The computations of potential evapotranspiration and actual evapotranspiration (crop evapotranspiration) followed the procedures of Makadho and Butlig (1979) and Chukwu (2004). The estimated evapotranspiration for the two seasons (dry and wet) was statistically analyzed using student's T-test.

RESULTS AND DISCUSSION

Potential Evapotranspiration

The potential evapotranspiration (Et_0) is shown in Table 3. The Et_0 varied directly with E pan in the dry season months (November through February) with a range from 1.7-2.8mm/month. Conversely, it showed an inverse relationship as the wet season progressed (April through July), with a range from 1.9-1.3mm/month. When the values for dry and wet seasons were compared, it was observed that Et_0 in the dry season was 30.8-47.4% higher than in the wet season. Surprisingly, the monthly coefficient (Kc/month) calculated for the dry season months (November/December, January and February) was equal to that of the wet season months (April, May, June, July) (Table 4). The values ranged from 0.27-0.65.

Crop Evapotranspiration

The crop Evapotranspiration (actual Evapotranspiration) (Et_{crop}) is presented in Table 5. The dry season value was significantly ($P = 0.05$) higher than the wet season value by 20.8mm. However, mean monthly values between the two season were not statistically significant. Nevertheless, the mean monthly Et_{crop} in the dry season was higher than the mean wet months by 10.4mm.

Pan evaporation (mm) data for the 11-year period (Table 1) showed an increase from November through February and a decrease from April through July. This bimodal nature of evaporation in the area explained the trends in Et_0 obtained. The Et_{crop} established using data from the class A pan was 166-95.7% lower than that established by Chukwu and Mbanaso (1999) based on Blaney-Criddle model, using the same test crop (radish) in the environment. The same trend of very low value of Et_{crop} is obtainable when the results are compared with tabulated Et_{crop} for radish by Brouwer and heibloem (1986). The results therefore corroborated the view of Chukwu and Eze (2002) in a study using soyabeans, that estimated Et_{crop} based on class A pan obtained from the same environment is unreliable.

Probably, the disadvantages of class A pan enumerated by Miller (1994) and Chukwu and Eze (2002) could be responsible for the low values of Et_{crop} obtained.

Theory of Pan Evaporimeter Method

A pan with known surface area is installed in the field. The pan is filled with water to a known depth (zero mark) in the pan. The water is allowed to evaporate usually for 24hours. The remaining quantity of water (water depth) is measured at 7.00am in the morning. Rainfall, if any,. is measured simultaneously. The difference between the 2 water depths is the pan evapotranspiration (Et_{pan}) (Brouwer and Heibloem, 1986) or evaporative power of the air (Dupriez and Leener, 1992). The E_{pan} is multiplied by a pan coefficient (K_{pan}). The K_{pan} is an experimental constant relating evaporation from the water surface in the pan with evapotranspiration of a standard grass or with evaporation from water bodies (Brouwer and Heibloem, 1986; Miller, 1994). The product of K_{pan} and E_{pan} gives potential evapotranspiration (Et_0). Actual evapotranspiration or water consumptive use is obtained by relating Et_0 to crop growth stage (Kc) called crop coefficient (Makadho and Butlig 1979; Chukwu, 2004).

Conclusion

It is concluded that Class A pan appeared to be unreliable in modelling crop evapotranspiration, especially in udic and an isohyperthermic environment in the southeast agro-ecology of Nigeria. In the alternative,. the application of Blaney-Criddle and the Modified Penman methods of modelling crop evapotranspiration is suggested in the area. The result also challenge scientists involved in research on crop water modelling to compare the use of class A pan with alternative approaches, using the same test crop, in other agro-ecological zones of Nigeria.

Table 1.11 Years Class A Pan Evaporation Data (mm/day) at Umudike during Months of Radish Growth

	Years (19....)											
Months	89	90	91	92	93	94	95	96	97	98	99	Mean
November	2.6	2.6	2.0	2.6	2.2	2.7	2.9	2.2	2.3	2.3	2.3	2.5
December	2.7	2.7	3.3	3.0	2.5	4.1	2.3	2.9	2.8	2.7	3.1	2.9
January	4.9	4.2	3.7	4.2	4.2	3.0	3.3	2.5	3.6	3.4	3.0	3.6
February	5.7	4.6	3.3	4.9	4.0	3.2	3.5	3.3	5.4	4.2	2.7	4.1
April	2.9	2.6	2.6	2.8	3.4	2.8	2.5	2.5	2.6	3.6	2.4	2.8
May	2.1	2.2	2.1	2.5	3.8	2.4	2.0	2.4	2.5	2.3	2.0	2.4
June	2.4	2.3	1.9	2.1	2.6	1.8	2.1	2.1	1.6	2.0	2.3	2.1
July	2.3	2.3	1.6	1.8	1.9	1.9	1.8	1.6	1.9	1.9	2.0	1.9

Table 2: Growth Stages and Crop Coefficient of Radish.

Growth Stages	Number of days/growth stage	Crop coefficient
Initial	10	0.45
Crop development	10	0.60
Mid-season	15	0.85
Late season	5	0.83

Sources: Chukwu and Mbanaso (1999); Brouwer and Heibloem (1986).

Table 3: Mean of 11 Years (1989 - 1999) Potential Evapotranspiation at Umudike based on Class A Pan.

Months	Potential evapotranspiration (mm/month)
November	1.7
December	2.1
January	2.5
February	2.8
April	1.9
May	1.7
June	1.5
July	1.3

Table 4: Monthly Coefficient of Radish at Umudike

Dry season		Wet season	
Months	Coefficient	Months	Coefficient
January	0.27	April	0.27
February	0.65	May	0.65
November	0.27	June	0.27
Mean	0.46		0.46
SE	0.11		0.11

Table 5: Seasonal and Mean Monthly Crop Evapotranspiration (mm) of Radish in Dry and Wet Seasons

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	Dry Season	Wet Season	tcal	0.05	0.01
Seasonal value (mm)	63.8	43.0	3.74*	2.920	6.965
Mean Monthly value(mm)	31.9	21.5	0.95ns	1.943	3.143

* = Significant at 5%

Ns = Not Significant

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