Zagazig J. Agric. Res., Vol. 35 No .(2) 2008 423-437

EVALUATING SOME PAN COEFFICIENT EQUATIONS UNDER FAYOUM CONDITIONS

Abdel-Wahed, M.H.

Soil and Water Dept., (Agric. Eng.), Fac. of Agric., Fayoum Univ.

Accepted 9/ 3/2008

ABSTRACT: Reference evapotranspiration (ETo) is an important component in water management of irrigated crops. Reliable estimation of ETo using pan evaporation (Epan) depends on the accurate determination of pan coefficient (Kp). This study was carried out to evaluate eight Kp equations (Cuenca (1989), Allen and Pruitt (1991), Snyder (1992), Orang (1998), Raghuwanshi and Wallender (1998), Allen *et al.* (1998), Grismer *et al.* (2002) and Snyder *et al.* (2005)) using climate data for a 10-year (January 1997–December 2006) period obtained from Atsa Weather Station, Fayoum Governorate. The accuracy of the Kp equations to estimate ETo and crop evapotranspiration (ETc) by comparing them against FAO Penman-Monteith (FAO-PM) equation (1998) and ETc of grain sorghum based estimates of means, standard deviation (SD), percent error (PE), linear coefficient of determination (R^2), linear regressions, and standard error of estimate (SEE) was also investigated. These comparisons led to select the suitable equation for estimating Kp under the environmental conditions of Fayoum Governorate. Under these conditions, all tested equations gained similar and lower results than those of FAO-PM and ETc of grain sorghum, except with the Kp calculated by Snyder *et al.* (2005) equation that provided more accurate estimates when compared to FAO-PM and ETc of grain sorghum. The Kp data from Snyder *et al.* (2005) equation to estimate ETo was close to the FAO-PM where the PE value was close to zero, the regression coefficient was close to 1.0, with the lowest SEE and it had the highest R^2 value. Snyder *et al.* (2005) equation was also ranked first for estimating the mean daily and seasonal ETc, PE, coefficient (a) and SEE. The mean daily and seasonal ETc from Snyder *et al.* (2005) equation were close to the

mean daily and seasonal ETc of grain sorghum. In addition, the PE was close to the ETc of grain sorghum with the lowest SEE. Finally, the regression coefficient (a) was closest to 1.0. As wind speed and relative humidity are unavailable at pan evaporation sites, Snyder *et al.* (2005) equation was found to be the most suitable one to estimate ETo.

Key words: Crop coefficient, evaporation and evapotranspiration.

INTRODUCTION

In arid and semiarid regions, there is a great need to increase limited water resources. One of the most important ways is to manage the crop irrigation, increase water use efficiency and conserve water. Any water saving could be used in the new expansion of the reclaimed soils. A good estimation of evapotranspiration is vital for proper water management because it improves water use efficiency, water productivity and efficient farming practices. Estimates of ETc are important in irrigation planning and scheduling, overall crop and irrigation system management in large-scale producing areas. ETc can be determined from ETo, which is calculated using various weather parameters obtained from a weather station, or from evaporation pan data that are calibrated for wind and humidity conditions.

Phene and Campbell (1975) reported that many different methods for estimating ETo have been developed, most of which are complex and require a significant number of weather parameters. They also added that, evaporation pans are used extensively throughout the world because of the simplicity of the method and ease of data interpretation.

Doorenbos and Pruitt (1977) cleared that a high correlation between Epan and ETo could be obtained when evaporation pans are properly maintained and interpreted. They also, added that the ratio of ETo to Epan defines the Kp whose values range from 0.40 to 0.85 and provides an essential calibration factor that depends on the prevailing upwind fetch distance, average daily wind speed, and relative humidity conditions associated with the sitting of the evaporation pan.

The Epan data are often used to estimate ETo for a short canopy for use in irrigation scheduling and water resources' planning. Commonly, ETo is estimated as the product of the Epan data and a Kpan: ETo = Kp × Epan (Snyder *et al.*, 2005).

In Egypt, Eid *et al.* (1982) used the evaporation pan method for scheduling irrigation of maize and Egyptian clover in the agro-climatological regions; Sakha in Kafr El- Sheikh and Giza 1 in Giza Governorates respectively. Recently, class A pan evaporation records were used in scheduling irrigation for many crops; El-Marsafawy (2000) for wheat crop in Middle Egypt, Rayan *et al.* (2000) for cotton in upper Egypt, Abdou (2004) in El-Fayoum Governorate, for grain sorghum crop and Ertek, *et al.* (2006) for cucumber in Turkey.

There are many equations to calculate Kp, and these equations should give reliable results when applied to climatic conditions similar to those where they were developed. These equations, however, require testing or calibration when they are used under different climatic conditions. The accuracy and reliability of the equations may differ from one location to another (Irmak *et al.*, 2002).

Allen *et al.* (1998) indicated that the use of tables or the corresponding equations may not be sufficient to consider all local environmental factors influencing Kp and that local adjustment may be required. To do so, an appropriate calibration of Epan against ETo computed with the FAO-PM method is recommended. The International Commission for Irrigation and Drainage (ICID) and the Food and Agricultural Organization of the United Nations (FAO) expert consultation on revision of (FAO) methodologies for crop water requirements (Smith *et al.* 1992) recommended that the FAO-PM equation could be used as the standard method to estimate ETo. More recently, the American Society of Civil Engineers (ASCE) also recommended that the FAO-PM equation could be used to estimate ETo (ASCE-EWRI, 2005). The ASCE equation for ETo using daily data is identical to that of Allen *et al.* (1998) and Smith *et al.* (1992), but the hourly equation is slightly different (i.e., the canopy resistance is fixed at 70 sm^{-1} in the FAO hourly equation, whereas it is 50 sm^{-1} during daytime and 200 sm^{-1} during nighttime in the ASAE recommendation).

Estimating ETo with FAO-PM equation frequently results in a good agreement with the observed data from lysimeters (Jensen *et al.*, 1990 and Steiner *et al.*, 1991). El-Saadawy (2004) studied the relative performance of six different equations on Bostan region (Nobaria sector, Egypt). He recommended that, a map of Kp for different areas in Egypt should be created to help farmers in estimating the quantity of water that could be applied.

This study was planted to: 1) evaluate the accuracy of Kp equations to estimate ETo by comparing them against the FAO-PM equation under the climatic conditions of Fayoum Governorate, 2) test the accuracy of Kp equations for estimating ETc (Epan ×Kp×Kc) by comparing them against the ETc of grain sorghum crop under Fayoum Governorate climatic conditions carried out by (Abdou, 2004).

MATERIALS AND METHODS

Study Area and Weather Station

Monthly mean weather data for a 10-year (January 1997–December 2006) period were obtained from Atsa weather station, Fayoum Governorate, where' Longitude is 30°.85' E, Latitude is 29°.3' N, Altitude is -25 m and the fetch (F) of short vegetation around the evaporation pan is 1000 m. Monthly mean relative humidity, wind speed and class A pan evaporation for Atsa Weather Station are shown in Fig.1.

Equations Used to Calculate Pan Coefficient

In the last decade, several Kp equations have been developed, including Cuenca (1989), Allen and Pruitt (1991), Snyder (1992), Orang (1998) and Raghuwanshi and Wallender (1998). The equations developed by Cuenca (1989), Snyder (1992) and Raghuwanshi and Wallender (1998) were based on the FAO-24 Kp table, while those of Allen and Pruitt (1991) and Orang (1998) were developed using the original Kp data that were first published in Allen and Pruitt (1991) and upon which the FAO-24 table was developed. Grismer *et al.* (2002) followed the Snyder (1992) approach, but based their equation on the original data table and referred to it as the Grismer *et al.* (2002) equation.

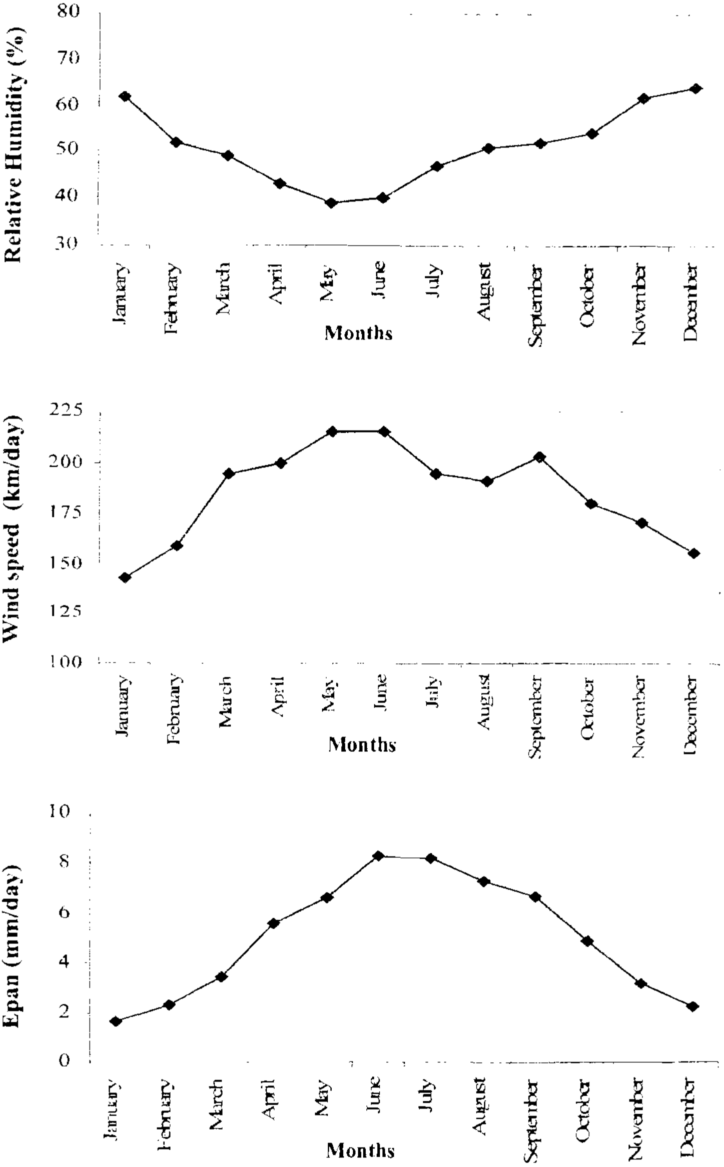

Fig. 1. Monthly mean relative humidity, wind speed and class A pan evaporation of average of ten years for Atsa Station

The derived Allen *et al.* (1998) regression equation was based on the original Kp table. Snyder *et al.* (2005) developed a new model to estimate ETo where the Epan data were first adjusted to estimate evaporation from a pan with 100m of fetch ($Epan_{100}$) and then the Kp values were estimated as a function of the $Epan_{100}$ rate. This will be used to eliminate the need for wind speed and relative humidity data and simplifies the conversion of Epan to ETo.

The equations to calculate daily Kp are summarized as:

1) Cuenca (1989)

$$Kp = 0.475 - 2.4\times10^{-4}(U) + 5.16\times10^{-3}(RH) + 1.18\times10^{-3}(F) - 1.6\times10^{-5}(RH)^{2} - 1.01\times10^{-6}(F)^{2} - 8.0\times10^{-9}(RH)^{2}(U) - 1.0\times10^{-8}(RH)^{2}(F) \ldots\ldots (1)$$

2) Allen and Pruitt (1991)

$$Kp = 0.108 - 0.000331(U) + 0.0422\ln(F) + 0.1434\ln(RH) - 0.000631\,[\ln(F)]^{2}\ln(H) .. (2)$$

3) Snyder (1992)

$$Kp = 0.482 - 0.000376(U) + 0.024\ln(F) + 0.0045(RH) \ldots\ldots\ldots\ldots (3)$$

4) Orang (1998)

$$Kp = 0.51206 - 0.000321\,(U) + 0.002889\,(RH) + 0.031886\ln(F) - 0.000107H\ln(F) \ldots (4)$$

5) Grismer *et al.* (2002)

$$Kp = 0.5321 - 0.0003(U) + 0.0249\ln(F) + 0.0025(RH) \ldots\ldots\ldots\ldots (5)$$

Where:

RH =Daily mean relative humidity (%),
U =Daily mean wind run (km/day),
F =Fetch distance (m) defined by Doorenbos and Pruitt (1977).

6) Raghuwanshi and Wallender (1998)

$$Kp = 0.5944 + 0.0242\,X1 - 0.0583\,X2 - 0.1333\,X3 - 0.2083\,X4 + 0.0812\,X5 + 0.1344X6 \ldots\ldots (6)$$

Where:

X1 = ln(F);
X2 ,X3,X4 = 0 (if category is not present) or 1 (if present), corresponding to wind run categories of 175–425, 425–700, and > 700 km/day, respectively;
X5 ,X6 = 0 (if category is not present) or (1 if present), corresponding to relative humidity categories of 40–70 and > 70%, respectively.

7) Allen *et al.* (1998)

$Kp = 0.108 - 0.0286(U) + 0.0422 \ln(F) + 0.1434 \ln(RH) - 0.000631 [\ln (F)]^2 \ln (RH)$ ....(7)

Where: U daily mean wind run, m/s.

8) Snyder *et al.* (2005)

$Epan_{100} = E_{pan} \times F_{100}$ ....(8)

$F_{100} = -0.0035(\ln (F))^2 + 0.0622 (\ln(F)) + 0.79$...............(9)

$$ETo = 10 \sin\left[\left(\frac{Epan_{100}}{192}\right)\frac{\pi}{2}\right] \quad ......(10)$$

$Epan_{100}$: pan evaporation for 100m of fetch (F_{100}),

The FAO-PM equation was used with the daily meteorological data to estimate ETo, and these values were compared to the ETo obtained from (Epan×Kp) calculated from previous equations. The daily-time-step, FAO-PM equation as given by Allen *et al.* (1998) is as follows:

$$ETo = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{(T_{mean} + 273)} u_2(e_s - e_a)}{\Delta + \gamma.(1 + 0.34U_2)} \quad ....(11)$$

Where:

Δ = Slope of the saturation vapor pressure curve at air temperature (kPa $^0C^{-1}$),

R_n = Net radiation at the crop surface (MJm^{-2} d^{-1}),

G =Soil heat flux density (MJm^{-2} d^{-1}),

γ = Psychometric constant = $0.665 \times 10^{-3} \times P$, kPa $^0C^1$ (Allen *et al.*, 1998),

U_2 = Wind speed at 2 m height (m s^{-1}),

e_s = saturation vapor pressure (kPa),

e_a = actual vapor pressure (kPa),

$(e_s - e_a)$ = saturation vapor pressure deficit (kPa)

T_{mean} =mean daily air temperature at 2m height (^0C).

Assessment of Pan Coefficient Equations

Assessment of the relative performance of each (Kp) equation was based on:

- Comparing mean, standard deviation (SD), percent error (PE%), linear coefficients of determination (R^2), linear regression (Y) and standard errors of estimate (SEE) against Kp equations to estimate ETo and FAO-PM.

-Comparing ETc estimated by Kp

equations (ETc=Kp×Epan×Kc) and measuring ETc of grain sorghum crop under Fayoum Governorate conditions with the results reported by (Abdou, 2004).

RESULTS AND DISCUSSION

The 10-year means of monthly measured class A evaporation Epan are given in Fig. 1 showing that the peak values of Epan at the Atsa weather station occur in June and July (8.28 and 8.21 mm/day), respectively. The daily Epan values ranged from 1.70 mm/day in January to 8.28 mm/day in the peak month of June.

To find the best indicators and assess reliability of ETo equation to match the FAO-PM; the mean predicted ETo, standard deviation (SD), percent error (PE %), linear regression (Y), the linear coefficients of determination (R^2) and standard errors of estimate (SEE) were calculated by comparing the above equations results with those obtained from FAO-PM equation specific to the Atsa station. The results are summarized in Table 1 and Fig. 2.

PE of mean daily estimates of each method was computed to relative to the FAO-PM Table 1. A positive or negative PE indicates overestimation or underestimation compared to the FAO-PM, respectively. A linear regression analysis was calculated using the equation ETo values (Y) as the dependent variable and the FAO-PM values (X) as the independent variable. The regression was forced through the origin giving the equation: $Y = a X$

The coefficient (a) is the slope of the regression line through the origin. To choose the most suitable equation, Parmele and McGuinness (1974) reported that the best method is the one with the slope 'a' closest to unity, the smallest SEE, and the highest R^2. Other literature indicates that the best equation gives a PE that is close to zero with mean predicted ETo close to FAO-PM.

As shown in Table 1, the mean values of ETo ranged between 3.87± 0.0175 for Grismer *et al.* (2002) equation to 5.01± 0.0207 for FAO-PM equation (1998). All equations underestimated PE relative to the FAO-PM equation. Also all equations similar results than those of FAO-PM, but ETo estimated by Snyder *et al.* (2005) equation (4.13 mm/day) was closest to that obtained from FAO-PM (5.01 mm/day).

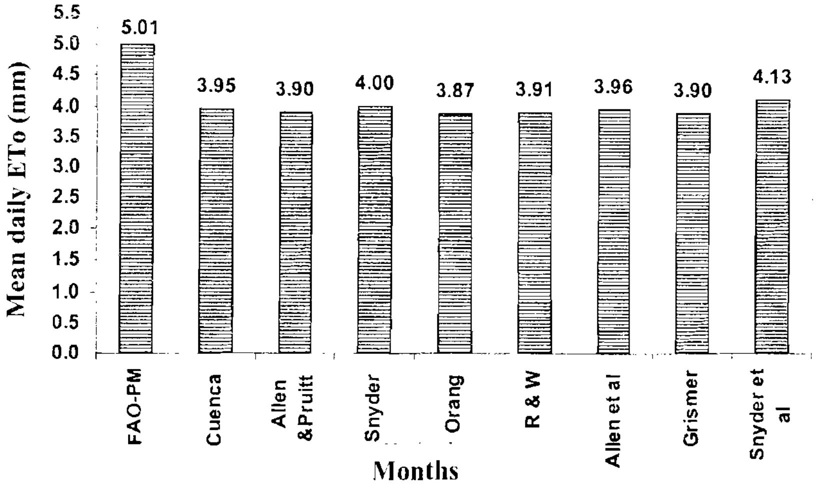

Fig. 2. The mean daily ETo from Kp and FAO-PM equations

Table 1. The mean daily of ETo, SD, PE, coefficient (a), R^2 and SEE estimated by Kp equations and FAO-PM equation

Methods	Mean mm/day	SD	PE (%)	a	R^2	SEE
FAO-PM	5.01	0.0207	--	--	--	--
Cuenca	3.95	0.0180	-22.38	0.7964	0.956	1.206
Allen &Pruitt	3.90	0.0177	-23.21	0.7872	0.956	1.254
Snyder	4.00	0.0177	-20.70	0.8032	0.947	1.180
Grismer *et al.*	3.87	0.0175	-23.81	0.7801	0.956	1.291
Orang	3.91	0.0178	-23.18	0.7879	0.957	1.249
R&W	3.96	0.0179	-21.83	0.7968	0.940	1.225
Allen *et al.*	3.90	0.0177	-23.21	0.7872	0.956	1.254
Snyder *et al.*	4.13	0.0184	-18.79	0.8309	0.969	1.005

The Snyder *et al.* (2005) equation produced remarkable estimates of the daily ETo that resulted in the mean daily ETo which was close to the FAO-PM Table 1. The PE = -18.79% is close to zero. Regression coefficient from the Snyder *et al.* (2005) equation was the closest value to 1.0 it had the lowest SEE, and the highest R^2 values Table 1. The Snyder *et al.* (2005) equation gave ETo value close to the FAO-PM among all methods.

The results obtained Form Atsa weather station are in agreement with that of Snyder *et al.* (2005), who pointed out that their equation, was more accurate than the other methods' equations for the studied locations; therefore, it was recommended for calculating Epan to ETo conversions. The Snyder (1992) equation ranked the second and the other methods ranked in the third group based on the previous statistical parameters.

To get the best-related equation to the measured ETc of grain sorghum, the mean daily and seasonal ETc values, SEE, coefficient (a) and PE estimated are presented in Table 2.

The daily average ETc values estimated from the predicted Kp equations generally gave lower values than the measured ETc as shown in Fig. 3 and Table 2. The measured ETc for grain sorghum crop ranged from 3.17 mm/day in October to 5.97 mm/day in August with seasonal of 660.75mm. The PE of daily average ETc values, estimated by Kp equations, generally gave lower results than the measured ETc.

The daily and seasonal ETc calculated by Snyder *et al.* (2005) equation was more accurate when daily and seasonal ETc used as a reference under the local climate conditions Table 2. Based on the daily and seasonal values for ETc, PE, coefficient (a) and SEE, the Snyder *et al.* (2005) equation ranked first with mean daily ETc = 3.67mm and seasonal ETc = 549.95mm, respectively. It was close to the measured daily ETc= 4.41 and seasonal ETc = 660.75mm. Also, the PE = -16.99 % was close to the measured ETc with the lowest SEE = 0.851. Finally, the coefficient (a) (0.8343) is close to 1.0.

Sometimes, wind speed and relative humidity are unavailable at pan evaporation sites, so Snyder *et al.* (2005) equation was found to be the most suitable one for estimating ETo.

Table 2. The mean daily and seasonal ETc values, SEE, PE and coefficient (a) estimated by Kp equations and measured for sorghum crop under Fayoum conditions

Monthes	Measured	Cucnca	Allen-Pruitt	Snyder	Grismer	Orang	R&W	Allen	Snyder *et al*
June	3.65	2.97	2.94	2.94	2.91	2.95	3.09	2.94	3.11
July	4.84	4.16	4.12	4.20	4.07	4.12	4.19	4.12	4.22
August	5.97	4.92	4.86	5.01	4.81	4.85	4.88	4.86	5.01
September	4.40	3.34	3.29	3.40	3.27	3.29	3.31	3.29	3.44
October	3.17	2.44	2.42	2.51	2.40	2.41	2.40	2.42	2.55
ETc (mm/day)	4.41	3.57	3.52	3.61	3.49	3.52	3.57	3.52	3.67
ETc (mm/ season)	660.75	534.94	528.74	541.72	523.81	528.60	535.79	528.74	549.95
SEE	--	0.959	1.006	0.904	1.043	1.008	0.964	1.006	0.851
PE (%)	--	-19.44	-20.37	-18.44	-21.10	-20.38	-19.25	-20.37	-16.99
a	--	0.8132	0.8038	0.824	0.7963	0.8035	0.8137	0.8038	0.8343
R2	--	0.9655	0.965	0.9711	0.9659	0.9644	0.9514	0.965	0.9727
m^3/fed.	2775	2247	2221	2275	2200	2220	2250	2221	2310

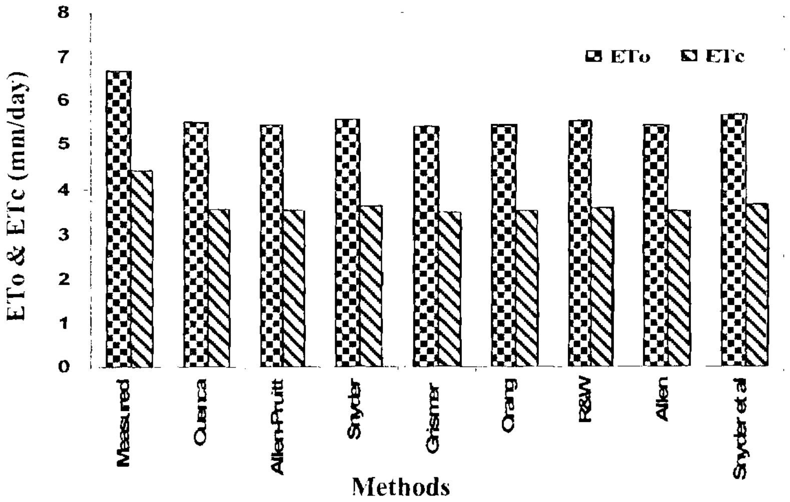

Fig. 3. The mean daily ETo and ETc estimated by Kp equations and measured for sorghum crop under Fayoum conditions

Conclusion

The equations of Cuenca (1989), Allen and Pruitt (1991), Snyder (1992), Orang (1998), Raghuwanshi and Wallender (1998), Allen, *et al.* (1998), Grismer *et al.* (2002) and Snyder *et al.* (2005) were evaluated to predict Kp for calculating ETo using weather data for a 10-year period (January 1997 – December 2006) obtained from Atsa Weather Station, Fayoum Governorate. The relative performance of Kp prediction equations to estimate ETo by comparing them against the FAO-PM equation was evaluated using the mean, standard deviation (SD), percent error (PE), linear coefficient of determination (R^2), linear regression (Y), and standard errors of estimate (SEE).

All equations gained similar and lower results than those of FAO-PM and ETc of grain sorghum, but ETo estimated by Snyder *et al.* (2005) equation was the closest to that obtained from FAO-PM and ETc of grain sorghum.

The Snyder *et al.* (2005) equation produced remarkable estimates of the daily ETo resulted in the mean daily ETo that is close to the FAO-PM. The PE is close to zero. Regression coefficient from the Snyder *et al.* (2005) equation is the closest value to 1.0 it had the lowest SEE and the highest R^2 values. The Snyder *et al.* (2005) equation gave ETo value close to the FAO-PM among all methods. It also ranked first for the comparisons of mean daily and seasonal ETc from measured ETc for grain sorghum crop under Fayoum region climate conditions carried out by Abdou (2004). The PE value was close to zero and it had the lowest SEE. The Snyder (1992) equation ranked the second, while the other methods ranked in a descending order; Allen and Pruitt (1991), Allen *et al.* (1998), Raghuwanshi and Wallender (1998), Orang (1998) and Grismer *et al.* (2002), respectively.

Finally, Snyder *et al.* (2005) equation is the most suitable one at the pan evaporation sites that unavailable wind speed and relative humidity. As a conclusion, a complete map of Kp for different areas in Egypt should be created to help farmers in estimating the quantity of water should be applied.

REFERENCES

Abdou, S.M. 2004. Scheduling grain sorghum irrigation using pan evaporation under different management systems. Ph.D. Thesis, Fac. Agri., El-Fayoum, Cairo University.

Allen, R.G. and W.O. Pruitt. 1991. FAO-24 reference evapotranspiration factors. J. Irrig. Drain. Eng., 117(5), 758–773.

Allen, R.G., L.S. Pereira, D. Raes and M. Smith. 1998. Crop evapotranspiration (guidelines for computing crop water requirements FAO Irrigation and Drainage Paper No.56.

ASCE-EWRI. 005. The ASCE Standardized Reference Evapotranspiration Equation. Technical Comm. Rep. to the Environ. and Water Res. Inst. of the Amer. Soc. of Civil Eng. from the Task Comm. on Standardization of Reference Evapotranspiration. p173.

Cuenca, R.H. 1989. Irrigation system design: An engineering approach, Prentice-Hall, Englewood Cliffs, N.J., 133.

Doorenbos, J. and W.O. Pruitt. 1977. Crop water requirements. FAO Irrigation and Drainage Paper No.24 united Nations – Food and Agricultural Organization, Roma, Italy.

Eid, H.M., M.A. Metwally and F.N. Mahrous. 1982. Evaporation pan as index to consumptive use of water and scheduling irrigation in some field crops. Agric. Res. Rev. Vol. 60 No. 5.

El-Marsafawy-Samia, M. (2000). Scheduling irrigation of wheat crop under different phosphorous fertilizer application times in Middle Egypt. The 5th Conference – Meteorology & Sustainable Development, P: 182-195.

El-Saadawy, M.A. 2004. Comparison study of pan coefficient models. Misr J. Ag. Eng., 21 (3):841-850.

Ertek, A., S. Sensoy, I. Gedik and C. Kucukyumuk. 2006. Irrigation scheduling based on pan evaporation values for cucumber (*Cucumis sativus L.*) grown under field conditions. Agric. Water Manage. 81 (1), 159–172.

Grismer, M.E., M. Orang, R. Snyder and R. Matyac. 2002. Pan Evaporation to Reference Evapotranspiration Conversion Methods. J. Irrig. Drain. Eng., 128 (3), 180-184.

Irmak, S., D.Z. Haman and J.W. Jones. 2002. Evaluation of class A pan coefficients for estimating reference evapotranspiration in humid location. J. Irrg. Drain. Eng., 128(3), 153-159.

Jensen, M. E., R.D. Burman and R. G. Allen. 1990. Evapotranspiration and irrigation water requirements. New York: ASCE. 332p. Manuals and reports on engineering practice.

Orang, M. 1998. Potential accuracy of the popular non-linear regression equations for estimating pan coefficient values in the original and FAO-24 tables.

Raghuwanshi, N.S. and W.W. Wallender. 1998. Converting from pan evaporation to evapotranspiration. J. Irrig. Drain. Eng., 124 (5), 275-277.

Rayan, A.A., F.A. Khalil, T.M. El-Amin and M. El-Marsafawy-Samia. 2000. Scheduling irrigation of cotton crop under different nitrogen fertilizer levels in upper Egypt. The 5th Conference Meteorology & Sustainable Development.

Parmele, L.H. and J.L. McGuinness. 1974. Comparison of measured and estimated daily potential evapotranspiration in a humid region. J. Hydrology. 22 (1974), 239-251.

Phene, C.J. and R.B. Campbell. 1975. Automating pan evaporation measurements for irrigation control. Agric. Meteorol., 15(2), 181-191.

Smith, M., R.G. Allen, J.L. Montieth, A. Perrier,L. Pereira and A. Segeren. 1992. Report of the expert consultation on procedures for revision of (FAO) guideline prediction of crop water requirements. UN-FAO, Roma, Italy.

Snyder, R.L. 1992. Equation for evaporation pan to evapotranspiration conversions. J. Irrig. Drain. Eng., 118 (6): 977-980.

Snyder, R.L., M. Orang, S. Matyac and M.E. Grismer. 2005. Simplified Estimation of Reference Evapotranspiration from Pan Evaporation Data in California. J. Irrig. Drain. Eng., 131(3): 249 – 253.

Steiner, T.A., T.A. Houer, and A.D. Scheider. 1991. Lysimetric evaluation of daily potential evapotranspiration models for grain sorghum. Agronomy Journal, Madison, 83 (1) : 240-247.

تقييم بعض معادلات معامل وعاء البخر تحت ظروف محافظة الفيوم

محمد حسن عبد الواحد

قسم الأراضي والمياه (هندسة زراعية) - كلية الزراعة - جامعة بالفيوم

يعتبر تقدير البخر نتح القياسي احد العوامل الهامة في إدارة المياه لري المحاصيل. وتتوقف دقة حساب البخر نتح القياسي باستخدام وعاء البخر علي دقة اختيار معامل وعاء البخر المستخدم في الحساب. لذلك أجريت هذه الدراسة لتقييم 8 معادلات لحساب معامل وعاء البخر تحت ظروف محافظة الفيوم باستخدام البيانات المناخية لمحطة اطسا في الفترة من (1997-2006). وقد تم مقارنة قيم البخر نتح المتحصل عليها من تلك المعادلات مع مثيلتها الناتجة من كل من معادلة فاو- بنمان مونتيث (1998) والاستهلاك المائي لمحصول السورجم المزروع بمنطقة الدراسة باستخدام بعض التحاليل الإحصائية منها الخطأ المعياري والنسبة المئوية للخطأ ومعامل الانحدار ومعامل التقدير، وذلك لاختيار انسب معادلة لحساب معامل وعاء البخر تحت ظروف محافظة الفيوم.

وقد ثبت من الدراسة أن كل المعادلات المختبرة أعطت نتائج متقاربة ولكنها اقل من المتحصل عليها من معادلة فاو- بنمان مونتيث، باستثناء قيم البخر نتح المتحصل عليها من معادلة سنيدر وآخرون (2005) والتي كانت اقرب إلى القيم المتحصل عليها من معادلة فاو- بنمان مونتيث و والاستهلاك المائي لمحصول السورجم وذلك اعتمادا علي التحاليل الإحصائية. وتعتبر معادلة سنيدر وآخرون (2005) هي انسب معادلة يمكن استخدامها لحساب البخر نتح في المناطق التي لا تتوفر بها بيانات عن سرعة الرياح والرطوبة النسبية.