

Relationship between actual evapotranspiration estimated by water balance method and soil moisture depletion method

By

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Background

- **Availability of fresh water and Share of irrigation in it is decreasing day by day**
- **Need for accurate estimation of the seasonal actual evapotranspiration (SET) of crops for judicious use of this precious natural resource.**
- **Different methodologies are used to estimate SET.**
- **Accurate estimation of SET requires sophisticated instruments along with huge man power.**
- **Screening of most effective method which can estimate SET to the close proximity of the recommended method.**

Objective

To compare status of SET estimated through depletion method over the field water balance method.

Materials and methods

Study site: Central Research Farm of the University at Gayespur (22° 58' N, 88° 31' E and 9.75 m amsl).

Study period: Winter season of 2003-04 and 2004-05.

Soil type: Fine loamy Climate: Hot sub-humid.

Test Crop: Tomato (F₁ hybrid CV. Rocky)

Individual sub-plot size: 4.9m x 4.2m =20.58 m²

Date of transplanting: 4.11.03 (2003-04)

10.11.04 (2004-05).

Age of transplanted seedling: 30 days in both the years

Experimentation

Design – Split-plot, **Replications** – Three

Main Plot Treatments (Irrigation frequency):

Rainfed- Crop was grown under rainfed condition,

Epan_{50mm} – Crop was irrigated when cumulative pan evaporation (CPE) value was 50mm

Epan_{25mm} – Crop was irrigated when CPE value was 25mm.

Sub Plot Treatments (Mulch managements):

NM – No mulch; **RSM** – Rice straw mulch @5 t ha⁻¹;

WPM – White polyethylene mulch (30 μ thickness);

BPM – Black polyethylene mulch (30 μ thickness).

Depth of irrigation – 30 mm

Observation

- **Soil water content was measured thermogravimetrically at 0.0- 0.15, 0.15 – 0.3, 0.3 – 0.45 and 0.45 – 0.60 m profile layers at sowing and harvest dates, before and two days after each irrigation and after each notable rainfall (≥ 20 mm).**
- **Tensiometers were installed at 500 and 700 mm soil depths to estimate vertical soil water flux at 600 mm plane.**

Computation

Seasonal evapotranspiration (SET) was calculated using Water balance method (Standard method, SET_{watbal})

$$AET = P + I + C - D \pm \Delta SWS$$

Where, P is precipitation (mm), I is total irrigation water applied (mm), C is capillary contribution (mm), D is vertical drainage (mm) and ΔSWS is depletion in soil water storage (mm).

Moisture depletion method (Sepaskah and Kasetipur, 1994, SET_{dep})

$$\Delta SWS = \sum_{x=1}^n [(\theta_b - \theta_f) z_x] dt$$

where, x is number of layer, in the presently case it was 5, θ_b is the moisture content two days after irrigation; θ_f is the moisture content before the next irrigation, z_x is the thickness of particular soil layer, dt is the time interval between measurement of θ_b and θ_f .

Results

Table 1 Seasonal evapotranspiration (mm) calculated through depletion (SET_{dep}) and water balance (SET_{watbal}) methods under different irrigation regime

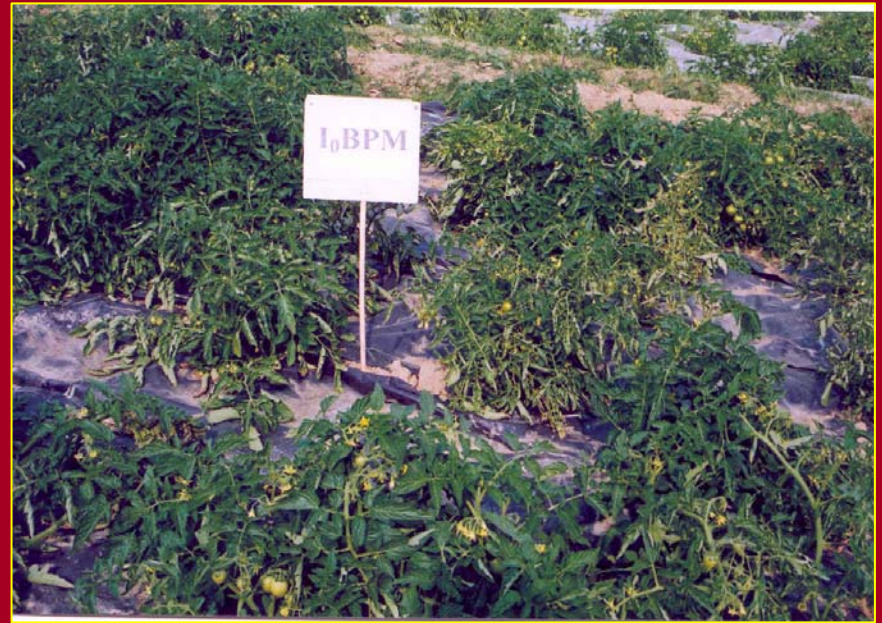
Treatment	SET_{dep}		SET_{watbal}	
	2003-04	2004-05	2003-04	2004-05
Irrigation regime				
RF	121.4	124.2	149.5	127.2
CPE₅₀	175.1	150.0	185.8	153.2
CPE₂₅	222.6	232.3	229.9	212.6

Table 2 Seasonal evapotranspiration (mm) calculated through depletion (SET_{dep}) and water balance (SET_{watbal}) methods under different mulch management

Treatme nt	SET_{dep}		SET_{watbal}	
	2003-04	2004-05	2003-04	2004-05
Mulch management				
NM	179.1	174.8	194.3	168.3
RSM	173.9	171.2	187.1	163.7
WPM	169.2	165.7	186.6	163.0
BPM	169.9	163.5	185.5	162.4



Rainfed-No Mulch



Rainfed-BPM



CPE₂₅-No Mulch



CPE₂₅-BPM

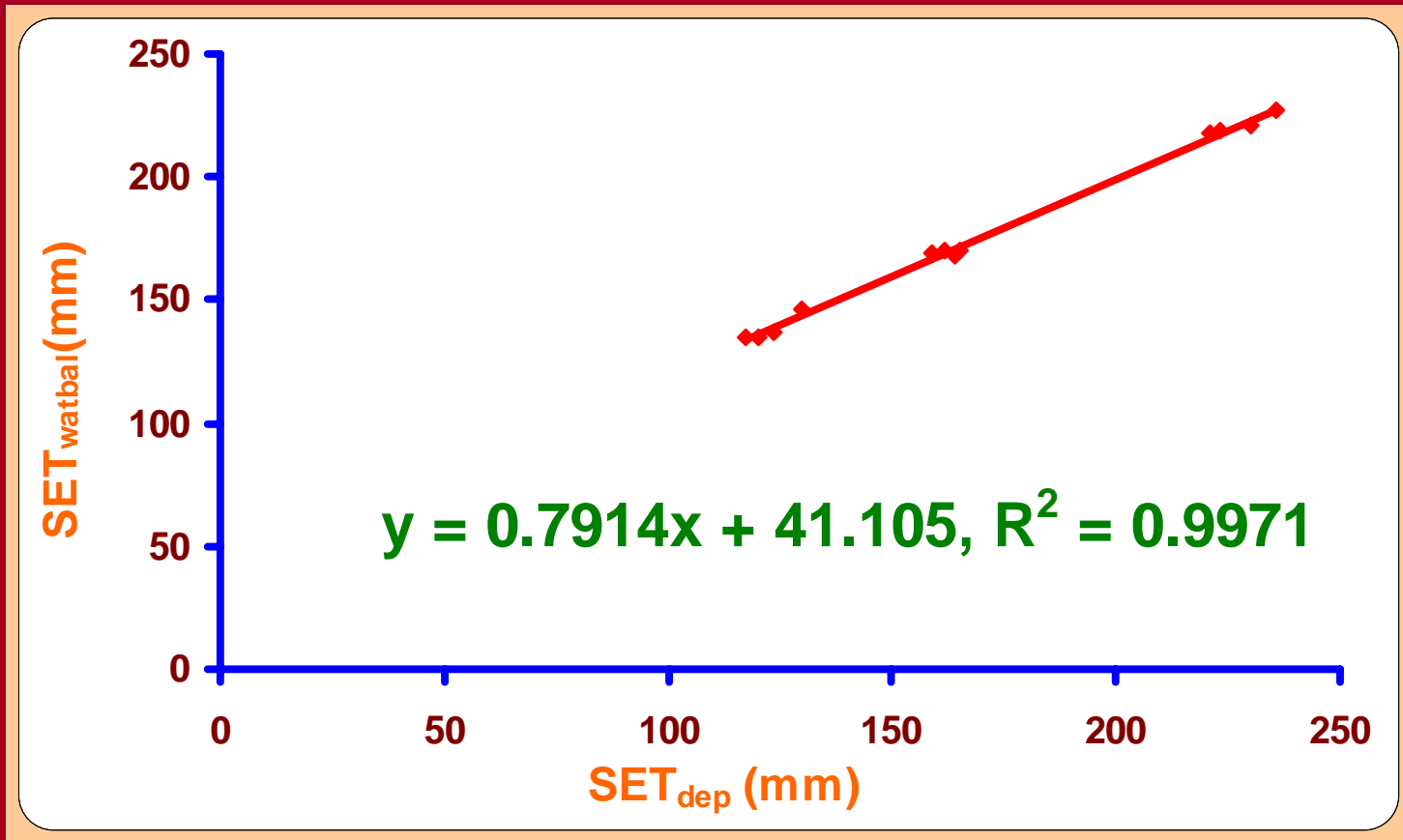


Fig. 1 Relationship between SET_{watbal} and SET_{dep}

Conclusion

- In comparison to water balance method, SET estimated by moisture depletion method underestimated SET by 11 % under rainfed condition, 4% under moderately wet (CPE_{50}) condition and overestimated by 3% under wet condition (CPE_{25}).
- Under different mulches, depletion method overestimated SET by 1 to 4% only compare to water balance method.
- Except dryland ecosystem, depletion method can be adopted in place of water balance method

Thank you