WATER USE EFFICIENCY OF COFFEE (*Robusta*) UNDER MULCH AND DRIP IRRIGATION ON THE TAY NGUYEN PLATEAU, VIETNAM

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Outline:

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I. Background of the coffee production in Viet Nam and Purpose of the study

1. In 2011: 1.2 million tones coffee bean (2.7 billion USD) has been exported
2. Area of coffee crop: around 290,000 ha, mostly on the Tay Nguyen Plateau, Central Part of VN. Coffee plantations are hilly with steep slopes
3. Annually 300,000 T N-P-K and 100,000 T Urea is applied to the crop
4. Erosion and: soil and nutrient loss causing euthrophication in watersheds

5. WUE and FUE of coffee is not well known but it's reportedly that these quantities are low.

Purpose of this study is to:

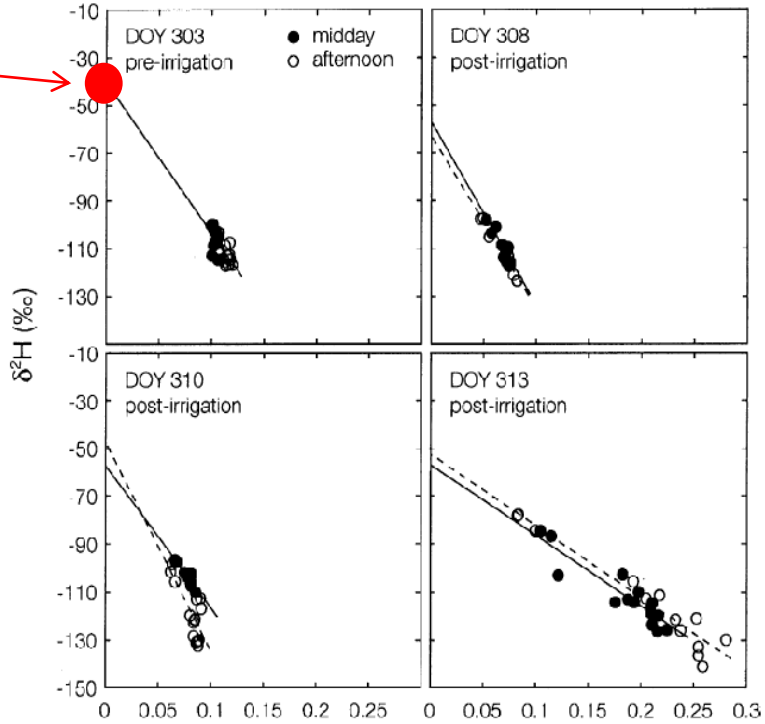
- estimate the WUE in different stages in one cycle of coffee development;
- assist the local farmers with appropriate approaches to improve WUE of the crop.

II. Experimental

- Isotopic technique was used to separate E&T from ET_c ,
- Approach for E&T separation was to construct "Keeling Plot" based on the isotopic composition ($\delta^{18}O/\delta^{2}H$) of the air moisture along the canopy [*Wang and Yakir, 2000; Williams et al., 2004*].

$$\delta_{moist} = C_{above}(\delta_{above} - \delta_{ET})\frac{1}{C_{moist}} + \delta_{ET} \quad (1)$$

δ_{ET}



or

$$\delta_{canopy} = K * \frac{1}{C_{canopy}} + \delta_{ET} \quad (2)$$

and

$$F_T = \frac{\delta_{ET} - \delta_E}{\delta_T - \delta_E} \quad (3)$$

Experiment (cont.)

- Experiments were conducted for 6 stages during a cycle of coffee (*Robusta*, 12 years, LAI 6-7) development as:

i) mature and harvesting stage
ii) reforming canopy,
iii) buds development
iv) flowering
v) bean formation, and
vi) bean development

Experimental (cont.)

- Experiment was conducted on 2 ha, split into 3 plots: one with traditional furrow irrigation no mulch, the second with drip irrigation but no mulch, the third with mulch (old branches) and drip irrigation

Soil in the Tay Nguyen plateau is clay.

Experiment (cont.)

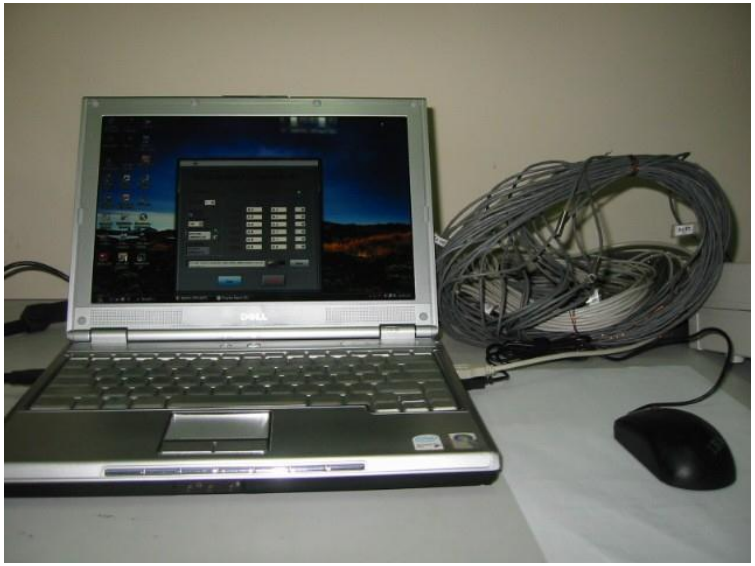
-Total amount of water irrigated along with the crop yield on each plot was recorded to estimate WUE.

-Air moisture along the canopy (20, 60, 120, 170 and 280 cm above the ground) was collected (10:00 AM-14:00 PM, 30 min interval) thrice for each stage using a set of cryogenic traps.

- Surface soils and skin of the secondary branches were collected also.

Experimental (cont.)

- The air moisture concentration (C_{moist}) at each sampling position was calculated based on the temperature of dry and wet bulb (psychometer) installed on the study areas and connected to a computer with software to record and further processing.



Experiment (cont.)

- In the Lab moisture from soils and plant skin was extracted using a cryogenic distillation line

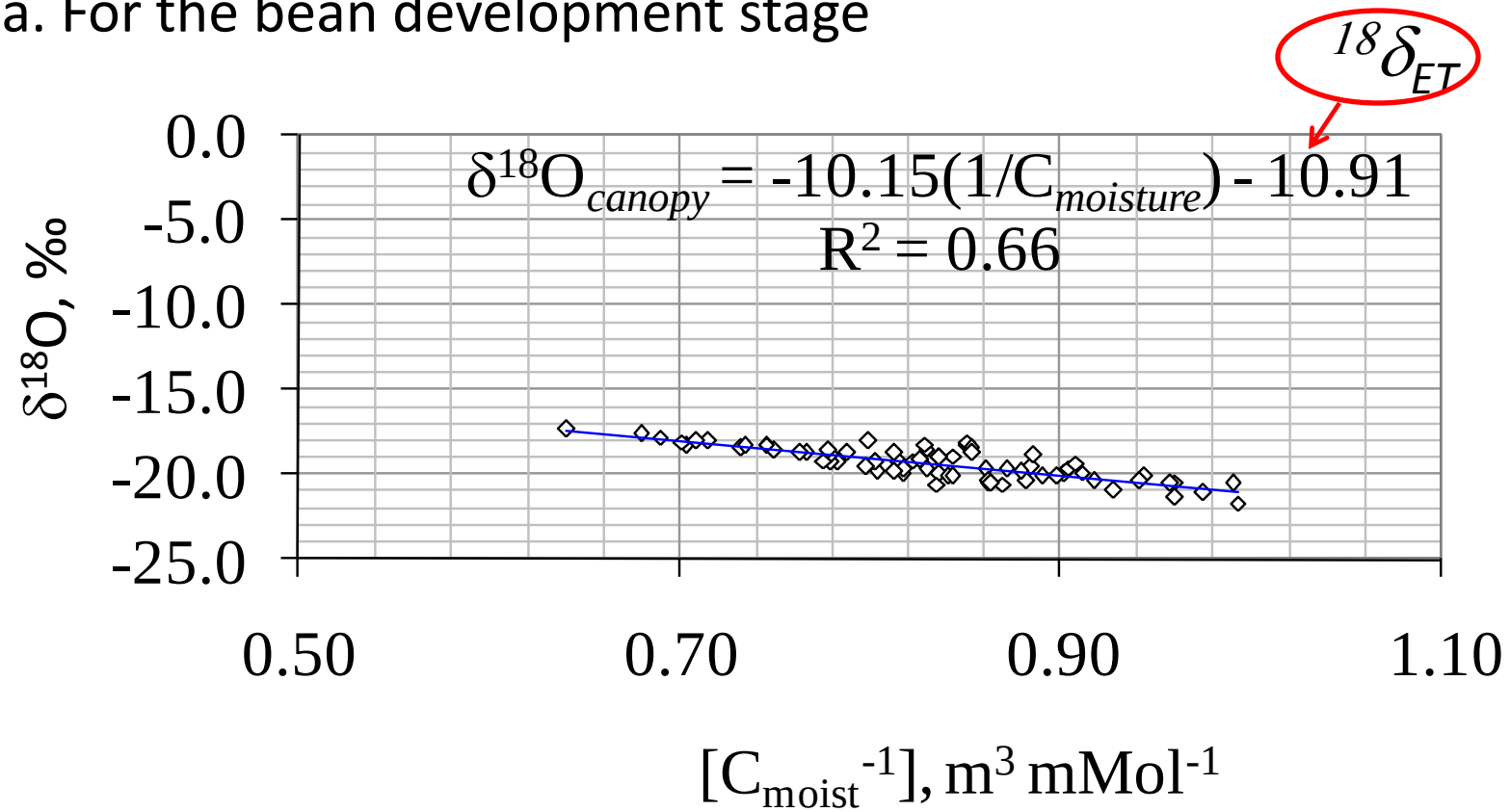
Experiment (cont.)

-Isotopic composition of moisture samples was analyzed using an IR-MS (Micro mass, UK)

III. Results and Discussions

1. E & T separation for coffee at different stages

1.a. For the bean development stage



$^{18}\delta_{ET}$ = -10.91‰; $^{18}\delta_T$ = -10.34‰; $^{18}\delta_E$ = -13.85 ‰ → T= 83%; E=17%

1.b. Summary of the results of isotopic compositions of moisture at different stages and *E&T* contribution in the ET_c

Stages	δ_{ET}(‰)	δ_E(‰)	δ_T(‰)	F_T (%)
Mature and canopy reforming (Sep-Nov)	-11.64 (5%)	-12.72 (10%)	-10.43 (7%)	47 (3%)
Buds development and flowering (Dec-Feb)	**-9.55 (7%)**	**-10.51 (6%)**	**-9.49 (10%)**	**94 (3%)**
Bean development (Apr-Aug)	-10.91 (3%)	-13.85 (5%)	-10.34 (5%)	84% (2%)

During the buds development and flowering stage coffee needs more water than any other stages.

2. Contribution of Transpiration of coffee with and without mulch and DI at the fowering stage

delta values, ‰	With mulch	Without mulch
δ_{ET}	-9.55	-9.14
δ_{E}	-10.51	-9.75
δ_{T}	-9.49	-9.01
F_T(%)	95 (±3)	83 (±2)

Mulch reduces evaporation of coffee.

3. T & E of coffee under different cultivation practices (at flowering stage)

- Traditional practice: T = 83%, E = 17%,
- Drip watering, no mulch: T = 85%, E = 13%
- Drip watering with mulch: T = 90%, E = 10%

Uncertainty of the estimate was within 5-7%

Transpiration rate of coffee under drip irrigation and mulch was the highest.

4. WUE of coffee under different irrigation practices

Cultivation Practices	Y, T ha^{-1}	Irrig. water, m^3 ha^{-1}	WUE, kg m^{-3}
Furrow Irrig., no mulch	3.2	2,882	1.11
Drip Irrig., no mulch	3.5	1,995	1.75
Drip Irrig., with mulch	3.8	1,784	2.13

WUE of coffee could be improved by 60 and 90% under drip irrigation without and with mulch, respectively, compared to that under traditional furrow irrigation and no mulch.
With 290,000 ha coffee plantation in the Tay Nguyen Plateau, the DI +M could save 320 millions m^3 of water and the extra-profit amounted in 295,800 tones of coffee bean or around 590 millions USD could be gained each year.

IV. Conclusions

-Coffee needs more water during the flowering stage made the T component of the ET_c to be highest (80-90%).

-The transpiration component of coffee under drip irrigation and mulch is higher (90-95)% than that in furrow irrigation and no mulch (80-85%).

- Compared to furrow irrigation and no mulch practice, WUE of coffee could be improved up to 60 and 90%, respectively, if drip irrigation but without and with mulch were applied.

-Local farmers were advised to apply drip irrigation and mulch practice to improve economic parameter in their coffee production.

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