Infrared Thermometry and Opportunities to Quantify Water Stress and Crop ET

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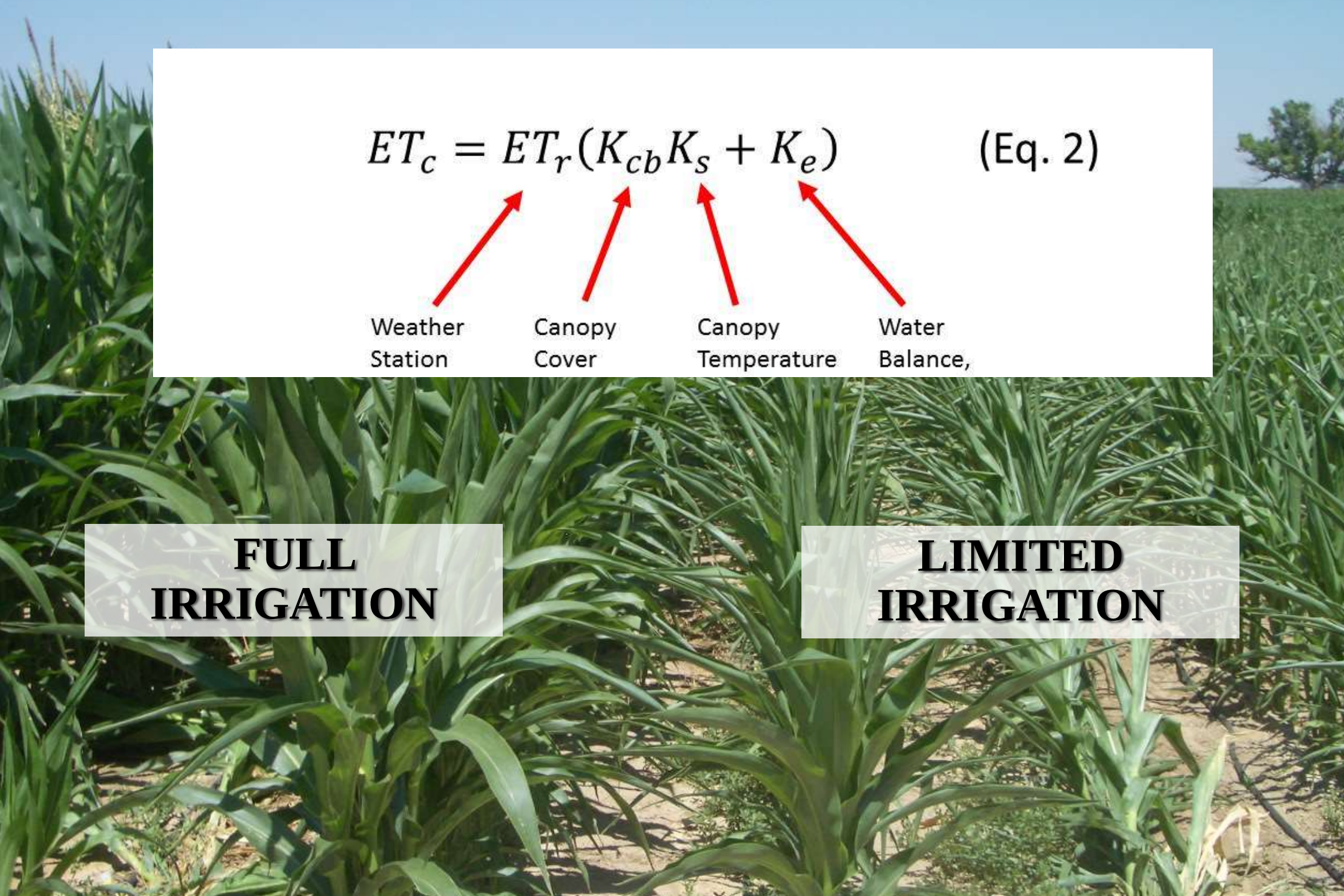
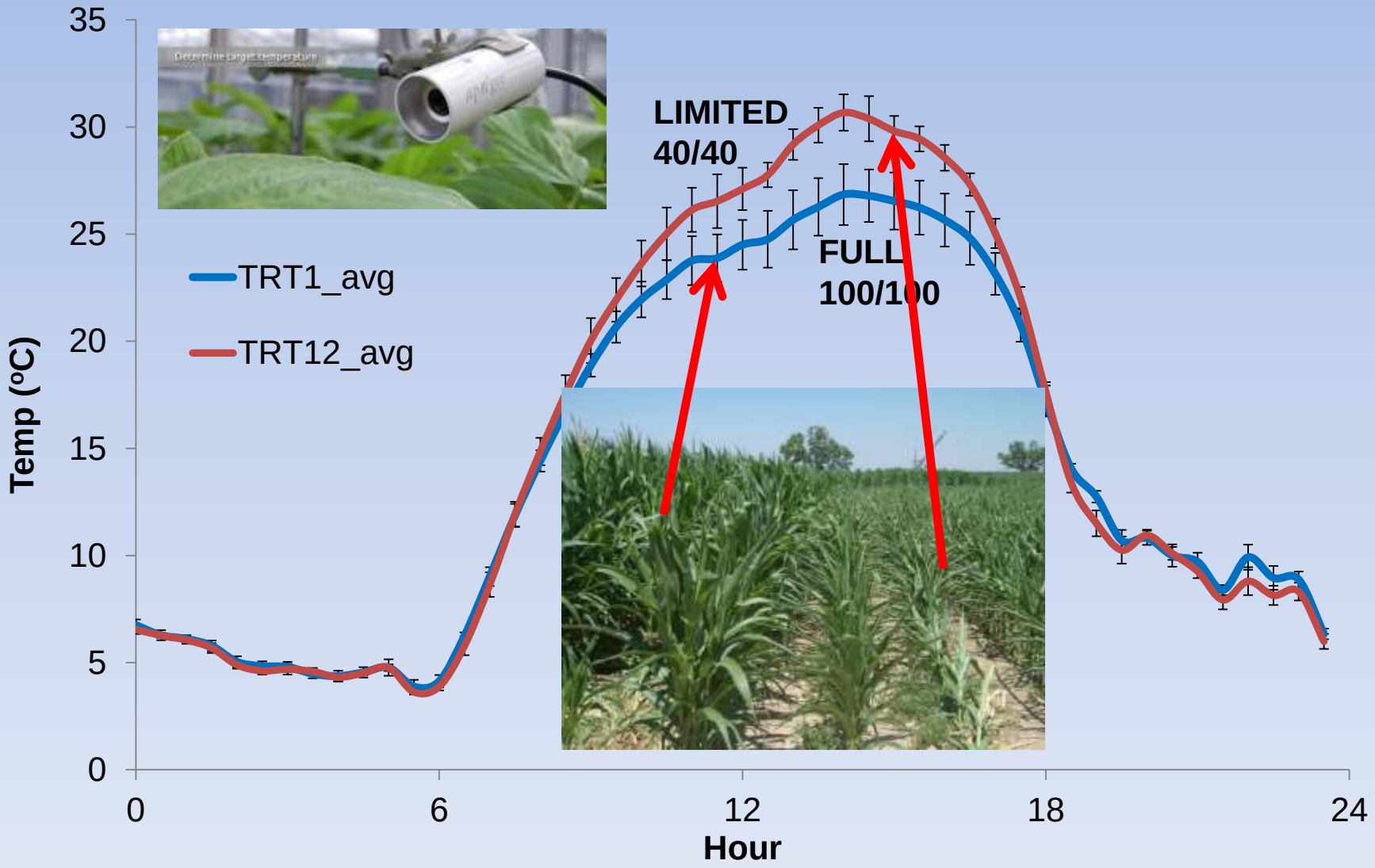
Water Management Research Unit
Fort Collins, CO

United States Department of Agriculture
Agricultural Research Service

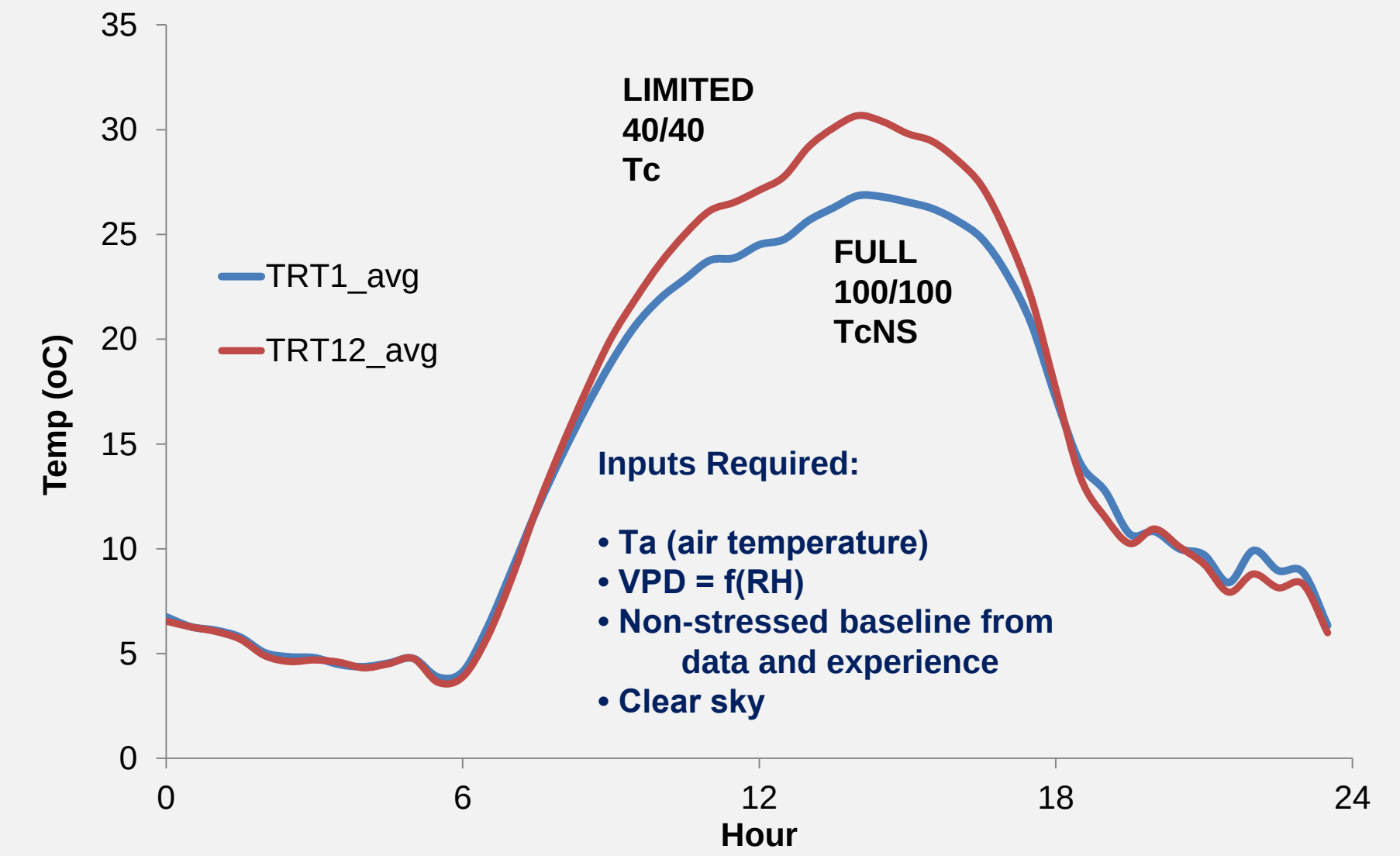
Innovations in Irrigation Water Management since 1911


$ET_c = ET_r(K_{cb}K_s + K_e)$ (Eq. 2)
Weather Station
Canopy Cover
Canopy Temperature
Water Balance,
FULL IRRIGATION
LIMITED IRRIGATION

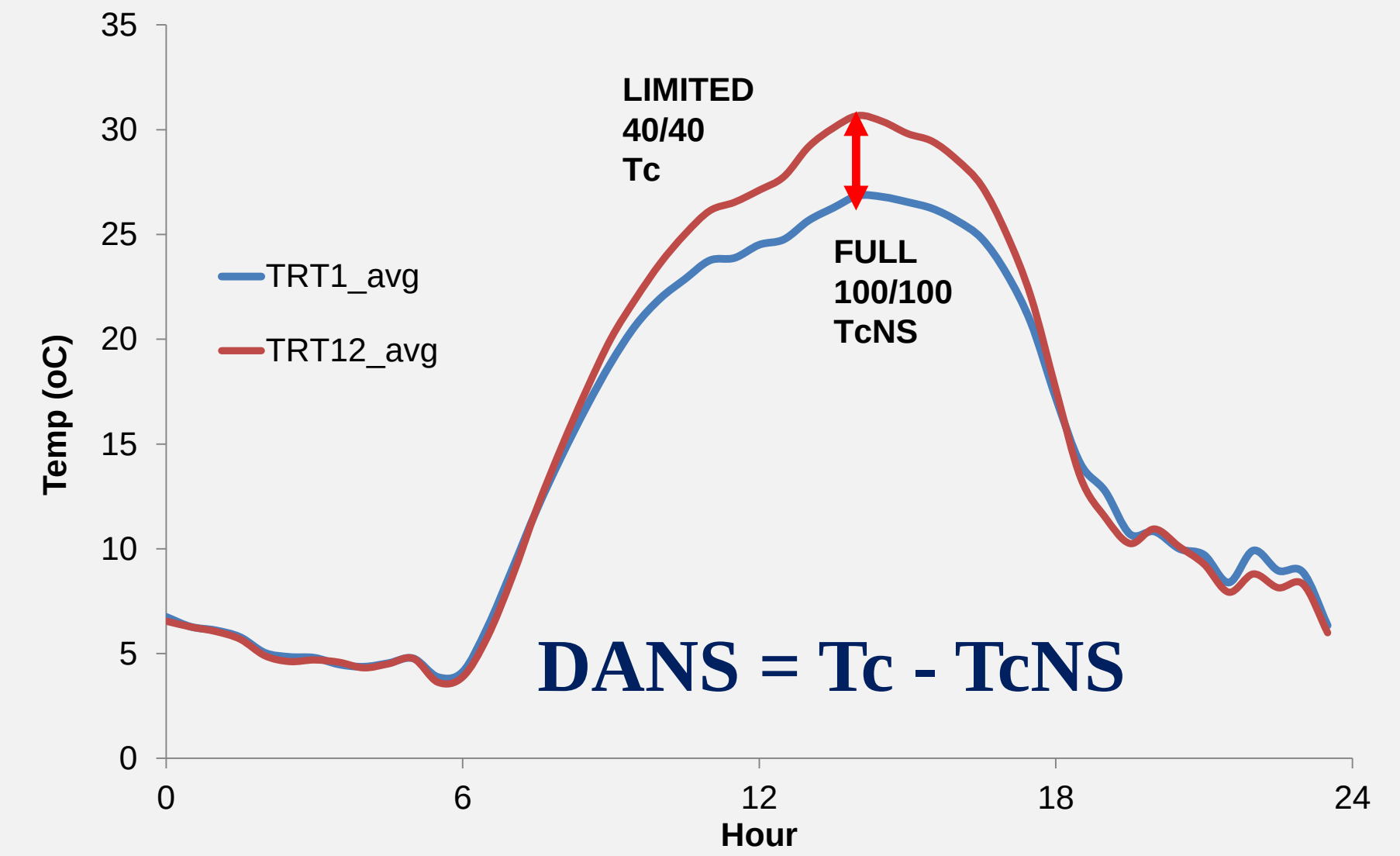
Continuous infrared thermometer (IRT)



Crop Water Stress Index (CWSI)

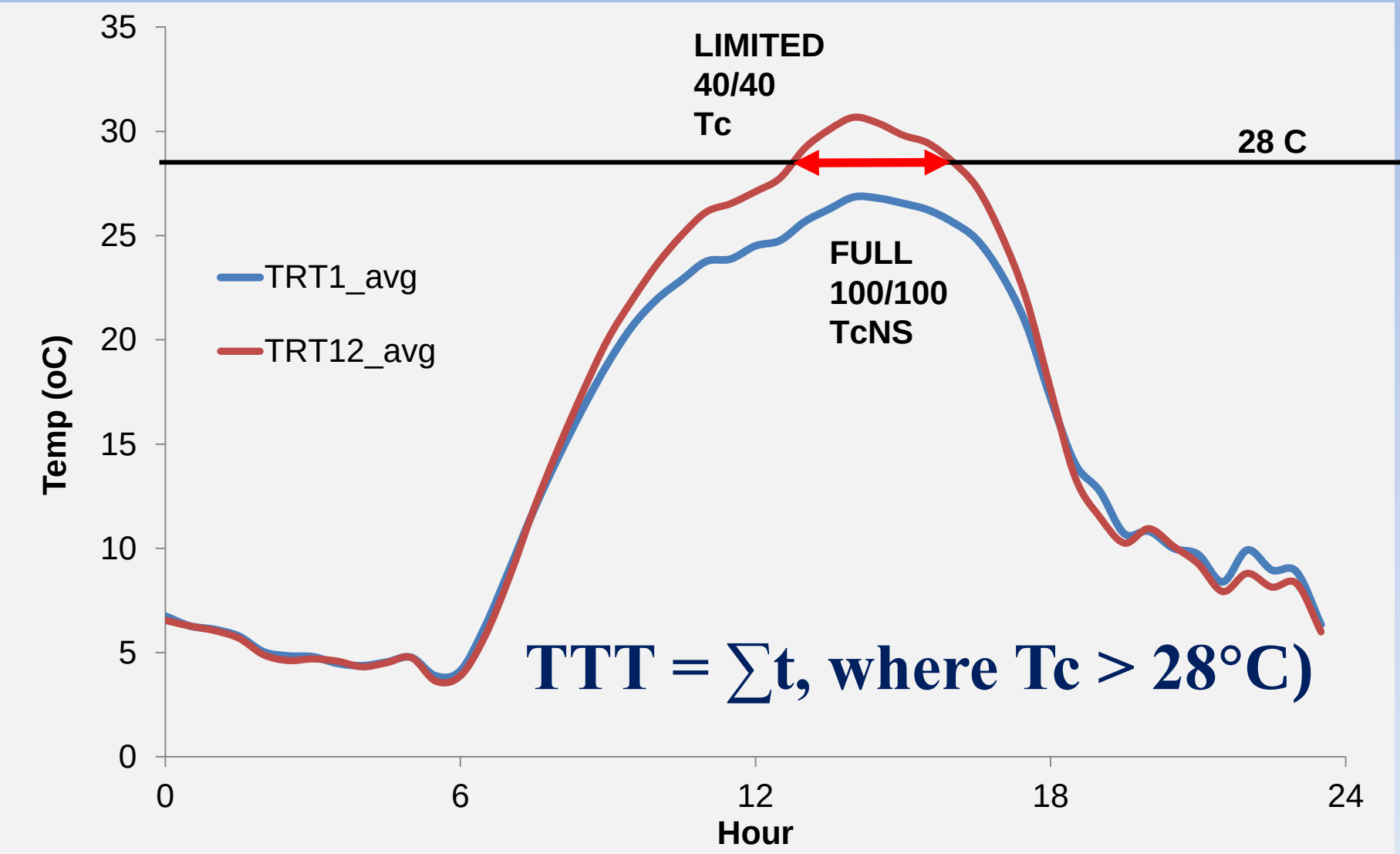


Degrees Above Non-Stressed (DANS)



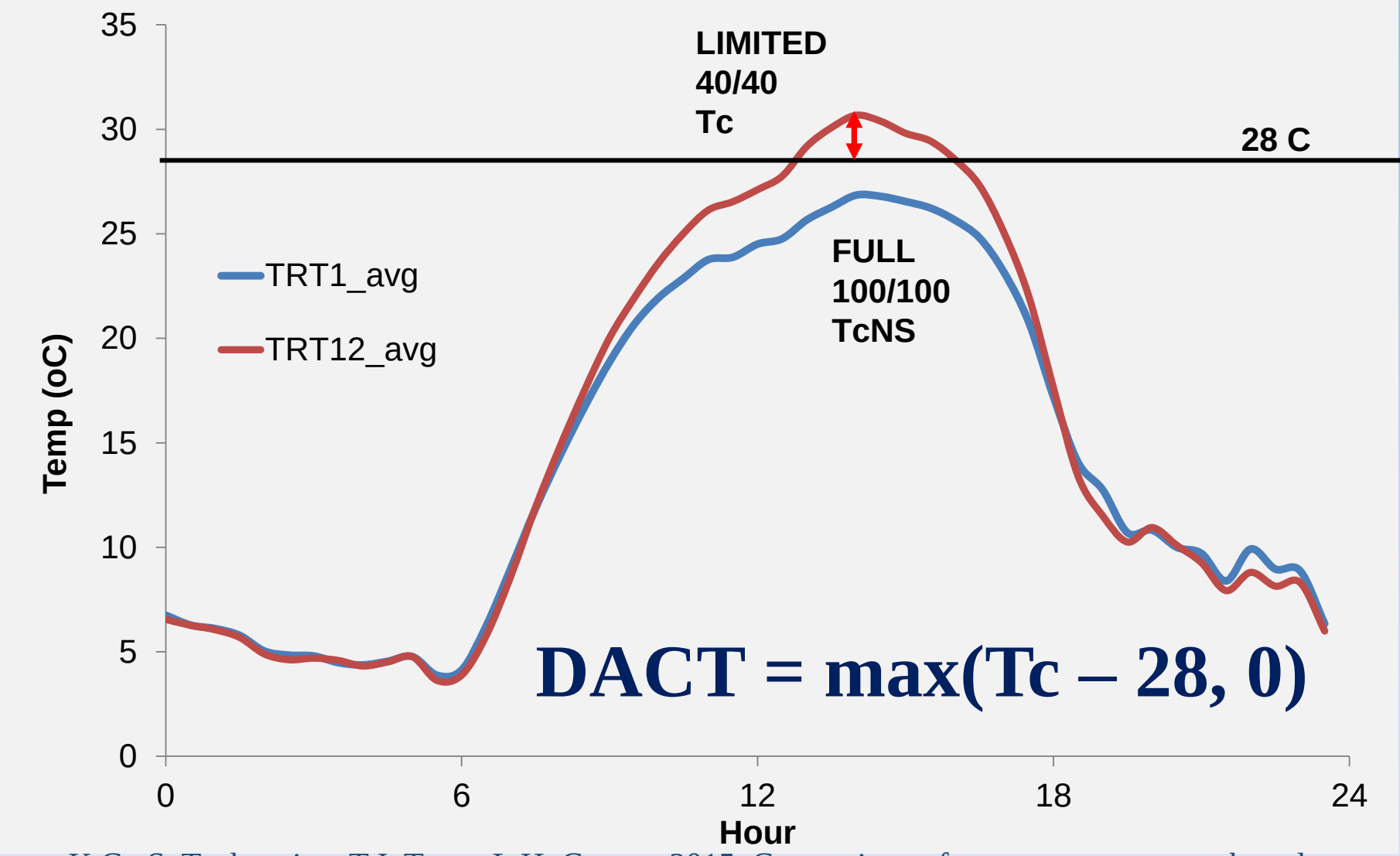
Taghvaeian, S., L.H. Comas, K.C. DeJonge, T.J. Trout. 2014. Conventional and simplified canopy temperature indices predict water stress in sunflower. Agricultural Water Management. 144: 69-80. DOI 10.1016/j.agwat.2014.06.003

Time Temperature Threshold (TTT)



Published in many studies, especially from USDA-ARS Bushland TX (Evett, O'Shaugnessey, Tolk, et al.)

Degrees Above Critical Temperature (DACT)



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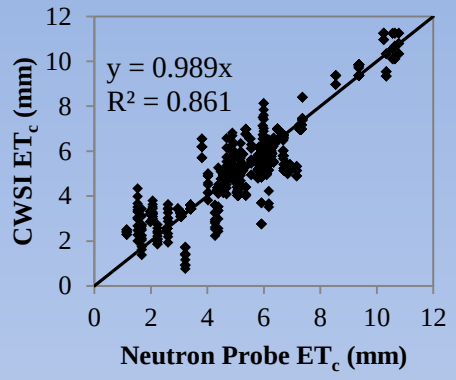
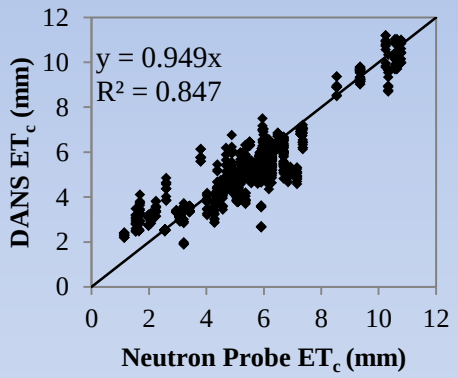
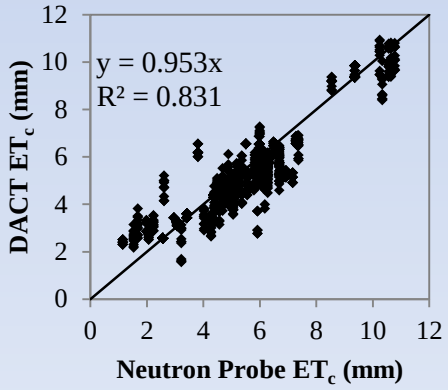
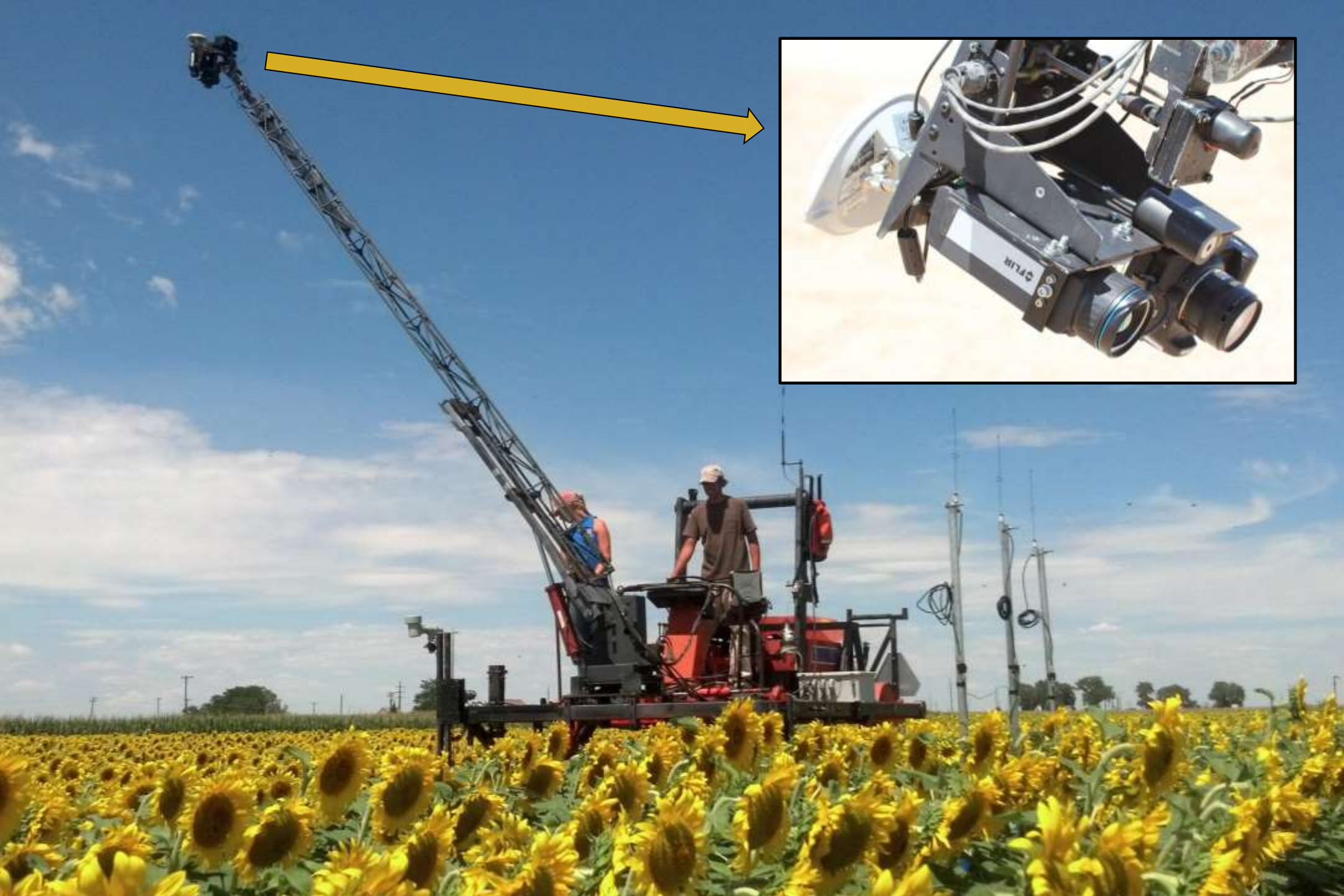
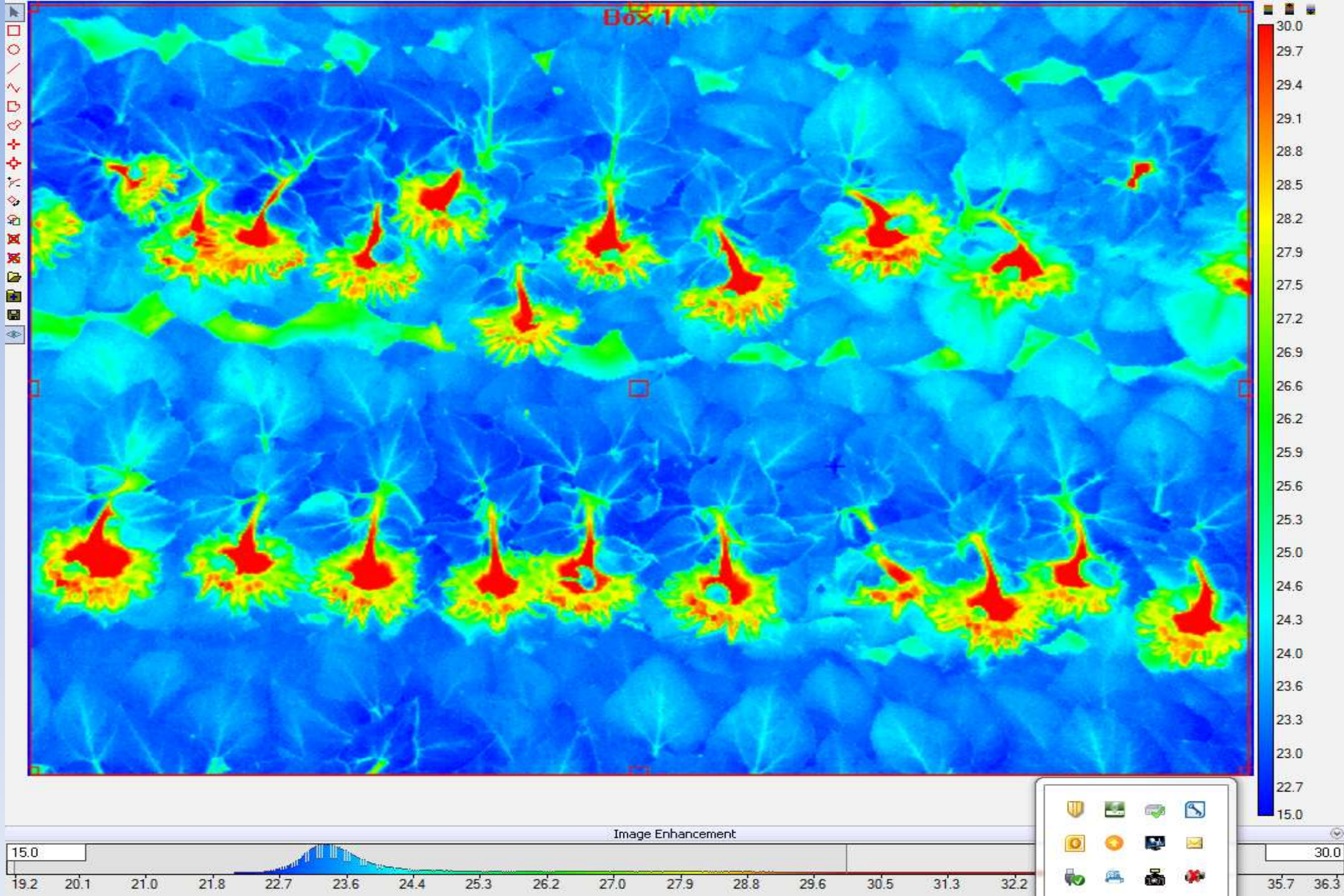






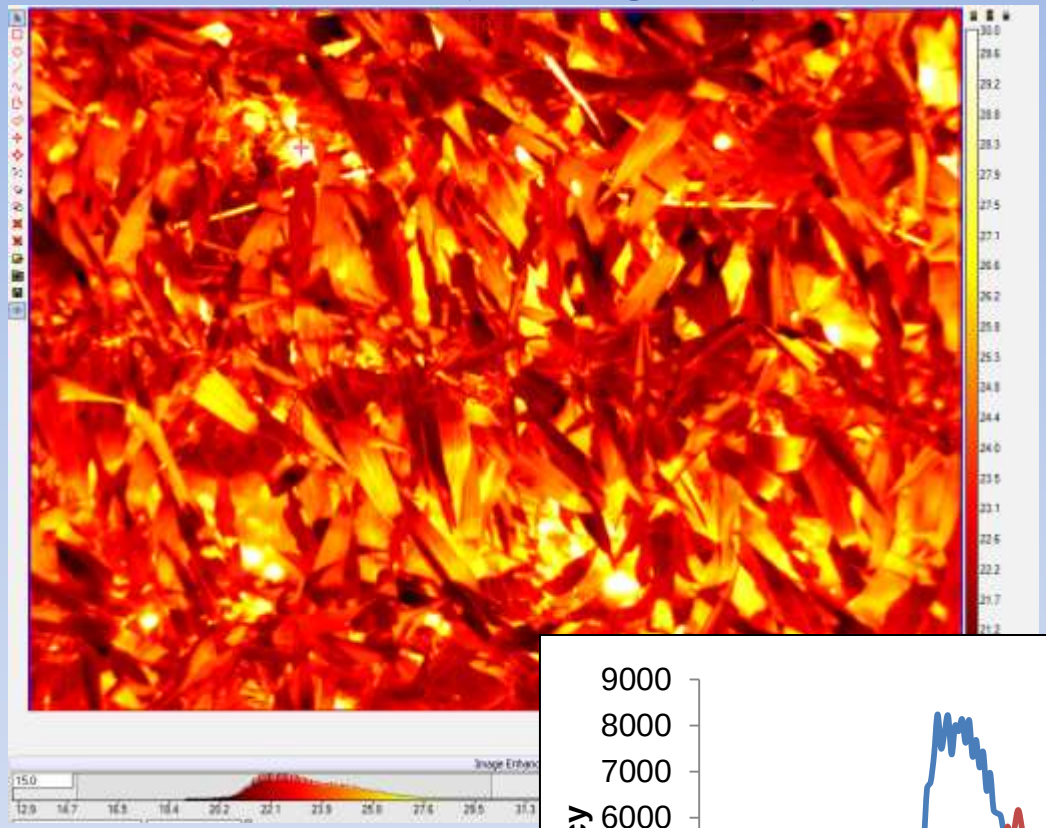
Category	Requirement	K_s method		
		CWSI	DANS	DACT
Canopy Temperature	Target	X	X	X
	Non-Stressed Reference		X	
Environmental	Relative Humidity	X		
	Air Temperature	X		
	Clear Sky	X	X	X
Pre-Calculation	Baselines (locally calibrated)	X		
	Threshold Temperature			X
	Scaling Coefficient (locally calibrated)		X	X
	Daily ET_c RMSE (mm/day)	0.77	0.80	0.80
	Daily ET_c RMSE (%)	14.6	15.2	15.2




Box 1
30.0
29.7
29.4
29.1
28.8
28.5
28.2
27.9
27.5
27.2
26.9
26.6
26.2
25.9
25.6
25.3
25.0
24.6
24.3
24.0
23.6
23.3
23.0
22.7
15.0
Image Enhancement
15.0
30.0
19.2
20.1
21.0
21.8
22.7
23.6
24.4
25.3
26.2
27.0
27.9
28.8
29.6
30.5
31.3
32.2
35.7
36.3

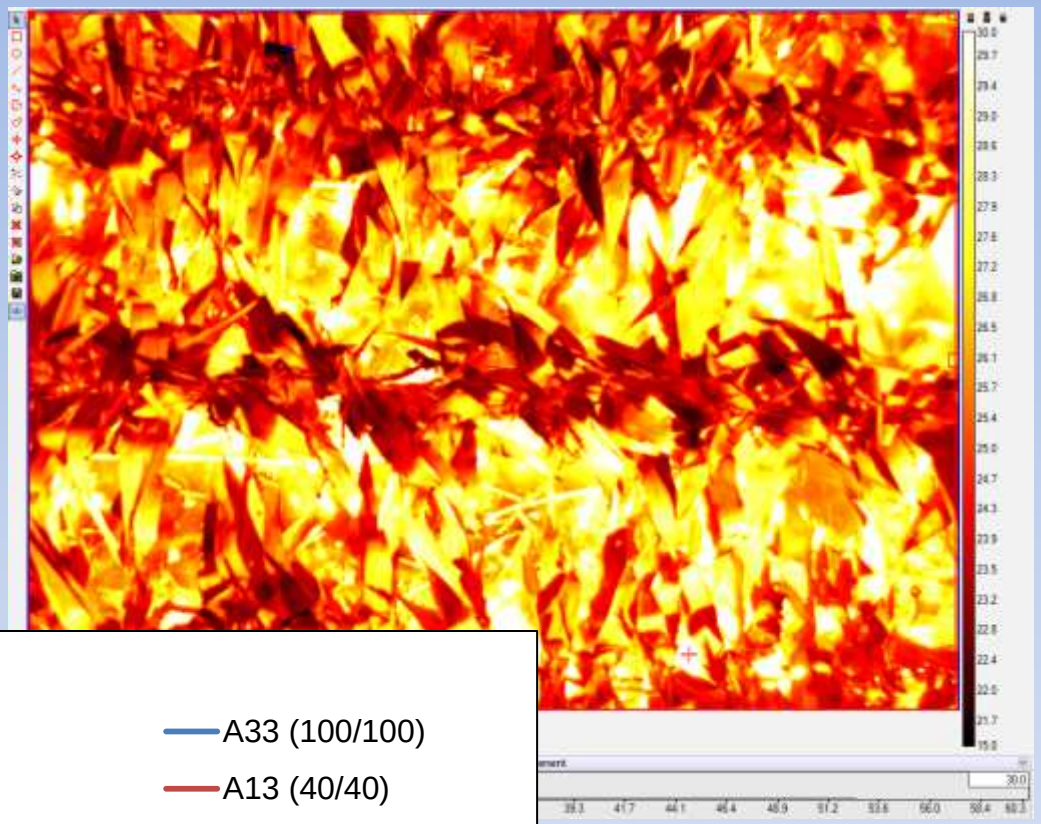
THERMAL IMAGING (~1pm)

Trt: 100/100 (full irrigation)

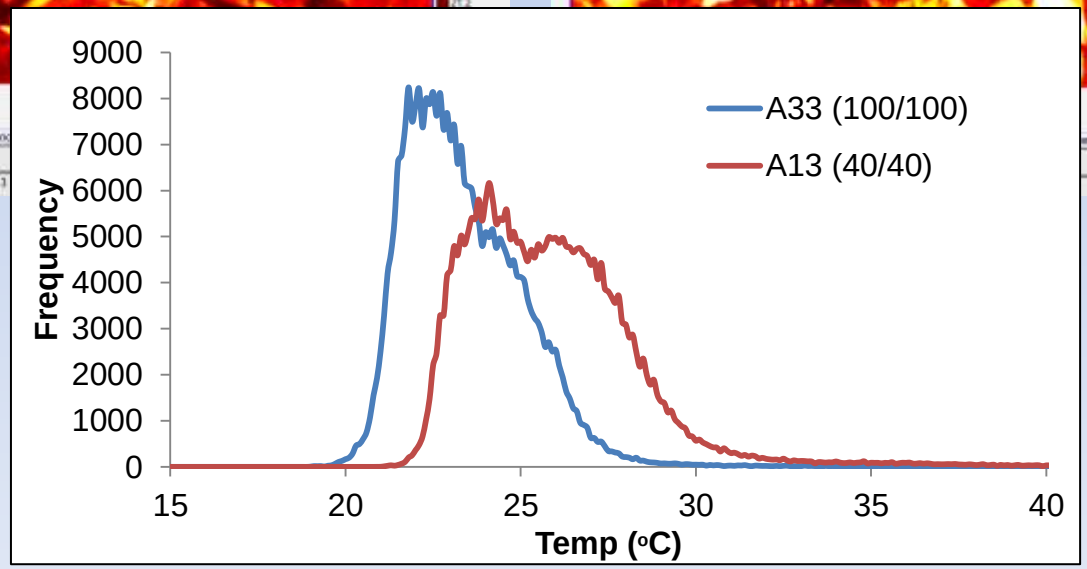


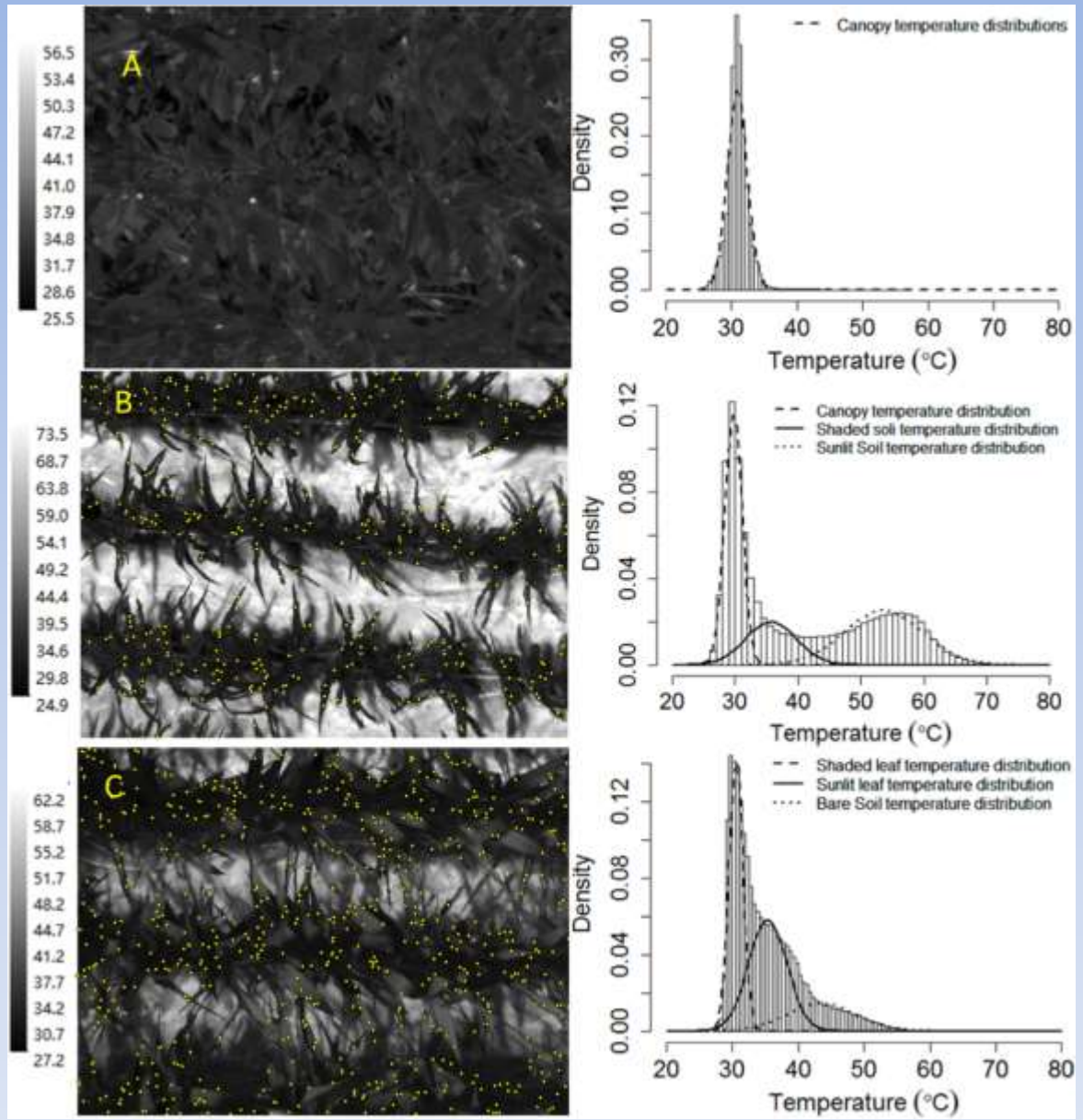
Tmin = 18.9
Tmean = 23.3
Tmax = 43.3
SD = 1.7

Trt: 40/40 (limited irrigation)



Tmin = 20.9
Tmean = 25.8
Tmax = 52.4
SD = 2.6





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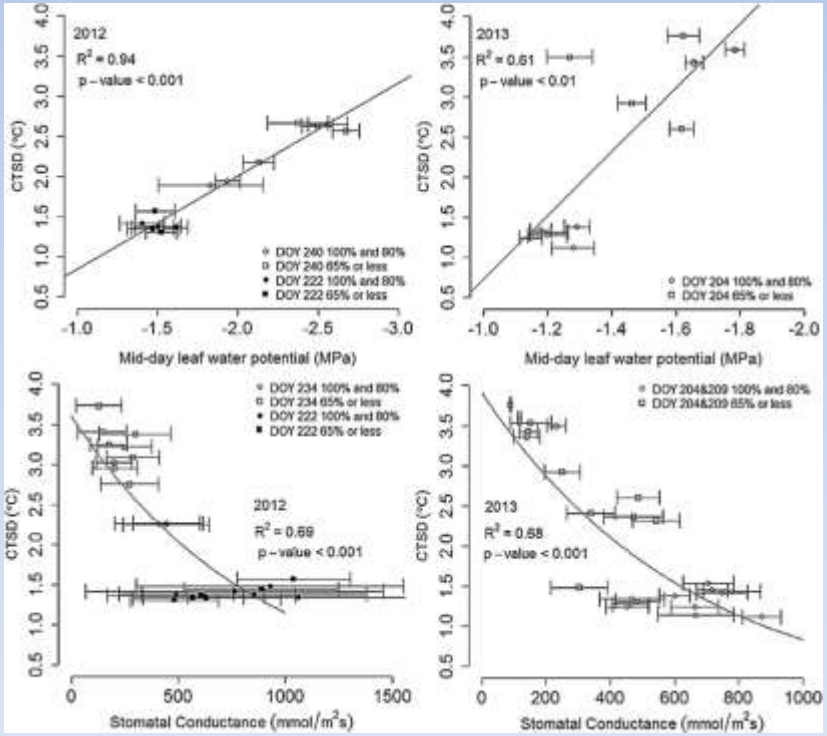
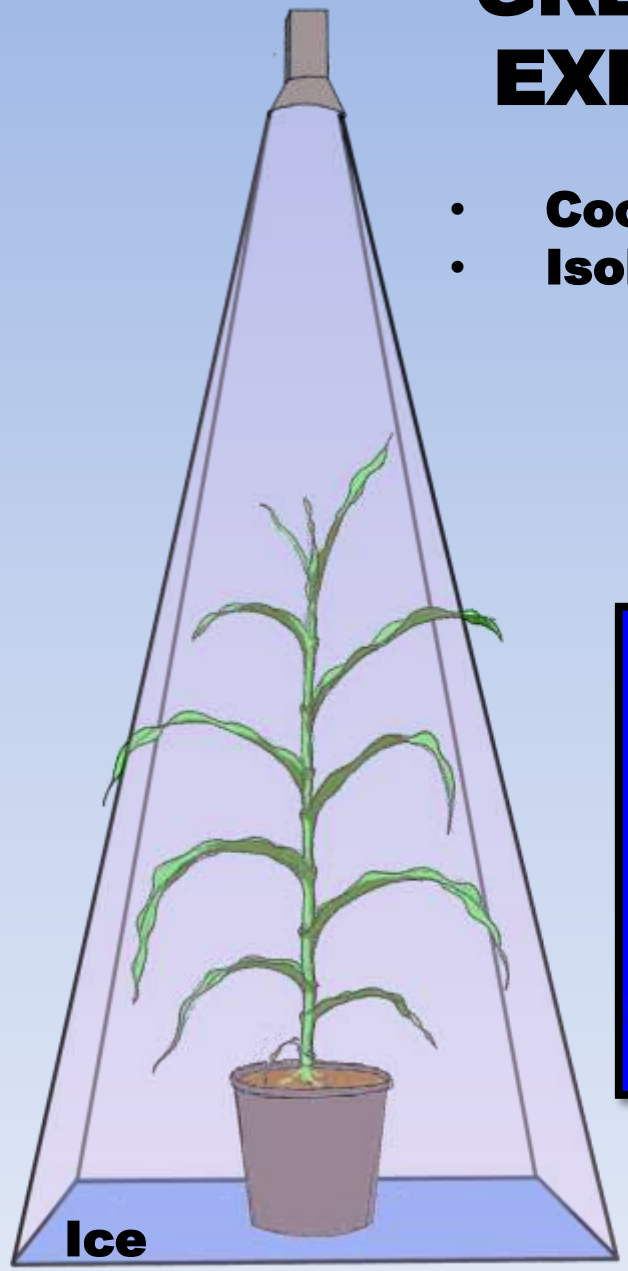
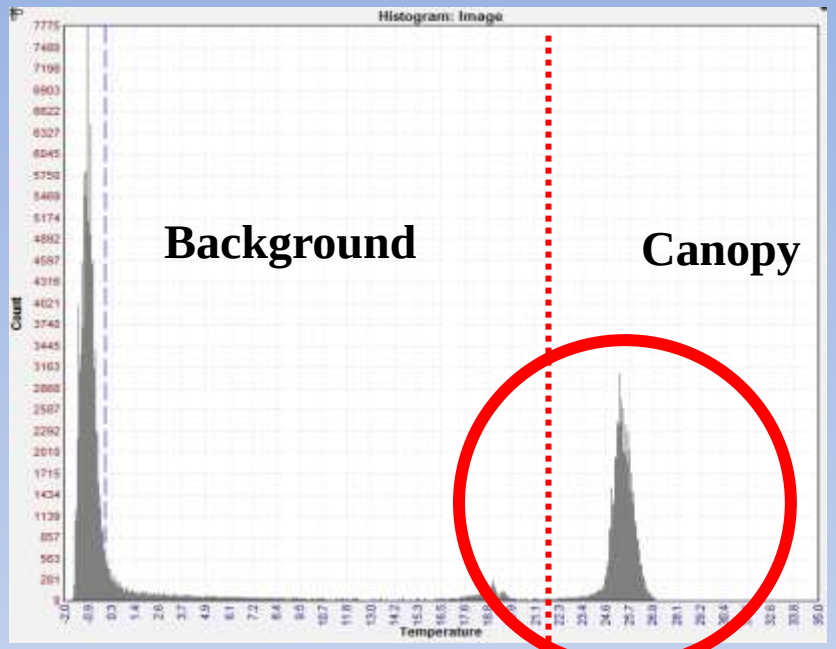
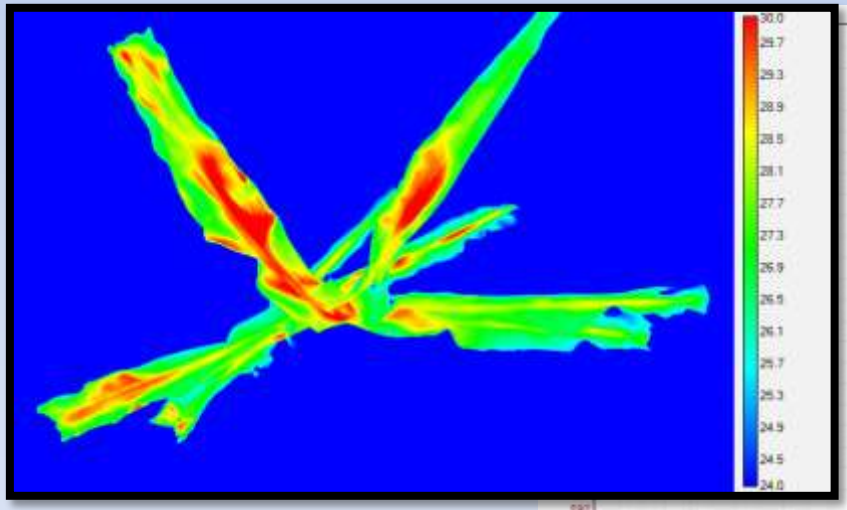


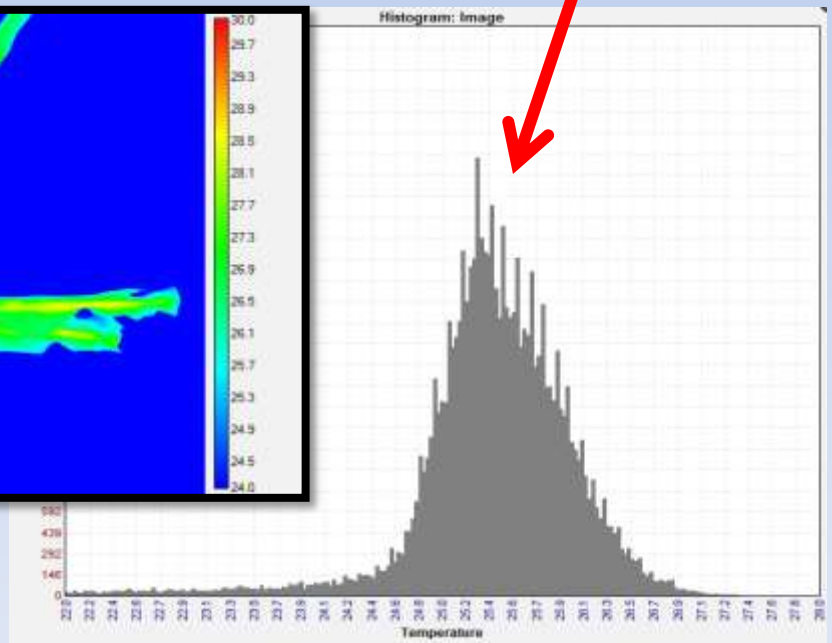
GREENHOUSE EXPERIMENT

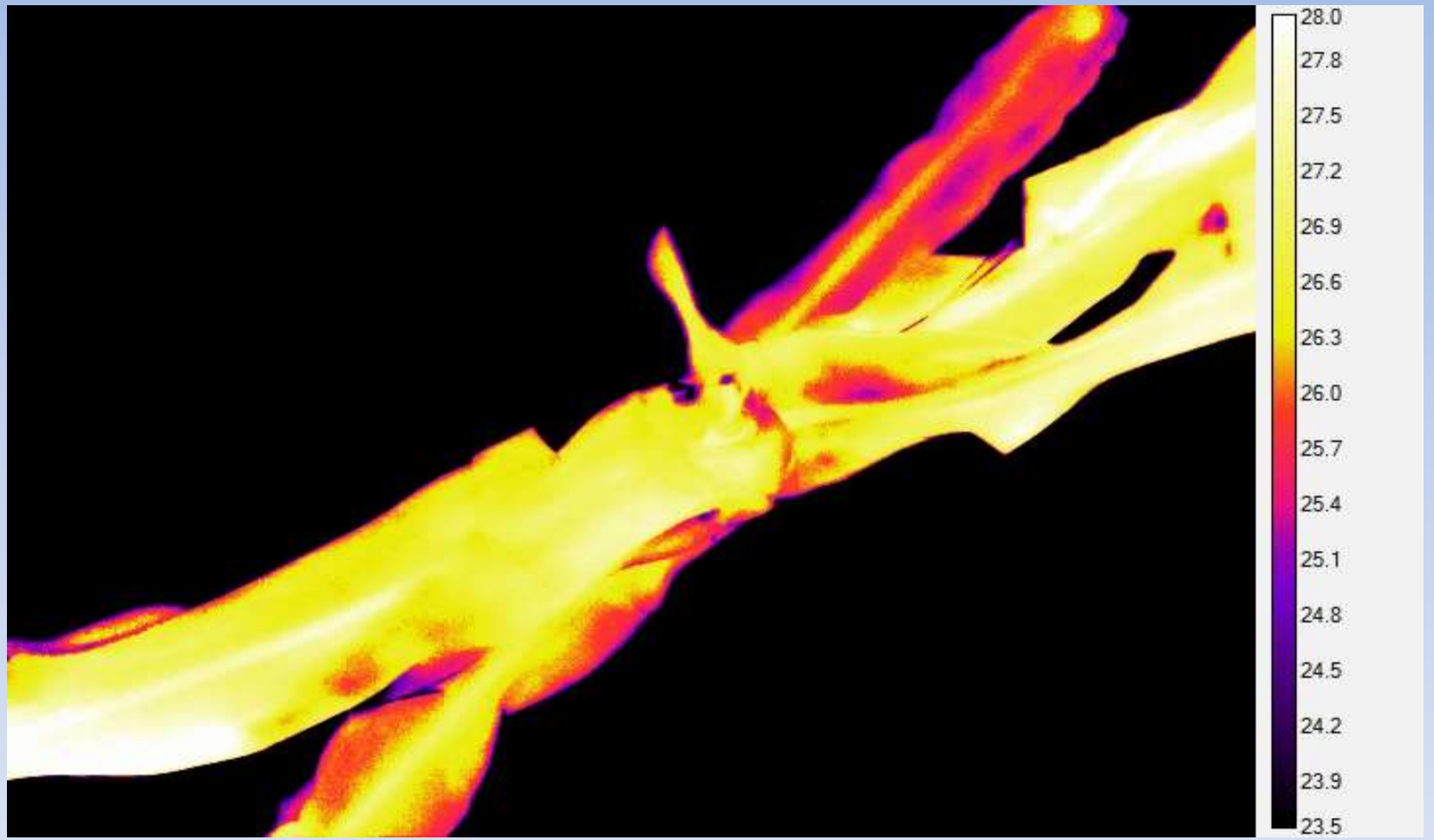
- **Cool background**
- **Isolate canopy Tc**



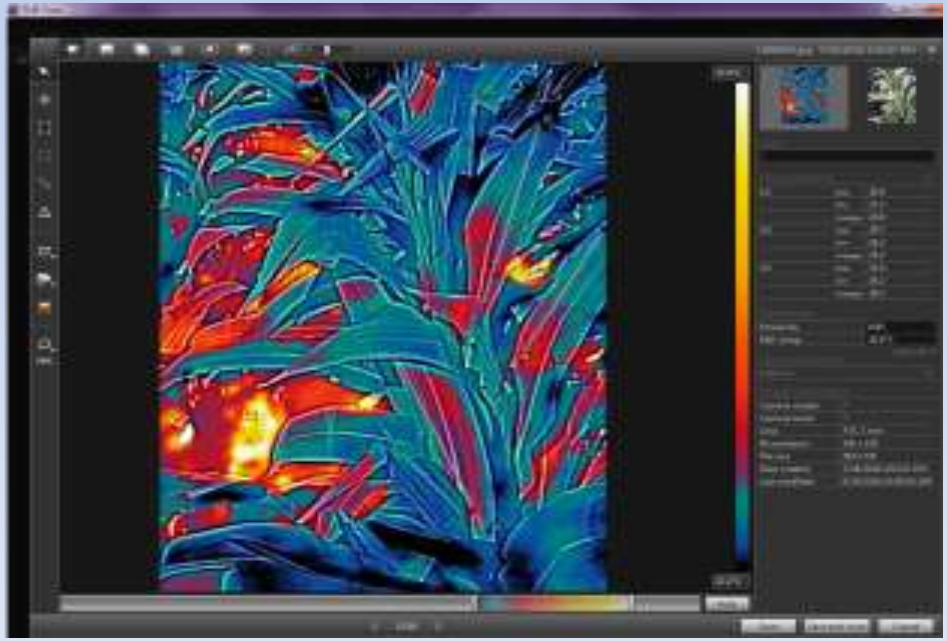







28.0
27.8
27.5
27.2
26.9
26.6
26.3
26.0
25.7
25.4
25.1
24.8
24.5
24.2
23.9
23.5


FLIR
65.5°
FLIR



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Thank You!