

# Physiological Activity and Biomass Production in Crop Canopy under a Tropical Environment in Soybean Cultivars with Temperate and Tropical Origins

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## Introduction

The seed yield of cultivars from temperate regions was poor under a tropical environment compared to those from the tropical region even after considering different growth duration, but harvest index did not differ considerably indicating that the process of biomass production may be involved in this differences (Saryoko et al., 2017). This present study aimed to assess the genotypic variability of soybean from temperate and tropical regions with respect to crop physiological activity and biomass production, relative transpiration activity, and its associated factors under a tropical environment.

## Conclusions

Low biomass production in temperate cultivars was not only due to the  $CIR_{R5}$  but also due to low RUE. Low RUE in temperate cultivars was associated with low gas exchange activity, in which leaf morphological traits were involved. Within temperate cultivars, US cultivars tended to perform better than the Japanese cultivars with respect to gas exchange activity.

## Material and methods

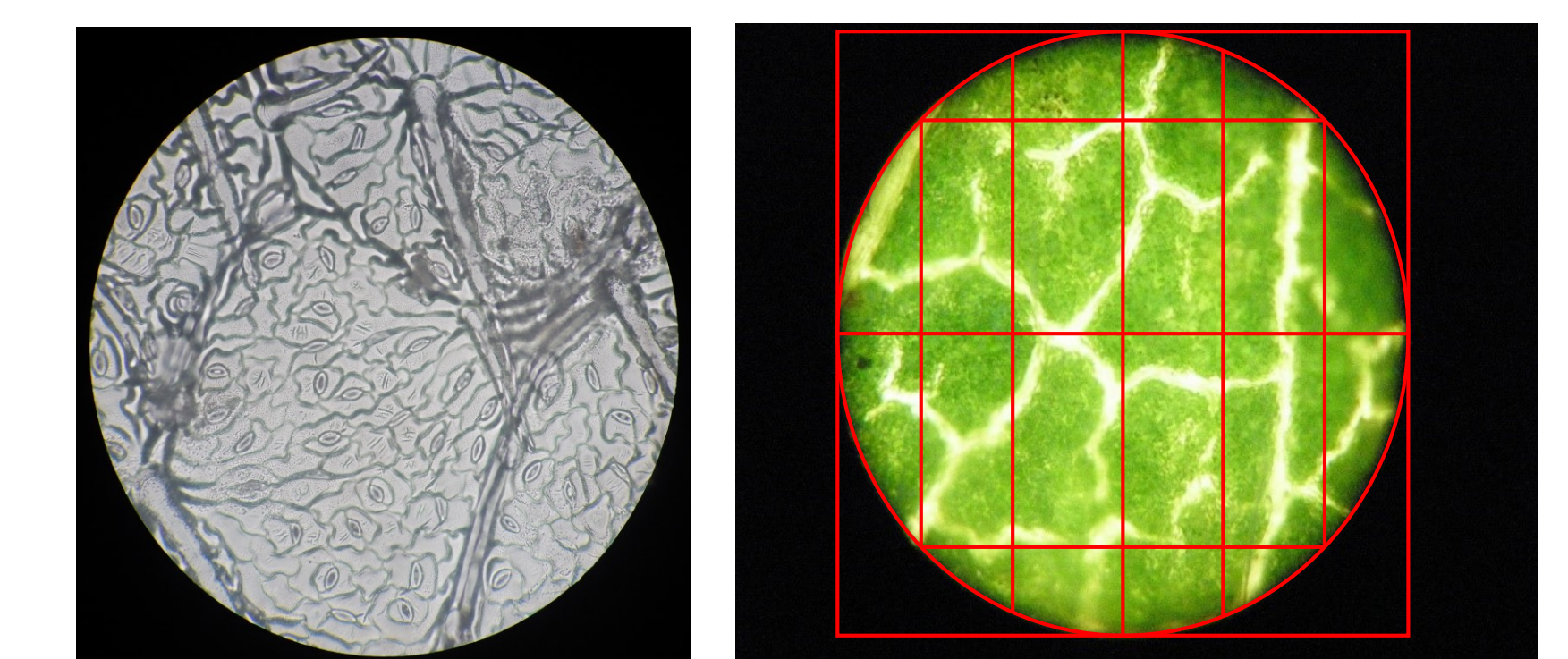
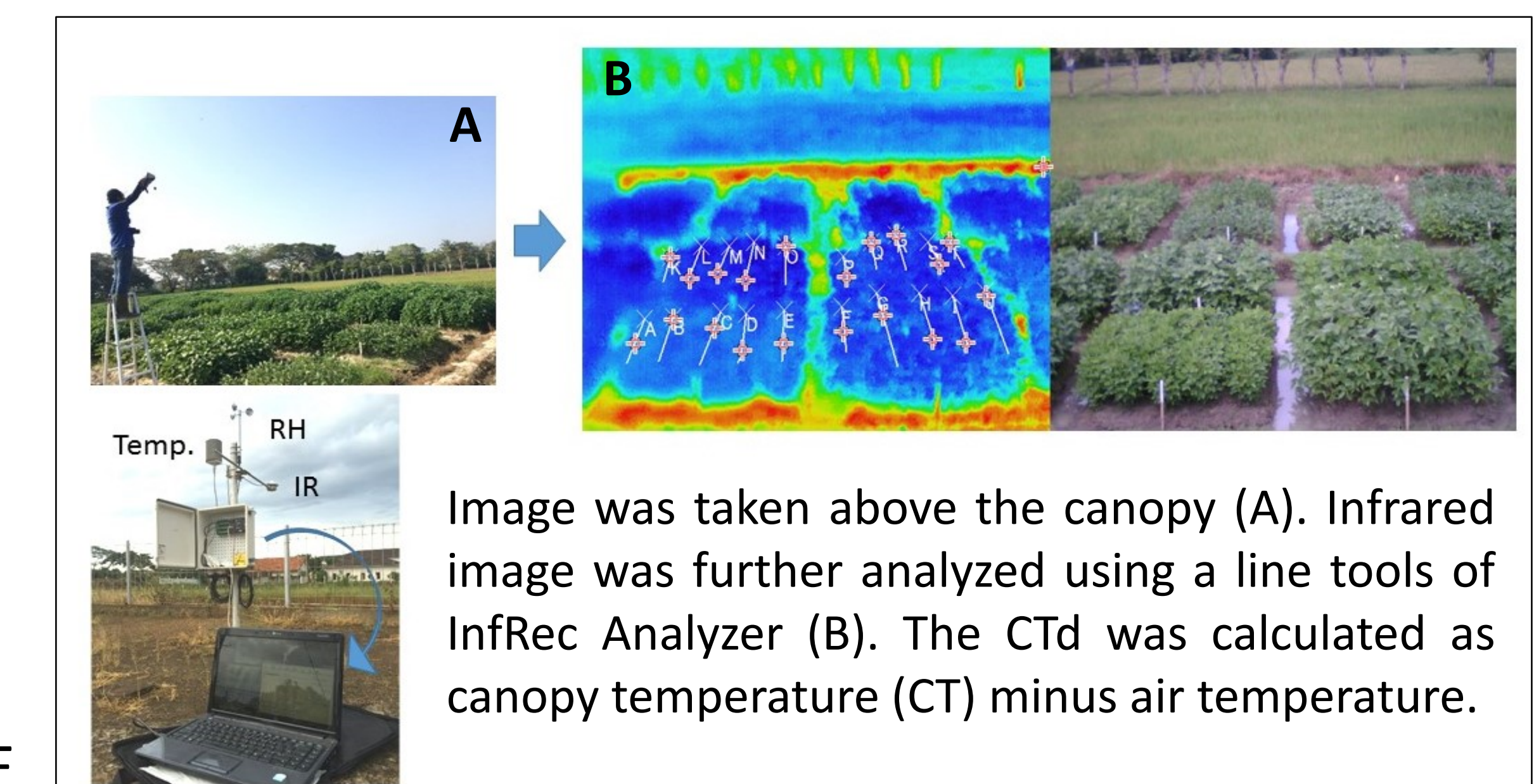
Twenty-nine (in 2014 and 2015) and 20 (in 2016) soybean cultivars of temperate (Japan and USA) and tropical (Indonesia-old, Indonesia-modern, and others) origins were grown in Serang, Banten (2014 and 2015; Exp. 1) and in Bogor, West Java (2016; Exp. 2), Indonesia.

### Exp. 1.

- Aboveground biomass at R5 ( $TDW_{R5}$ )
- Canopy development; mean value of the fraction of radiation intercepted ( $F$ )
- Cumulative intercepted radiation till R5 ( $CIR_{R5}$ ) and RUE
- Canopy temperature (CT), canopy minus air temperature (CTd)

### Exp. 2.

- CTd, stomatal conductance ( $g_s$ ), stomatal morphology (stomatal density,  $N_{stoma}$ ; guard cell length,  $L_{guard}$ ; and epidermal cell density,  $N_{epi}$ ) and total of length venation ( $L_{vein}$ )

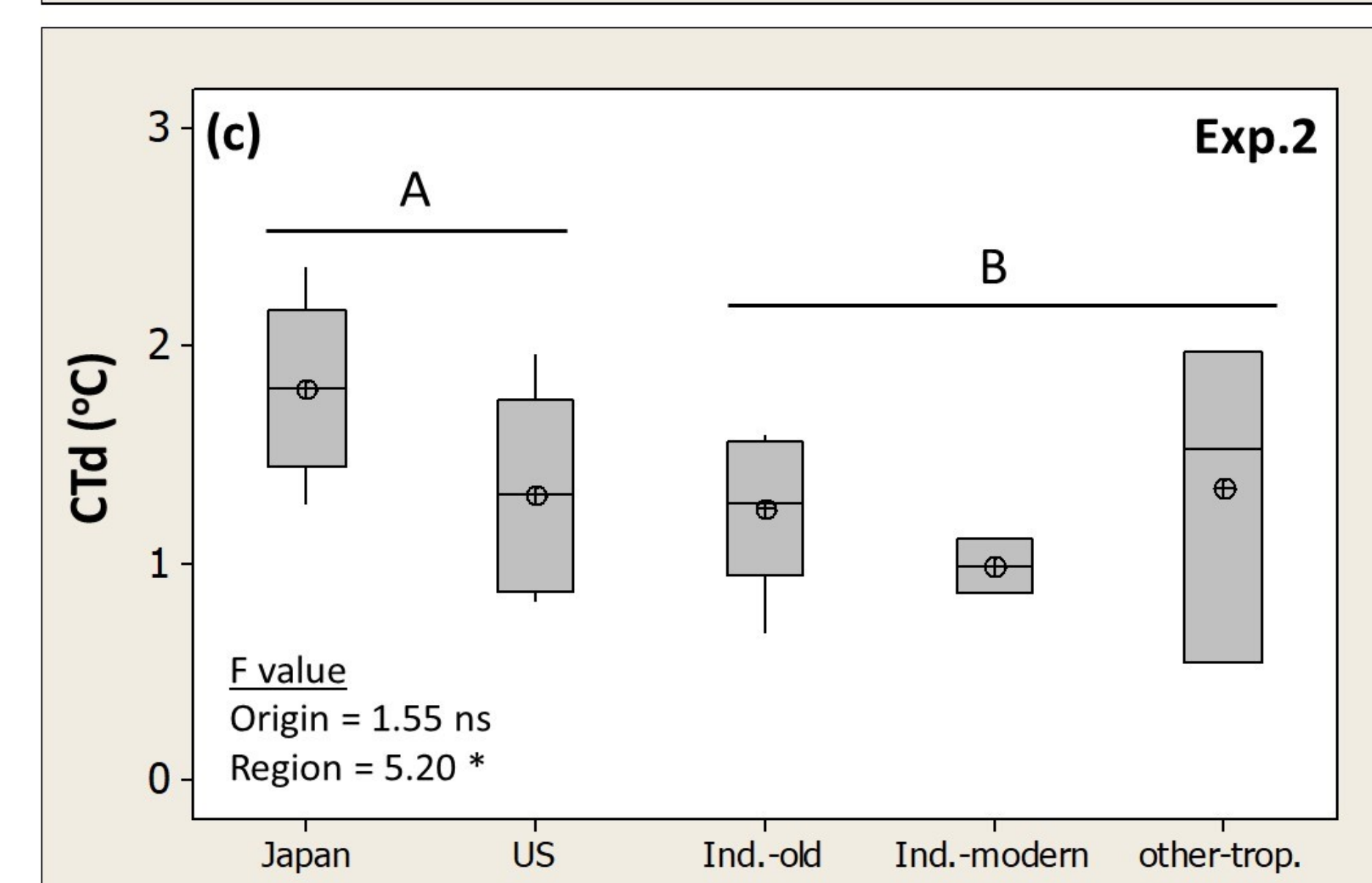
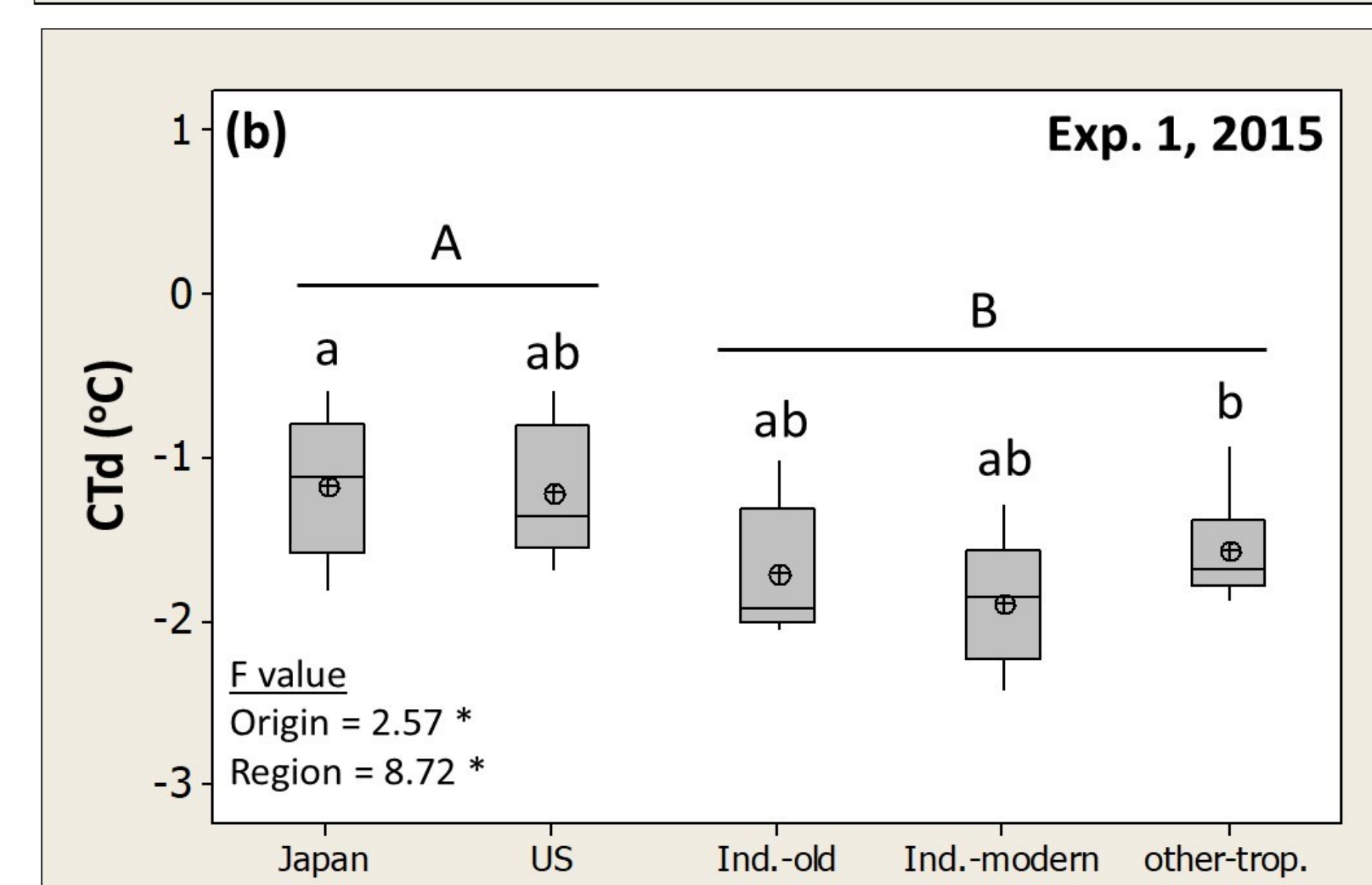
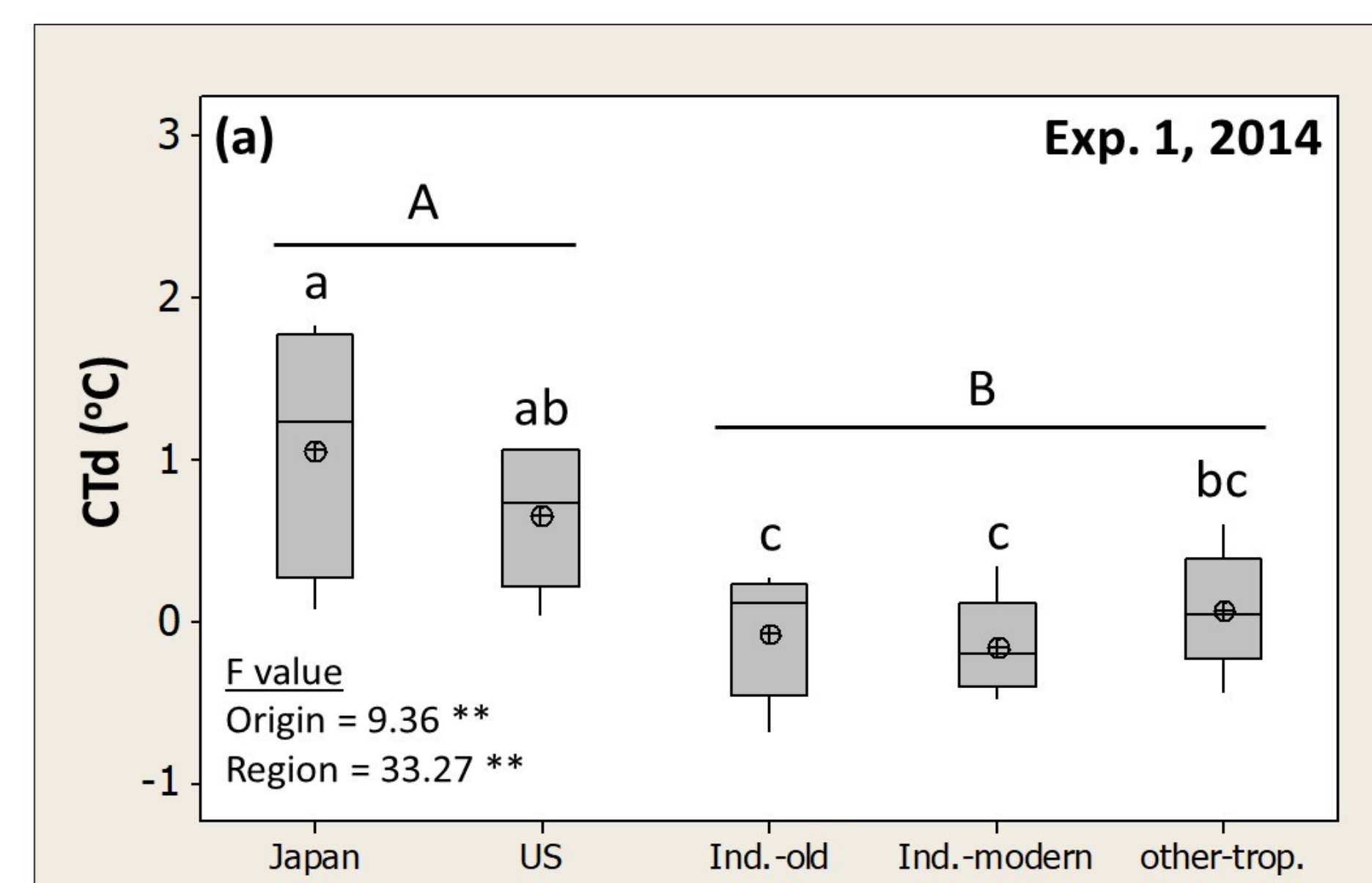


stomatal morphology leaf venation

## Result and discussion

### 1. Biomass Production till R5 ( $TDW_{R5}$ )

- Small  $TDW_{R5}$  of temperate cultivar group was associated with less than half the amount of the  $CIR_{R5}$  of tropical cultivar group.



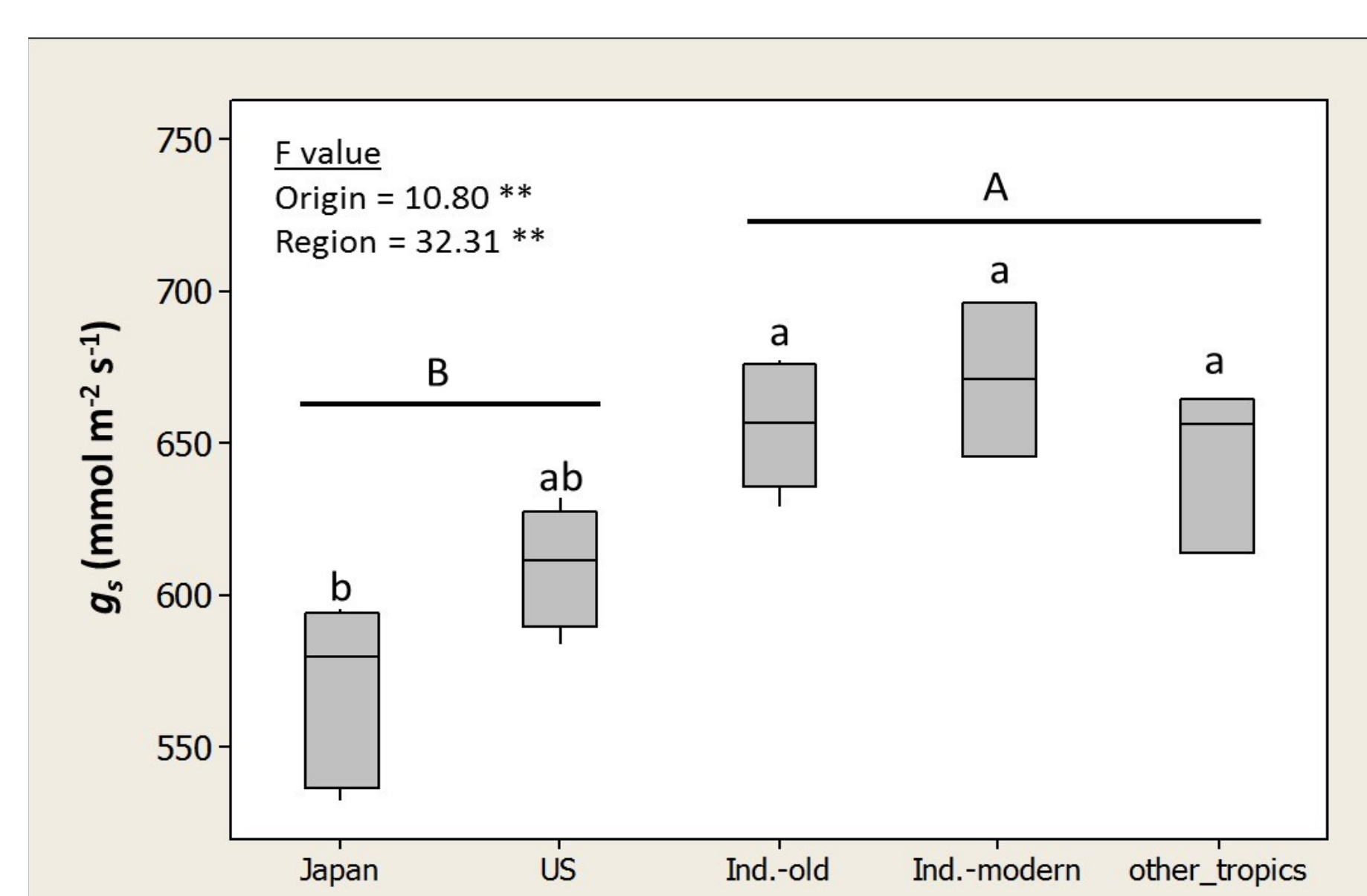
- Temperate cultivar group was shorter in days to R5 and lower mean  $F_{VE-R5}$
- The speed of canopy development (mean  $F_{VE-4WAP}$ ) was similar.

### 2. Transpiration Activity (CTd)

- The temperate cultivar group was larger in CTd than that from tropical regions.
- Larger value of CTd of temperate cultivar group indicated that lower transpiration activity.

### 3. Stomatal Conductance ( $g_s$ )

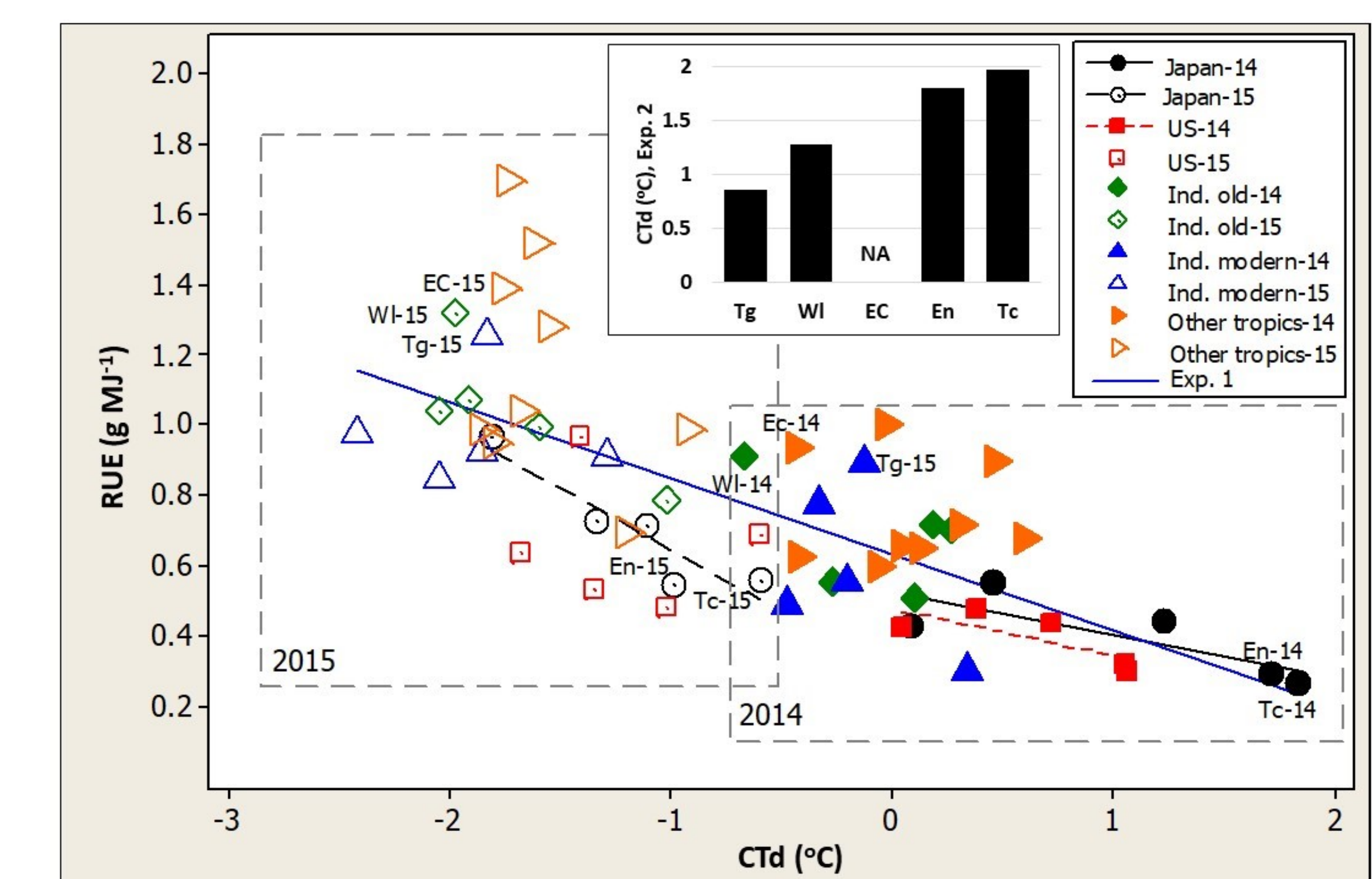
The temperate cultivars had lower  $g_s$  than tropical cultivars. The  $g_s$  was negatively correlated with CTd.



### 4. Radiation Use Efficiency (RUE)

- RUE of temperate cultivar groups was lower as compared to those from tropical regions.
- RUE was negatively correlated with CTd.
- Correlation for each group was significant only for Japanese cultivar group in 2014 and 2015, and US cultivar group in 2015.

- Small  $TDW_{R5}$  of temperate cultivars was also due to poor RUE.
- In temperate group, US cultivars tended to show better CTd and RUE than Japanese cultivars.



### 5. Stomatal Morphology

- The  $N_{stoma}$  of the temperate cultivars was lower than that of the tropical cultivars.
- The  $N_{stoma}$ ,  $L_{guard}$ ,  $N_{epi}$  and  $L_{vein}$  were associated with  $g_s$ .
- Stomatal morphology seem to be involved in the difference of relative transpiration activity.

Group	Stomatal Morphology			$L_{vein}$ (mm mm <sup>-2</sup> )
	$N_{stoma}$ (mm <sup>-2</sup> )	$L_{guard}$ (μm)	$N_{epi}$ (mm <sup>-2</sup> )	
<b>Origin</b>				
Japan (n=5)	279	18.4 <sup>a</sup>	1,209 <sup>b</sup>	5.13 <sup>b</sup>
USA (n=5)	293	18.1 <sup>ab</sup>	1,202 <sup>b</sup>	5.03 <sup>b</sup>
Indonesia-old (n=5)	337	17.7 <sup>ab</sup>	1,379 <sup>a</sup>	6.06 <sup>a</sup>
Indonesia-modern (n=2)	327	17.5 <sup>ab</sup>	1,329 <sup>ab</sup>	6.39 <sup>a</sup>
Others tropical (n=3)	321	17.4 <sup>b</sup>	1,368 <sup>a</sup>	5.63 <sup>ab</sup>
<b>Region</b>				
Temperate (n=10)	287 <sup>b</sup>	18.2 <sup>a</sup>	1,219 <sup>b</sup>	5.17 <sup>b</sup>
Tropics (n=10)	335 <sup>a</sup>	17.6 <sup>b</sup>	1,367 <sup>a</sup>	5.99 <sup>a</sup>