Leaf pigments and wax as traits of heat tolerance in field pea

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Heat stress

- Pea is sensitive to heat stress
- 25^{o}C or more leads to heat stress

- Pigment and photosynthesis
- Flower and pod abortion
- Short duration of flowering (Less flowers, less pods)
- Yield loss

FAOSTAT, 2016; Jiang et al., 2016; Bueckert et al., 2015

Pea has diverse leaf and canopy traits

- Leaf greenness
- Flower color
- Leaf type
- Canopy habit
- Determinacy

→ Heat tolerance traits

Hypothesis

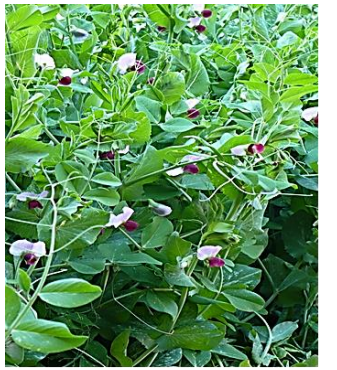
- Higher pigment and wax concentration in pea leaves provide protection against heat damage

Objective

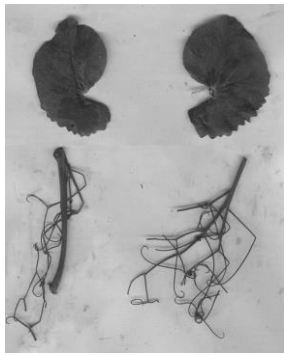
- Investigate role of pigments and wax as heat tolerance traits and, their association with leaf spectral properties

Methods

- 24 diverse pea cultivars were tested across six environments (2014-2016, Rosthern and Saskatoon)
- Delayed seeding date
- RCBD, 4 replication

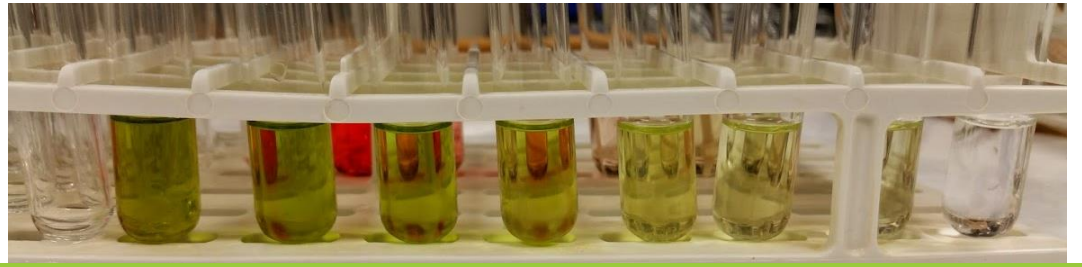






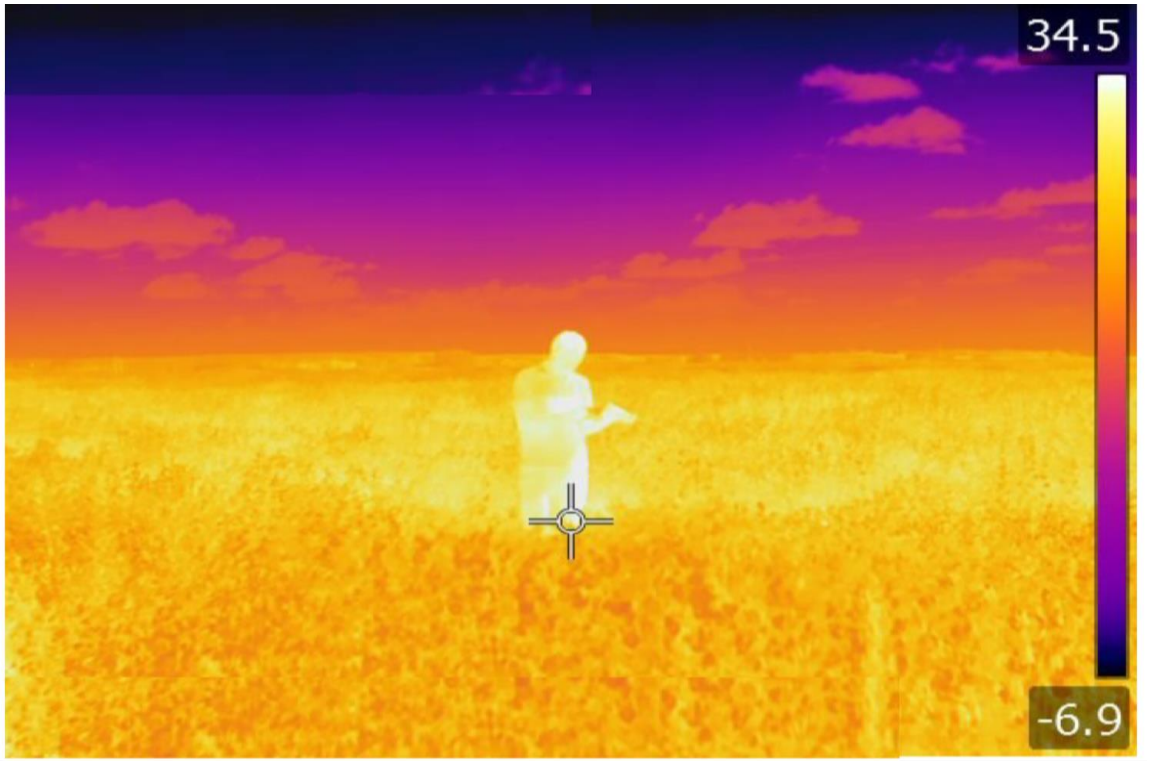

Measurements

- Weather data –-In situ weather stations
- Canopy temperature – IR thermometer
- Spectral reflectance – Spectral radiometer
- Chlorophyll – 100% Acetone
- Anthocyanin – Acidified ethanol,
- Total wax – Chloroform, Acidic $K2Cr_2O_7$
- Data analysis- Mixed procedure of SAS

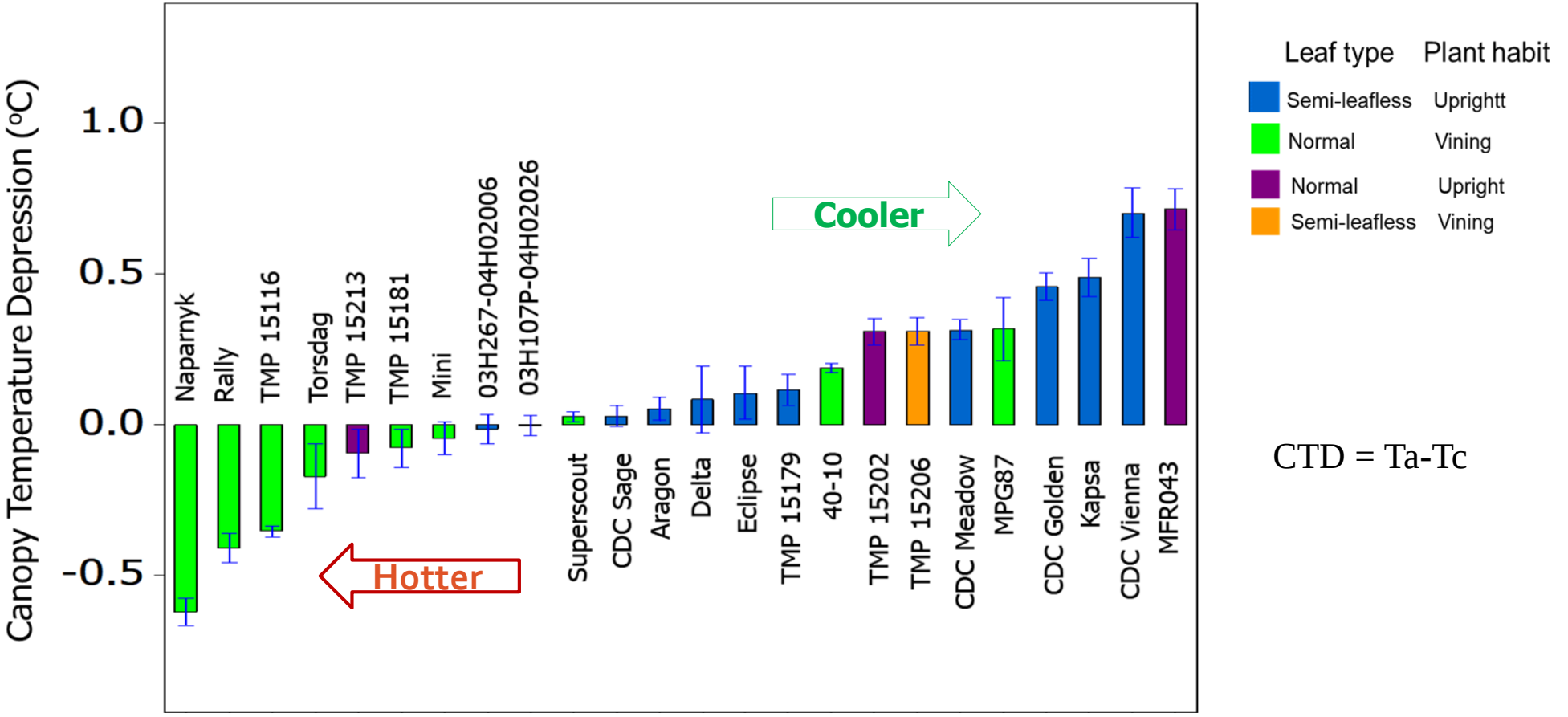


Results

Heat stress lead to high canopy temperature

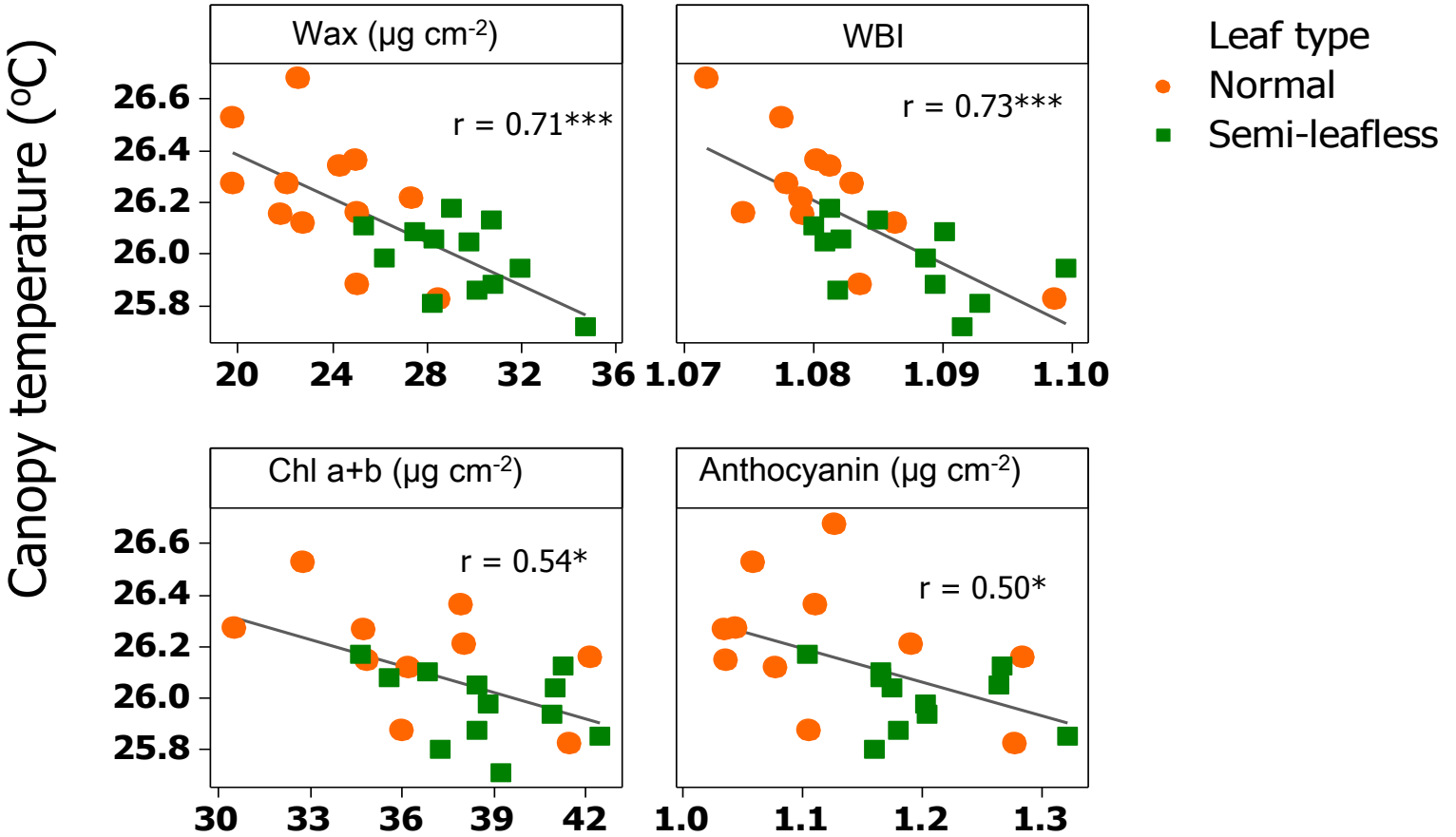


Pea cultivars varied in their canopy temperature depression

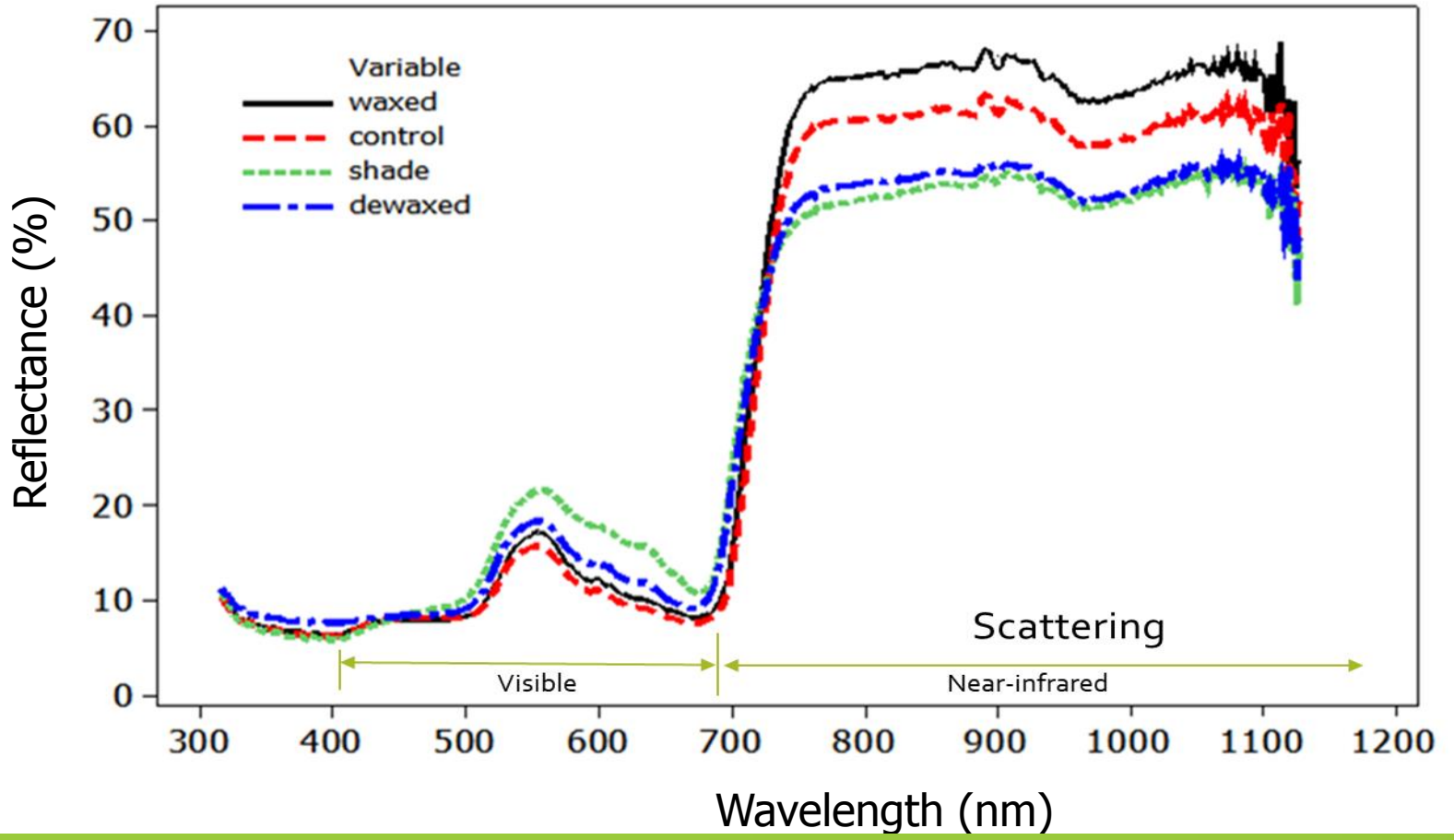


CTD = Ta-Tc

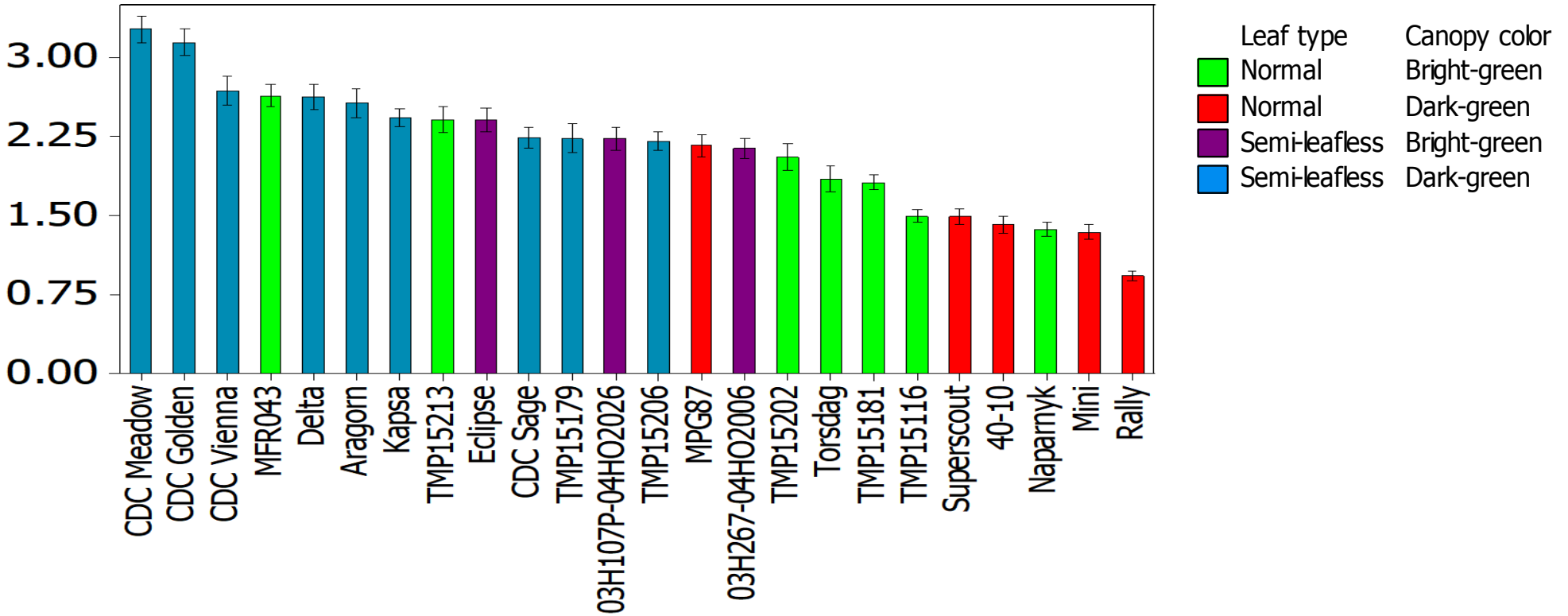
Canopy temperature was negatively correlated with Wax and pigments



Leaf spectral property was affected by wax and pigments



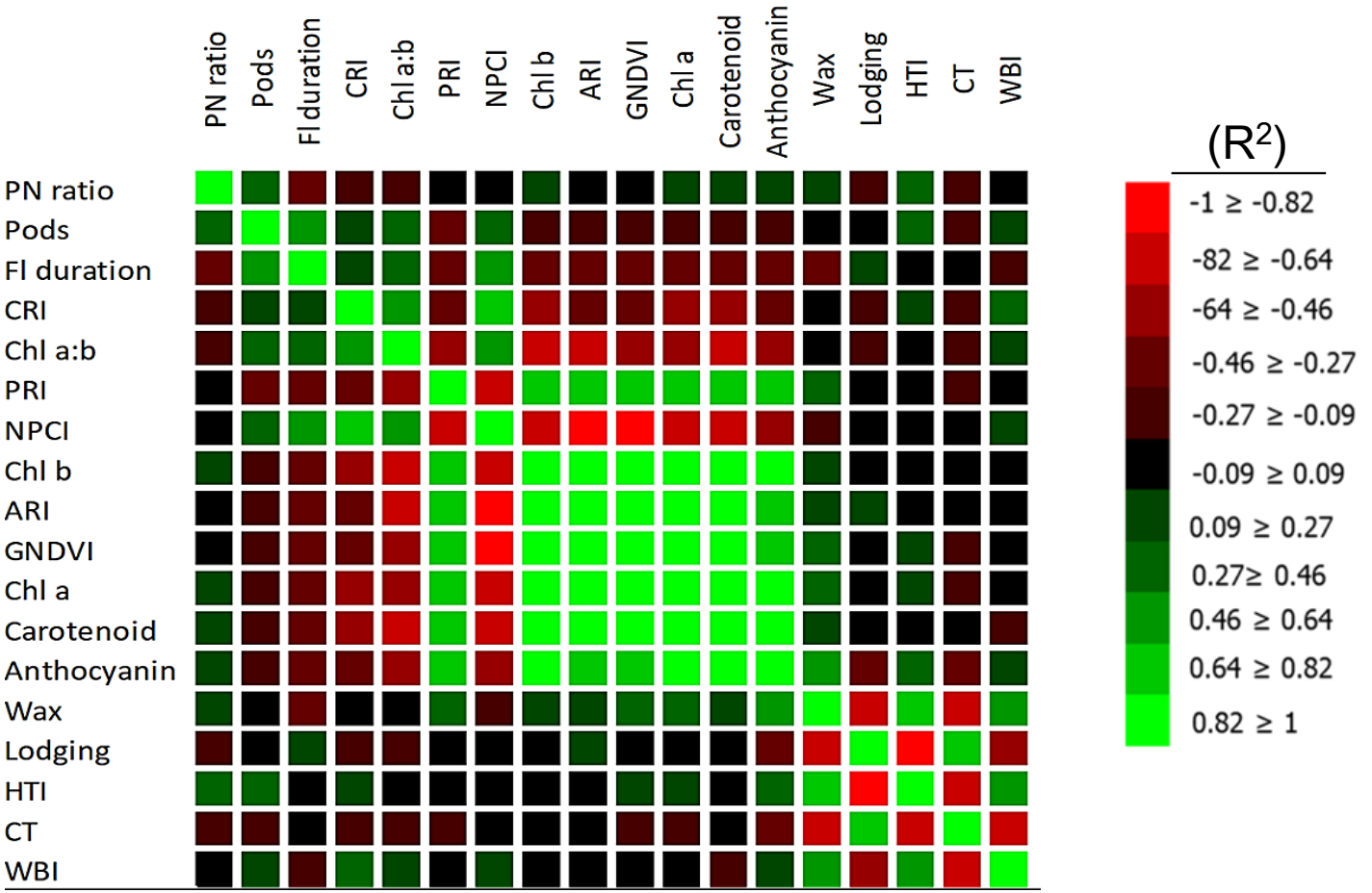
Pea cultivars varied in heat tolerance index



Plant characteristics contribute to heat tolerance

Trait	Level	HTI	Chl a	Chl b	Car	Anth	Wax
Canopy color	Dark-green	2.21*	30.9**	9.3 **	7.3 **	1.41	37.2**
	Bright-green	2.0	26.0	7.6	6.2	1.43	31.1
Flower color	Colored	2.2	29.0	8.8	6.9	1.28	34.4
	White	2.1	28.8	8.6	6.8	1.47*	34.7
Leaf type	Normal	1.74	28.1	8.5	6.8	1.52**	30.9
	Semi-leafless	2.51**	29.6*	8.7	7.0	1.32	38.4**
Growth habit	Upright	2.50**	32.0	8.7	7.1*	1.37	37.8**
	Vining	1.61	32.7	8.4	6.4	1.50*	30.2

Association of pigments, vegetation indices, and heat tolerance index



Conclusions

- Significant trait differences in wax, pigment, canopy temperature, and VIs
- Higher wax and pigment concentrations lead to lower canopy temperature by reflecting heat load, and contributed to heat tolerance
- Semi-leafless leaf, dark-green canopy color, upright plant habit had higher HTI
- Vegetative indices: WBI, PRI, GNDVI, NPCI, VS, were significantly associated with pigment and wax traits

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