Thermal Regime Agronomic Cereal Experiment

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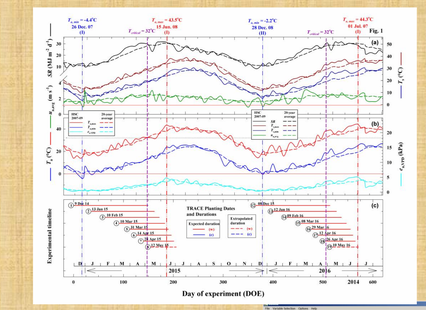
ABSTRACT

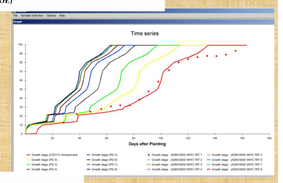
Global climate uncertainty will alter thermal regimes of the Earth's major cereal grain production regions. Therefore, a need exists to elucidate thermal tolerant mechanisms in cereal grain crops and parameterize genetic controls available for adaptation. Semi-arid desert regions experience some of the widest temperature ranges. Therefore, intra- and inter-annual variations in ambient temperature provide a cost effective means to obtain a robust dataset across multiple cereal grain crops simultaneously. To refine crop model thermal response curves at higher temperatures, we intend to stagger our wheat planting dates, from the normal cropping season in December, to be in closer intervals during the April-May time frame. Experimental artifacts, such as soil physical properties, precipitation, solar radiation, photoperiod, and vapor pressure deficit, are unavoidable, and may complicate interpretation of thermal responses. Nevertheless, our use of day-neutral cultivars without any vernalization requirement will minimize photoperiod effects and ensure floral induction regardless of planting date. Our objectives are: (1) determine cereal grain crop responses to a wide range of air temperature via planting date; (2) quantify crop growth; (3) evaluate and refine thermal response on crop growth and development; (4) validate crop growth models with regard to thermal dependent processes believed to be mediated through canopy energy balance. Our materials of study include: Wheat (*Tritium aestivum* L.); Durum Wheat (*T. durum* L.); Barley (*Hordeum vul*gare L.); and Triticale (x*TriticumSecale)* WheatxRye. Overall, four cereal grain crops, over eight planting dates (four of which will be replicated to determine intra-annual variability), totaling four replications, over two years (inter-annual variability), will provide 384 differently treated crop responses across an air temperature ranging from -2 to 42°C. These data will be assembled and formatted in accordance with ICASA Version 2.0 standards and will be distributed to the AgMIP-wheat team for model improvement and validation as deemed appropriate.

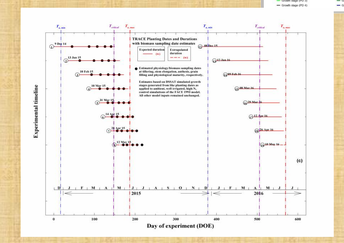
HYPOTHESES

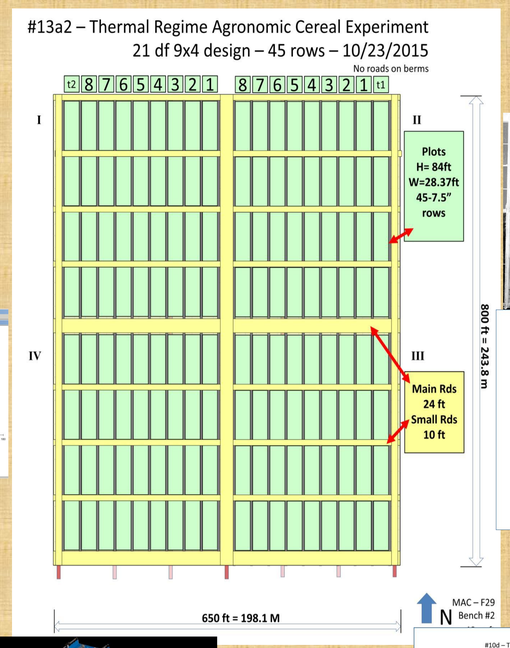
- Thermal response will be similar among cereal grain crops, nevertheless species and cultivar specific parameterization will be required to accurately depict any differences in thermal response.
- Plant organ temperature, rather than air temperature, will provide the most accurate depiction of thermal response to Genotype x Environment x Management interactions.
- Deleterious effects of thermal stress on cereal grain crops will occur at acute thermal regimes that will be dependent on growth stage when thermal stress occurs.

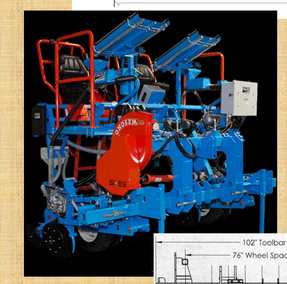


. Meteorology
. DSSAT
. Planting Date

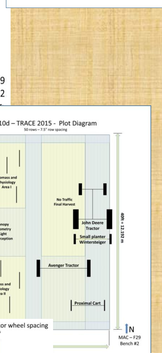




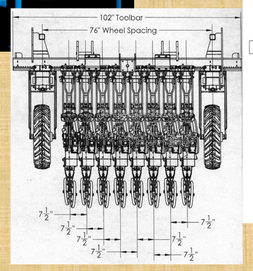


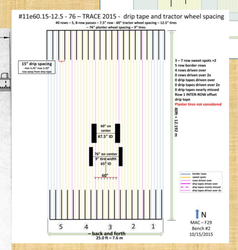


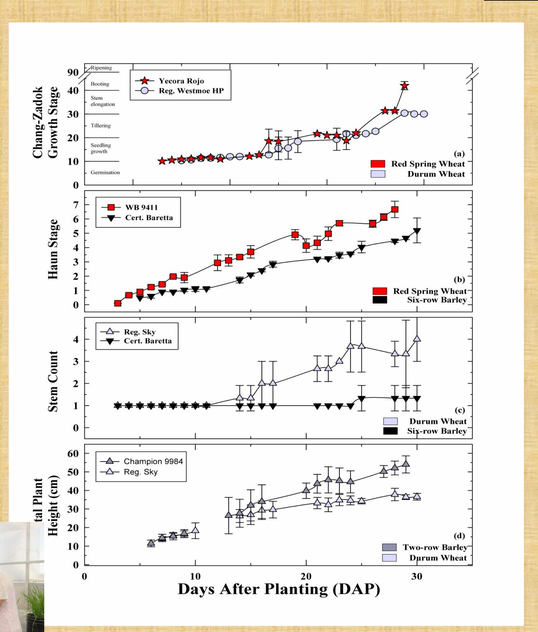
. Greenhouse Trial

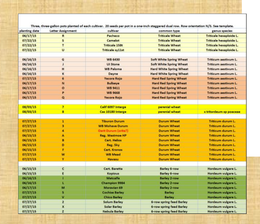


Agronomy

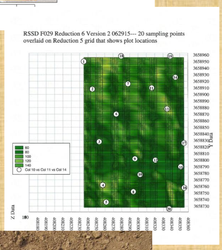


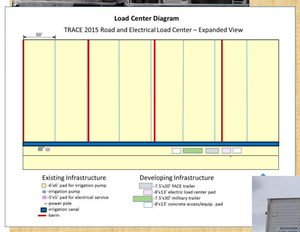






. Field Site
. Infrastructure
. Soil Physics





Variable	Unit	Definition
Treatment	#	AgMIP Treatment number
Trt_n	alpha-numeric	Temperature Treatment numeric
Trt	alpha	Temperature Treatment
CTrt	#	Carbon dioxide
TrtC	alpha-numeric	Temperature x Carbon treatment
Rep	#	Treatment Replicate
Observation	notes	notes
Planting date	YYYYMMDD	Nominal planting Date – Zadoks 00
Planting doy	DOY	Nominal planting Date – Zadoks 00 (Day of Year)
Harvest #	alpha-numeric	Harvest number (Independent and cumulative for each treatment)
sDate	YYYYMMDD	Sampling date
SDOY	DOY	Sampling Day of Year
DAS	days	Sampling date in days after sowing
LAI	m^2/m^2	Daily leaf area index (green)
GAI	m^2/m^2	Daily green area index (green)
Biom	kDM/h_a	Cumulative daily total above ground dry biomass (including grain)
totalplant wt	kDM/h_a	Cumulative daily Total Plant weight (including grain and crown)
Yield	kDM/h_a	Cumulative daily grain dry mass
CropN	kgN/h_a	Cumulative daily total above ground N (crop N uptake including grain)
GrainN	kgN/h_a	Cumulative daily grain N
NNI	dimensionless	Nitrogen nutrition index
GDW	mg DM/grain	Cumulative (from anthesis) daily single grain dry mass
GNC	mg N/grain	Cumulative (from anthesis) daily single grain nitrogen
totalleaf wt	kDM/h_a	Cumulative total (green + dead) leaf dry mass
leaf wt	kDM/h_a	Cumulative green leaf dry mass
stem wt	kDM/h_a	Cumulative stem (true stem + leaf sheath) dry mass
chaff wt	kDM/h_a	Final chaff dry mass
straw wt	kDM/h_a	Final straw dry mass
crown wt	kDM/h_a	cumulative crown dry mass
totalleaf N	kgN/h_a	Cumulative total (green + dead) leafN
leaf N	kgN/h_a	Cumulative green leaf N
stem N	kgN/h_a	Cumulative stem (true stem + leaf sheath) N
chaff N	kgN/h_a	Final chaff N
straw N	kgN/h_a	Final straw N
SLW	gDM/m^2 leaf	Specific green leaf weight
SLN	gN/m^2 leaf	Specific green leaf N content
Emergence date	YYYYMMDD	Crop emergence date – Zadoks 10
Emergence doy	DOY	Crop emergence date – Zadoks 10 (Day of Year)
Ant date	YYYYMMDD	Anthesis Date – Zadoks 65
Ant doy	DOY	Anthesis Date – Zadoks 65 (Day of Year)
Mat date	YYYYMMDD	Physiological maturity date (YYYYMMDD)
Mat doy	DOY	Physiological maturity Date – Zadoks 89 (Day of Year)
da	days	Days from sowing to anthesis
ea	days	Days from crop emergence to anthesis
egdf	days	Days for anthesis to physiological maturity
FLN	Leaf/main stem	Final leaf number per main stem
GNumber	grains/m^2	Grain number
GPC	% of grain dry mass	Final grain protein concentration
stem density	stems/m^2	Number of stems per square meter
stems pl	stems/plant	Number of stems per plant
NGE	grains/ear	Number of grain per ear
NEM2	ear/m^2	Number of ears per square meter
Tas	°C	Mean of average daily temperature between planting and anthesis
Tea	°C	Mean of average daily temperature between emergence and anthesis
Taegf	°C	Mean of average daily temperature between anthesis and physiological maturity
Tasgf	°C	Mean of average daily temperature between planting and physiological maturity
Teagf	°C	Mean of average daily temperature between emergence and physiological maturity
HIarea	Haun Index	Haun Index
Canopy height	m	Canopy height

Database made available for modeling exercises

Carpe Diem