

## Screening Ornamental Pepper Cultivars for Heat Tolerance by *in-vitro* Pollen Germination, Pollen Tube Length and Physiological Parameters

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## Presentation Outline

- ✓ Introduction and Rationale
- ✓ Objectives
- ✓ Materials and Methods
- ✓ Results
- ✓ Conclusions

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## Introduction and Rationale

- Ornamental peppers (*Capsicum annuum* L.) are widely used as a potted flowering or bedding plants.
- Grown primarily for their attractiveness of fruits with foliage.
- Flowers are not fertilized at temperature above 32°C (87°F).
- High temperatures may cause reduction in fruit set and reduces aesthetic and commercial value.
- Changes projected in the future climate will exacerbate the high temperature effects on fruit set.
- It is important to develop new cultivars tolerant to major environmental stress like high temperature.

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## Objectives

- Quantify *in vitro* pollen germination and pollen tube length responses of ornamental pepper cultivars to temperature.
- Determine cultivar-specific cardinal temperatures based on pollen parameters of ornamental peppers.
- Develop correlation between pollen based parameters and physiological parameters for thermotolerance.
- Classify the cultivars for thermotolerance using cardinal temperatures and physiological parameters.

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## Materials and Methods

- Materials:
  - Twelve ornamental pepper cultivars were raised in the greenhouse.(Black Pearl, Chilly Chili, Explosive Ember, Medusa, Purple Flash, Red Missile, Salsa Yellow, Sangria, Thai Hot, Treasures Red, Variegata)
- Growth Conditions:
  - Growth period: May 2009 - July 2009
  - Pot size and media: 1 L plastic pots and PROMIX as rooting media
  - Irrigation and fertilization: Manually (Twice daily)
  - Temperature: 28 ± 4°C
  - Flowers collection: Between 09:00 and 10:00 h



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## Materials and Methods

### Measurements:

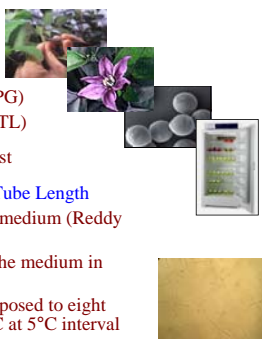
- Physiological parameters
  - Cell membrane thermostability (CMT) (Martineau et al. 1979)
$$CMT(\%) = [1 - (TEC1/TEC2)] / [1 - (CEC1/CEC2)] \times 100$$
  - Chlorophyll stability index (CSI) (Murty and Majumdar, 1962)
$$CSI(\%) = \frac{\text{Total chlorophyll content (heated)}}{\text{Total chlorophyll content (control)}} \times 100$$
  - Canopy temperature depression (CTD) (Amani et al. 1996)
$$CTD = T_a - T_c$$

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### Materials and Methods

**Measurements**

- **Reproductive Parameters**
  - Pollen viability
  - *in-vitro* pollen germination (PG)
  - *in-vitro* pollen tube length (PTL)
- ✓ **Pollen Viability - Tetrazolium test**
- ✓ **Pollen Germination and Pollen Tube Length**
  - Modified pollen germination medium (Reddy and Kakani, 2007)
  - Pollens were spreaded on to the medium in Petri-dishes
  - Pollens were cultured and exposed to eight temperatures from 10 to 40°C at 5°C interval



### Materials and Methods

- **Curve fitting and analysis**
  - Bilinear and quadratic regression models were used to analyze the data on pollen germination and tube length
- **Cardinal temperature**
  - Cardinal (Minimum, optimum and maximum) temperatures were derived from the models.
- **Ornamental pepper cultivars were classified for temperature tolerance based on following parameters:**

1. Pollen viability (%)	4. Cell membrane thermostability
2. Maximum pollen germination (%)	5. Chlorophyll stability index
3. Maximum pollen tube length	6. Canopy temperature depression
7. Cardinal temperatures ( $T_{min}$ , $T_{opt}$ , $T_{max}$ ) for both PG and PTL	

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### Materials and Methods

✓ Individual stress response indices (ISRI) and then cumulative temperature response indices (CTRI) were calculated based on 12 parameters

$$ISRI = P_t / P_h$$

$$CTRI = \left( \frac{PV\%_{t_i} + PG\%_{t_i} + PTL_{t_i} + PG_{min_{t_i}} + PG_{opt_{t_i}} + PG_{max_{t_i}}}{PV\%_{h_i} + PG\%_{h_i} + PTL_{h_i} + PG_{min_{h_i}} + PG_{opt_{h_i}} + PG_{max_{h_i}}} + \frac{PTL_{min_{t_i}} + PTL_{opt_{t_i}} + PTL_{max_{t_i}} + CMT_{t_i} + CTD_{t_i} + \left( \frac{CSI_{t_i}}{CSI_{h_i}} \right)^{-1}}{PTL_{min_{h_i}} + PTL_{opt_{h_i}} + PTL_{max_{h_i}} + CMT_{h_i} + CTD_{h_i} + \left( \frac{CSI_{h_i}}{CSI_{h_i}} \right)^{-1}} \right)^{-1}$$

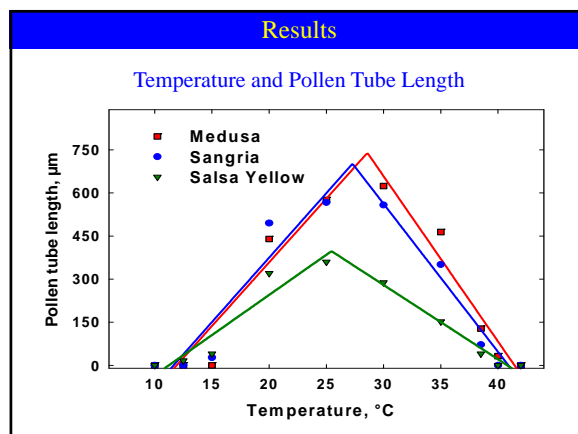
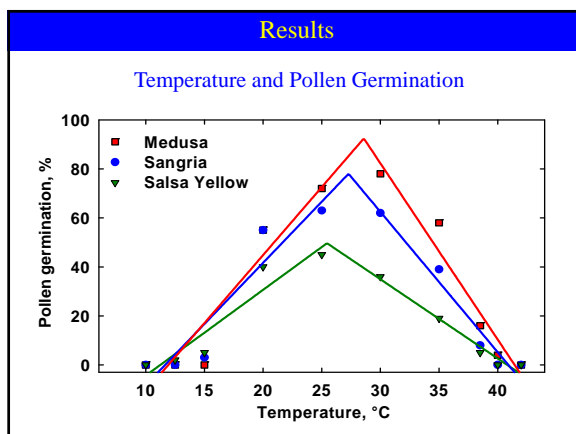
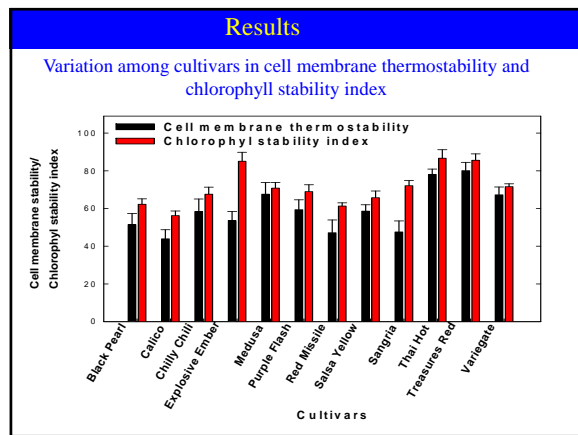
✓ Classification of cultivars for thermotolerance based on CTRI

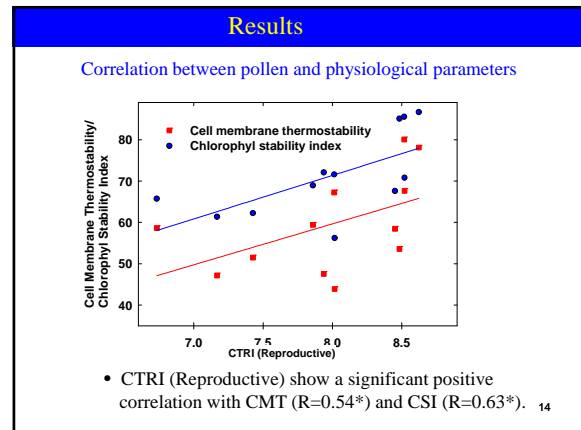
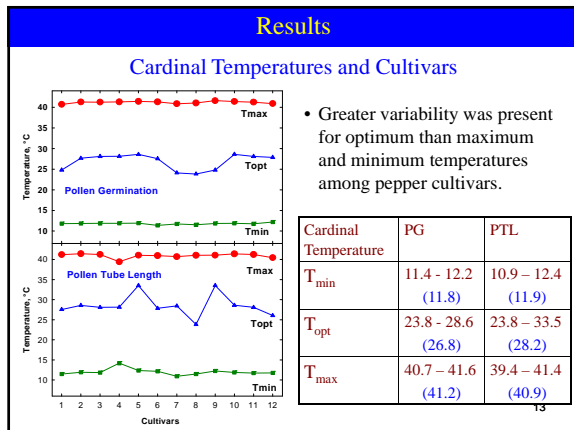
Sensitive: > Minimum CTRI + 1.5 stdev and < minimum CTRI + 2.5 stdev

Intermediate: > Minimum CTRI + 2.5 stdev and < minimum CTRI + 2.5 stdev

Tolerant: > Minimum CTRI + 2.5 stdev

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### Results

#### Classification of Cultivars Based on CTRI

Sensitive (CTRI < 9.74)	Intermediate (CTRI = 9.74 - 10.57)	Heat Tolerant (CTRI > 10.57)
Black Pearl (9.33)	Calico (9.84)	Thai Hot (11.33)
Red Missile (9.08)	Explosive Ember (10.75)	Treasures Red (11.19)
Salsa Yellow (8.56)	Purple Flash (10.04)	Medusa (11.18)
	Sangria (9.89)	Chilly Chilli (10.57)
	Variegata (10.32)	

*Heat tolerance* →

### Conclusions

- ✓ Both physiological (Cell membrane thermostability and chlorophyll stability index) and pollen parameters seems to be useful to screen ornamental pepper cultivars for thermotolerance.
- ✓ Even though significant correlation exists between physiological and pollen-based parameters ( $r = 0.54^*$  and  $r = 0.63^*$ ), screening based on pollen would yield better results for reproductive tolerance.
- ✓ The identified heat tolerant cultivars are potential candidates for ornamental pepper breeding programs and in selecting cultivars for a niche environment. 16

### References

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### Acknowledgements

Dr. Frank Matta  
Dr. Meng Meng Gu  
Dr. S. Singh  
Mr. Ramdeo Seepaul  
Mr. Suresh Lokhande  
Ms. Dinum Perera

**Questions?**

## Acknowledgements



Calico – Purple flash

Dr. Frank Matta  
Dr. Meng Meng Gu  
Dr. S. Singh  
Mr. Ramdeo Seepaul  
Mr. Suresh Lokhande  
Ms. Dinum Perera



*Questions?*